R.A.F. FORM 2190

A.P.1095A
Volume I

ELECTRICAL EQUIPMENT MANUAL
GENERAL (AIRBORNE)

Prepared by direction of the Minister of Aircraft Production

Promulgated by order of the Air Council

AIR MINISTRY

M38665 10/43

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GENERAL CONTENTS LIST

Note :—**A detailed contents** list appears at the beginning of each chapter.

AMENDMENT RECORD SHEET

Incorporation of an Amendment List in this document should be recorded by inserting the amendment list number, signing the appropriate column, and inserting the date of making the amendment.

A.L. No.	Amendments made by	Date
6 (SEC I)	C. C. Donkin P/O.	NOV 1943
70 (SEC I)	C. C. Donkin P/O.	AUG 1945
31 (SEC 2)	C. C. Donkin P/O	DEC 1943
34 (SEC 2)	C. C. Donkin P/O.	JAN 1944.
62 (SEC 2)	C. C. Donkin P/O.	JUN 1945
86 (SEC 2)	C. C. Donkin P/O	JAN '1947

AMENDMENT RECORD CONTINUATION SHEET.

A.L. No.	*Amendments made by*	*Date*
16 (SEC 3)	C. C. Donkin P/O.	JUN 47
1 (SEC 4)	C. C. Donkin P/O.	OCT 43.
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38 (SEC 3)	C. C. Donkin P/O	FEB 44
40 (SEC 4)	C. C. Donkin P/O.	APR. 44
43	C. C. Donkin P/O.	JUN 47
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48 (SEC 3)	C. C. Donkin P/O.	SEP 44
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77 (SEC 6)	C. C. Donkin P/O	OCT 45
80 (SEC 7)	C. C. Donkin P/O	JAN 46.

A.L. No.	Amendments made by	Date
83 (SEC 3)	C. C. Donkin P/O	MAY 46.
84 (SEC 2)	C. C. Donkin P/O	JAN 47.

* An Amendment Record Continuation Sheet (R.A.F. Form 2094A), obtainable from A.P.F.S., Kensington, will be required when this page is full. Order it now.

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Air Ministry Orders and Volume II Leaflets as issued from time to time will affect the subject matter of this publication. It should be understood that Amendment Lists are not always issued to bring the publication into line with the Order or Leaflets and it is for holders of this book to arrange the necessary linking-up.

Where an Order or Leaflet contradicts any portion of this publication an Amendment List will generally be issued, but when this is not done the Order or Leaflet must be taken as the overriding authority.

Where amendment action has taken place by the insertion of leaves, the number of the Amendment List concerned will be found on the top of each page affected, and amendments of technical importance will be indicated by a vertical line in the outer margin of the page against the matter amended or added. Vertical lines relating to previous amendments to a page will not be repeated. They will not be employed when amendment action is effected by gummed slips, nor will they be employed when any complete revision of any division of the book (e.g. a chapter) is made, as this will be indicated in the title page for that division.

PREFACE

Owing to the increasing size of the Electrical Equipment Manual and to the fact that it contains information intended for personnel other than Electricians, A.P.1095 has been sub-divided into a number of separate Air Publications, those affecting Electricians having 1095 as their basic A.P. number and each distinguished by a different suffix letter, while chapters affecting Signals and R.D.F. personnel will be re-issued as A.P.1186D (Royal Air Force Signal Manual, Part IV, Electrical Equipment (Airborne)), and A.P.1186E (Royal Air Force Signal Manual, Part IV, Electrical Equipment (Ground)), as appropriate. The A.P. numbers and titles of the new publications are as follows:—

A.P. No.	*Title.*
1095A	— Electrical Equipment Manual, General (Airborne).
1095B	— Electrical Equipment Manual, Armament.
1095C	— Electrical Equipment Manual, Power Services (Airborne).
1095D	— To be issued later.
1095E	— To be issued later
1095F	— Electrical Equipment Manual, American Aircraft.
1095G	— Electrical Equipment Manual, Ground.
1095H	— Electrical Equipment Manual, Meters and Testing Apparatus.
1095J	— To be issued later.
1095K	— To be issued later.
1095L	— To be issued later.
1095M	— Electrical Equipment Manual, Marine Craft.
1186D	— Royal Air Force Signal Manual, Part IV—Electrical Equipment (Airborne).
1186E	— Royal Air Force Signal Manual, Part IV—Electrical Equipment (Ground).

The chapters of A.P.1095, Vol. I, dealing with obsolete equipment will be cancelled and the remaining chapters, after having been reviewed and brought up to date, will be incorporated, by amendment list action, in Air Publications 1095A–1095M, 1186D and 1186E, Vols. I, as appropriate. Simultaneously, Amendment Lists will be issued cancelling the corresponding old chapters of A.P.1095, Vol. I. A table showing the old section and chapter numbers of A.P.1095, Vol. I, and the position of each of these chapters in the new Air Publications is included in this manual.

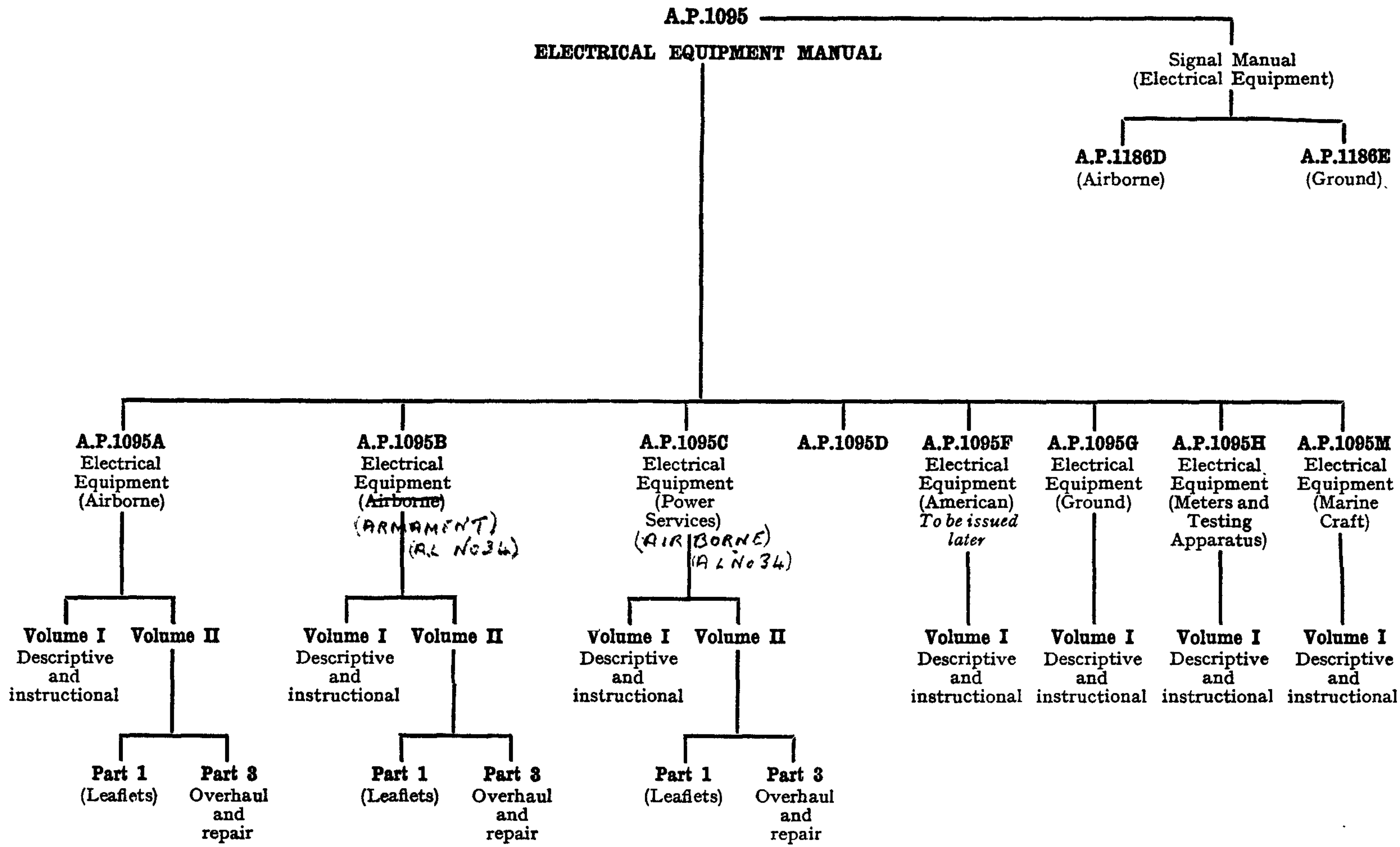
A.P.1095
ELECTRICAL EQUIPMENT MANUAL
Signal Manual (Electrical Equipment)
A.P.1186D (Airborne)
A.P.1186E (Ground)
A.P.1095A Electrical Equipment (Airborne)
Volume I Descriptive and instructional
Volume II
Part 1 (Leaflets)
Part 3 Overhaul and repair
A.P.1095B Electrical Equipment (~~Airborne~~)
(ARMAMENT) (A.L No34)
Volume I Descriptive and instructional
Volume II
Part 1 (Leaflets)
Part 3 Overhaul and repair
A.P.1095C Electrical Equipment (Power Services)
(AIRBORNE) (A L No 34)
Volume I Descriptive and instructional
Volume II
Part 1 (Leaflets)
Part 3 Overhaul and repair
A.P.1095D
A.P.1095F Electrical Equipment (American) *To be issued later*
Volume I Descriptive and instructional
A.P.1095G Electrical Equipment (Ground)
Volume I Descriptive and instructional
A.P.1095H Electrical Equipment (Meters and Testing Apparatus)
Volume I Descriptive and instructional
A.P.1095M Electrical Equipment (Marine Craft)
Volume I Descriptive and instructional

TABLE I

This table giving corresponding section and chapter numbers in old and new volumes is provided for information only.

A.P.1095		New Volume		
Section	Chapter	A.P.	Section	Chapter
I	1, 6	1095C	1	1
	2	1095C	1	2
	3	1095C	1	2
	4	1095C	1	3
	5	Delete	–	–
II	1 and 2	Delete	–	–
	3	1095G	4	4
III	1	1095A	3	1
	2	1095A	3	2
	3	1095A	3	3
	4	1095A	3	4
	5	1095A	3	5
	6	1095A	3	6
	7	1095A	3	7
IV	1	1095A	4	1
	2	1095A	4	2
	3	1095A	4	3
V	1	1095C	5	1
	2, 3, 4, 5, 6, 7	Delete	–	–
	8	1095C	5	2
	9	1095C	5	3
	10	1095C	6	1
	11	1095A	5	2
	12	1095C	6	2
	13	1095H	4	1
	14	1095H	4	3
	15	1095H	4	2
	16	1095C	5	5
	17	1186D	2	3
	18	1095C	5	6
	19	1095C	5	7
	20	1095C	5	8
	21	1186D	2	1
	22	1095C	6	2
	23	1186D	2	3
	24	1186D	1	1
	25	1186D	2	1
	26	1095C	5	3
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VI	1	1095H	1	1
	2	1095H	1	2
	3	1095H	1	1

A.P.1095		New Volume		
Section	Chapter	A.P.	Section	Chapter
VI (*contd.*)	4	1095H	3	1
	5	1095H	3	2
	6	1095H	1	1
	7	1095H	2	4
	8	1095H	2	5
	9	1095H	2	1
	10	1095H	5	1
	11	1095H	5	2
	12	1095H	5	3
	13	1095H	5	4
VII	1	1095A	7	1
	2	1095A	7	2
	3	1095A	7	3
	4	1095A	7	1
	5	Delete	–	–
	6	1095A	7	1
	7	1095A	7	5
	8	1095A	7	6
	9	1095A	7	7
	10	1095C	7	1
	11	1186D	5	1
	12	1095A	2	1
	13	1095A	1	1
	14	1095A	1	2
	15	1095B	2	1
	16	1095B	2	2
	17	1095B	2	3 and 5
	18	1095B	2	7
	19	1095A	7	1
	20	1095A	3	10
	21	1095A	7	4
	22	1186D	5	2
	23	1095A	2	3
	24	1095C	7	2
	25	1186D	4	1
	26	1095A	7	8
	27	1186D	6	1
VIII	1	1095A	8	1
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	3	1095A	8	2
	4	1095A	8	3
	5	1095A	8	4
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	8	1095G	5	2
	9	1095G	5	3
	10	1095A	8	9
	11	1095A	8	10
	12	1095A	8	11
	13	1095A	8	12
IX	1	1095B	4	1
	2 and 3	Not yet issued	–	–
	4	1095B	4	3
	5	1095B	4	4

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A.P.1095		New Volume		
Section	Chapter	A.P.	Section	Chapter
X	1	1095B	3	1
	2	1095B	3	2
	3	1095B	3	3
	4	1095B	3	4
	5	1095B	3	5
	6	1095B	3	6
XI	1	1095B	1	1
	2 (to be issued later)	1095B	1	3
	3	1095B	1	2
XII	1	1095A	1	3
	2	1095A	5	1
	3	1095A	6	1
XIII	1	1095C	2	1
	2	1095C	2	2
	3	1095C	2	3
	4	1095C	2	4
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XIV	1	1186D	3	1
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	4	1186D	3	4
	5	1186D	3	5
	6	1186D	3	6

LIST OF SECTIONS

Note:—A list of Chapters appears at the beginning of each Section

SECTION 1

INDICATORS

LIST OF CHAPTERS

Note:—A List of Contents appears at the beginning of each Chapter

CHAPTER 1

INDICATION AND WARNING LIGHTS FOR DROGUE CONTROL

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LIST OF ILLUSTRATIONS

Introduction

1. This signalling system has been designed mainly for flying boats to provide the means of communicating control instructions for drogues between the pilot and his crew. It enables the pilot to signal and the crew to acknowledge, by means of visual lamp indications, release and tipping instructions relative to drogues.

2. The apparatus comprising this signalling system has been designed to operate on either a 12 or 24-volt supply. The fitments and instruments, containing the indicating lamps and necessary control gear, are constructed of black moulded waterproof cases with enclosed terminals and cable glands suitable for use in flying boats. Multiple conductor "cel" or waterproof cable is most generally used for all external connections, such cables forming part of the general cabling system of the aircraft. The appropriate aircraft wiring diagram should be seen for the actual connections. Drogue control makes use of a persistent light indication which may be flashed out, if desired, in a pre-arranged code.

Types available

3. Particulars of the drogue control signalling system available are as follows:—

Part	*Type or mark*	*Stores Ref.*	*No. or quantity required*	*Weight*
Box selector	—	5C/778	1	9½ oz.
Box receiver	—	5C/779	2	8 oz.
Box receiver	-	5C/781	1	3½ oz.

Lamps, which are supplied separately, are as follows:—

For a 12-volt system, 2·4-W (Stores Ref. 5L/1319).
For a 24-volt system, 3·0-W (Stores Ref. 5L/1928).

Part	*Stores Ref. of apparatus*	*No. of lamps required*
Box selector	5C/778	3
Box receiver	5C/779	3
Box receiver	5C/781	1

DESCRIPTION

4. The apparatus consists of a box selector for the pilot, illustrated at A in fig. 1, two box receivers, one for each drogue station, one of which is illustrated at B in fig. 1, and a box receiver for the crew quarters, illustrated at C in fig. 1. The box selector is made up in a box of black moulded material. The box and equipment have dimensions of about 3½ in. × 4 in. × 2 in. overall depth. A removable panel at the back gives access to the interior. Two panels on the front are removable. The upper panel carries three coloured lenses, that on the left-hand being coloured red, the right-hand green and the centre one clear. The lower panel acts as a cover for the terminal block moulded into the lower portion of the box, and the push button of a push switch protrudes through this panel. The fixed centre panel carries three switches and in the upper portion of the box are moulded housings for three lamp-holders. Two cable glands are moulded in to the bottom of the box. All panel joints have rubber gaskets cemented in to render these joints water-proof. Two holes passing through the box moulding provide for screws to fix the selector to the aircraft. Internal wiring is shown in the complete wiring diagram, fig. 2.

5. The drogue station box receiver, B in fig. 1, is made up in a box of black moulded material. Box and equipment have dimensions of about 3½ in. × 3½ in. × 2 in. overall depth. A removable panel at the back gives access to the interior. Two panels on the front are removable. The upper one carries three lenses, red, clear, and green, placed as in the box selector. The lower panel acts as a cover for the terminal block moulded into the lower portion of the block, and the push button of the push switch protrudes through this panel. In the upper portion of the box are moulded housings for three lamp-holders. Two cable glands are moulded into the bottom side of the box. All panel joints have rubber gaskets cemented in to render these joints waterproof. Two holes, through the box moulding, provide for screws to fix the receiver to the aircraft. Internal wiring is as shown in the complete wiring diagram, fig. 2. If only one drogue station exists, as is sometimes the case, the connection shown dotted must be made. If two drogue stations exist and are equipped, this connection is made in the second drogue station box receiver only.

6. The crew quarters box receiver, C in fig. 1, is made up in a circular box of black moulded material. Box and equipment have dimensions of about 1½ in. diameter (2 in. over cable glands) by 1½ in. overall depth. A removable panel at the back gives access to the interior. A circular panel, which screws on to the front, carries a clear lens. A moulded housing is provided in the centre for a lamp-holder. Two cable glands are moulded into the box. All panel joints have rubber gaskets cemented in to render these joints waterproof. Two holes passing through the box moulding provide for screws to fix the receiver to the aircraft. Internal wiring is as shown in the complete wiring diagram, fig. 2.

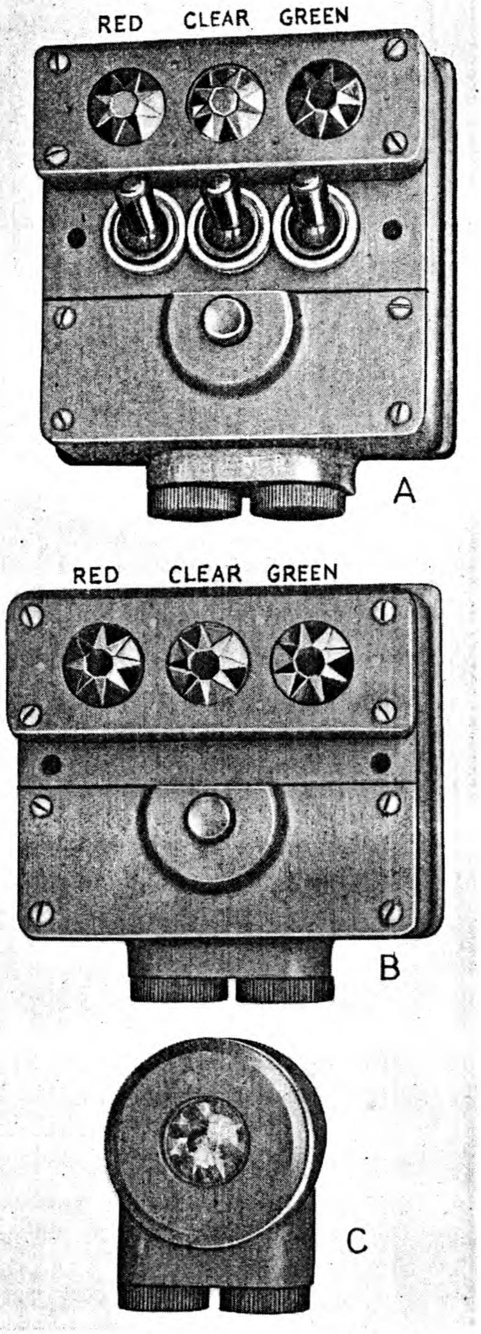

Fig. 1.—Indication and warning lights for drogue control

A. Box selector for pilot (Stores Ref. 5C/778)
B. Box receiver for drogue station (Stores Ref. 5C/779)
C. Box receiver for crew quarters (Stores Ref. 5C/781)

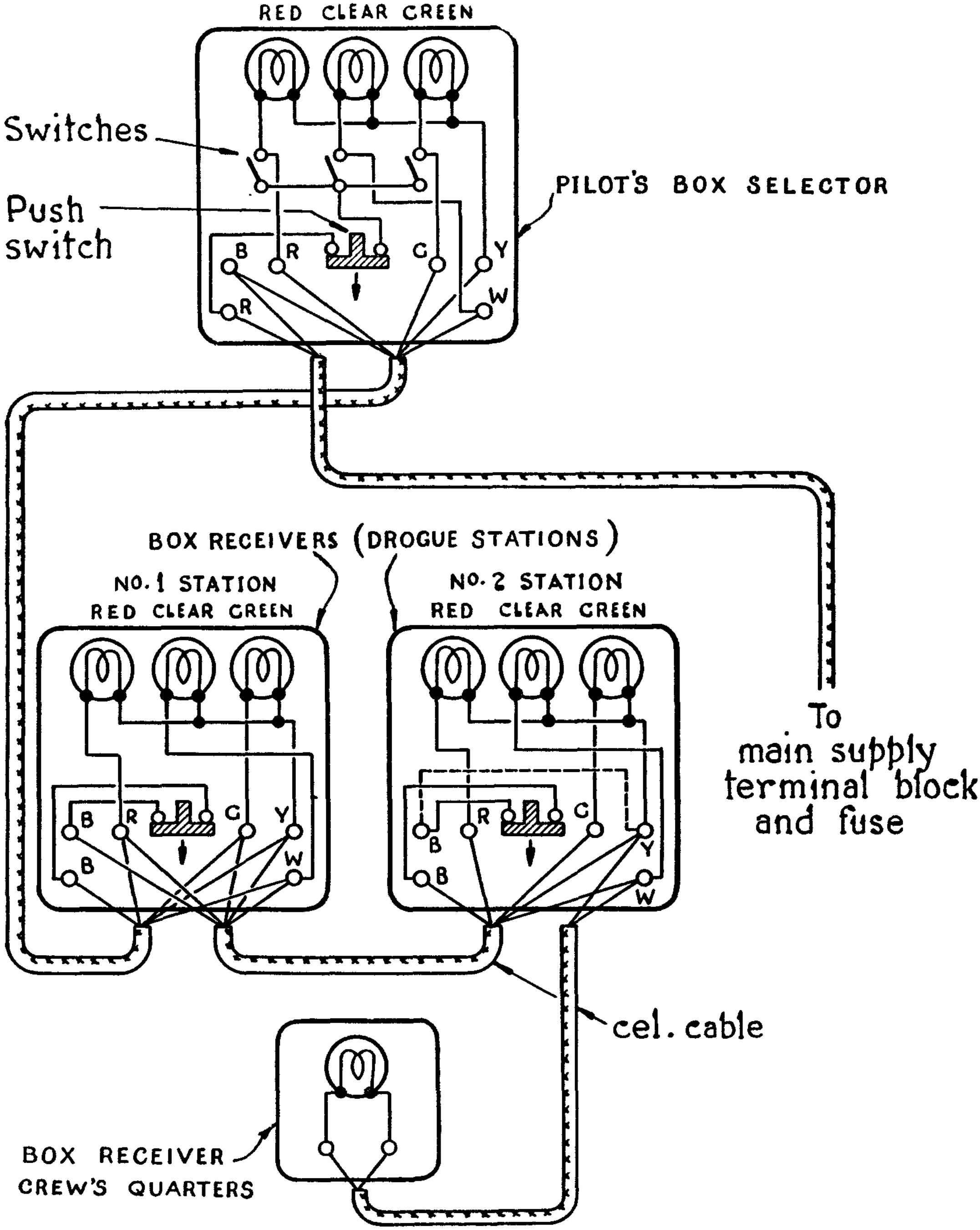

Fig. 2.—Wiring diagram of drogue control lights

OPERATION

7. When it is necessary to release a drogue, this signalling system can be used in the following typical manner. The pilot calls the crew to stations by switching on the centre, call, or white-light switch on the selector box, fixed in a convenient position beside him. He then depresses the push-button immediately below the call or white-light switch thus flashing out the call or white lights on each of the drogue position receivers, as well as the call or white light on the crew quarters receiver, and his own call or white light on the selector box. The crew, taking stations, reply by pushing the push-button on the receivers in their respective drogue positions. This flashes out the call or white lights at all stations including the pilot's selector. When the pilot wishes to give the signal for the actual release of, say, the port drogue, he pushes down the switch controlling the red lights on his selector panel. This lights the red light on each drogue station receiver as well as the red light on the pilot's selector. In a similar way he can indicate that the starboard drogue is to be released by operating the switch controlling the green light. The crew, having released the drogue or drogues, in response to the pilot's signal, can indicate such release to the pilot by pushing the push-button on their respective receiver, thus flashing the appropriate red or green light on the pilot's selector, as well as those on the drogue position receivers. All such flashing can be to a pre-arranged code as desired. Simplified electrical diagrams (fig. 3 and 4) explain how the drogue control switching operates.

INSTALLATION

8. The positions occupied by the selector and receiver will depend upon the particular aircraft. The selector is situated at the pilot's position, the two receivers in their respective stations and the single (white) light receiver in the crew's quarters. External connections are made by multi-core cables which form part of the aircraft wiring system and that portion directly concerned with drogue control is shown in the wiring diagram, fig. 2. The respective cable cores must be connected to the respectively marked terminals of the apparatus, colour for colour. The connection in the internal wiring of the receiver shown dotted in fig. 2 and referred to in para. 5 should be checked, to ensure that it is correct for the particular installation. Connections from the main supply of the aircraft is brought through a 5-ampere fuse and terminal block which forms part of the aircraft wiring equipment.

SERVICING

9. Periodical testing of the operation of the system should be a matter of routine. Vibration may tend, after some time in service, to loosen the lamps in their screw holders causing apparent lamp failure. Lamps should be inspected regularly, tightened up where necessary, and, where these are burnt out or broken, renewals should be made. The terminals should be tightened, and in operation there should be no flickering after the operation of the switch. Push buttons must be free and easy but definite in action.

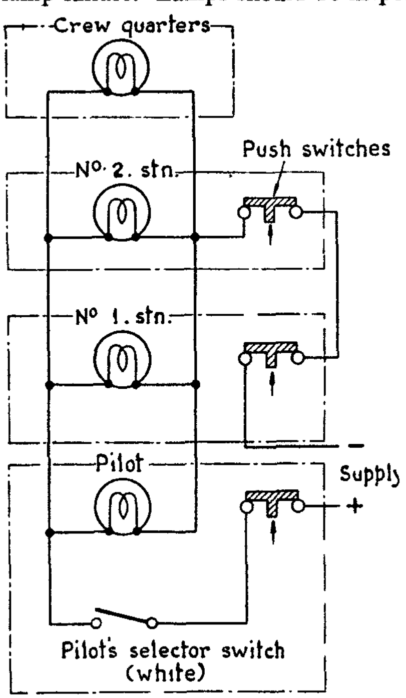

Fig. 3.—Diagram showing operation of white call lights

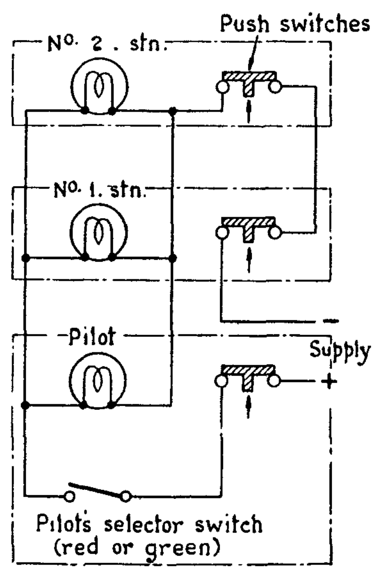

Fig. 4.—Diagram showing operation of red (port) and green (starboard) lights

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CHAPTER 2

INTERCOMMUNICATION SIGNALLING

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LIST OF ILLUSTRATIONS

Chapter 2
Intercommunication Signalling

Introduction

1. This signalling system, which is suitable for all aircraft, provides intercommunication by means of visual lamp indications by using a pre-arranged code. This enables the pilot to indicate, for example, to any member of the crew that he is required to put on his helmet for telephonic intercommunication.

2. The apparatus comprising this signalling system has been designed to operate on either a 12 or 24-volt supply. The instruments, containing the indicating lamps and the control button, have black moulded waterproof cases fitted with enclosed terminals and cable glands suitable for use in flying boats. Multiple conductor "cel" waterproof cable is used for all external connections, forming part of the general cabling system of the aircraft. For the actual wiring the appropriate aircraft wiring diagram should be consulted. The system makes use of a light indication which is normally out and is flashed on, using a pre-arranged code if desired.

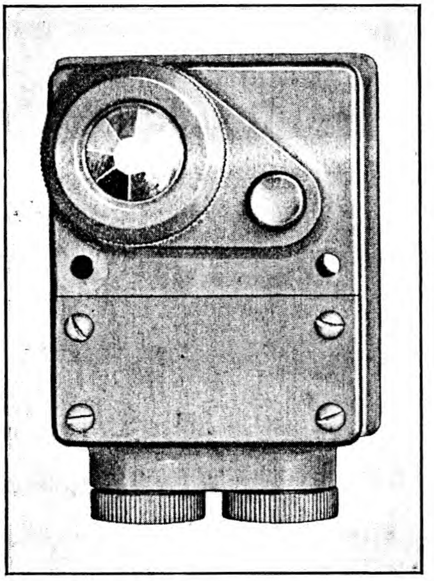

Fig. 1.—Receiver box

Types available

3. The equipment available consists of a receiver box and a lamp: one receiver box with its associated lamp is required for each station. The official nomenclature of the receiver box is lamp, intercommunication and warning, receiver box, 1 unit (Stores Ref. 5C/780), and the filament lamp required for a 12-volt circuit is of 2·4 watts rating (Stores Ref. 5L/1319). For 24 volts a 3-watt lamp (Stores Ref. 5L/1928) is used.

DESCRIPTION

4. The apparatus consists of one type of unit only, a receiver box, illustrated in fig. 1. The number of stations at which this unit is fitted will depend upon the particular aircraft. The receiver box is made up in a box of black moulded material. Box and equipment have overall dimensions of about 3½ in. × 4 in. × 2 in. overall depth. The box is moulded to take the lamp, push switch, terminals, fixing screws and the like which make up the receiver. A removable panel at the back gives access to the interior. The upper of the two panels on the front is integrally moulded and carries a screw-on cap housing a clear lens. This panel has the push-button of the push switch passing through it. The lower panel acts as a cover for a terminal block moulded into the lower portion of the box. In the upper portion of the box is moulded a housing for the lamp-holder. Two cable glands are moulded into the bottom side of the box. All panel joints have rubber gaskets cemented in, to render these joints waterproof. Two holes passing through the box moulding provide for wood screws for fixing the receiver to the aircraft. Internal wiring is as shown in the complete wiring diagram, fig. 2.

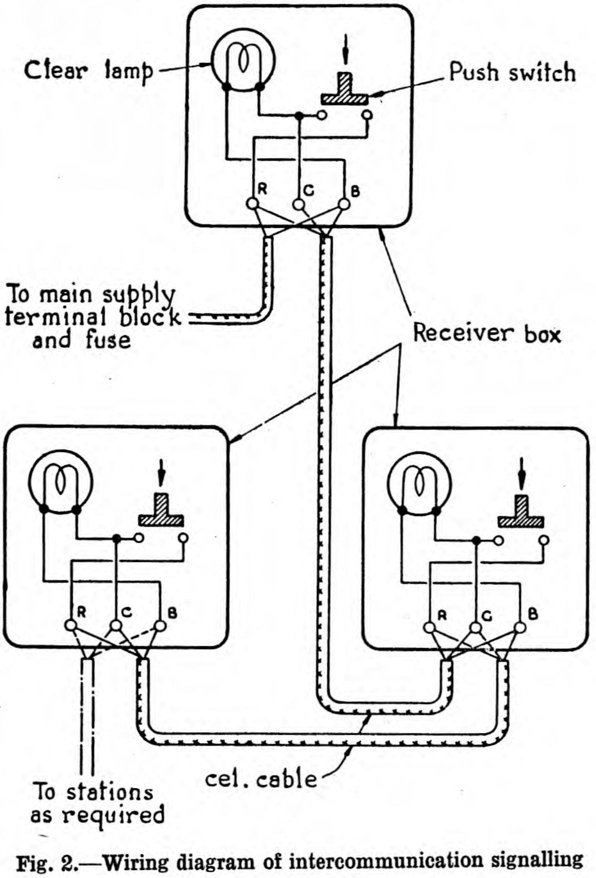

Fig. 2.—Wiring diagram of intercommunication signalling

CHAPTER 4

LAMPS, warning, Types A and B

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LIST OF ILLUSTRATIONS

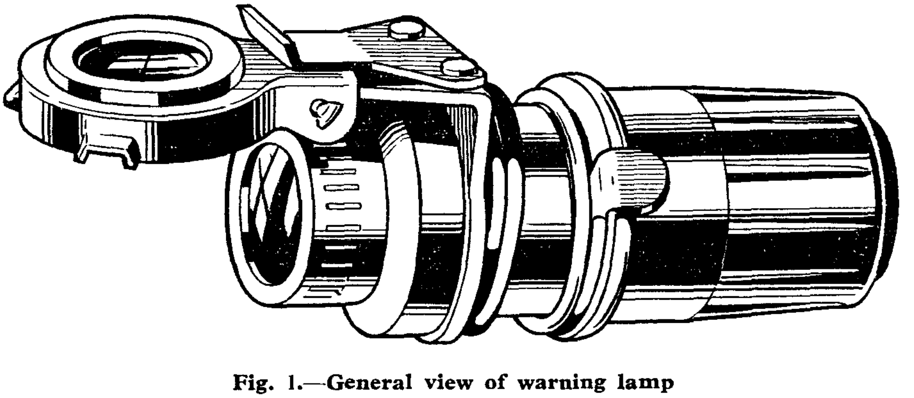

Fig. 1.—General view of warning lamp

CHAPTER 4

LAMPS, warning, Types A and B

Introduction

1. Warning lamps, types A and B are intended for use whenever a general purpose warning lamp is required. They are simple in construction, easily fixed, and can be supplied with clear, green or red glasses. Although similar in design to the type A, the type B incorporates a night screen and is used on night flying aircraft when the lamp is in the pilot's line of vision and visibility would be impaired by the employment of an unscreened light.

Leading particulars

2. The following table gives details of the types of lamp available. It may be found that lamps made by different manufacturers vary somewhat in construction, but the general principle of design is common to all. A typical lamp is described in the following paragraphs.

Type	*Clear Stores Ref.*	*Green Stores Ref.*	*Red Stores Ref.*	*White Stores Ref.*	*Blue Stores Ref.*	*Remarks*
Type A	5C/1556	5C/1635	5C/1069	—	—	Without night screen
Type B	5C/1645	5C/1552	5C/1553	—	—	With night screen
H1102	—	5C/1637	5C/1638	5C 1639	5C/1636	As type A but with flange fixing
H1103	—	5C/1641	5C/1642	5C/1643	5C/1640	As type A but with slot illumination
H1105	—	5C/1647	5C/1648	5C/1649	5C/1646	Flange fixing, slot illumination
H1106	—	5C/1651	5C/1652	5C/1653	5C/1650	Spring fixing, twin slot illumination, flap attachment for night screen
H1107	—	5C/1655	5C/1656	5C/1657	5C/1654	As H1106 but with single slot illumination
H1108	—	5C/1659	5C/1660	5C/1661	5C/1658	Spring, fixing, semi-spherical window
H1109	—	5C/1663	5C/1664	5C/1665	5C/1662	Flange fixing, twin slot illumination

DESCRIPTION

Warning lamp, type A

3. An exploded view of a typical warning lamp is given in fig. 2 and a sectional view in fig. 3. The glass is carried in a metal shroud which is attached to the lamp body by a bayonet fitting. A knurled ring facilitates easy removal and a rubber sealing washer fitted inside the shroud renders the assembly vibration-proof and reasonably waterproof. The body is constructed of moulded

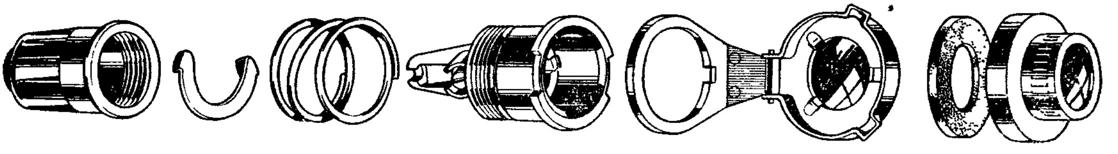

Fig. 2. —Exploded view of warning lamp

insulating material and is flanged and slotted at one end to receive the shroud. This flange also acts as a bearing for the fixing spring which holds the lamp rigidly in position on the dashboard. A groove in the body receives the C washer which locks the fixing spring in position. The C washer itself locked by the moulded terminal cover when it is screwed home on the lamp body. The spring contacts for the lamp are located in slots in the bore of the body, and pass through to the body extension where they are riveted to the brass terminal inserts. The terminals are threaded

6 B.A. and the spring connections to the bulb are of nickel silver. M.E.S. cap filament lamp 12 volt, 2·4 watt, Stores Ref. 5L/1319, or 24 volt, 3 watts, Stores Ref. 5L/1928, should be used with this fitting. A Hellerman sleeve is provided to protect the cable where it enters the terminal cover.

Warning lamp, type B

4. The warning lamp, type B, is exactly as described in the preceding paragraphs, but a snap-hinged night screen, Stores Ref. 5L/2080, which slips over the lamp body and bears against the flanged end is provided. This screen is illustrated in fig. 1 and is shown in the open position; when closed, it folds down over the glass window and obscures the light.

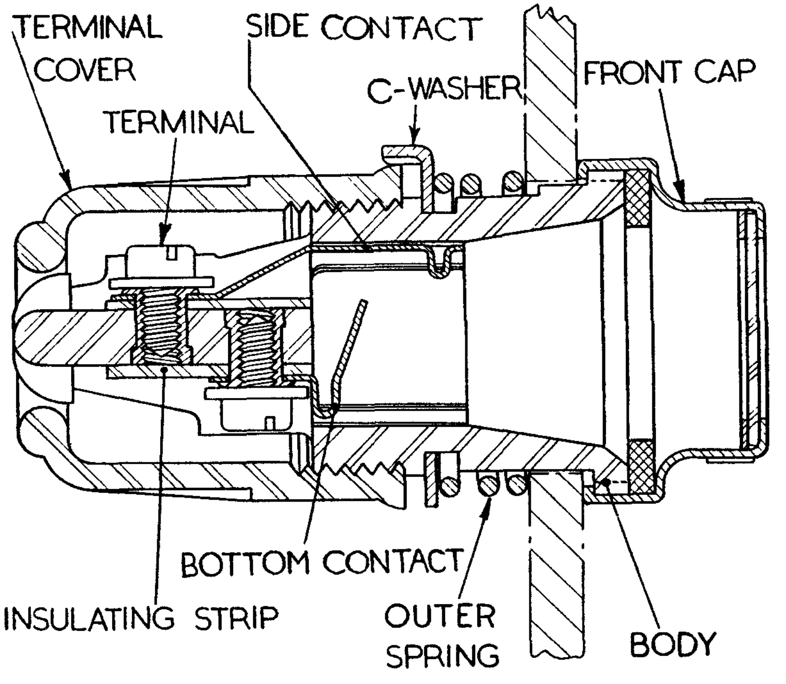

Fig. 3.—Sectional view of warning lamp

SERVICING

5. The terminal connections should be kept clean and tightly screwed home and the cable should be examined periodically at the point of entry for signs of abrasion. The filament lamp must be kept firmly screwed in position, and to avoid failure during operational periods should be renewed when the glass shows signs of discoloration.

P8800 M /G2329 11/45 8500 C & P Gp. 1

CHAPTER 7

UNDERCARRIAGE POSITION INDICATOR (DOWTY TYPE)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The undercarriage indicator described in this chapter is intended to give visual indication of the various positions of the undercarriage. With the undercarriage locked UP, all lights are switched off, with the undercarriage unlocked red warning lights are shown, and with the undercarriage in the DOWN position, green lights are illuminated. An additional set of red lamps, wired in parallel with the primary set, is provided and a combined single and double-pole change-over switch brings into operation a reserve set of green lamps should the normal set fail.

DESCRIPTION

2. The indicator is constructed of moulded resinous material and an exploded view of the unit may be seen in fig. 1. The terminal block is located at the rear of the unit, the terminals being covered by a terminal cover, which is secured by four slotted captive screwdriver nuts. The terminal block is permanently wired to the spring plunger assembly, and both are secured to the instrument case by two retaining screws. The lamps are carried in a removable lamp mounting and they are so disposed that both their centre contacts and the common contact stud press against the spring plunger contacts. The spider, which is an integral part of the dial assembly unit, has webs which locate in the necessary slots in the lamp mounting, thus forming light tight cells. A dimming screen is fitted in the dial assembly. This screen is pierced in the same way as the dial and it can be partly rotated by a control knob. When in the day position, both the dial and screen apertures coincide and the colour screens are fully illuminated, but when turned to the night position, the apertures in the dial are covered by the screen with consequent reduction of the illumination. A bezel ring, which screws on to the front of the case, holds the lamp mounting and dial and spider assembly in position.

INSTALLATION AND OPERATION

3. The indicator is mounted on the pilot's instrument panel, four holes being provided in the moulding for fixing purposes. The undercarriage indicator switch, controlling the unit, is mounted adjacent to the ignition switches. It is fitted with a locking bar in such a manner that the ignition cannot be switched ON until the undercarriage indicator has been switched ON. Conversely, the undercarriage indicator cannot be switched off before the ignition. Incorporated in the undercarriage indicator switch is a change-over switch, which brings into operation a reserve set of green lamps. This unit is fully described in A.P.1095A, Section 7, Chap. 14.

4. Operation of the indicator is by the undercarriage up and down switches, which are depicted in the diagram of connections given in fig. 2. The two up lock switches on each side of the aircraft are used as ON-OFF switches, they are connected in parallel, and remain in the ON position until the undercarriage is locked up; therefore red lights will show until both latches on each undercarriage unit have been locked. Used as two-way switches, the two down lock switches on each side are connected in series and ensure that the green lights for each undercarriage unit cannot indicate until the undercarriage is locked down and both switches have been operated.

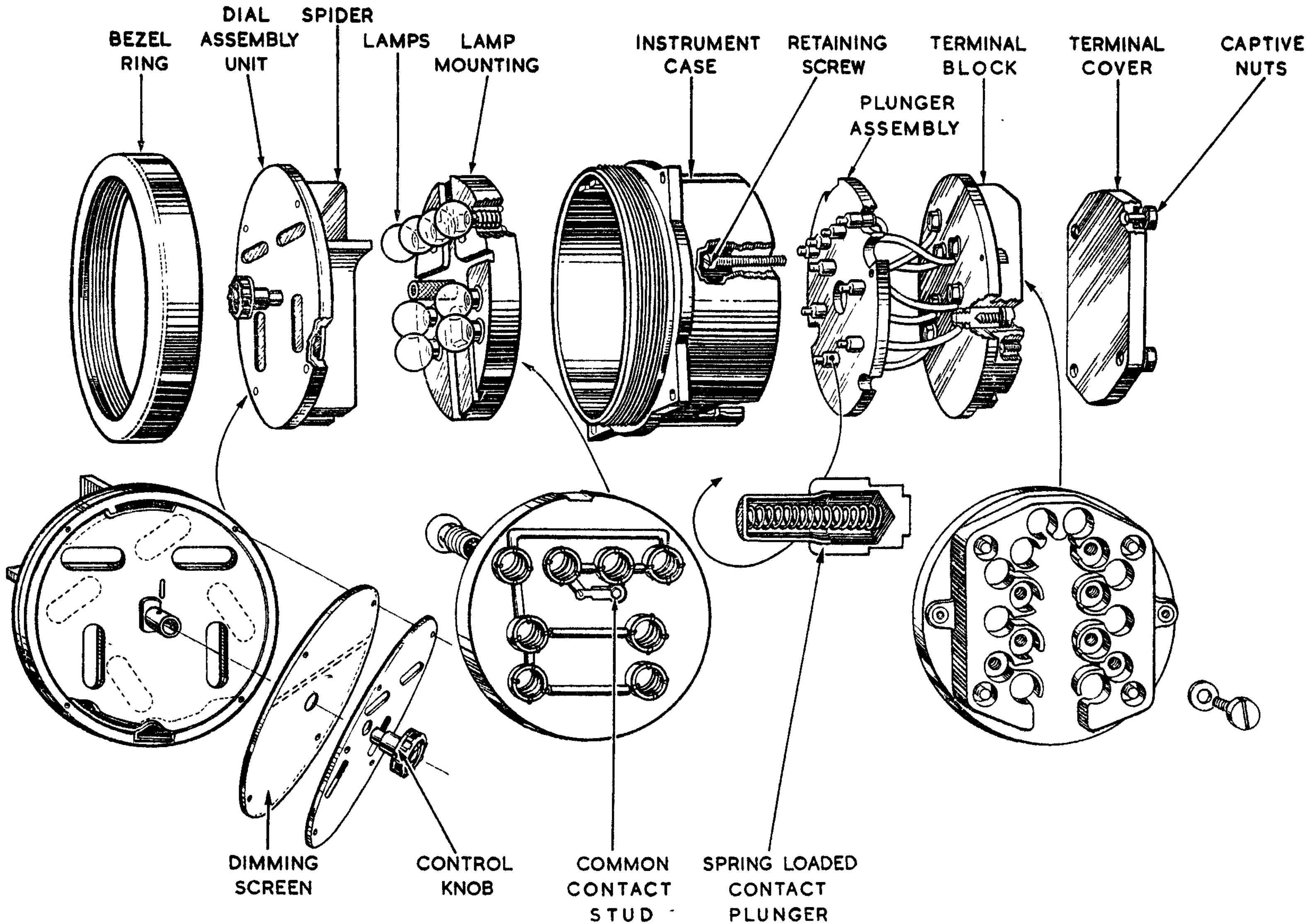

Fig. 1.—Exploded view of indicator

SERVICING

5. Referring again to fig. 1, the spring-loaded plunger contacts are assembled by a spinning operation and cannot be repaired. The contacts are lubricated before delivery and should there be any trouble through sticking, it may be remedied by additional lubrication. Should this treatment prove ineffective the complete plunger assembly must be replaced. No grease or foreign matter, which may set up a high resistance, must be allowed to collect on the tops of the plungers which make contact with the lamps.

6. The wires connecting the terminal block to the contact plungers are looped at the terminal block ends, and the loops are passed over the terminal screws and clamped in position by means of lock-nuts. Removal of the lock-nut will therefore free this end. The other ends of the wire are attached to soldered tags, which are in turn soldered to the contact plunger. In the event of a tag becoming detached, it must be re-positioned and carefully re-soldered. Dry joints are not permissible.

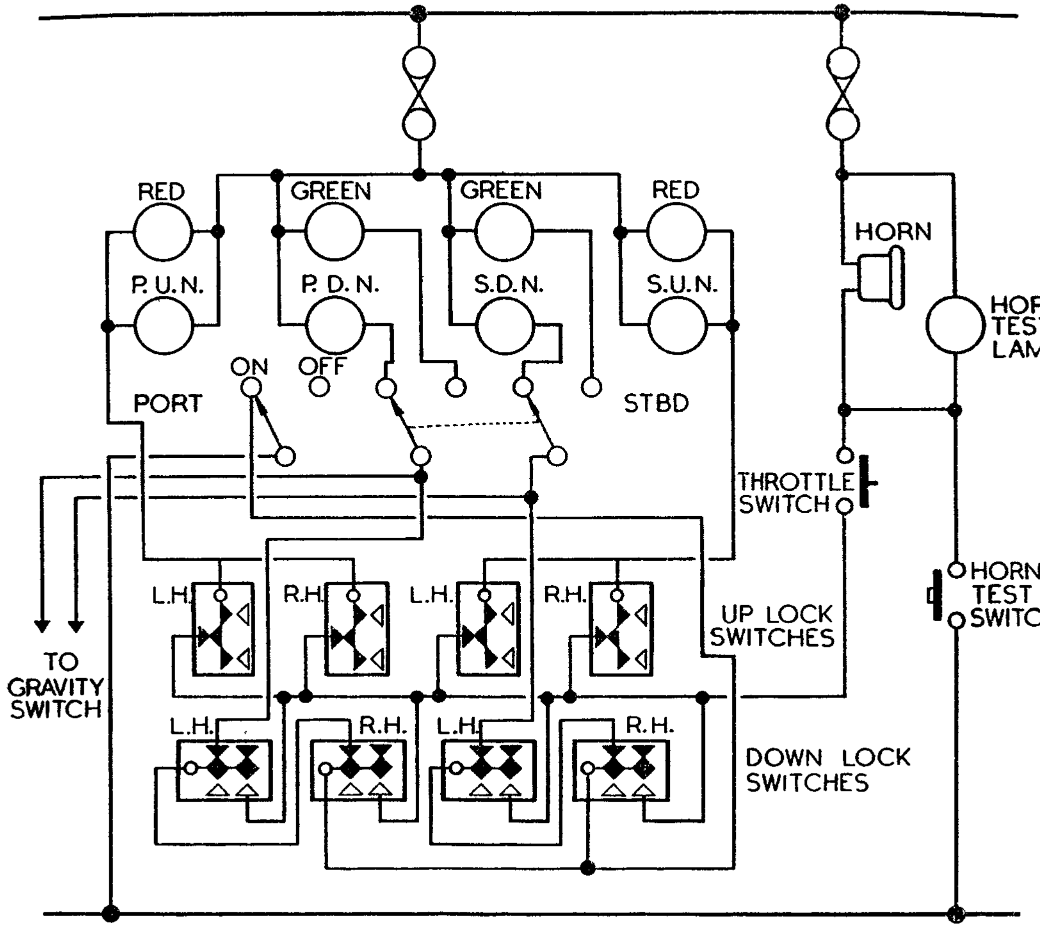

Fig. 2.—Diagram of connections

7. When replacing a defective lamp it will only be necessary to unscrew the bezel ring and withdraw the dial and spider assembly followed by the lamp mounting. It may be found that these portions are withdrawn simultaneously, in which case they may be separated by a gentle pull. To avoid looseness due to vibration or other cause, replacement lamps must be screwed firmly home in their sockets.

8. The terminal cover should always be screwed firmly in position, as it not only affords protection to the terminals but also clamps the cables in position.

9. A groove is provided in the top of the lamp mounting and to avoid incorrect positioning, this groove should clear the two fillets moulded integrally with the case. To ensure correct alignment when returning the dial and spider assemblies to the case, the vertical spider web must pass along the groove formed by the two fillets already referred to. When the bezel ring is screwed home, the lamp mounting is forced rearwards and contact is established between the lamps, contact stud, and spring-loaded plunger; it is important therefore that the bezel be screwed firmly home.

Dismantling

10. To remove the spring contact plunger assembly and terminal block from the case it is only necessary to unscrew the two 6 B.A. screws. The terminal block and contact plunger assembly are withdrawn rearwards. The cover plate may be removed by withdrawing the four fixing screws, thus exposing the terminals and cable leads. To withdraw the dial, spider and lamp mounting assemblies, the instructions given in para. 7 must be carried out.

Re-assembly

11. When replacing the contact plunger assembly plate and the terminal block, they must be returned to the case simultaneously; therefore all connections between the terminals and the plungers must be made before attempting to return the assemblies to the case. The contacts plunger plate can only be returned to the case correctly when the two semi-circular gaps diametrically opposite one another are passed over the two semi-circular lugs which carry the retaining screws. These lugs are an integral part of the case itself. The contact plunger plate must then be partially rotated so as to bring the two 6 B.A. clearance holes in line with the lugs, when the retaining screws may be passed through both plate and lugs and allowed to project to the rear of the inserts. The screws may now be passed through the holes in the terminal block and tightened down, thus clamping the block firmly to the back of the instrument. When performing this operation it must be ascertained that the connection wires do not rub against the screws or damage to the insulation may result.

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SECTION 2

MAGNETIC RELAYS AND SOLENOIDS

LIST OF CHAPTERS

Note.—A list of contents appears at the beginning of each chapter

OPERATION

5. The intercommunication system may be operated in the following typical manner. The pilot pushes the push-button of the receiver box, fixed in a convenient position beside him. A white indicating light appears on all the other receiver boxes fitted in the aircraft. It is necessary to use a pre-arranged code to indicate which station is being called. The member of the crew at the station called puts on his helmet for telephonic communication and can repeat back the call signal by pushing the push-button on the receiver at his station. Telephonic communication then follows. A simplified electrical diagram, fig. 3, explains how the intercommunication switching operates.

INSTALLATION

6. The positions occupied by the receiver boxes will depend upon the particular aircraft. One receiver box is situated at the pilot's position and the others distributed at the various stations on the aircraft to which the pilot wishes to communicate. External connections are made by means of multi-core cables which form part of the aircraft wiring system and that portion directly concerned with intercommunication signalling is shown on the wiring diagram, fig. 2. Connection from the main supply of the aircraft is brought through a fuse and terminal block which form part of the aircraft equipment.

SERVICING

7. Periodical testing of the operation of the system should be a matter of routine. Vibration may tend, after some time in service, to loosen the lamps in their screw holders, thus causing apparent lamp failure. Lamps should be inspected regularly, tightened up where necessary and, if there are burnt-out or broken lamps, renewals should be made. The action of the switches must be definite and there must be no flickering after the operation of the switch. Push-buttons must be free and easy but definite in action.

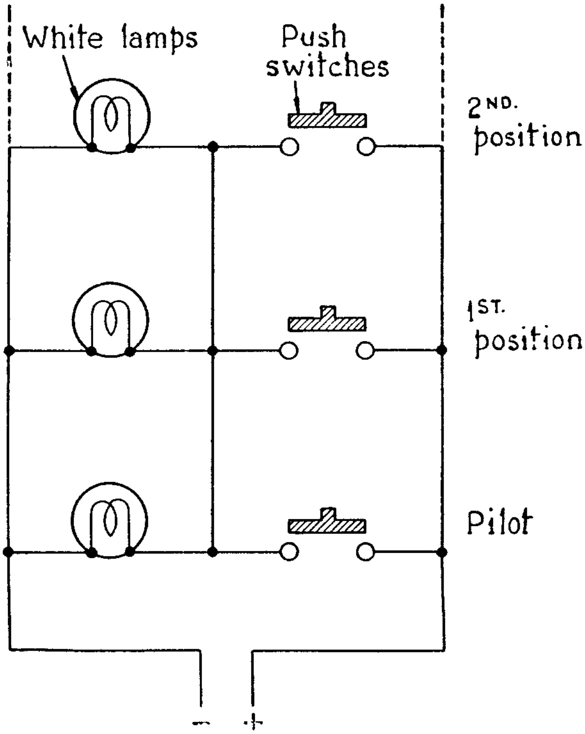

Fig. 3.—Diagram showing operation of intercommunication call-lights

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This chapter issued with A.L. No. 31
December, 1943

CHAPTER 1

MAGNETIC RELAY SWITCHES, Types B and C
(Type B, Stores Ref. 5C/649)
(Type C, Stores Ref. 5C/723)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. Magnetic relay switches are used to enable heavy currents to be controlled by the operation of a small control switch. The control switch carries a small current only and can, therefore, be mounted in the most convenient position for the operator. The relay switch is connected directly in the supply cable to the apparatus taking the heavy current, and may be mounted in any position in the run of the heavy cable. Thus by the use of the relay switch the running of the heavy cable to the control position is obviated. Type B switch is designed to control a nominal load of 40 amp. at 12 volts, and type C, 20 amp. at 24 volts.

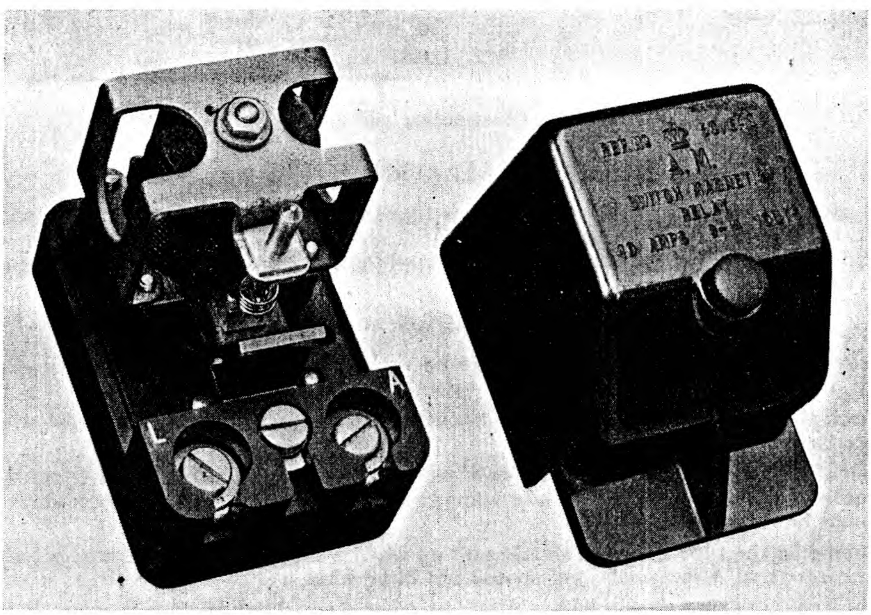

Fig. 1.—Magnetic relay switch, type B

DESCRIPTION

2. The type B and C magnetic relay switches are similar in construction; the type B switch is designed for use in 12-volt installations and the type C for 24-volt installations. They consist of

simple electro-magnets operating single-pole switches, the construction being as shown in fig. 1 and fig. 2. The mechanism is mounted on a base of black moulded insulating material and has a moulded cover fixed by a single cap-nut.

3. The solenoid is mounted in a frame which forms part of the magnetic circuit, the armature being across the bottom of the core and extending outwards so that its ends are close to the lower arms of the frame. The armature is fixed to a copper contact plate and the assembly turns on a pivot pin fixed in a brass bridge piece. The contact plate is connected to a terminal underneath it by means of a flexible connector of thin copper strips. It makes contact on to a laminated copper brush fixed to the base, the contact being held open by a small helical spring anchored to the lower end of the cover fixing stud. The three terminals are mounted at the lower edge of the base and the connections to them are made by means of heavy copper strips fitted underneath the base. A cover plate underneath the base protects these connections. A section of the switch and the circuit are given in fig. 2.

4. The solenoid of the type B switch is wound with 1,700 turns of 32 s.w.g. enamelled copper wire and has a resistance of about 26 ohms. The solenoid of the type C switch is wound with 3,300 turns of 36 s.w.g. enamelled copper wire and has a resistance of about 93 ohms. The two switches are otherwise identical.

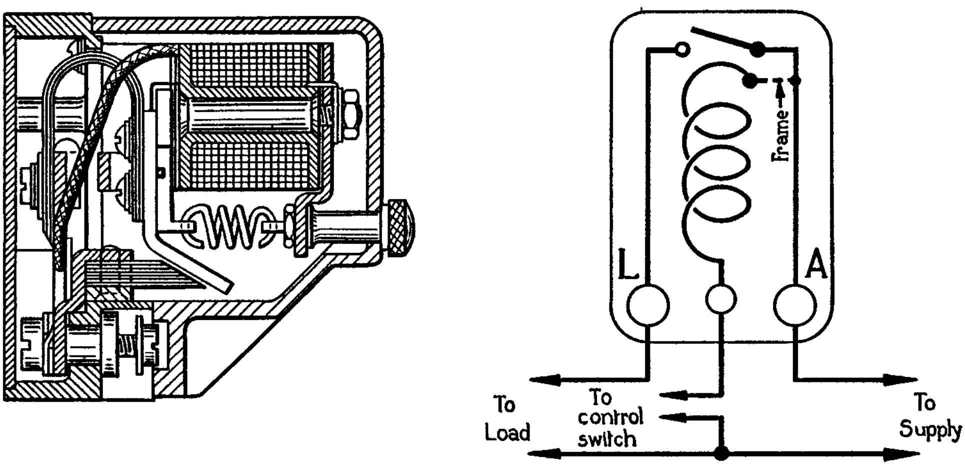

Fig. 2.—Construction and circuit

INSTALLATION

5. The switch is installed in any suitable position in the run of the heavy cables, and is fixed by two 4 B.A. bolts or No. 6 wood screws. The heavy cables are connected to the two outer terminals, the terminal designated A being connected to the supply and L to the load. The centre terminal is connected to the control switch.

SERVICING

6. The relay switches will normally require no attention, but during overhaul or if a switch appears to be out of adjustment the following tests should be applied:—

(i) Check that when the contacts are just touching, the air gap between the armature and the pole face is 0·018 in.

(ii) Check that the contact gap is at least 0·03 in. and that good electrical contact is made evenly over the whole contact face when the armature is pulled in. The contact surfaces should be smooth and clean.

(iii) When cold the type B switch should pull up when a supply at 8 volts is connected between the centre and A terminals, but should not close when a supply at 6 volts is so connected.

(iv) When cold the type C switch should pull up when a supply at 16 volts is connected between the centre and A terminals, but should not close up when a supply at 12 volts is so connected.

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CHAPTER 3

MAGNETIC RELAY SWITCHES, Types G, H, J, and K

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. Engine starting relays, types G, H, and J are used to provide remote control for engine starting and other short-rated heavy duties. All types are similar in construction, type G red spot (Stores Ref. 5C/896) being designed for 12-volt, type H red spot (Stores Ref. 5C/897) for 24-volt, type J (Stores Ref. 5C/1936) for 12-volt and type J (Stores Ref. 5C/1937) for 24-volt systems.

2. The relays, types G and H will be satisfactory in most cases for short-rated duties up to 450 amps on 12 or 24-volt systems. The relays, type J are similar mechanically to the types G and H but differ in the following particulars.

(i) Less contact over travel.

(ii) All manufacturing tolerances effecting operational characteristics have been tightened up.

(iii) Lower operating voltages resulting from (ii).

They have been specifically designed for engines such as the Centaurus where the starting currents are high, and will be found satisfactory for short rated duties up to 600 amps.

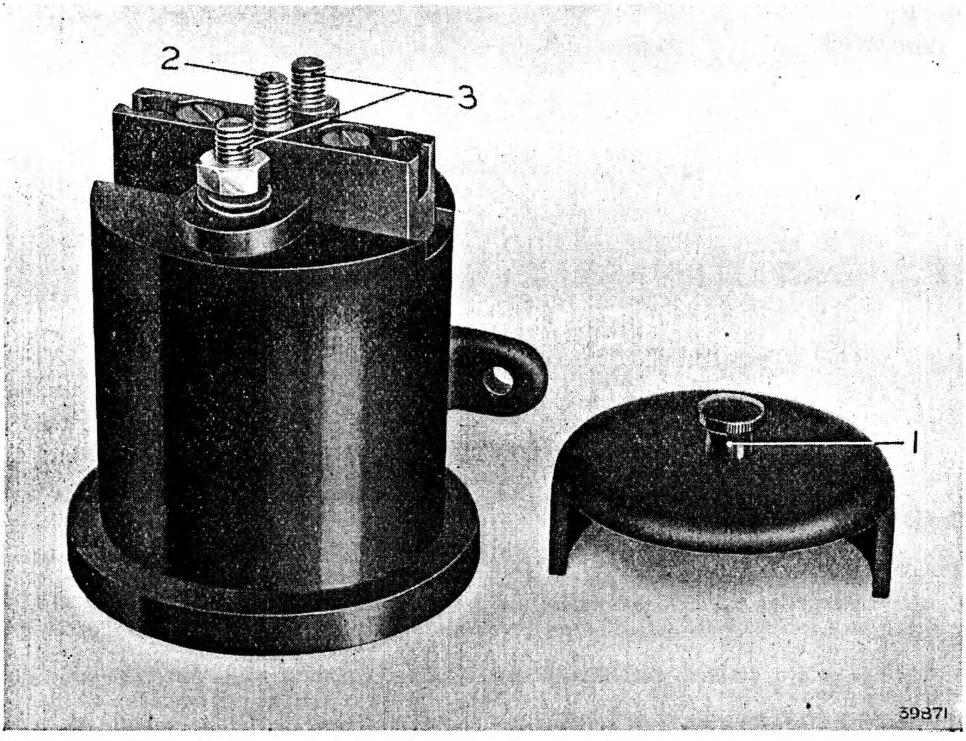
The relays, Type K, 12 volt (Stores Ref. 5C/2471) and 24 volt (Stores Ref. 5C/2472) are continuously rated for current not exceeding 100 amps.

3. Relays, types G, H, J, and K, comprise a single-pole, double-break switch, operated by an electro-magnet with one winding. The closing of a control switch energises the electro-magnet, thus causing a moving copper contact plate to bridge the two main terminals and energise the load to which the relay is connected. Engine starting relays, types G and H, are now issued marked with a red spot on the top cover plate adjacent to the reference number, and instructions for the modifications of relays issued, or in service without this marking will be found in paras. 6 and 7 of this chapter.

Types available

4. Details of the coil resistances and the types available will be found in the following table:—

Type	*Stores Ref.*	*Volts*	*Amps.*	*Coil resistance*
G (Red spot)	5C/896	12	450 INT.	1·51 ohms
H (Red spot)	5C/897	24	450 INT.	6·5 ohms
J	5C/1936	12	600 INT.	1·51 ohms
J	5C/1937	24	600 INT.	6·5 ohms
K	5C/2471	12	100 CONT.	21·9 ohms
K	5C/2472	24	100 CONT.	90·8 ohms



1. Captive nut 2. Central pillar 3. Terminals

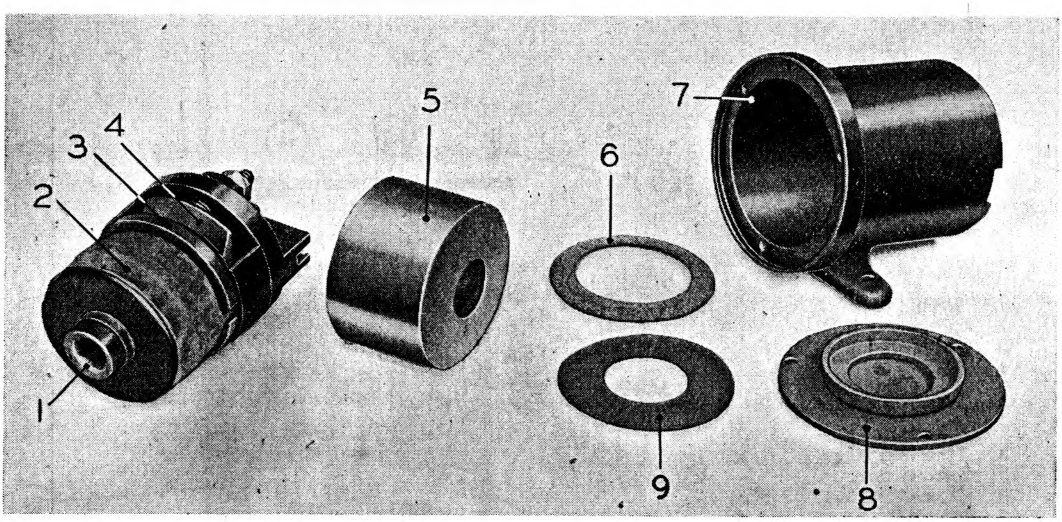
Fig. 1—Engine starting relay, type H

DESCRIPTION

5. A general view of the type H red spot relay, showing the terminal cover removed is given in fig. 1. This is constructed of black insulating material and is fixed to the terminal shroud by a knurled captive nut (1) that screws on to a central pillar (2). The cover is cut away to give access to the terminals (3) which are mounted at the top of the relay. The switch contact plate (4) fig. 2 is fitted on the spindle and retained in position by a 2 B.A. nut. The coil (2), which has a resistance of 6·5 ohms for 24-volt and 1·51 ohms for 12-volt relays, is housed in a pot (5) fitted with a magnet end plate (3). The solenoid plunger (1) slides in a brass core tube fixed on a boss in the magnet end plate, and it is secured to the spindle by a 4 B.A. nut. The contact plate is free to slide on the spindle and is held in position by a brass coil spring. A band of insulating material is fitted between the solenoid assembly and the magnet pot and, should the unit be dismantled, care must be taken to see that it is replaced correctly during assembly. The pot, magnet end plate and solenoid core are constructed of zinc plated mild steel. A cork gasket (6) and insulating washer (9) are fitted between the magnet pot and the cover plate (8). This cover plate maintains the magnet pot against the spigoted magnet end plate, and also retains the solenoid and contact assembly inside the case (7) to which it is secured by three countersunk brass screws.

INSTALLATION AND OPERATION

6. Referring to fig. 5 it will be seen that the control switch can be placed in any position convenient to the operator, enabling the relays to be placed in or near the main run of the heavy cables. The coil circuits should be connected to the supply as near to the accumulator terminals as possible in order to minimise voltage drop in the coil due to current flowing in the main circuit when the relay contacts close. The relays should be so mounted that the cable entry comes uppermost as when in this position gravity assists the action of the return spring when the current is switched off. The relays, types G, H, and J, should not be energised continuously for periods exceeding two minutes since the coils are short rated and when operated at their rated voltage for two minutes will rise to a temperature of 80 deg. centigrade.



1. Solenoid plunger
2. Coil
3. Magnet end plate
4. Switch contact plate
5. Magnet pot
6. Cork gasket
7. Case
8. Cover Plate
9. Insulating washer

Fig. 2—Exploded view, type H relay

Modification of relays, types G and H

7. Standard relays, types G and H, when operated on the heavy loads necessitated by present electrical duties have been found unsatisfactory and modification is necessary to remove the splines from the spindle, thus eliminating the turning movement of the contact at the end of the travel. All switches not marked with a red spot are to be modified as follows:—

(i) Remove the terminal cover (1) fig. 4 by unscrewing the captive nut (2).

(ii) Unscrew the three countersunk screws (3) and remove the cover (4).

(iii) Remove the cork gasket (5) and insulating washer (6) on the top of the relay unit.

(iv) Withdraw the relay unit from the outer case (7).

(v) Remove the two terminal screws (8) and special nuts (9) thus exposing the coil connecting lugs (10).

(vi) Prise up the connecting lugs from the terminal shroud and unsolder the coil leads, taking care to prevent fracture of the copper connecting wire. If the wire breaks, a soldered joint with a new piece of 21 s.w.g. copper wire (Stores Ref. 5E/588) or a length of flexible copper cord (Stores Ref. 5A/1489) is to be made.

(vii) Remove the magnet pot (11) and coil (12) from the relay unit by withdrawing the connections through the relay base (13).

(viii) Remove the solenoid plunger (14) by unscrewing the nut (15).

(ix) Remove the four countersunk screws now exposed and also the magnet end plate (16).

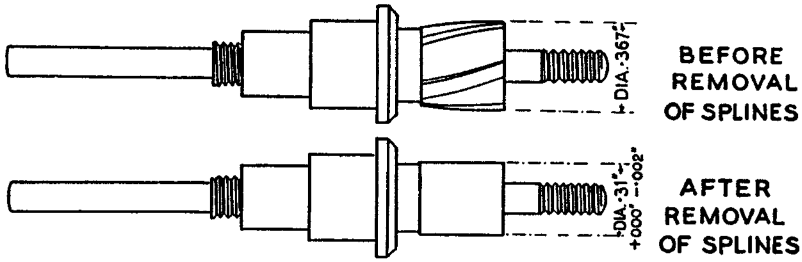


Fig. 3—Operating plunger (removal of spiral splines)

1. Terminal cover
2. Captive nut
3. Countersunk screws
4. Cover
5. Cork gasket
6. Insulating washer
7. Outer case
8. Terminal screw
9. Special nut
10. Connecting lug
11. Magnet pot
12. Coil
13. Relay base
14. Solenoid plunger
15. Nut
16. End plate

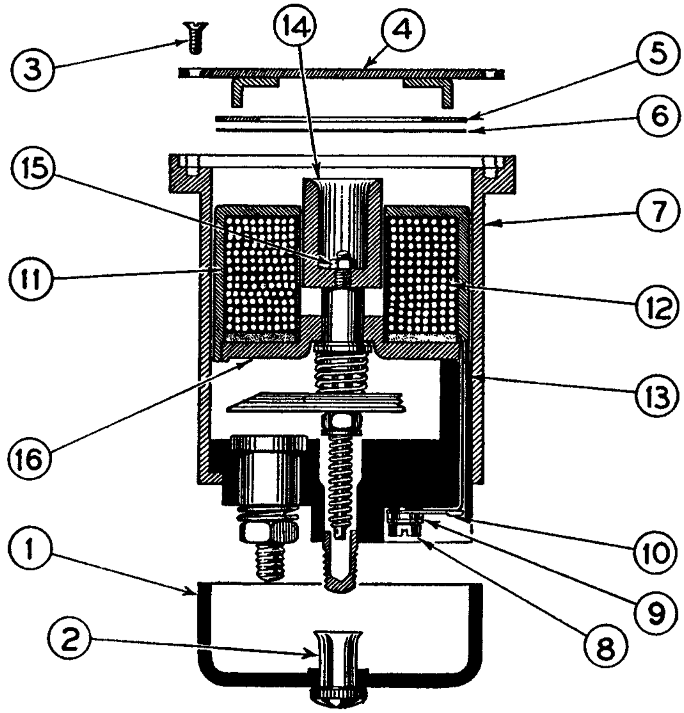


Fig. 4—Section (schematic)

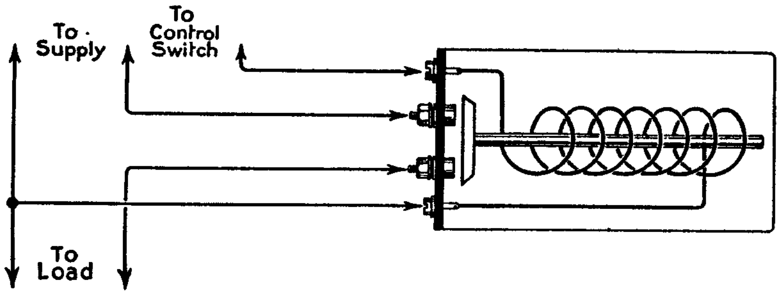


Fig. 5—Theoretical circuit

(x) Withdraw the operating plunger and remove the springs, washer, nut, and movable contact plate. The nut retaining the contact plate on certain switches is pinned and the pin is soldered in position. Care should be taken to ensure that this pin is removed before attempting to remove the nut.

(xi) Modify the operating plunger as shown in fig. 3 by grinding off the special splines.

(xii) Re-assemble without replacing the pin referred to in sub-para. (x).

(xiii) Test for operation. Apply 8-volts to the coil terminals of the relay, type G and 16-volts to the coil terminals of the relay, type H. With this applied voltage the relay should give a sharp make, and should break sharply on disconnection. After modification, each switch is to be marked with a red spot adjacent to the reference number to indicate that it has been modified.

8. The following table gives a list of the cable lugs to be used with these relays; lugs number 1, 2, 3 and 8 being used for copper, and 4, 5 and 6 for aluminium conductors.

Lug number	*Stores Ref.*	*Diameter of cable hole*
1	5C/850	0·45 in.
2	5C/851	0·34 in.
3	5C/852	0·185 in.
4	5C/918	0·45 in.
5	5C/919	0·34 in.
6	5C/920	0·185 in.
8	5C/1901	0·55 in.

The number 8 lugs are normally only to be used on the relay, type J, in order to carry the increased current for which these units are intended. In cases where Chater Lea, or incorrect lugs have been used on existing wiring, defects have been reported in which the cable connections fouled the body of the relay switch, resulting in a short circuit when the starter-button was pressed. In the event of this trouble being experienced, a distance piece should be fitted under the terminal to prevent existing cable connections earthing on the case of the relay. This distance piece should be of ½ in. diameter, $\frac{3}{16}$ in. thick, with a ¼ in. central hole.

SERVICING

9. The relays normally require very little attention. The switch contacts and contact plate should be kept clean, and the operation of the unit should be checked after any modification or in the event of faults developing.

Operational tests for relays, types G, H, J, and K

10. *Closing voltages.*—The coil voltage should be gradually increased until the relay closes and the closing voltage noted. Relays must close with a snap and under no circumstances should the armature move slowly or the closing voltage exceed the values given in the following table:—

Relays	*G. 12-volt*	*H. 24-volt*	*J. 12-volt*	*J. 24-volt*	*K. 12-volt*	*K. 24-volt*
Maximum Closing Volts	8	16	7	14	8	16

11. *Drop out voltages.*—On the relay, type J, the coil voltage is to be gradually decreased until the relay opens, and the opening voltage must not exceed 5-volts for the 24-volt, and 2·5 for the 12-volt relays.

12. *Contact resistances.*—With the coil excited off a supply of 8 or 16-volts for the 12 or 24-volt units respectively, and with a current of 100-amp flowing in the main circuit, the voltage drop across the main terminals must not exceed 50 millivolts.

13. *Insulation resistance.*—The insulation resistance is to be measured between the following points with a 500-volt insulation tester and should not be less than 20 megohms.

(i) Between one coil terminal and the case.

(ii) Between one coil terminal and both main terminals.

(iii) Between the main terminals.

(iv) Between one main terminal and the case with the relay closed.

(v) Between one main terminal and one coil terminal with the relay closed.

14. Before assembly of the coil and magnet pot on the relay, type J, only, the magnetic air gap should be checked with a feeler gauge, the settings being 0·162 in. with the switch contacts open and 0·023 to 0·010 in. with the switch contacts closed.

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CHAPTER 5

MAGNETIC RELAY SWITCHES, Types P1 and P2

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. Magnetic relay switches are used to enable heavy currents to be controlled from a remote position by the operation of a small control switch. The relay switch is connected at any suitable point in the supply cable taking the heavy current to the apparatus, and a lighter cable is then run from the relay to the control switch, which is mounted at any position convenient for the operator.

2. The Type P magnetic relay switch is designed for general use for controlling a nominal load of 20 amp. at 12 V. or 24 V. These relays are produced by more than one manufacturer, so that individual switches may be found to differ slightly in internal design; the size, operation, and mounting holes are, of course, standard. The following types are available:—

Type	*Stores Ref.*	*Nominal load*	
Type P1, 12 V.	5C/1969	20 amp.	Contacts normally open
24 V.	5C/1722	20 amp.	Contacts normally open
Type P2, 12 V.	5C/3643	20 amp.	Contacts normally closed
24 V.	5C/3181	20 amp.	Contacts normally closed

DESCRIPTION

Type P1

3. Magnetic relay switch Type P1 is illustrated in fig. 1. It consists of a simple electro-magnet operating a single-pole switch. When the control current is switched on, the electro-magnet is energised and pulls down the armature, bringing together the moving contact on the armature and the fixed contacts attached through connections in the base to the heavy current supply, thus completing the heavy current circuit. A tension spring controlled by a stop plate ensures that the contact will be broken as soon as the electro-magnet is de-energised.

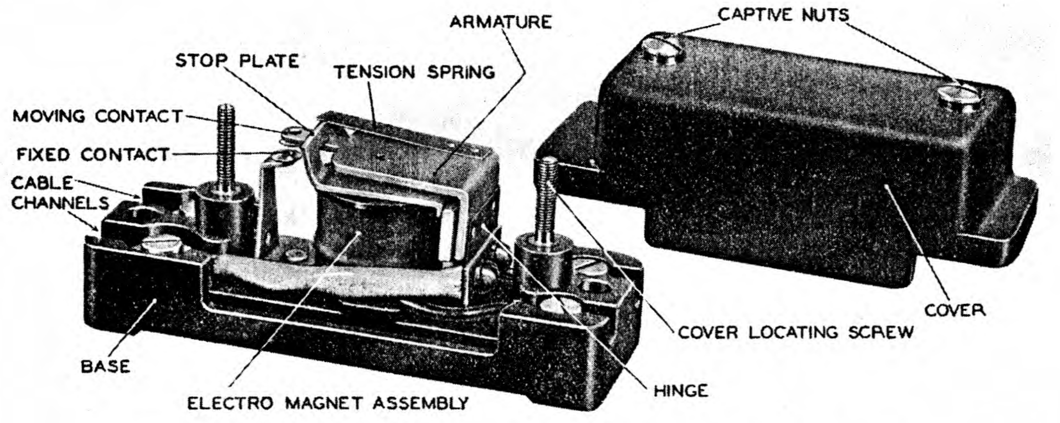

Fig. 1.—Magnetic relay switch, Type P1—contacts normally open

4. The mechanism is mounted on a base of moulded insulating material, and the cover, of the same material, is located by two threaded screws in the base plate, and secured by captive nuts. The relay switch, complete, weighs 7½ oz.

Type P2

5. Magnetic relay switch Type P2 is similar in appearance and make-up to the Type P1. Its difference lies in the fact that in the Type P2 the contacts are normally closed; operation of the electro-magnet pulls down the armature to which the moving contact is attached, thus disconnecting the contacts and breaking the heavy current circuit. The type P2 is shown in fig. 2.

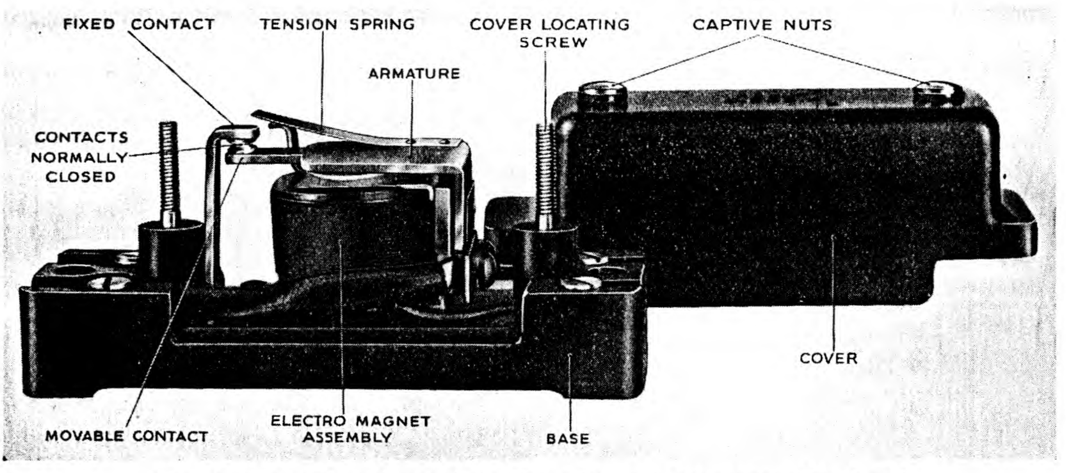

Fig. 2.—Magnetic relay switch, Type P2—contacts normally closed

INSTALLATION

6. The magnetic relay switch may be installed at any convenient point in the heavy current circuit. The base is secured to the aircraft structure by screws through the two recessed ¼ in. dia. holes at each end. The heavy current circuit is connected to the two larger terminals at the contact end of the assembly, and the lighter control current cables to the smaller terminals.

SERVICING

7. Tests of the relay switch should give the following results:—

Test	*P1*		*P2*	
	24 V.	*12 V.*	*24 V.*	*12 V.*
Contact gap fully open...	0·060 in.	0·060 in.	0·060 in.	0·060 in.
Minimum contact pressure	—	—	3 oz.	3 oz.
Gap between bobbin core and armature with contacts fully closed ...	0·005–0·010 in.	0·005–0·010 in.	—	—
Gap between bobbin core and armature with contacts fully open ...	—	—	Closed	Closed
Coil resistance limits ...	255–285 ohms	54–68 ohms	255–285 ohms	54–68 ohms
Operating voltage limits at coil, cold	14–16 V.	7–8 V.	14–16 V.	7–8 V.
Release voltage	10 V. max.	5 V. max.	10 V. max.	5 V. max.
~~Minimum~~ MAX voltage drop across terminals at 20 amps. with 24V. applied to coil must not exceed	50 millivolts	—	—	—
~~Minimum~~ MAX. voltage drop across terminals at 20 amps. with 12V. applied to coil must not exceed	—	50 millivolts	—	—
~~Minimum~~ MAX voltage drop across main terminals with 20 amp. flowing	—	—	50 millivolts	50 millivolts
Insulation resistance between coil terminals and frame must not be less than	20 megohms	20 megohms	20 megohms	20 megohms
Insulation resistance between main contact terminals with relay open must not be less than	50 megohms	50 megohms	50 megohms	50 megohms

Weatherproofing

8. If its position or conditions of service make it desirable, the relay switch may be weatherproofed in the following manner. The cover should be sealed to the base of the switch with an application of varnish, insulating, Golden Pakyderm (Stores Ref. 33B/484), and the captive nuts securing the cover should be treated at the same time. P.I.C. No. 2 (Stores Ref. 33C/887) should then be built up round the cable entries at both ends of the switch.

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CHAPTER 6

ROTAX DOUBLE-ACTING RELAYS
Types D.2703 and D.2704

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Introduction

1. Relay, type D.2703, is employed in 24-volt circuits to govern the battery feed to the starter motor and propeller feathering motor in an aircraft. When in the normal position the starter motor circuit is complete. The relay is actuated by a feathering push switch in the pilot's cockpit which energises a solenoid within the relay. This action breaks the starter circuit and makes the feathering circuit, allowing the hydraulic operation of the propeller feathering system to function. The type D.2704 is identical apart from the fact that it has a solenoid wound for use in 12-volt aircraft electrical systems. The type D.2703 is being widely used in conjunction with Rotol and de Havilland propellers. A general view of relay is shown in fig. 1.

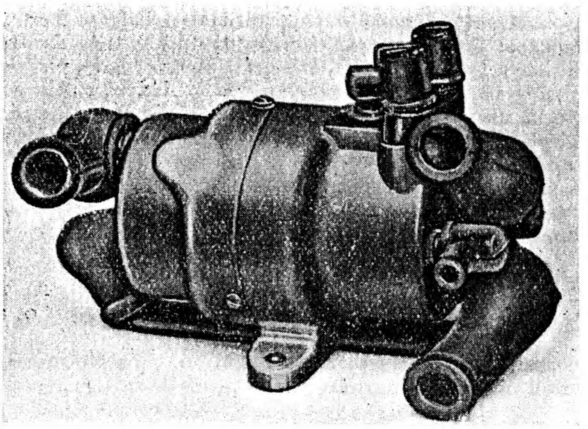

Fig. 1.—General view of relay, type D.2703

DESCRIPTION

2. Each relay consists basically of three items, two outer alloy casings and a detachable solenoid core with two contacts. The solenoid cup or pot is located within the main outer casing of the relay by two grub-screws in the base, while the smaller of the outer casings fits over an integral lip and is secured to the main casing by three round-headed screws. The whole unit is mounted by two bolts which pass through lugs in the base-piece.

3. On each of the two outer casings enclosing the solenoid are a number of terminals, as may be seen from fig. 2, the main casing incorporates in the end two feathering motor terminals, bearing annotations 1 and 2, together with two other spring-loaded auxiliary contacts. The latter bear on one of the solenoid contacts regardless of whether the starter or feathering motor circuit is complete, thus giving a virtual permanent connection. The two terminals marked 6 are connected by an insulated metal strip and, as is indicated by a transfer on top of the relay, it is only necessary to connect up to one of these terminals. Similarly, a metal bus-bar insulated with strip fabric and running along the underside of the relay is secured at terminals 1 and 3.

4. At the opposite end of the relay are the two starter motor terminals, 3 and 4. They pass through, and project slightly from a bakelite insulating ring which prevents the terminals from contacting the metal casing. The four terminals in the other end of the relay are insulated by an identical ring. A permanent circuit is maintained across the starter motor terminals, 3 and 4, when the relay is at rest, by the action of a spring housed in the main casing which bears on the solenoid core and ensures that one of the solenoid contacts is across the starter terminals. All terminals are protected by rubber boots, seen in fig. 2, which cover the whole of the terminals, the lugs and leads attached to them. The solenoid is encased within a metal solenoid pot, or cup, the two leads from the coil being brought out through a rubber grommet, which prevents chafing on the casing, to the terminals 7 and 8 mounted on a terminal block on top of the relay. The terminal block is made of black bakelite and is secured to a shoulder on the main outer casing by a central screw. The detachable solenoid unit, consisting of a solenoid cup and a central core with one spring-loaded circular copper contact situated at either end, is rigidly secured by three rd/hd screws which pass through the outer casings of relay and the wall of the solenoid pot. The contacts are insulated from the metal core by a bakelite backing piece in which they are moulded. They are also secured in position by a castellated locking nut and split pin.

Application of the double-acting relay

5. The action of the relay when used in aircraft starter and feathering circuits may be seen with references to fig. 4 and is as follows. In its normal position, as shown in the illustration, the negative supply to the starter motor is complete across terminals 3 and 4. The starter motor is then operated by depressing the starter push switch thus energising the motor relay. To change over the supply from starter to feathering motor, the double-acting relay must be energised by depressing the cockpit feathering push switch, which will then remain in this position throughout the feathering operation. This action allows current to pass through terminal 8 of the relay and energise the solenoid, which, in turn, attracts the core, breaks contact across terminals 3 and 4 in the starter circuit, and makes the negative line to the feathering motor across terminals 1 and 2. At the same time the contact 6, being permanently connected to the moving contact on the solenoid through spring-loaded contacts, is also connected to terminals 1 and 2. Negative potential is thus applied to the motor relay completing the circuit of the feathering motor to the positive feed. When feathering has been completed, pressure built up in a pressure switch breaks the hold-on circuit of the feathering push; this, in turn, breaks the solenoid circuit of the double-acting relay. The solenoid now becomes de-energised and is returned by action of a spring to its original position, making the circuit once more across terminals 3 and 4.

SERVICING

6. The relays normally require very little attention. The terminals should be kept clean and the operation of the unit checked after any modification or in the event of any fault developing as outlined below.

Dismantling relay, type D.2703

7. In normal circumstances, this work should be undertaken by qualified Maintenance Unit personnel only. Firstly, withdraw the three round-headed screws located circumferentially about the centre of the relay. Detach the bus-bar joining terminals 1 and 3 and release the leads from terminals 7 and 8. Push the rubber grommet, through which pass the leads from the solenoid to terminals 7 and 8 into the inside of the relay. Do not attempt to pull the leads through the grommet. The smaller casing of the relay may now be withdrawn, and after making sure that the grub screws in the base are not bearing on the solenoid pot, the latter may also be pulled away from the main casing.

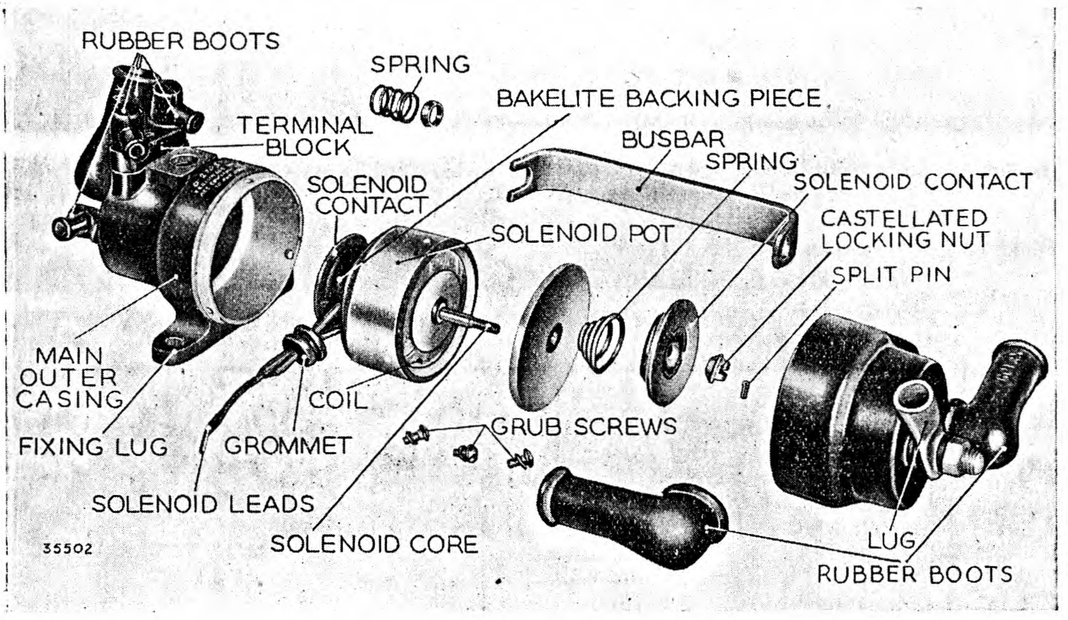

Fig. 2.—Exploded view of relay, type D.2703

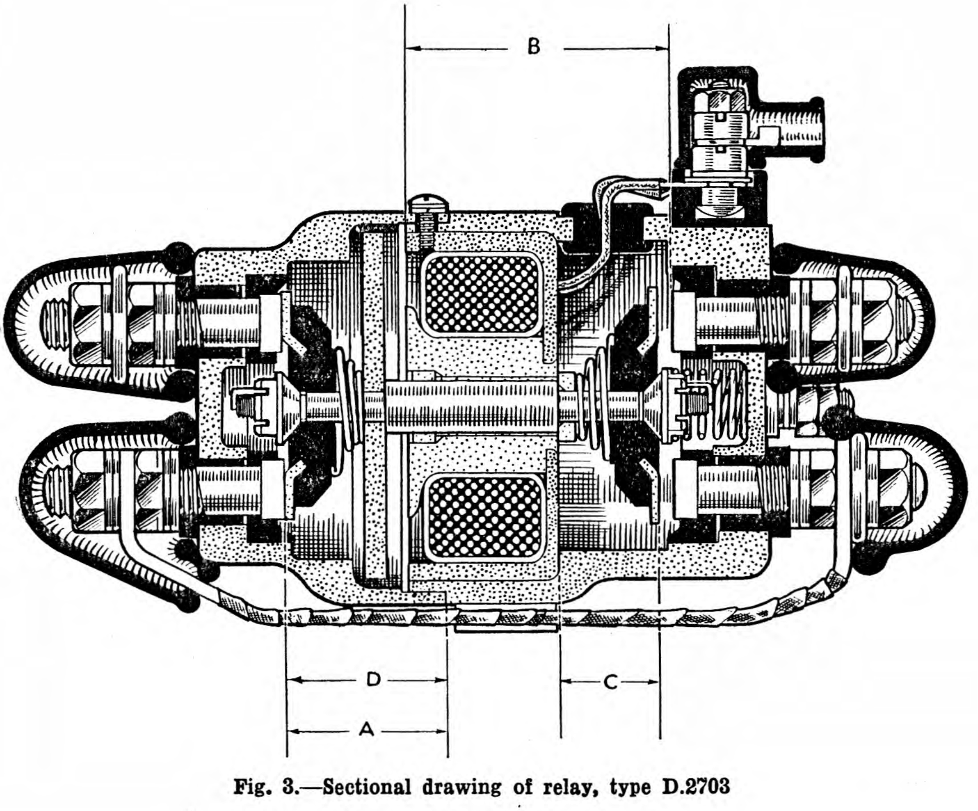

Fig. 3.—Sectional drawing of relay, type D.2703

Re-assembling relay, type D.2703

8. Before starting to re-assemble the components check settings A, B, and C detailed below. If these are correct, place the solenoid in the relay, replace the rubber grommet and leads and see that the screw holes in the solenoid cup correspond to those in the outer casing. Tighten up the two grub screws in the base to secure the cup against the spring in the end of the casing, and check the setting D. Secure the smaller casing with the three round-headed screws, replace the bus-bar across terminals 1 and 3 and see that all screws, lugs, washers, and boots are correctly and tightly replaced.

Settings for relay, type D.2703

9. Should the relay be dismantled it is essential to re-assemble the components in conjunction with the settings detailed below.

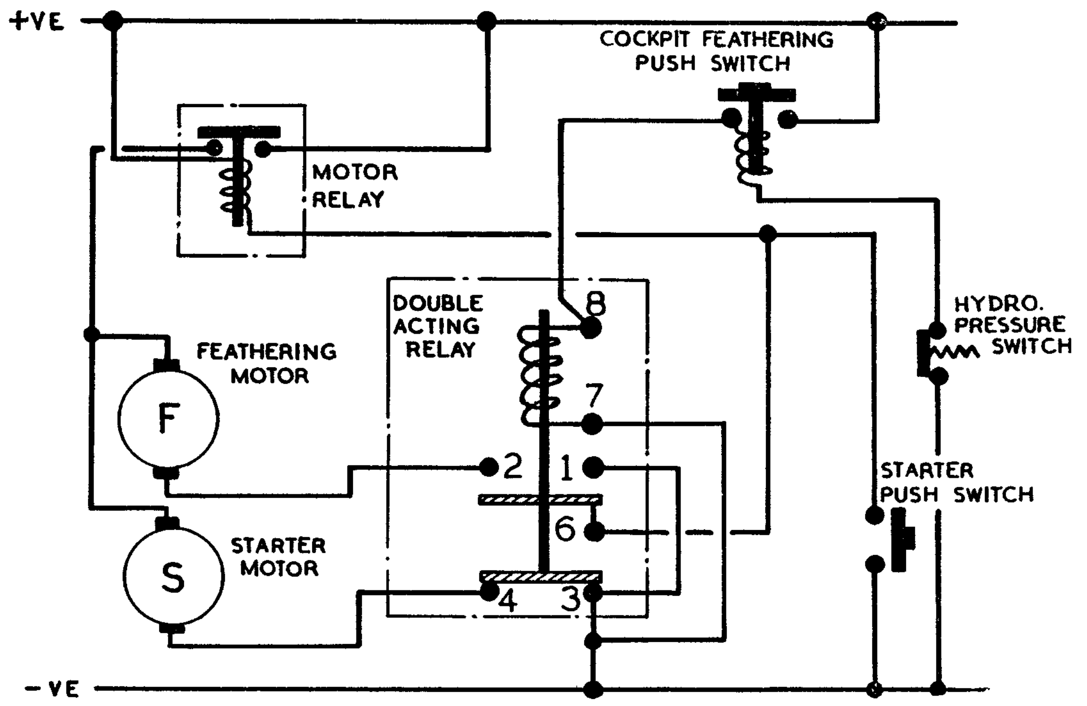

Fig. 4.—Theoretical diagram of relay, type D.2703

Casings and terminals

(*a*) The distance A, in fig. 3, i.e. between the face of terminals 3 and 4 and the edge of the smaller casing must be $1{\cdot}000 \frac{+\ 0}{-\ 0{\cdot}005}$ in.

(*b*) The distance B, in fig. 3, i.e. between the face of terminals 1 and 2 and the edge of the main casing must be $1{\cdot}625 \frac{+\ 0}{-\ 0{\cdot}005}$ in.

Movable solenoid contacts

(*c*) Before inserting the solenoid cup in the main casing of the relay distance C, i.e. that between the base of the solenoid cup and the contact face, as shown in fig. 3, should be set at $0{\cdot}593 \frac{+\ 0{\cdot}010}{-\ 0}$ in.

(*d*) After replacing the solenoid cup in the main casing and locking it with the two grub screws in the base setting D, i.e. the free distance (without the smaller casing in position) between the edge of the spigot seating and the solenoid contact face must be $1{\cdot}030 \frac{+\ 0{\cdot}010}{-\ 0}$ in.

If the terminals of the relay have to be replaced, the contact surfaces of the new terminals must be machined after assembly to conform with settings (a) and (b). The finish obtained must be clean, and comparable with that of the solenoid contacts. If the terminals are left with a rough finish there will be an excessive voltage drop on test and detrimental arcing will occur.

Tests for relay, type D.2703

10. After repairing the relay or replacing any major component, tests, as outlined below, should be carried out to ensure that the relay will operate satisfactorily under all conditions in service.

(i) Measure the resistance of the solenoid coil across terminals 7 and 8. This should lie between 4·37 and 4·83 ohms.

(ii) The relay must operate if a voltage not greater than 18 volts is applied to the coil terminals (7 and 8) after current at 24 volts has been flowing in the windings for 30 seconds. The relay must not open until the voltage is reduced to below 18 volts.

(iii) With a current of 100 amps. flowing across the starter contacts (3 and 4), normally closed, the voltage drop across the contacts must not exceed 40 m.V. (N.B.—As the starter motor contacts normally never break circuit, avoid doing so during the test.)

(iv) With 100 amps. flowing across the feathering motor terminals and the coil energised at 18 volts, the voltage drop across the contacts must not exceed 40 m.V.

(v) With a current of 5 amps. flowing across the auxiliary contacts and the coil energised at 18 volts, the voltage drop across *either* of the auxiliary contacts and the feathering motor contact to the copper link must not exceed 40 m.V.

(vi) Operate the relay 20 times with 18 volts applied to the coil. The relay must operate satisfactorily each time.

(vii) When tested with a 250-volt insulation resistance tester the resistance

(*a*) between all terminals and the frame

(*b*) between terminals 1 and 2, 6 and 1, 6 and 2

(*c*) between terminals 3 and 4, with the coil energised at 18 volts

must not be less than 20 megohms. The insulation must withstand a pressure of 500 volts A.C. 50 cycles for one minute between all live parts and the frame.

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CHAPTER 7

MAGNETIC RELAY SWITCH TYPE Q, No. 1, 24v.

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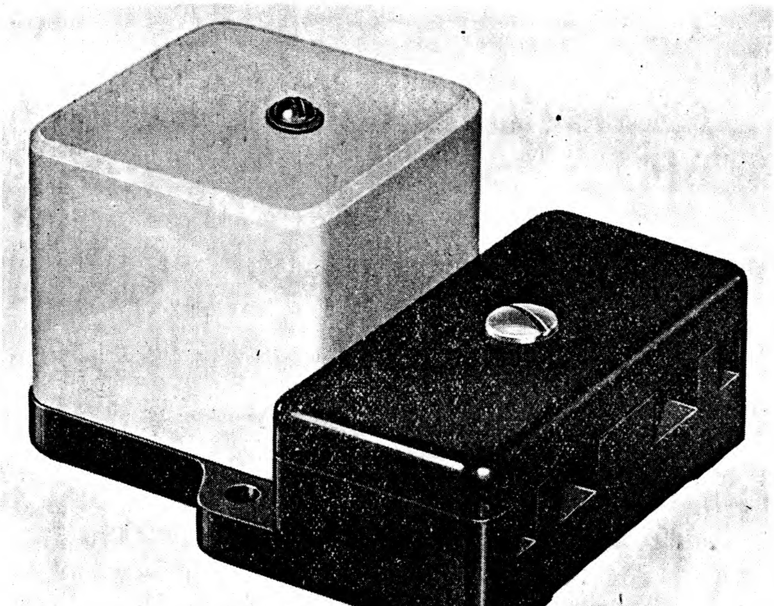


Fig. 1.—Magnetic relay switch Type Q, No. 1, 24 V.

Introduction

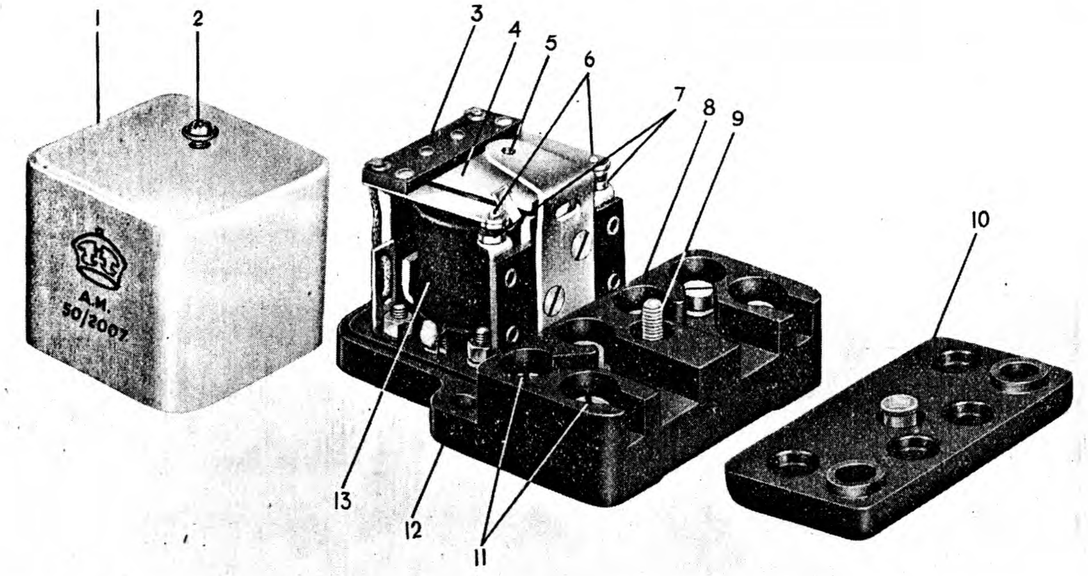
1. The magnetic relay switch Type Q, No. 1, 24 V. is a general purpose double pole magnetic relay switch used for controlling 29 V. circuits with currents of 10 amp. or less.

DESCRIPTION

2. The relay Type Q No. 1 is shown in fig. 1 with covers on, and in fig. 2, with the solenoid and terminal covers removed. It consists of a simple electro magnet operating a double pole switch. The two movable contact arms are attached to an insulating bar fixed to the armature; when the control current is switched on, the electro magnet is energised and attracts the armature, which

automatically pulls down with it the two moving contact arms so that they meet the fixed contacts and complete the operating current circuits.

3. The mechanism is mounted on a base of moulded insulating material, and the terminal cover, of the same material, is located by a threaded screw in the base plate and secured by a captive nut. There are six terminals in the terminal block section of the relay base. Terminals 1 and 2 are for the coil, terminals 3 and 4 for one pair of contacts, and terminals 5 and 6 for the second pair. These numbers are moulded into the block by the terminals to which they refer. The solenoid is housed separately under a metal cover which is secured by a small screw.



1. Switch cover
2. Cover fixing screw and washer
3. Insulating bar
4. Armature
5. Cover fixing screwhole
6. Moving contacts
7. Fixed contacts
8. Terminal block
9. Terminal cover locating stud
10. Terminal block cover
11. Terminals
12. Switch base
13. Electro magnet assembly

Fig. 2.—Relay with solenoid and terminal covers removed

SERVICING

Testing

4. The relay should be inspected and tested periodically for compliance with the following specification:—

(i) Minimum contact gap with contacts fully open ... ... 0·040 in.

(ii) Minimum gap between front of armature and frame with contacts just touching ... ... 0·020 in.

(iii) Pull-in voltage limits at 20° C. (minimum) ... ... 14 to 16 V.

(iv) Drop-out voltage at 20° C. (minimum) ... ... 5 V.

(v) Pressure at each contact with 16 V. applied to terminals 1 and 2 and armature fully closed to be not less than ... ... 100 grams

(vi) Voltage drop between terminals 3 and 4, or between terminals 5 and 6 with 10 amp. current flowing to be not ~~less~~ greater than ... 100 millivolts

(vii) Resistance of coil (cold) between terminals 1 and 2 to be within the limits of ... ... 350 ohms ± 5%

(viii) Insulation resistance between coil and frame, and any separated circuits measured at 500 V. d.c. to be not less than ... ... 50 megohms

Weatherproofing

5. These relays are not supplied fully weatherproofed, but the solenoid covers are sealed to the base with bakelite varnish before despatch. Where conditions make it necessary to weatherproof fully, or at any time after removal of the covers, the following procedure should be adopted.

6. The terminal block should be filled with P.I.C. No. 2 (Stores Ref. 33C/887). This should be well pressed down round the terminal screws and into the cable channels. When the terminal cover has been replaced, further P.I.C. No. 2 should be built up around the cable entry.

7. If the solenoid cover is removed for any reason, it should be re-sealed with varnish, insulating, Golden Pakyderm (Stores Ref. 33B/484) and the small screw and washer securing the cover should be treated at the same time.

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CHAPTER 8

SWITCHES, solenoid, Rotax types, D.0208 and D.0213

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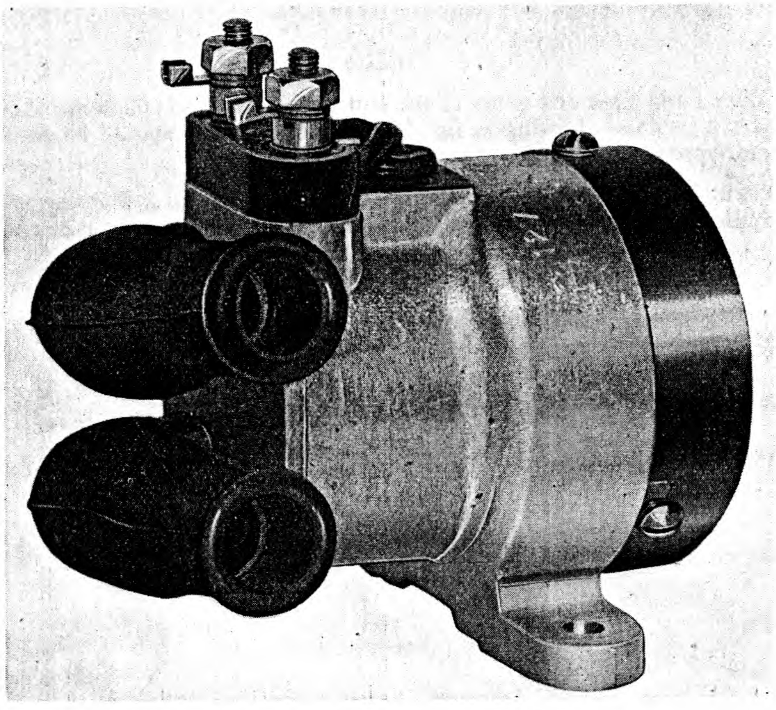

Fig. 1.—Rotax solenoid switch, type D.0213

CHAPTER 8

SWITCHES, solenoid, Rotax types D.0208 and D.0213

Introduction

1. The Rotax type D.0208 and D.0213 solenoid switches are of similar construction and are primarily used as relays for the remote control of electrical equipment installed in aircraft and marine craft, such as engine starting motors, undercarriage motors, etc., the operation of the switch being effected by means of a push-button located on the pilot's control panel. They are employed in heavy current circuits and may be installed adjacent to the controlled apparatus so that the amount of heavy cable required can be kept to a minimum. Only light gauge control wires are needed from the solenoid switch to the controlling push-button or circuit.

2. Many other applications are possible as the switches simply consist of two fixed contacts which are normally connected in series with the equipment to be controlled, and a moving contact which is attached to the armature of a solenoid. The moving contact bridges the two fixed contacts when the coil circuit is closed. When the solenoid is unexcited the main circuit is broken.

Leading particulars

3. Type	D.0208 (N5CP)	D.0213
Stores Ref.	5C/858	5C/1572
Voltage	12	24
Maximum current (main circuit)	300 amps.	300 amps.
Colour of coil leads	Yellow	1 Yellow, 1 red
Rating	30 secs.	30 secs.
Mounting	Flat	Flat

DESCRIPTION

4. General and exploded views of the Rotax switch type D.0213 are shown in fig. 1 and 2, together with a sectional drawing in fig. 3 to which reference should be made when reading the following descriptive paragraphs.

5. It will be seen from the exploded view shown in fig. 2 that the switch comprises two main assemblies, namely the switch body or housing assembly and the pole and coil cup assembly.

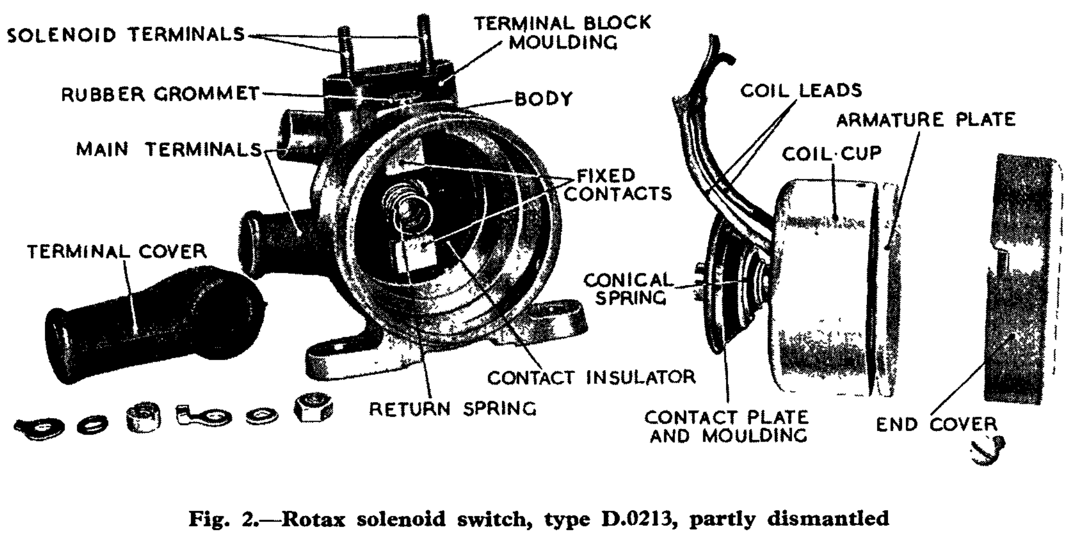

Fig. 2.—Rotax solenoid switch, type D.0213, partly dismantled

6. The switch body is a cylindrical metal casting closed at one end and machined internally to house the pole and coil cup assembly. Two drilled feet are cast integral with the body to form a flat mounting base for installation purposes. An external boss, also part of the main body casting, provides the location for a coil terminal block which is attached to it by means of a cheese-head screw. This boss is extended over the body and is drilled so that two flexible connector leads from the solenoid coil may be brought out through a rubber grommet to two terminal studs on the terminal block moulding. Each terminal stud is fitted with the following components after the coil connection leads have been placed in position: a tab-washer, Grover washer, round terminal nut terminal tag (for the external connection lead), terminal washer and finally a standard 3 B.A. terminal nut.

7. Two fixed contacts forming the heads of the two main terminal studs are located internally at the rear of the switch body. The studs are extended through holes drilled in the body casting to form the main terminals on the outside. The contacts are diametrically opposed and are insulated from the switch body by means of a moulded plate known as the contact insulator and also insulating bushes where the contact studs pass through the body. The contact insulator is interposed between the contacts and the body casting and held in place by means of round terminal nuts with Grover and plain washers fitted externally, to the main terminals studs. An external cable socket, held in position by a nut and Grover washer is fitted to each main terminal stud. Terminal cover mouldings are placed over each terminal assembly on installation.

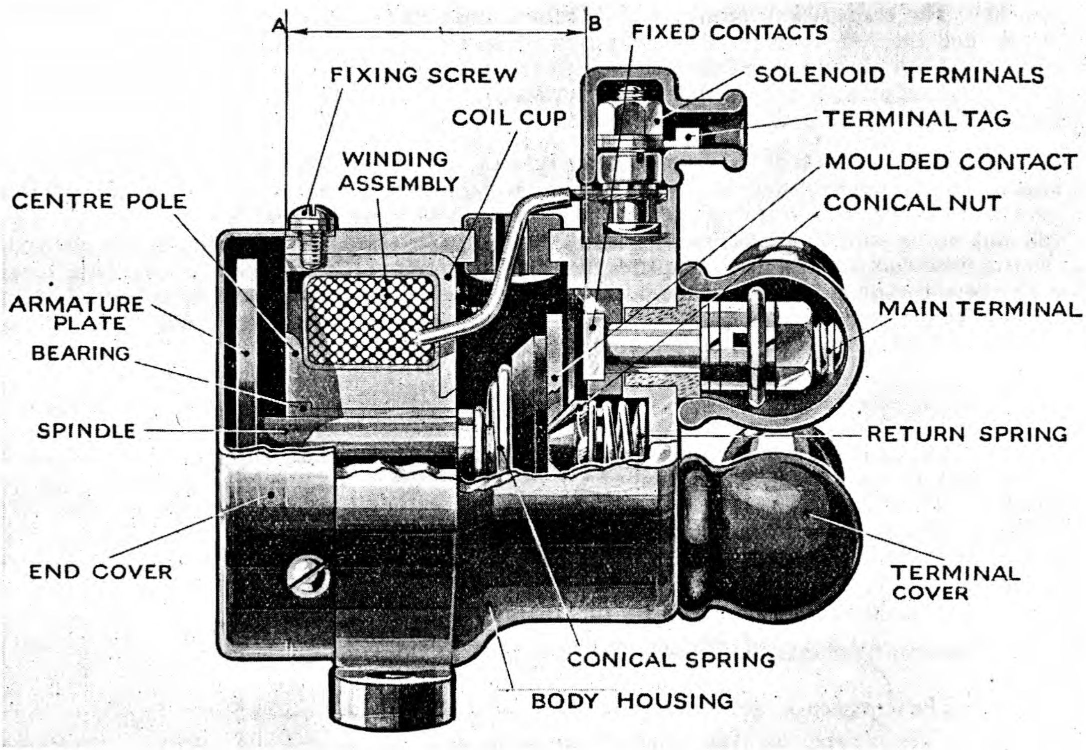

Fig. 3.—Sectional perspective of Rotax solenoid switch, type D.0213

8. The coil and cup assembly is housed in the switch body and secured by three filister head screws with lock-washers, which also hold the end cover in place. Slotted holes are provided in the cover, so that it may be detached from the switch without removing the fixing screws. The wound coil is inserted in the cup and suitably insulated from it. Two flexible connections leads from the coil

are brought out through holes drilled in the back of the coil cup. They are threaded through the rubber grommet in the switch body and connected to the coil terminal studs. The centre pole is spun over after the coil has been fitted and therefore this unit cannot be dismantled for coil replacement. A brass bush passes through the centre pole and forms a bearing for the armature spindle which is attached to an armature plate at one end and carries the moving contact assembly at the other end.

9. The moving contact is in the shape of a ring and is incorporated as an insert in an insulating moulding. A conical spring is fitted behind this moulding, locating up against a shoulder on the armature spindle. This spring ensures that the moving contact seats on the fixed contacts correctly when the switch is in the closed position. A spacing collar, followed by a conical nut secures the moving contact assembly to the armature spindle. The conical nut is locked by peening.

10. A return spring, housed in a recess at the centre of the switch body and between the two fixed contacts fits over the end of the armature spindle and returns the moving contact to the normal position when the solenoid circuit is broken.

INSTALLATION AND OPERATION

11. Reference should be made to the appropriate aircraft or marine craft handbook for information concerning the installation of these switches.

12. When used to control a single piece of equipment such as an engine starting motor, the switch should be wired up as shown in fig. 4.

13. The main switch terminals should be connected in series with the equipment and the supply and the coil terminals should be connected, by means of light cables, in series with the supply and a push-button switch mounted on the control panel. The coil connections should be connected to a point as near to the supply as possible in order to prevent voltage drop in the heavy current cables affecting the relay coil voltage.

14. The operation of the switch in this type of circuit is as follows. When the push-button switch is depressed the solenoid coil is energised and the outside edge of the coil cup and the centre pole become magnetised and of opposite polarities. The armature plate is then attracted to the coil cup, at the same time pushing forward the armature spindle so that the moving contact bridges the two fixed contacts and thus completes the external circuit to the equipment. The return spring is also compressed and as soon as the push-button is released the coil becomes de-energised, the coil cup and centre pole demagnetised, and the return spring forces the moving contact assembly back into the normal or open position, breaking the external circuit.

SERVICING

15. The only servicing required on these switches, apart from checking that all electrical connections are clean and the terminal nuts secure, consists of the regular inspection of the fixed contacts. If the fixed contacts are pitted, the solenoid assembly together with the moving contact should be detached from the switch body in accordance with the information given below. The whole switch body assembly should be changed, complete with contacts. If there are facilities for skimming, however, the pitted contacts may be replaced by new ones and when fitted, the body of the switch should be placed in a lathe and the contacts machined in position to the dimension A—B shown in fig. 3, which should be 1·625 in. $^{+\,0\cdot000}_{-\,0\cdot005}$ in.

16. The sequence of operations given below should be followed when dismantling the switch:—

(i) Take off the two coil terminal assemblies, and remove the coil connection leads from the terminal studs.

(ii) Ease the rubber grommet out of its location hole in the body and slip it off the coil connection leads.

(iii) Remove the three end cover fixing screws, detach the end cover and withdraw the coil and cup assembly from the switch body.

17. No further dismantling of the coil and cup is necessary. Cleanliness is essential when servicing these switches and any surplus oil, dust, swarf or moisture must be wiped off the switch

mechanism and housing, and the moving contact cleaned if required with Grade 00 sandpaper to give a smooth finish.

18. After cleaning or skimming the contacts should be lightly smeared with white petroleum jelly (Stores Ref. 13B/806) as soon as possible. If the coil is found to be defective, the coil and cup assembly should be renewed.

19. The operations given in para. 16 should be reversed to re-assèmble the switch.

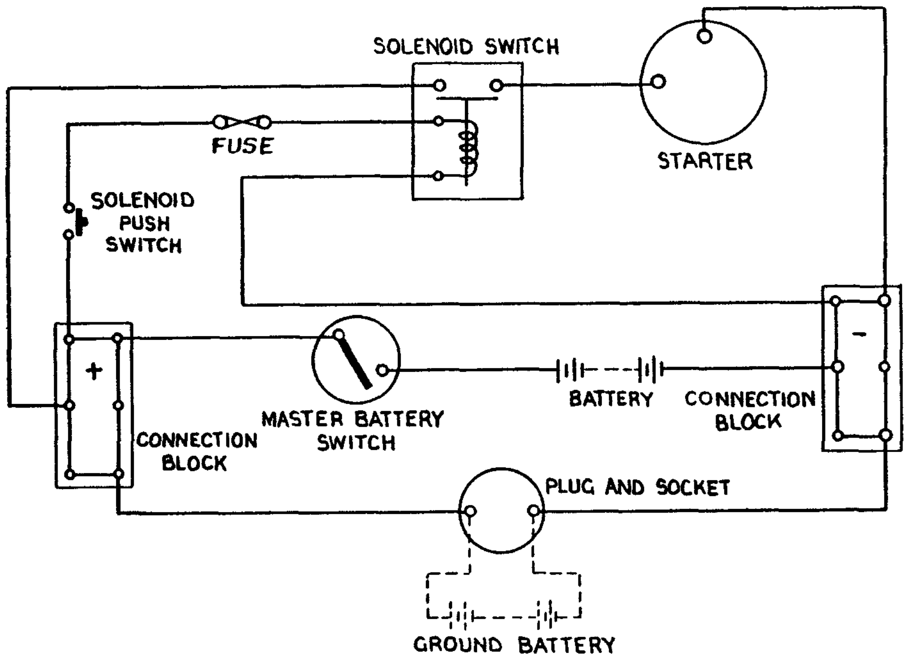

Fig. 4.—Typical circuit diagram

Testing

20. The following series of tests should be applied to switches that have been dismantled for servicing:—

(i) Check that the switch contacts close when a voltage not greater than 8·0 volts for the type D.0208 and 18 volts for the type D.0213 is applied to the solenoid coil, by connecting the main current terminals in series with a low tension source of supply, and an indicating light or a suitable testmeter.

(ii) Measure the voltage drop across the main contacts with a current of 100 amps. passing, and a voltage of 8·0 for the type D.0208 and 18 volts for the type D.0213 applied to the solenoid coil. This figure should not exceed 40 millivolts for either type.

(iii) The insulation resistance between the coil windings and the frame should not be less than 2 megohms, and not less than 20 megohms between the main contacts and the frame with the switch closed, when using a 250 volt insulation resistance tester.

(iv) Finally check the resistance of the solenoid coil at 20° C. This should be between 1·0 ohms and 1·2 ohms for the type D.0208, and between 5·0 ohms and 5·7 ohms for the type D.0213.

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SECTION 3

CABLE AND WIRING ACCESSORIES

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Note.—A List of Contents appears at the beginning of each Chapter

CHAPTER 1

LOW TENSION CABLES

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Introduction

1. The electrical supply on aircraft, which is normally low tension d.c. is distributed to the equipment by various types of cable which have been developed to fulfil in the most efficient manner the needs of each particular service.

2. These cables may be made up of one or more conductors, insulated from one another, bound together, and protected in various ways from mechanical and chemical damage, and from normal wear and tear. The conductor, which is the electrical connecting medium, generally consists of a number of stranded, tinned, annealed copper wires, twisted together and covered with rubber or other dielectric. This insulated conductor is called the core of the cable. Two-core cable for aircraft installation is normally flattish, like a thick ribbon, the two cores being placed side by side in the covering, but single or multi-core cable or two-core cable for ground trailing use is generally round. This shape is achieved by using "worming", usually thick threads of soft cotton, as a packing between and round the cores to build them up into circular form over which the protective covering is applied. Cables of various types for general purposes, variously assembled cores for specific purposes, special purpose cables, and cables with special protection for particular services are all available and are quickly recognisable. Provision is made for the easy identification of the circuit for which each cable is used. Multi-core cables, for example, have the outer layer of the dielectric of each core distinctively coloured in red, blue, green, yellow, white, black, brown or combinations of these colours. This enables the circuit for which each core is used to be quickly identified, and is useful in tracing a circuit for removal, renewal or modification.

3. The standard cables which have been developed for use in low tension circuits on aircraft are described in this chapter. Particulars are also given of cables used with certain associated ground equipment.

DESCRIPTION

4. The name under which a cable is listed for Stores Reference in A.P.1086 (Part 3D, electrical stores) is based on the make-up, covering and function of the cable. Each name is thus directly descriptive of the core, covering, rating and special purpose of the cable concerned, so that the correct type of cable for any specific purpose may be easily selected.

(i) *Core.*—The prefix of a cable name generally indicates the number of cores of which it is made up. Thus cables, the name of which begin with uni-, du-, or tri-, will have one, two or three cores respectively.

(ii) *Cover.*—The type of covering which binds the cores together is shown by the main part of the class name. For example, "cel" indicates a cable finished in cellulose varnish. "Met" in the cable name indicates that the outer cover of the cable is braided with metal wire.

(iii) *Rating.*—A numeral following the cable name generally classifies the normal current rating of the cable, based on voltage drop and temperature rise (see para. 9).

5. Thus "Ducel 4" is a two-core cable, finished in cellulose lacquer and nominally classified at 4 amperes. "Trimet 7" describes a three-core cable, finished in metal braiding and nominally classified at 7 amperes.

Cores

6. Each core of a cable is made up of a number of strands of copper wire, and on the gauge of these strands and the number used will depend the current carrying capacity of the core. For example, Unimet 4 is a one-core cable, the core being usually composed of 9 strands of 0·012 gauge wire, with a current carrying capacity of 4 amperes, while Unimet 64, still a one-core cable, has 368 strands of 0·012 gauge wire, and a current carrying capacity of 64 amperes.

7. The following prefixes are used to indicate core numbers in the general ranges of aircraft low tension cables:—

Uni-	meaning 1 core	Octo-	meaning 8 core
Du-	2	Nono- (obsolescent)	9
Tri-	3	Deca- or Tencore-	10
Quadra-	4	Twelve-	12
Quin- or quinto-	5	Twentwo-	22
Sexto-	6	Twenfive-	25
Septo-	7		

Covering

8. The following list gives the class names of the various types of cable used in aircraft and associated ground equipment for all purposes except high tension and radio frequency, together with a brief description of the covering indicated by each name. Unless otherwise stated, the conductor cores for these low tension cables are of tinned stranded copper, insulated with VIR—Vulcanised India Rubber—or an equivalent synthetic substitute. Details of H.T. cables will be found in Chapter 2 of this section.

Aircraft wiring

(*a*) -cel- Cores insulated with VIR, taped and cotton braided, with a cellulose finish overall, as in Ducel 4, fig. 3.

(*b*) -rubber- Cores insulated with VIR; no further covering, as in Unirubber 7, fig. 3. "Unirubber small" cables are used for radio cable forms only.

(*c*) -vin- Cores insulated with VIR, and protected by an overall sheath of PVC (Polyvinal chloride), as in Trivin 7, fig. 3. The VIN range of cables is intended to supersede the CEL range, when adequate supplies are available.

(*d*) -met- Cores insulated with VIR, taped and braided overall with tinned copper wire, as in Sextomet 4, fig. 3.

The flexmet range is similar in covering, but has a more flexible conductor. Uniflexmet, fig 3.

Special purpose cables

(*e*) -sheath small- Cores insulated with VIR, and protected by T.R.S. (tough rubber sheath). For use on armament requiring very flexible cable at extremely low temperatures. Quintosheath small 4, fig. 3, illustrates this type.

(*f*) -flamet- The VIR insulated cores have a glass silk covering; they are then taped and tinned copper braided overall. This class, of which Duflamet 7, fig. 3, is an example, is designed for use in positions where fire-resisting qualities are a requirement.

(*g*) -flex- The cores are insulated with VIR and then cotton braided. This class of cable is used for special purpose low rating wiring only, as in Instruflex, for electrical instrument wiring.

(*h*) -flexrubber- The cores are insulated with VIR; no further covering. This cable is similar to 8 (*b*) but with extra-flexible conductors. It is used for electrically heated clothing.

(*i*) -genmet- The VIR insulated cores are taped and braided with tinned copper wire overall. This cable is designed for connecting engine-driven aircraft generators to the general installation. Trigenmet, fig. 3, is typical of this range.

(*j*) -coremet- Cores insulated with VIR, taped, and braided overall with tinned copper wire, as in Sextocoremet No. 1. Sometimes individual cores also are braided with tinned copper wire, as in Octocoremet No. 2.

(*k*) -corevinmet- Cores insulated with rubber and/or polythene, are sheathed with PVC and metal braided overall. For connecting Type WW. sockets used for inter-connecting radio equipment.

(*l*) -petrol-resisting- The conductor is insulated with a petrol resisting material. The cores are wormed to circular form, and sheathed with a petrol resisting material. This cable, as its name implies, is designed for use with petrol gauges. 3-core petrol resisting cable, fig. 3, is typical of this range.

(*m*) -univinstwire- A single core cable, the stranded copper conductor being sheathed in a thin wall of PVC in one of eleven different colours. Designed for use with instruments where space restriction prevents the use of a larger sized wire. Univinstwire Red is shown in fig. 3.

(*n*) -stretch- Elastic core covered with metal wire braiding, interlaced with rayon to form the conductor, rubber-sheathed overall. An extensive intercommunication cable.

Cables for ground use

(*o*) -TRS-(sheath) Tough rubber sheathed cables for trailing across open ground only. Several class names come under this head, including Dusheath, Trisheath, Quadrasheath and Quintosheath.

(*p*) -allvin- The stranded copper conductors are PVC (Vin) insulated and sheathed. These cables are introduced as substitutes for the rubber cables in the TRS group, to relieve the rubber shortage. It should be noted that while Duvin, used for aircraft installation, is flat, Duallvin, used for ground training purposes, is round. Duallvin, fig. 3, is a typical example.

(*q*) -vircom- The VIR insulated cores are taped, cotton braided, and compounded. This type of cable is intended for fixed wiring on ground equipment and buildings.

(*r*) -Lead sheathed cables- The VIR insulated cores are taped and lead sheathed overall. This group is intended for fixed wiring under outdoor ground conditions. In this range are Unilead and Twinflat; fig. 3 shows Twinflat.

Current rating

9. The numeral at the end of the cable name usually indicates the nominal classified current rating, based on temperature rise and voltage drop. As a general approximation, it may be said that the current rating of the small sizes up to and including the 19 size is based on a permissible

voltage drop of 0·1 volt per yard. The 37 size gives a drop of 0·1 volt in 1·5 yard and the 64 size a drop of 0·1 volt in 2·5 yds. For greater accuracy, the following table gives the normal and maximum possible continuous current for cables installed *each by itself in free space.* The maximum figures are based on a temperature rise in air of about 20 deg. C. Allowances must be made when cables are bunched or enclosed in conduit, and the *voltage drop must be taken into account.*

TABLE 1

NORMAL continuous rating amps	*Volt drop per yd.*	*MAXIMUM continuous rating in amps., varying with the number of cores forming the cable*							
		1 core	*2 core*	*3 core*	*4 core*	*5 core*	*6 core*	*7 core*	*Over 7*
4	·100	10	10	10	6	6	6	6	4
7	·100	12·5	12·5	12·5	9	9	9	9	7
19	·100	30	25	22	19	19	19	19	19
37	·062	60	50						
64	·039	106	95						
83	·034	144							
138	·034	206							

INSTALLATION

10. In view of the low voltages used and the relatively high currents flowing, it is essential in aircraft wiring to use cables capable of carrying the load; otherwise, the drop in voltage over a length of cable may be such that the apparatus will not operate efficiently.

11. Cables are tested in various ways to ensure their efficient operation in service. Effects of exposure to weather, sea-water, and dampness can be largely overcome by weatherproofing. Exposure to acid or other injurious conditions should be avoided where possible. Cables should not be installed near fuel or oil fillers, vents, or overflow pipes, if this can be avoided, and correct types of cable for use in such situations should be selected. Continuous vibration, undue stretching, and over-loading must also be avoided. Where cables are taken through bulkheads, fairings, fabrics and the like, the holes must be bushed to prevent chafing. Conduits through which cables are to be drawn must have clean smooth edges, and their ends should be flared or bell-mouthed to prevent abrasion of the cable-covering on the sharp edges.

12. The fixing of cables, ducts, cleats, etc., must not involve any drilling or modification of the aircraft structure which would be liable to weaken it. Cables must be adequately supported throughout their whole length, and loops, slackness or straining must be avoided. When connected to terminal blocks, cables should be cut approximately 2 in. longer than the minimum necessary, to allow for renewal at the connection point in case of breakage. Details of servicing and installation of the various systems of aircraft wiring are given in other chapters in this section of A.P.1095A.

They are:—

Chap 5 Breeze wiring systems
6 G.E.C. wiring system
7 Strip connector wiring system
8 Lucas Supermarine system of aircraft wiring
9 Lucas wiring system

13. Cable drawn into a conduit or similar fitting must be handled carefully and systematically, and *every precaution must be taken to avoid twisting or kinking* which might result in damage to conductors.

14. Cables for power services must not be run in common ducts with wireless, ignition, or similar circuits, and must be separated from these as far as space permits.

15. Joints are not permissible in any cables, except in extreme emergency (see para. 21) and no looping is allowed. Where a cable passes between two components of the aircraft, as for example between fuselage and planes, or between fin and rudder, provision is made for disconnecting the cables. Terminal blocks, plugs and sockets, etc., fixed in accessible positions, may be installed for this purpose.

16. The cable should not be soldered to the terminals of any piece of apparatus if a satisfactory joint can be made in any other way. The core of the cable should be looped round screws in a clockwise direction, so that tightening the screw will not unhook the wire from the terminal. When the wire is held between two plane surfaces, such as a washer and the body of a terminal, it must not be soldered. In the following instances, however, it may be necessary to solder the wire to ensure good connection:—

(i) Where space does not permit the use of a screw type terminal, in which case the cable conductor may be soldered directly into a hole on the contact point of the fitting. This method can only be used where very infrequent disconnection is required.

(ii) In engine starter and similar heavy multi-strand cables, where the strands cannot be suitably clamped under a screw head, a suitable soldering lug must be used.

(iii) Where apparatus is fitted with terminals of the pillar type with nuts, it may be advisable to use small metal eyelets which clamp the strands, or suitable soldering lugs. In both these cases, spring washers must be fitted.

(iv) Where apparatus is fitted with terminals of the grub screw type, a thin copper sleeve may be passed over the strands of the cable and spot-soldered at the end, if it is necessary to increase the size of the core to ensure good mechanical clamping.

17. Soldering the flexible strands of a cable requires great care, as the strands are liable to break away at the point where the core loses its flexibility through the rigidity of the solder. Great care must be taken to prevent the solder running up the core. The flexible cable must be well supported at the point near the soldered portion to avoid a bending movement which might cause the strands to break. Only resin flux complying with DTD.599 may be used as a soldering flux.

Compass interference

18. Care must be taken to place cables so that their magnetic field does not interfere with the functioning of the aircraft compasses. Services must be run as far as possible with the positive and negative leads of each service adjacent to each other, to avoid loops which will create a magnetic field. Particular care must be taken in the case of aircraft in which an earth return system of wiring is employed.

19. When new circuits are installed, tests should be carried out on various headings to ensure that compass interference is not caused. The maximum permissible deviation in compass readings when the circuit is energised is 1°.

SERVICING

20. Aircraft wiring installations must be examined periodically in accordance with the relevant inspection schedules. Details of insulation tests will be issued in Chapter 4 of this section of A.P.1095A. Soldered joints or connections should be inspected at the point where the stiff soldered portion of the cable meets the unsoldered flexible portion. If the loosened strands of the core are breaking away at their junction with the soldered portion, the soldered end must be cut off, the covering of the cable stripped back a little further, and the end re-soldered. Damaged or broken cable should be entirely replaced whenever possible. In extreme emergency, however, it may be necessary to repair the cable, in which case, the following instructions must be followed.

Cable jointing

21. When, in a case of extreme emergency, a cable has to be jointed, special precautions must be taken to ensure that the joint is sound electrically and mechanically, and adequately insulated. The method to be used is shown stage by stage in fig. 1. Bare back the insulation for approximately 1 in. from each cable end to be jointed and slip a rubber sleeve, not less than 1½ in. long, over one of the ends. Twist the two bared ends of wire tightly together, and solder them into position with a resin solder, or other approved type (see para. 17). Wrap the joint with rubber tape and pull the rubber sleeve along until it covers the joint in the wires. Bind each end of the sleeve firmly with twine, and finish with a coating of dope. Where there is not sufficient cable to allow for the cores to be twisted and soldered, a short length of cable may be inserted, both ends being joined to the original cable in the manner described above.

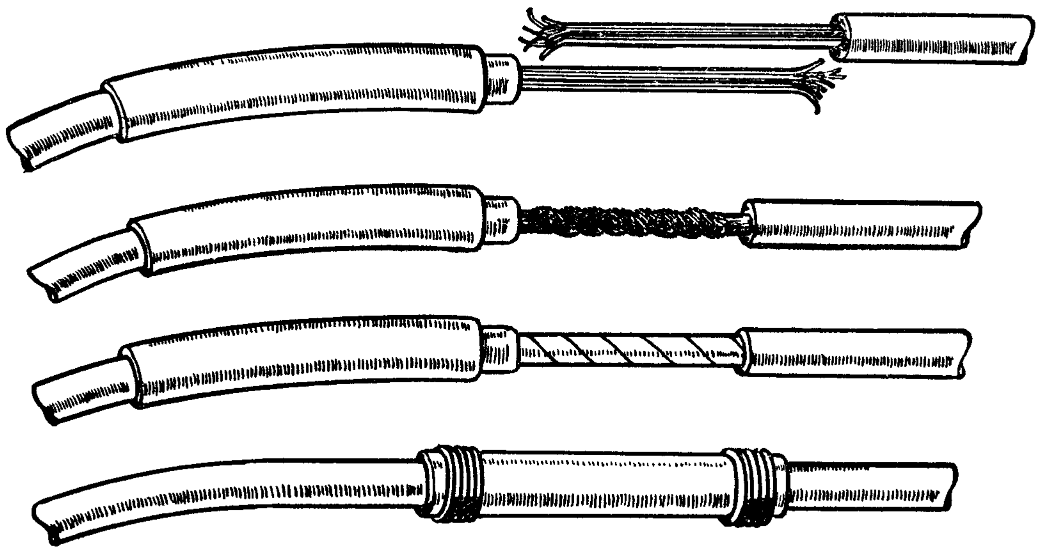


Fig. 1.—Stages in cable jointing

Repairs to P.V.C. conduit

22. Deterioration of the insulation of cable may be caused by prolonged exposure, or by the action of heat or deleterious substances such as oil or petrol, and damage may be caused by accidental stresses or by chafing at the fixing points, at lead-in sections to instruments, conduits, or other points of contact with adjacent parts. Such points should therefore be examined regularly, and any looseness of the cleats rectified.

23. Damaged P.V.C. conduit may be repaired quite successfully, providing the damage is not excessive—that is, providing that holes are no larger than ⅜ in. in diameter and tears no longer than 4 in. Fig. 2 shows the method to be followed. Take a patch of P.V.C. large enough to cover the damaged part. Clean both patch and conduit with a rag dipped in petrol, and dry thoroughly. Apply P.V.C. cement (Stores Ref. 33C/817, in 4 oz. tins) to both patch and conduit, and put the patch in place, pressing it down firmly in position to make sure that it adheres well. A slight chamfer on the edge of the patch will help to make a good joint. If a clean, smooth soldering iron is available, it should be heated slightly and run gently round the edges, welding the patch into place. Do not overheat the iron, or the P.V.C. will be charred, and the cement will lose its grip.

CARE OF ELECTRIC CABLES IN STORAGE

General

24. Electric cables must be stored in such a manner that they will be in prime condition when needed. Cables require a clean, dry, sheltered place, free from extreme changes in temperature. Careless handling, improper storage, heat, direct sunlight, and moisture are the principal causes of damage to cables in storage.

Conditions of storage

25. Wherever possible, cables should be stored indoors, in a cool, dry place. Avoid storing them near the oils, acids or other chemicals which might cause damage through corrosion.

26. When cable is stored in an open shed, or in the open, the cables and reels must be protected from moisture from the ground by being placed on a raised platform or on planks.

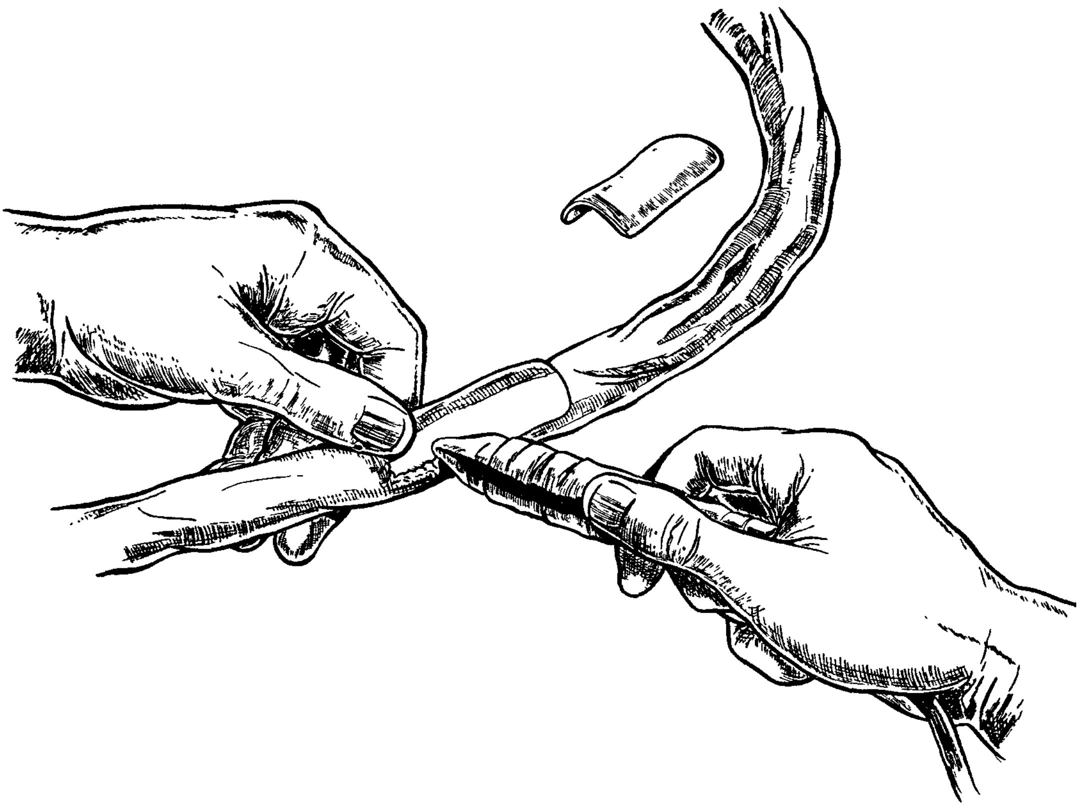


Fig. 2.—Method of repairing P.V.C. conduit

27. Cables should never be exposed to direct sunlight. Extreme temperatures should be avoided. The P.V.C. or cellulose lacquer covering of cables will soften and may adhere to adjacent layers at temperatures above 160°F., and it will become very brittle and crack easily at −4°F., so that extreme caution must be used in handling such cables at temperatures much below freezing. Rubber insulation may become brittle and crack at approximately −40°F., while high temperatures will increase the oxidisation or ageing of the rubber.

28. Cable wrapped or packed in cartons should be kept in the original wrapping or carton. When reels of cable are moved, they must be rolled in the direction that will tighten the layers of cable on the reel; they should be rolled on a smooth surface, to avoid breaking the lagging or the flanges of the reel.

Sealing of cable ends

29. All types of cable should have the ends sealed when in storage to prevent the entry of moisture.

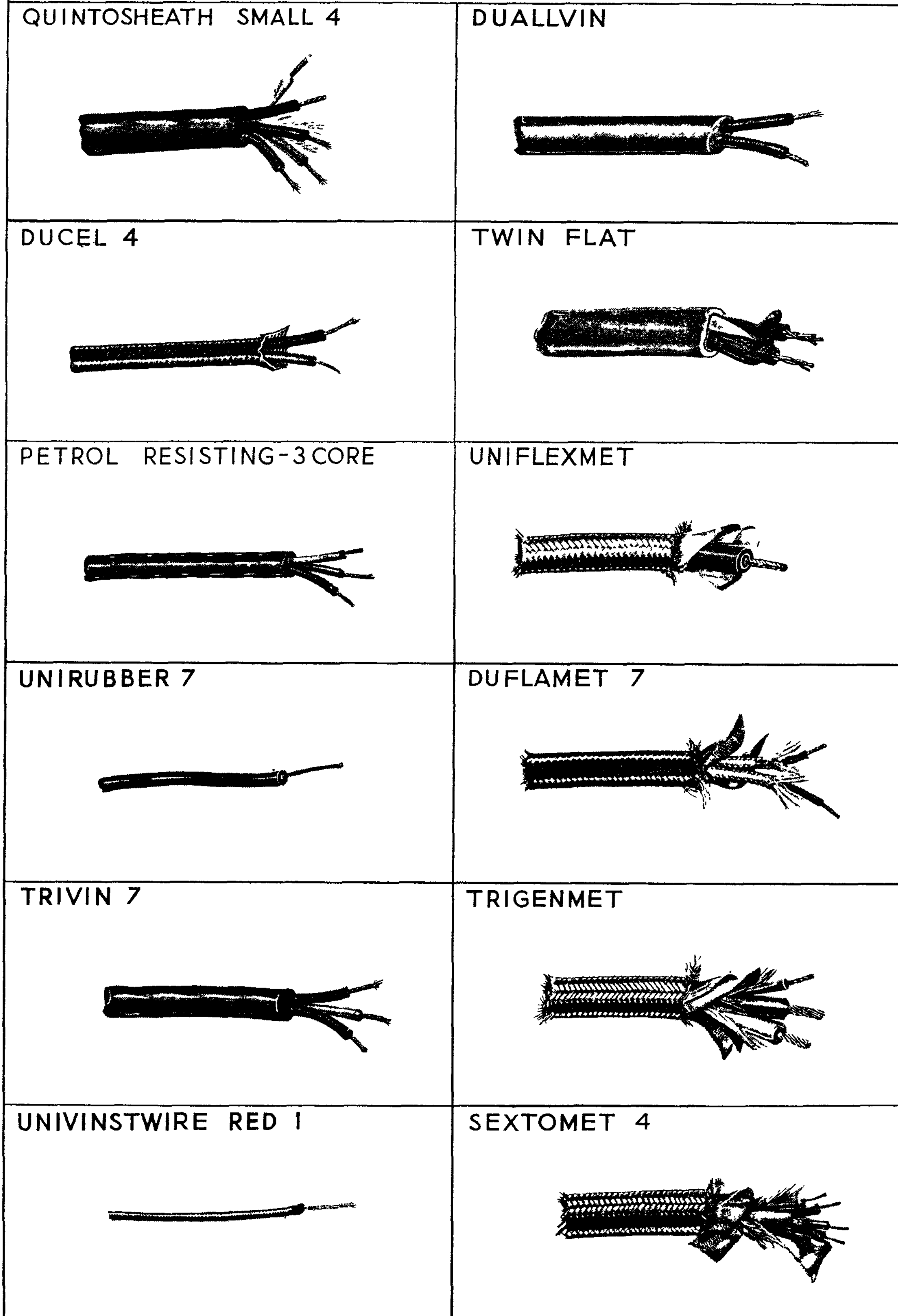
30. Lead covered cable must always be sealed. The small size cables should have their ends dipped in hot paraffin wax (Stores Ref. 33C/318); in larger sizes, the end of the lead sheath should be stripped back for a short way, and a seal of plumber's metal or solder should be applied.

31. Alternatively, the lead sheath should be extended beyond the conductors by tapping with a wooden cable dresser, and the cable should then be sealed by soldering a lead disc or elipse on the end of the protruding sheath.

32. Braided and rubber covered cables are best sealed by having their ends dipped in hot paraffin wax.

33. "Met" covered cables should be sealed by having enough of the braiding removed to allow for the application of sealing tape directly on to the insulation first, and then on to the braiding.

P7225 M /G4835 6/45 8500 C & P Gp. 1



To face para. 33

FIG. 3 TYPES OF LOW TENSION CABLE

CHAPTER 2

HIGH TENSION CABLES

LIST OF CONTENTS

Introduction

1. The cables described in this chapter are those normally used for high tension ignition leads or for the high tension circuits of wireless installations. The main distinction between these and the low tension cables lies in the greater electric strength of the insulating covering.

DESCRIPTION

2. *Uniplug* cable (Stores Ref. 5E/81) has a single conductor consisting of 40 strands of 0·010 in. (33 s.w.g.) tinned annealed copper wire. This is covered with a layer of pure rubber and two or more layers of vulcanised indiarubber, to an external diameter of 0·3 in. The resistance is not greater than 8·5 ohms per thousand yards, and the current rating for a voltage drop of 0·1 per yard of single cable is 12 amperes. The weight is approximately 0·06 lb. per foot.

3. Uniplug is primarily intended for making the connections to the sparking plugs of aero-engines, and is used on aircraft not equipped with wireless apparatus. It is also used on sea-borne and naval aircraft and on motor boats for the aerial lead from the set to the aerial winch or insulator, and may also be used for the high tension positive lead from the high tension supply to the transmitter, when this lead is not incorporated in the multi-core cable.

4. *Uniplugcotton* cable (Stores Ref. 5E/917) consists of uniplug cable covered with a varnished cotton braiding coloured red The thickness of the rubber covering is the same as that of uniplug cable, and the diameter over the braiding is 0·35 in.

5. It is intended for wireless circuits only, as indicated by the red colour, and is used on land aircraft for the aerial lead and for the high tension positive lead of the transmitter. It should not be used on sea-going or naval aircraft as the cotton braiding is liable to become saturated with salt water and leakage would result.

6. *Uniplugmet* cable (Stores Ref. 5E/758) consists of uniplug cable with the addition of a lapping of varnished cambric and a close braiding of tinned phosphor-bronze wire. The metal braiding forms a complete electrostatic shield round the conductor. and should always be earthed. The weight of the cable is approximately 0·12 lb. per foot.

7. Uniplugmet is used for making the connections to sparking plugs and starting magnetos on aircraft and motor boats fitted with wireless apparatus.

8. *Unispark* 7 cable (Stores Ref. 5E/82) is similar in construction to uniplug cable but is larger in diameter and so has a higher insulating strength. The conductor consists of 41 strands of 0·0108 in. (32 s.w.g.) copper wire and the diameter over the rubber insulation is 0·42 in. The nominal current carrying capacity is 7 amperes.

9. Unispark 7 is intended for use as an aerial lead for aircraft wireless installations where very high voltages are generated, such as certain of the short wave transmitters.

10. *Unilead* (*H T*) 7 cable (Stores Ref. 5E/1429) and *Unilead* (*H.T.*) 19 cable (Stores Ref. 5E/1430) have a rubber-insulated core which is taped and covered with a lead sheath. They are for use in the high tension circuits of ground transmitters, and are not used in aircraft. The figures 7 and 19 indicate the nominal current carrying capacity.

INSTALLATION

11. Cables used for aerial leads of transmitters are arranged to be as short and rigid as possible. They must be kept away from earthed metal, particularly sharp edges, a clearance of at least two inches being desirable. In wooden frame aircraft the cable may be fixed to a member of the frame if one is available. In other aircraft of wooden construction and in all-metal aircraft where special insulators are not provided the cable is fixed with cleats of insulating material to a varnished wooden board. Special bakelite insulators are used for supporting Unispark 7 cable, which is normally associated with extra high voltage.

12. Where cables come into contact with the supports measures are taken to prevent abrasion of the insulation. At the cleats a short length of varnished insulating tubing is fitted over the cable and where the cable passes through a fairing or bulkhead an insulating bush is used.

SERVICING

13. Every cable must be examined periodically throughout its entire length. If any part is damaged or shows signs of deterioration of the insulation the complete cable must be replaced. No joint is permissible in any cable.

14. Deterioration of the insulation may be caused by prolonged exposure or by the action of deleterious substances such as oil, and damage may be caused by accidental stresses or by chafing at the fixing points or other points of contact with adjacent parts. Such points should therefore be examined and any looseness at the cleats should be rectified.

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CHAPTER 3

FUSES AND FUSE BOXES

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. Fuses employed in aircraft are intended to operate should the normal loading of the circuit in which they are installed be exceeded. All fuses are explosion proof and unaffected by vibration. Although the various fuses differ in detail their general construction is similar and all function on the same principle. The following types of fuse are available:—

TABLE 1

Stores Ref.	*Type of fuse*	*Nominal capacity (see para. 4)*	*Section of end cap.*
5C/204	Type A	20 amp. continuous	Round
5C/463	Type B	10 amp. continuous	Round
5C/515	Type D	5 amp. continuous	Round
5C/550	Type E	40 amp. continous	Square
5C/878	Type F	60 amp. for 15 secs.	Square
5C/907	Type G	25 amp. for 5 mins	Round
5C/1264	Type H	2 amp. continuous	Round
5C/1321	Type J	100 amp. for 15 secs.	Square
5C/1666	Type L	60 amp. for 15 secs.	Round
5C/1667	Type M	60 amp. continuous	Square
5C/1963	Type N	120 amp. continuous	—
5C/879	Type S	2·5 amp. continuous	Small round
5C/880	Type S	5·0 amp. continuous	Small round
5C/881	Type S	10·0 amp. continuous	Small round
5C/1225	Type S	20 amp. for 1 min.	Small round

Note.—All round cap fuses have a length of 1·5 in. overall and a cap diameter of 0·45 in. Square cap fuses have a length of 1·5 in. overall and a cap 0·50 in. square. Small round cap fuses have a length of 1 in. overall and a cap diameter of 0·30 in.

2. The fuse boxes installed in aircraft vary considerably in size and form according to the number and types of fuses they accommodate. Three assemblies are in service for the round cap and small round cap fuses, the 1-way, 4-way, and 8-way boxes. Type B fuse box is the only one housing square cap fuses. It is a 1-way assembly. The following types of fuse box are available:—

TABLE 2

Stores Ref.	Type of fuse box	Weight	Dimensions length and depth	Fuses housed
5C/445	Type A	2 oz.	2½ in. × 1¼ in	1 Round
L.37 5C/~~[illegible]~~549	Type B	4 oz	3¼ in × 1¾ in	1 Square
5C/758	Type C		4½ in × 2¼ in	4 Round
5C/761	Type D		2¾ in. × 1½ in	8 Round
5C/882	Type E	–	2¾ in. × 1½ in	1 Small Round
5C/883	Type F	–	4 in. × 2¼ in	4 Small Round
5C/886	Type G	—	7½ in. × 2¼ in	8 Small Round
5C/1967	Type J	—	2¾ in. × 2¾ in	1 "N" type

Note.—Fuses are not supplied with fuse boxes from stores and must be applied for separately

DESCRIPTION

3. The majority of fuses have an element of tinned copper wire to B.S.128. Type N fuse is an exception, employing an element of pure sheet electrolytic zinc. Earlier models of type E fuse also differ from normal practice in having an element of two lengths of cadmium copper wire soldered together at the centre of the tube. When normal current is exceeded the joint fuses thus breaking the circuit. Tinned copper wire is now the standard element in fuse, type E.

Current rating

4. Referring to Table 1, the term *nominal capacity* means that the fuse will withstand the rated current for the period stated without deterioration. Continuous use above the rated capacity will result in progressive deterioration, eventually resulting in the fuse blowing even on rated load (*see* para. 38).

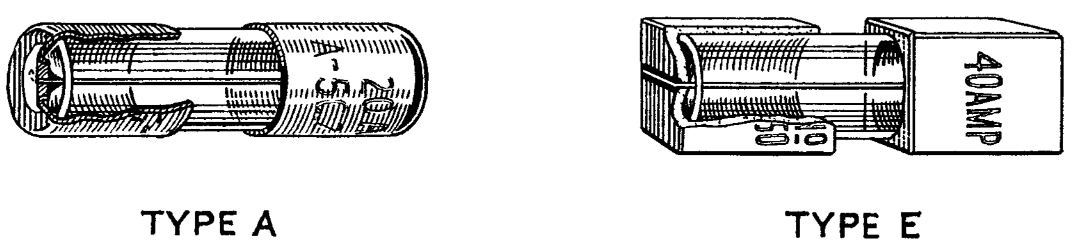

Fig. 1.—Fuses, types A and E

Fuse, type A

5. Construction of fuse, type A is shown in fig. 1. Two brass end caps are secured with sealing compound over the ends of the glass tube. The fusing element runs axially through the tube and passes through a hole in the centre of each end cap. It is then soldered into position on the outer face, the solder filling the hole in the caps and forming a sealed chamber. With one exception (fuse, type N) the caps form the terminals of the element. Two clips, one for each cap, are provided to hold the fuse rigid and make the electrical connection. Removal and replacement is therefore easily effected.

Fuse, type B

6. This fuse is similar in construction to fuse type A, but of higher current carrying capacity. It is in use in fuse boxes, types A (1-way), C (4-way), and D (8-way).

Fuse, type D

7. Essentially the same as fuse, type A, in constructional features but of lower nominal capacity, this fuse is used in fuse boxes, types A (1-way), C (4-way), and D (8-way).

Fuse, type H

8. This fuse is similar in construction to fuse, type A, but of higher current carrying capacity It is in use in fuse boxes, types A (1-way), C (4-way), and D (8-way).

Fuse, type G

9. Structurally similar to fuse, type A, this fuse has a nominal capacity of 25 amp. for 5 mins. It is used in fuse boxes, types A (1-way), C (4-way), and D (8-way).

Fuse, type L

10. Fuse, type L, is similar in construction to fuse, type A, but has a rating of 60 amp. for 15 secs. It is used in fuse boxes, types A (1-way), C (4-way), and D (8-way). A number of these fuses have been issued incorrectly marked "40 INT". To avoid confusion, this marking should be obliterated, and the marking "60 INT" substituted.

Fuse, type E

11. At present the lowest rated of the square cap fuses, fuse, type E, shown in fig. 1, is designed to fit into heavy clips providing a large contact area. In general, this class of fuse is employed in circuits where large currents are encountered. Fuse, type E, is included in fuse box, type B (1-way) only.

Fuse, type F

12. Constructionally identical with fuse, type E, this fuse is rated to carry 60 amp. for 15 secs. It has a continuous rating of 40 amp. and is used in circuits where the continuous load is not greater than 40 amp. but where heavy starting currents are encountered. Fuse, type F, is employed in fuse box, type B (1-way). These fuses were originally marked "40 amp.". This marking was subsequently changed to "60 int." (*i.e.* 60 amps. intermittent) to denote more particularly the function for which this fuse is intended, *viz.* high starting currents. Stocks of fuses with both markings are in existence.

Fuse, type M

13. This is a square cap type of fuse, similar to fuse, type E, in construction but having a 60 amp. continuous rating. Employed in fuse box, type B.

Fuse, type J

14. Of square cap construction, this fuse is similar to fuse, type E, but rated at 100 amp. for 15 secs. It is used in conjunction with fuse box, type B.

Fuse, type N

15. Fuse, type N, is of unusual design and is used in conjunction with a special fuse box, type J. Basically the fuse consists of a glass tube, two end caps of insulating material, and an element extending on either side of the sealed chamber for terminal connections (*see* fig. 4). The element is of pure sheet electrolytic zinc and is calculated to carry a current of 120 amp. continuously. An identification tag is fitted round the glass tube, this also serves to lift out the fuse for replacement.

Fuse, type S

16. There are four versions of this fuse differing in current carrying capacity (*see* para. 1). In appearance and construction, fuse, type S, is a reduced model of type A, the description of which appears in para. 5. These fuses are employed in conjunction with fuse boxes, types E, F, and G, which are 1-way, 4-way, and 8-way assemblies respectively.

Fuse box, type A

17. Type A fuse box, with the operating fuse inserted, is shown in fig. 2. It consists of a light alloy box with mounting lugs and a hinged lid. The inside of the box is lined with insulating material, upon which is mounted an insulating block to hold the fuse clips and terminals. Bushed holes for the cable are situated at each end of the box adjacent to the terminals.

18. The terminals, consisting of screws with captive washers, fit into blocks of conductive material forming shrouds round the screw heads. The lower end of each terminal block passes through the insulating block and is spun over on to a countersunk washer. Two clips grip the fuse in position, each consisting of two parts. One end of each clip part is held in position beneath one of the terminal blocks whilst its other extremity is shaped to make good contact with a circular fuse cap. The clips are in direct electrical contact with both the fuse and the terminals.

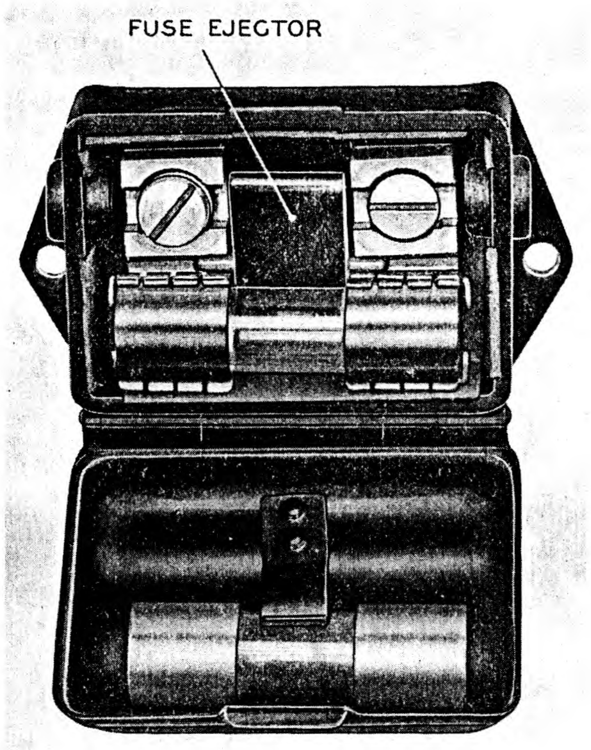

Fig. 2:—Fuse box, Type A

19. The lid is hinged to the box at the rear and clips on to a lip at the front. It is shaped to accommodate the spare fuse which is held in position by a spring clip riveted to the lid. A square sheet of varnished cambric is fitted between the spare fuse and the fuse in use to prevent the spare shorting across the clips accidentally.

20. In order to eject the fuse, which, being round is hard to grasp, a fuse ejector is provided. This consists of a broad lever pivoted at its centre with the inner end lying beneath the centre of the fuse. It is chamfered off at one corner, and when pressure is applied the ejector throws up one end of the fuse thus facilitating its removal.

Fuse box, type B

21. The type B fuse box is shown in fig. 3 with fuse inserted. It consists of two mouldings of insulating material, a base and a cover. The base has flanges at the ends with a metal bushed hole in each to take a fixing screw. Two knurled captive screws hold on the cover.

22. Each fuse clip consists of two springs, which are extended at the base and fixed over bushes moulded into the box. The top edges of the bushes are spun over to hold the clips rigidly and make good electrical contact. The bushes are threaded internally and fitted with screws and washers, forming the body of the terminal. An insulating shrouding piece that protects the screw heads is screwed to the base block in the centre.

23. The cover is recessed to accommodate a spare fuse which is secured by clips. An internal rib shaped to grip a square cap fuse bears on the operating fuse and makes sure it does not work out while in use. When the cover is removed the fuse is easily withdrawn. Slots in the cover and base form an aperture at each end for entry of the cables.

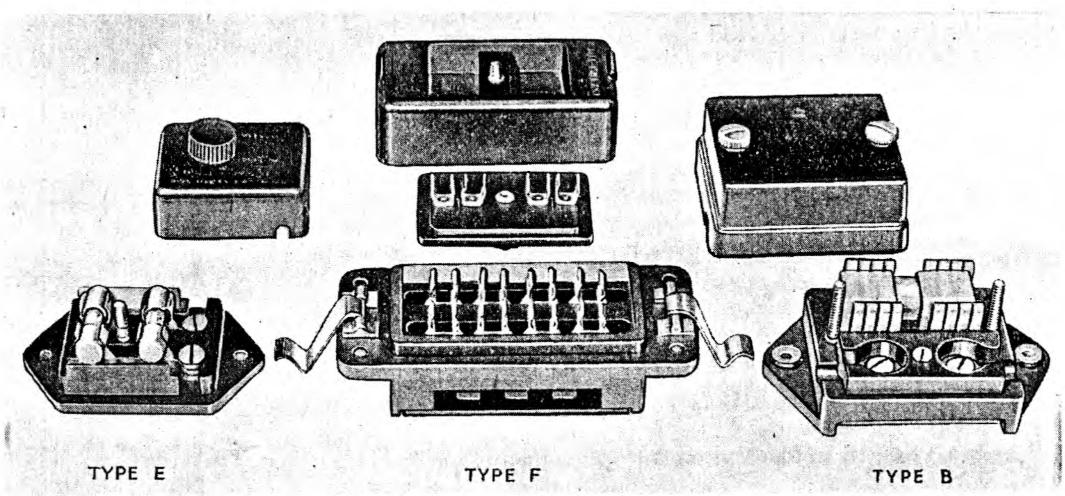

Fig. 3.—Fuse boxes, types E, F and B

Fuse box, type C

24. This is a four-way assembly housing round cap fuses such as type A, being generally similar in construction to fuse box, type F, shown in fig. 3. It consists of two primary mouldings, a base and a cover, a false lid accommodating four spare fuses, and a protective terminal cover. The base mounting has two countersunk fixing holes at either end and the cover is affixed to the base piece by two slotted captive screws. The latter fit on to pillar mountings sunk into the base piece.

25. The four pairs of fuse clips are of U form and circular in shape at their extremities for the insertion of round cap fuses. Each clip is riveted to the base of a brass pillar drilled and tapped to take the terminals which are inserted from the opposite side of the moulding. The screws are fitted with a captive washer and the heads protected by a shrouding piece moulded integral with the base.

26. Accommodating the four spare fuses is a panel that fits into a recess in the main cover, and is held in position by a knurled, captive screw. The cover has two observation inlets in the base of the recess, making it possible to ascertain whether the spare fuses are in position without removing the panel. Access to the terminals in the base is made by removing a rectangular protective cover of insulating material, secured to the base by four countersunk screws.

Fuse box, type D

27. This fuse box, an eight-way assembly, is an enlargement of fuse box, type C, described in paras. 24–26. It has accommodation for eight round cap fuses, such as the type A fuse. As fuse box, type C, is essentially similar in lay-out to fuse box, type D, the description of the former will serve for both assemblies. The following points of difference should be noted, however. Fuse box, type D, has eight spare and eight operative fuses and the protective terminal cover is held in position by eight countersunk screws.

Fuse box, type E

28. The type E fuse box shown in fig. 3 is a one-way assembly consisting basically of two mouldings of insulating material, base and cover. The former has two flanges at the ends with a fixing hole in each. A single brass screw with head of insulating material secures the cover in position.

29. The fuse clips are of U-form and circular in shape at their extremities to house fuse, type S. A connecting strip extends from the base of each clip, being fixed over bushes moulded into the box.

The strips are also riveted centrally to the base of the fuse clips. Internally threaded and fitted with screws and washers, the bushes form the body of the terminals. The screw heads are protected by a shrouding piece which is an integral part of the base moulding.

30. The positioning of the spare fuse in fuse box, type E, is unusual in that it is on the base and adjacent to the operating fuse. To assist in ejecting the fuse a chamfered portion is moulded in the base piece. When it is to be removed, pressure should be applied to either end of the fuse and the opposite end slides up the chamber disengaging the cap from the clip and making removal easy. Slots in the base and cover form an aperture at each side for entry of the cables.

Fuse box, type F

31. The type F fuse box shown in fig. 3 is a four-way assembly consisting of two basic mouldings, a false lid taking four spare fuses, and a protective terminal cover. All these mouldings are of insulating material. The base mounting has two fixing holes at either end. Between these holes is the hinge pin and mounting of an S-clip employed to secure the lid.

32. A description of the fuse clips, terminals, etc., appears in para. 25. Fuse box, type F, houses four small round cap fuses, type S. Accommodating the spare fuses is a panel that fits into a recess in the main cover, and is held in position by a captive screw. The cover has two observation inlets in the base of the recess, making it possible to ascertain whether the spare fuses are in position without removing the panel. Holding the main cover in position are two S-clips that fit over the lips on the end of the moulding. The method of extracting the fuse is the same as for the type E fuse box. Access to the terminals is made by removing a rectangular protective sheet of insulating material secured to the base by four countersunk screws.

Fuse box, type G

33. This fuse box is an eight-way assembly housing S type fuses. It is essentially similar in lay-out to the smaller type F fuse box described in paras. 31 and 32. This description also serves to cover the type G box, bearing in mind that fuse box, type F houses only four fuses, and is approximately half the length of the type G unit.

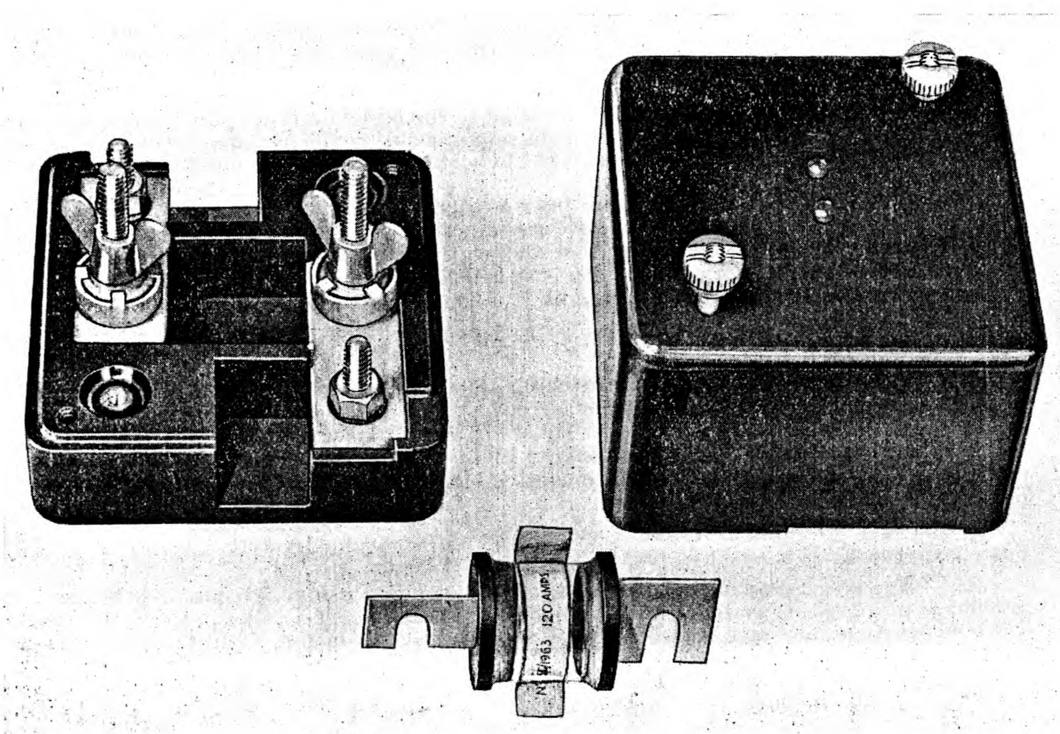

Fig. 4.—Fuse box, type J and fuse type N

Fuse box, Type J

34. This fuse box, which is illustrated in fig. 4, is designed in conjunction with fuse, Type N. It is a large one-way assembly and consists of two mouldings of insulating material, a base and a cover. The base has two fixing holes in diagonally opposite corners, and the cover is held in position by two long captive screws. The fuse is secured by two wing nuts and spring locking washers fitting on pillar mountings sunk into the base. A connecting strip joins the end of the fusing element to the terminals. Slots in the base allow entrance for the terminal leads which are secured by hexagonal nuts and washers. The cover is so designed that, when in position, the fuse and wing nuts are sectioned off from the terminals and leads, thus helping to screen off any flame within the box.

35. The cover also accommodates a spare fuse, Type N, in a U-clip riveted to the moulding. Two ribs locate the spare fuse, and prevent it moving sideways under vibration. It is essential that the spare fuse should have insulating sleeves over the end connections to prevent these making contact with live metal and paralleling the main fuse. If not already provided, suitable sleeves can be made from insulating tubing 13 mm. diameter (Stores Ref. 5F/2031), and 8 mm. diameter (Stores Ref. 5F/2036), cut into 0·7 in. lengths.

INSTALLATION, OPERATION, AND SERVICING

36. Fuse boxes should be mounted in an accessible position, allowing space for the removal of the cover. They are usually grouped together on an instrument or electrical panel with other electrical apparatus. In the strip wiring system employed on numerous aircraft they are mounted inside the distribution boxes.

37. The blowing of a fuse always indicates a fault in the circuit or misuse of some part of the equipment. Fuses should *not* be renewed, therefore, until the cause of the excess current has been ascertained, and the fault rectified. When a fuse has been replaced by the spare carried in the box, a new spare of the correct current carrying capacity should be obtained from stores at the earliest opportunity and the deficiency made good.

38. Fuses should be periodically inspected and if there are signs of overheating or sagging of the element the fuse should be renewed. Any overheating of a copper fuse wire may be noticed by discoloration of the tin coating. This may turn light yellow in colour through overheating, and from dark yellow to blue in later stages if the overheating is continued. An overheated clip is very apt to lose its resilience. The clip and fuse cap should be kept clean so as to make good contact.

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CHAPTER 4

Insulation Testing of Electrical Installations in Aircraft

(Two-pole insulated, and two-pole with earthed negative)

LIST OF CONTENTS

Introduction

1. This chapter deals with the insulation resistance testing of two-pole wired aircraft under dispersal conditions at Service Units, the numerous factors upon which testing in these circumstances depend, and the minimum readings acceptable.

General

2. The insulation resistance of an aircraft electrical installation should be tested with a 250-volt insulation resistance tester, Stores Ref. 5G/152. The readings obtained will be dependent upon the following factors:—

(i) Amount of cable, number of circuits, and equipment under test.

(ii) Deterioration of cable insulation.

(iii) Permissible insulation resistance standard originally required for individual items of electrical equipment when new, or after overhaul.

(iv) Atmospheric conditions.

(v) Ingress of moisture into components during service due to their location in the aircraft.

3. Because of these factors, a reading taken on an aircraft at dispersal, compared with any fixed minimum figure, would be no indication as to the actual physical standard of the insulation. The recommended method of progressively assessing the condition of the insulation of an aircraft is to keep a record of the insulation resistance values obtained, stating the climatic and other conditions obtaining prior to the test, and at the time of testing. It is important, and contributory to good insulation resistance readings, that a high standard of maintenance is maintained, and any necessary action taken in accordance with the instructions laid down in Air Diagram 2551 and Chapter 11 of A.P.1095A, Volume I, Section 3.

4. With reference to sub-paragraph 2 (iii), before an aircraft is put into service the following minimum insulation resistance test figures are obtained by the aircraft contractor after trial flights, and under dispersal conditions.

For bunched positives to earth and bunched negatives to earth:—

(i) 50,000 ohms in dry atmospheric conditions.

(ii) 20,000 ohms in damp atmospheric conditions.

These values are obtained on a complete installation with all items of equipment connected except starter motors and the electrical bomb gear and R.P. installations.

5. Where insulation resistance tests are carried out in service at the appropriate inspection period with the aircraft under dispersal conditions, the following minimum figures may be accepted:—

(i) 20,000 ohms in dry atmospheric conditions.

(ii) 10,000 ohms in damp atmospheric conditions.

These values should be obtained for a complete installation with all items of equipment connected except starter motors and the electrical bomb gear installation.

6. When testing aircraft that have the negative pole earthed to the aircraft frame, it is necessary to isolate the negative by either removing the earth fuse or link, or open-circuiting the earthing switch.

7. The test reading obtained, together with the previous insulation resistance record mentioned in paragraph 3, should then be referred to the Electrical Officer, who will decide on the serviceability or otherwise of the installation. An installation that shows low insulation resistance in wet weather conditions should be tested again in fine weather at the first opportunity in order to ascertain whether the low insulation resistance reading is due to surface moisture or to bad insulation.

Bomb gear circuits

8. These circuits should be tested for insulation resistance separately from the main aircraft electrical system. All control switches must be closed, the pre-selector, if fitted, set in numerical sequence, and the drum switch of the selector switchbox set to "single and salvo". The reading obtained for insulation resistance to earth must not be less than 500,000 ohms. This test reading should then be referred to the Electrical Officer, as stated in paragraph 7.

R.P. circuits

9. These circuits should also be tested separately from the main electrical system of the aircraft. The reading for insulation resistance to earth must not be less than 200,000 ohms.

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CHAPTER 5

BREEZE WIRING SYSTEM

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The Breeze system of aircraft wiring has been developed in order to provide a flexible conduit system with junction boxes at advantageous distribution points, the intersectional connections being made with multiple plugs and sockets of single-ended or double-ended types as appropriate, to permit easy and certain making and breaking of the electrical circuit at:—

(i) the wing breaks,

(ii) removable panels, including pilot's dashboard, carrying electrical equipment and having four or more conductors on the same route,

(iii) the walls of pressure cabins,

(iv) engine bulkheads,

and (v) transport breaks provided to meet the requirements laid down in A.P.970, Section 802, for the removal of components for packing, transport, and storage.

2. A number of flexible conduit assemblies are used and these may contain various combinations of 4-, 7-, 19-, 37-, 64-, and 200-amp. wires, each of which terminates at an appropriate metal socket pin assembled in a bakelite moulding and enclosed in a metal housing to form a multiple socket. The conduit is connected by means of these sockets to junction boxes or panels on which are mounted multiple plugs having suitable combinations to accommodate the socket assemblies. All the sockets and terminal strips within the junction boxes are designated by numbers and/or letters so that the cables appertaining to any particular circuit can be traced, thus simplifying very considerably the task of fault finding. Multi-pin bulkhead plugs act as disconnection points at section breaks.

3. Risk of disconnection due to vibration is reduced by the use of rubber sleeving within both the conduit and junction box. Fault rectification is simplified by the fact that any defective conduit or junction box can be rapidly removed and replaced, thus enabling the damaged item to be repaired on a bench, or a like part to be drawn from stock and fitted without delay. The conduit system is screened and bonded wherever necessary to minimise radio interference and a degree of mechanical protection is provided for the cables.

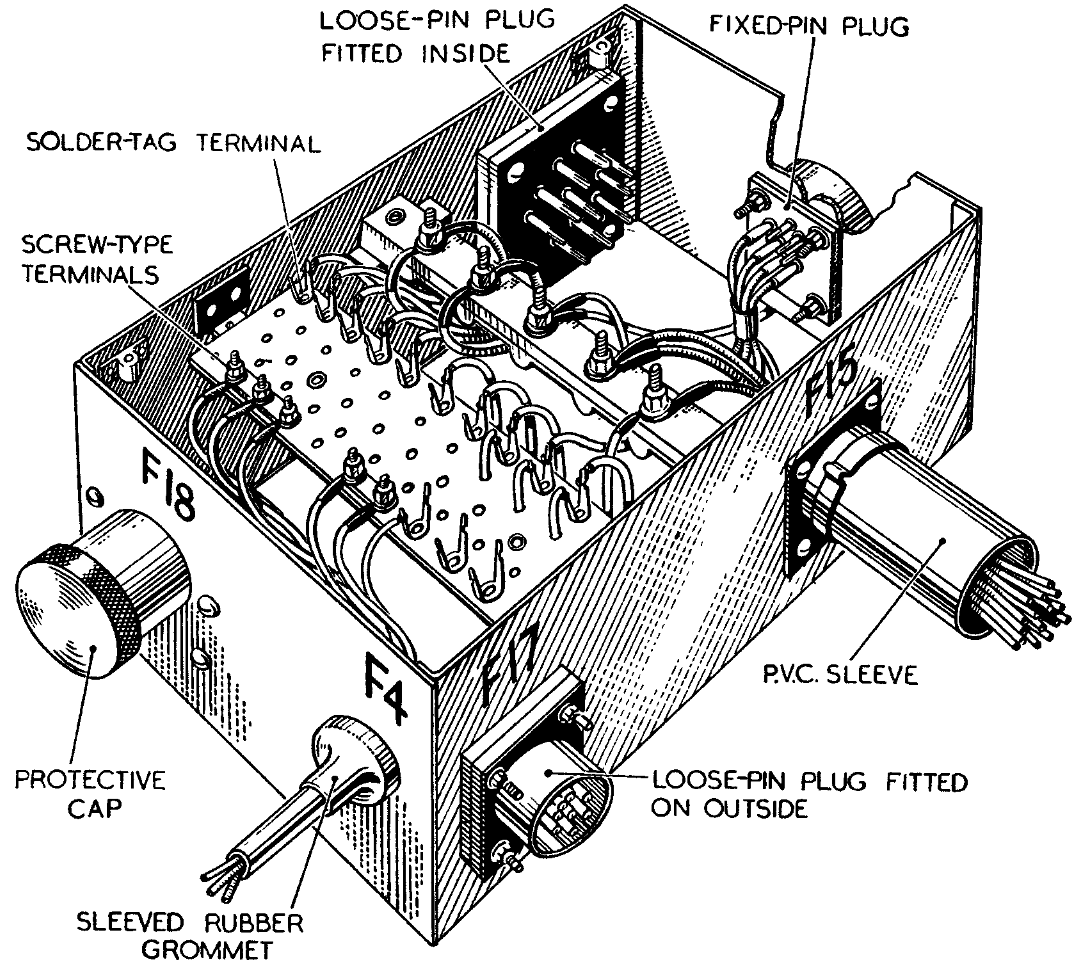


Fig. 1.—Junction box

4. By using a standard aircraft routing chart, which will be found in the appropriate aircraft handbook, the various leads connecting the electrical equipment on the aircraft can be recognised at any point during their travel by their code lettering.

DESCRIPTION

5. While the original system called for conduits of flexible aluminium tubing protected and screened by aluminium alloy or tinned copper braiding, recent developments both in saving metal and for water and oil proofing, have led to the use of Polyvinyl Chloride conduits everywhere except where metal sheathing is essential for screening. In general, fittings are interchangeable for the two types, but where it is necessary to differentiate between the metal braided and the Polyvinyl Chloride conduits they will be referred to in this chapter as the Screened and Unscreened systems, respectively.

6. The following paragraphs describe typical examples of the various types of fittings which are employed in the Breeze installation system. Their variations and development are clearly shown in the comparative diagram, fig. 3.

Multiple plugs

Fixed pin type

7. An example of the fixed pin multiple plug is shown fitted to the junction box in fig. 1. A group of single-ended plug pins is moulded in a bakelite plate, each pin being designated by a raised number and/or letter moulded on both faces of the plate. The pins are carried by the moulding and are so disposed that incorrect location of the associated socket on the plug is not possible. The moulded plate is assembled in a metal housing. In the case of single-ended plugs, which are normally used with junction boxes, there is only one metal housing and the pins project from one side of the moulding only, the other ends of the pins, which project from the back of the moulding, being adapted for soldering to the cables. This type of plug, which is fitted inside the junction box, ensuring metal to metal contact, is always used for such work as pressure cabin connections, where sealing is essential.

Loose pin type

8. In this type of multiple plug, the loose pins are held in position between two bakelite mouldings. The fixing holes in the plug shells are tapped so that the assembly is held together when the screws are inserted through the mouldings into the shell. Normally, this assembly is fitted from inside the junction box, and secured to the box with nuts outside, but cases have arisen where space inside the box is limited and the extra space taken up by the second moulding would cause congestion; in such a case the assembly is mounted on the outside of the box. It should be noted that the fixed and loose pin plugs are completely interchangeable.

Multiple bulkhead plugs

Fixed pin type

9. A series of similarly constructed double-ended plugs is used in this type. These have pins projecting from both sides of the moulded plate. Owing to the reversal of the pin dispositions on the opposite faces of the moulding, the two socket assemblies associated with any one bulkhead plug must have oppositely disposed socket pins, and correct assembly is facilitated by the engraving of the letter "A" on one face of each plate. The moulding is assembled with one plug housing on each side of the moulded plate. The plug is secured to the bulkhead by four screws and nuts, the metal flanges of the plug shells being on the aircraft side of the bulkhead, that is, inboard of the aircraft. In fitting, the plain side of the mouldings should be inboard, and the reversed, "A" side, outboard of the bulkhead. A special bulkhead socket with the engraving "A" on the moulding must be used to fit the pins on the side of the plug also marked "A".

Loose pin type

10. The double-sided plug with loose pins instead of fixed pins is similar in construction to the loose pin multiple plug described in para. 8. Two bakelite mouldings hold the pins in position, and the tapped screw holes in the shell housing the pins on the "A" side simplifies the assembly of the loose parts. In fitting, the same rules apply concerning the position of the "A" side of the plug and the use of the "A" socket as described for the fixed pin type in para. 9.

Multiple sockets

Turned pin type

11. Two types of socket are in service at present, their major difference being in the form of the socket inserts and the positioning comb. The type shown in fig. 2 (original) comprises a set of turned pins freely assembled in a bakelite housing on both faces of which are raised designation numbers and/or letters, and retained by a locking comb. A clearance in the socket assembly serves the dual purpose of ensuring the alignment of the various plug pins with their associated socket pins, and also of permitting the multiple sockets to be assembled after the soldered connections have been made.

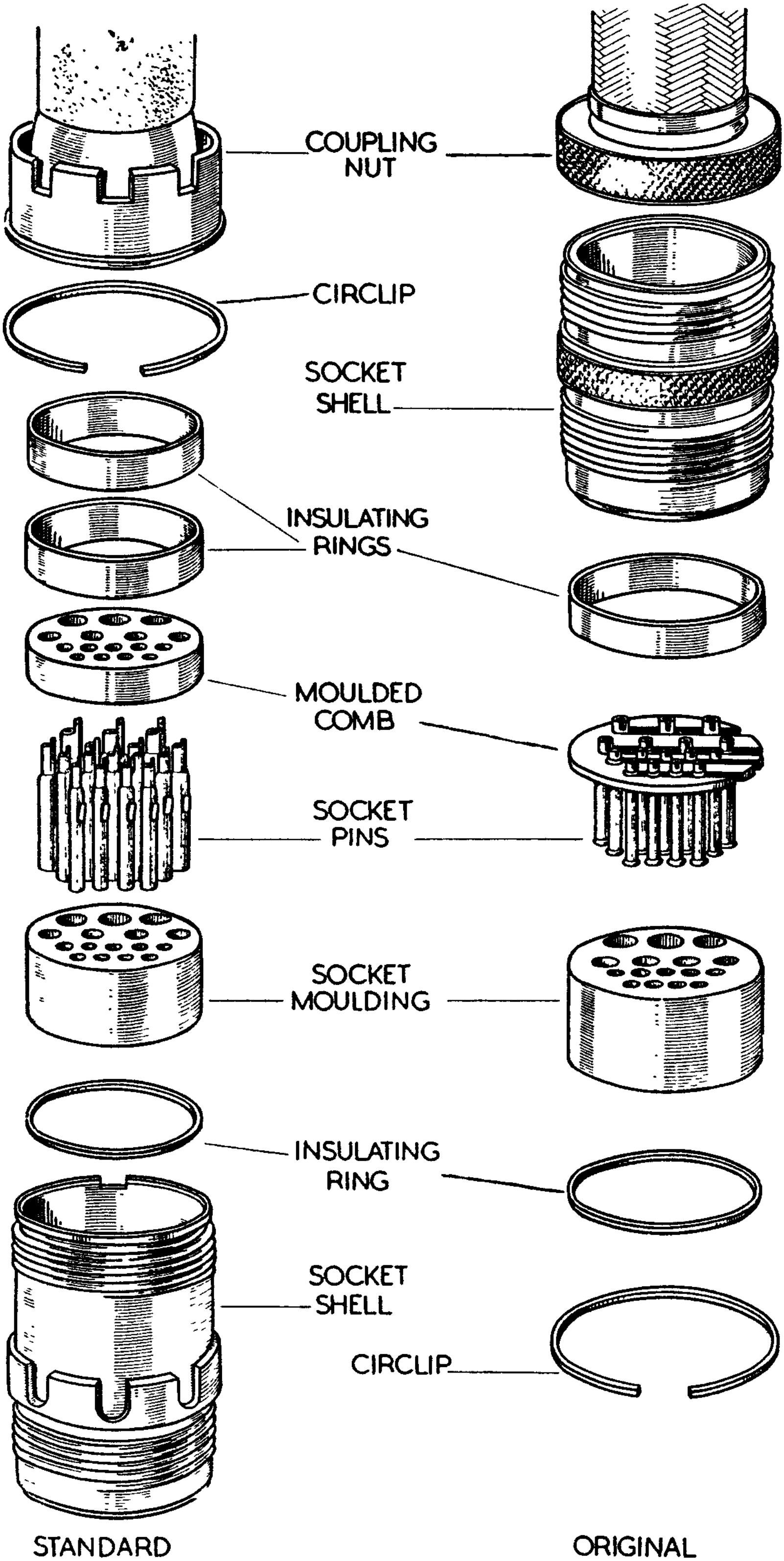


Fig. 2.—Original and standard sockets

12. The whole assembly is secured in position within the main shell by a circlip, which is placed in position outside the insulating ring. The moulding carrying the pins floats in the socket housing in such a manner that the housing is free to rotate around it, thus allowing the shell to be rotated without twisting the cable once the coupling nut has been released. A moulded sleeve provides an insulated covering for the inside of the shell and the cable may emerge from either a cut ferrule or a full ferrule, which is secured by a coupling nut.

Pressed pin type

13. A recent development is the pressed type socket insert shown in fig. 2 (standard). These pressed inserts have a small raised flap cut in the metal barrel which acts as a locking device. When the wire has been soldered on, the insert is threaded through the correct hole in the moulded comb and housing, which are held firmly together, and the spring flap prevents it from falling out again, while the housing prevents it from going too far through the comb. This means that the cables cannot be unintentionally removed from the housing, and a special "Ejection" tool is required to hold down the locking flap and eject the insert back through the hole, as shown in fig. 6. The moulded housing has holes numbered to correspond with those in the comb. Moulded sleeves and insulating rings, fastened by a circlip, hold the socket assembly firmly together, while allowing it to rotate freely inside the main shell, so long as the coupling nut is released.

Flexible conduit assemblies

14. Two types of conduit and cable coverings may be found in the assemblies. These are:—

(i) The screened system; consisting of lengths of aluminium tubing protected and screened by aluminium alloy or tinned copper braiding. This type of conduit is now only used in those sections of the wiring system where screening is essential.

(ii) The unscreened system; in all parts of the wiring where electrical screening is not essential, polyvinyl chloride, a plastic conduit, replaces the metal conduit.

15. Coupling nuts are assembled on these lengths, and the ends are finished by means of a ferrule, which is swaged on in the case of the screened conduit, or fixed by metal clamp rings on the unscreened, as shown in fig. 7. The cables carried within the conduit may terminate in a multiple socket as described in paras. 11–13, or they may emerge from the conduit through a ferrule in the form of tails, which are connected to the various pieces of equipment.

16. When the cable terminates in a multiple socket the connections to the socket pins are soldered and finally covered with a rubber sleeve, which serves to protect the joint. Each wire bears a designating marker corresponding to the socket pin to which it is wired. When the socket assembly is completed it is attached to the conduit by means of a coupling nut.

17. When the shortness of the run does not warrant the use of multiple plugs and sockets on junction boxes, the wires emerge through a cut ferrule, anchored by binding with waxed twine or thread on the unscreened system and copper wire on the screened, and sealed with ~~Bostik B~~.x The whole ferrule area is treated with "Polan" paint to render it waterproof, and finally, if the tails are of screened cable, two coats of "Polan" paint are sprayed over a minimum distance of 3 in. beyond the end of the ferrule, avoiding the area covered by the coupling nut. This system is shown in fig. 13. Alternatively, a single cable may emerge through a sleeved rubber grommet, as shown fitted to the junction box in fig. 1. This method is also used where wires are brought out of the conduit assembly for direct connection to the equipment which they serve as in fig. 13. The grommet sleeve is most easily put into position by the use of the Hellermann tool described in para. 45 (iii) and illustrated in fig. 5. The prongs of the tool should be treated with a lubricant before use to enable them to slip easily out of the sleeve; for this, Hellermann lubricant or a very light smear of castor oil may be used. A.L.5

18. It should be noted that where screened cable is installed in positions exposed to oil or other liquids, a length of P.V.C. conduit may be drawn over the metal braiding as a protection.

19. The Helvin split sleeve has been specially designed to make for oil- and water-proof conditions where two or more tails emerge from one ferrule. Fig. 7 shows how each individual tail may be threaded through a smaller sleeve moulded off the main sleeve, which is fastened with a coupling nut in the same way as the standard ferrule. The Hellermann tool is used to enable the cables to be fed through the smaller sleeves.

Junction boxes

20. The junction boxes used in this equipment have outlets fitted with multiple plugs, as depicted in fig. 1. All the outlets bear conduit reference numbers (as F4, F15, etc., in fig. 1) which correspond to the appropriate conduit run. Wiring within the box is soldered to the ends of the

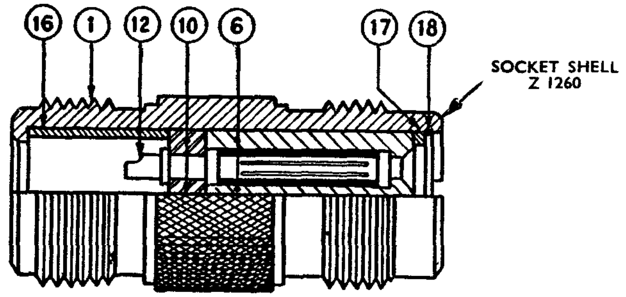
x BOSTIK SEALING COMPOUND No 771 (STORES REF. 33C/951) AL 54

Example:—

CZ 1114 (5x101)

Original type socket assembly. No suffix to part numbers.

A



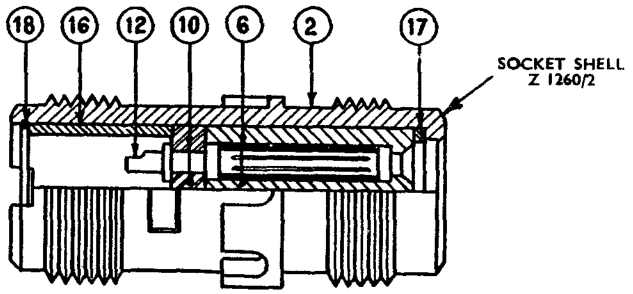
Assembly number with suffix 2 permits the use of either castellated or knurled type of slip-on socket shell.

Example:—

CZ 1114/2 (5x101)

Identical inserts as shown in "A" (above) and housed by a slip-on castellated socket shell indicated by a suffix 2 on original part number.

B

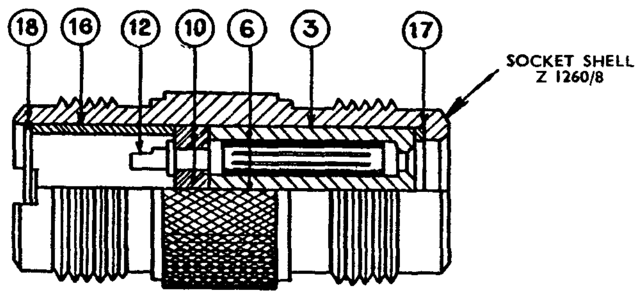


Example:—

CZ 1114/2 (5x101)

Identical inserts as shown in assemblies "A" and "B" above but alternatively housed by a knurled slip-on shell.

C

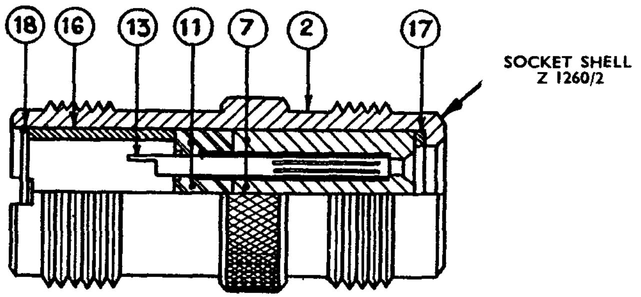


Example:—

CZ 1114/3 (5x101)

Comprising all latest parts, i.e. pressed socket inserts, moulded comb, short socket moulding and knurled type slip-on socket shell.

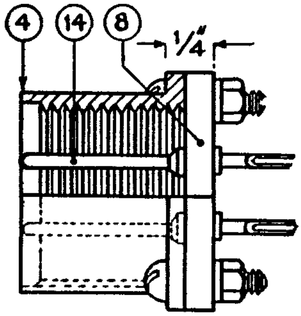
D



NOTE:—

The location centres of original and new type plugs and sockets being identical, it is possible to mate a new type socket assembly with an original type plug assembly and conversely an original type socket assembly with a new type plug assembly, thereby permitting 100% interchangeability between complete assemblies.

Fig. 3.—Variations in design of Breeze plugs and sockets



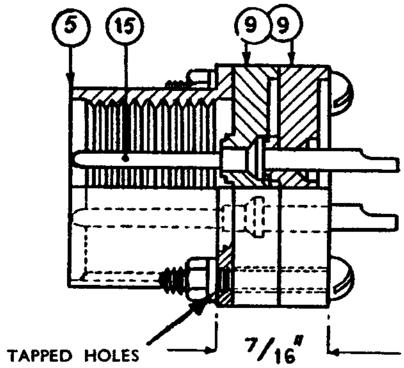
E

FIXED PIN TYPE

Example:—

CZ 1064 (5x/1)

Original type plug assembly—no suffix to moulding number but suffix 2 to plug shell number.



F

LOOSE PIN TYPE

Example:—

CZ 1064/2 (5x/4001)

Loose pin plug assembly. The assembly number takes suffix 2, shell takes suffix 3, pins and mouldings take new number. The parts are not interchangeable with the parts in CZ 1064 (5x/1) above.

6 B.A. for sizes A, Z, B, C and D
4 B.A. for sizes E and F

On sizes D, E and F it will be found that there are short and long shells in service. The differences in lengths are shown below. They are comparable with the length of the respective insulating sleeves.

Type	*Short shell*	*Long shell*
D	1·641	2·195
E	1·641	2·195
E (200)	2·281	2·951
F	2 281	2·951

NOTE:—

Both of the complete sets of socket inserts shown above are interchangeable with each of the shells specified. The socket inserts, comb and moulding in a suffix 3 assembly, although interchangeable as a set, are not interchangeable as piece parts with their counter parts in a suffix 2 or plain number assembly.

Item	*Part*	*Description*
1	Z 1260	Original type socket shell. ("A" size) knurled.
2	Z 1260/2	Reversed type socket shell. ("A" size) castellated
3	Z 1260/3	Reversed type socket shell. ("A" size) knurled
4	Z 1240/2	Original type plug shell ("A" size)
5	Z 1240/3	New type plug shell ("A" size) tapped holes
6	Z 1194	Original type socket moulding for turned sockets
7	Z 1194/2	New type socket moulding for pressed sockets
8	CZ 1164	Original type plug moulding
9	Z 19274	New type loose pin plug moulding (2 per set)
10	Z 1224	Pressed type comb (Tufnol) for turned sockets
11	Z 1224/2	Moulded type comb (for pressed sockets)
12	Z 1340	Original type turned socket insert
13	Z 1340/2	New type pressed socket insert
14	Z 1320	Original type plug pin (for fixed pin moulding)
15	Z 19264	New type plug pin (for loose pin mouldings)
16	Z 1280	Insulating sleeve (unchanged)
17	Z 1650	Insulating washer (unchanged)
18	Z 1300	Circlip (unchanged)

plug pins, the opposite ends being connected to terminal strips within the box. The wires are designated with the circuit reference and joints are protected by rubber sleeves which cover the soldered connection and extend over both the cable and plug pin. For ease in service, some tag panels are fitted with two types of terminal; screw terminals are provided for all leads which may be commoned, or require splitting for fault location, while solder tag terminals are fitted for single cable connections. All terminals are marked with their circuit reference number. It will be observed from the illustration that the fixed pin plugs fitted from inside the box have the bolts securing them to the box run through the side of the junction box, the metal plate of the plug shell, and the moulded plate, in that order, to the nuts *inside* the junction box. In the loose pin plugs, however, the bolts run through the two moulded plates, through the plate of the plug shell, and finally through the wall of the junction box to the nuts on the *outside* of the box. Originally a cut ferrule was used for single cable termination, but the sleeved rubber grommet is now replacing this for single connectors, as it makes for a more oil and water-tight entry. These grommets are made in six sizes, from 0·1 to 0·6 in. internal diameter of sleeve. The heavy synthetic rubber base, which is standard in size, has a groove in the perimeter; a V-cut in the back-plate allows for this groove to be fed on to the edge of the hole in the junction box, and a twisting movement will thread the rest of the groove into position. Fasteners in the box lid are screwed into side anchor nuts of the Simmonds type fixed to the box side, holding the lid securely in position.

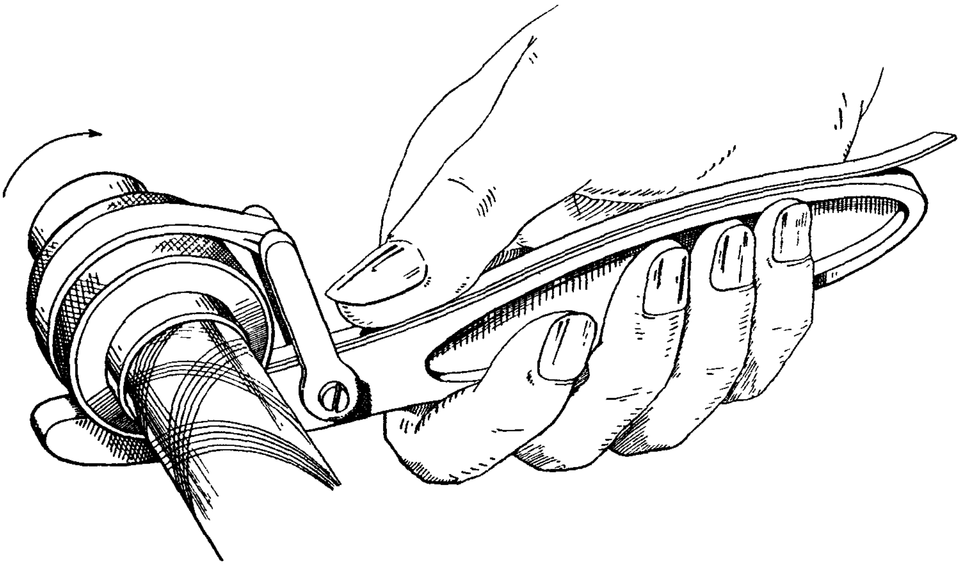


Fig. 4.—Manipulation of strap wrench

Engine bulkhead junction box

21. The bulkhead junction box shown in fig. 10 has been specially designed for installation in engine nacelles. The internal wiring of the box is shown in fig. 11.

Other fittings

22. Where lack of space would otherwise necessitate the bending of screened conduit in a sharp curve, a 45° or 90° elbow must be employed instead of bending the conduit. When little pull or vibration is likely to take place and there is only a minimum of space available, the tails may emerge from a ferrule, a rubber sleeve being fitted over the conduit. With the more general use of unscreened cable, permitting a smaller bending radius, the use of the elbow fitting is gradually becoming obsolete.

23. A conduit assembly may also have a socket at one end and a plug at the other. In this case, when disconnection is required on one side only, the plug is used at the section break. This type of assembly may also be used where lack of space or weight rules out the use of a bulkhead plug, or where the combination of contacts required is not available in the bulkhead type of plug and socket.

Routing charts

24. At first sight a routing chart, which is an essential part of the fault-finding equipment, may appear complicated and difficult to comprehend, but closer inspection will prove that it simplifies the task of tracing the circuit, very considerably. The following description of the chart, and the conventions used, will therefore be found of some assistance if read in conjunction with a routing chart given in one of the aircraft handbooks.

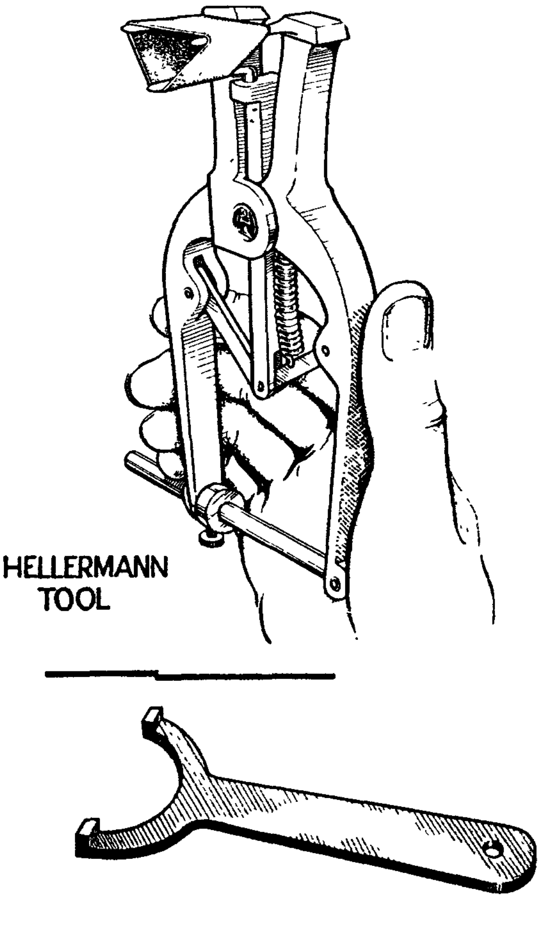


Fig. 5.—Breeze service tools

25. The object of the chart is to obtain a horizontal straight line diagram of the circuit with wide spacing in order to afford maximum legibility without strain. The first column gives the service title and circuit reference used in the theoretical wiring diagram, and the electrical equipment on the particular services is shown in the various equipment columns. The space between these equipment columns is divided conveniently to carry the junction box (J.B.) numbers, and conduit references and pin numbers are given within the conduit column. It should be noted that where connection is made by means of a plug and socket to a particular junction box or piece of equipment, the joint is indicated by a dot on the line. Where, however, a cut ferrule or rubber grommet is employed no dot is shown, connection being indicated solely by the terminal number in the column.

26. The type of cable employed is indicated by designations above the cable line, usually at the left-hand side of the cable run. In order to avoid confusion with lines indicating wires, the vertical lines separating the various columns are dotted, bus-bars within a particular piece of equipment being shown by full vertical lines.

Coding system

27. The coding system provides for every wire to bear a letter and number for the purpose of easy identification. Reference to the theoretical wiring diagram or aircraft routing chart will show that each circuit incorporated is allocated a reference letter or letters, whilst individual wires comprising each circuit have a number as a suffix to the circuit letter. For example, if a circuit comprising a fuse, a switch and a lamp bears the letter "H" as circuit reference, the wire between the fuse and the switch will be "H1" and from the switch to the lamp will be "H2". The positive feed to the fuse and the negative to the lamp will bear the reference of the generator system from which the circuit is fed.

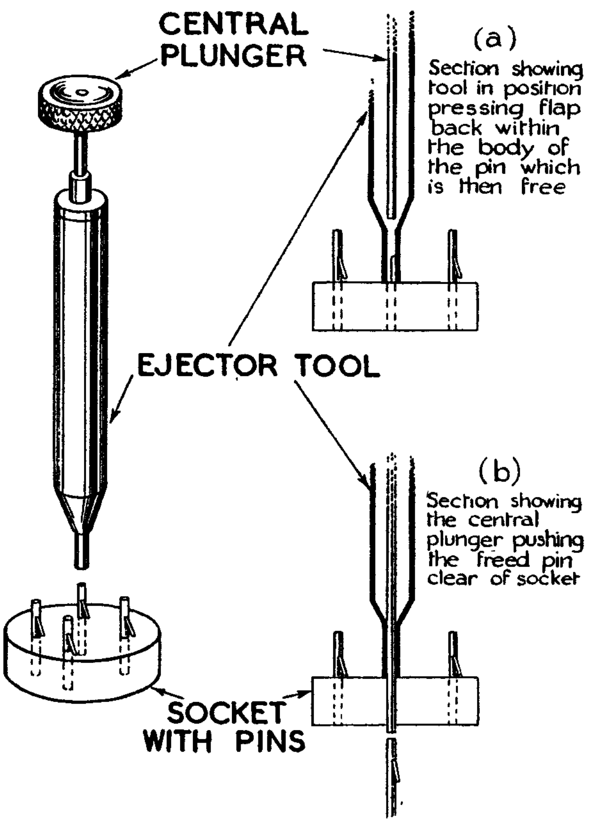


Fig. 6.—Ejector tool

28. Similarly, the main feeds from batteries and generators will remain the main feeds throughout the aircraft, so that where essential loads are coded A, metered loads will be marked A1 and generator loads A2. If two generators are employed, the second one may be coded respectively B, B1, B2, etc., the appropriate designation + or − being added to the letter and number combination where necessary.

29. General service conduits situated in the fuselage are given the prefix F, being numbered F1, F2, F3, etc. Conduits located in the port wing are lettered with the prefix P, while those in the starboard wing use the prefix S. Junction boxes are given the prefix JB and conduits used for bomb fuzing and release systems are lettered with the designation of the junction boxes which they serve, i.e., AB indicates a conduit connecting junction boxes "A" and "B". Where several conduits are used between the same points the designations AB2, AB3, etc., are used. The leads from junction boxes to bomb racks have the junction box letter and bomb rack number, thus A7 indicates rack 7 from junction box A. Junction boxes are lettered with the prefix JB so that the combinations JB "A" and JB "B" are formed. In later Breeze systems the conduits are numbered and prefixed with the letters BF. The lettering used varies according to the make of aircraft, but the system of coding which has been given here may be accepted as a general guide.

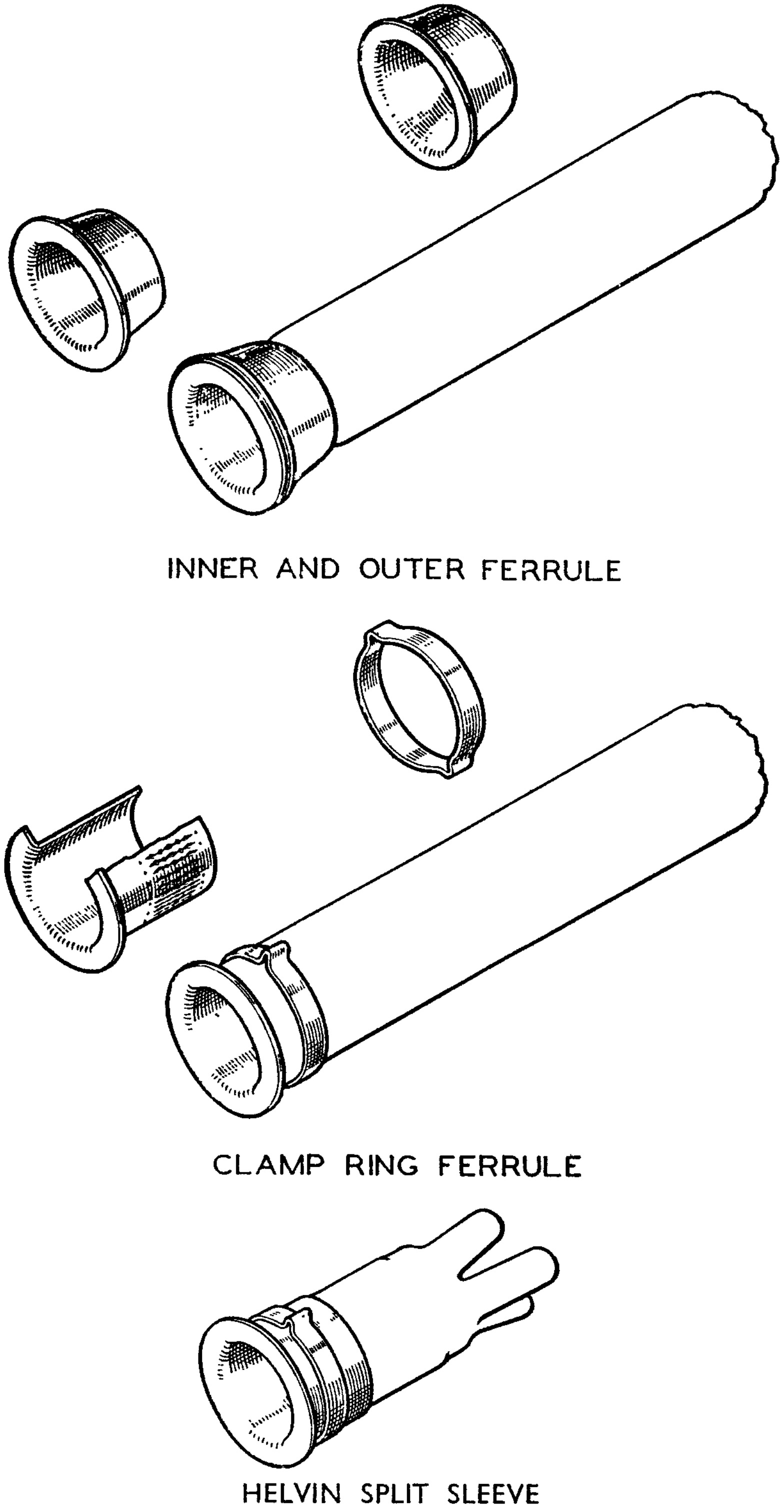


Fig. 7.—Ferrules and sleeves for Polyvinyl Chloride conduit

30. Radio intercommunication system conduits bear the prefix WT followed by numbers, so that the combinations WT1, WT2, etc., are formed. Junction boxes in this system are prefixed with the letter W and lettered so that the form WA, WB, etc., is obtained. Bulkhead plugs are designated according to their identification letter followed by a number.

31. Where wires pass through conduits they are not given individual wire reference numbers but are coded with the letter or number of the socket pin to which they are attached.

32. Where, however, the wire is broken at a junction box by a terminal, the appropriate circuit code letter and number is used to identify this terminal and the particular wire in the box. Thus, if a certain cable in the navigation lamp circuit is marked H2, the same designation will appear on all terminals in the junction boxes through which it passes. Full information is given in the appropriate theoretical wiring diagram with regard to identification at the ends of the leads, and the correct marking off is usually obvious. The size of the wires for a particular service, and the core colour (where used) are sometimes indicated on the theoretical wiring diagram and always on the routing chart.

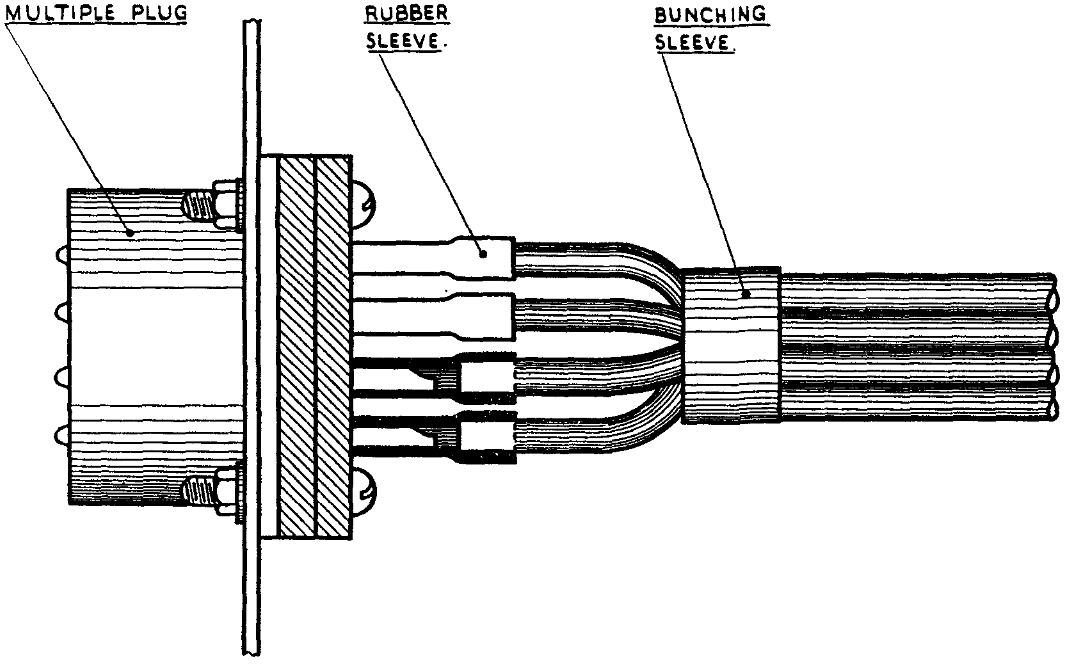


Fig. 8.—Method of connecting cable to a multiple plug

INSTALLATION

33. As the complete Breeze wiring system is installed by the aircraft manufacturer, the installation work which is likely to be necessary in the Service will consist mainly of replacement work after repair. The junction boxes are fitted to their respective sections by means of screws or bolts, and the associated conduit and cable assemblies are clipped to the air frame. The conduit and cable sockets are screwed to their appropriate junction box plugs, which should have similar references, the coupling nuts finally locking the connections.

54 34. It should be noted that BEFORE ATTEMPTING TO SCREW A SOCKET INTO A PLUG, the pins should be smeared with ~~woolfat~~ (Stores ~~Ref. 33C/511~~)X and THE CONDUIT COUPLING NUT MUST FIRST BE SLACKENED OFF so that the socket shell is free to rotate independently of the conduit. The same precaution applies equally when removing sockets from plugs at section breaks. This is MOST IMPORTANT.

Method of dismantling and replacement

35. A standard conduit and socket assembly is shown in fig. 2 from which the method of dismantling can be followed. First, the coupling nut must be unscrewed and pushed back over the conduit. The conduit should then be collapsed to its minimum length so as to leave a gap between

X P.I.C. No1. (STORES REF 33C/811.) A.L54 the ferrule and the shell. The circlip should then be removed so that the shell may be withdrawn, leaving the socket moulding, comb and moulded sleeve in position. A finger should be inserted in the front of the sleeve to prevent the moulding being removed with the shell. The socket moulding may then be withdrawn followed by the comb and sleeve, thus leaving the pins completely free. Where the socket inserts are of the pressed locking type described in para. 12 they can, of course, be released from the socket moulding only by the use of the ejection tool supplied for the purpose.

36. In the original type of socket assembly, shown in fig. 2, samples of which are still in service, it should be noted that the circlip is situated at the face of the socket. In dismantling, the coupling nut must first be unscrewed and pushed back over the cable. The circlip must then be removed by inserting a penknife in the slot at the edge of the shell and lifting it out. The insulating ring at the front end is then taken out so that the socket shell may be pushed back to enable the moulding and comb to project from the front of the shell. The socket moulding may now be withdrawn from the pins so that the latter remain located by the comb. Removal of the comb then leaves the socket pins free and allows access to the soldered connections, which are covered by a rubber sleeving. In order to carry out repairs, the faulty cables can now be pulled through complete with the socket pins attached. If it is required to have access to one cable only, the comb should be withdrawn without removing the moulding. A single socket pin can then be withdrawn from the socket. This operation is facilitated by holding the cable vertically with the socket downwards against the bench.

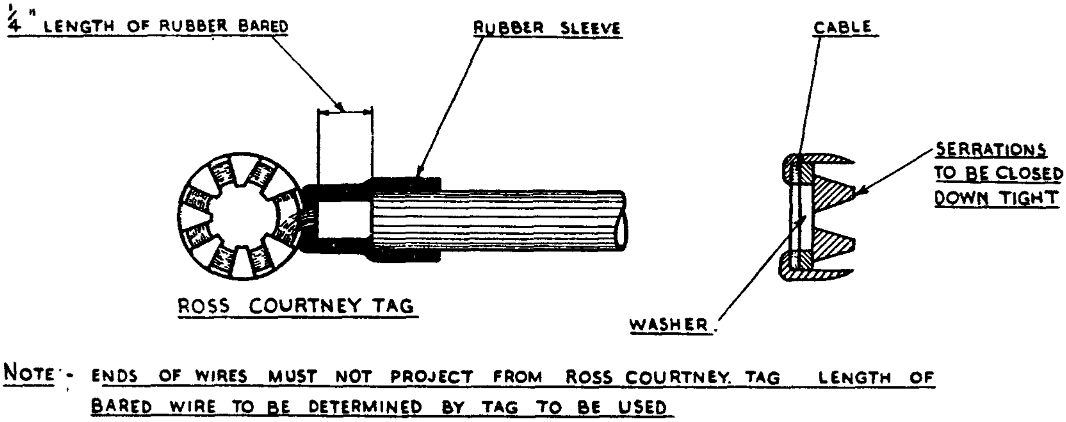


Fig. 9.—Procedure for fixing Ross Courtney tags

37. A strap wrench (Ref. No. 5X/1564) has been developed for tightening and loosening the knurled coupling nuts, and its application is indicated in fig. 4.

38. "C" spanners, fig. 5, are available for manipulating the castellated coupling nuts. These are made in seven sizes, to fit nuts sizes A, B, C, D, E, F, and Z.

39. If a cable is found to be faulty it should be replaced from store and the following instructions are intended to assist in the work of connecting up the new cable.

40. After removal of the socket assemblies from the ends of the conduit, individual cables may be withdrawn from the conduit complete with the socket pins. Where a single conduit carries a number of cables it may be found advisable to use the old cable as a draw-wire for the new cable, and it should therefore be left in position until the new cable is ready to be drawn through the conduit. In doing this, however, it should be remembered that the cables are held together in bunching sleeves inside the conduit; the ends of the cable which is to be used as a draw-wire should therefore be removed from these sleeves before pulling, to avoid any chance of tearing the rubber sleeves.

41. When preparing a new cable, the insulation should first be cut back; then the bared wire and the solder end of the appropriate plug or socket pin can be tinned at the same time. When connecting the cable to socket pins, the two parts may be sweated together, using resin-cored solder for preference, before threading the cable through the bunching sleeve and applying the rubber sleeve over the joint by means of the special Hellermann pliers. When, however, the cable is being connected to a multiple plug as shown in fig. 8 it is important to remember to thread the cable through the bunching sleeve and to place the protecting sleeve on the cable *before* carrying out the soldering. After the joint has been made the small sleeve should be rolled back over the joint, as shown in the illustration. "Viskring" cable markers should be fitted to new cables when possible; where these are not available some other method of cable identification must be employed.

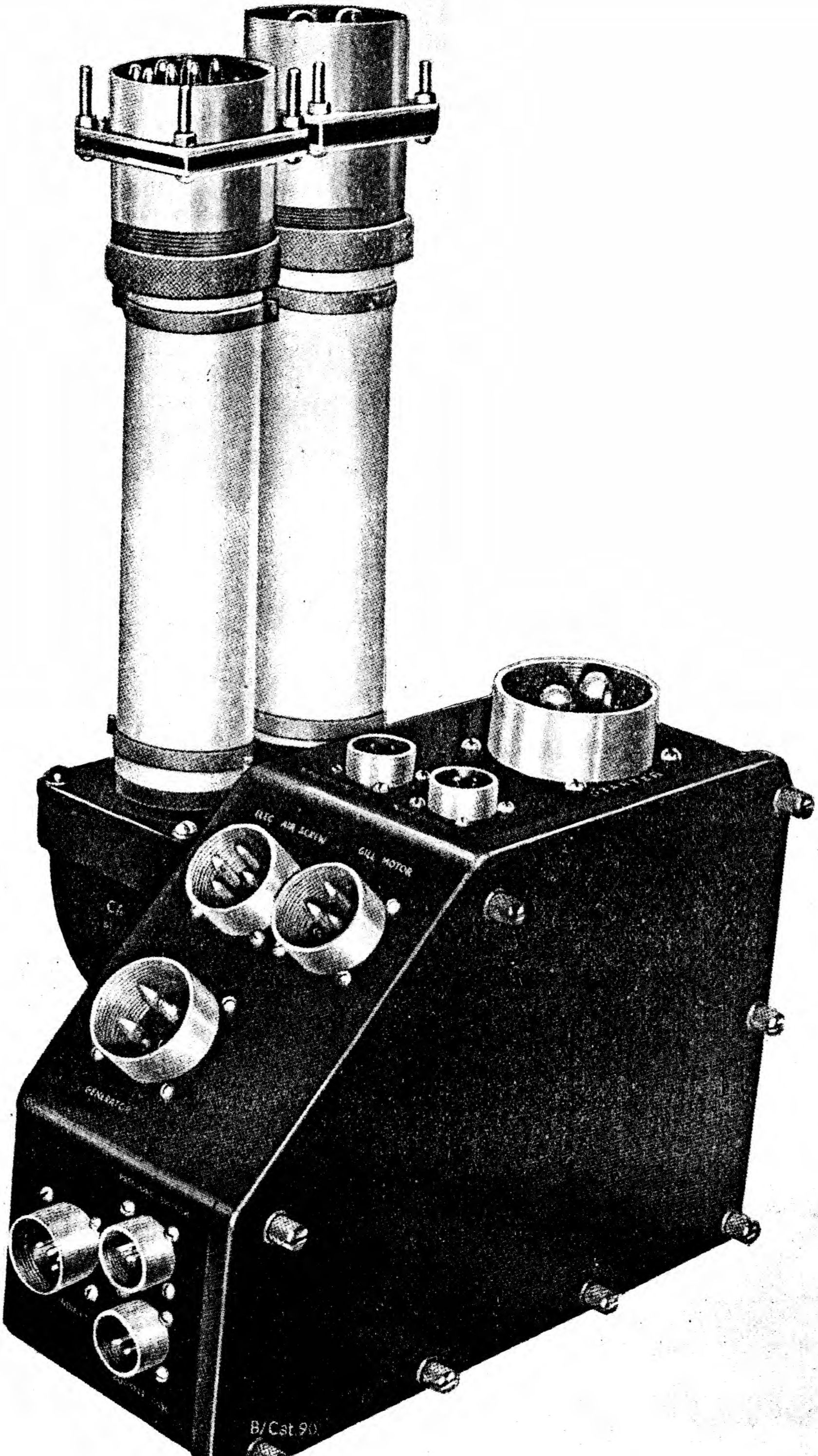


Fig. 10.—Engine bulkhead junction box

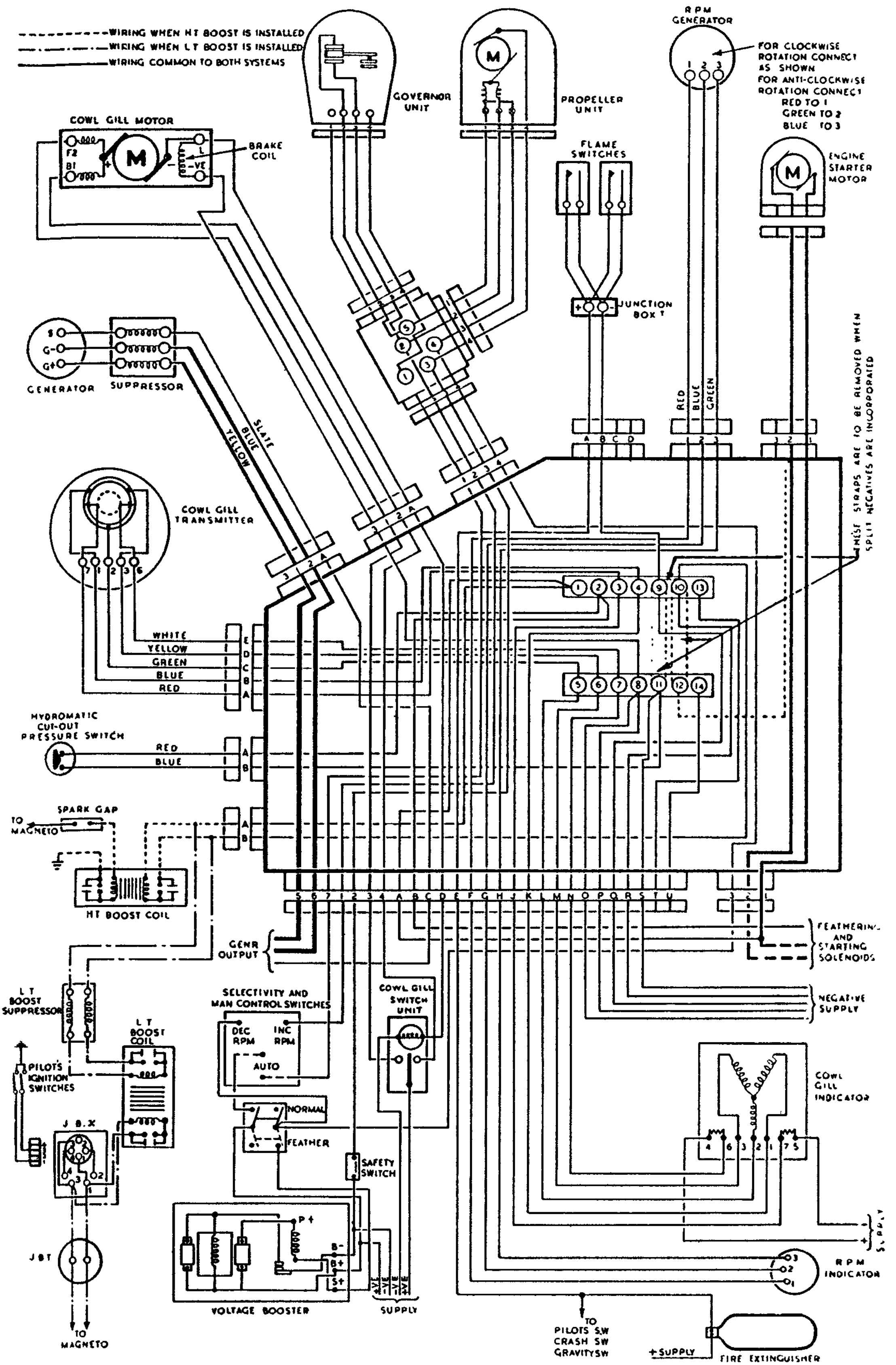


Fig. 11.—Wiring scheme of bulkhead junction box

42. A similar procedure with regard to the application of the rubber sleeves, is followed when connecting cables to tags within junction boxes. Fig. 9 shows the method of connecting Ross Courtney tags to V.I.R. or Unicel cables. When connecting a Ducel, Tricel, or Quintosheath cable to a Breeze plug, a bunching sleeve should be placed on the cable before connection is made. Each of the ends should then be covered with a small rubber sleeve which should be rolled back to expose the end of the wire. After the joints have been made they should be covered with the small sleeve. When Dumet and other "met" cables are used the method of connection is slightly different and is illustrated in fig. 12. The braiding of the cable, which should first be soldered or trimmed with taping, is passed through the ferrule, and clamped against the washer by the coupling nut, which is screwed on to the socket shell. Fig. 12 indicates the method of connecting Dumet cable to a multiple socket, but the same principle applies to all types of metal braided cable and of sockets.

43. It is seldom necessary in aircraft repair to dismantle 200-amp. plug pin assemblies, samples of which are shown in fig. 15, but should the necessity arise it should be noted that 200-amp. cables are soldered or otherwise fixed to lugs or socket pins which screw through the blocks on to the plug pins. Soldering should be done before these two parts are screwed together, as the excessive heat required will break the blocks.

44. Fig. 14 shows the method of terminating the end of the screened cable for use with cut ferrules. The cable should first be cut to length and then prepared for trimming by binding with five turns of 33 s.w.g. tinned copper wire, after which the braiding should be lightly soldered or taped to prevent fraying. The ends should then be trimmed. Small variations involving the use of slightly different equipment such as a cut ferrule with screw threads for attaching the conduit by means of coupling nuts may be found in Breeze wiring systems, but the same principle of attachment applies.

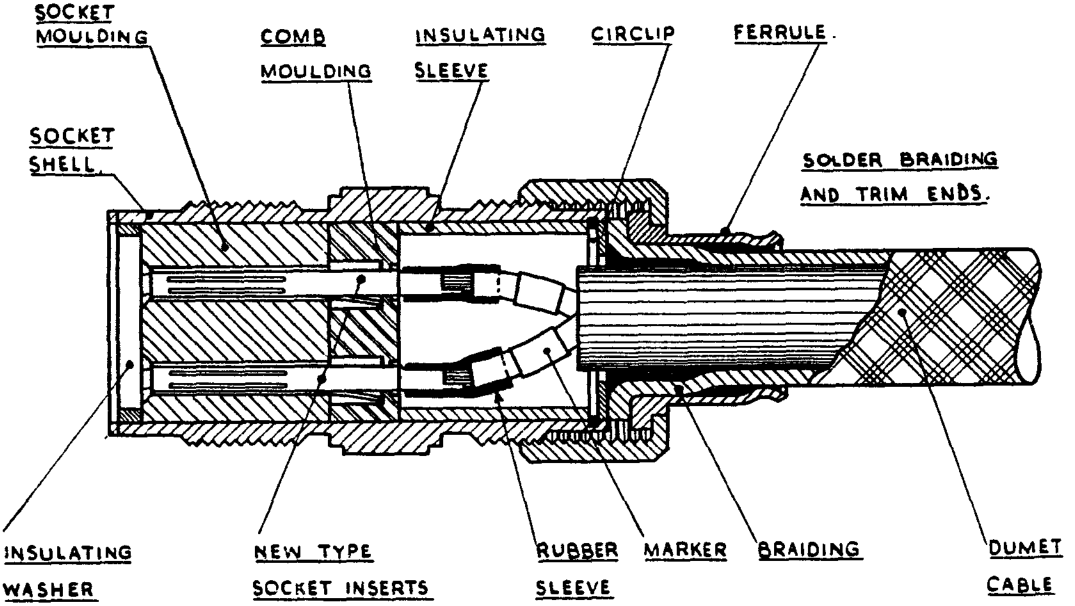


Fig. 12.—Connection of screened cable to multiple sockets

45. Special equipment required for the servicing of the wiring system is:—

(i) Strap wrench, fig. 4, for manipulating knurled nuts and sockets (Stores Ref. 5X/1564).

(ii) "C" spanner for castellated nuts, fig. 5:—

Size A	(Stores Ref. 5X/1486)	Size E	(Stores Ref. 5X/1491)
B	(Stores Ref. 5X/1488)	F	(Stores Ref. 5X/1492)
C	(Stores Ref. 5X/1489)	Z	(Stores Ref. 5X/1487)
D	(Stores Ref. 5X/1490)		

(iii) Hellermann pliers, or sleeve-fixing tool, a special tool for fitting rubber sleeves over the ends of cables: shown in fig. 5. The rubber sleeve is slipped over a mandrel composed of three prongs, set at right-angles to the tool handles. Compression of the handles causes the prongs to open out triangularly, so that the rubber sleeve expands and allows for easy insertion of the cable.

Type A (Stores Ref. 1C/5862), for rubber sleeves sizes 0–4.

Type B (Stores Ref. 1C/5863), for rubber sleeves sizes 5–10.

SERVICING

46. When not in use all plugs and sockets must be kept covered with protective rubber or fibre caps to prevent the ingress of dirt and swarf.

47. Correct lubrication of the threads of the plugs and sockets is essential to prevent seizure, and should be carried out regularly with an approved lubricant to Specification D.T.D.143C. This is available in 3 sizes—1 lb. (Stores Ref. 34A/49), 7 lbs. (Stores Ref. 34A/150), 14 lbs. (Stores Ref. 34A/103). The lubricant must be free from dirt and should always be applied sparingly and all excess wiped off. Only the approved lubricant must be used, and on no account should a lubricant with a graphite base be employed. THE IMPORTANCE OF CLEANLINESS AND THE NEED FOR REGULAR LUBRICATION CANNOT BE OVER-EMPHASISED IF THE BINDING OF JOINTS IS TO BE AVOIDED.

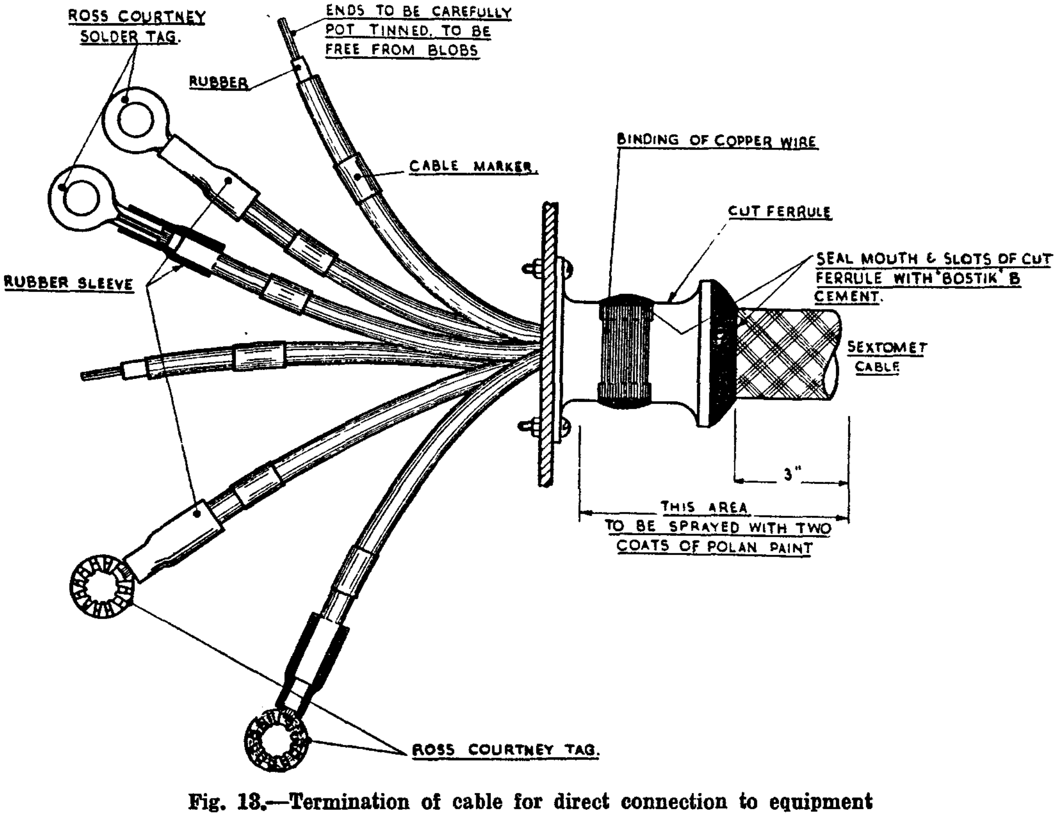


Fig. 13.—Termination of cable for direct connection to equipment

48. The aircraft wiring system should be inspected regularly with a view to locating possible sources of future trouble, and in this connection the following points should be studied.

49. Screw terminal connections should be examined for tightness in order to ensure that high resistance conditions will not develop. Terminals which form part of the Breeze system are coated with bakelite varnish after final assembly and, when the wires are replaced after removal, the varnish must again be applied in order to prevent loose connections developing. All screws holding fixtures should be checked for tightness and an examination should be undertaken to ascertain that no loose parts, ends of wire, swarf, or similar material which might cause short circuits, are left behind in the junction boxes. In particular, preventive action should be taken immediately if signs of condensation are found as, if this is allowed to persist, it is likely to cause considerable corrosion between plug pins.

50. Generally speaking, a visual inspection will be sufficient to ensure that no insidious depreciation is evident at the various points of connection. This method of checking applies also to fractures of wires at joints as excessive handling and pulling of leads is strongly discountenanced, and, in any case, plug connections should not be interfered with during normal routine inspections.

51. The conduits should be examined for external damage, and denting on screened cable may be observed at a point where collapse of the inner lining may exist. Such a collapse is liable to set up a local failure. In the event of part of the electrical system being damaged, the faulty section may be uncoupled and a new section from stores substituted. When fitting the new section, care should be taken to ensure that the conduit is not stretched or strained during assembly.

52. Coupling nuts must never be cross-threaded or forced on to the sockets; the same precaution applies when connecting a socket to a plug. Should excessive tightness be felt when connecting a plug and socket the trouble should be investigated. Excessive pressure must not be used to force the two parts together. The trouble may be due to displacement of the plug shell in relation to the plug pins and re-alignment may be necessary by slackening the plug shell fixing screws, inserting the socket and re-screwing. A tight fitting may also be due to a lack of lubrication, as mentioned in para. 47.

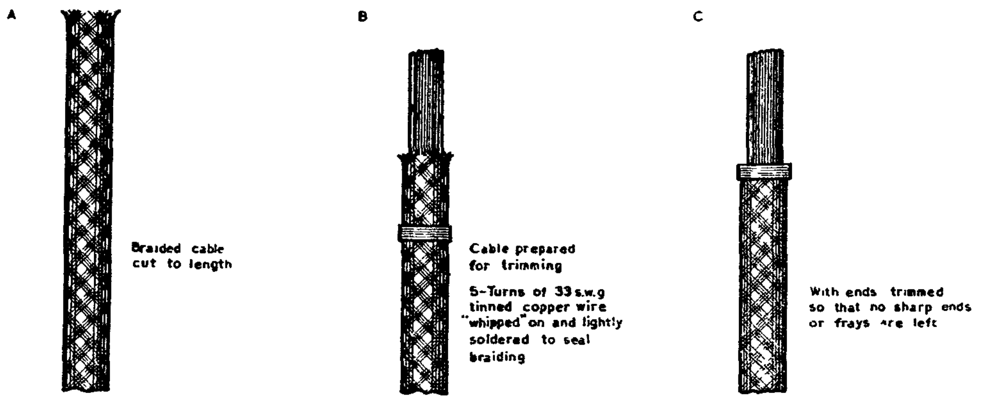


Fig. 14.—Preparation of the ends of screened cable

53. A socket with a damaged thread must not be inserted into a plug housing because fine metal shavings may be detached and cause short circuits between the pins. Badly damaged fittings should be renewed, but minor damage to threads may be cleared with a suitable tap or die.

54. It is important to ensure that when a cable has been disconnected from a junction box it is reconnected to the plug outlet having a designation corresponding to the cable reference.

55. Serious trouble may arise if water is allowed to percolate into conduits or junction boxes. The screened cable is not waterproof, and should not be exposed to rain or splashes from the ground. If screened cable installed in such a position is not protected by a P.V.C. outer cover, other steps should be taken to prevent the ingress of moisture, such as wrapping it with oil-resisting tape, or spraying with waterproof paint.

56. When a plug or socket shows signs of corrosion owing to the ingress of moisture, the fitting should be thoroughly cleaned, dried, and filled with ~~woolfat (Stores Ref. 33C/511)~~.* The woolfat should be applied to the plug fitting with a knife blade until it reaches the level of the 7-amp. pins. If it is filled above this level difficulty will be experienced in finding the correct location for insertion of the socket. When the socket is screwed home the woolfat is forced up into the socket. The woolfat has no detrimental effect on the rubber sleeving and does not affect the contact between the pins and sockets. It is important that no dirt, or more especially metal dust or filings, should be allowed to contaminate the woolfat. Moisture, too, is exceedingly harmful to woolfat and the tins should be kept carefully covered and stored in a dry place. A.L

57. Care must be taken to avoid the risk of damage to cables by oil, petrol, or water. Where it is not possible to avoid running cables near the oil filters, vents or overflows, adequate protection must be provided, preferably by P.V.C. sleeving.

58. Cables connecting to equipment should, wherever possible, be arranged to run downwards from the item of equipment, but if this is not possible, the cables must be turned downward immediately after leaving the point of entry. Where cables leave the conduit at a cut ferrule, water may run down the cable into the conduit, in which case the end of the conduit should be sealed by filling the space in and around the cable with Bostik 325, and wrapping it with oil-resisting tape.

* P.I.C. NO1 (STORES REF 33C/951) A.L. 54

59. Any circumstances which call for special remedial moisture-proof action should be reported, with a view to future modification of the lay-out.

60. When the aircraft is grounded and the electrical equipment is not in use, the batteries must always be switched off or disconnected. This precaution is essential in order to prevent electrolytic action setting up between multi-pin connections or groups of wires should the aircraft be subject to heavy internal condensation.

61. Finally, it should be pointed out that although the Breeze system possesses considerable mechanical strength, it should never be used as a handrail or footrest, as this will result in serious electrical failure.

Fault finding

62. The tracing of faults which may develop in the Breeze wiring should be carried out in conjunction with a location diagram and a routing chart, which will be found in the appropriate aircraft handbook. This chapter does not cover all troubles involving electrical circuits but deals, in a general way, with the method of procedure.

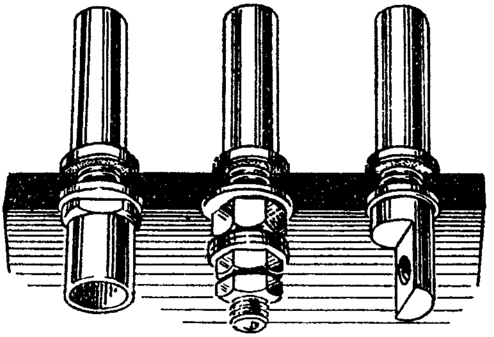


Fig. 15.—200 amp. plug pin assemblies

63. Fault tracing must be carried out methodically and thoroughly, stage by stage, as "hit and miss" methods will cause more trouble than they cure. As a preliminary procedure, it is necessary to examine the theoretical wiring diagram in the appropriate aircraft handbook in order to obtain a thorough grasp of the particular circuit in which the trouble lies. The routing chart gives the necessary information as to the conduits and junction boxes through which the cables associated with the faulty circuit pass, and the location diagram will show their position in the aircraft. Any abnormal conditions prevailing, and any particular coincidence of peculiarities which may be apparent on other services should be noted carefully, as the trouble may not necessarily be associated only with the service on which the fault was originally noticed. Thus, if the defect applies to more than one service the conclusion may be drawn that the trouble is outside any particular service and in one of the common sections, and it will be appreciated that, after study of the circuit, the next procedure is to locate the position of the fault by the process of elimination. Section breaks may be made, for example, in the centre of the cable run and tests made forward and backwards, further section breaks being made until the faulty section is found.

64. It should generally be possible to locate the defect by testing each circuit with an insulation tester and a test lamp or bell set.

65. When a test lamp is used it may normally incorporate a 12- or 24-volt lamp, according to the voltage of the general service supply in the aircraft, but smaller lamps, rated at 6 or 3 volts and used with a battery, will provide visual indication even when only a small current is flowing, further, it permits coils and windings of instruments to be checked.

66. When carrying out tests the following precautions should be borne in mind:—

(i) Do not pull the wires about needlessly as this may weaken the soldered joints.

(ii) Do not disconnect the wires in junction boxes except for a final test.

(iii) Do not dismantle socket assemblies and cables unnecessarily.

(iv) Do not disconnect conduits and cables at connecting points without having a definite objective in mind, primarily following the process of elimination based on diagnosis.

AIR MINISTRY
January, 1945

A.L. No. 54 to A.P.1095A
Volume I

ELECTRICAL EQUIPMENT MANUAL—GENERAL (AIRBORNE)

Note.—When making the hand-written amendments called for by this Amendment List, *write* "A.L.54" in the outer margin of the A.P. against each such amendment.

SECTION 3. CHAPTER 5

(1) In para. 17, line 3, *delete* "Bostik B" and *insert* "Bostik sealing compound No. 771 (Stores Ref. 33C/951)".

(2) Para. 34, line 2, *delete* "Woolfat (Stores Ref. 33C/511)" and *insert* "P.I.C. No. 1 (Stores Ref. 33C/811)".

(3) Para. 56, line 2, *delete* "Woolfat (Stores Ref. 33C/511)" and *insert* "P.I.C. No. 1 (Stores Ref. 33C/811)".

(4) Para. 58, line 5, *delete* "Bostik 325" and *insert* "Bostik sealing compound No. 771 (Stores Ref. 33C/951)".

When you have done this, make an entry in the Amendment Record Sheet at the beginning of the book.

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CHAPTER 6

G.E.C. WIRING SYSTEM

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The G.E.C. aircraft wiring harness comprises multi-core cables to which are attached the male halves of special ten-way connectors, the female halves generally being wired to the appropriate services. The connectors are easily split and may be removed for servicing purposes complete with the cable.

DESCRIPTION

2. The multi-core rubber-covered cables, which are used in this wiring system, are built up in the form of " looms ". Each " loom " terminates at the male half of a ten-way connector block ; if there are more than ten cores contained within the cable, two or more connectors may be attached.

3. The arrangement of panel interconnections in an aircraft is indicated in the location diagram which is provided in the aircraft handbook. Part of a typical diagram of this kind is reproduced in fig. 5, from which it will be observed that each cable connects two panels on the aircraft. A cable may be connected to any number of connector blocks, according to the number of cores carried, as one connector block is required for every ten cores contained within the cable. These connector blocks are used only within the fuselage of the machine, terminal blocks being used on the wings where direct connection to apparatus is not possible. For bulkhead servicing either terminal blocks or Breeze plugs may be used.

4. The connector blocks are held in position on the panel by a special rack in the manner illustrated in fig. 1, an adjustable clamp (1) being used to secure the blocks against the end bracket (2).

1. Adjustable clamp.
2. End bracket.
3. Clamp securing nut.
4. Retaining strips.

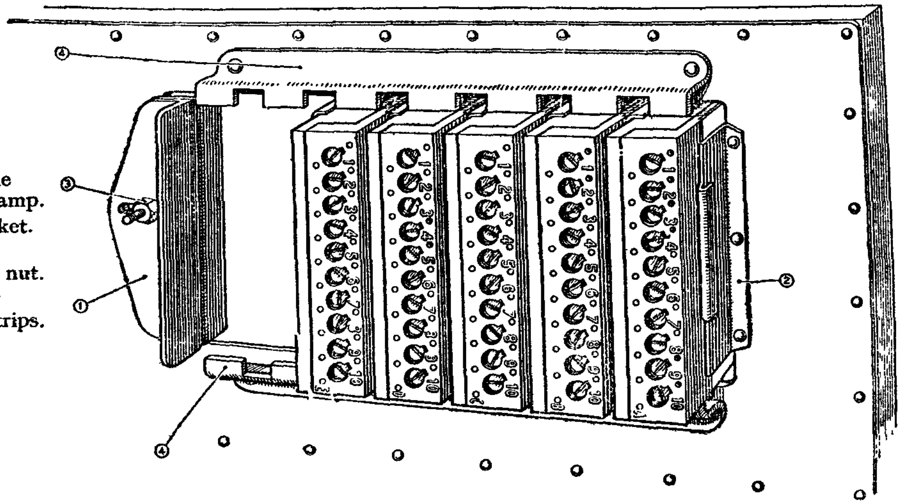
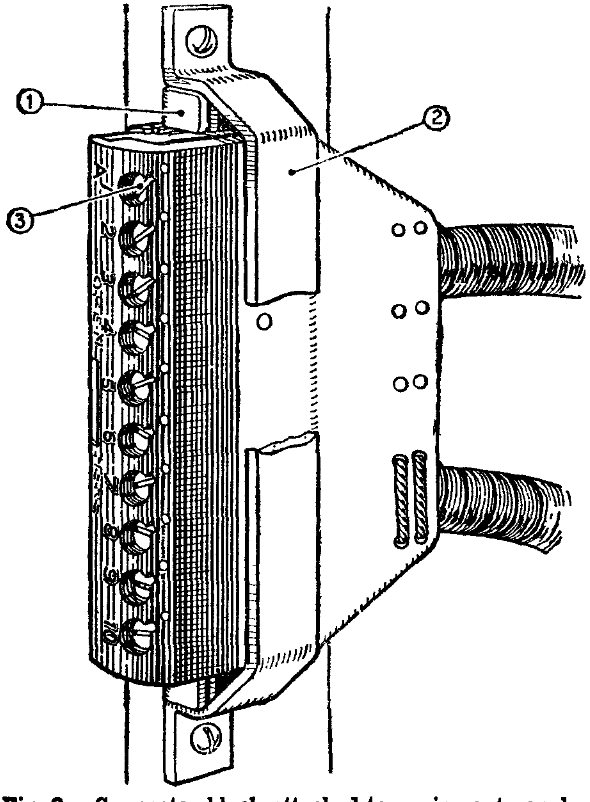


Fig. 1.—Connector block rack

Dummy blocks are used when the rack, or panel as it is more often called, is designed to carry more blocks than are actually in use. In some aircraft the panel may be situated within a wooden box.

5. Connections to the equipment on the bomb aimer's panel, main electrical panel and pilot's dashboard may be made by cables attached to the female halves of the blocks which are an integral part of the panel. In this event the bomb aimer's panel has the connector blocks attached to the side of the equipment panel, in the manner shown in fig. 2. The bakelite connections on the connector blocks fit into special sockets (1) on the panel, and strap bands (2) secure the block in position. Other types of aircraft employ the standard type of connector assembly in racks for these particular panels.

6. The construction of the connector block itself is shown in fig. 3. This illustration depicts the original type of connector, which has a moulded housing (3) with a metal back plate (8), and comprises two halves which form the plug and socket sections. The plug section contains ten flat pins (1) held in position by a retaining slide (7) which passes through slots in the bakelite dividers.



1. Special socket.
2. Strap band.
3. Captive screw.

Fig. 2.—Connector block attached to equipment panel

7. The socket portion of the connector contains ten socket pins, which fit into recesses in the moulding. They are held in position by screws (2), which pass through holes in (3) fig. 3, in the front of the block. When the two parts of the connector are mated, these screws serve to lock the plug and socket together by securing the socket pins to the plug pins in the manner shown in the bottom inset drawing (fig. 3). The cables are normally covered by a rubber sleeve (4) where they enter the connector and are anchored to the connector plate by waxed thread (5) which passes through holes in the back plate. Each connector block is supplied with ten plug and socket pins and, where the cable contains fewer cores than this, the spare pins are merely left disconnected. In positions where it is required to connect one lead to a number of pins a form of bus-bar connection is employed, a special comb (6) being inserted into the pins which are to be short-circuited.

8. The later type of connector, which is illustrated in fig. 4, has an additional locking device in the form of a single captive screw (3), which passes through the plug of the connector between the incoming and outgoing cables. The screw is threaded into a pillar (2) attached to a metal plate on the socket half of the connector. Rubber inserts (4) are also provided on both halves to prevent the ingress of moisture, the rubber being stuck to the metal plates. The moulded face of the new type of plug is flat, whereas that of the old type is bowed ; in addition, the moulded shields on the plug between the pins are raised to prevent tracking or flash-over.

CODING SYSTEM

9. Each " loom ", or cable, is marked with a coding band on which are the letters of the panels between which the cable runs. This is illustrated in the diagram in fig. 5. Thus the cable between the panel D and the panel F is known as the cable, type D–F, the two ends of the cable being marked D–END and F–END. Details of the cores comprising any particular cable may be obtained from a table which is included in the General Arrangement diagram included in the appropriate aircraft handbook.

10. There are three methods of coding the G.E.C. wiring system. In that most generally used in the Wellington aircraft all the cores within the cable bear a code which consists of two letters followed by a number. The first letter denotes the panel to which the cable is connected ; the second letter

1. Flat pins.
2. Screws.
3. Moulded housing.
4. Rubber sleeve.
5. Waxed thread.
6. Special comb.
7. Retaining slide.
8. Metal back plate.

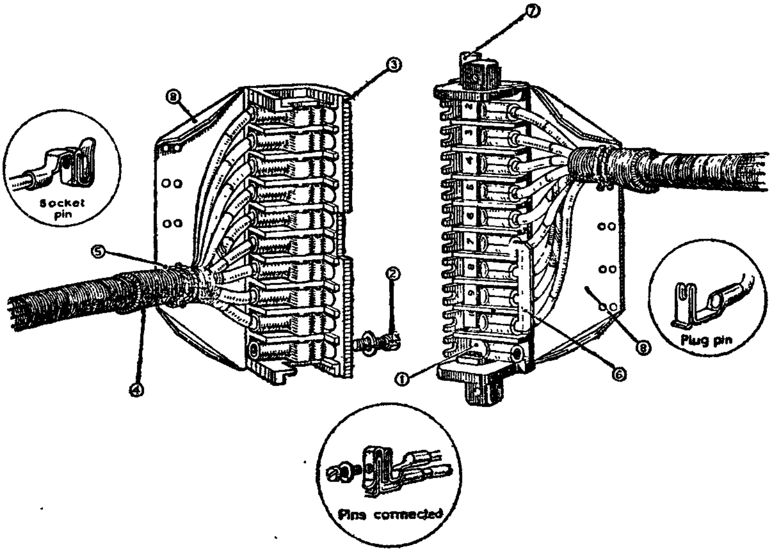


Fig. 3.—Typical connector block

indicates the particular connector block to which the cable is connected and the number denotes the particular connector pin to which a particular core is connected. Thus it may be assumed that, if a certain lead within a multi-core cable bears the lettering AE1, it is connected to a panel A, connector block E, pin 1.

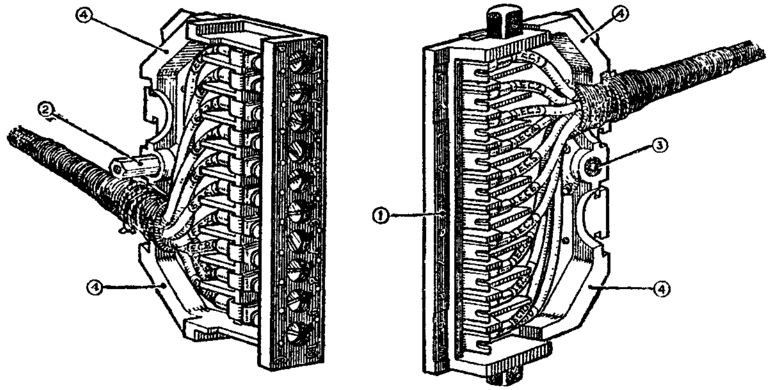
11. On some later types of Wellington aircraft the alphabetical denomination is not used, and the order is reversed. Instead, the connector blocks are numbered and the designation code comprises the connector block number, followed by panel letter, followed by pin number. Thus the core 7C2 will indicate connector block 7, panel C, pin 2. In other aircraft the panels are numbered but the original order is retained so that the code formation is, panel number followed by connector block letter, followed by terminal pin number. Reference should always be made to the aircraft handbook in order to obtain confirmation regarding the coding used on any particular aircraft, but, in emergency, the following method of identification may be used.

12. If it is required to ascertain the panel letter or number remove two connector blocks and examine the coding on the cores within the connector block. One letter (or number) will be common to all cores on both blocks—this will be panel designation. Thus if one block contains cores marked EK1 to EK10 and the other is EB1 to 10 the panel letter is E. The designation of the connector block may be obtained in the same manner. Having ascertained the panel designation it will be found that there is one letter (or number) which is common to all pins but only to one block. This is the connector identification mark.

13. The method of coding is the same for identical types of aircraft, and should be ascertained before commencing servicing from the appropriate aircraft handbook in cases where various types of the same aircraft differ, e.g. in the case of the Wellington aircraft. It may, however, be safely assumed that the final number in any code designation refers to the connector pin number.

14. On the male portion of the connector the numbers of the pins may be found either on the sliding key which holds the key in position or raised on an extension of the moulding (1, fig. 4) in front of the pins. On the female portion the numbers are raised on the face of the moulding below

the holes through which the screws pass. The connector block letter may be found on the face of the socket half of the connector block, and the plug portion carries its designation letter in the corner on the metal back. The lettering of both old and new types can be seen in figs. 2 and 4. On the old type of connector a single row of coloured spots is carried on the face of the moulding against each screw head. The new type of connector block carries two rows of spots, one marked S



1. Moulding.
2. Pillar.
3. Captive screw.
4. Rubber insert.

Fig. 4.—New type of connector block

and one marked P. The latter row indicates polarity of each pin and is marked accordingly red and blue. The upper row, marked S, indicates the service to which each pin is connected.

SERVICING

15. If the multi-core cable is damaged in service, it should be removed together with the halves of the connectors, and replaced by a new cable assembly bearing the same type number as that of the one removed. It is **MOST IMPORTANT** that only an identical cable should be substituted. It may happen, however, that owing to damage, a connector block only has to be replaced, in which case the following notes will be found of assistance.

16. Assuming that it is required to dismantle a connector block fitted to a panel the following instructions should be carried out :—

(i) Remove the hinged cover which is held by round-headed screws.

(ii) Slacken nut (3, fig. 1), which secures the clamp in position and slide clamp as far as possible to the left.

(iii) Slide the appropriate connector to the left until the lugs on the connector are opposite the slots in the retaining strips (4, fig. 1).

(iv) Withdraw the connector from the front or back of the panel according to the type of aircraft.

(v) Slacken, but do not remove, all the screws in the face of the block. On the new type, undo the captive screw (3, fig. 4) which locks the two halves together.

The connector may then be separated easily by pulling the two halves apart, or prising them apart with a screwdriver, provided that the screws have been slackened sufficiently. This procedure allows access to the plug and socket pins which will still remain in position on the moulding.

17. The pins to which the leads are attached may be detached, in the case of the socket, by unscrewing and removing the screws (2, fig. 3) from the face of the socket. The socket pins may then be lifted out of the moulding together with the leads to which they are attached. The plug pins may be removed from the other half of the connector by sliding out the retaining key (7, fig. 3), thus enabling the pins to be lifted from their locating grooves. New connector blocks are supplied complete with pins so that it is only necessary to solder the leads (which carry the corresponding pin number) to the appropriate pins.

18. When reassembling, the procedure is similar but reversed. In this connection it is necessary to stress the importance of ensuring that all the contact screws (2, fig. 3) are tight before replacing the connector block in the panel, otherwise trouble may develop owing to intermittent contact. The last number on the Viskring identification sleeves on the cable cores, must coincide with the number on the key or on the extension of the moulding. During routine servicing the covers should be taken off and all the screws holding the contacts checked for tightness. These screws should also be examined immediately any trouble is experienced due to intermittent contact.

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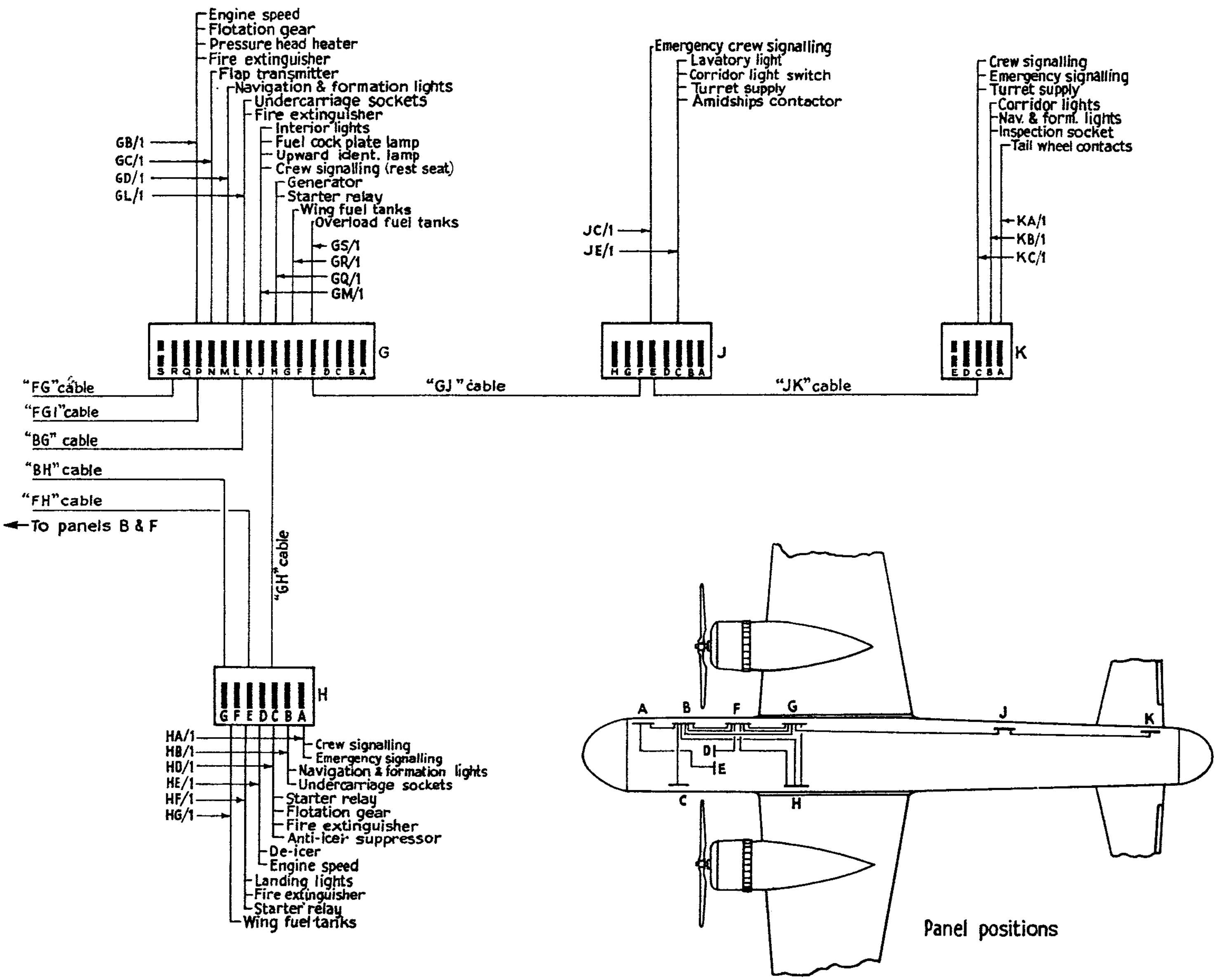

Panel positions

Connector blocks

Panel	Blocks	Cable type	Connected to panel	Blocks
G	EJ	"GH"	H	ABC
G	FGHP	"GJ"	J	ABCEGH
J	ABDF	"JK"	K	ABCD

Panels

Letter	Description
G	Stbd. Wing root panel
H	Port Wing root panel
J	Rear fuselage connt. panel
K	Rear gunner's connt. panel

Cable contents

Type	4 Amp.	7 Amp.	2 Amp.
"FG"	21	11	9
"FGI"	26	5	3
"FH"	13	4	4
"GH"	9	4	4
"GJ"	26	5	3
"JK"	26	5	3

LOCATION DIAGRAM

FIG. 5

FIG. 5

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CHAPTER 7

STRIP CONNECTOR WIRING SYSTEM

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LIST OF ILLUSTRATIONS

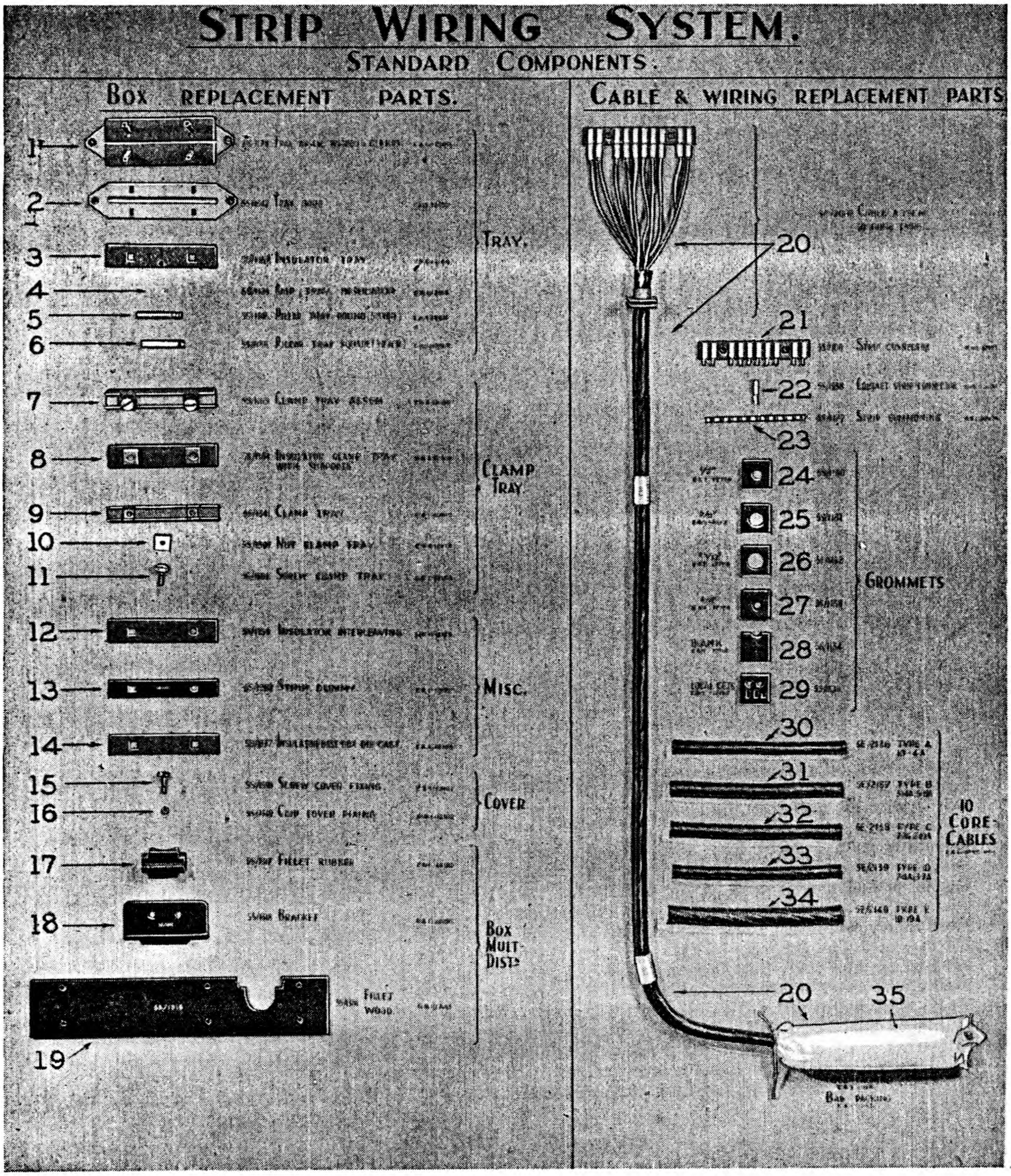


Fig. 1.—Components of strip wiring system

CHAPTER 7

STRIP CONNECTOR WIRING SYSTEM

Introduction

1. The strip connector wiring system is a simple form of electrical wiring harness. The necessity for accurately turned or fitted parts is avoided and, apart from screws and mounting pillars, all metal parts are produced by press operations.

2. The system employs standard ten-core cables of five standard sizes fitted with strip connectors. The strip connectors are assembled in junction boxes and distribution boxes, which are of the same basic design but differ in size, and standard Air Ministry fuse boxes are incorporated in the distribution boxes. Each standard component part of the strip system bears an Air Ministry Stores Ref. Number and is suitable for all aircraft employing the system, thus possessing a high degree of interchangeability. No metal screening is employed, interference being suppressed at the source by means of suppressors.

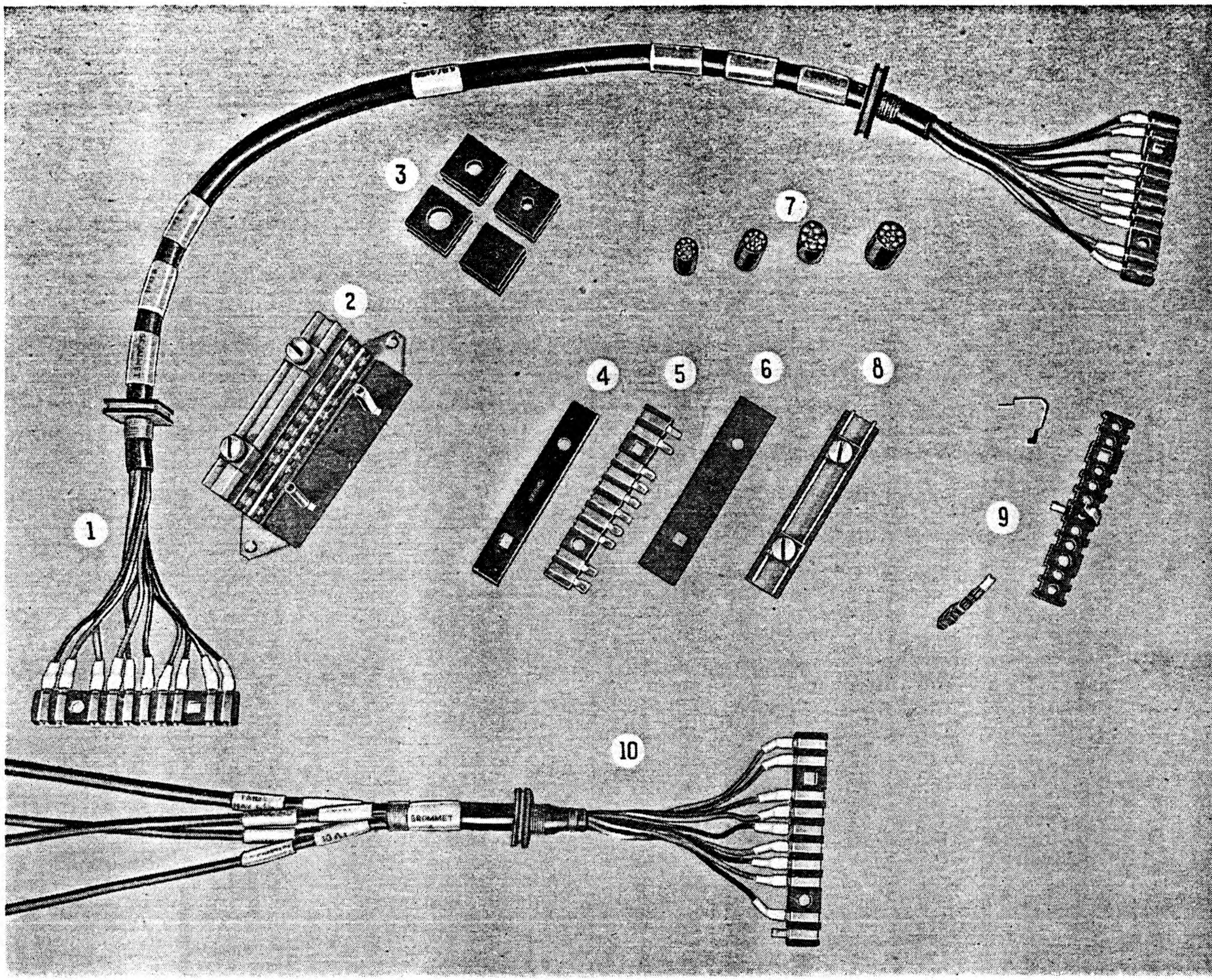
3. The system is so designed that replacements or modifications can readily be prepared and carried out without special tools.

DESCRIPTION

Standard components

4. The following is a list of the main components employed in the strip system of wiring. Reference should be made to the appropriate illustration in fig. 1. Complete details may be obtained from A.P.1086.

Component	*Stores Ref.*	*Illustration, Fig. 1*
Tray assembly without clamps	5S/1178	1
Tray, bare	5S/1342	2
Insulator, tray	5S/1157	3
Clip, tray insulator	5S/1129	4
Pillar, round tray (5 tier)	5S/1145	5
Pillar, square tray (5 tier)	5S/1149	6
Clamp, tray assembly	5S/1163	7
Insulator clamp, tray with supports	5S/1164	8
Clamp, tray	5S/1341	9
Nut, clamp tray	5S/1303	10
Screw, clamp tray	5S/1301	11
Insulator, interleaving	5S/1158	12
Strip, dummy	5S/1282	13
Insulator base, box die cast	5S/1337	14
Screw, cover, fixing	5S/1309	15
Clip, cover fixing	5S/1310	16
Fillet, rubber	5S/1317	17
Bracket	5S/1318	18
Fillet, wood	5S/1316	19
Cable assembly, ten-core	—	20
Strip connector	5S/1100	21
Contact strip connector	5S/1338	22
Strip, commoning	5S/1177	23
Grommets	{ 5S/1130/34 5S/1339 }	24 to 29
Cable, type A	5E/2136	30
,, ,, B (*obsolescent*)	5E/2137	31
,, ,, C	5E/2138	32
,, , D	5E/2139	33
,, ,, E	5E/2140	34
,, ,, F	5E/2386	—
Packing, protective	—	35
Connector, bulkhead		
Base, assembly, 40-way	5R/381	—
Holder, grommet, top and end entry	5S/1093	—
Holder, grommet, assembly, bracket, top	5S/1094	—
Cover, bare, top and end entry, 40-way	5S/1095	—
Wedge, assembly	5S/1096	—
Gasket, connector, 40-way	5S/1097	—
Holder, grommet, end entry	5S/1098	—
Cover, assembly, end entry, 40-way	5S/1099	—



1.—Cable assembly
2.—Tray
3.—Grommets
4.—Dummy strip
5.—Strip connector
6.—Insulating strip
7.—Types of cable
8.—Clamp
9.—"Exploded" strip connector
10.—Group of "cel" cables

Fig. 2.—Cable length and tray dismantled

Equipment	*Complete box*	*Bare box*	*Cover*
Box junction tray	5R/371	5S/1311	5S/1304
2 tray	5R/372	5S/1312	5S/1305
3 tray	5R/373	5S/1313	5S/1306
Box, half tray die cast	5R/370	5S/1126	5S/1127
Box, distribution, 2 tray	5R/376	5S/1314	5S/1307
3 tray	5R/377	5S/1315	5S/1308
5 tray	5R/378	Use 3 + 2	—
6 tray	5R/379	Use 3 + 3	—

Strip connectors

5. The strip connector (21, fig. 1) attached to each cable assembly consists of a bakelite former strip around which, at regularly spaced intervals, are wrapped ten detachable strip contacts (22) each provided with a soldering tag. These contacts are copper strips, silver plated and gold flashed in order to prevent the development of corrosion. A stainless steel spring, which exerts a pressure of 3 lb., is fitted inside each strip contact and compensates for any irregularities which may occur in the material.

6. The strip connectors are also used on local circuits, the "cel" wiring being connected to the appropriate strip connector at one end and terminating at the equipment at the opposite end. Several "cel" cables may terminate at a single strip connector, and, in order to avoid dismantling the complete set of cables attached to a strip when only one is damaged, replacement contacts are available. These tags, an example of which is shown in fig. 2, enable a single "cel" cable to be attached to a strip connector without detaching the remaining cables. A small lug is provided on the opposite side of the strip contact to hold a commoning bar, which is soldered to it when circuit conditions require a number of strip contacts to be linked together.

Cable assemblies

7. Cable connections between junction boxes or distribution boxes are made with standard ten-core cable assemblies, each of which comprises ten rubber-covered cores housed in a Vinyl sheathing, for protection against water, oil, acids and alkalis. This sheathing affords good mechanical protection while retaining the natural flexibility of the cable. The following types of cable assembly are fitted to aircraft:—

Type A Comprising ten 4-amp. conductors.
Type B Comprising five 4-amp. and five 19-amp. conductors. (Now obsolescent, being replaced by Type F.)
Type C Comprising seven 7-amp. and three 19-amp. conductors.
Type D Comprising seven 4-amp. and three 7-amp. conductors.
Type E Comprising ten 19-amp. conductors.
Type F Comprising five 7-amp. and five 19-amp. conductors.

The inner cores of these cable assemblies are coloured according to their rating, i.e., 4 amp. black, 7 amp. red and 19 amp. blue. Each length of cable is fitted with a strip connector and rubber grommet at each end. The grommets slide into appropriate positions in the distribution and junction boxes and serve to prevent the ingress of moisture. All ten-core cable assemblies have No. 1 contact at one end connected to No. 1 contact at the other end, No. 2 to No. 2, and so on, so that when the strip connectors are assembled on trays as described later, each of these connections will be continuous throughout the circuit.

8. Connection between boxes and individual pieces of equipment is made with local circuit cable assemblies, which comprise standard "cel" cables, fitted with a local circuit grommet (fig. 1, 29). A rubber sleeve is fitted where several cables pass through one grommet, a separate hole in the grommet serving each cable. When the cables are originally installed in aircraft, the local cable assemblies are identified by a red or white grommet number, as required, a box number, tray letter and terminal number for each group of cables, and the name of the circuit on each individual cable. Coloured identification markers will not be available in service, but those originally fitted can be detached and used again. At the equipment end, each cable is identified with a box number, tray letter, terminal series number, name of circuit served, and terminal marking on separate cables.

9. The various components of a pile assembly are clearly shown in fig. 2, which shows a complete cable assembly (1) such as is used between two junction boxes, a tray (2) with one pile complete, four different types of grommets (3), a dummy strip (4) for packing a pile when less than

five strip connectors are used, a complete strip connector (5), insulating strip (6), clamp (8) and "exploded" strip connector (9). The four types of cable are shown at (7) and a group of "cel" cables (10), connected to a connector strip. In the original aircraft installation, each local circuit cable assembly is allotted a Stores Ref. No. and supplied on embodiment loan, but unlike the main ten-core cables, the reference numbers for these local circuit cables are peculiar to each type of aircraft. Spare local service cables will not necessarily be available to the Service; the instructions are therefore given in this chapter for making up appropriate local circuit cables from ordinary "cel" cable and strip connectors. Certain local circuit cables may, however, be available at Maintenance Units.

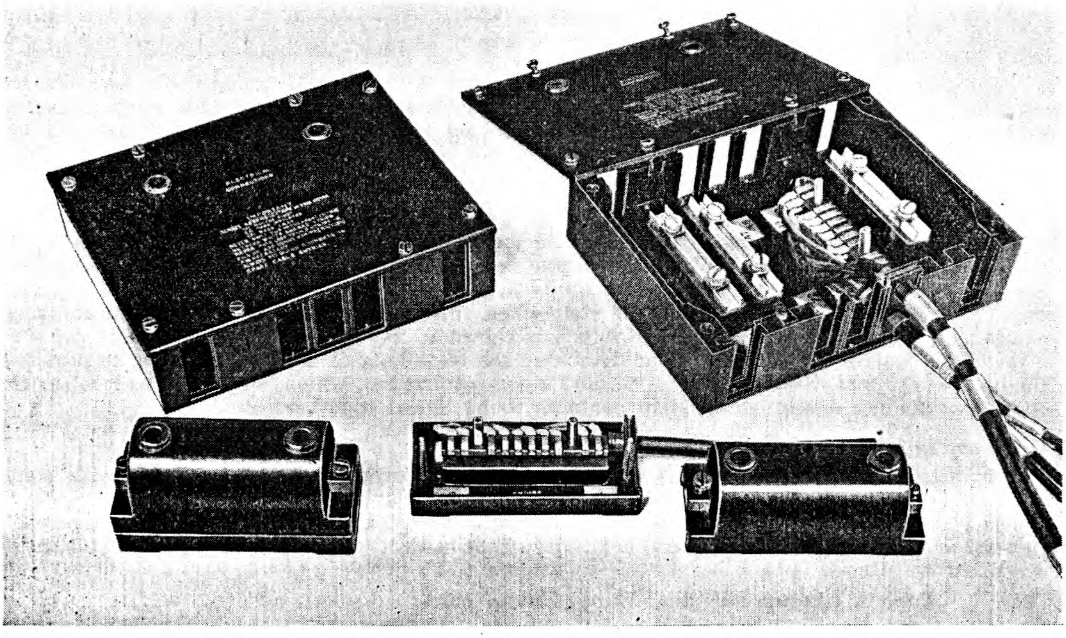


Fig. 3.—Two-tray and half-tray junction boxes

10. Local circuit cable assemblies comprise one or more independent "cel" cables which pass through a special rubber grommet of standard dimensions and are soldered to a strip connector at one end only, the other end being left free for connection to equipment. In the event of failure in one of these assemblies the individual "cel" cable should be renewed and connected to the appropriate strip connector with replacement contacts. All tags have two projecting ears which are bent over the cable to clamp the rubber covering of the individual cores, and a master sleeve over the joint serves as a protection against vibration and short-circuit. These "ears" may also be bent over a cable to form an emergency contact when solder is not available.

Distribution and junction boxes

11. Interconnection between different main ten-core cable assemblies, and between main cable assemblies and local circuit cables, is obtained by the use of distribution and junction boxes, each fitted with standard trays and clamps between which the strip connectors are assembled.

12. Each tray has two pairs of pillars and accommodates two separate piles of strip connectors. Each pile has two pillars, one of which is square and the other round, and these register with corresponding holes in the strip connectors, thereby preventing accidental reversal of the strip during assembly. The height of the pillars allows for five strips and one insulator to be fitted, the insulator being positioned on top of the second or third strip as required. This gives each pile a 20-way capacity instead of the 10-way capacity which would result if all strips were in direct contact. The number of strips on a pile must be made up to five, blanks or dummy strips being added if necessary.

13. To ensure the correct assembly and connections of the strips on the trays colour identification has been adopted to differentiate between strips which should be at the top of a pile and those which should be at the bottom. The normal procedure is to have two or three strips marked with white designations in contact with one another at the bottom of the pile followed by three or two strips

with red designations on top, an insulating strip separating the two groups. The markers on the cable are coloured the same as the strips to which they are attached. The colour markings on the strip may be found at the end of the strip and on the flat surface next to the pillar holes.

14. As already stated, all pillars provide for five strips to be assembled on the pile, and this number must be maintained by the use of dummy strips when the full number of contact strips is not employed, otherwise the necessary inter-contact pressure will not be exerted when the clamp is screwed down. This clamp, which fits on top of an assembly of contacts on a pile, has two screws which fit into the pile pillars, and exerts an even pressure throughout the pile of strips, small irregularity in pressure being counterbalanced by the effect of the springs within the contact tags.

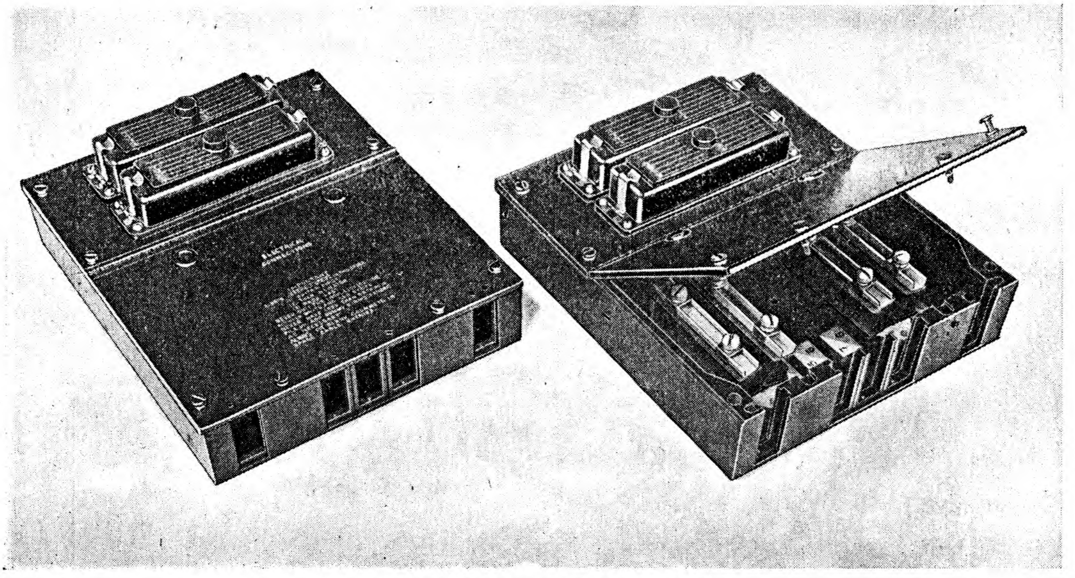


Fig. 4.—Two-tray distribution box

15. Junction and distribution boxes are made in a standard range of sizes and are similar as regards the method of mounting the trays.

16. Standard junction boxes are made in three sizes, carrying one, two and three trays. There is, in addition, a half-tray die cast junction box with one pile only with a capacity of 20 individual connectors. Typical boxes are shown in fig. 3 and 4.

17. The sealed connector bulkhead, 40 way, figs. 6, 7, and 8, has been specially designed for connecting to circuits inside a cabin where a high degree of air seal is required in varying temperatures and pressures It consists of a base with cable entries, and with contacts sealed into the base, arranged so as to connect contact No. 1 of the outside strip connector to No. 1 of the inside, No. 2 to No. 2 and so on. These contacts are silver plated and gold flashed on all exposed parts. Strip connectors are clipped in position behind the projecting strip-retaining springs. Moulded wedges fitting on the wedge-fixing screws, or threaded pillars shown in fig. 7, are secured by two nuts and force each pair of strip connectors apart so that they make good connection with the bulkhead connector contacts. The capacity of the junction box is 40 through connections, and in all cases 4 strip connectors must be fitted on each side of the box, a spare unwired strip connector being used if necessary, so that displacement of the vertical springs does not prevent the fitting of the wedge. Covers fit on both sides over the base and wiring, and are fixed by two nuts which can be seen in figs. 6 and 8.

18. The standard distribution boxes are made in four sizes, carrying two, three, five and six trays; these four sizes of distribution boxes have 16, 20, 36 and 40 fuses, a hinged cover being provided on the distribution box to facilitate access to the terminal and fuse connections. The

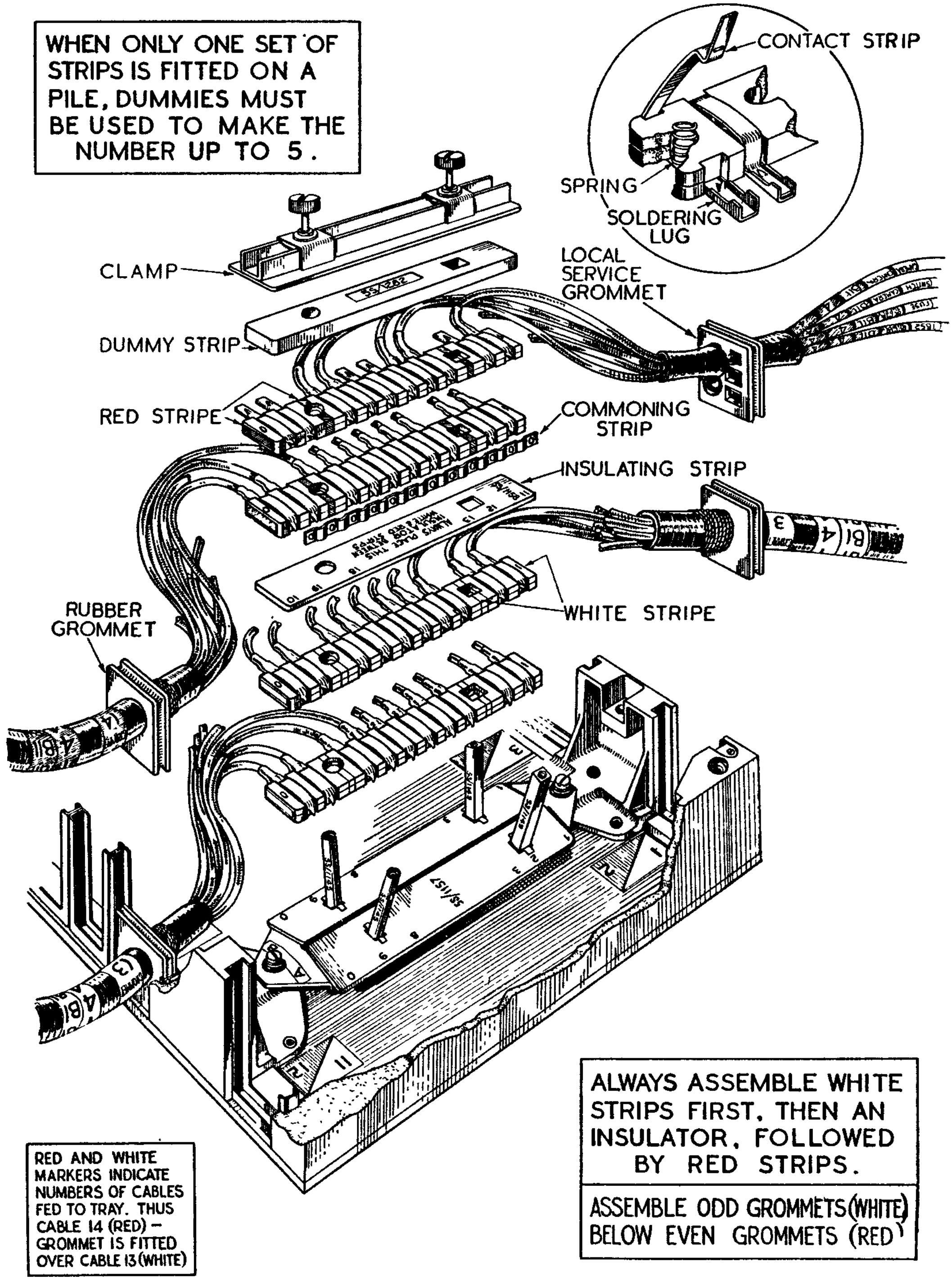


Fig. 5.—Assembly of a typical tray

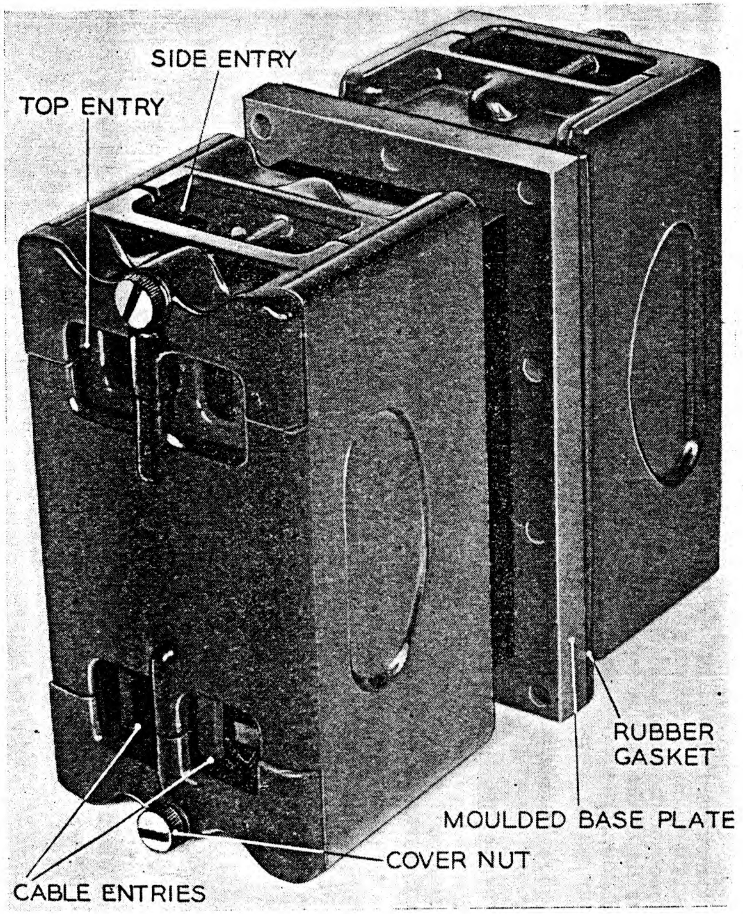


Fig. 6.—Sealed junction box for pressure cabins

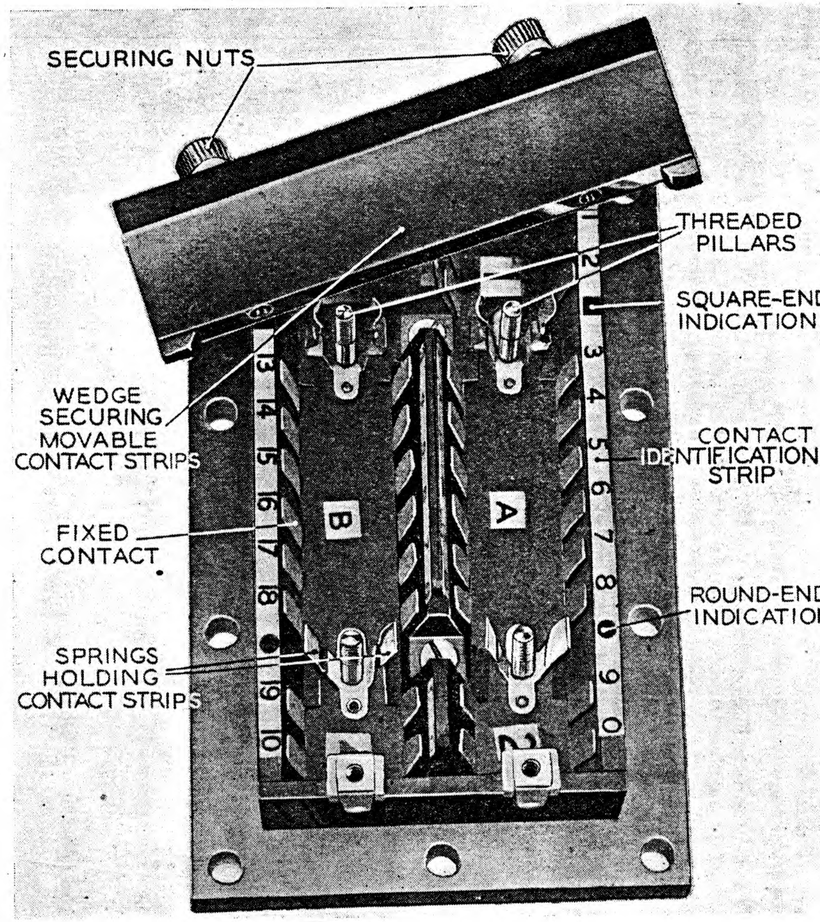


Fig. 7.—Sealed junction box with cover removed

fuses employed are of the type S with the exception of four fuses in three- and five-tray boxes and eight fuses in the six-tray boxes, which are the type B, although they may be any of the large, round ended types. Fuses are normally mounted on top of the distribution boxes, but in certain installations it is necessary to mount the fuses separately.

19. Standard distribution boxes may be fitted with internal cable looms by means of which any strip contacts within the box may be connected together or to one of the fuses. Cable looms may also be fitted inside junction boxes when it is found necessary to cross-connect strip contacts. As cable looms are detachable, they can be fitted into or removed from distribution or junction boxes as necessity arises. When required, however, the cable terminations can be clamped together without the introduction of loom wiring. Cable looms are not generally used in junction boxes, the main purpose of which is to make or break electrical connections at transport joints of the aircraft

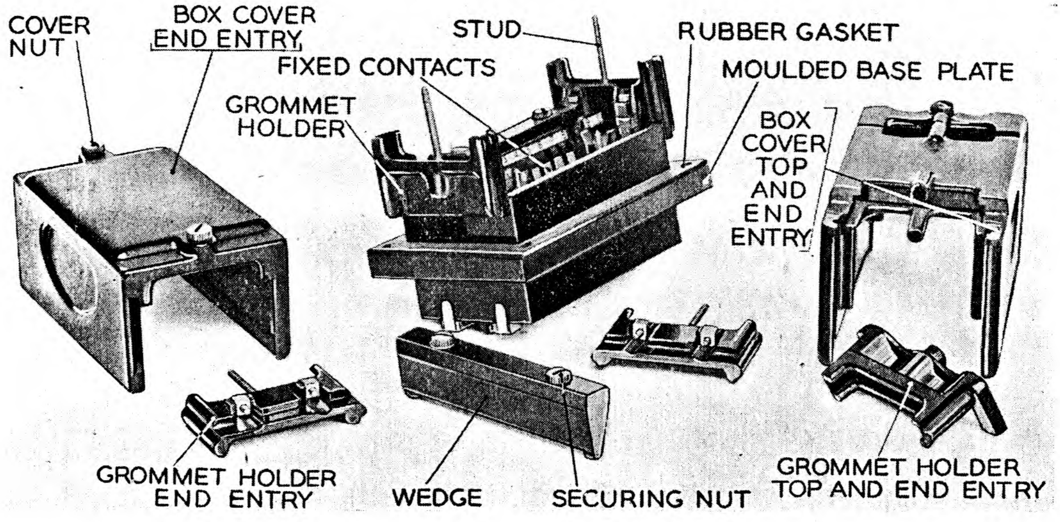


Fig. 8.—Dismantled components of sealed junction box

and at the instrument panel, but recent developments of the system have necessitated some looming. The sides of both junction boxes and distribution boxes are fitted with grooved slides to accommodate the grommets on the cable assemblies, and when these grommets are clamped down tightly by screwing down the lid of the box, a reasonably watertight box results. Ventilators in the form of double gauze windows, are provided in the front of the boxes to allow for natural ventilation but are designed to exclude actual drops of water.

20. Tray mounting positions are lettered in sequence and grommet positions are numbered in sequence to correspond with the markers on the cable assemblies.

21. Boxes drawn from stores do not bear transfers, but those in aircraft are numbered in sequence from the front to the rear of the aircraft, odd numbers for the port side and even numbers for the starboard side. Simple instructions for the assembly of strip connectors in the boxes are given in this transfer, which is available for application to standard boxes drawn from Stores.

22. In the case of replacements, the transfers are applied by service personnel to avoid de-standardisation of boxes in stores. The number of the box, letters of the tray and first number of the terminal strip at the same end are carried on the cable assembly, e.g. 2A1 or 2A11, indicating box 2, tray A and strip 1 or 11. Designating labels terminated by "1" are white, and those terminated by "11" are red, thus indicating whether they are part of the upper or lower strip assembly.

INSTALLATION

Preparation of 10-core cable assemblies for installation

23. When a new cable assembly is required to take the place of damaged cable, a suitable length of cable may be cut from a reel and the ends prepared in the manner described in paras. 25 to 27 and illustrated in fig. 9. In this case, markers must be fitted according to the instructions given in para. 24 and illustrated in fig. 10.

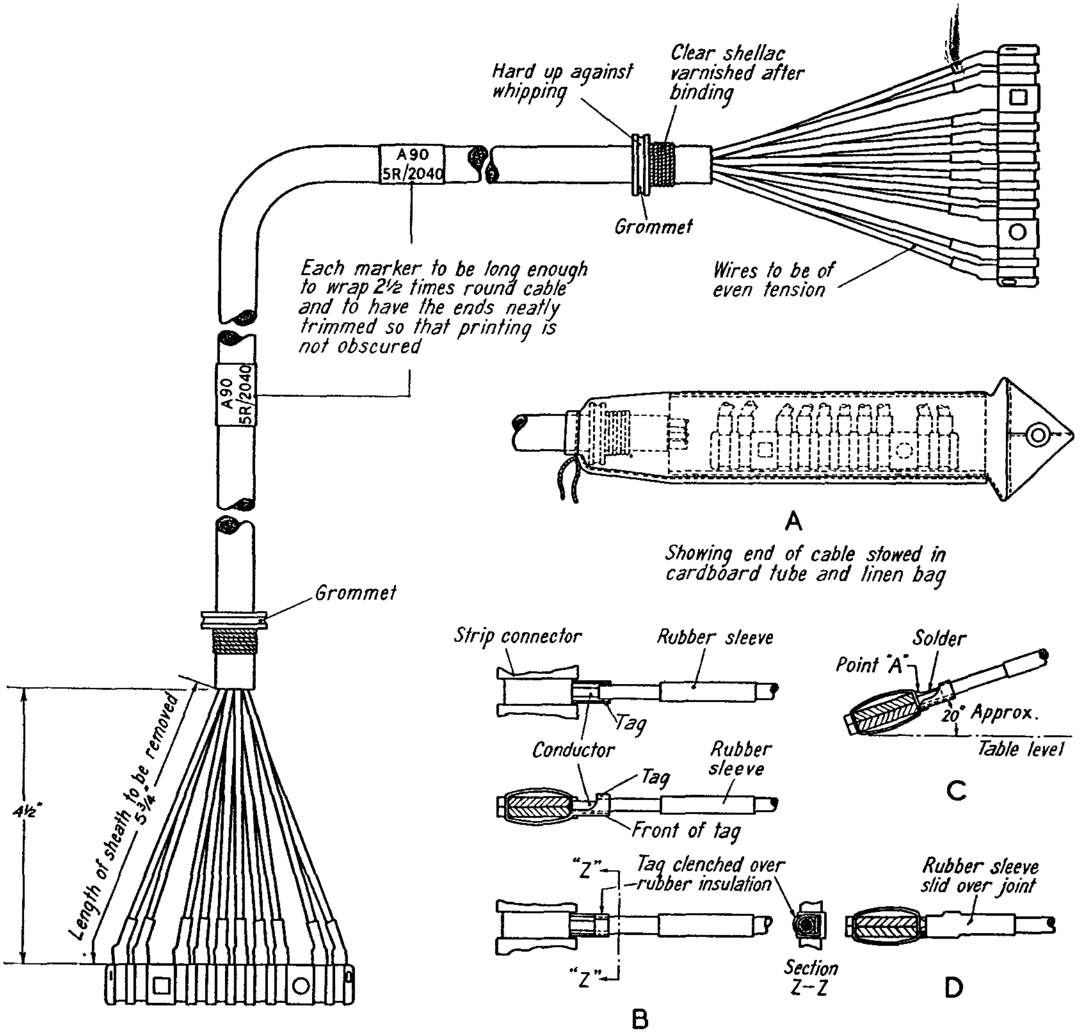


Fig. 9.—Method of preparing cable assemblies

24. Three sets of adhesive cable markers have to be fitted to each end of each cable assembly, and when required for replacement may be removed from the damaged cables or made up locally. The three sets of cable markers refer to the positions in the boxes in which the cables are assembled, thus, referring to fig. 10 marker "A" refers to the grommet number, "B" gives the box number followed by the tray letter and pile position number of the "Y" end of the cable. The "C" marker contains similar demarkations to "B" marker but refers to the opposite (i.e. Z) end of the cable. In this respect it should be noted that all cable markers relating to strips at the bottom half of the pile are coloured white, and bear the designation "1", while cable markers relating to strips in the top half of the pile are coloured red and bear the designation "11". It will be observed that *at each end of the cable,* markers indicate the grommet number at that end only, and box numbers and tray letters of *both* ends of cable. The strips are painted red or white at the points shown shaded in fig. 10 according as to whether they are to be assembled at the bottom or the top of a pile. In any case, the colour of the strip must coincide with that of the markers on the cables to which it is attached. If made up from a reel of cable, markers showing the cable type should be attached. These may be removed from the damaged cable.

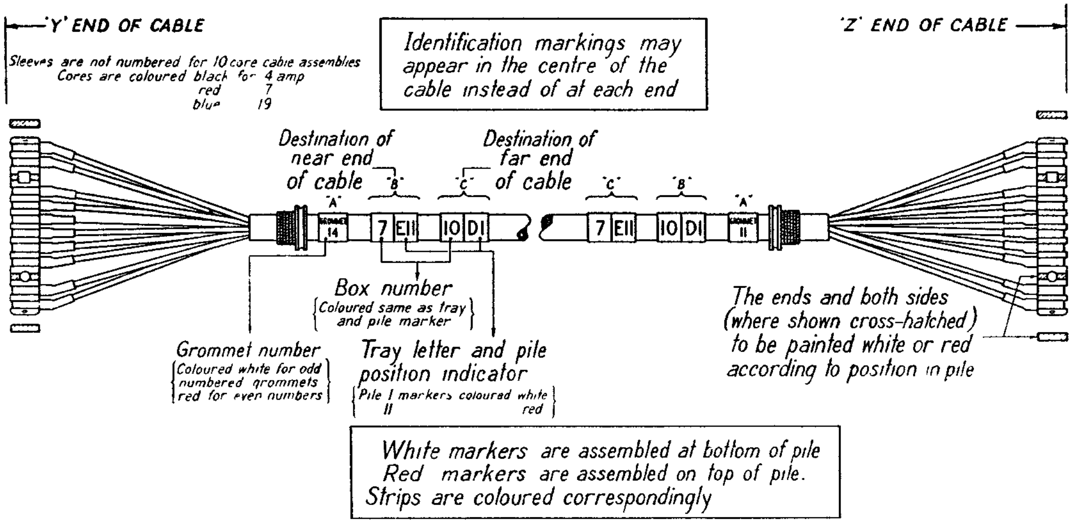


Fig. 10.—Fitting of cable markers

Preparation of cable ends when cut from reel

25. The method of attaching strips to cables is outlined below, and the instructions should be read in conjunction with fig. 9.

(i) Cut the cable to the required length. This is always 14 in. longer than the distance from grommet to grommet of the boxes.

(ii) Slide the appropriate grommet over the cable and apply a firm whipping of six turns of lacing twine, commencing $6\frac{3}{4}$ in. from the end of the cable sheath. Paint the binding with clear Shellac varnish. Note that the grommet must fit tightly up to the end of the binding after the Shellac is dry.

(iii) Remove $5\frac{3}{4}$ in. vinyl sheath from the cable.

(iv) Fit the strip connector and cable into a wiring fixture. If a fixture is not available, fix the cable and strip connector to a wiring table so as to ensure that the correct dimension of $4\frac{1}{2}$ in. is maintained (fig. 9).

(v) Untwist the cable cores so that they lie flat. Cut each individual core so that it runs straight and without slack to the appropriate strip contact.

(vi) Slide the rubber sleeves over the cores for a distance of about 2 in. from the end, using a suitable tool and French chalk.

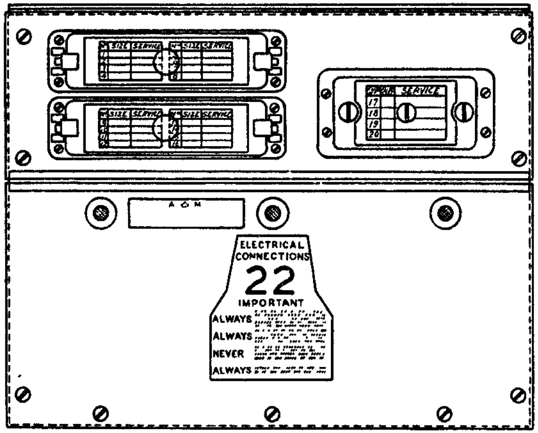
(vii) Remove the rubber of the core, leaving just sufficient to be gripped by the projecting ears of the tag, as shown in fig. 9. When carrying out this operation care must be taken not to cut or damage any of the wire strands. Cut away any excess of bared wire so that it just reaches the back of the tag, as indicated in the illustration.

(viii) Clench the projecting ears of the tag over the rubber insulation of 4- and 7-amp. cables but over the bared conductor of 19-amp. cables.

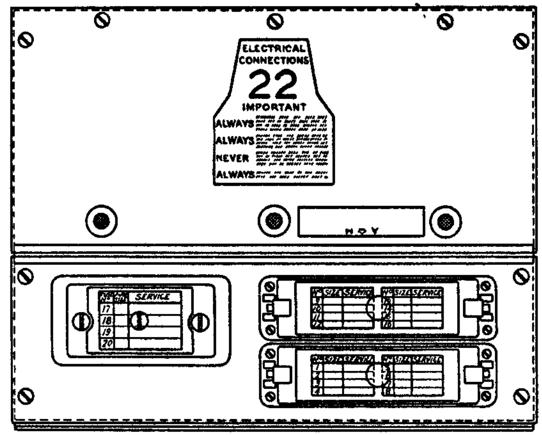
(ix) Prepare the opposite end of the cable in the same way, testing each individual core with a buzzer or lamp to ensure that cores are attached to strip contacts in the same order on the strip connectors at each end.

Soldering

26. When soldering leads to tags only resin may be used as a flux, resin-cored solder being a convenient form. Soldering spirits and pastes must not be used, and care must be taken to avoid under or over-heated irons. If a cable fixture is used, tilt the fixture so that the back of the strip connector slopes downward at an angle of approximately 20 deg.; if no fixture is available arrangements must be made to produce the slope, as shown in fig. 9 (C). Next, hold the soldering iron on the tag at the joint, but clear of the rubber. When the joint is hot, apply resin-cored solder to the wires so that the solder runs over them and fills the tag, at the point "A". All joints must be

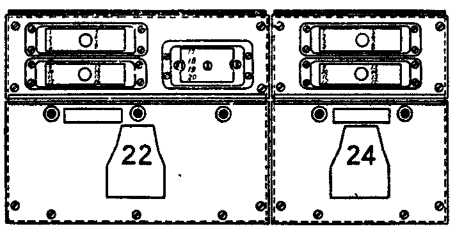


NORMAL MOUNTING
Bottom cable entry

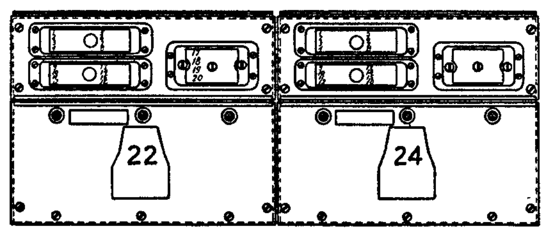


INVERTED MOUNTING
Top cable entry

METHOD OF MOUNTING THREE-TRAY DISTRIBUTION BOX



NORMAL MOUNTING - *Five tray distribution box*



NORMAL MOUNTING - *Six tray distribution box*

Fig. 11.—Method of marking distribution boxes

inspected at this stage. When carrying out these operations, care must be taken to prevent dirt, grease, resin, solder or any foreign matter from damaging the contact faces of strip contacts. Strip contacts damaged by solder must be rejected, but in other cases the contacts should be cleansed with a suitable spirit, such as industrial methylated spirit or Pool rubber solvent.

Protection of the joint

27. Finally, in order to protect the joint, slide the rubber sleeve over from the back, pressing it well up to the bakelite of the connector, as shown in fig. 9 (D).

Markers

28. Identification markers, detached from the damaged cable, stating the type of cable, should be wrapped round the cable at a point 6 in. from the grommet. The marker should bear the type letter and length in inches; for example, a cable, type A, 7 ft. 6 in. long, is marked "A.90".

Installing cable assemblies

29. The cable assemblies should be fitted to the aircraft in the normal manner, clips being used to secure the cables to the airframe. The lids of the appropriate junction or distribution boxes should be removed or lifted and the rubber grommet on the cable fitted in the appropriate position in the box. Reference to fig. 10 will indicate that the grommet positions are numbered and coloured, and the grommet should be fitted in the appropriate position according to the marking on the cable itself. Care should be taken to ensure that the grommet is pressed right home and is securely retained in its slots. The strips should then be assembled on the tray in the following order:—

(i) White coloured strips

(ii) Insulator

(iii) Red coloured strips

(iv) Dummy strip if required to bring the number up to five strips.

(v) Clamp.

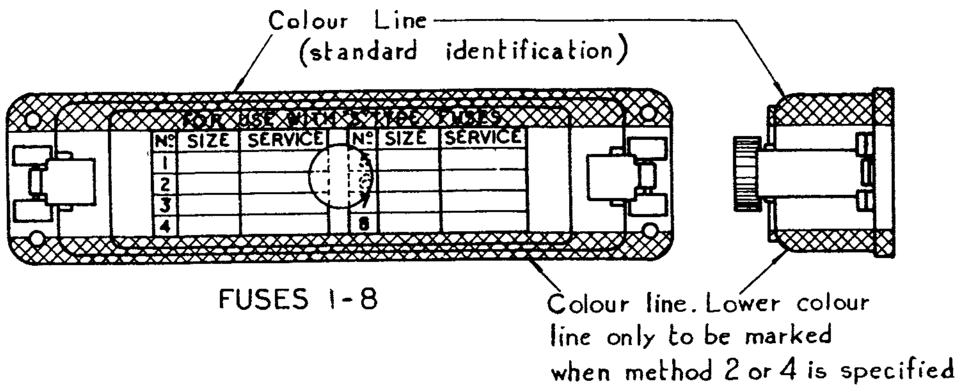
The strips are fitted with a round hole at one end and a square hole at the other, so that they must register with the pillars in the tray. It is important NEVER TO OMIT the insulator between the red and white coloured strips, otherwise serious damage may result. When all the cables have been fitted to the box in this manner, the lid of the box may again be screwed down. If, however, a faulty distribution or junction box has to be replaced, the standard replacement box withdrawn from store will have to be identified in the manner described in the subsequent paragraphs.

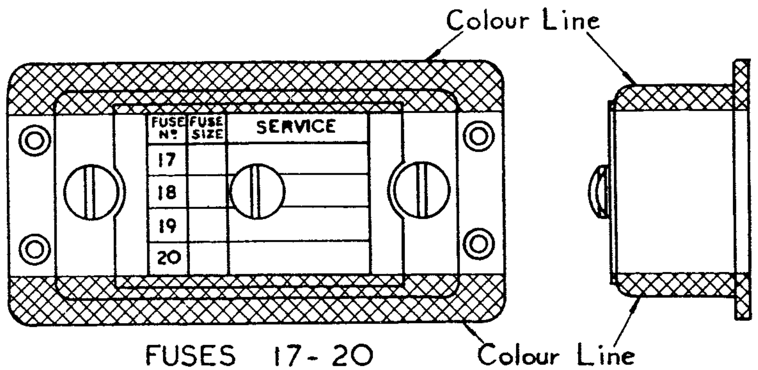
Preparation of distribution boxes

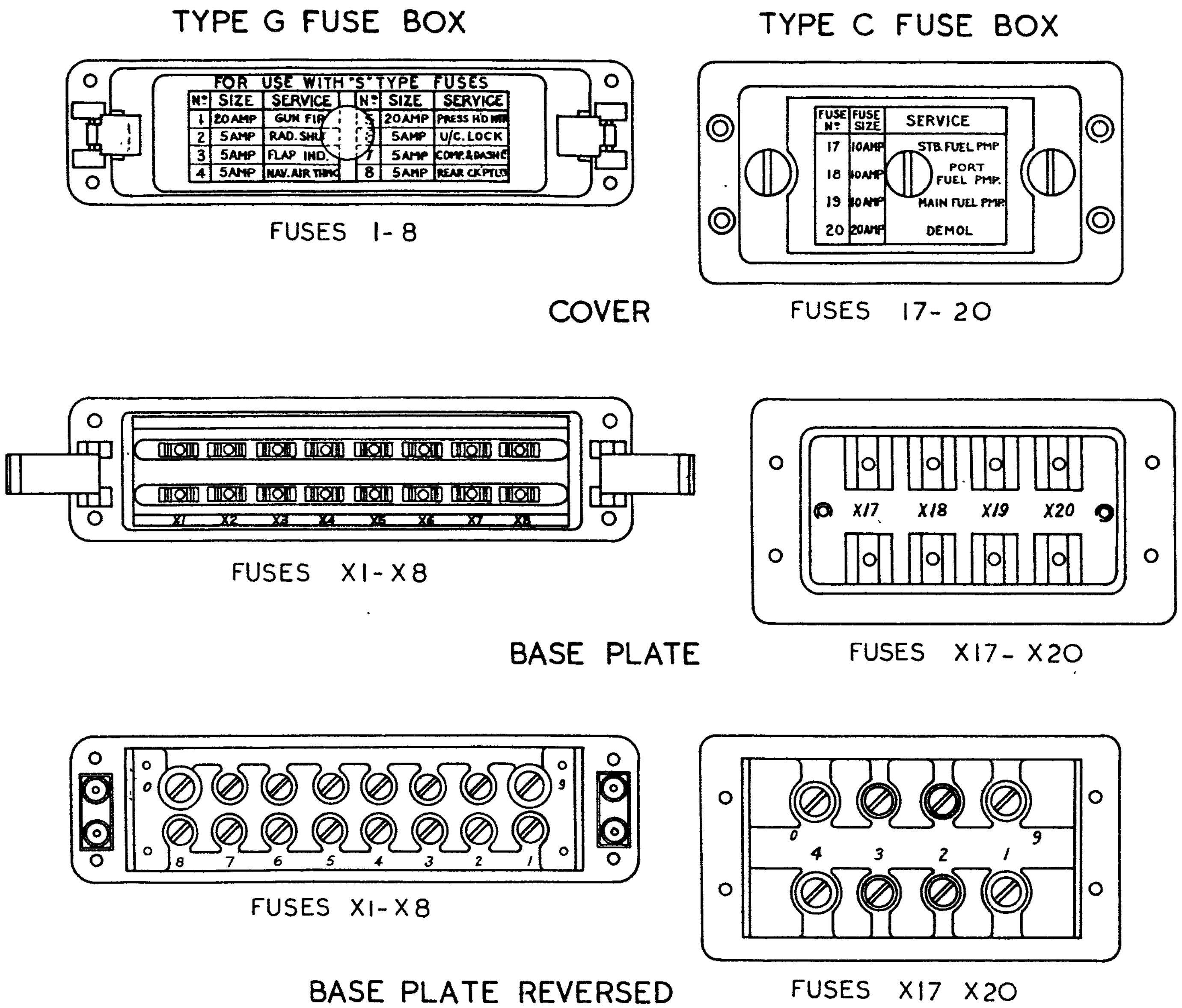
30. Distribution boxes, when drawn from store for installation in aircraft, require certain preparatory work, according to the type of aircraft in which they are installed and their relative position. The operations involved in the preparation of distribution boxes include the attachment of the box number by transfers or sign painting, the preparation and marking of fuse-boxes, the preparation and installation of cable looms, and the preparation and installation of a diagram of connections.

Transfers

31. Every box on an aircraft, whether a distribution or junction box, is allotted a number for identification, and in addition, carries instructions on the cover for assembling the electrical connections. The box number and instructions are attached to the cover in the form of a waterslide transfer. There are two positions in which box number transfers may be attached to a distribution box, depending upon the manner in which the box is to be installed in the aircraft namely "normal" and "inverted" mountings. The normal method of attaching the transfer is used when the boxes are mounted so that the cables enter the bottom of the box, but when the cables enter from the top of the box, the transfers are fixed the opposite way up. The transfers are attached in the following manner. Soak the transfer in clean water for about 30 seconds until it is free to slide in the paper backing. Slide the appropriate edge of the transfer off the paper backing and apply to the cover of the box. Hold this protecting edge on the cover, and working close to the surface, deposit the remainder of the transfer by steadily withdrawing the paper backing. Adjust the position of the transfer until it is mounted centrally and squarely on the cover, and, whilst still wet, press the transfer down firmly with a soft cloth. When the transfer is affixed and dry, a coat of clear non-cellulose varnish may be applied. In the case of multibox distribution boxes, containing five and six trays, a separate box number transfer must be fixed to each box cover. If box transfers are not available paper labels or sign painting should be used.







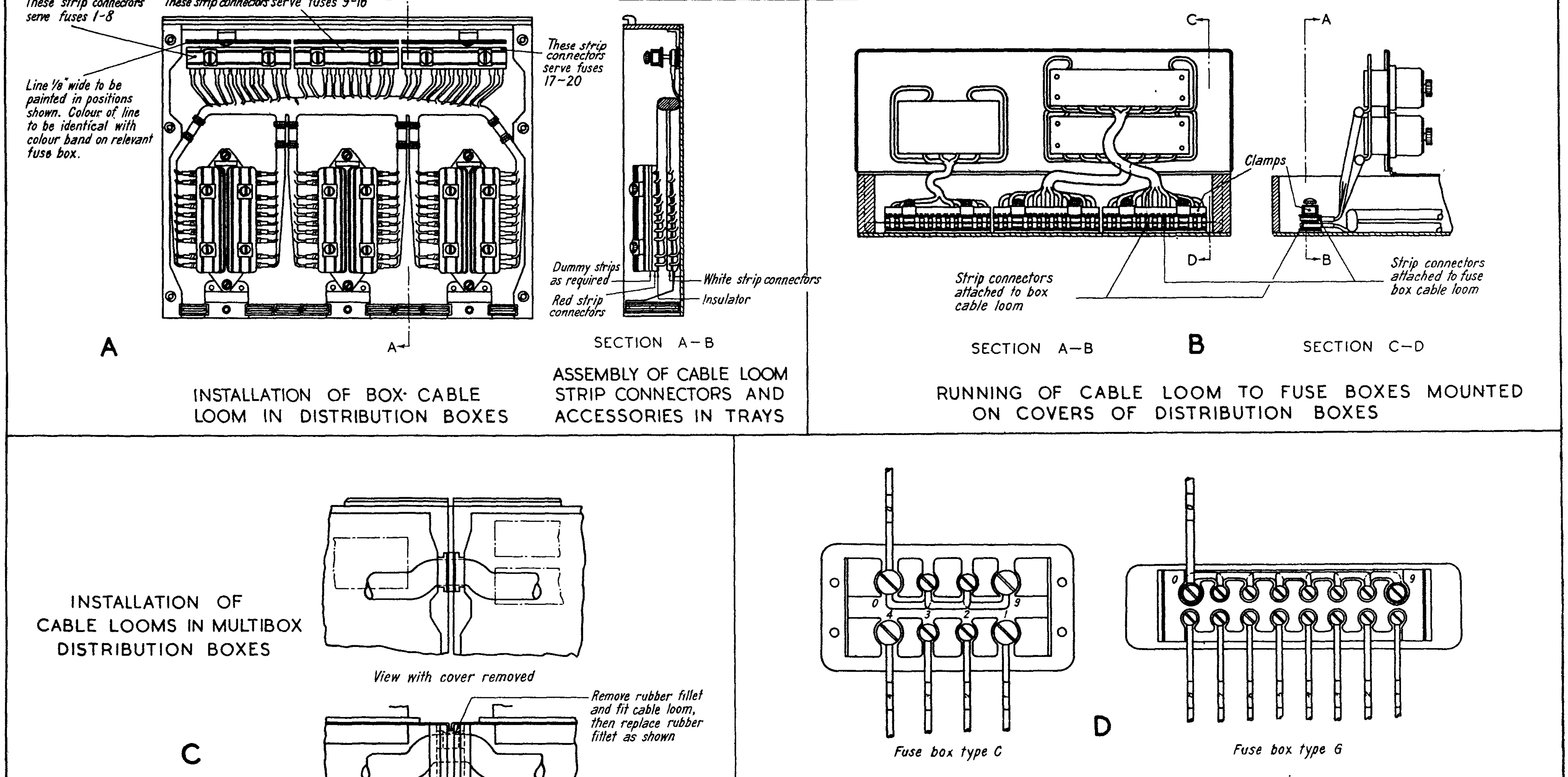
FUSES MARKED:	METHOD NO.	COLOUR	NO. OF BANDS.	TRANSFER NUMBER
1-8	1	WHITE	1	E&I.12104/1
	2	WHITE	2	12104/5
	3	GREEN	1	12104/2
	4	GREEN	2	12104/6
9-16	1	RED	1	E&I.12104/3
	2	RED	2	12104/7
	3	YELLOW	1	12104/4
	4	YELLOW	2	12104/8
17-20	1	YELLOW	1	E&I.12104/9
	2	YELLOW	2	12104/11
	3	WHITE	1	12104/10
	4	WHITE	2	12104/12

METHOD OF MARKING FUSE NUMBERS, & COLOUR IDENTIFICATION BANDS ON COVERS & BASES

FIG. 12

FIG. 12

PP2852 M /163 4/44 8500 C & P Gp 959 (4)



A

INSTALLATION OF BOX CABLE LOOM IN DISTRIBUTION BOXES

SECTION A–B

ASSEMBLY OF CABLE LOOM STRIP CONNECTORS AND ACCESSORIES IN TRAYS

B

SECTION A–B

SECTION C–D

RUNNING OF CABLE LOOM TO FUSE BOXES MOUNTED ON COVERS OF DISTRIBUTION BOXES

C

INSTALLATION OF CABLE LOOMS IN MULTIBOX DISTRIBUTION BOXES

D

ATTACHMENT OF CABLE LOOM, SUPPLY AND CIRCUIT CONDUCTORS ALSO CONNECTING LINKS TO FUSE BOXES

FIG. 13 METHOD OF INSTALLING CABLE LOOMS IN 3 TRAY DISTRIBUTION BOXES FIG. 13

Marking of fuse boxes

Colour identification

32. Fuse box covers must be replaced on the correct base and colour bands are used to prevent the wrong cover being fitted. Fig. 12 shows the method of marking colour bands and the colours used, and the following alternatives are employed:—

(*a*) With one distribution box in a cockpit. Only the top colour band is used.

(*b*) With two distribution boxes in a cockpit, the fuse boxes of one distribution box are marked with the top colour band only, and the fuse boxes of the other distribution box are marked with both the top and bottom colour bands.

When replacing a damaged fuse box or cover, the correct colour bands must be painted on the base and cover.

Fuse numbers, capacities and circuit titles

33. The fuse circuits contained in all distribution boxes are numbered consecutively as shown in fig. 12, *viz.*— two tray boxes contain fuses 1 to 16, three tray boxes contain fuses 1 to 20, five tray boxes contain fuses 1 to 20 in the left-hand box and fuses 1 to 16 in the right-hand position. Six-tray boxes contain fuses 1 to 20 in both the left- and right-hand boxes of the multi-box assembly, when mounted in the normal position.

Marking of covers

34. The fuse number, together with the fuse capacity and title of the circuit is marked on the cover of each fuse box; on the front of the base of each fuse box is marked the fuse number prefixed by the letter X: the terminals on the back of each fuse box are also numbered. All these markings can be seen in fig. 12, where it will be noticed that fuses numbered 17–20 will be shown as 1–4 on the back of the box.

Method of marking fuse boxes

35. There are three methods of marking fuse boxes, namely, by transfers, engraving and sign-writing. Engraving provides the best method for preparing small quantities of boxes, but where it cannot be employed, resource should be made to sign-writing. Transfers will not normally be used by the service. In each case the fuse rating and service identification should be designated and the same methods are used where operational requirements necessitate the addition of extra circuits. Except when transfers are employed, it will be necessary to remove the existing embossed fuse circuit numbers on the fuse boxes, type G. These numbers do not exist on the fuse box, type C and, when transfers are used, it will suffice to stick them over the numbers and apply a coat of clear varnish in order to seal the transfer on the uneven base provided. Cellulose lacquer must not be used and sign painting must also be done with varnish.

Fitting the connecting links

36 The supply sides of all fuses in the same fuse box are coupled together by means of connecting links, except in special cases where stated to the contrary.

Insertion of fuses

37. A fuse of appropriate capacity and type must be inserted in each fuse holder and, in addition, a spare fuse of the same type and capacity for each circuit must be fitted in the corresponding spare fuse holder in the detachable portion of the cover.

Preparation and installation of box cable looms

38. The function of the cable loom is to provide internal box connections between a number of strip contacts as set out in the running list, which varies for every distribution or junction box according to the type of aircraft. When a box cable loom requires replacement, a new loom should be requisitioned by the Stores Ref. No. shown on a label attached to the damaged loom.

39. If a replacement is not available from Stores, a new box loom can be made up by following the instructions given in paras. 38 to 48. The running list referred to above will be required; if it is not available, a new one may be made out by referring to the diagram attached to the lid of the box, which shows a diagrammatic outline of the box loom, indicating connections between each fuse and a strip contact, and interconnections between strip contacts of different piles. Except for checking purposes, the fuse to strip contact connection is not required in this instance, and each wire should therefore be listed FROM the strip contact concerned TO the strip contact designated against it, so that the running list reads in the manner shown in fig. 15. This should be done

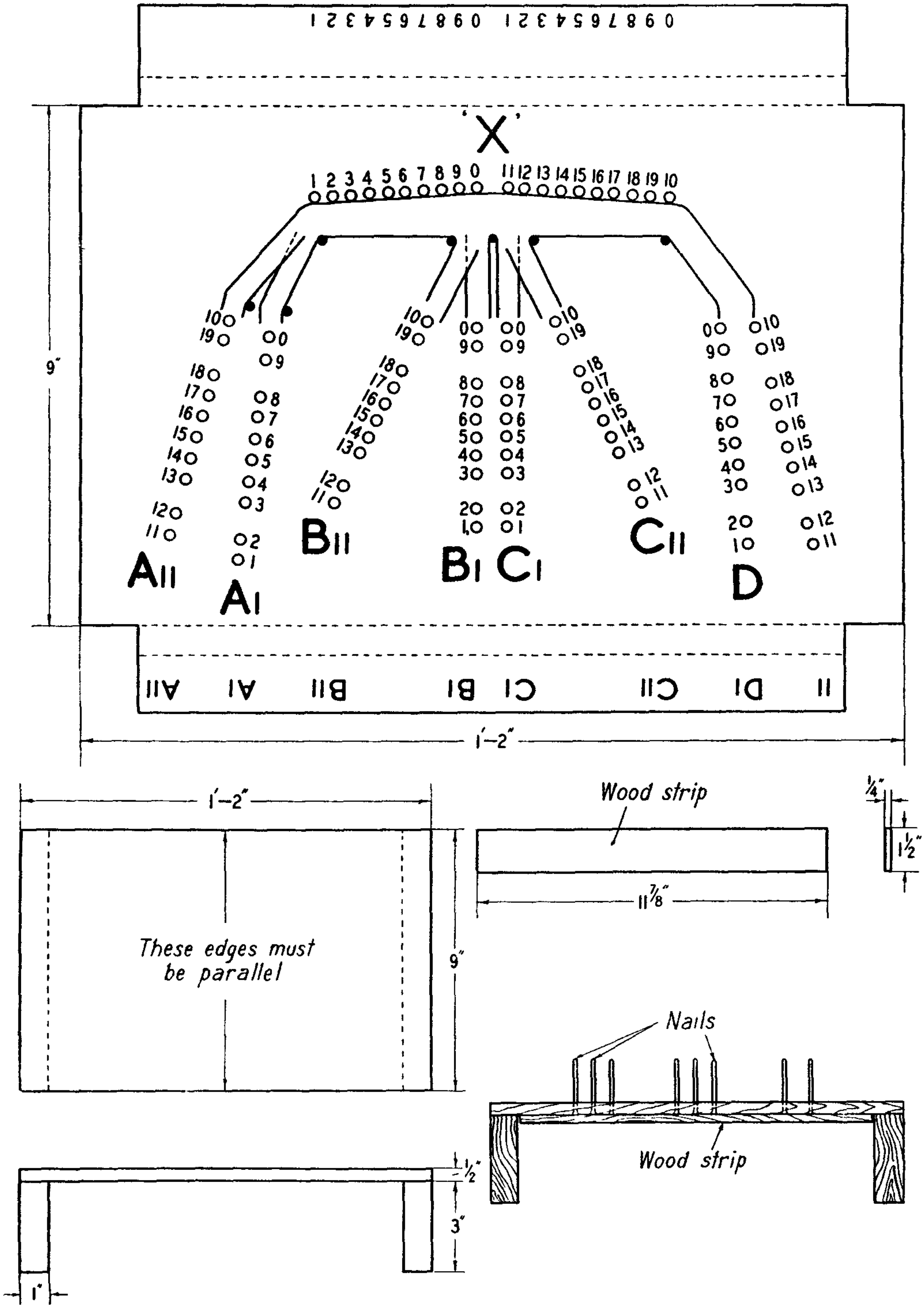
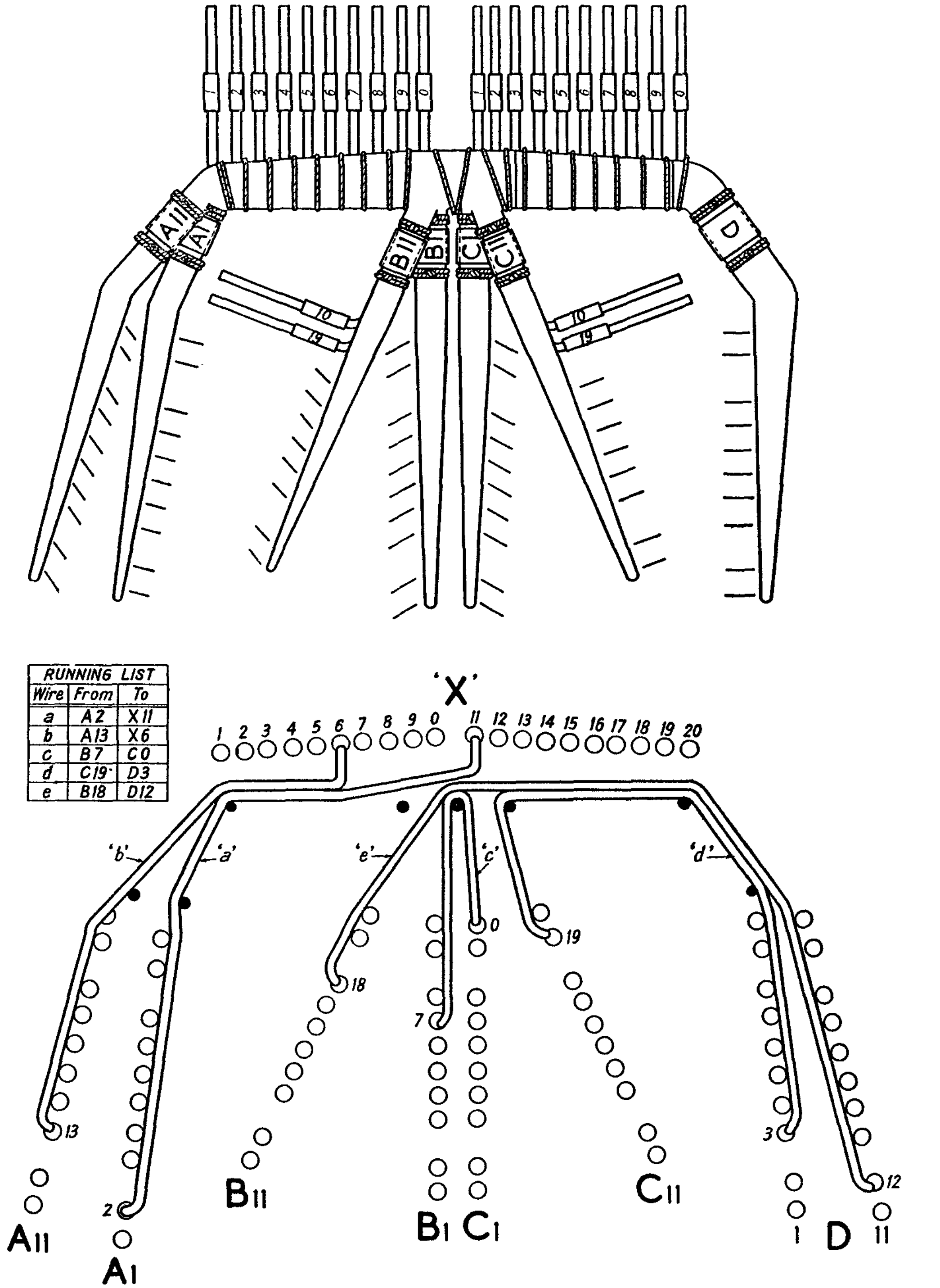


Fig. 14.—Template for 2-tray distribution box cable loom



RUNNING LIST		
Wire	From	To
a	A2	X11
b	A13	X6
c	B7	C0
d	C19	D3
e	B18	D12

Fig. 15.—Preparation of cable loom for 2-tray distribution box

methodically to avoid listing wires twice, and it should be noted that there may be more than one wire from a strip contact. On the box lid diagrams, 7 amp. wires are marked with one inverted comma, 19 amp. wires with two inverted commas, and all unmarked wires are 4 amp. For example:—

A8 indicates that this wire is 4 amps.
A8' indicates that this wire is 7 amps.
A8'' indicates that this wire is 19 amps.

40. The cable loom consists of a number of separate unirubber wires laced together with twine; if unirubber wire is not available, cores of the correct amperage recovered from 10-core or "cel" cables may be used. Each of these wires connects two strip contacts. Fig. 15 shows a typical running list and gives a view of the template with these wires run in position. The full circles represent nails and open circles represent holes so that the running of the leads can easily be traced. All other leads in the running list are run in a similar manner.

Forming the cable loom

41. While the following instructions refer specifically to the template and box loom for a 2-tray distribution box, the same procedure with, of course, a suitable template, is followed in making up box cable looms for 3-tray boxes. First of all, a template must be constructed with battens. A layout, similar to that in fig. 14 but 14 in. × 9 in. in size should be drawn and glued to the top of a wooden board, cut to fit the boundary lines of the layout. The procedure is then as follows:—

(i) Drill a series of $\frac{1}{4}$ in. diameter holes where the circles are shown on the diagram.
(ii) Obtain the required number of 2 in. round wire nails and file the points smooth and round.
(iii) Drill holes suitable for driving the nails tightly through, where shown by the solid circles in the diagram.

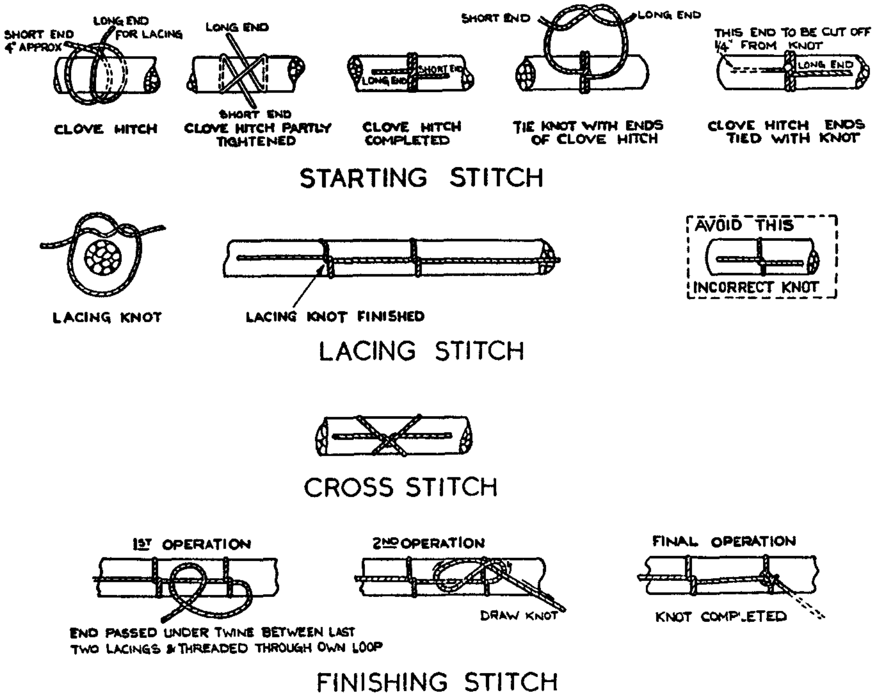


Fig. 16.—Method of lacing cable loom

(iv) Drive the nails into the prepared holes with the heads below the board. A wooden strip screwed over the nail heads will prevent them giving way while the loom is being formed, but this strip must not cover any of the cable holes.
(v) Bend the ends of the drawing along the dotted lines, and turn it under the board so that the numbers correspond with the holes on this side: stick it in place.
(vi) Number the remaining holes in pencil to correspond with the numbers on the front of the board. The template is now ready for running the cable wires.

42. The sequence of operations for running a wire is as follows:—

(i) Push the wire of the size specified, 4, 7, or 19 amp., through the hole quoted in the FROM column of the running list until it just touches the bench top, then bend it sharply.

(ii) Run the wire round the nails by the shortest route to the hole referred to in the TO column, and cut the wire off 3 in. beyond this hole.

(iii) Push the wire through the hole and bend it sharply. The wires must not be run tightly, or allowed to build up round the nails.

43. When all the wires have been run, the main arm should be laced with 6-cord wax lacing twine in the manner outlined below, reference being made at the same time to fig. 16 which illustrates the method of lacing:—

(i) Take all the wires that are to be connected to one side of a strip connector—e.g., those in the A1 arm, and tie them where shown in fig. 15, using the "Starting stitch". Repeat for each arm in turn.

(ii) Start the lacing of the main arm on the left-hand side with the forming table placed on the bench and the arms A1, A11 etc., pointing away from the operator. Begin with the starting stitch, using a clove hitch knot.

(iii) Continue along the front of the loom, using the lacing stitch. In order to tighten the knot, draw the lacing stitch first to the rear and then to the front, this will help to prevent slip. The stitches must be regularly spaced, and at each point where a short arm turns off the main arm, the cross stitch is used to pull firmly at the corners.

(iv) A label with the Stores Ref. number should be placed on the main arm in the position shown. The lacing terminates on the right-hand side, and the "Finishing stitch" should be used.

(v) The markers numbered A1, A11, etc., are fitted on the wiring arms to each strip connector in the position shown. For replacement cable looms the markers can generally be detached from the existing cable loom and used again.

(vi) The cable may be removed from the board by carefully pulling the wires, complete with markers, through the holes, taking care that the markers are not rolled back, and that the rubber covering of the wire is not damaged. The strip connectors should then be attached in the manner described in paras. 25 to 28.

44. One strip connector is required for each arm of the cable loom, and a rubber sleeve is required for each separate wire connected to a strip connector. The numbers of the strip contacts to be "commoned" is also given on the running list. Finally, before installation, the cable loom arms must be identified, the ends and both sides of all strip connectors being painted as shown in fig. 17, so that strip connectors which are attached to the arms associated with the bottom or "1" position are painted white, while those which are associated with the top or "11" position, usually indicated by red cable markers, are painted red, and those associated with the negative pile, i.e., those with blue cable markers, are painted blue. Both sides and ends of the main box loom connectors associated with the fuse box connectors are painted as shown in the illustration, and in all cases care must be taken not to allow paint to fall on the contact surfaces.

45. Each separate loom connection must be tested for electrical continuity with a buzzer or lamp. One lead of the testing apparatus should be placed in turn on each terminal tag in the FROM column of the running list, and the other lead on the corresponding tag in the TO column. The insulation resistance between any two tags (except those which are "commoned") must not be less than 20 megohms when tested with a 250-volt insulation tester (Stores Ref. 5G/152).

46. Before installing the cable looms, remove any clamps and interleaving insulators in position on the tray. In the case of multi-box distribution boxes the rubber fillet between the two boxes should also be removed. The cable loom, which is appropriately marked for each individual box, should then be inserted in the box so that the arms A1 and A11 correspond with the position of tray A; arms B1 and B11 with tray B, and arms C1 and C11 with tray C, etc. The loom will already have been prepared in approximately the correct shape but will require a certain amount of final dressing so that the conductors lie in the manner shown in fig. 13. The cable loom strips should now be assembled in the tray in the normal manner, insulating strips and dummy strips being inserted as required.

Connections to fuse boxes

47. The cable loom is connected to the fuse boxes through auxiliary cable looms as shown in fig. 13 for the type G fuse box. Before replacing the distribution box cover, the backs of the fuse

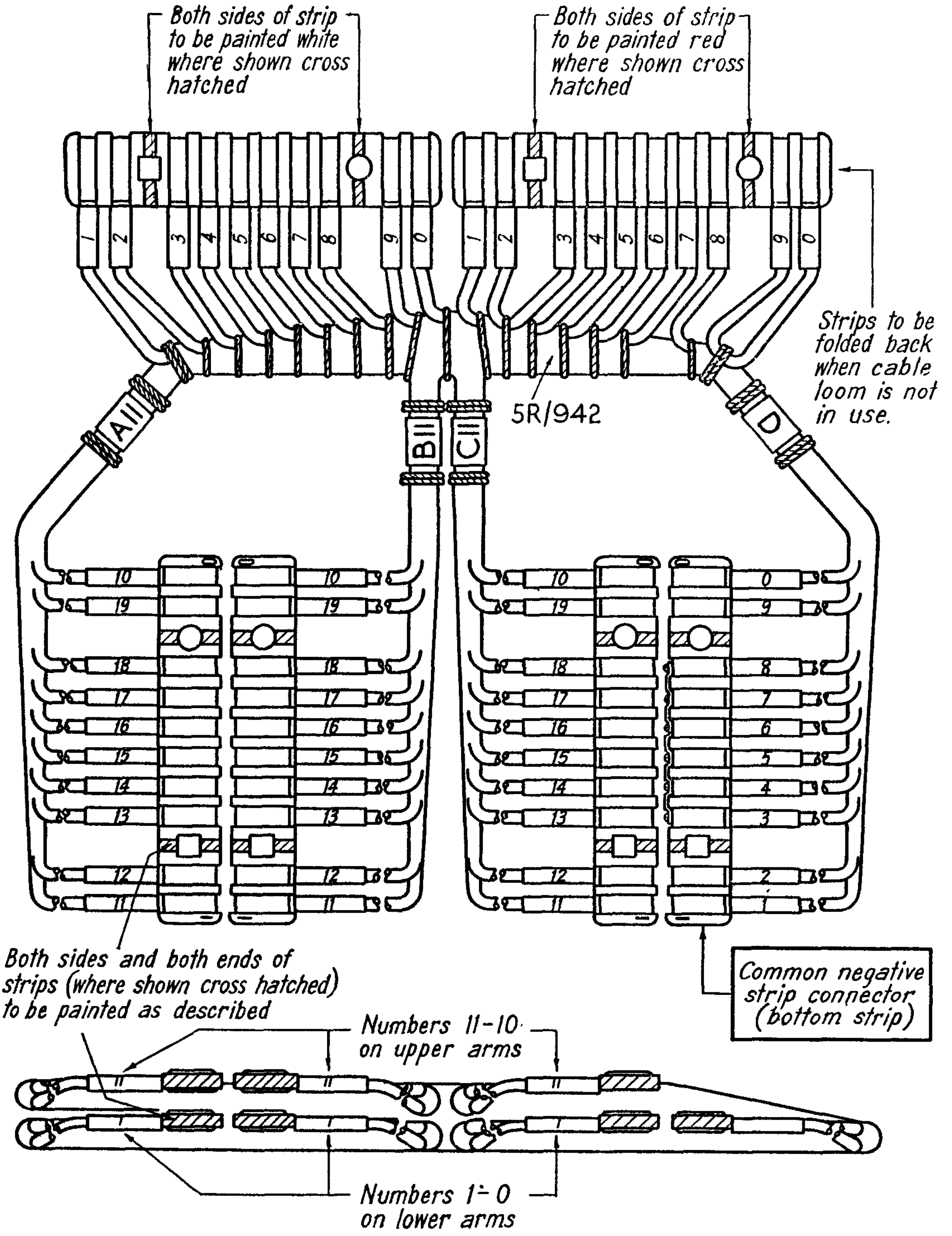


Fig. 17.—Complete cable loom for 2-tray distribution box

boxes should be removed to expose the terminals, which should already have been marked according to the instructions given above. An appropriate fuse box loom should then be connected to each of the fuse boxes mounted on the cover of the distribution boxes. The loom conductors are marked with numbers corresponding with the fuse box terminals and care must be taken to ensure that the connections are correctly made. The strips and cases of the distribution boxes must be painted as shown in fig. 13, to correspond with the colour identification band in the fuse box covers. When all connections have finally been made, it is important to replace the back plates in the fuse boxes.

Connection diagrams

48. The relevant box wiring diagram is to be fixed to the underside lower portion of the cover.

Preparation of junction boxes for installation

49. The method of preparing junction boxes for installation in aircraft comprises only the application of transfers and inspection. Every box on the aircraft is allotted a number for identification purposes and, in addition, carries instructions on the cover for assembling the electrical connections. This number and also the instructions are attached to the cover in the form of a transfer, although signwriting may be employed where transfers are not available. The junction boxes may be installed in the aircraft either in a horizontal or vertical position and the procedure is the same as that employed for distribution boxes.

SERVICING

Testing

50. When repairs have been completed, or when a routine inspection is made, the following points should be checked:—

Check that:—

(i) Bottom insulator on tray is fitted.

(ii) Strip connectors are assembled on piles corresponding to cable marking.

(iii) Interleaving insulators are fitted and are between red and white strips.

(iv) Dummy strips are fitted to complete pile of five.

(v) Clamp screws are clamping strips tightly and are "penny" tight.

Electrical functioning test

51. When all wiring has been re-assembled electrical functioning and insulating tests should be applied to all circuits, following the normal routine:—

(i) Referring to the list of electrical connections attached to the inside of the lower cover, place one lead of the test set in turn on each of the strip connections (A1, A2, B1, B2, etc.) and at the same time place the other lead on the corresponding terminal referred to in the "connected to" column of the connection diagram. This test will not apply to strip connectors, for which no corresponding number appears in the "connected to" column. During this test, the fuses and negative supply strips should be removed and the test lead applied to the circuit side of the fuse holders and *not* to the supply side.

(ii) One lead of the test set should be connected to the positive terminal X1a of the fuse box and, at the same time, the other lead should be placed on each of the other positive terminals (X8a, X9a, etc.) in turn. If in any instance the test set should indicate no electrical connection the wiring should be corrected.

Routine maintenance

52. The clamps should be checked periodically to ensure that they are tight and the insulation resistance should be tested regularly with a 250-volt megger.

CHAPTER 8

LUCAS-SUPERMARINE SYSTEM of AIRCRAFT WIRING

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The Lucas Supermarine wiring system has been introduced primarily with the object of providing a complete aircraft wiring system using the minimum number of basic-parts; it is light in weight, has a quick method of attachment and release, requires the minimum amount of skilled labour for assembly, can readily be modified and is easy to inspect and maintain. It is based upon a direct-run wiring system using connectors as breakdown points.

2. The system avoids the use of junction boxes almost entirely, and joints in cables are made only at the essential breaks, that is, at the wing breaks, removable panels, the walls of pressure cabins, engine bulkheads, and other such breaks as are specified to allow for the removal of components for packing, transport, and storage.

DESCRIPTION

3. This is a simple system of aircraft wiring employing special connector blocks with a quick release method of attaching cables; the blocks themselves can be easily attached to one another to form a bank of connectors. Unicel, univyn, or unirubber cables are used almost exclusively, thus simplifying the replacement of individual cables, and identification is on the cables themselves, not the terminals. The blocks are mounted on the aircraft structure and are not enclosed inside junction boxes though in particularly exposed positions a form of cover is provided.

Wiring connections

4. The following table gives the individual component parts called for in this system:—

Description	*Stores Ref.*
Block, connector, 3-way, single tier (complete)	5X/2344
Block, connector, 3-way, double tier (complete)	5X/2345
Strip, backing (5·573 in. long) ...	5X/2346
Cover, top (10·115 in. long) ...	5X/2347
Foot, fixing, end ...	5X/2348
Foot, fixing, intermediate ...	5X/2349
Cover, clip, single tier ...	5X/2350
Cover, clip, double tier ...	5X/2351
Strip, shorting (10-way) ...	5X/2352
Nipple, cable end (4 and 7 amp.) ...	5X/2353
Nipple, cable end (19 amp.) ...	5X/2354
Rod, tie ...	5X/2355
Nuts, brass, 6 B.A. ...	~~28/603~~ 28M/663
Washers, brass, 6 B.A. ...	~~28C/3526~~ 28W/5326

A.L.37

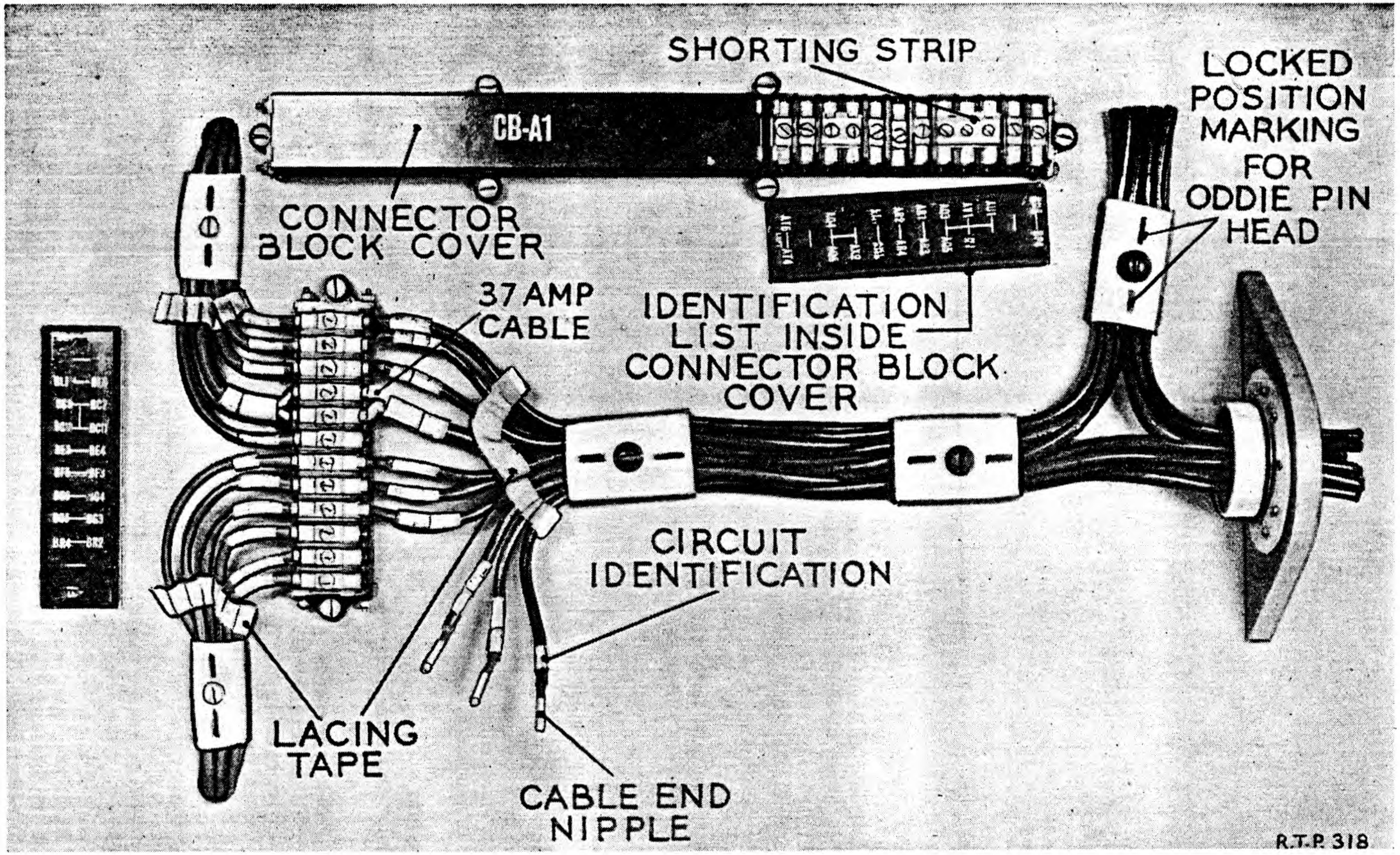


Fig. 1.—Cable assembly lay-out

5. The general lay-out of the cable-assembly method is shown in fig. 1, and the individual components of the connectors in fig. 2. The connector blocks of moulded plastic material are made up to hold either three or six double-sided sockets. The total number of connections required for any assembly is made up from a series of these blocks, held between end-blocks, or fixing feet, locked together on a screwed bolt and backed with a plastic backing strip. The threaded locking bolt and the backing strip are issued in the maximum lengths given in para. 4 and can be cut to fit any assembly. The end-blocks, which also hold the metal cover-clips in position, are drilled to take the pin fixing them to the structure; where the length of the block assembly makes it desirable, or where space prohibits the use of the end fixing foot, an intermediate fixing foot is used.

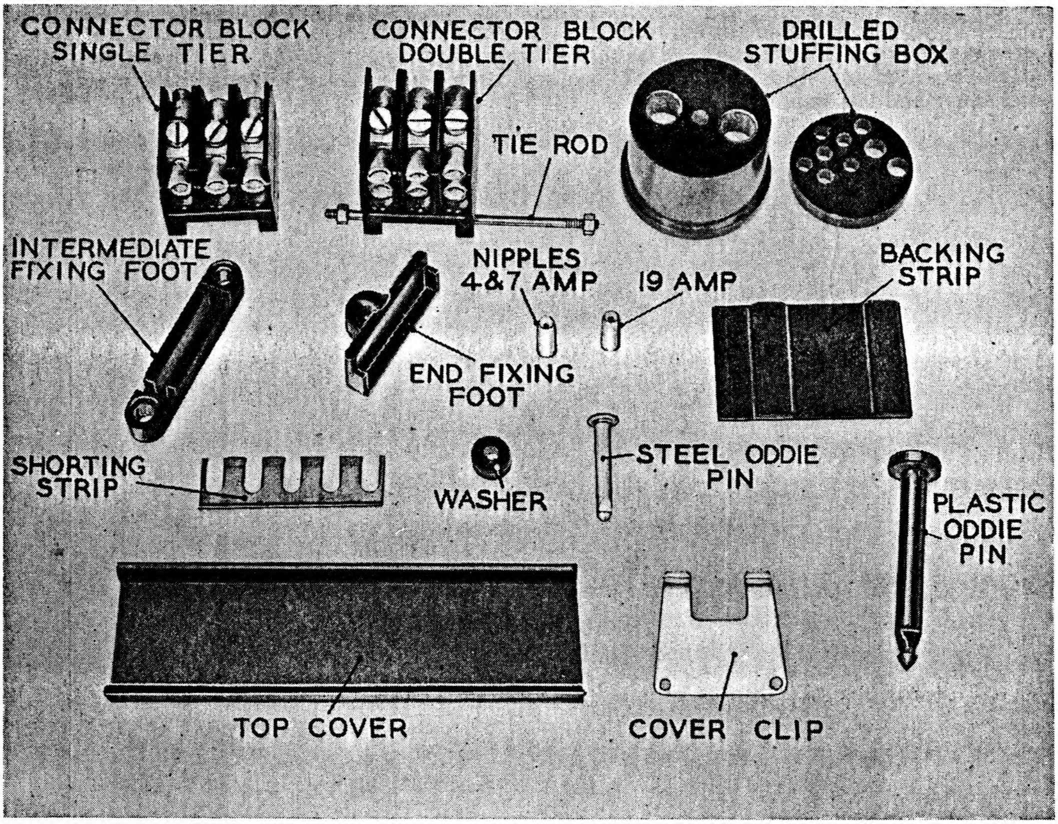


Fig. 2.—Connector components, dismantled

6. The double-sided sockets, mounted on springs in the connector block, are held down by screws which have soldered washer tips to prevent their being inadvertently screwed too far out of the block and releasing the spring.

7. The ferrules at the ends of the cables, which fit into these sockets, are of standard external dimensions, but have two sizes of drilling, to take cable up to 7 amps. or 19 amps. respectively. The drillings are of a size to allow for the insulation to be inserted right into the ferrule, which makes for greater strength at this vital point.

8. Commoning of two or more cables is achieved by a shorting strip inserted under the heads of the socket screws; this shorting strip is issued in a maximum length from which pieces are cut to individual requirements.

9. Metal cover clips, held in place at each end of the block assembly by the end-blocks and the locking rod and nuts, hold the black plastic strip cover which again is issued in maximum lengths and cut to fit the assembly. Inside the cover is printed the identification list of the cables in that connector assembly.

Cable harness and wiring

10. Standard single core cables are used throughout as far as practicable, cables being laid direct from the source of supply to the point of consumption. The cables are bunched together where possible on their run, and the necessary T-branches and feeds to various accessories are led off from the main group direct to the equipment without junction boxes or other breaks in the cable.

11. This cable harness, or loom, is fitted with P.V.C. sleeves of appropriate diameter at convenient intervals to keep the lay-out in formation and to prevent sag. In places where the cable may be exposed to damage or the effects of oil or weathering, a continuous sleeve is used for protection. A typical loom is shown in fig. 3.

12. For inaccessible wiring, such as a closed wing structure, tubular conduits of ample size are provided to enable the cables to be pulled through from one point of access to another. Uni-rubber cables are used in all protected portions, such as continuous tubes or behind panels, to give increased flexibility and less bulk.

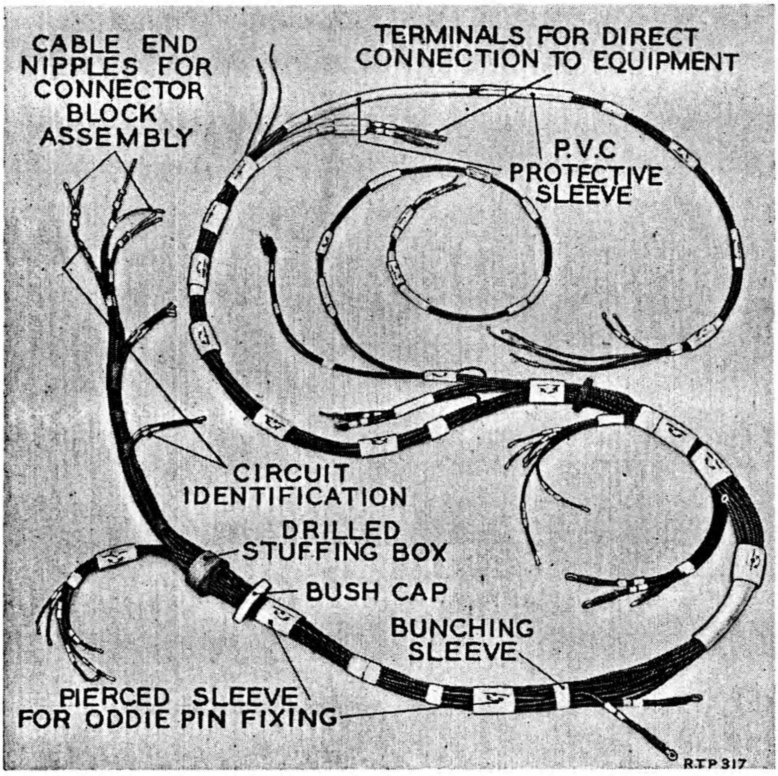


Fig. 3.—Typical cable loom

13. To maintain sequence of assembly of the nipples in relation to their correct sockets in the connector blocks, the cable ends are laced together in the manner shown in fig. 1. By this means, once the left or right-hand cable of any particular group is located, the rest are picked up automatically, making further reference to identification lists or markings unnecessary except for a final visual check.

14. As stated in para. 7, the ferrules or nipples at the ends of the cable are drilled in two sizes, the smaller drilling taking cable up to 7 amp., and the larger up to 19 amp. If cable of 37-amp. size is used, the wires of the cable are divided between two ferrules, as shown in fig. 1. The drilling of the nipples is large enough to accommodate the insulation so that in fitting the cable only about $\frac{1}{8}$ in. of the wire need be bared; the cable is then pushed home into the nipple, and the wires spot-soldered as they emerge through the small hole at the tip. In an emergency, it is permissible to bare the wires for $\frac{1}{2}$–$\frac{3}{4}$ in., thread them through the hole at the tip and then turn them back over the body of the nipple. This gives a perfectly good contact, but should be regarded as a temporary measure only, as it will be appreciated that the soldered job makes a better permanent connection.

15. The nipples slip easily into the sockets which are then screwed down. To extract a cable, the screw on that socket should be released to the end of its travel—its washer-tip prevents its coming right out—and the cable should then be pulled *upwards* and outwards. The upwards movement is essential to release the nipple from its housing in the socket; a direct pull will not release the nipple, but may result in damage to the cable-nipple connection or to the socket itself.

16. It should be noted that the wiring scheme described caters for cables up to 37-amp. size. For the larger starter cables, it is still intended, where necessary, to use the standard type of connector at present in service.

Pressure cabin connections

17. Special attention must always be paid to the point of entry of wiring into a pressure cabin, as it is essential to ensure that air-leakage from the cabin at high altitudes is reduced to the absolute minimum. In this system, cables passing into a pressure cabin are taken through a gland, as shown in fig. 6. The metal gland shell is riveted to the skin or bulkhead, and takes a stuffing box which is drilled to accommodate the appropriate number of cables. The stuffing box consists of a cup filled with non-setting "Dum-Dum" putty (Stores Ref. 33C/631) or its equivalent, after the cables have been inserted, and is closed with a bush-cap, held down by a clamping bolt. The use of non-setting compound here allows for the point to be broken for subsequent addition or replacement of cables.

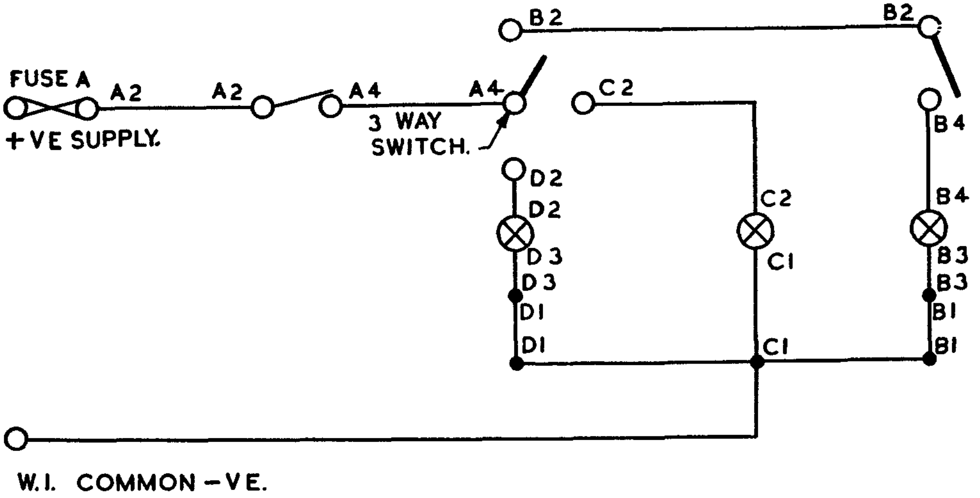


Fig. 4.—Diagram showing identification system

18. The stuffing box is pre-assembled on the cable harness, and on installation is clamped by the gland nut into position, the sealing of this joint being made with "Trinasco" or its equivalent. There is a very small amount of leakage through the cables themselves, but it is insufficient to warrant the sealing of the ends.

Identification

19. Circuit identification is provided at the end of each individual cable.

20. Each circuit is identified initially by a letter corresponding to the fuse marking. When the circuit splits up, additional letters are allotted; numbers are used to indicate each break in the cable, even numbers being used for the positive leads and odd numbers for the negative, stepping up progressively at each break from the supply to the point of consumption; fig. 4 indicates this method of marking, showing that in effect each individual cable has a separate identity which constitutes its part number. The cables are marked as near each end as possible with a binding of adhesive tape bearing the identification letters and figures.

21. Each bank of connector blocks is allotted a letter which appears on the wiring diagram, on the outside of the connector lid, and on the aircraft structure adjacent to the connector bank. On the inside of the lid is printed an identification list of the cables connected in that assembly. Fig. 7 illustrates typical identification lists; the horizontal line between two numbers shows a through connection, and the vertical line between two horizontal lines signifies a shorting link.

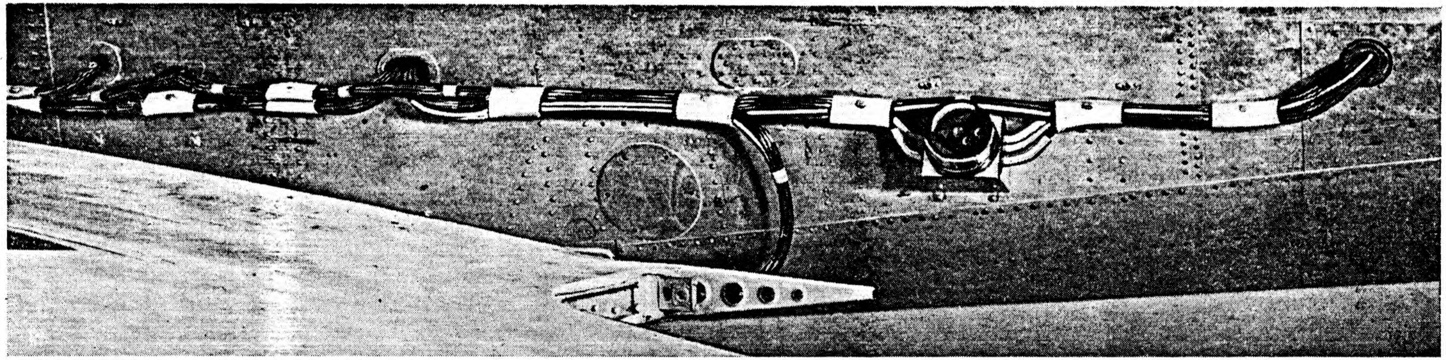


Fig. 5.—Wiring on outside of structure, showing superimposed loom

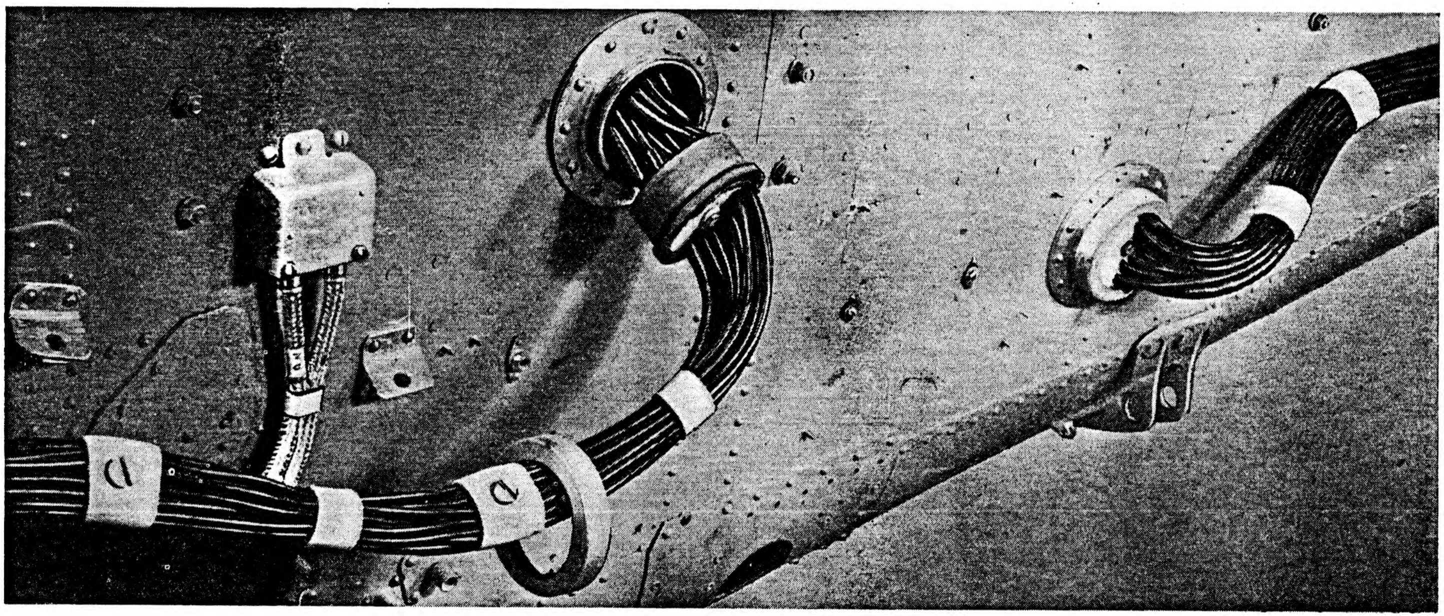


Fig. 6.—Pressure cabin gland connections

22. When new cables are added to or deleted from a circuit by modification action, existing numbering and lettering is not altered. The new cables are given the next higher numbers not already used in that circuit, and the connector lid inscriptions are altered to suit. This is not consistent with the basic scheme, but it avoids extensive modifications to the marking of existing cables.

23. Where multi-core cables are used, the circuit identification letter only is employed, the individual cores retaining their recognised colour coding.

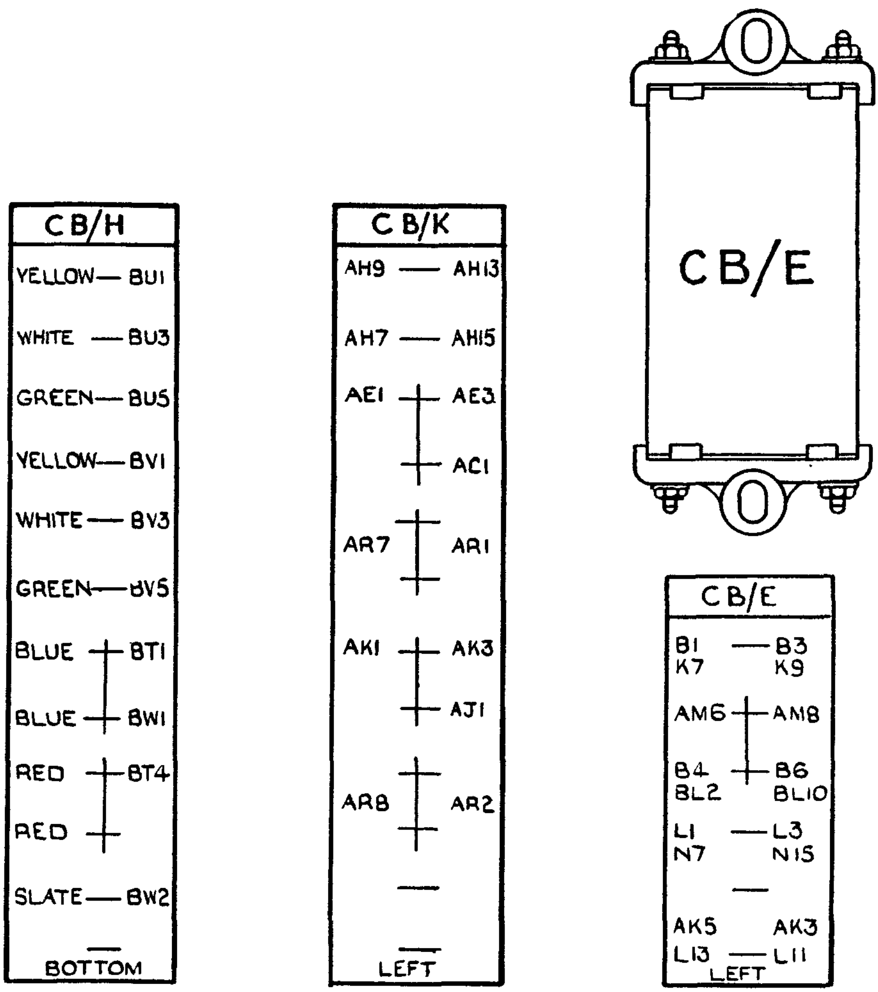


Fig. 7.—Typical inside-cover identification lists

Cable harness attachment

24. The cable harness is secured to the frame of the aircraft by Oddie Quick-release "Midget" or "Atom" pins. These pins are pushed through holes in the PVC sleeves, between the cables held by the sleeve, and finally clipped into metal springs riveted on to the frame of the aircraft itself. Fig. 9 shows the construction of the Oddie pin and clip; the pin stem is notched on opposite sides near to the tip, so that when these notches are gripped by the metal spring clip, the pin is held firmly in place. A quarter turn of the pin releases the notches, bringing the full diameter of the pin to bear between the clips, so that the pin can be easily withdrawn.

25. Oddie pins are made in steel in 14 sizes of effective lengths from 0·25 to 2·30 in. They are also available in plastic in 6 sizes, from 0·25 to 1·30 in. Plastic pins should be used in most cases where they are available in a suitable length, being non-conducting and very light, but an exception is made when metal braided cables are being fixed to the structure; in this case, the steel pin must be used to ensure earthing.

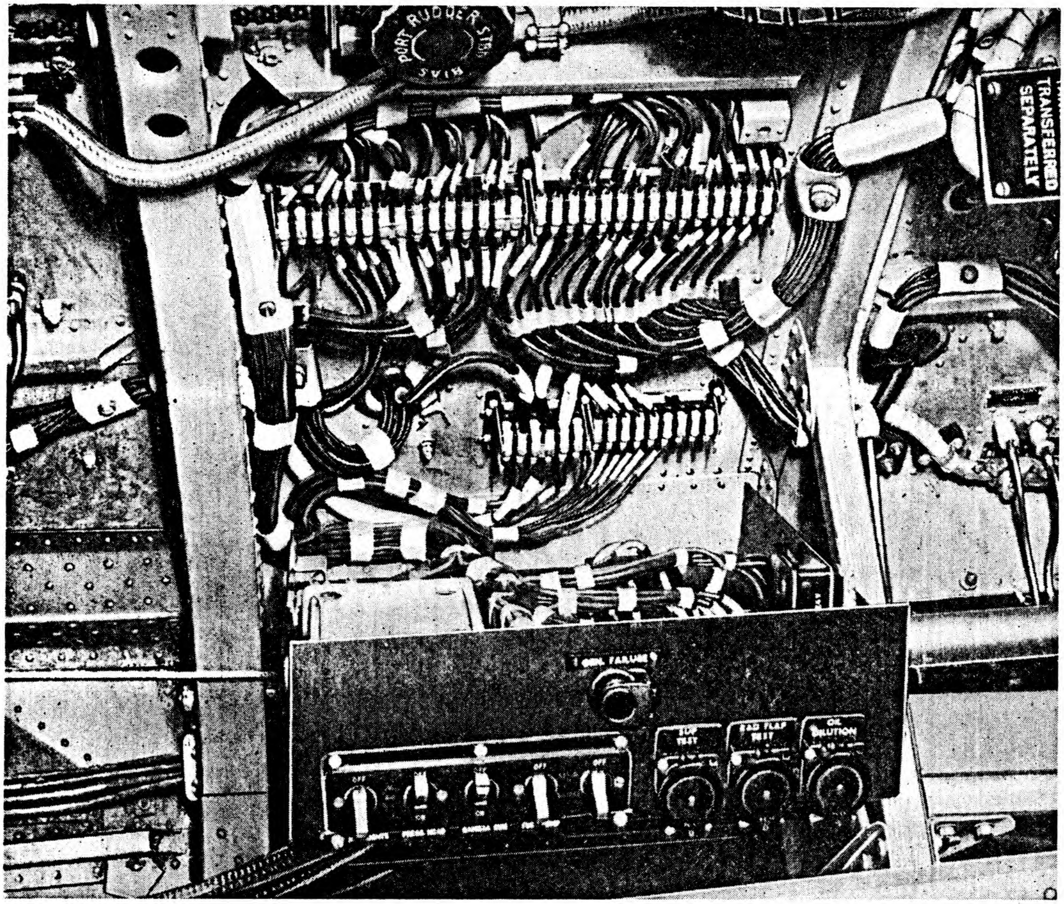


Fig. 8.—Typical layout of panel

26. The following table gives the lengths in which Oddie steel and plastic pins are available:—

Type	*Effective length*	*Material*
Atom	0·25	Steel
Atom	0·45	Steel
Atom	0·65	Steel
Atom	0·85	Steel
Midget	0·25	Plastic or steel
Midget	0·45	Plastic or steel
Midget	0·65	Plastic or steel
Midget	0·85	Plastic or steel
Midget	1·05	Plastic or steel
Midget	1·30	Plastic or steel
Midget	1·55	Steel
Midget	1·80	Steel
Midget	2·05	Steel
Midget	2·30	Steel
Midget washer		
Standard washer		

INSTALLATION

27. The connector assembly is made up of the integral parts described in paras. 3–9. The grouping of any particular unit is determined by the physical lay-out of the wiring at that point, the final assembly block being made up of a suitable number of the small 3-way blocks to accommodate the wiring. Where multiplicity of commoned connections renders space important, a double tiered block is used.

28. When the right number of blocks has been determined these are assembled with the cover-clips, end-blocks and locking rod, a plastic backing strip cut to fit the unit being sealed into position with Bostik (Yellow) Grade C cement (Stores Ref. 33C/605). The connector can then be fixed into place by the fixing feet, with Oddie pins. An intermediate fixing foot should be used if the connector assembly warrants it, or if lack of space makes it necessary to dispense with the lug on the end fixing foot.

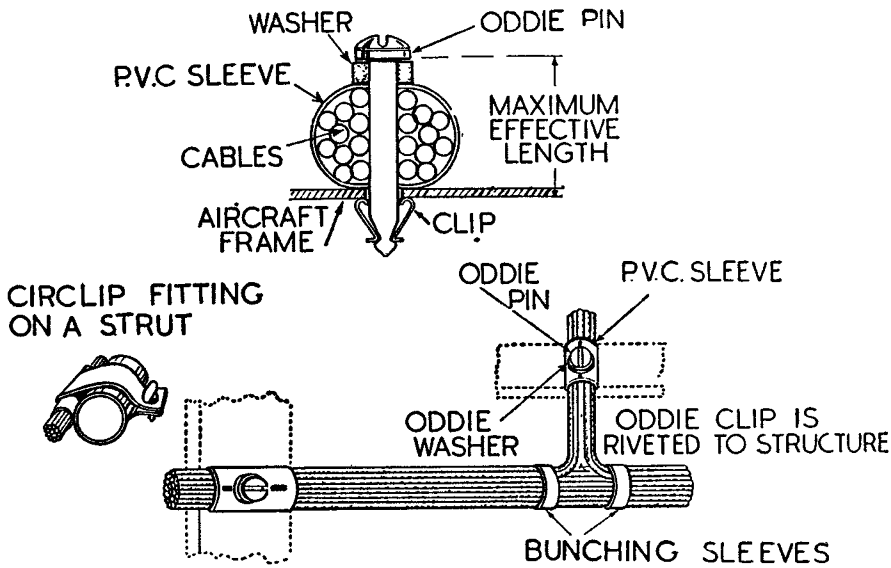


Fig. 9.—Oddie pins and clips

29. The cable nipples are fitted in the manner described in para. 13, and the ends of the cables are then identified by markers and laced in correct sequence to enable them to be quickly replaced in their appropriate sockets. In this connection, it should be noted that where unused sockets occur, or where cables from another loom enter that connector, the appropriate number of pockets is left in the lacing tape to account for each space or cable. Where a socket is left unused in the connector assembly, a 19-amp. nipple should be inserted to keep the pressure even.

30. Shorting strips of the length required can be cut from the 10-way piece supplied. It will be necessary to snap off the top of the socket-dividing walls before the shorting strip can be inserted under the screw heads; this is quite easily done with a pair of pliers. All screws should be loosened to their full extent and all nipples inserted in their sockets. The strip should be pushed gently against the screw heads; the opposite sides of the retaining screws are levered on to the strip with a screw-driver, and the strip is pushed home.

31. Finally, a suitable length of cover-strip is cut and clipped into place over the completed assembly by means of the metal cover-clips held at each end.

32. When installing the cable harness in the aircraft, Oddie pins are passed through holes pierced in the PVC sleeves, slipping between the cables held thereby, and clipping into the metal spring clips riveted direct to the structure. The holes in the sleeves must be clean cut to prevent tearing, and large enough to take the Oddie pin. The sleeves themselves should be of an adequate size to allow for additional cables if modification calls for expansion in the wiring system of the original installation. Generally speaking, the original sleeve should be of such a size that the cables in it occupy only 75 per cent. of its capacity, allowing 25 per cent. for future additions. Thus, if 9 cables are bunched in one run, the sleeves holding them should be of a size to allow for 12 cables.

33. When service replacements of the PVC sleeves are required a suitable size should be selected from the following list:—

Nominal Internal Diameter in inches	*Stores Ref.*
0·25	5F/2143
0·375	5F/2034
0·5	5F/2035
0·625	5F/2036
0·75	5F/2037
0·875	5F/2047
1·0	5F/2038
1·25	5F/2039
1·5	5F/2040

34. The Oddie pins used for clipping the harness to the frame should also allow room for future expansion. In the first place they should be installed with thick rubber washers, which may later be changed for thinner washers, or entirely removed. If still further expansion is required, a longer pin can be used.

35. The PVC sleeves are marked with lines or arrows in contrasting colour to indicate the locked position of the Oddie pinhead slot. Before the Oddie pin is inserted, it should be moistened slightly. The pin should then be pushed through the holes and between the cables with the slot in the head of the pin at right-angles to the run of the cables; the pin is then turned so that the slot is in line with the "locked position" marking on the sleeve, and pressed home until it engages in the clip. Generally, steel "Atom" pins are used on sleeves up to 12 mm. diameter and "Midget" plastic or steel pins for larger diameters.

36. Where it is required to fasten the cable loom to a strut or other circular member, circlips of standard form are used, fitted with Oddie "Atom" pins, the combination of pin and washer again being chosen to give the required grip and yet allow for expansion later by the removal of the washer. Fig. 9 shows this method of attachment.

37. Metal-braided cables may either form part of the main loom, or they may be superimposed in separate sleeves on top of the main loom, the two looms being then secured by one pin. Fig. 5 shows an instance of this double loom method in practice.

SERVICING

38. Servicing in this system of wiring is a simple matter. The use of single core cables and their method of identification makes it easy to locate any faulty cable and to remove and replace that particular conductor without disconnecting or otherwise disturbing the rest of the harness.

39. Removal of the connector bank cover gives immediate access to the connectors for point-to-point testing. Circuits may be tested as complete units, or each cable isolated progressively at chosen points by withdrawing individual nipples.

40. Replacements can be carried out in the manner described for installation in this chapter, the only apparatus required being reels of suitable cable, integral parts of the connector, screwdriver, pliers, and a soldering iron if available. If the repair involves the breaking down of the connector bank assembly or the pressure cabin gland, the sealing compounds mentioned in the paragraphs describing these items must be used for re-sealing the joints; that is, Bostik C for the connector assembly, "Dum-Dum" or equivalent for the stuffing box of the pressure cabin gland, and "Trinasco" or equivalent for the outside of the gland locking bolt.

41. A final inspection should check the following points:—

(i) That no excess of solder exists on the ends of the nipples likely to interfere with the assembly contacts.

(ii) That the soldering is mechanically efficient.

(iii) That cables are identified by cable markers and replaced in their correct sockets.

(iv) That the retaining screws in the sockets are screwed well home.

Modifications

42. With this single cable point-to-point wiring system small numbers of additional cables are added in a straightforward manner up to the capacity pre-allowed by the size of the sleeve and vacant connector sockets, in which case the existing wiring will not have to be disturbed. For larger modifications it may be necessary to increase the size of the sleeves and add further connector blocks. Alternatively, as an interim measure, a separate loom made up of the additional wiring may be superimposed on the existing loom.

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APPLICATION OF PRESSURE CABIN SEALING COMPOUND TO CABLE GLANDS

43. Special treatment is required for the airtight sealing of the cable glands running into pressure cabins; everything possible must be done to prevent the leakage of air from the cabin at high altitudes. Paragraphs 17 and 18 mention the use of Dum-Dum putty in the stuffing box of the cable gland and Trinasco as a compound for sealing the joints. The following instructions and illustrations show how the gland should be refitted and sealed to the cabin if the original sealing is broken at any time.

44. From fig. 3 it will be noted that the gland bush or stuffing box should be pre-assembled on the cable harness, with the coupling nut on the outboard side of the bush. Fig. 6 shows the pressure cabin gland connections, with the gland body riveted to the structure, the bush ready assembled on the cables, and the coupling nut in position to screw down on to the gland body. Fig. 10 is a section of this cable gland in position, and shows the points at which the different parts should be sealed.

45. Absolute cleanliness is the first essential for a good joint. Before any work is started, every trace of dirt, grease, oil, paint, and old compounds must be removed. If petrol or any other de-greasing liquid is used for this purpose, it must be carefully dried off with a soft clean cloth. Once the working surfaces have been cleaned, they should not be handled again, as even the slight amount of grease left by the fingertips will be sufficient to spoil the joint.

46. From fig. 10 it will be seen that the gland bush is stuffed with Dum-Dum putty all round the cables; the coupling nut is screwed home with a seal of Trinasco, and finally the point at which the gland body comes through to the inside of the cabin is sealed with a fillet of the same compound.

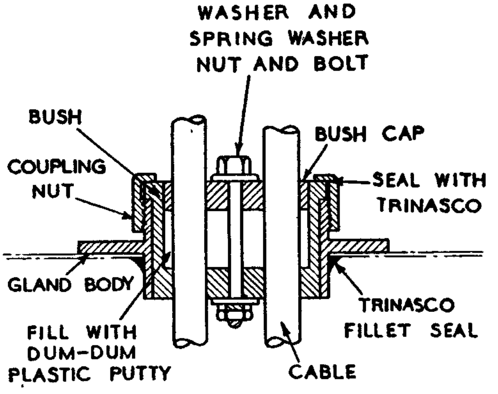

Fig. 10.—Application of Trinasco to cable gland

47. The procedure for this sealing is as follows:—When the stuffing box is fitted into the gland body, the screw at the top of the bush and the inside of the coupling nut should be carefully cleaned, and then treated with T.1 (Pressure cabin sealing compound, Medium). This is best applied with a stiff bristle brush, using a stippling action rather than a painting stroke. The compound should be allowed to get tacky before the two parts are screwed together.

48. For the sealing of the gland nut to the structure, from the inside of the pressure cabin, all three grades of Trinasco will be required. A thin, even coat of T.1 (Medium) is applied first to the joint, covering the surface approximately 1 in. all round, and worked well into the seam. This coat must be allowed to dry until its original grey colour has turned to black.

49. When the first coat is thoroughly dry, a thick coating of T.2 (Thick) is applied in the same way, and worked into the joint until a fillet is formed making a smooth rounded surface over any irregularities.

50. When the second treatment is thoroughly dry, a coat of T.3 (Thin) is applied to "feather off" the built seal.

51. The threads and shanks of all bolts securing the fittings to the walls of the pressure cabin should be treated with T.1 before being finally tightened up. The proper use of this compound at all seams, rivets and bolts will guard against small leakages at these points. It should be remembered, though, that Trinasco should always be applied on the pressure side—that is, inboard of the pressure cabin—as it cannot be relied on to make an airtight seal *against* heavy pressure. Fig. 11 shows the way it should be applied in various positions.

52. The application of Trinasco should be done in a good light, with sufficient room for every part of the job to be reached comfortably. The work should be carried out in a temperature of not less than 65° F.

53. The brushes used should be a good stiff hair or bristle; separate brushes should be used for each grade of the compound, and all brushes should be thoroughly cleaned and dried after use. Bostik cleaner (Stores Ref. 33C/589) is suitable for cleaning the brushes.

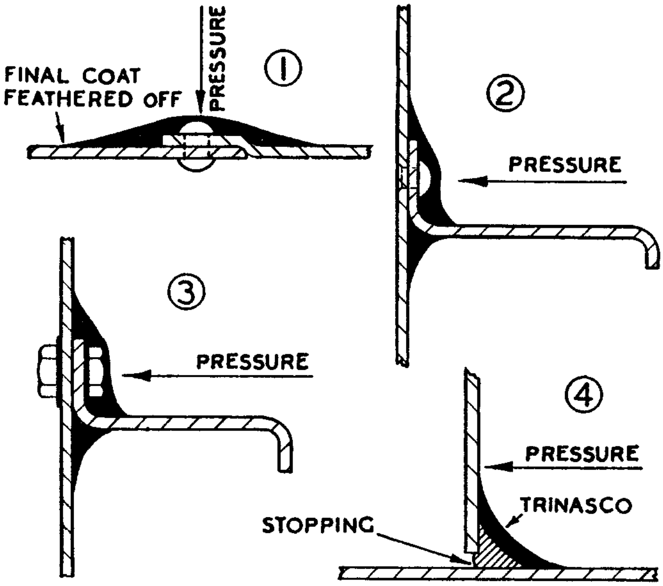

Fig. 11.—Various other applications of Trinasco in pressure cabins

54. Trinasco or, officially, Pressure cabin sealing compound, is available in the following grades:—

Grade T.1	... Medium	... ½ pt., Stores Ref. No. 33C/779	... 1 gal., Stores Ref. No. 33C/780
,, T.2	... Thick	... ,, ,, 33C/781	... ,, ,, 33C/782
,, T.3	... Thin	... ,, ,, 33C/783	... ,, ,, 33C/784

Note.—**The compound is highly inflammable and should not be used near a naked flame.**

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CHAPTER 9

LUCAS WIRING SYSTEM

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

General

1. The Lucas system of wiring has been developed to reduce the number of connections to be made when installing the wiring in the aircraft, junction boxes being, wherever possible, already connected with the appropriate lengths of cable and equipment to form complete assemblies. To facilitate installation when aircraft are built in sections and for constructional reasons it is necessary to divide the complete installation into 3 or 4 major assemblies, which, after fitting in the aircraft are connected by means of plugs and sockets. The connections between the various components are made by separate cables assembled together and carried in a flexible tubing of synthetic material (polyvinyl chloride).

2. All conduits, individual cables and terminals are clearly marked for identification purposes, and a plan of the wiring of each junction box is provided in the lid.

Junction boxes

3. A drawing giving details of a junction box is shown in fig. 2. The junction box comprises a box shell (1) made in light alloy sheet with black varnish finish, fitted with brackets (14 and 15) suitable for mounting in the aircraft and having a sheet metal cover (5) secured either by a coin slotted screw (7) located at its centre or by quick action screws at each corner. Inside the box, clamping strips (13) are provided, on which are fitted the insulated terminal bars (2). These are of moulded construction and may be provided with either 4 or 6 terminals according to the number of connections to be made. The terminals (3), which are threaded are moulded into the bars and separated from each other by means of a moulded wall (4) which prevents any danger of short circuits between them. When it is required to common a number of terminals the shrouds may be broken off with pliers and the terminals connected by means of a drilled metal strip (6).

4. The ends of the cables may be connected to the terminals in the junction box with eyelets of a size suitable for fitting on the terminal post. The eyelet (11) is placed on the terminal post and is secured by means of a plain washer (10), a spring washer (9) and a nut (8).

5. Where necessary, fuses of the cartridge type are incorporated in the junction boxes (see fig. 3). These are fitted in standard holders bolted to the bottom of the box. The fuse number, service, and rating are stencilled on the inside of the box lid. Spare fuses are provided in clips on the inside of the lid of the box.

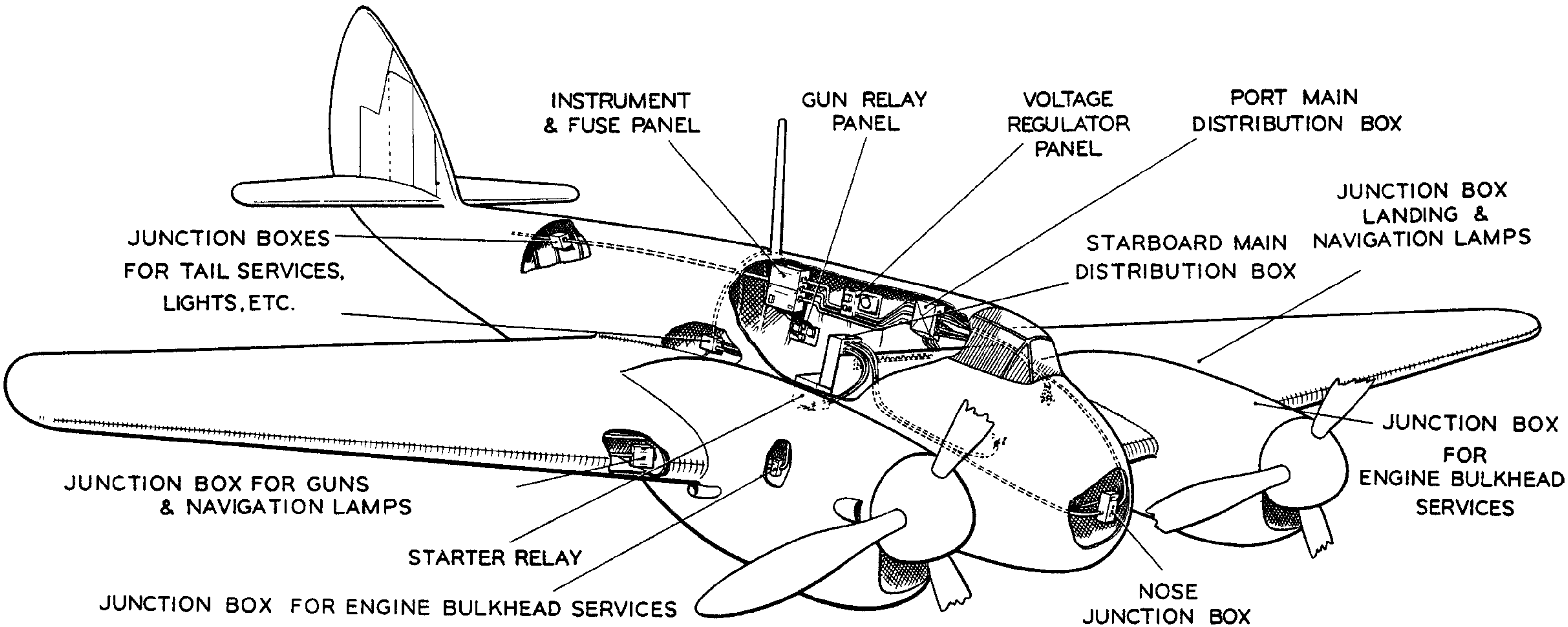

Fig. 1.—Typical Lucas installation—Beaufighter aircraft

Plug and socket connectors—*Fig. 4*

6. Connectors of various sizes are used, and these incorporate the correct number of plugs and sockets of appropriate current carrying capacity for the connections to be made. Each connector comprises two main assemblies; the plug portion which is mounted on the junction box and the socket attached to the conduit assembly.

7. The plug comprises a cylindrical metal housing (12) and a base plate (9) in which the plug pins (10) are moulded. The housing and the base plate are secured to the junction box by four nuts (8) and bolts (11), one fitted at each corner. The inside of the housing is provided with a screw thread to receive the socket.

8. The socket assembly is housed in a cylindrical metal shell (1) screwed at one end for screwing into the plug body, and at the other end to receive the lock-nut (7) which secures the ferrule at the end of the conduit tubing. The socket pins (4), which are fitted with spring clips to make good contact between plug and socket, are assembled into the insulated cylindrical holder (2) and are located in position by means of an insulated comb (3) which fits between the pins at the back of the holder. The holder, complete with pins is fitted into the metal housing (1) and is secured by means of a spacing collar (5) and a jump ring (6) located in a recess at the end of the housing. It should be noticed that the portion of the housing which fits into the plug is not threaded to the end, thus ensuring that the plug and socket pins are correctly aligned before the socket assembly is screwed home.

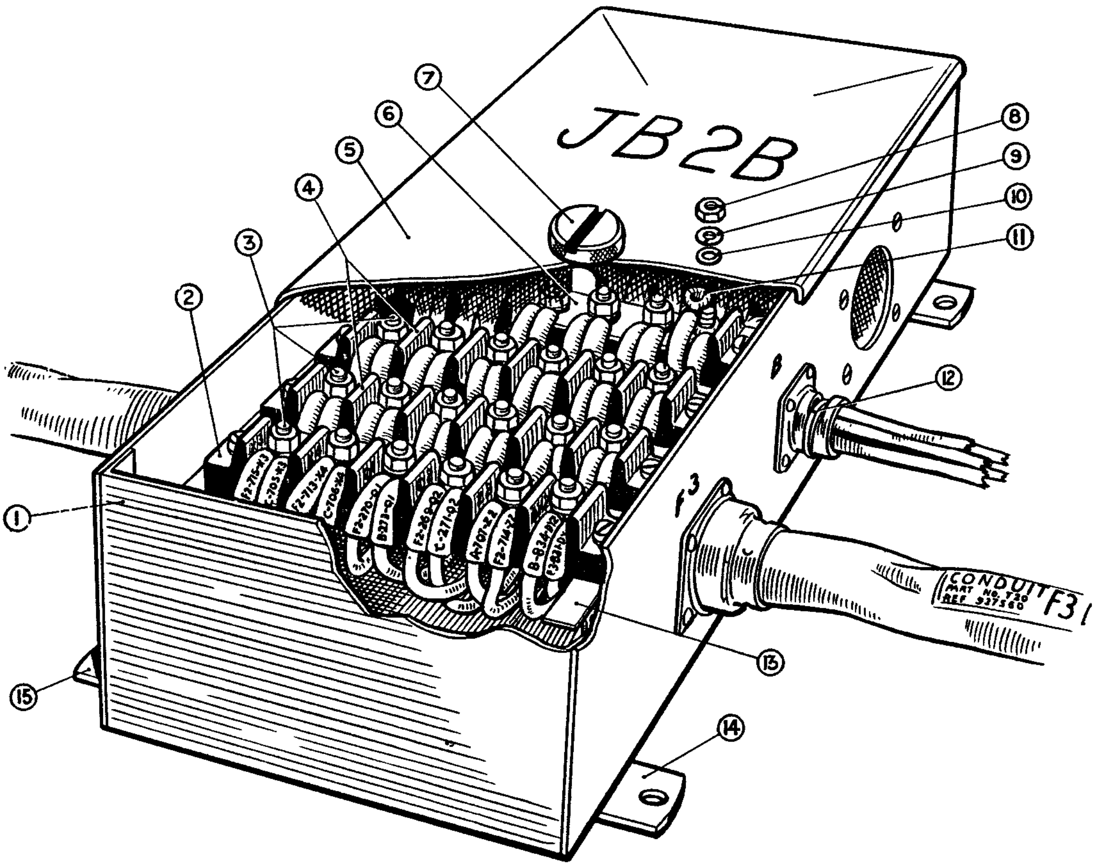

Fig. 2.—Junction box details

Ferrules—*Fig. 5*

9. Connections to the junction boxes which are not made through plugs and sockets are taken straight through a hole in the side of the junction box on to the terminals, the conduit tubing being secured to the junction box by means of two flanged metal ferrules and a fixing plate. The conduit tubing (2) is drawn over the small diameter of the inside ferrule (1), and the outside ferrule (3) is then drawn over the inside ferrule; the conduit being held firmly between the two. To ensure that the tubing cannot be pulled out, the outside ferrule is "centre popped" at two diametrically opposed positions. The flange of the ferrule is held in position by means of a fixing plate (4) which is bolted to the junction box.

Note.—When fitting ferrules to the tubing, before "centre popping" the ferrules, place a mandril of suitable diameter in the inside ferrule to prevent distorting them.

10. Split ferrules are used where small numbers of cables are connected direct from the box to electrical components. In these cases only one ferrule is used and this is secured to the junction box by means of a fixing plate; the conduit or cables being held in position by binding with twine (12), fig. 2.

Coding

Junction boxes

11. All junction boxes have on the lid the letters J.B. followed by a number and letter. These numbers have no particular significance but are merely a means of identification; the suffix letter denotes the aircraft to which it is fitted, i.e. in J.B.3B the B stands for Beaufighter.

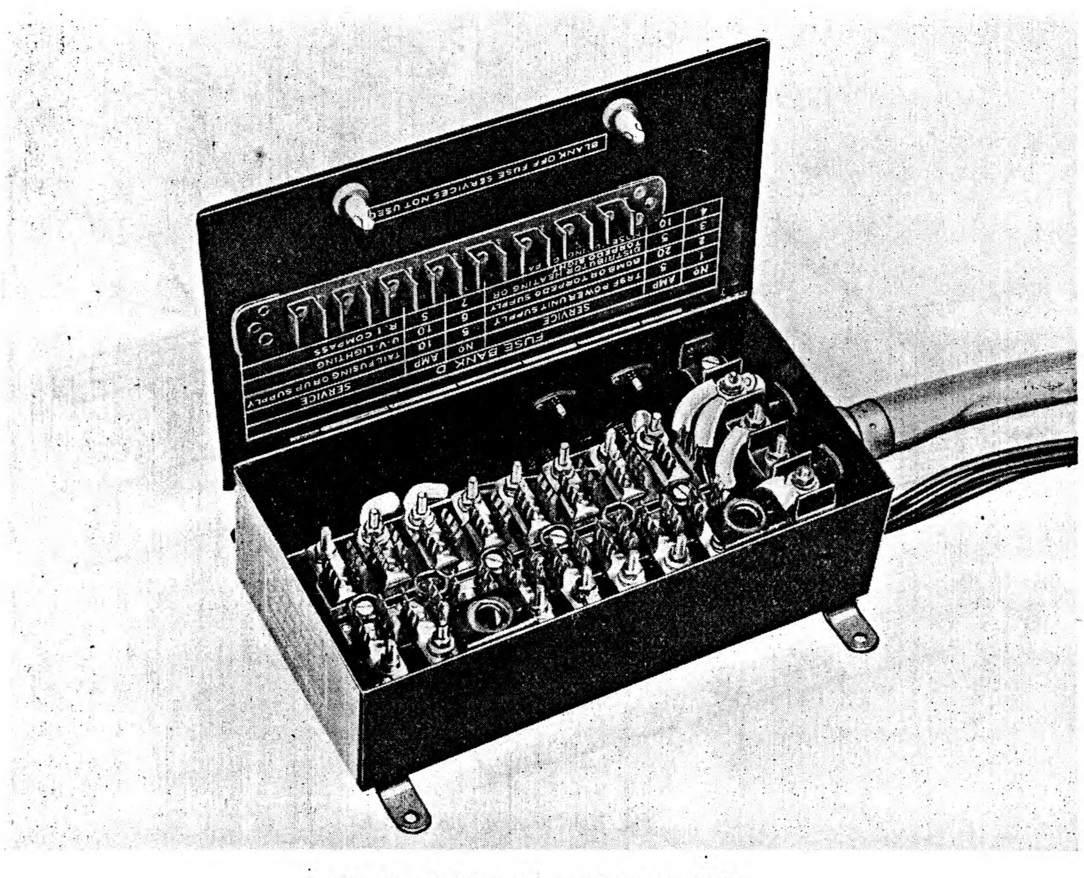

Fig. 3.—Junction box with fuse-holders

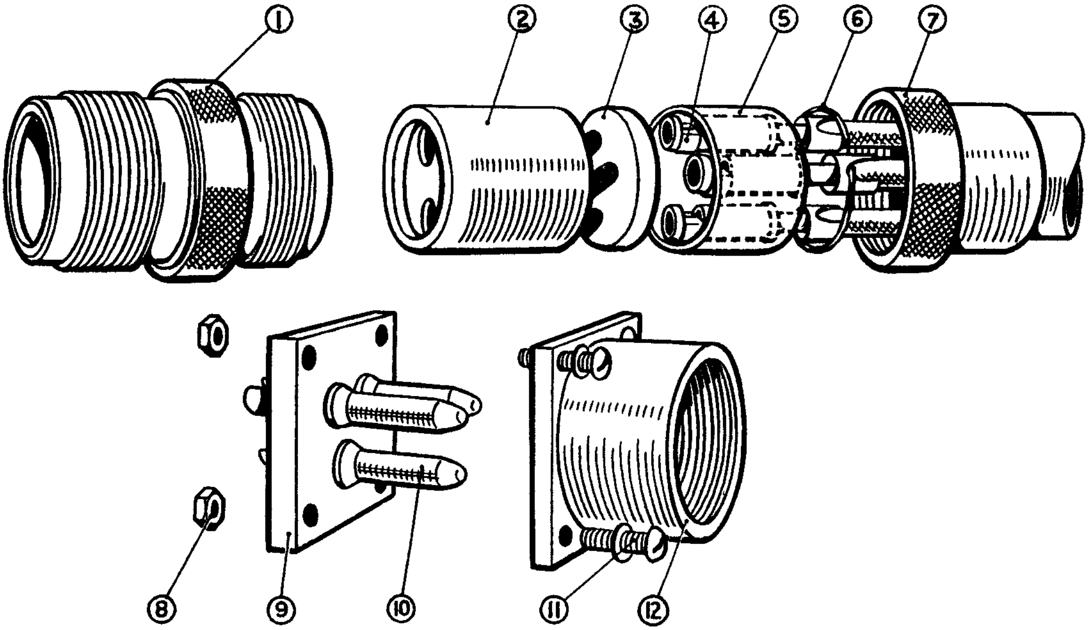

Fig. 4.—Plug and socket

12. Each terminal in the junction box is identified by a letter, followed by a number, stencilled on the side of the adjacent moulded shroud. The letter indicates on which circuit the terminal is used and the number is one of the series used in that circuit. Terminal numbers are changed when the circuit is broken by an item of equipment. All external connections to the junction boxes are identified by a letter and a number which agrees with the conduit coding.

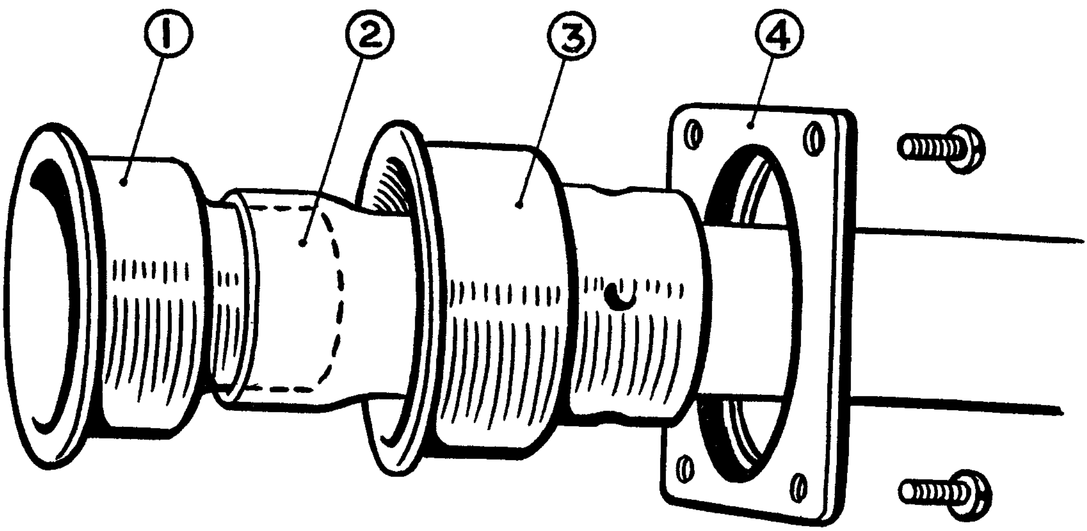

Fig. 5.—Ferrule

Conduit tubing

13. Conduits are marked with a transfer about 3 inches from each end and are identified by a letter followed by a number. The letter indicates where the conduit runs (e.g. F for fuselage, P for port plane and S for starboard plane) and the number serves to prevent confusion between conduits in the same section of the aircraft.

Cables

14. At the end of each cable is provided a short length of rubber tubing which bears the same identification as the conduit in which it is carried, a serial number, and the same engraving as the terminal in the box to which it is to be connected. For example, a cable with the following marking, F.2–715–X3 means that it is carried in conduit marked F.2, its part number is 715, and it is to be connected to the terminal marked X3 in the junction box.

15. No spare sets of conduits are supplied to the service. Conduits can be made up from lengths of appropriate cable, tubing, and ferrules obtainable at stores. Standard junction boxes are available which can be modified to suit particular aircraft.

Typical installation

16. Fig. 1 shows the Lucas wiring system as used in a Beaufighter aircraft. The supply cables from the generators are run out from the engine via a plug and socket on the bulkhead to the starboard distribution box, and the port distribution box, thence to the instrument and fuse panel in the centre section fuselage. The instrument and fuse panel contains the voltmeter, ammeter, generator switch, and other generator accessories; it also contains the fuses for the individual services. All services in the tail are fed through a conduit to J.B.6 and to the tail plane; services in the port plane via J.B.7 and J.B.9 and services in the starboard plane via J.B.3 and J.B.5. All cables from the engines are fed through J.B.4 or J.B.10. J.B.8 feeds the pilot's instrument panel.

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CHAPTER 10

EXTERNAL SUPPLY SOCKET
(B.T.H. TYPE E1 AND E2)

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LIST OF ILLUSTRATIONS

Introduction

1. The external supply socket, type E1 (Stores Ref. 5C/859), sometimes known as the B.T.H. socket, has been designed to enable a heavy duty ground accumulator to be used for engine starting and ground testing of electrical and radio equipment, thus saving the imposition of heavy loads on the accumulator installed in the aircraft. Should the socket be used in conjunction with the master change-over switch (Stores Ref. 5C/1877 or 5C/1742), certain modifications in the wiring will be necessary, and details of these will be found in Chapter 5 of Section 7 which deals with this switch.

DESCRIPTION

2. The socket, type E1, which is illustrated in fig. 1, is constructed of black moulded insulating material. The cover is held by a central fixing screw and is secured against vibration by a hexagon locknut situated at the back of the socket. A felt washer is fitted at the point of contact between the lid and the base to exclude dirt and moisture from the interior of the unit.

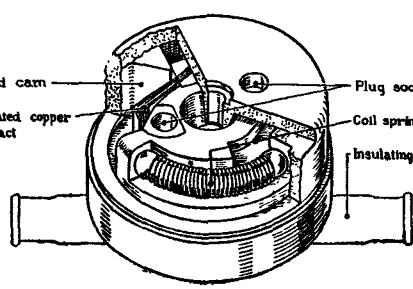

Fig. 1.—External supply socket

3. To insert the plug leading from the external supply truck the cover must be turned in a clockwise direction against the action of a coil spring which is compressed between two steel balls shown in fig. 1. Pressure is then removed from the laminated copper contact and the connection between the terminals marked B— and M_2 is broken (see fig. 3). The plug can then be inserted. In this position the engine starting motor can be connected to the external source of supply through the engine starting relay installed in the aircraft. All aircraft electrical equipment can also be ground tested from the ground starter battery in this position thus saving a heavy drain on the aircraft accumulator. When the plug is removed the spring restores the socket cover to its original position, and pressure from the raised cam on the inside of the lid, closes the copper contact, completes the connection between B— and M_2, and brings the aircraft accumulator back into circuit. In order that the plug shall be inserted correctly the plug sockets are of unequal sizes, that marked B+ being the larger of the two.

4. The terminals, as seen in fig. 2, are situated at the back of the socket, each terminal being appropriately marked. The cables are sweated into the terminal lugs, which are secured to the terminal pillars by hexagon nuts locked by spring washers, an insulating boot of black rubber covering each terminal assembly.

5. An external supply socket, type E2 (Stores Ref. 5C/2225) has been introduced for use on aircraft where master change-over switches are fitted. The external appearance of this socket is similar to the type E1 already described, but there are only two terminals on the type E2. The

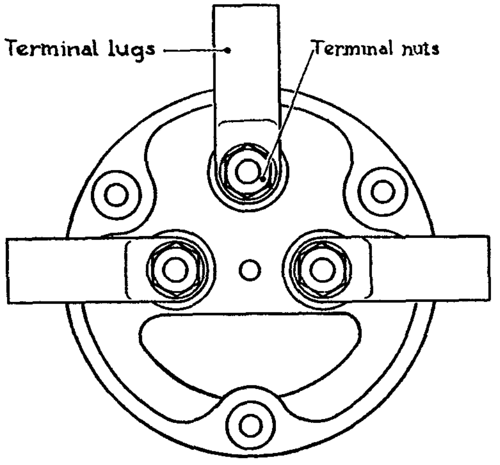

Fig. 2.—Terminal assembly

terminal connected to the larger of the two plug sockets is marked +ve and the remaining terminal, which is connected to the smaller plug socket, is marked −ve. The internal isolating switch has been omitted, and to facilitate dismantling and re-erection the steel balls used on the original E1 socket for the switch return mechanism have also been dispensed with. When installing the type E2

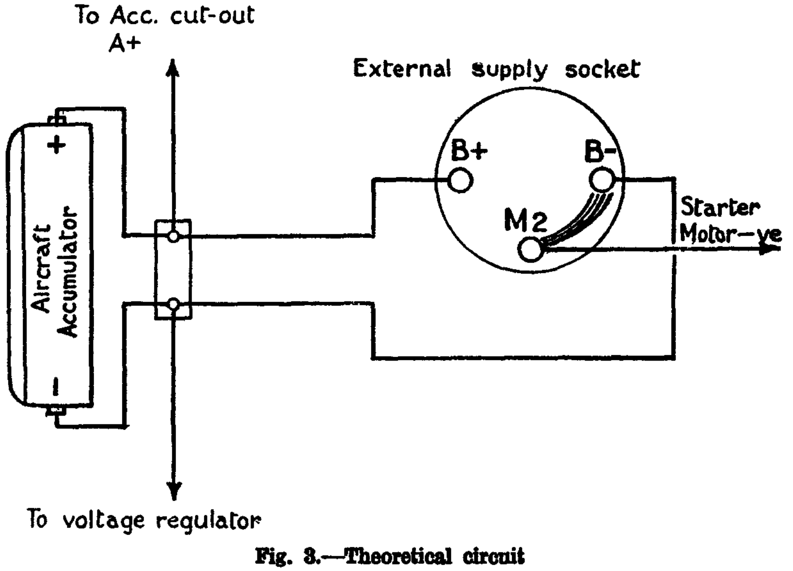

Fig. 3.—Theoretical circuit

socket the terminal marked + is connected to the aircraft accumulator + and the terminal marked − to the G.D. terminal on the master change-over switch. On aircraft where an earth return system is employed the master change-over switch is connected in the positive lead and the positive terminal of the socket is connected to the G.D. terminal of the switch and the negative terminal to earth.

The use of the socket is identical with that of the E1 socket, and the ground starter trolley plug can only be inserted after turning the socket cover in a clockwise direction to its extreme position. The master change-over switch must be in the "Ground" position to connect the external supply to the aircraft system. No maintenance other than occasional cleaning and oiling of the felt is necessary.

INSTALLATION AND OPERATION

6. The socket is mounted in, or near the run of the supply cables to the starter motor and in a position convenient for the insertion of the ground accumulator plug. Three tapped holes are provided in the base for fixing screws. The cables are sweated into the appropriate terminal lugs, which can be secured, before the insulating boots have been drawn into position. Reference to fig. 3 will give an indication of the external wiring connections.

SERVICING

7. Should it become necessary to take off the cover to inspect the interior of the socket, special care must be taken not to lose the steel balls and the spring when the tension under which they are normally kept is removed. The copper contacts should be kept clean but the laminations should not be bent or disturbed in any way. The contact gap measured at the centre of the contact with the cover removed must be between 1 mm. and 1·2 mm.

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CHAPTER 11

Weatherproofing of Electrical Equipment on Aircraft

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Introduction

1. Corrosion resulting either from condensation or from the penetration of moisture is occasionally experienced in the electrical equipment of aircraft. Items of equipment which have been found to be most susceptible to this defect are now being improved in manufacture to obviate the trouble. In the meantime, however, it is possible to reduce the defect to a minimum on existing equipment when specific cases arise, by approved methods of weatherproofing. The following paragraphs give details of these measures and of the materials required, for the guidance of servicing personnel. The information given in this chapter does *not* refer to any item of radio equipment: separate instructions are issued for this.

DESCRIPTION OF WEATHERPROOFING MATERIALS AVAILABLE

Washers and similar items

2. Rubber washers or gaskets are available, and should be used wherever possible on flat joints. Ordinary soft rubber is suitable for most purposes, but where oil or petrol is present, oil-resisting synthetic rubber or Langite should be used. If neither of these last two materials is available, it is permissible to use a rubber washer well coated with dope. The washer or gasket should be in one piece if possible; otherwise, it will be necessary to seal the joints between the various pieces. Where the use of a washer is impracticable, exposed joints should be covered with doped cotton tape, or with rubber tape (Stores Ref. 5F/457, ½ in. wide). Such a case arises with suppressors, where electrical continuity between the metal box and its lid is essential; here, cotton bands should be wrapped twice round the joint of lid and box, and sealed with dope. Suitable dope for this purpose is a cellulose lacquer, either covering, dope, transparent (Stores Ref. 33B/86) or resin, synthetic, varnish (Stores Ref. 33B/139), both of which resist petrol. Small rubber washers, used with brass washers, will make a weatherproof seal for the screws holding down the lids of suppressors and other metal boxes.

3. The following special weatherproof washers and gaskets are available for specific items of equipment.

Type of gasket or washer		*Equipment for which supplied*		*Stores Ref.*
Laminated cork washer	...	Magnetic relay switches, G, H, J and K	...	5C/3044
Synthetic rubber gasket	...	Magnetic relay switches, G, H, J and K	...	5C/3045
Impregnated felt washer	...	2-pole sockets, B.T.H. type E1 and E2	...	5C/3054

Rubber sleeves and rubber taping

4. Cables entering equipment or terminal studs running through holes in equipment often make a loose fit; this can be improved by the use of an appropriate synthetic rubber sleeve (Stores Ref. Nos. 5K/2576 to 5K/2582). These sleeves can be slipped over the cable end or terminal screw with the help of the Hellermann tool which expands the sleeve while the cable or screw is inserted. Alternatively, to avoid dismantling the equipment, rubber tape (Stores Ref. 5F/457) may be wrapped round the cable entry, tied with thin cord, and painted over with one of the dopes mentioned in para. 2. Slight heating will encourage the rubber taping to stick in place. The following special sleeves are available for weatherproofing specific items of electrical equipment:—

Sleeve		*Equipment for which required*		*Stores Ref.*
Terminal cover No. 4	...	2-pole sockets, B.T.H. types E1 and E2	...	5C/3057
Moulded weatherproof	...	Switch, push button, type C	...	5C/3041
Moulded weatherproof	...	Switch, firing, bare	...	5C/3041

P.V.C. conduit

5. Cables, particularly "met." covered cables, which are exposed to weathering or splashing should be protected by P.V.C. conduit. P.V.C. sleeves may also be used for weatherproofing cable entries or for covering unavoidable cable jointing. The following sizes of P.V.C. conduit are held in service for replacement:—

			Stores Ref.
P.V.C. conduit—Internal diameter	0·25 in.	...	5F/2143
	0·375 in.	...	5F/2034
	0·5 in. ...	...	5F/2035
	0·625 in.	...	5F/2036
	0·75 in.	...	5F/2037
	0·875 in.	...	5F/2047
	1 in. ...	...	5F/2038
	1·25 in.	...	5F/2039
	1·5 in. ...	...	5F/2040

Weatherproof caps

6. Rubber weatherproof caps have been designed for specific items of equipment and are available as follows:—

Cap		*Equipment for which required*		*Stores Ref.*
Cap, weatherproofing, No. 1	...	Switch, push button type B	...	5C/2908
Cap, weatherproofing, No. 2	...	Switch, push button type C Switch, firing	...	5C/3040
Weatherproofing	...	2-pole sockets, B.T.H types E1 and E2	...	5C/3055

Protective insulating compounds

7. Some types of electrical equipment cannot be weatherproofed by the use of rubber washers, sleeves or taping alone, and in these cases a Protective Insulating Compound is recommended. Three types of such compounds are available; each has its specific use, and *they are not interchangeable.*

8. Types available are:—

(i) P.I.C. No. 1 (Stores Ref. 33C/810 in ½ lb. tubes with extruding nozzle and ejector key, and 33C/811 in 1 lb. tins). This is rather like dark yellow Lanoline in appearance; it should be used for smearing switches, Breeze type plugs and sockets, and other pieces of equipment where easy movement or disconnection of the parts is essential. If P.I.C. No. 1 is not available, Lanoline (Stores Ref. 33C/511) may be used in its place, but it should be remembered that Lanoline will run under tropical conditions and harden in a very cold atmosphere, so that it cannot be as satisfactory or as permanent a treatment as P.I.C. No. 1.

(ii) P.I.C. No. 2 (Stores Ref. 33C/887 in ½ lb. blocks) is a plasticine-like substance, and is used for sealing terminals in electrical equipment which is not normally required to be opened in use, such as switch-boxes, terminal boxes, terminal joints in push-button and dimmer switches, and cable entries into all types of equipment.

(iii) Kingsnorth compound No. 998, Stores Ref. 33C/715, may be called for in certain specific cases such as "W" type plug mentioned in para. 12.

PREPARATION OF EQUIPMENT FOR WEATHERPROOFING TREATMENT

9. Before work is started on the weatherproofing of any equipment, the accumulator must be disconnected at both poles on a two-wire system, and at the live pole on an earth return system. No engine-driven generator must be running. The equipment itself must be thoroughly dry before it is treated; this is best ensured by drying it in an oven at a temperature of 50°C. (122° Fahr.) for 16 hours, but failing this, some drying can be effected by leaving the equipment in a warm dry room. If this is not possible, the part should be carefully dried with a clean dry rag. If a hot air blower is available, this will greatly assist in the drying. When it is thoroughly dry, the equipment should be inspected for any signs of corrosion. Any part affected should be replaced by a new part if possible, but if no new components are available, great care must be taken to ensure that all signs of corrosion are removed from the equipment before it is treated.

APPLICATION OF WEATHERPROOFING MATERIALS

10. It is unnecessary to describe in detail every item of electrical equipment which may be found to require safeguarding against corrosion. The following instructions and diagrams, while dealing with specific cases, will indicate the general principles to be followed, and the uses to which the various types of weatherproofing materials may be applied.

Breeze type plugs and sockets

11. When Breeze type plugs and sockets are being assembled on bulkheads or in exposed positions, the plug should be well filled with P.I.C. No. 1, and the socket screwed home. The plug and socket should then be opened up again, more P.I.C. No. 1 added, and the parts screwed together again.

"W" type plug and socket

12. The "W" type plug and socket requires rather different treatment. The front of the plug recess should be partly filled with P.I.C. No. 1 and the compound should then be forced through the plug with a socket die, until it appears at the back of the plug. The surplus P.I.C. No. 1 should then be removed, and the back of the plug should be packed with Kingsnorth Compound No. 998 (Stores Ref. 33C/715), care being taken to ensure that all bare wires and connections are completely covered.

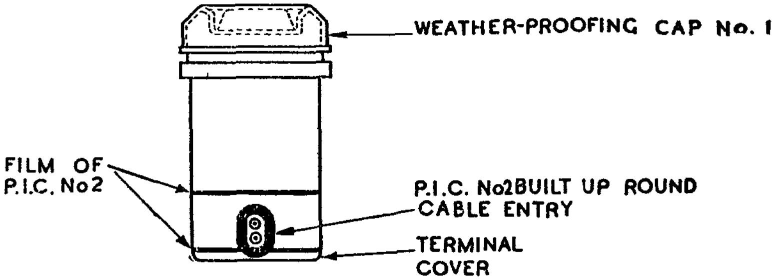


Fig. 1.—Push-button switch, type B

Push-button switch, type B

13. There are several rather similar types of push button barrel switches, but whether they are single or double pole, the treatment for weatherproofing follows the same line. The base plate should be removed, and P.I.C. No. 2 should be pressed well into the terminal space and round the wires. Enough P.I.C. No. 2 should be used to allow for some of the compound to be squeezed out when the base plate is replaced, thus forming a thin film which acts as a waterproof

washer between the base plate and the body of the switch. The sheathing over the cores of the cable should enter the terminal space as far as possible, and the cable entries should be well packed with P.I.C. No. 2 from the outside. Finally a rubber cap (Cap, weatherproofing, No. 1, Stores Ref. 5C/2908) is stretched over the top of the switch completely covering the push-button, which may be operated through it. Fig. 1 illustrates this treatment.

Push-button switch, type C

14. The pear shaped type C push-button switch should if possible be weatherproofed as it is connected to the cable. Otherwise, to make a satisfactory job of it, it must be disconnected, and re-assembled according to these instructions. The cable ends should be prepared with as little of the sheathing removed as possible. It should be enough to bare the wires completely for 0·10 in. and to cut the outer sheathing back for a further 0·10 in. Put a weatherproofing sleeve of suitable size (see para. 4) over the cable end, and over this, an outer sleeve of a diameter large enough to go over the lower part of the switch body (Stores Ref. 5C/3041). Thread the cable through the lower part of the switch body and solder the cable ends to the contacts in the adaptor. Press P.I.C. No. 2 round the contacts and leads fairly liberally, and slide the outer sleeve—larger diameter—over the lower part of the switch body, squeezing the compound up, around and between the two cables, as shown in fig. 2. Roll up the smaller diameter sleeve, to cover and grip the end of the larger sleeve. If suitable rubber sleeves are not available, bind the cable for ¾ in. either side of the point of entry with rubber tape. Assemble the top cover, push-button and spring, and put a weatherproofing cap No. 2 (Stores Ref. 5C/3040) over the assembly, easing it down as far as possible.

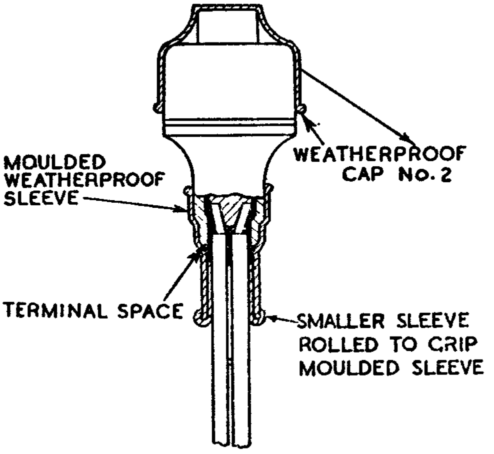


Fig. 2.—Push-button switch, type C

Firing switch

15. This type of switch, fig. 3, is similar to the type C switch described in the last paragraph. The only weatherproofing advised in this case, however, is the fitting of a weatherproofing cap No. 2 (Stores Ref. 5C/3040) eased down over the press-button to grip the switch body, and a moulded weatherproof sleeve (Stores Ref. 5C/3041) to cover the cable entry to the switch body. To avoid dismantling a switch which is already installed, the junction of the switch body and cable may be bound with rubber tape for a distance of ¾ in. either side of the cable entry point.

Dimmer switches

16. There are several types of dimmer switch with small variations in construction, but the measures advised for weatherproofing are applicable to all types. First remove the cover and knob from the base, and apply P.I.C. No. 2 liberally around the jointing faces of the base. Replace the cover, squeezing out excess compound. Next remove the base plate and press P.I.C. No. 2 firmly over the terminals and into the cable channels, working it well into all corners and completely filling all cavities, till the compound covers the whole moulding. The excess will be squeezed out as the base plate is replaced, and some more P.I.C. No. 2 should be built up round the cable entries. Finally, take a black rubber insulating sleeve (Stores Ref. 5K/133) and cut it to a length of ⅜ in. Expand

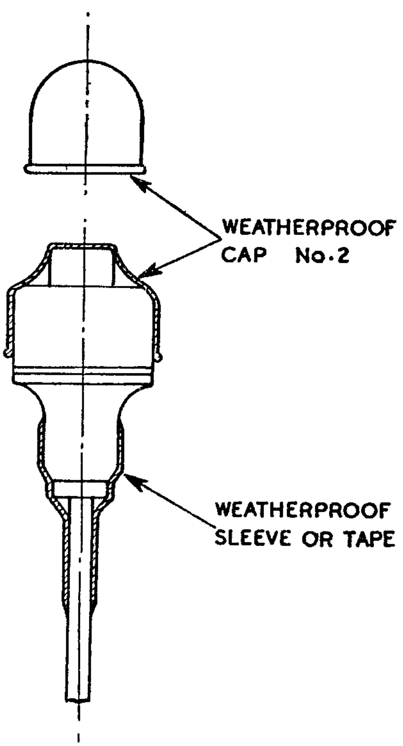


Fig. 3.—Bare firing switch

this, and put it over the knob, working it well down the joint between the knob and cover. Fig. 4 shows the points at which weatherproofing treatment should be applied, and also emphasises the importance of having the cable sheathing long enough to run well into the terminal space. In the type of switch in which the main body is split, it is permissible to use a P.V.C. or rubber washer, $\frac{1}{32}$ in. thick in place of the film of P.I.C. No. 2.

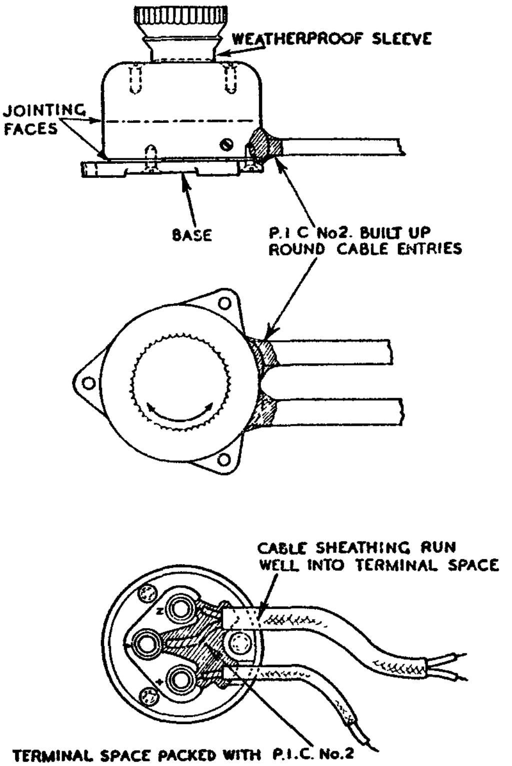


Fig. 4.—Dimmer switch

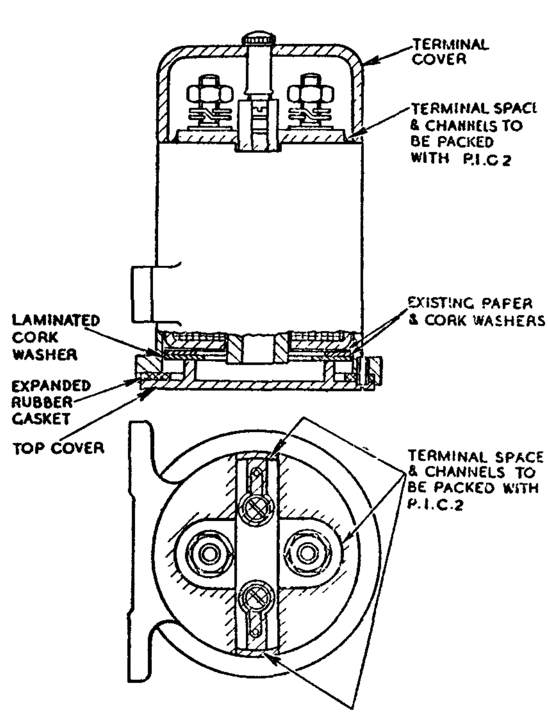


Fig. 5.—Magnetic relay switch

Magnetic relay switches

17. Magnetic relay switches, types G, H, J and K are sufficiently alike to be covered by the same weather-proofing instructions. Remove the top cover, and put a laminated cork washer (Stores Ref. 5C/3044) over the existing paper and cork washers. Next, lay an expanded synthetic rubber gasket (Stores Ref. 5C/3045) on the seating of the case, with its holes corresponding to those in the case, then replace the cover and screw down tightly. When the magnetic relay switch, type J, is modified in this way, the three 6 B.A. × $\frac{1}{4}$ in. screws which secure the top cover must be removed and replaced by three 6 B.A. × $\frac{3}{8}$ in. screws (Stores Ref. 28S/2122). Take off the terminal cover at the base of the relay, and apply P.I.C. No. 2 liberally round the projecting moulding, over the coil terminals, in the channels, and round the coil leads. Excess compound will be squeezed out by the replacement of the terminal cover. See fig. 5.

Micro switches

18. The standard micro switches, types 1, 2 and 3, are already designed to prevent the ingress of oil, dust, spray, etc., through the push-switch connection, but weatherproofing protection may be required for the terminals and leads after they are wired up. Remove the terminal cover in the base, and press P.I.C. No. 2 into all the channels, round the leads, and over the terminals. When the terminal cover is replaced, and screwed down, enough excess compound should be squeezed out

to form a thin layer between the terminal cover and body of the switch. Build up with P.I.C. No. 2 round the cable entries, as shown in fig. 6. Micro switches are usually fitted in positions exposed to weathering and splashing, so it is essential that weatherproofing treatment should be carried out with care to ensure that it is effective.

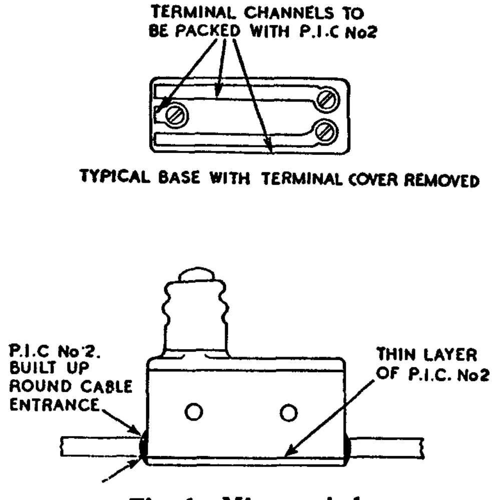
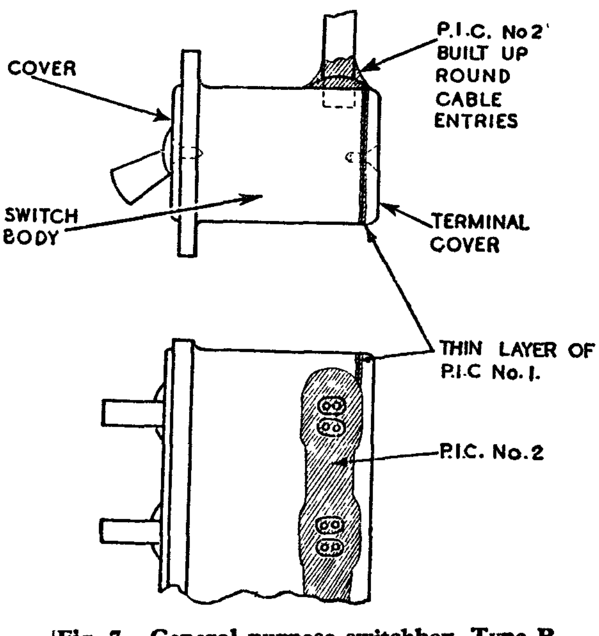


Fig. 6.—Micro switch

General purpose switch boxes, type B

19. General purpose switch-boxes may be of 1, 2, 3 or 5 units, but in each case the treatment for weatherproofing is the same. The instructions will also apply to boxes in which the switches are linked externally. The cover should be removed, and the switch body liberally smeared with P.I.C. No. 1. A thin layer should also be smeared over the jointing faces of the cover and body. Next, take off the terminal cover on the base of the switch box, and fill the terminal spaces with P.I.C. No. 2, pressing it well round the wires and over the terminal screws. Enough of the compound should be used to allow for the surplus to be squeezed out when the terminal cover is screwed down. On the outside, build up with P.I.C. No. 2 round and between the cable entries, as shown in fig. 7. It is of course essential that the sheathing over the cable cores should run as far as possible into the terminal space.



[Fig. 7.—General purpose switchbox, Type B

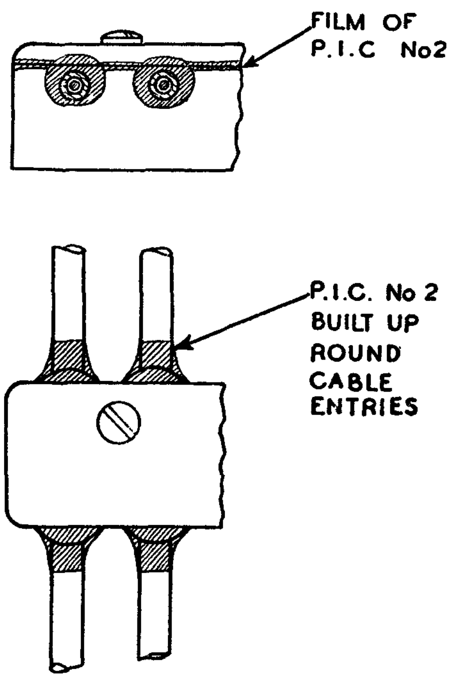


Fig. 8.—Terminal block, type B

Terminal blocks, type B

20. There are several sizes of these type B terminal blocks, but the method of weatherproofing is the same for each. Remove the terminal cover, and see that the sheathing of the cables runs as far as possible into the terminal space. Press P.I.C. No. 2 liberally over the terminals, round the cable leads, and into all corners. Use enough compound to ensure that when the terminal cover is replaced, and the excess is squeezed out, there will be a thin film of P.I.C. No. 2 between body and cover to act as a weatherproof washer. Finally build up with compound round each cable entry, as shown in fig. 8.

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Electric horn, type C

21. Horns of this type are now being weatherproofed in manufacture by the use of P.I.C. No. 1, and all horns already treated in this way are marked with the letter "W" in white paint. Horns not marked in this way may be weatherproofed in the following manner. Unscrew the 6 front cover fixing screws and remove the cover. Smear both faces of all the shims with P.I.C. No. 1. Squeeze the shims back into position, replace the front cover, and paint the letter "W" in white paint on the body of the horn. Next remove the terminal cover, and see that the sheathing of the cable cores runs as far as possible into the terminal space. Press P.I.C. No. 2 over the terminals and round the leads, filling all the available space. Replace the terminal cover, squeezing out the surplus compound, and build up with P.I.C. No. 2 round the cable entry, as in fig. 9. When a horn in service is treated in this way, make sure that it is correctly adjusted after re-assembly.

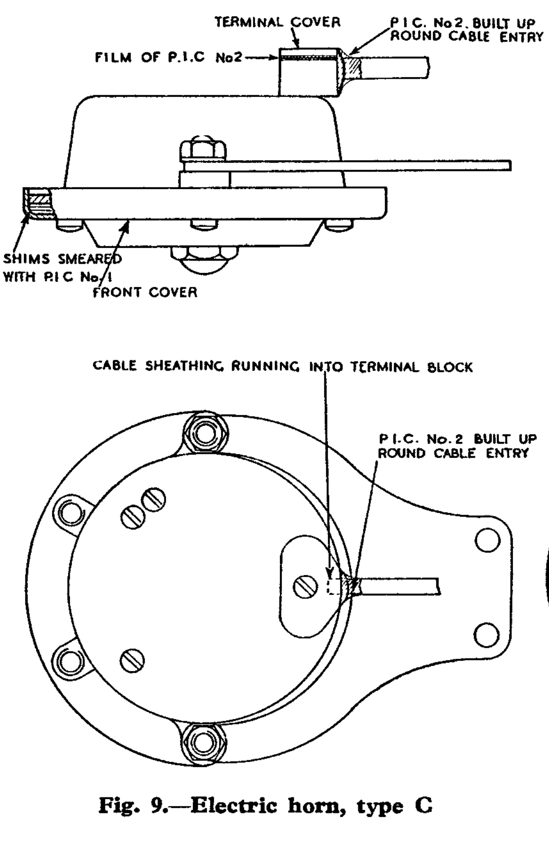

Fig. 9.—Electric horn, type C

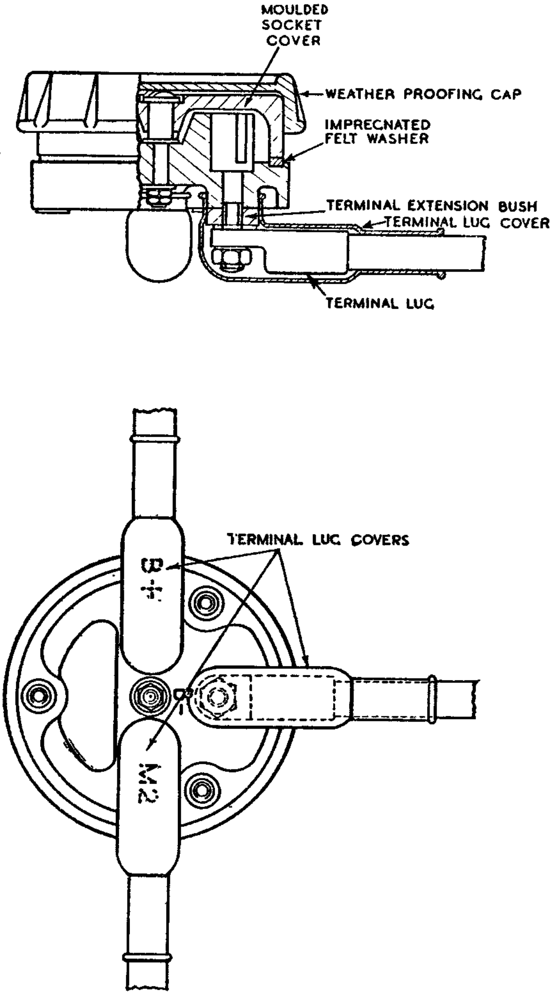

Fig. 10.—2-Pole socket, B.T.H. type E.1.

2-Pole sockets—B.T.H., types E.1 and E.2

22. These two accumulator starting sockets are somewhat different in construction, but much of the instructions for weatherproofing will apply to both types. Some of the sockets have already been partially weatherproofed in manufacture by the fitting of an impregnated felt washer. If this has been done, the socket will be marked with a "W" in white paint on the front cover. If

the socket is not so marked and it is required to be weatherproofed, remove the nuts and washers below the base, and take out the screw running through the assembly. Remove the moulded socket cover with great care, so that the spring does not fly out. Take out the old felt washer in the groove on the base of the socket, and press an impregnated felt washer (Stores Ref. 5C/3054) in the groove instead. Place the spring against the stops in base and cover, and with the cover in the right hand, turn in a clockwise direction, compressing the spring until it allows the cover to seat on the new felt washer. Replace the through-screw, the washers and the nuts, adjusting the tension until the cover returns easily to its original position when it is released after being turned in a clockwise direction to expose the socket holes. Tighten up the screw sufficiently to prevent slackness on this return spring movement. Fit a weatherproofing cap No. 1 (Stores Ref. 5C/3055) over the socket cover. When this has been done, mark the socket with a "W" in white paint on the front cover.

23. *On the type E.1 sockets* it will be seen that the base insulation at the terminal marked B — is below the level of the other two terminals. To correct this, remove the nut, washers and terminal lug, and fit a terminal extension bush (Stores Ref. 5C/3056). Before refitting the terminal lug, pass a terminal cover No. 4 (Stores Ref. 5C/3057) over it, and well back on to the cable. Replace the terminal lug, washers and nut, and finally pull the terminal cover well down on the terminal insulation, so that it completely covers the bush. Fit terminal covers in the same way to the two other terminals.

24. *The type E.2 sockets* have only two terminals. Both of these should be fitted with terminal covers in the manner described in the last paragraph. Fig. 10 shows the weatherproofing of the type E.1 socket. Type E.2 is similar except for the omission of the B — terminal.

Graviner inertia switches

25. In the Graviner inertia type switch, shown in fig. 11 (Stores Ref. 27N/20), the possible points of entry for moisture are by way of the terminal block, at the various cover plate joints, and particularly the end plate, through its breathing action. The terminal cover should be removed, and the terminal space completely filled with P.I.C. No. 2, which should be pressed firmly round the screws and cable ends, and into all corners, spaces and channels. Enough compound should be used to allow for the excess to be squeezed out when the terminal cover is replaced, leaving a thin film as a washer between cover and switch body. The switch setting and tripping knobs should be well smeared with P.I.C. No. 1, or if this is not available, with Lanoline. The base plate should be removed, its inner edges should be coated with lacquer (Lanolin-resin pigmented solution, Stores Ref. 33C/584), and the plate immediately fixed in place to make a sealed weatherproof joint. The same lacquer should be used for coating all joints, plates and screws in the assembly. Finally, additional P.I.C. No. 2 should be built up round the cables entries to the terminal box.

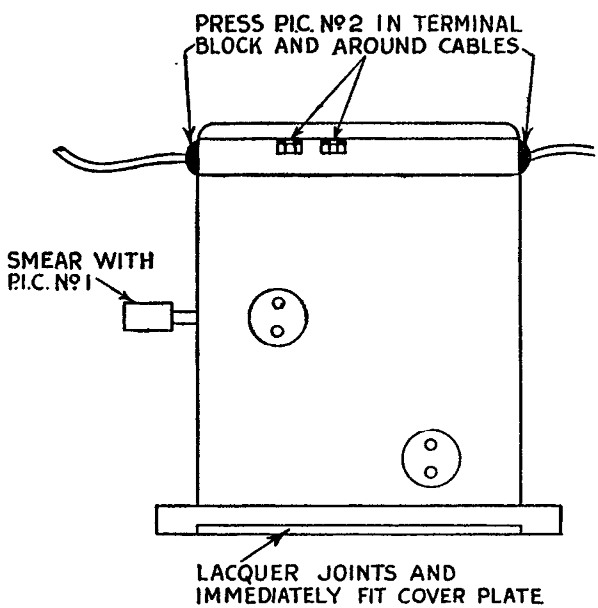

Fig. 11.—Graviner inertia switch

Flame switch, Mk. II

26. The Mk. II flame switch (Stores Ref. 27N/18) is being supplied painted all over with an oil and water resisting paint, which makes it weatherproof except for the terminals. The terminal

box therefore is the only part that may need special attention in service to ensure that the whole is completely weatherproof. Remove the terminal cover, and press P.I.C. No. 2 firmly round the terminals and cable ends, completely filling the terminal space, and using enough compound to allow for the excess to be squeezed out into a thin film between cover and box when the cover is replaced. Additional P.I.C. No. 2 should be built up round the cable entries (fig. 12).

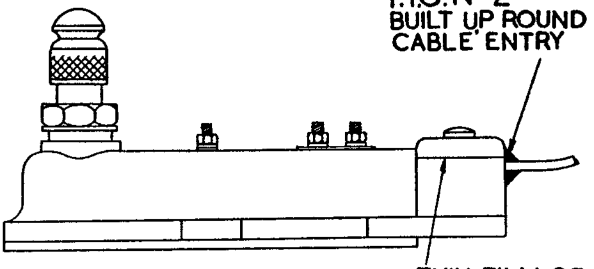

Fig. 12.—Flame switch, Mk. II

GENERAL CARE OF EQUIPMENT

27. Much condensation, which is one of the chief causes of corrosion, can be prevented if care is taken to keep the inside of the aircraft as dry as possible. Weatherproof covers are provided for the cockpit, engine, turret and other vents, and these should be used, particularly when the aircraft is at dispersal point in damp cold weather. When the weather is fine and dry, the aircraft should be allowed to air thoroughly, with covers off and all vents open to promote good air circulation. On some stations, heater vans are available for drying out aircraft, and regular treatment will do much to keep down condensation.

28. It has been estimated that as much as a pint of water could be collected from inside a large aircraft from the condensation caused by a cool night following a warm day, and it will be realised from this that constant care and attention is necessary if a high standard of electrical serviceability is to be maintained.

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CHAPTER 12

STANDARD S.B.A.C. WIRING SYSTEM

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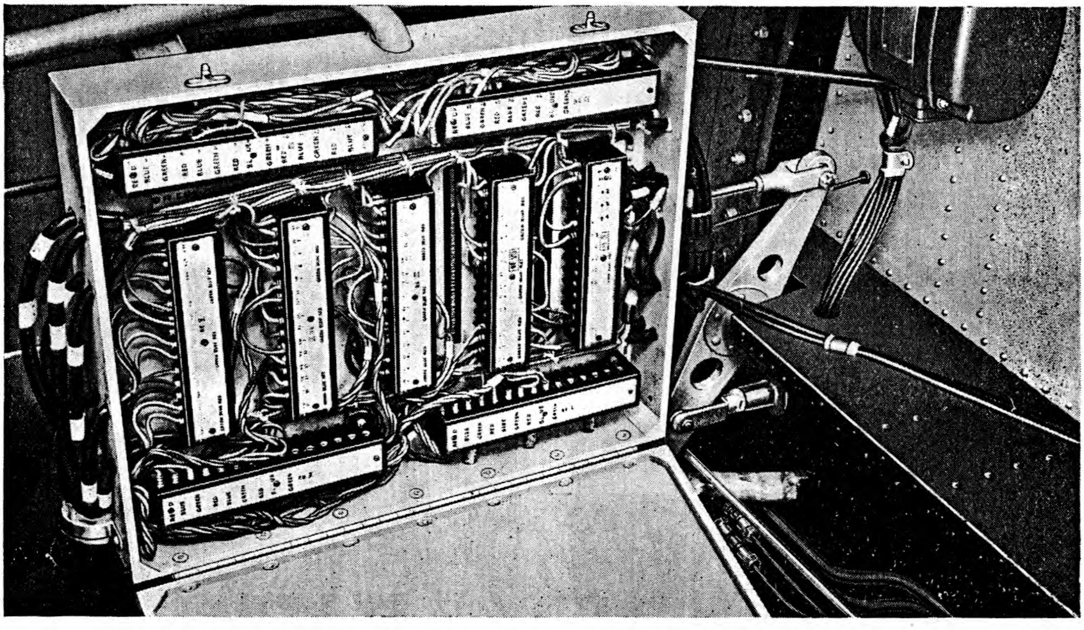


Fig. 1.—Junction box showing cable identification on terminal block covers

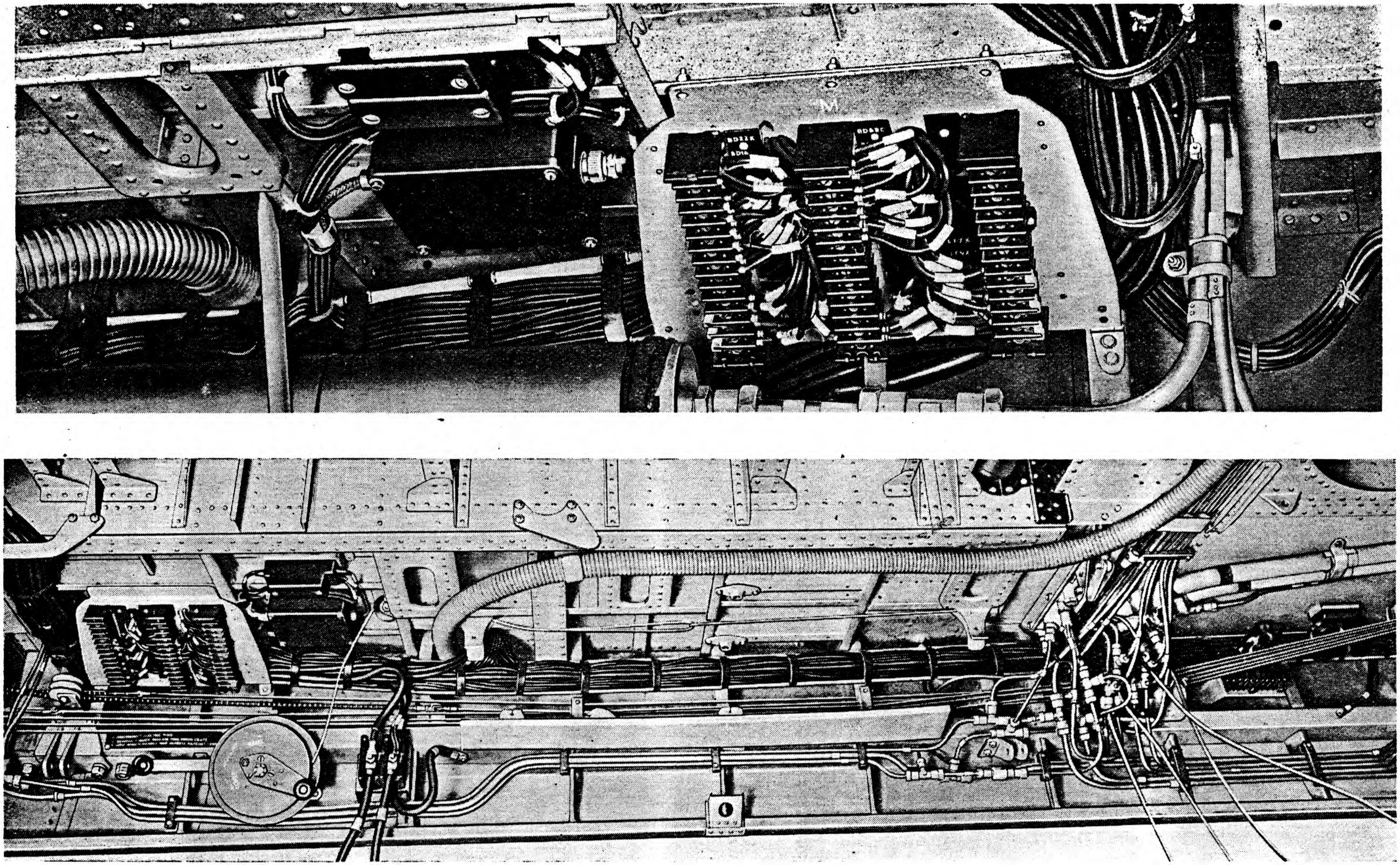


Fig. 2.—Typical bomb bay installation assembly

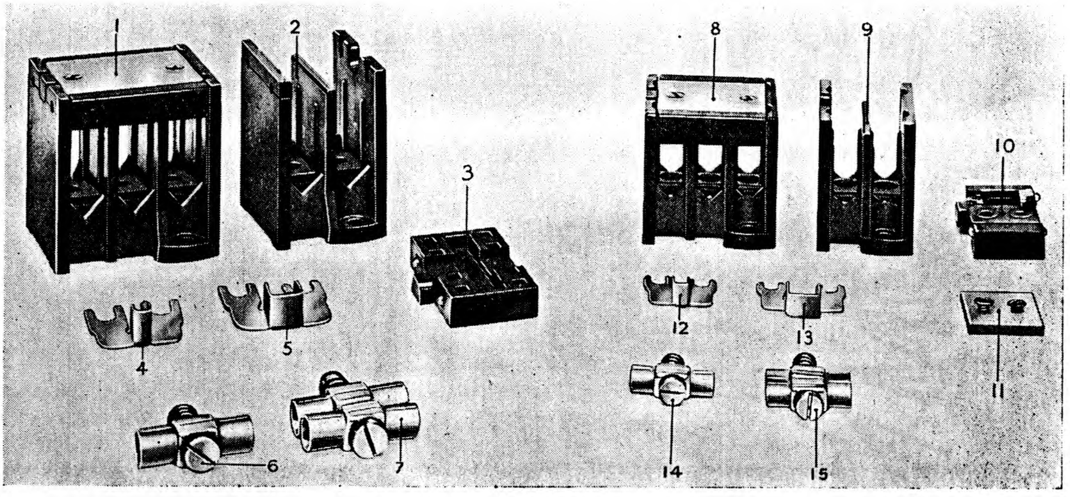
CHAPTER 12

STANDARD S.B.A.C. WIRING SYSTEM

Introduction

1. The Standard S.B.A.C. Wiring System has been developed for aircraft electrical installations as a method which is easy to handle, and flexible for modification. It is based on the single-pole, single-core principle, using cables of the uni-rubber or "vin" range, run in ducts or conduits between connector blocks. All metal used is non-ferrous to reduce risk of depreciation through corrosion.

2. Basically, the component parts may be described under three headings; the 19-amp. range, which covers 4, 7 and 19-amp. wiring; the 37-amp. range; and the heavy duty range, for 64, 83 and 138-amp. wiring. In each of these ranges, components are standardised so that the minimum range of parts is required. A list of the parts, with their Stores Ref. numbers is given in Appendix. 1.



37-AMP RANGE
1. 3-way block
2. 2-way block
3. 2-way block cover (underside)
4. Inter-terminal connecting link
5. Inter-block connecting link
6. Single-tier socket
7. Double-tier socket

19-AMP. RANGE
8. 3-way block
9. 2-way block
10. Cover for 2-way block with perspex removed
11. Perspex for 2-way block cover
12. Inter-terminal connecting link
13. Inter-block connecting link
14. Single-tier socket
15. Double-tier socket

Fig. 3.—Items from 37-amp. and 19-amp. ranges, showing comparative sizes

DESCRIPTION OF COMPONENTS

19-amp. series

3. The components in this series are designed to cover all requirements of wiring for 4, 7 and 19-amp. capacity, giving the maximum degree of flexibility with the minimum number of parts.

Blocks

4. Connector blocks in this range are made in 2, 3, 5, and 15-way sizes. Each block of moulded plastic material is supplied bare, the Stores Ref. number of the item being stamped on the underside of the base. The dividing walls between the socket channels are high enough to

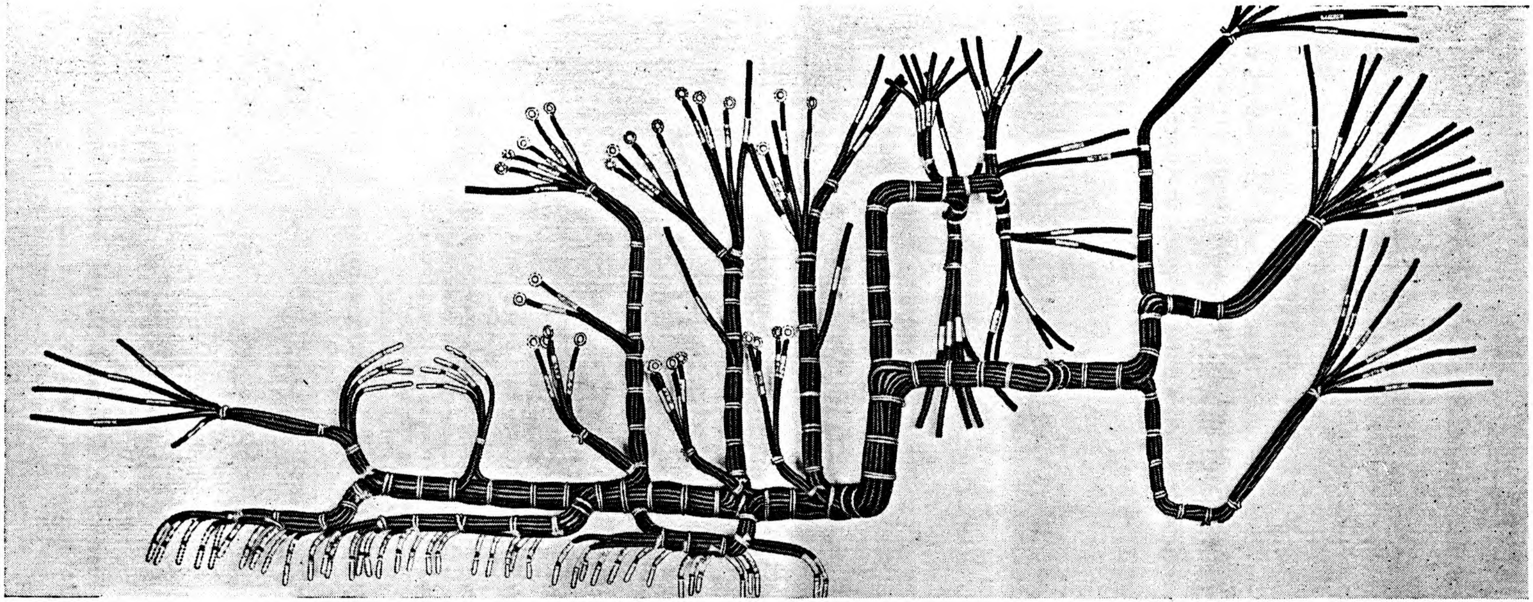


Fig. 4.—Typical cable loom showing cable ends prepared for various terminals

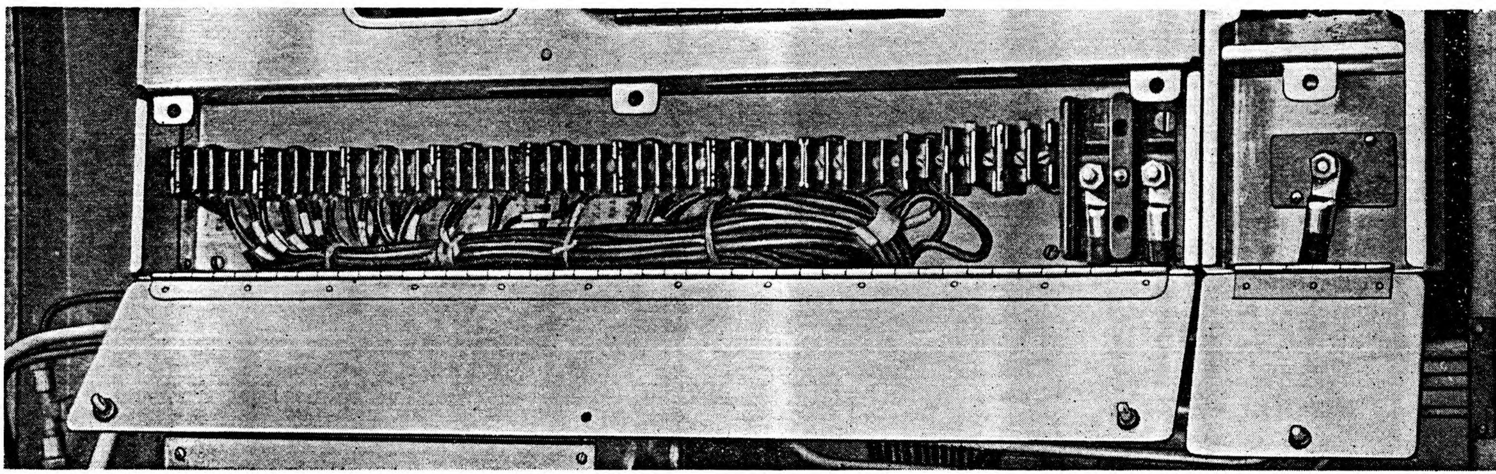


Fig. 5.—Panel showing terminal blocks mounted in line

allow for either single or double-tier sockets. The blocks are screwed down within their own compass, making it possible to line up the requisite number for any bank without waste of space. As can be seen in fig. 7, the blocks are designed with ventilation holes to prevent possible collection of moisture, and to provide an "airflow" which will help to limit corrosion.

Sockets

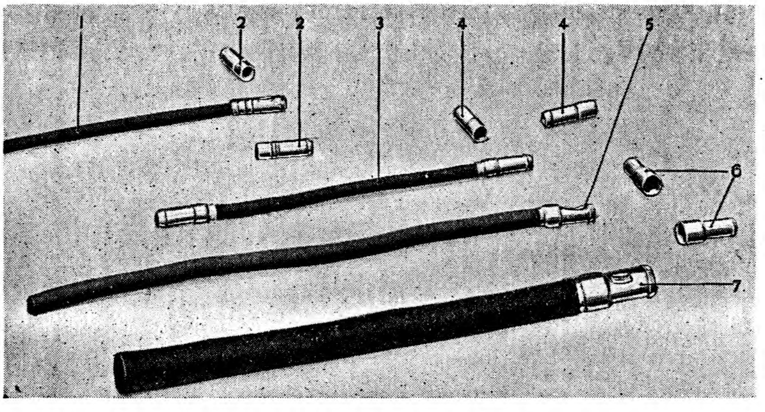
5. The make-up of the sockets can be seen in fig. 3. There is only one size socket in the series. Each complete socket assembly, single or double-tier, as required, is built up of two or four socket halves held together on captive screws, spring-locked by a securing washer above the thread. The requisite number of complete sockets for any block assembly must be drawn from store as separate items under their own Stores Ref. numbers.

Ferrules

6. Three sizes of ferrules are provided, to take 4, 7 and 19-amp. cables, respectively; these are illustrated in fig. 6 and 9. It will be seen that the difference in size affects the internal bore only, allowing for the varying sizes of the cable used; the nipple-end is a standard size, to give constant contact in the standard 19-amp. series socket. Ferrules are mechanically attached to the cables by crimping the cable-entry end on to the conductor. The 4-amp. ferrule can be distinguished by the identification ring at the cable entry end; the 7-amp. and 19-amp. ferrules can be recognised by the difference in the size of the bore.

Connecting links

7. Two sizes of connecting link are available in the 19-amp. series, both shown in fig. 3. The type A is used for linking adjacent terminals within one block and the type B for connecting the end terminals of two adjacent blocks. Links are stamped with their Stores Ref. numbers.



1. 4-amp. cable with ferrule attached by crimping
2. 4-amp. ferrules, showing identification ring
3. 7-amp. cable with ferrules attached by crimping
4. 7-amp. ferrules
5. 19-amp. cable with ferrule attached by crimping
6. 19-amp. ferrules
7. 37-amp. cable with ferrule attached by crimping

Fig. 6.—Ferrules before and after attachment to cables

Covers for blocks

8. The block-covers, made of moulded material to fit the 2, 3, 5, or 15-way blocks, are fitted by a quick-release spring-ball method, each spring-ball registering with a hole in the end wall of the block. These spring-balls and their registering holes can be identified on items 9 and 10 in fig. 3. A locating register at one end only of each cover fits into a recess provided in one of the end-walls, ensuring the correct replacement of the cover. This is essential, as identification for the terminals is provided by a white cellulose label, which is protected by transparent synthetic resin or Perspex, and screwed down to the cover. Stores Ref. numbers are stamped on the underside of the cover.

37-amp. series

Blocks

9. 2- and 3-way blocks only are provided in this range. They are on a larger scale than those in the 19-amp. range, but are identical in design, and again the appropriate Stores Ref. number is stamped on the underside of the base. Comparative sizes are shown in fig. 3.

Sockets

10. Either single or double-tier sockets are available, to take one size of ferrule-nipple only. These are shown in fig. 3, and again the required number of complete sockets for any block assembly must be drawn from Store under their own Stores Ref. number.

Ferrules

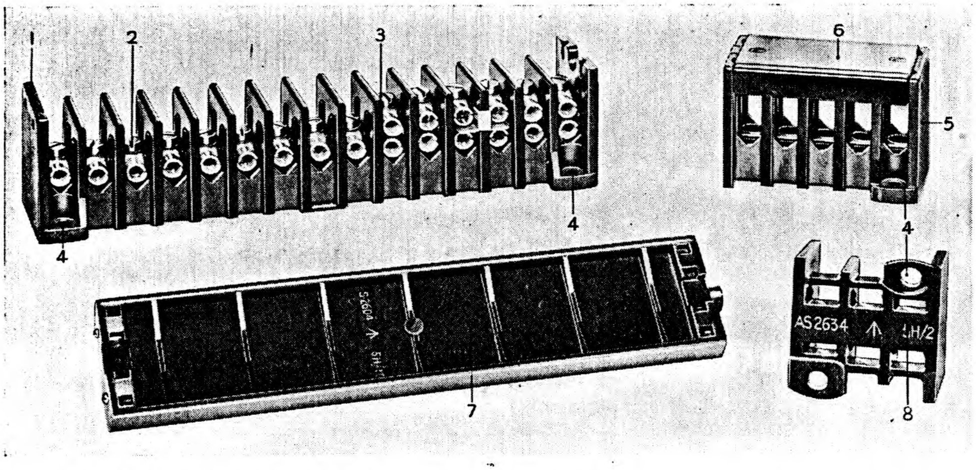
11. Since this range is for 37-amp. supply exclusively, only one size of ferrule is provided. As in the 19-amp. range, the ferrule is mechanically connected to the conductor by crimping. Fig. 6 shows an example of a ferrule on 37-amp. cable.

Connecting links

12. Two sizes of connecting links are available, type A for inter-terminal commoning on a block, and type B for connecting end terminals of adjacent blocks. These are shown in fig. 3.

Covers for blocks

13. Two sizes of cover are available in this range, to fit the 2- and 3-way blocks. They are of the same design as the covers described in para. 8, and again, the Stores Ref. number is stamped on the underside.



1. End wall of 15-way block
2. Single-tier socket
3. Double-tier socket
4. Holes for fixing screws
5. 5-way block
6. Transparent cover over cable identification
7. Underside of 15-way block cover
8. Underside of 3-way block

Fig. 7.—Blocks in the 19-amp. range

Heavy duty range

14. The heavy duty range is used for 64-amp, 83-amp. and 138-amp. capacity cables and the design of the components is based on the existing screw-down type of lug. Various items in the range are shown in fig. 8 and 9.

Block

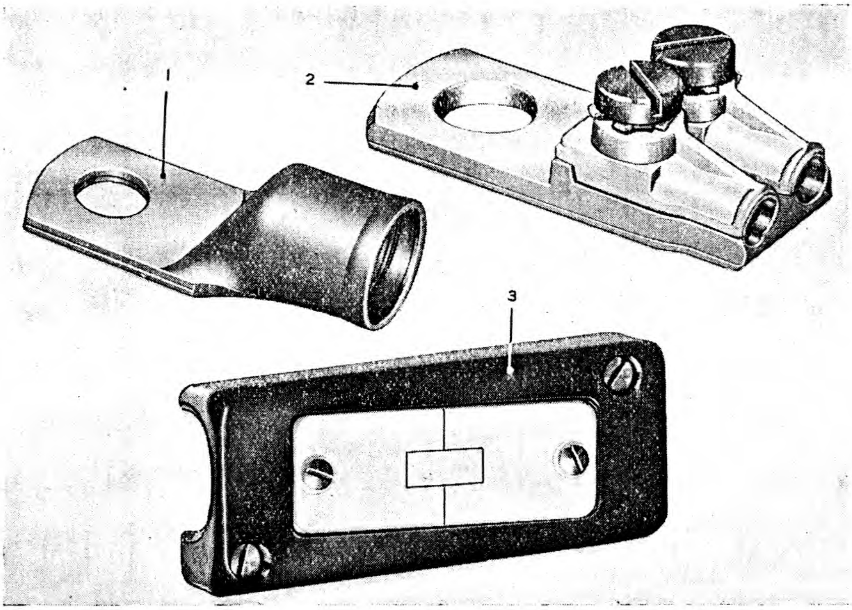
15. One type of block only is provided in this range, but it is adaptable to take various arrangements of connections. The block base, Stores Ref. 5H/13, is of moulded plastic material.

Terminal stud

16. A terminal stud, complete with a self-locking nut, is moulded into the centre of the base. The various lugs making up the electrical connection on this terminal are slipped over the stud, and held down by the stiff nut.

Lugs

17. There are three sizes of lugs in this range, for 64, 83 and 138 amp. cables, respectively, each stamped with its own Stores Ref. number. The lugs are mechanically connected to the cables by crimping the lug on to the cable-core; the dielectric should previously have been cut back sufficiently to allow the cable core to extend to the end of the lug, as shown in fig. 9.



1. Lug 2. Lug adapter 3. Block cover

Fig. 8.—Heavy duty lug, lug adapter, and block cover

Commoning links

18. The side walls of the heavy duty block-base are cut away to allow for a commoning link to connect the terminal studs of two adjacent blocks. Each link is stamped with its Stores Ref. number, 5H/23.

Cover

19. One type of cover is provided, so designed that it is impossible to replace it incorrectly. A label protected by Perspex and fastened to the cover by captive screws, identifies the terminal and associated cable connections. The Stores Ref. number of the cover, 5H/14, is stamped on the underside.

General

Ferrule adapters

20. A series of ferrule adapters is provided to enable ferrules in one range to be used in sockets of another range. One adapter fits over the nipple of the 37-amp. range ferrule, and extends into a nipple fitting the 19-amp. series socket. Three others, fitting over the 4, 7 and 19-amp. ferrules, extend to nipples of the 37-amp. series socket gauge. Finally, a large gauge ferrule enables a 64-amp. cable to be used in a 37-amp. socket. These items, shown in fig. 9, have been developed to simplify modification work, and their use should be limited.

Lug adapters

21. There are three types of lug adapters which enable cables in the 19 and 37-amp. series to be connected on the heavy duty terminals. These adapters have cable-entry ends designed to take 2–19 amp. ferrules, 4–19 amp. ferrules, and 2–37 amp. ferrules, respectively. These are shown in fig. 9.

Tools

22. Special crimping tools are provided for crimping the ferrules on to the cable. Details of these tools will be given in a separate chapter.

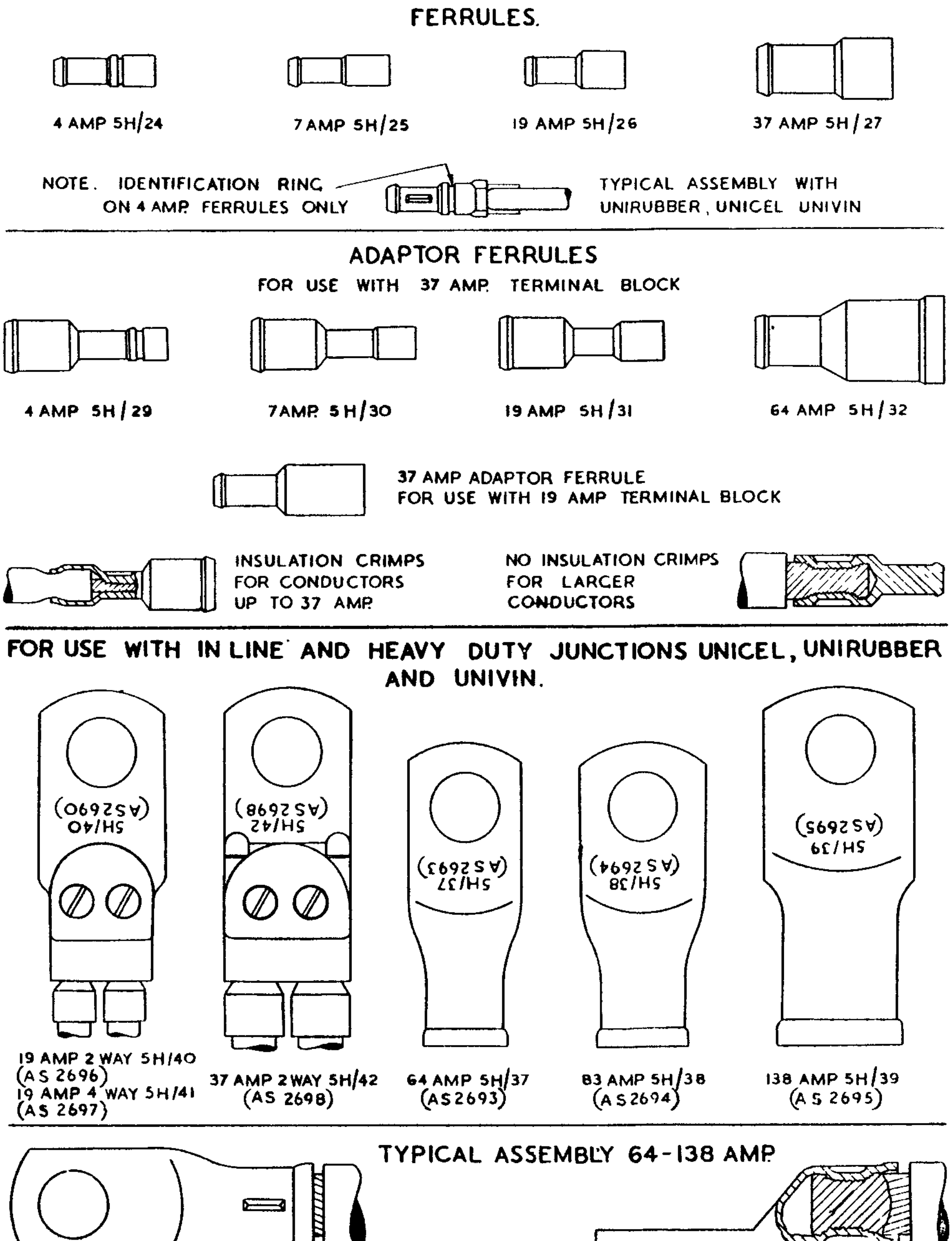


Fig. 9.—Components of standard S.B.A.C. wiring system

APPENDIX 1

LIST OF COMPONENTS

1. The simplicity of this wiring system and the reduction of components to the lowest possible variety consistent with adequate flexibility has resulted in the following standard components, available from stores under the Stores Ref. numbers given; these numbers must be verified in A.P.1086 before ordering as from time to time additional equipment may be developed, and numbers altered.

Description		*Stores Ref.*
Blocks, moulded, 19-amp. series	2-way	5H/1
	3-way	5H/2
	5-way	5H/3
	15-way	5H/4
Blocks, moulded, 37-amp. series	2-way	5H/5
	3-way	5H/6
Cover-assembly, 19-amp. series	2-way	5H/7
	3-way	5H/8
	5-way	5H/9
	15-way	5H/10
Cover-assembly, 37-amp. series	2-way	5H/11
	3-way	5H/12
Block-assembly, heavy duty series		5H/13
Cover-assembly, heavy duty series		5H/14
Socket assembly, 19-amp. series	Single tier	5H/15
	Double tier	5H/16
Socket-assembly, 37-amp. series	Single tier	5H/17
	Double tier	5H/18
Links, commoning, 19-amp. series	Type A	5H/19
	Type B	5H/20
Links, commoning, 37-amp. series	Type A	5H/21
	Type B	5H/22
Link, commoning, heavy duty series		5H/23
Ferrules	4-amp.	5H/24
	7-amp.	5H/25
	19-amp.	5H/26
	37-amp.	5H/27
Ferrules, adapter	37-amp. cable to 19-amp. connector	5H/28
	4-amp. cable to 37-amp. connector	5H/29
	7-amp. cable to 37-amp. connector	5H/30
	19-amp. cable to 37-amp. connector	5H/31
	64-amp. cable to 37-amp. connector	5H/32
Lug, cable, heavy duty	64-amp.	5H/37
	83-amp.	5H/38
	138-amp.	5H/39
Lug, adapter, heavy duty series	2-way, 19-amp.	5H/40
	4-way, 19-amp.	5H/41
	2-way, 37-amp.	5H/42
Heavy duty junctions, components for use with		
Bracket, insulating bus-bar		5H/48
Stud, terminal, complete with self-locking nut		5H/49
Shield, insulating		5H/50

Description		*Stores Ref.*
Bus-bar, end-connecting	2-way	5H/51
	3-way	5H/52
Clamp, bus-bar locating		5H/53
Bus-bars, 500-amp.	2-way	5H/54
	3-way	5H/55
	4-way	5H/56
	5-way	5H/57
	6-way	5H/58
	7-way	5H/59
	8-way	5H/60
	9-way	5H/61
	10-way	5H/62

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CHAPTER 14

NOTES ON EARTHING TWO-POLE AIRCRAFT WIRING SYSTEMS

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LIST OF ILLUSTRATIONS

Introduction

1. In American equipment and certain items of British equipment the negative connections are earthed internally. The installation of one or more of these items of single-pole equipment may be a requirement in two-pole wired aircraft, and in such cases a return current path of ample capacity to carry both the equipment current and fault currents must be provided by earthing the negative pole of the electrical supply system.

2. Since each type and mark of aircraft has individual wiring features, it is not possible to give a general description which will cover the earthing of all types. This chapter gives general information only, and should be read in conjunction with the relevant modification leaflets in Vol. II of the A.P. for the particular aircraft concerned.

DESCRIPTION

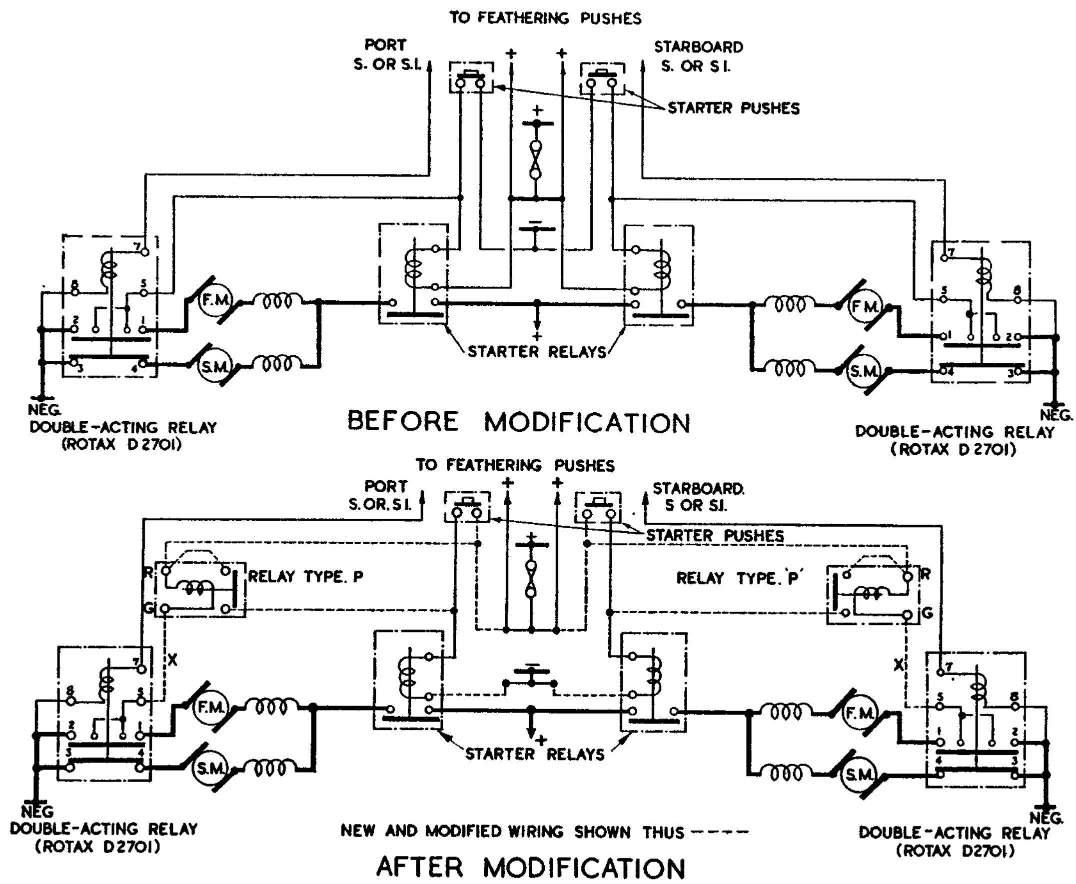
Method of earthing

3. The earthing of two-pole wired aircraft is effected by connecting the negative pole of the system to the aircraft frame, or, in the case of wooden aircraft, to the main bonding system. The earth connection should be on the direct lead from the master switch or external supply socket to the negative pole of the general services, at a point which conveniently allows ground testing to be carried out from an external accumulator. The size of the earthing cable varies according to the total loading of the single-pole equipment installed.

4. An isolating switch was originally fitted in the earthing cable on certain installations, but this is no longer a requirement, and where such a switch is already installed, it should be locked in the ON position.

Circuit alterations

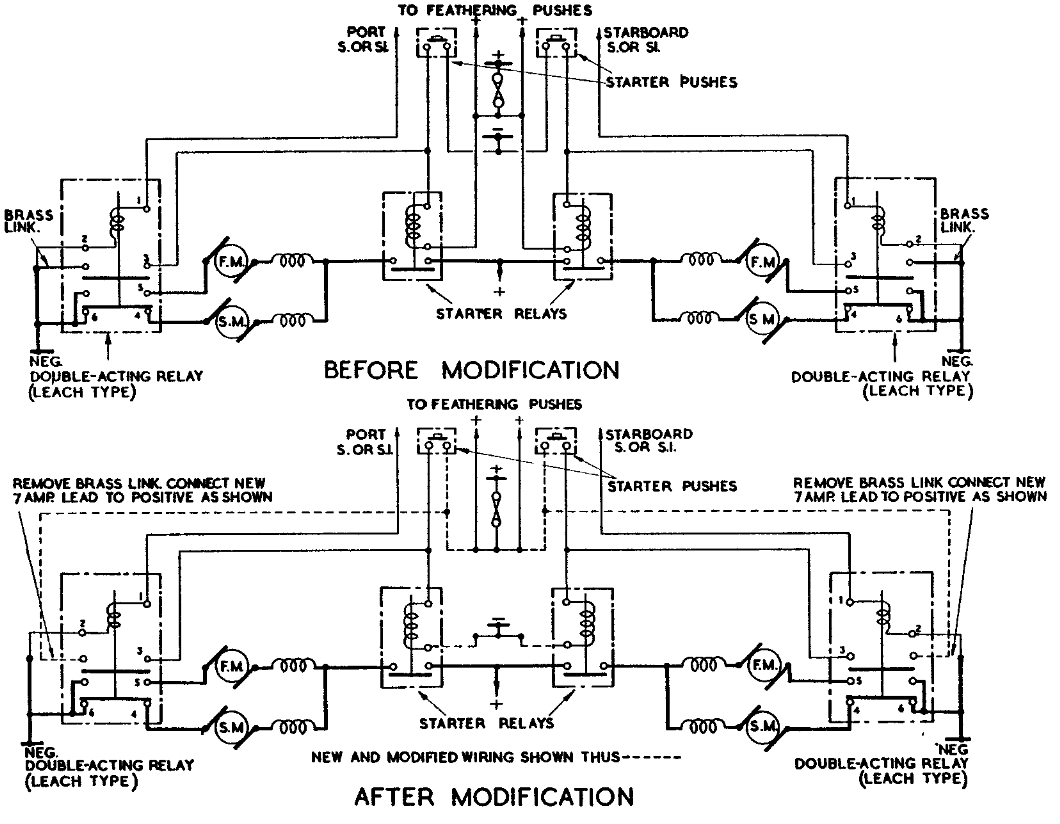
5. When the negative pole of an aircraft is earthed, it is desirable to use positive switching on most circuits in order to prevent inadvertent operation of equipment owing to earth faults. Extensive re-wiring would be necessary if all switching on existing aircraft were to be changed to the positive lead; to avoid this, the only circuits to be considered are those which, if operated inadvertently by an earth fault, would endanger the aircraft in flight or personnel on the ground.



Notes

1. All new wiring to be 7 amp.
2. Type P relays to be mounted close to double-acting relays in each case so that wires marked "X" are as short as possible.
3. The modification for a 4-engine installation using a *common* fuse is similar except that only one new positive wire (to type P relays) per wing is required.
4. If separate fuses are used the new positive wire to each type P relay must be taken from the corresponding engine fuse in each case.

Fig. 1.—Wiring modification to starter push switch on aircraft fitted with double-acting relay (Rotax D2701)



Notes

1. **All new wiring to be 7 amp.**
2. **The modification for a 4-engine installation using a *common* fuse is similar except that one new positive wire (to Leach type relays) per wing is required.**
3. **If separate fuses are used the new positive wire to each Leach type relay must be taken from the corresponding engine fuse in each case.**

Fig. 2.—Wiring modification to starter push switch on aircraft fitted with Leach type double-acting relay (Stores Ref. 5C/2270)

6. Unless a fuse is fitted in the earthing cable, it is also necessary to fit fuses in all unfused positive wiring up to at least 37 amp. size, in order to reduce fire risks to a minimum.

Fuse in earthing cable

7. In certain cases a fuse is installed in the earthing cable. Its size, 40 or 60 amps., will depend upon the type and size of fuses used in the positive feeds of the single-pole items, and upon the total loading of such equipment.

8. When a fuse is fitted in the earthing cable, it should be noted that:—

(i) Unfused positive wiring need not be fused.

(ii) On aircraft fitted with starter and hydromatic propellers employing double-acting relays, the circuit wiring need not be modified.

(iii) On aircraft fitted with Rotol·electric propellers the circuit wiring need not be changed if the fuse is a 40 amp. one; if the fuse is a 60 amp. one, it is necessary to change the existing Rotol thermal switch from the negative lead to the "normal" positive lead.

Direct earthing

9. A fuse of higher rating than 60 amps. is not installed in the earthing cable because the degree of protection given to unfused positive wiring would be small and the starter and hydromatic propeller circuit employing double-acting relays would not be protected against inadvertent operation; wiring modification would therefore still be essential and the fuse in the earthing cable would be redundant. Where the conditions given in para. 7 would call for a fuse of higher rating than 60 amps., therefore, the earthing cable is connected direct to the airframe, and the circuit alterations given in para. 5 and 6 must be embodied. Fig. 1 and 2 show in diagrammatic form the wiring alterations required in changing the starter push switch to the positive lead on aircraft fitted with starter and hydromatic propellers.

INSTALLATION OF SINGLE-POLE EQUIPMENT

10. When the negative pole has been earthed, single-pole equipment can be installed. In metal aircraft, the earth terminals on negative connections of single-pole equipment must be attached direct to the airframe, preferably at the nearest convenient point. In wooden aircraft, the negative pole is connected to the main bonding system, and the earth terminal or negative connection of the single-pole equipment must be connected to the bonding system either at the same point as the main earthing cable or at a point on the bonding system where the cross-sectional area to the main earthing point is of ample capacity to carry the load current.

11. To prevent by-passing the fuse in the earthing cable, and to facilitate insulation testing, THE EARTH TERMINAL OR NEGATIVE CONNECTION OF SINGLE-POLE EQUIPMENT MUST BE MADE ON THE POSITIVE SIDE OF THE FUSE AND NOT BE CONNECTED DIRECT TO THE NEGATIVE POLE OF THE ELECTRICAL SYSTEM.

INSULATION RESISTANCE TESTING

12. When the negative pole of two-pole wired aircraft has been earthed, a single-earth fault will put a circuit out of action. Insulation resistance testing is therefore of vital importance, and the instructions for testing given in A.P.1095A, Vol. II, C—7W. should be followed in detail.

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SECTION 4

HEATING APPARATUS

LIST OF CHAPTERS

Note.—A list of contents appears at the beginning of each chapter

CHAPTER 1

ELECTRICALLY HEATED BOOTS AND GLOVES AND WIRED FLYING SUIT

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. When flying at high altitudes or in climatic conditions where flying boots and gloves are inadequate to retain normal temperatures in the extremities of the human body, it is necessary to apply artificial warmth to the hands and feet in order that they may be able to function properly. For this purpose boots and gloves containing heating elements are provided. These garments are fed from the electrical services of the aircraft, and enable the amount of clothing worn on the feet and the hands to be reduced to a reasonable minimum for freedom of action, whilst retaining the degree of warmth necessary for alert and comfortable movement.

2. In order to provide the electrical connections necessary to keep a constant supply of electricity flowing in the heating elements of the boots and gloves, the flying suit has to be specially wired and is provided with a means of connection to the aircraft electrical services. The flying suit distributes the electrical supply to the heating elements in the gloves and the boots. Appropriate external means of controlling the supply to the comfort of the wearer are provided in the aircraft wiring system. The flying suit and supply connections are designed so that they do not interefere with the freedom of movement of the wearer or with the oxygen mask, microphone and helmet assembly. The equipment has been designed primarily for use at altitudes up to 20,000 feet.

Types available

3. The flying suits, comprising flying jackets, trousers, gloves and boots, which are available for service are as follows:—

Jacket and trousers

Stores Ref.	*Garment*	*Size*	*Weight (average) lb.*
22C/109	Jacket	To individual requirements	5¼
22C/110	Trousers		6

Boots

Stores Ref. Left	*Stores Ref.* Right	*Voltage*	*Size*	*Fitting*	*Weight (average) per pair*
22C/163	22C/164	12	7	7	3½ lb.
		12	8	7	
		12	9	7	
		12	10	7	
22C/103	22C/104	24	7	7	3½ lb.
		24	8	7	
		24	9	7	
		24	10	7	

Gloves

Stores Ref. Left	*Stores Ref.* Right	*Voltage*	*Size*	*Weight per pair*
22C/105	22C/106	12	8	12 oz.
		12	8½	
		12	9	
		12	10	
22C/107	22C/108	24	8	12 oz.
		24	8½	
		24	9	
		24	10	

DESCRIPTION

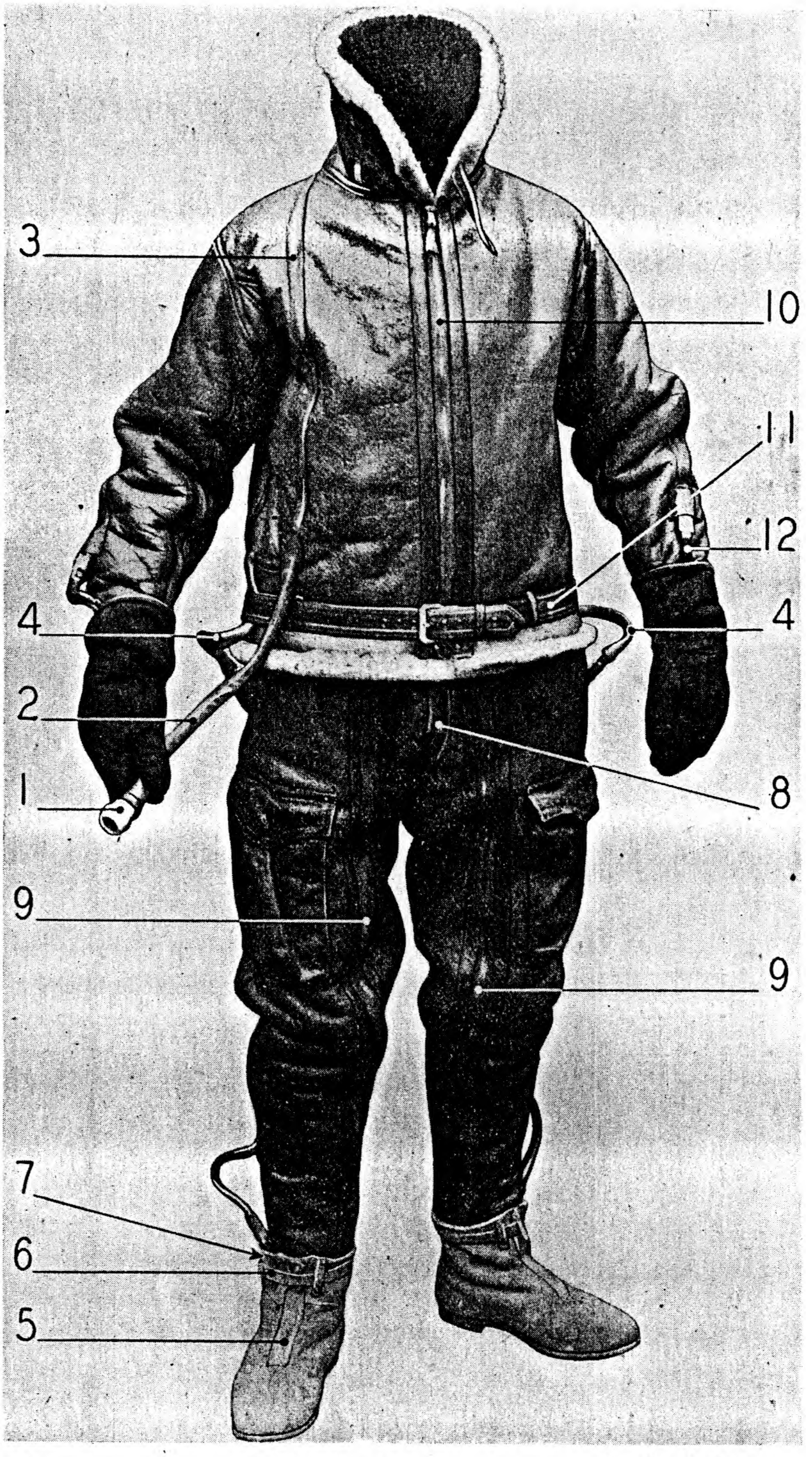
4. The complete flying suit, including the boots and the gloves, is of special design to give the wearer full protection, whilst at the same time it is capable of being fitted and removed easily as well as allowing entire freedom of movement when worn. Furthermore, the wearer can at all times disconnect himself from the aircraft electrical services by a simple movement. The jacket and the trousers of the flying suit are wired so that they provide a channel of distribution for the electrical supply to the heating elements in the boots and the gloves.

Flying suit

5. This part of the equipment consists of a thermally insulated leather flying jacket and trousers, which are provided with suitable electrical wiring and plug and socket connections, to enable the boots and the gloves to be attached to the trouser ends and sleeves respectively, and the suit to be electrically connected to the aircraft electrical services. A three-pin plug which can be seen at (1) in fig. 1 is attached to the jacket, and a socket is provided on the aircraft in a suitable position. This socket is connected to the aircraft electrical service through the necessary switches to provide separate control for the heating of the gloves and the boots.

6. The electrical wiring of the flying suit is illustrated in figs. 1 and 2. In fig. 1 the 3-pin supply plug (1) is attached to four connecting cables which are bound up into a flexible lead (2) encased in a leather sheath. This is attached to the jacket of the flying suit and, dividing at the point of attachment to the suit, forms two suitably protected cable runs, one of which passes round the waist to flexible leads (4), on each side of the waist. The other passes up the suit to the neck where connection is made to the glove supply cables which run down each sleeve. In fig. 2 the cable running down the sleeve and round the waist can be seen at (1) and (3) respectively. The cable which runs down each sleeve terminates in a patch pocket (2) which contains a 2-pin socket, and the flexible leads at the side terminate in sockets which fit into 2-pin plugs contained in patch pockets (4) on the trousers of the flying suit. From each of these patch pockets a suitably protected cable (5) passes down each leg and terminates in a flexible lead (6) with a 2-pin plug at its free end.

7. The wiring of the jacket employs a common return. It is shown diagrammatically in fig. 3 which indicates the circuit as it appears with the coat and trousers opened out fully and laid flat with the inside down. It will be seen that separate circuits are provided for the boots and gloves, each however, having a common return through the supply plug *via* the pin which has a green indent. The cables used in wiring the flying suit are all uniflex 4. Joints are made in the cables to an approved specification and are well insulated and secured to the jacket. Special precautions are taken to prevent chafing at points where cables cross.



1. Supply plug
2. Flexible lead
3. Cable run
4. Flexible leads at waist
5. Zip fastener
6. Leather strap
7. Boot connector
8. Flap
9. Zip fasteners
10. Zip fastener
11. Belt
12. Glove connection

Fig. 1.—Flying suit with electrically heated boots and gloves

1. Cable run in sleeve
2. Patch pocket
3. Cable run at waist
4. Patch pocket
5. Cable run
6. Flexible lead
7. Boot connection
8. Snap fastener

Fig. 2.—Side view of flying suit

8. The free ends of the cables of any one garment, which make connection to the adjacent garment by means of plugs and sockets, are relieved of any strain on the cables by means of a length of tape. This tape is attached to the garment at one end and to the plug or socket at the other in such a manner that any pull on the plug or socket is transmitted to the adjacent garment by the tape and not by the cables. This construction avoids any undue strain upon the cables which may result from inadvertent pull upon the leads when disconnecting the plugs from the sockets. The cables and the tapes are enclosed in a leather sheath which is sewn to the garment and bound to the plug or socket. The relative movement of the gloves and the jacket may cause some strain to be imposed upon the cable connections. To prevent the plug being pulled from the socket, a special form of snap fastener connection is employed. The male or stud portion of the snap fastener (8 in fig. 2) is carried on the sleeve of the jacket.

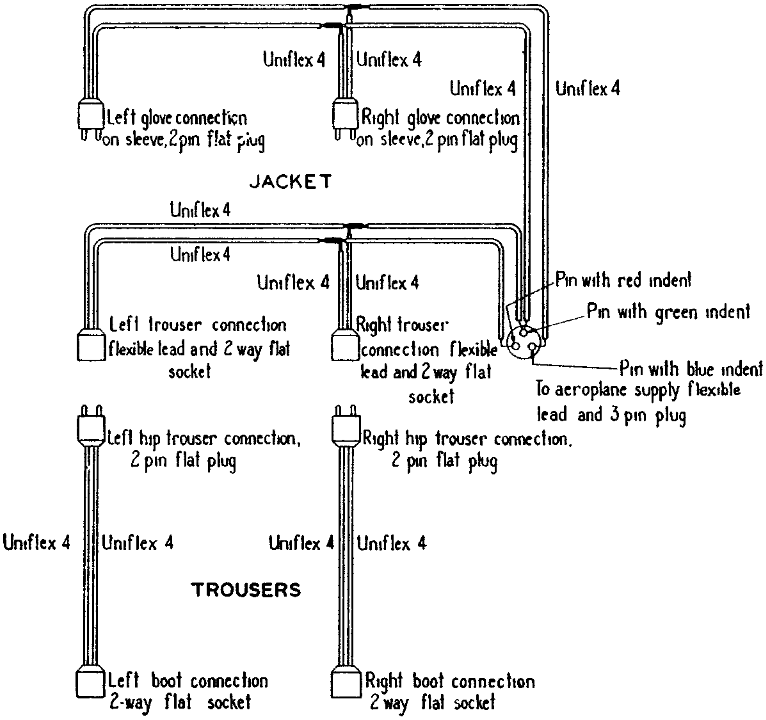


Fig. 3.—Wiring diagram of flying suit

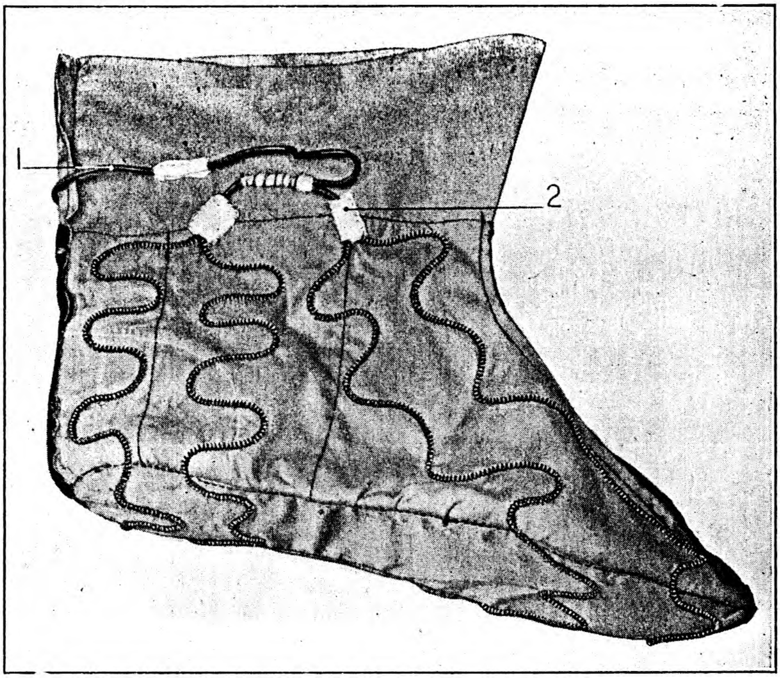
Boots

9. The boots, which are shown in fig. 1, are made in four sizes and one fitting, to normal good boot-making practice. They are constructed of willow calf leather uppers with composite rubber outsoles and rubber heels; the whole boot is lined with sheepskin. A nickel plated zip-fastener (5) laces the boot in front over a leather tab. A leather tightening strap (6) with a roller buckle and loop runner is attached to the top of the boot, about ½ in. from the rim, and stitched to the boot on the buckle side only. The free side runs through loops attached to the side of the boot. This strap serves to tighten the top of the boot over the trouser leg of the flying suit and makes a draught-proof joint at this point. Each boot is a complete oversize garment without the lining carrying the heating element. The latter is inserted as a sock and is practically self-contained. In addition, a loose leather sock backed with sheepskin is included in each boot.

10. The heating elements are carried in the special lining which forms the inserted sock. It is illustrated in fig. 4 and consists of five parts, namely a main lining, an inner lining, an outer lining, not shown in the illustration, a sole piece, and a heel piece. The main and outer linings are of cotton cloth. The inner lining is of stockinette and the sole and heel pieces, of light leather, are sewn to the linings. When fitted, the heating element sock is stitched round the top of the boot, down the edges and front opening, down the back, and secured to the foot portion in a serviceable manner.

11. The layout of the heating elements attached to the ankle sock is also shown in fig. 4 which illustrates the 12-volt lining. The connections from the 2-pin plug to the heating elements consist of a pair of uniflex 4 flexible cables which pass through the main lining, just below the plug body, to supply the front or toe-heating elements. The leads do not cross each other at any point. The lead from the element connections on the opposite side of the boot to the plug is taken round the back of the lining, approximately parallel to the top of the boot, and secured in place by tabs or tape as can be seen at (1) in the illustration. The front or toe-heating elements are connected by short leads teed off the leads supplying the back or heel elements. In each case the lengths of the leads and the position of the joints is such that no tension is imposed on any flexible cable.

12. A table giving details of the heating elements is given under para. 33. They consist of 32 s.w.g. bare, non-corrosive, steel wire. This wire is wound into a close spiral, and after winding it is stretched out to the required length. The element when sewn on to the lining is kept uniform in coil pitch, kinkless, and free from sharp bends. Every coil of the heating elements is sewn with a lock stitch to the element-carrying lining. No gather, fold or tuck is permitted in the lining over the heated area. The elements are set to certain minimum distances from each other and are so disposed that the heat dispersion is as equable as possible.



1. Lead to element with securing tab
2. Joint in element.

Fig. 4.—Boot lining showing 12-volt heater elements

Note:—The outer lining has been removed to reveal the heater elements.

13. The 2-pin plug is sewn by its stitching plate to the inside of the top of the off side of each boot and covered by a pocket made of the main lining material. It is positioned about half an inch below the top of the boot. The flexible cables are T-jointed and soldered and insulated with oiled silk which is held in place by thread whippings at each end of the joint. The completed joint is sewn to the lining and a piece of white tape sewn over the joint to the lining.

14. The joints between the heating elements and the uniflex 4 flexible cable connections are of the clamped type. Small pieces of 22 s.w.g. copper tube $\frac{5}{8}$ in. long, finished smooth and flared at the ends are slipped over the cable, the ends of the elements being coiled over the bared ends of the cable, and the copper tube then slid over the joint and clenched securely by flattening at three points with a flat-nosed punch; the centre clench is on the opposite side of the tube to the other two. The joint when completed is secured to the lining. One such joint is illustrated at (2 in fig. 4).

the back of the hand. The swansdown patch is not in position in the illustration but it is stitched to the lining round its edges, between the leads and round the edges of the slit in the lining, in such a manner that a pair of channels $\frac{3}{8}$ in. wide are formed and permit free movement of the loops of the connecting cables (3) under the patch. This prevents any possibility of strain upon the flexible connecting leads being transmitted to the heating elements or to the joints (4) between them and the flexible connections. The heating elements are stitched to the smooth side of the swansdown cloth inter-lining. The elements are lock-stitched at every coil and thus held securely in position, care being taken that no gather, fold or tuck exists in the lining under the elements. Certain minimum clearances to avoid any danger of short circuits are maintained over the whole layout of the heating elements.

23. Joints between the heating elements and the flexible connections are situated 1 in. above the slit under the swansdown patch and are made, insulated, protected and fastened in an exactly similar manner to those of similar function in the boots as previously described. The swansdown flap and the lining are over-sewn tightly round all the joints. Cable crossings are avoided wherever possible, and in instances where they are unavoidable a strip of tape is sewn between the cables to prevent chafing.

24. Labels inside the gauntlet of the glove on the palm side and approximately 3 in. from the gauntlet edge give details of the glove, including the garment voltage, size, whether left or right hand the Stores Reference Number and similar relevant details.

OPERATION

25. It is necessary before either the boots or gloves can be fitted that the flying suit should be worn. The trousers should be put on first. They open out flat and are put into position from the back, lifting the flap shown at (8 in fig. 1), through the legs up in front and folding the trouser legs round into position. The zip-fasteners (9) on each side of the flap can then be entered at the top of each run at the waist and drawn right down each leg to the ankle. The jacket is slipped on in the usual manner and when comfortably in position is closed down the front by the zip-fastener (10) provided. The belt (11) round the waist should be buckled and adjusted to suit the wearer. The cuffs should be closed in by the zip-fasteners provided. The electrical connections between the jacket and the trousers should be completed at this stage by inserting the sockets on the loose leads, which are shown at (4), and are situated one at each side at the waist of the jacket, into the plug pockets on the trousers, situated one at each hip and shown at (4 in fig. 2). It should be ensured that the plugs and sockets are pushed well home and make firm contact.

26. The suit having been fitted, the boots should next be put on the stockinged feet. After the feet have been slipped into the boots, carefully and gently, it should be ensured that each boot is well and comfortably fitted with no folds or creases in the sock or in the linings of the boots. It is preferable, at this stage, to insert the socket, on the loose lead on each trouser leg shown at (6) in fig. 2, into the corresponding plug socket (7) in the inside of the top of the boot, again taking care to ensure that the plug and socket are in good and firm contact. The end of the trousers should then be smoothed down carefully with the zip-fastener fully in position and the boots pulled up over the trouser ends and laced by the zip-fasteners (5 in fig. 1), taking care to ensure that the tongue is smoothly in position. The strap (6) at the top of each boot should then be buckled to a comfortable firm hold.

27. Final adjustment to the flying suit and boots should now be made, including the collar of the jacket, which is buckled into a draughtless comfortable position after the oxygen mask and helmet are fitted. The gloves should then be drawn on, again ensuring that they fit comfortably before fastening. The socket on the end of the tension tape in the gauntlet of each glove which can be seen at (12 in fig. 1), should be inserted into the corresponding plug socket (2 in fig. 2) on the sleeve of the flying jacket, ensuring firm contact between the two. The fasteners (8) in the centre of each tension strap should be snapped over the corresponding stud on the sleeve of the flying jacket and the gauntlets pulled well up over each sleeve. The wrist-strap on the front of the glove should then be drawn taut and snapped into position.

28. The electrically-heated boots and gloves are now ready for use and are brought into service by inserting the supply plug (1 in fig. 1), which hangs on a flexible lead at the right on the waist line of the flying jacket, into the relevant heating supply on the aircraft. The switches provided on the aircraft enable the heating of the boots and the gloves to be controlled separately to the comfort of the individual wearer.

29. The garments should be stored in a hanging position. They should be aired after use in a dry warm temperature where condensation is reduced to an absolute minimum. The elements, cables, and fittings are rust-proof, but other considerations have to be taken into account where the human body is concerned and the garments should, therefore, be treated always with great care. They are tested and examined at every stage in their manufacture thus ensuring against mechanical and electrical faults. They are, however, subject to some strain in service and the practice of looking them over before and after use should be adopted. In addition, they should be examined and tested periodically, both relative to their serviceability as garments, as well as to the mechanical and electrical condition of their heating elements and connections.

30. Defects can easily render a garment unserviceable and can be avoided not only by careful usage but also by detecting defects before they develop. The visual examination must be thorough. The suit, gloves and boots must be examined carefully to detect any damage, wear, tearing or loosening of seams, or damage to pockets, fasteners, or buckles. Particular care should be taken in the inspection of the plugs, sockets, and their loose connecting leads. The plugs and sockets should be kept clean and bright. The plugs should always fit well, deeply, and firmly into the sockets with no play or looseness. An electrical continuity test should be applied. This requires a battery (accumulator), an ammeter, a voltmeter, and necessary connecting wires. The battery should supply a voltage of 14 volts or 26 volts, according to whether the boots or gloves are of the 12-volt or 24-volt type. The connections of this testing equipment should be as shown in fig. 6.

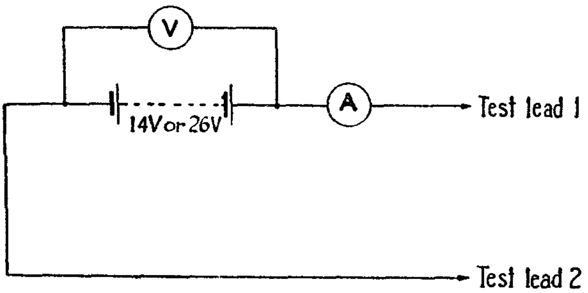


Fig. 6.—Test circuit

31. The whole flying suit should be laid out flat on a suitable clean, dry surface and electrically connected by joining the plugs and sockets of the jacket and trousers. The supply plug attached to the jacket of the flying suit has colour spots to indicate the service of the plug. It is a four-pin plug with one pin removed. The common lead cable is connected to the pin with the green spot; that from the glove connection to the pin with the blue spot and the cable from the boots connection is connected to the pin with the red spot. The pin with the yellow spot is removed and blanked off. Tests for continuity are facilitated by using a spare socket into which the supply plug on the flying suit can be plugged. The socket should be connected so that the test lead (1 in fig. 6) is connected to the green spot socket. The test lead (2) should then be used to make the individual circuit tests.

32. If the test lead (2) is connected to either of the red or the blue spot sockets there should be no reading at all on the ammeter A. If there is a reading it indicates that there is a short-circuit in the flexible leads or in the plug or socket connections in the flying suit. This can be localized in either the jacket or the trousers by uncoupling the plugs and sockets between the two garments.

33. With the jacket and trousers connected, the right-hand boot should be connected to the trousers. The test lead (2) should be connected to the red spot socket and the reading on the ammeter noted. The right-hand boot should then be disconnected and the left-hand boot connected to its appropriate trouser leg. A similar test should be made with the test lead (2) and the reading noted. The right-hand glove should now be connected to the right jacket sleeve and the test lead (2) connected to the blue spot socket and the reading on the ammeter noted. The right-hand glove should then be disconnected and the left-hand glove connected to its appropriate sleeve. A similar test should be made with the test lead (2) and the reading noted. The table below gives details of the readings which should be obtained. A 14-volt red or boot circuit reading should be 1·07 amperes and a 26-volt similar circuit 0·576 amperes. A 14-volt blue or glove circuit reading should be 1·5 amperes and a 26-volt similar circuit 0·808 amperes. A tolerance of ± 5 per cent. is allowed, but readings which are not within this tolerance condemn the garment as faulty.—

Garment	*Test voltage*	*No. of elements*		*Garment resistance, ohms*	*Current in garment, amps*	*Garment consumption, watts*
		Toe or outer	*Heel or inner*			
12-volt boots ...	14	2	2	13·05	1·07	15
24-volt boots ...	26	1	1	45	0·576	15
12-volt gloves ...	14	2	2	9·35	1·5	21
24-volt gloves ...	26	1	1	32·15	0·808	21

An insulation resistance test can be applied to the garments by means of a tester, insulation resistance, miniature type, or type B. The boots and the gloves should be disconnected from the flying suit, leaving the jacket and the trousers connected together. An insulation resistance of 2 megohms is required. In case of low readings, the fault can be localised in either the jacket or the trousers by disconnecting the trousers from the jacket, one side at a time, and applying the test after each disconnection. The proper resistance of each boot and each glove should also be tested by connecting the jacket to the trousers and then connecting one garment at a time to the trouser legs and the sleeves, measuring the resistance of each in turn. The readings obtained should agree with those specified in the table above.

34. In each test the garment being tested should be moved, shaken and reasonably bent about the elements and connecting leads. Intermittent faults are detected in this manner and are indicated by fluctuating readings on the ammeter (A) on the tester, which should normally remain steady during the test. As a final measure of protection, the test lead (2) should be connected to both the red and the blue spot sockets and both of the boots and the two gloves connected to the trousers and jacket respectively, the jacket remaining connected to the trousers. The parts of the garments in which the heating elements are disposed should be observed by placing the hands in contact with heater linings. Any tendency to overheat locally condemns the garment. In case of failure in any of these tests, the garment must be considered unfit for use as no repairs are permitted during actual service. A faulty garment must be returned to the appropriate maintenance depot for repair or replacement.

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CHAPTER 2

ELECTRICALLY HEATED WAISTCOATS

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LIST OF ILLUSTRATIONS

Introduction

1. The electrically-heated waistcoat is designed to be worn under normal flying clothes. Heating is applied to the trunk and shoulders by means of heating elements, and provision is made for the attachment of heated gloves and boots.

Types available

2. Reference to Table 1 gives the voltage, size, and types available.

TABLE 1

WAISTCOATS

Stores Ref.	*Size*	*Voltage*	*Height of wearer*
22C/706	1	12	5 ft. 3 in. to 5 ft. 8 in.
22C/707	2	12	5 ft. 8 in. to 6 ft. 1 in.
22C/708	1	24	5 ft. 3 in. to 5 ft. 8 in.
22C/709	2	24	5 ft. 8 in. to 6 ft. 1 in.

BOOT CONNECTORS

Stores Ref.	*Size*	*Length*
22C/731	1	39 in.
22C/859	2	45 in.

DESCRIPTION

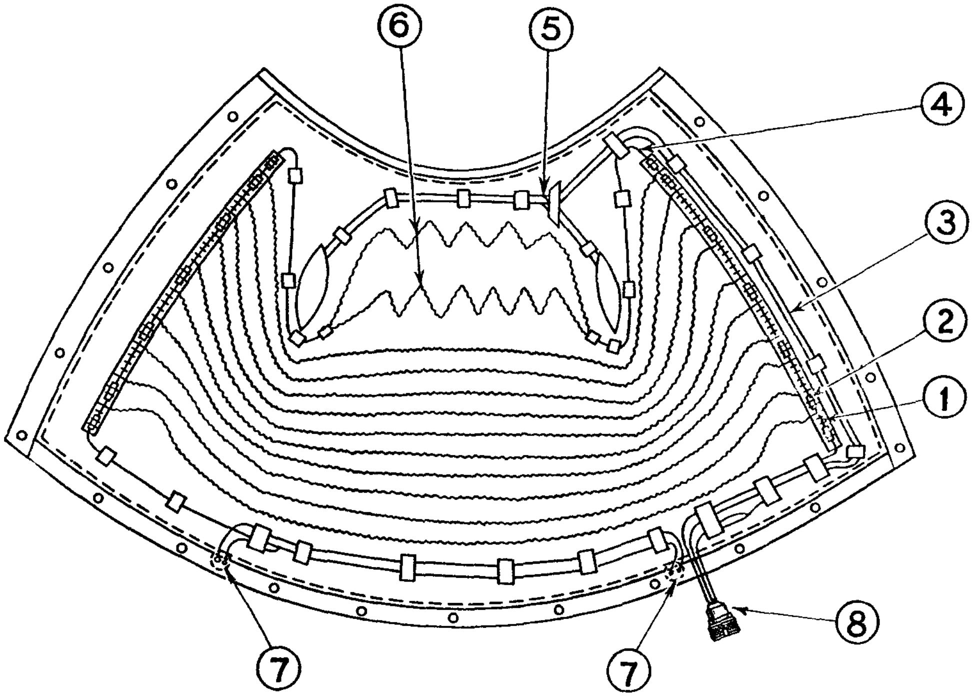
Waistcoat

3. The waistcoat itself is a single breasted, collarless garment, provided with sleeves which fit loosely at the wrists, and is fastened in front by buttons and has a hook and eyelet at the bottom. It consists of an outer cover and a wired lining, both of Egyptian cotton. The wired lining carries the heating elements and the wiring, and is covered by an additional lining of white lawn. These are fixed to the outer cover by press studs to give ease of access to the wiring. The supply for all the heating circuits is taken through a single 3-pin plug (Stores Ref. 5C/527) attached to the waistcoat at the right hip, as shown in fig. 1, the internal wiring being so arranged that the body, and hands and feet circuits, can be controlled by switches in the supply circuit. The connection for each of the boots is made by means of a flexible connector which terminates at each end in two-pin sockets.

4. A diagrammatic representation of the 12 V. waistcoat, size 1, is also given in fig. 1, which illustrates the relative layout of the elements and distributive wiring. A composite cable runs from the 3-pin supply plug (8) to the right hip, and comprises leads for two circuits and a common return lead. The following table gives the relation between the plug pins, the cable sizes, and the waistcoat circuits.

TABLE 2

Circuit	*Cable Size*	*Colour of spot adjacent to pin*
Common	Uniflex 7	Green
Body	Uniflex 4	Red
Hands and feet	Uniflex 4	Blue



1. Common leads
2. Element connections
3. Glove leads
4. Feed to shoulder element
5. Bifurcated joint
6. Shoulder element
7. Boot plugs
8. Supply plug
9. Cable sheath
10. Two-pin socket
11. Tape

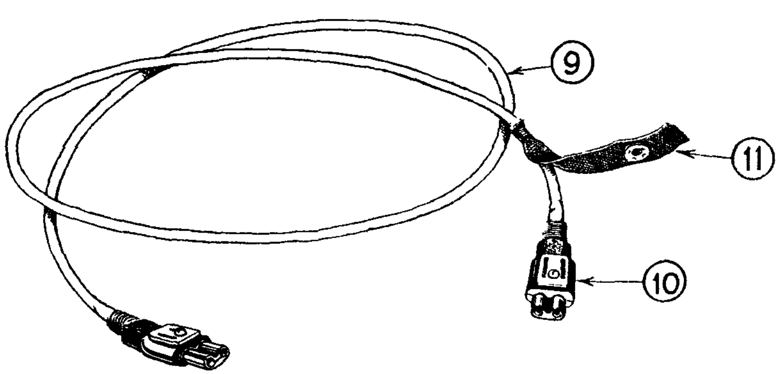


Fig. 1.—Layout of elements and wiring

5. The trunk and shoulder elements are of coiled 32 s.w.g. bare, non-corrodible steel wire, and are fed in parallel from non-corrodible wire rope common leads (1). The location of the element connections is also shown at (2) in this illustration. From the top end of each wire rope lead a Uniflex 4 cable (4) feeds the shoulder elements (6) which are positioned as shown.

6. The glove leads (3) from the distribution point, are taken up the right-hand forepart of the lining. They terminate at the right shoulder in a double bifurcated joint (5) from which a pair of cables feed each glove supply plug. A patch pocket covering the insulated plug is sewn on each sleeve, the pocket being situated to cover the hole from which the glove leads emerge.

7. The leads supplying the boot circuits (7) are teed on to the two leads at the bottom edge of the waistcoat, and are then taken through holes provided in the outer cover, and terminate in insulated plugs.

Boot connectors

8. Two lengths of Uniflex 4 cable (9), terminating at each end in 2-pin sockets (10) and covered with a sleeve of Egyptian cotton, carry the main supply from the waistcoat to the boots. The sockets are attached by stitching plates to the ends of a tension tape so that any tension applied is taken by the tape and not by the cables. Both the sleeve and tension tape are tightly whipped to the rubber sleeves on the sockets. To one end of the cable sheath is whipped a length of tape (11) carrying the female portion of a "lift the dot" fastener. This engages with the male portion on the boot connector plug on the waistcoat, and takes up any tension on the lead, making it impossible to disconnect the plug and socket by imposing tension below the point of attachment of the anchoring tape.

1. Plug pockets
2. Sleeve pockets
3. Snap fasteners
4. Hanging tab

Fig. 2.—Electrically heated waistcoat

9. When in use the waistcoat should be correctly fastened, and electrical connection to the boots made, by carefully inserting the socket provided on the boot connectors into the plug pockets on the waistcoat (1), fig. 2. The plugs should fit firmly in their sockets, and if there is any looseness the pins should be carefully adjusted. In order to prevent any tension on the connections it is essential to see that the female portions of the "lift the dot" snap fasteners on the boot connectors are engaged with the stud portions located on the plug pockets.

10. Connection for the gloves is made by inserting the glove sockets in the plugs in the pockets on the sleeves of the waistcoat (2) and the snap fasteners (3) should then be engaged. To ensure good electrical connections, precautions similar to those given in the preceding paragraph should be taken. When these operations are completed the 3-pin supply plug may be connected to the socket in the aircraft. The switches provided enable the waistcoat, and boots and gloves, to be controlled separately.

11. When not in use the waistcoat should, if possible, be kept on a coat hanger, or suspended by the hanging tab (4) provided for that purpose. Rough usage should be avoided, and the garments should be tested periodically for faults. A test schedule for the various types of waistcoat is given in Table 3; the figures given in the two right-hand columns include the voltage drop in the leads and distributing cables. The tolerance on the current per element and the rated consumption is ± 10 per cent.

TABLE 3

APPLIED VOLTAGE—14

Article	*Number of elements*	*Resistance of elements (ohms)*	*Current per element (amps.)*	*Rated consumption of waistcoat*	
				Amps.	*Watts*
Waistcoat. 12 V. Size 1 ...	12	46·6	0·30	3·43	48
Waistcoat. 12 V. Size 2 ...	14	46·6	0·30	4·15	58

APPLIED VOLTAGE—26

Waistcoat. 24 V. Size 1 ...	7	86·7	0·30	2·04	52
Waistcoat. 24 V. Size 2 ...	8	86·7	0·30	2·35	61

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CHAPTER 3

ELECTRICALLY HEATED CLOTHING, TYPE D

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Introduction

1. The electrically heated waistcoat, described in this chapter, is a loose fitting garment, made in one size only, and is intended to be worn under normal flying clothes. Provision is made for the attachment of heated socks and gloves, by means of "Dura dot" press fasteners connected in the electrical circuit. The socks are intended to be worn inside flying boots, the gloves being of the gauntlet type with a heated removable lining and a leather outer.

2. The clothing can be used on 12 or 24-volt systems, by the use of 12 or 24-volt belt pads which connect the heating elements in parallel or series, respectively. The internal connections are so arranged that the body circuit, and the hands and feet circuit can be separately controlled by switches in the aircraft supply circuit. All heating circuits are supplied through a three-pin plug connected to the belt pad, which is attached to the waistcoat at the right hip by means of press fasteners.

Types available

3. The sizes, voltages and stores reference numbers of the garments and their accessories will be found in Table 1.

TABLE 1

Stores Ref. No.		*Garment*	*Size*	*Voltage*
22C/711		Waistcoat	1 size only	12 and 24 volt
22C/722		Belt pad	1 size only	12 volt
22C/713		Belt pad	1 size only	24 volt
Left	*Right*			
22C/714	22C/717	Glove linings	8½	12 and 24 volt
22C/715	22C/718	Glove linings	9	12 and 24 volt
22C/716	22C/719	Glove linings	10	12 and 24 volt
22C/767	22C/770	Gauntlets, outer	8½	12 and 24 volt
22C/768	22C/771	Gauntlets, outer	9	12 and 24 volt
22C/769	22C/772	Gauntlets, outer	10	12 and 24 volt
22C/720	22C/723	Socks	Small	12 and 24 volt
22C/721	22C/724	Socks	Medium	12 and 24 volt
22C/722	22C/725	Socks	Large	12 and 24 volt
22C/726		Sock connectors	One for each sock	

DESCRIPTION

Waistcoat

4. Referring to fig. 2 it will be seen that this is a single-breasted collarless garment with "Magya" type sleeves, fitting loosely at the wrists. The front edges and the neck are fitted with a

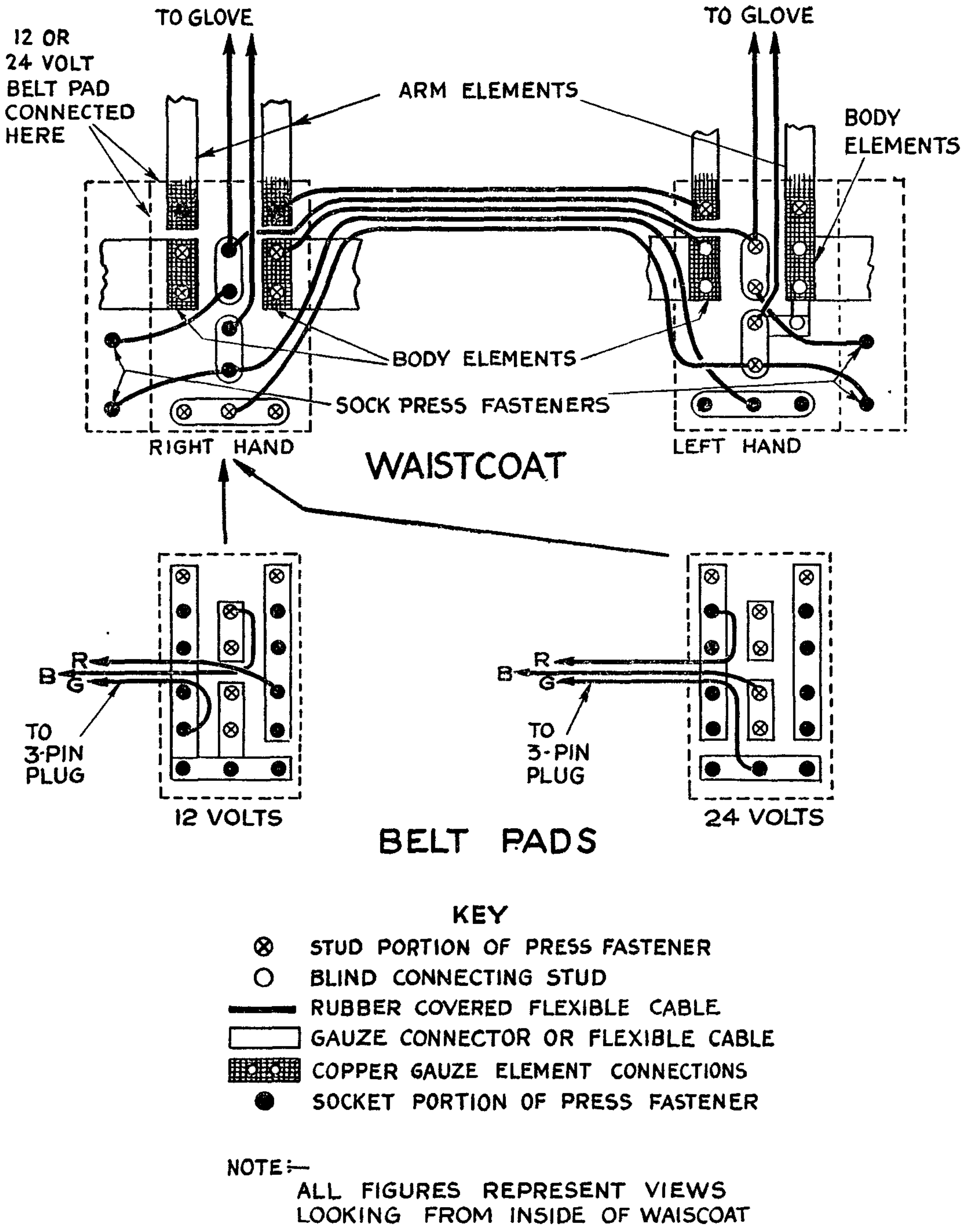


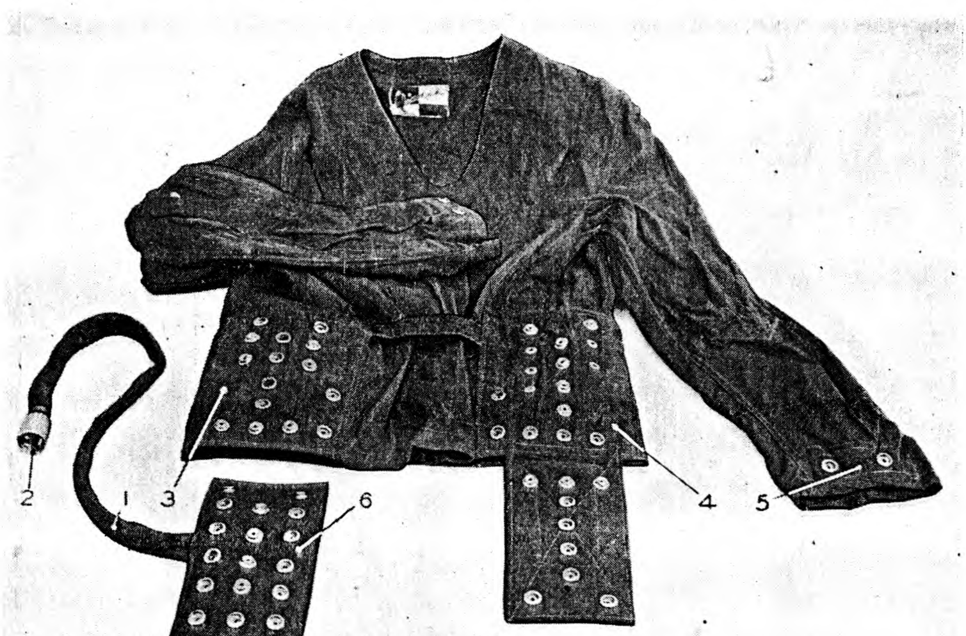
Fig. 1.—Wiring diagram, waistcoat and belt pads

fly, provided with nine button holes to enable the waistcoat to be buttoned to the flying suit, on which buttons are provided for this purpose. The outer cover, to which the heating elements are stitched, is constructed of brown flame-proof poplin.

5. The four elements are sewn to the inside of the outer cover along the edges of their covering sheaths and are positioned, two distributed in the body and one in each sleeve, the body elements being 2 inches and those for the sleeves 1½ inches in width. They are so arranged that the body and sleeve elements, for heating the right-hand side of the garment, are connected to a distribution point on the right (3), and those for heating the left-hand side of the garment to a distribution point on the left (4). The supply is taken from a supply pad through "Dura dot" press fasteners located on the right-hand distribution pad and flexible cables connect this to the left-hand pad. Press fasteners are provided on each distribution pad for supplying the boots and gloves when the waistcoat is used with a flying suit wired for such equipment and provided with corresponding fasteners.

6. The elements are constructed of wire gauze woven with 43 s.w.g. non-corrodible Firth Staybright, or its equivalent steel, in the warp, and 43 s.w.g. constantan or similar copper-nickel in the weft. Electrical connection is made to the press fasteners by nickel-plated brass eyelets which pass through the ends of the elements. Strips of copper gauze are also used to assist in making good electrical connection and to strengthen the ends of the element. The element is edged down both sides with edging tape to prevent fraying and is enclosed in brown flame-proof poplin, which is folded round the element and sealed with edging tape.

7. The press fasteners used to connect the elements and the wiring are anchored to double gabardine pads on each side of the garment. Each pad is covered by a patch, and a pocket is provided on the inside of the left-hand distribution pad. Flexible cables taken through a sleeve



1. Supply cable 2. Supply plug 3. Distribution pad (right) 4. Distribution pad (left)
5. Press fasteners 6. Supply pad

Fig. 2.—Electrically heated waistcoat, type D

along the waist are used as interconnections between the two pads, electrical connection to the press fasteners being made by nickel-plated brass eyelets. The ends of the cables are covered by sleeves of rubber tubing through which a length of bared conductor projects, the conductor and about ⅛ in. of the rubber tubing being clamped under the head of the eyelet. The poplin sleeve encasing these wires runs round the waist and is stitched to the inside of the garment. Press fasteners for connecting the socks are located on the bottom edge and those for connecting the gloves on the cuffs (5) of the waistcoat, the leads to the glove connectors being taken inside the waistcoat from their respective distribution pads to the shoulder, and then along the top sleeve round the elbow, terminating at the cuff. The supply from the aircraft general services is taken from the supply pad through press fasteners mounted on the right-hand distribution pad, and from thence to the left-hand pad *via* the flexible interconnecting cable.

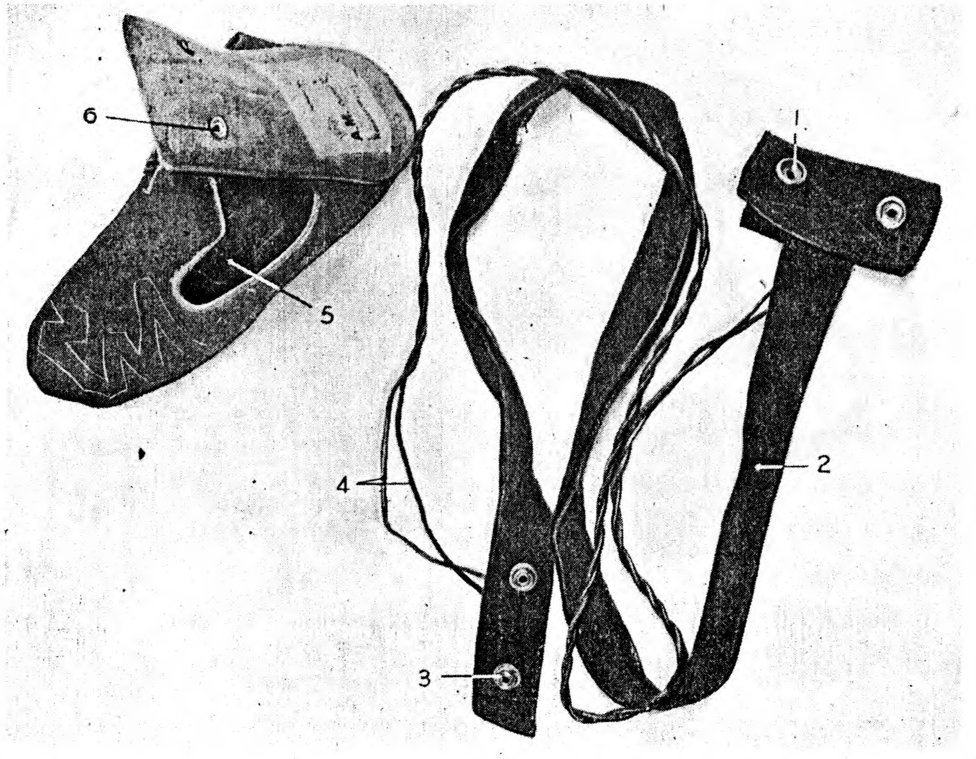
Supply pads, plug and leads

8. There are two types of supply pad, one for 12-volt, and the other for 24-volt operation, wired as depicted in fig. 1, marked with a yellow or a red label respectively, a corresponding label being attached to the end of the cable sheath near the plug. The connections in the supply pads are so arranged that, when a 12-volt pad is used all the elements are connected in parallel, and when a 24-volt pad is used the body elements are in series with each other and in parallel with the sleeve elements, which are also in series with each other. In the same way, glove and sock circuits are connected in parallel or series for 12, or 24-volt operation respectively. The supply pad is illustrated at (6) in fig. 2, and consists of a patch of brown poplin on which are mounted 17 press fasteners, the poplin being anchored to a pad of double-thickness gabardine. The connections are covered by a patch consisting of a layer of gabardine and one of brown poplin.

9. Three flexible rubber-covered cables (1) comprising the waistcoat supply lead, the sock and glove supply lead, and the common return lead, emerge from the pad. These cables are approximately 32 in. long and terminate in a three-pin plug (2), the relation between the plug pins and the circuits being as follows:—

Circuit	*Colour of spot adjacent to pin*
Common	Green
Body and arms	Red
Hands and feet	Blue

The cables are enclosed in a sheath of brown poplin, one end of the sheath being secured to the patch and the other to the plug in such a manner that any strain is taken by the sheath and not by the cables.



1. Press fastener sockets 2. Sheath 3. Press fastener studs 4. Cable 5. Lining
6. Press fasteners

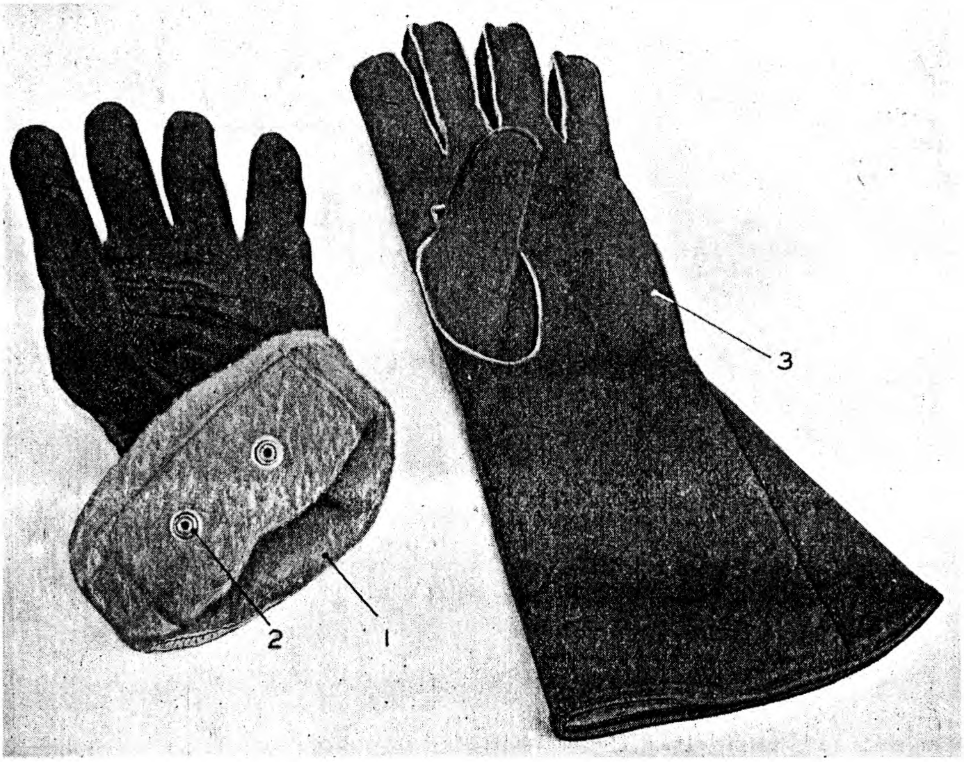
Fig. 3.—Sock and connector

Socks and sock connectors

10. The socks are to be worn inside flying boots, a sock and sock connector with the cable removed, being shown in fig. 3. Each sock consists of an outer cover of gabardine to the inside of which is sewn the heating element and a lining of brown stockinette fleece (5). The element is of the wire gauze type, it is ½ in. in width, is fitted with copper gauze end pieces, and is encased in flameproof, cotton fleece material. The ends of the element terminate above the heel and are riveted to press fasteners (6) which are supported by a pad of double gabardine. The sock connectors are used to connect the sock press fasteners to the corresponding press fasteners on the lower edge of the waistcoat. A pair of press fastener studs (3) secured to a double gabardine pad, and a pair of sockets (1) similarly secured, are connected by two lengths of rubber cable (4). The cable is encased in a sheath of flameproof gabardine (2) in such a manner that any tension imposed is taken by the sheath and not by the cable.

Glove linings and outer gauntlets

11. The glove linings, fig. 4, are of the gauntlet type and are made of stockinette with an inner lining of stockinette fleece (1) which carries the heating element sewn on the outside. The element is ½ in. in width and is fitted with copper gauze end pieces. It is enclosed in flameproof cotton fleece material, the edges of which overlap along the centre of the element. The ends of the element are riveted to press-fastener studs (2) on the inside of the glove, which are anchored to a pad of double gabardine. The outer gauntlets (3) are of cape leather lined with stockinette fleece and are worn over the glove linings.



1. Glove lining 2. Press fastener 3. Outer gauntlet

Fig. 4.—Outer gauntlet and lining

INSTALLATION AND OPERATION

12. Instructions for use with flying suits suitably wired for this type of clothing will be found in Chapter 1 of this section. With flying suits not so wired, the waistcoat should be fitted first, the socks should then be put on and connection from the waistcoat to the socks made by snapping the press

fasteners on the sock connectors to the appropriate fittings on the bottom edge of the waistcoat and top edge of the socks. The supply pad may at this stage be fitted to the right-hand distribution pad, care being taken to see that a pad with voltage markings appropriate to the supply is used. The flying suit should be put on next, followed by the boots. Before wearing the gloves the suit should be adjusted to the comfort of the wearer, after which the glove linings should be slipped on the hands and the press fasteners connected to the corresponding fittings on the cuffs of the waistcoat. Finally, the outer gauntlets may be drawn into position, and the three-pin plug connected to the aircraft supply.

SERVICING

13. The garments should be stored in a warm, dry place and the waistcoat should, if practicable, be kept on a coat hanger. Periodical inspection for damage should be made, and should visual inspection reveal any tear, loosening of seams, or damage to the fabric, the faulty garment should be sent to the appropriate depot for repair. Particular care should be taken to see that the "Dura dot" press fasteners are firmly anchored to their respective pads, that they show no signs of corrosion and that they made good electrical connection. The clothing and the leads may be tested for electrical continuity and insulation resistance, the method adopted being described in Chapter 1 of this section. A test schedule is given in table 2, the tolerance on the current per element and the rated current consumption is ± 10 per cent.

TABLE 2

Article	*No. of elements*	*Length*	*Width*	*Resistance Ohms*	*Rated consumption of garment at 12 v. Amps.*	*Watts*
Waistcoat	2 Body 2 Arms	14 ft. 12 ft.	2 in. 1½ in.	10·2 11·4	4·5	54
Gloves	1	7½ ft.	½ in.	11·0	1·1	13·2
Socks	1	7½ ft.	½ in.	11·0	1·1	13·2

Should faults develop in the garments they must not be repaired in Service but should be returned to the appropriate repair depot.

P3159 M42696/1044 11/43 8500 C & P Gp. 1

CHAPTER 4

ELECTRICALLY-HEATED CLOTHING, TYPE G

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LIST OF ILLUSTRATIONS

Introduction

1. The lining is a loose fitting one-piece garment made of flame-proofed brown poplin, and is intended for wear under normal flying clothes. Heated socks and gloves may be attached by means of press fasteners of Dura Dot design, connected in the electrical circuit. The socks are to be worn under flying boots, and the glove linings are for wear inside leather outer gauntlets, Type D, described in Chapter 3 of this section. Lining, socks, and gloves are all made in three sizes.

2. The clothing is for use on a 24-volt supply, distributed by means of pads on either side of the garment. The internal connections are so arranged that the two elements of the body, sleeve, or legs, are in series, and the three pairs are in parallel with each other. In like manner, the glove and sock circuits are connected in series parallel. All heating circuits are supplied through a three-pin plug attached to leads from the right hip which are connected to a distribution pad sewn to the lining.

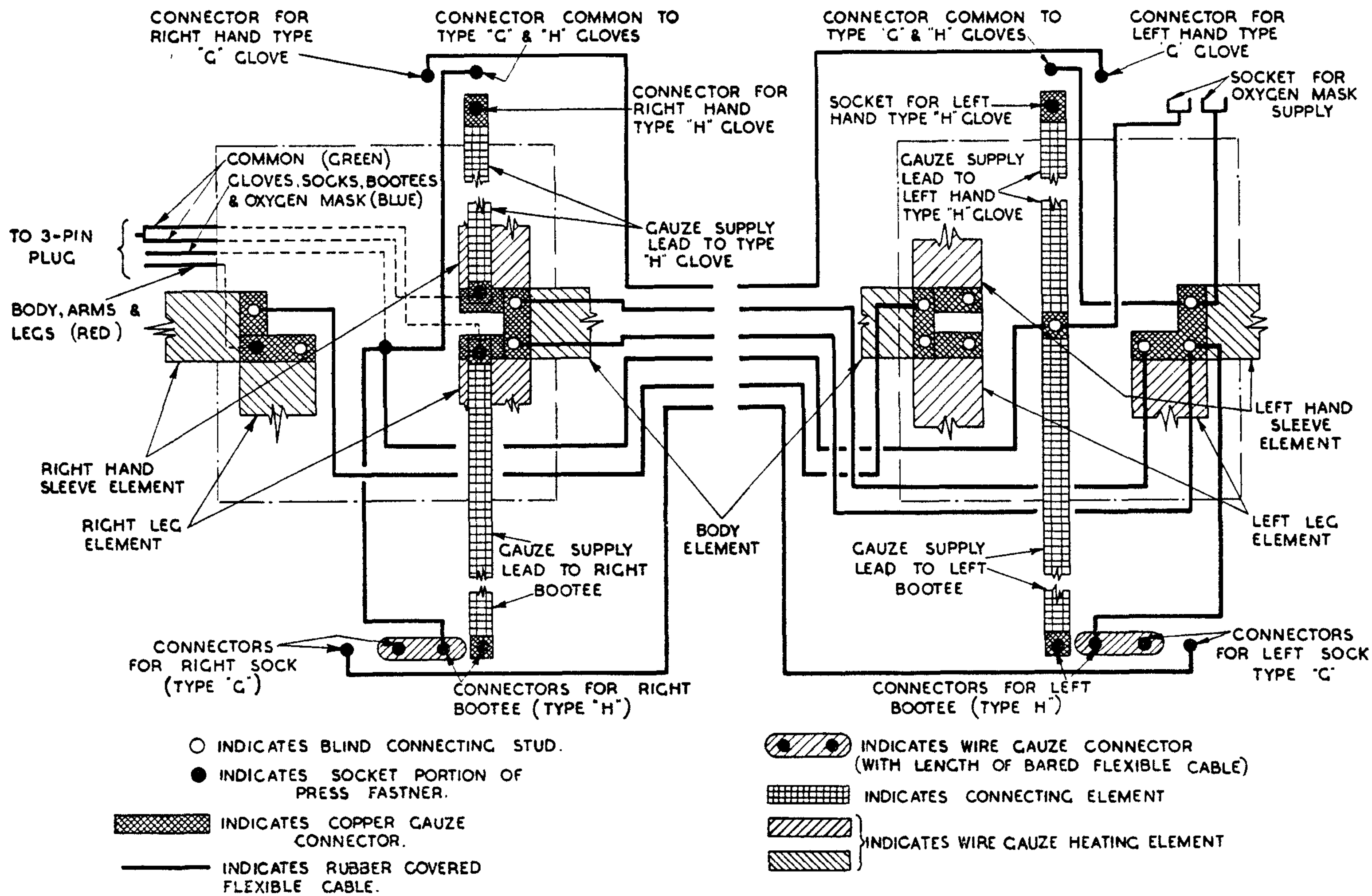

Fig. 1.—Wiring diagram of lining

Types available

3. The sizes, voltages, and stores reference numbers are given in table 1.

TABLE 1

Stores Ref.		*Garment*	*Size*	*Voltage*
22C/904		Suit lining	Small	24 volts
22C/903		Suit lining	Medium	24 volts
22C/902		Suit lining	Large	24 volts
5C/527		Four-pin cylindrical plug (adapted for use as three-pin connector)	One size only	24 volts
Left	*Right*			
22C/898	22C/901	Glove lining	Small	24 volts (2 in series)
22C/897	22C/900	Glove lining	Medium	24 volts (2 in series)
22C/896	22C/899	Glove lining	Large	24 volts (2 in series)
22C/767	22C/770	Gauntlet	9	12 and 24 volts
22C/768	22C/771	Gauntlet	9½	12 and 24 volts
22C/769	22C/772	Gauntlet	10	12 and 24 volts
22C/905	22C/908	Socks	Large	24 volts (2 in series)
22C/906	22C/909	Socks	Medium	24 volts (2 in series)
22C/907	22C/910	Socks	Small	24 volts (2 in series)

DESCRIPTION

Lining

4. From fig. 2 it will be seen that this is a collarless, single-breasted, front-opening garment with "Magya" type sleeves, fitting loosely at the wrists.

5. There are six elements heating the lining; two in the body and shoulders, two in the sleeves, and two in the legs. It is so arranged that the body, sleeve and leg elements for heating the right-hand side of the lining are connected to a distribution pad on the right-hand side of the garment and those for heating the left to a like pad on the left-hand side. From these pads, both of which are provided with insulating flaps to obviate short circuiting, is taken also the supply to the socks and gloves, the right-hand pad connecting the right-hand socks and gloves, and the left-hand pad connecting the left-hand. The supply is taken through press fasteners on the right-hand distribution pad, which is connected by flexible cable to the similar pad on the other side of the garment.

6. The elements which are stitched to the lining, are constructed of wire gauze and are connected to the press fasteners by means of nickel-plated brass eyelets passing through the ends of the elements, strengthened by strips of copper gauze which also serve to make good electrical connection.

7. The press fasteners, used to connect elements and wiring, are secured to double gabardine pads on either side of the lining, and the flexible wires for interconnection between the pads run round the waist of the garment through sleeves of flame-proofed poplin which are sewn to the inside of the lining. The ends of the flexible cables are enclosed in rubber tubing through which a length of bared conductor projects, the conductor, and about ⅛ inch of the tubing being clamped under the head of the eyelets. Flag terminals, clamped under the head of the eyelets, may also be employed. Press fasteners on the same pad are connected by short lengths of heating element enclosing bared connector flex or alternatively by flat braid copper connectors or lengths of flexible conductor and flag terminals.

8. Connection to socks and gloves is made by press fasteners anchored to double gabardine pads, attached to the bottom of the legs and sleeved cuffs respectively. The leads to the gloves and sock connectors are taken inside the lining from their respective connecting pads, those to the glove connectors are then taken to the shoulder, along the top of the sleeve and round the elbow, those to the sock connectors down the leg to the rear of the side opening.

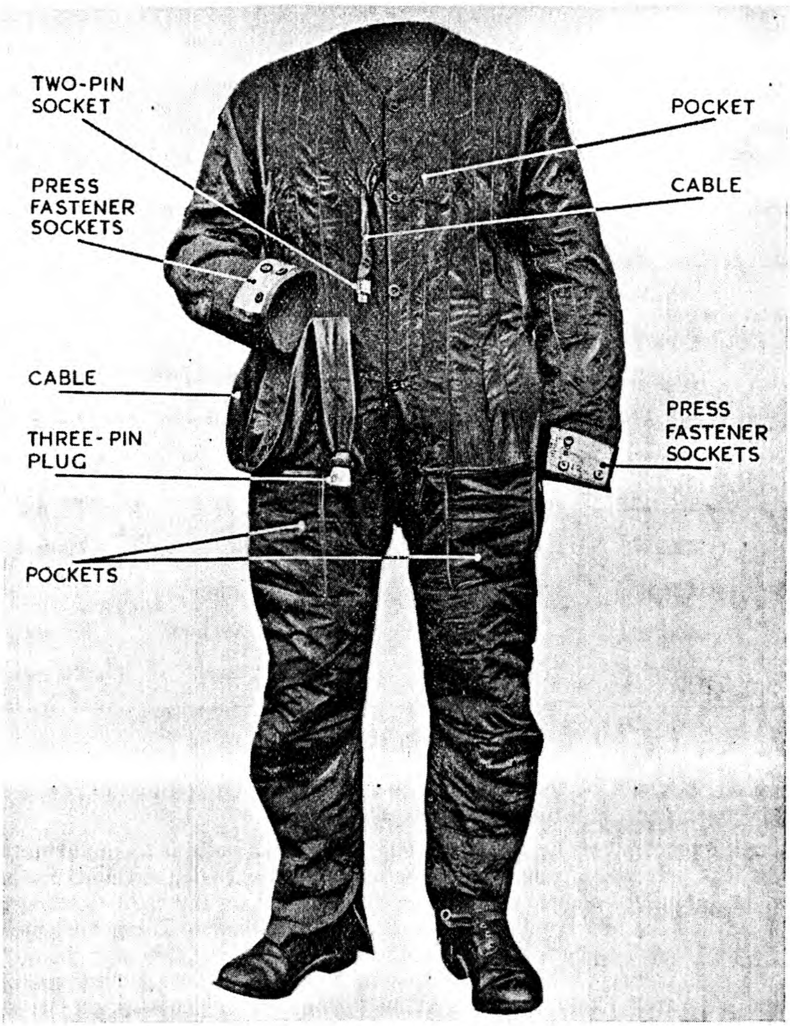

Fig. 2.—Lining, front view

Supply plug and leads

9. A flexible 4 lead rubber cable, two of the leads being common, one the lining supply and one the sock and glove supply, connects the distribution pad to the three-pin plug. The relation between the plug pins and circuits is as follows:—

Circuit	*Colour of spot adjacent to pin*
Common	Green
Body	Red
Hands and feet	Blue

The sheath enclosing the cables is secured to the pad and the three-pin socket in such a way that any tension on the plug is transmitted to the pad by the sheath and not by the cables.

Socks

10. Each sock has an outer cover of flame-proofed gabardine, to the inside of which are sewn the elements, and a stockinette fleece lining. The heating element is of wire gauze, is doubled along its entire length, fitted with copper gauze end pieces for reinforcement and connection purposes, and then enclosed in cotton fleece material, the edges of which overlap along the centre of the element. Nickel-plated brass eyelets pass through the ends of the element which, by this means, is riveted to press fasteners studs mounted on a double gabardine pad above the heel. Connection is made through these studs to press fastener sockets on the legs of the lining.

Gloves

11. The glove linings are of the gauntlet type. The element is stitched to the outside of a stockinette fleece lining, and its ends are riveted, by means of nickel-plated eyelets, to press fastener studs, anchored to a double gabardine pad on the inside of the lining. These studs are used to connect to similar sockets on the lining sleeves. The element is of the wire gauze type, is doubled along its whole length, and is enclosed in cotton fleece material, the edges overlapping along the centre of the element.

INSTALLATION

12. The suit lining should be fitted on first and adjusted to the comfort of the wearer. It is important that the lining should be the correct size and particularly that it is not too small. The socks should then be put on and connected to the lining by snapping the press fastener studs to the corresponding sockets on the bottom edge of the legs. The gloves may be pulled on next, care being taken to ensure that the fingers of the hand fit right into the tips. Connection should then be made to the sleeve cuffs of the lining by use of the press fasteners. After verifying that there is good electrical connections at all points, the three-pin plug may be connected to the aircraft supply, as required.

SERVICING

13. The clothing should be stowed in a warm dry place and where possible the lining should be kept on a coat-hangar. Inspection of the garments may be made at regular intervals, and, if any tear or damage to the fabric, fraying or loosening of the seams or loose ends of element wire are revealed, it is essential that the clothing be sent immediately to the appropriate depot for repair. It is particularly important that care be taken to ensure that all press fasteners are securely anchored to their pads, that they show no sign of corrosion, and that they make good electrical connection.

14. Tests of the garments and leads for electrical continuity and current consumption should always be carried out before use by means of the Universal Test Table, Mk. II. The limits of current consumption for the garments are shown in table 2. Instructions for the operation of the ammeter are given on the switchboard, and they must be strictly carried out in order to avoid damage to meters. The supply to the switchboard should be taken from the following accumulators connected in series, with a centre tapping to give 14 volts nominal.

(i) 2-Accumulators, Lead Acid, 20 ampere hours, 2 volts, Type B, Stores Ref. 5J/1387.

(ii) 2-Accumulators, Lead Acid, Type F, 25 ampere hours, 12 volts, Stores Ref. 5J/3042.

The accumulators are to be trickle charged by means of a Rectifier Unit, Type 20, Stores Ref. 5P/2456, and before using the board, the measuring instruments should be calibrated against sub-standard instruments or a calibrated "Avometer". This calibration should be repeated at two-monthly intervals. In order to save time when using the board, the values in table 2 should be corrected to match with the calibrated instrument readings. If necessary the pointer on the measuring instruments should be adjusted to zero. During every test, all garments should be flexed, when any faulty circuits will be indicated by incorrect consumption or sudden variations in ammeter readings.

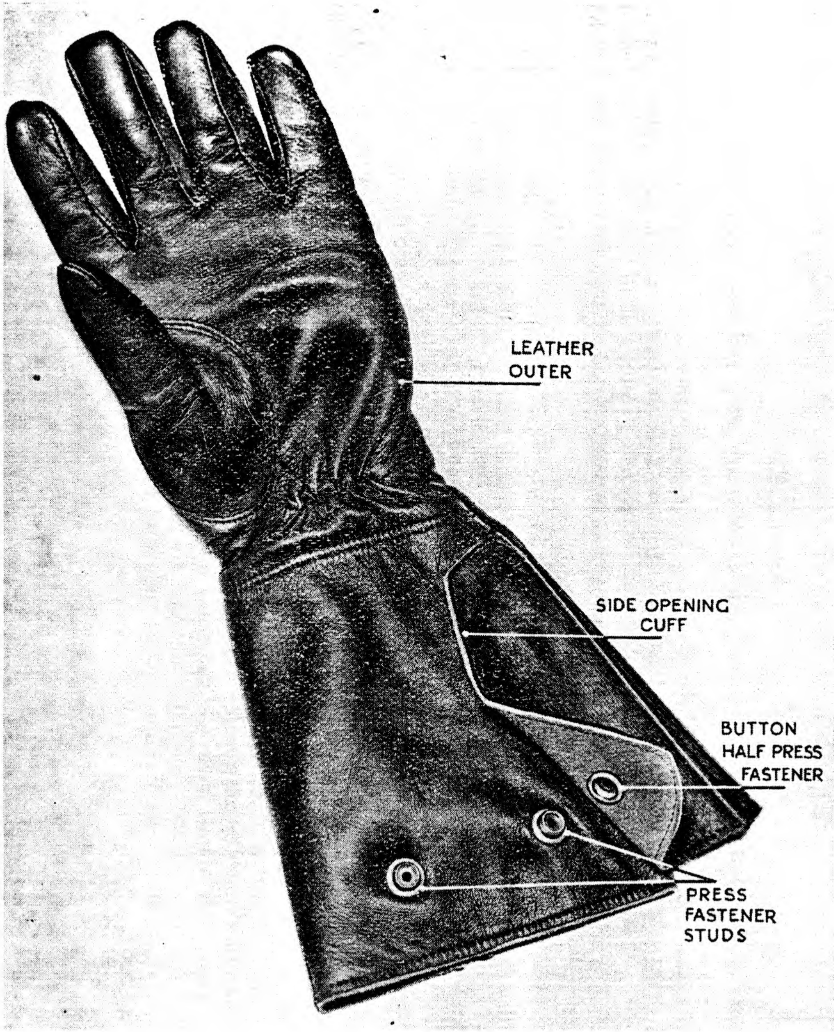

Fig. 3.—Glove

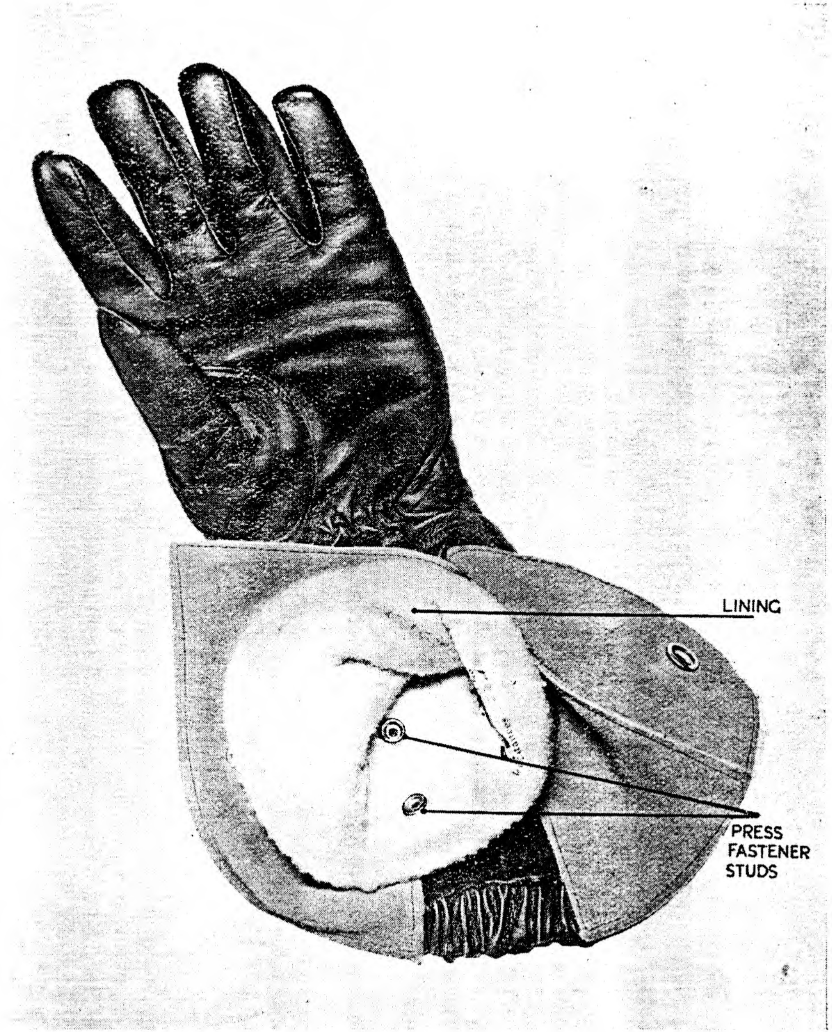

Fig. 4.—Glove lining

Testing data

15. When testing the garments particular attention should be paid to the warning given on the test table, which reads as follows:—

WARNING

Before pressing push-button check ammeter readings as follows:—

0–3 AMMETER

If reading exceeds 1·3 amps. on 12 volts, or 1·8 amps. on 24 volts, switch over to 15 amp. meter.

0–15 AMMETER

If reading exceeds 4·1 amps. on 12 volts or 6·5 amps.on 24 volts, switch off.

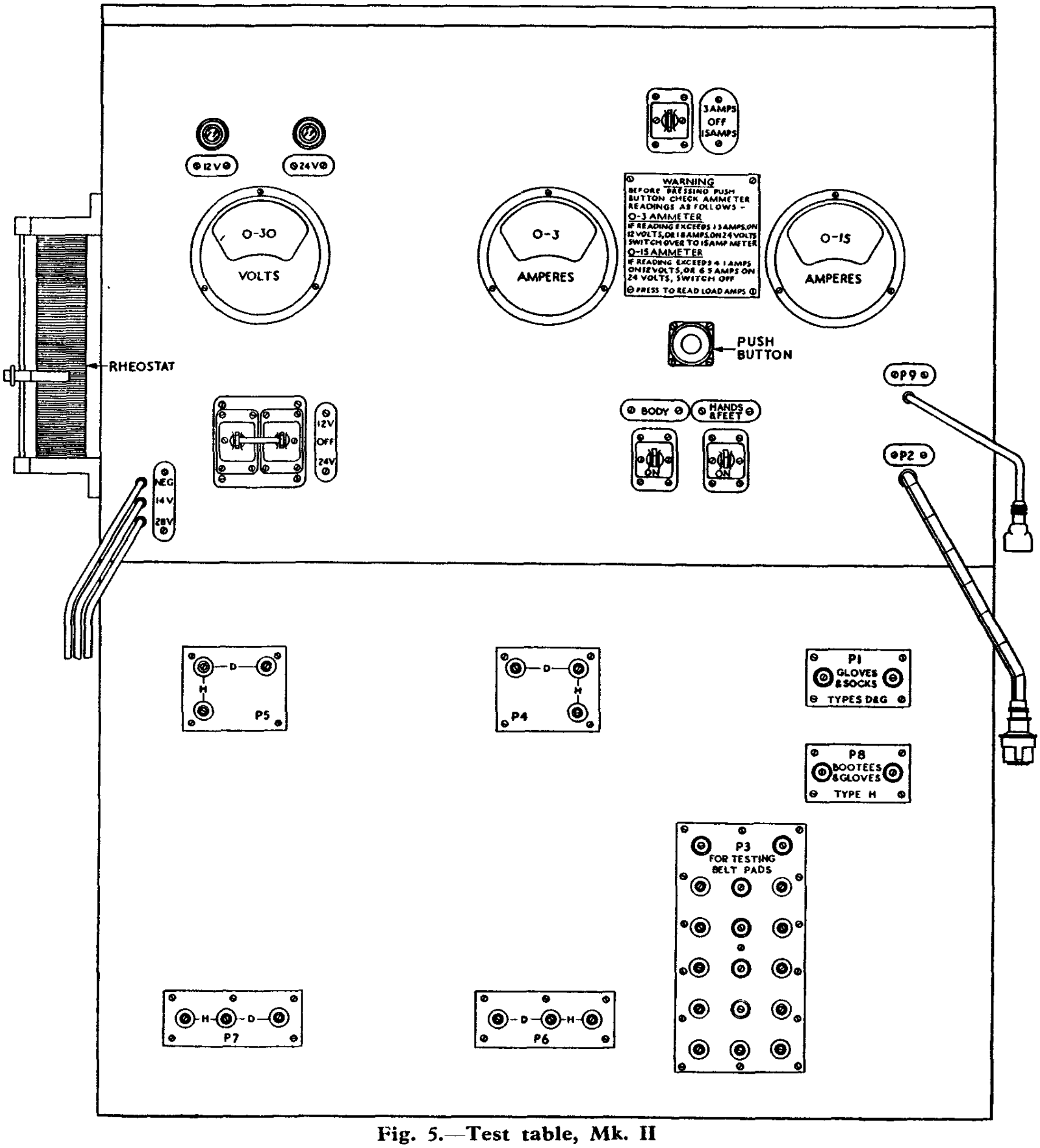

Fig. 5.—Test table, Mk. II

16. *Current consumption, body, sleeve and leg elements.*

(i) Connect plug on the lining to the socket P2 of the table.

(ii) Switch main switch into 24 volts position.

(iii) Switch ammeter switch into the 15 amps. position and the BODY switch into ON position.

(iv) Adjust volts with rheostat so that the voltmeter reads 24·0 volts.

(v) Read WARNING note on ammeter switch.

(vi) Press "push-button" switch to read correct amps. and re-adjust the voltage to 24·0. The current reading should then show the consumption of the body, sleeve, and leg elements.

17. *Continuity of circuit to glove and sock connectors.*

(i) Connect snap fastener sockets, on each wrist, and on both legs, into "D" portion of fastener connections on P4, P5, P6 and P7 respectively.

(ii) Switch main switch into 24 volts position.

(iii) Switch ammeter switch into 3 amps. position and the HANDS AND FEET switch into ON position.

(iv) Adjust volts by use of rheostat to 24·0.

(v) Read WARNING note on ammeter switch.

(vi) Press "push-button" switch to read correct amps. and re-adjust voltage to 24·0. The current should be as shown in table 2.

18. *Continuity of either circuit taken separately.*

Proceed as in para. 17 but either disconnect sleeves from P4 and P5, if continuity of sock connectors is to be checked, or disconnect legs from P6 and P7, if continuity of glove connectors is to be tested. The current should read as in table 2.

19. *Current consumption of glove element (12 volts)*

(i) Clip the snap fastener studs, on the wrist of the glove, to the fastener sockets of P1 of test table.

(ii) Switch main switch into 12-volt position.

(iii) Switch ammeter switch into 3 amps. position and adjust volts with rheostat to read 12·0.

(iv) Read WARNING note on ammeter switches.

(v) Press "push-button" switch to read the correct amps, and re-adjust volts to 12·0. The current should be as in table 2.

20. *Current consumption of sock element (12 volts).*

Proceed as in para. 19 except that (i) should read "Clip the snap fastener studs on the heel of the sock, to the snap fastener sockets at P1 of the test table".

TABLE 2

Stores Ref.	*Item*	*Test*	*Test Voltage*	*Specified current consumption*		
				Nominal	*Minimum*	*Maximum*
22C/902–904	Lining, Type "G", 24 volts, high wattage	Current consumption of body, sleeve and leg elements	24	6·7	6·0	7·7
		Continuity of circuit to glove and sock connectors	24	2·4	2·16	2·64
		Continuity of circuit to glove or sock connector	24	1·2	1·08	1·32
22C/896–901	Gloves, Type "G", high wattage	Consumption of glove element	12	1·65	1·49	1·89
22C/905–910	Socks, Type "G", high wattage	Consumption of sock element	12	1·65	1·49	1·89

P 9940 M /G4362 3/46 8500 C & P Gp. 1

CHAPTER 5

ELECTRICALLY-HEATED CLOTHING, Type H

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LIST OF ILLUSTRATIONS

Introduction

1. The garment, described in this chapter, is a one-piece lining made in three sizes, and is intended for wear under normal flying clothes. It is made of Union twill or, alternatively, brown flame-proof poplin, and is fitted with heating elements. Provision is made for the attachment of heated bootees and gloves, Type H, connected in parallel, by means of press fasteners of Dura dot design. The bootees are intended to be worn inside flying boots, and are made in four sizes, and the gloves, in three sizes, are worn without further covering. Heated socks and gloves, Types G and D (described in Chapters 3 and 4 of this section) may also be attached and these are connected in series parallel. It is extremely important that a pair of the same type should be used, i.e. a Type H glove may not be on one hand and a Type G on the other.

2. The clothing is intended for use on a 24-volt supply, distribution being achieved by pads sewn to the lining, and connecting the heating elements in parallel. The internal connections are so arranged that the body circuit and the hands and feet circuit can be separately controlled by switches in the supply circuit. All heating circuits are supplied through a three-pin cylindrical plug, attached to leads at the right hip and connected to the distribution pad. Provision is also made for an electrical supply to the oxygen mask heater.

Types available

3. The sizes, voltages and stores reference numbers of the garments and their accessories will be found in Table 1.

TABLE 1

Stores Ref.		*Garment*	*Size*	*Wattage (at 26 volts nominal)*
22C/1012		Suit lining	Small	196
22C/722		Suit lining	Medium	196
22C/1014		Suit lining	Large	196
5C/1582		Socket for oxygen mask supply	One size only	
5C/2202		Three-pin cylindrical plug	One size only	
Left	*Right*			
22C/1021	22C/1024	Gloves	Small	23·5
22C/1022	22C/1025	Gloves	Medium	23·5
22C/1023	22C/1026	Gloves	Large	23·5
22C/1015	22C/1018	Bootees	Small	18
22C/1016	22C/1019	Bootees	Medium	18
22C/1017	22C/1020	Bootees	Large	18
22C/1059	22C/1060	Bootees	Extra large	18

The wattages on the gloves and bootees shown in the above table apply only when these garments are used with a Type H lining, which incorporates a resistance in series with the glove and bootee connections.

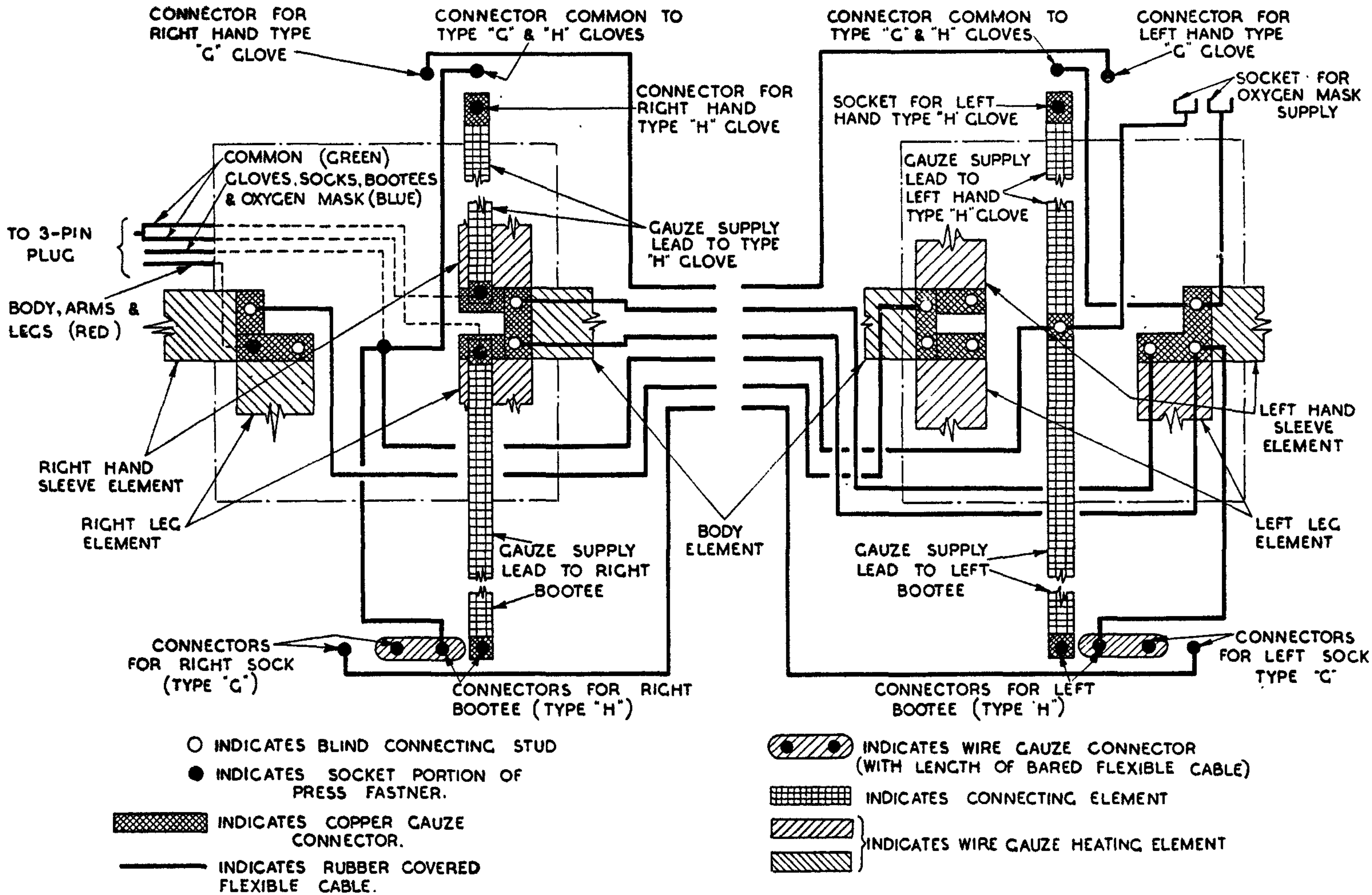

Fig. 1.—Wiring diagram, lining, showing inside view

DESCRIPTION

Lining

4. Referring to fig. 2, it will be seen that this is a single-breasted garment. It is made in Union twill, or alternatively, flame-proof poplin.

5. There are five elements heating the lining, two of them being distributed in the arms (one in each), breast and abdomen; one in the back; and one in each leg. They are so arranged that the arm and leg elements for heating the right-hand side of the garment are wired up to the

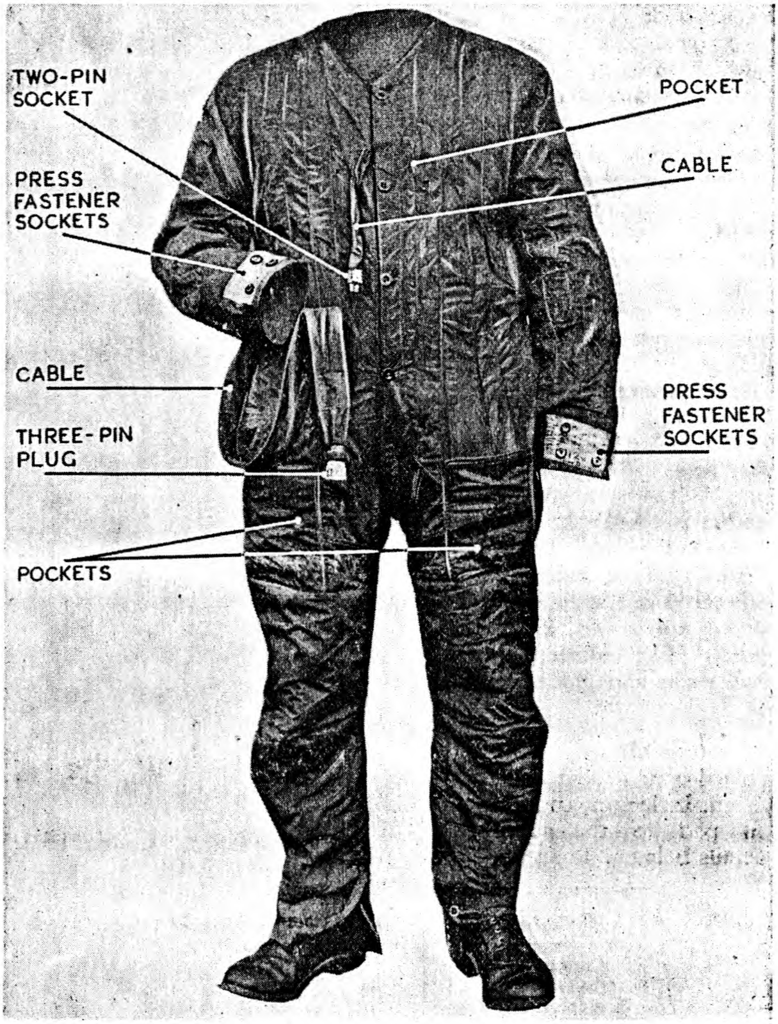

Fig. 2.—Lining, front view

connecting pads on the right, those for heating the left-hand side to the connecting pad on the left, and those for heating the back are connected between these two pads. The supply is taken through a distribution pad on the right hip by means of flexible rubber-covered leads, two of which are common, one the lining supply, and one the bootee and glove supply lead.

6. The elements are constructed of wire gauze and electrical connection is made to the press fasteners by nickel-plated brass eyelets passing through the ends of the elements. Strips of copper

gauze are used to reinforce the ends of the elements and to ensure good electrical connection. The elements are edged down both sides with edging tape to prevent fraying, and are enclosed in strips of flame-proof poplin which are folded round the element and sealed with edging tape. The elements are then stitched to the lining.

7. Press fasteners, used to connect the elements and wiring, are anchored to double gabardine pads on each side of the garment. The flexible cables used as inter-connections between the two pads are fed through channels of poplin round the waist of the garment. The bared ends of the cables, having been looped and twisted back over the insulation are covered by sleeves of rubber tubing through which the looped bared conductor projects, the conductor and about $\frac{1}{8}$ inch of the rubber tubing being clamped under the head of the eyelet. Press fasteners for connection to bootees are attached to the bottom edge of the legs, and those for connection to gloves are found on the sleeve cuffs of the lining, the pair perpendicular to the cuff edge being for use with Type H gloves, and the pair parallel to the edge for use with Type G. The leads to the bootee and glove connectors are taken from the connecting pads through channels of poplin inside the lining. The glove connector leads are then conveyed to the shoulder, the top of the sleeve and round the elbow, while the bootee connector leads are taken down the underside of the legs. A resistance in series is incorporated in the connections to Type H bootees and gloves, which are wired in parallel. The connections for Type D and G socks and gloves are in series parallel.

Fig. 3.—Lining, back view

Supply plug and leads

8. A flexible 4-core rubber cable, approximately 32 in. in length, connects the distribution pad to the supply socket, circuit details being as follows:—

Circuit	*Colour of spot adjacent to pin*
Common ...	Green
Body	Red
Hands and feet	Blue

The sheath enclosing the cables is secured to the pad and the socket in such a way that any strain on the plug is borne by the sheath and not by the cables.

9. The two supply leads for the oxygen mask heater are wired so that they are fed by the green and blue pins of the supply plug. The two leads which emerge from a pocket in the front opening of the lining are connected to a two-pin socket. The sheath covering the leads is anchored to the lining in such a way that all strain is taken in the sheath and not in the cable. The plug and leads should be stowed in the pocket when not in use.

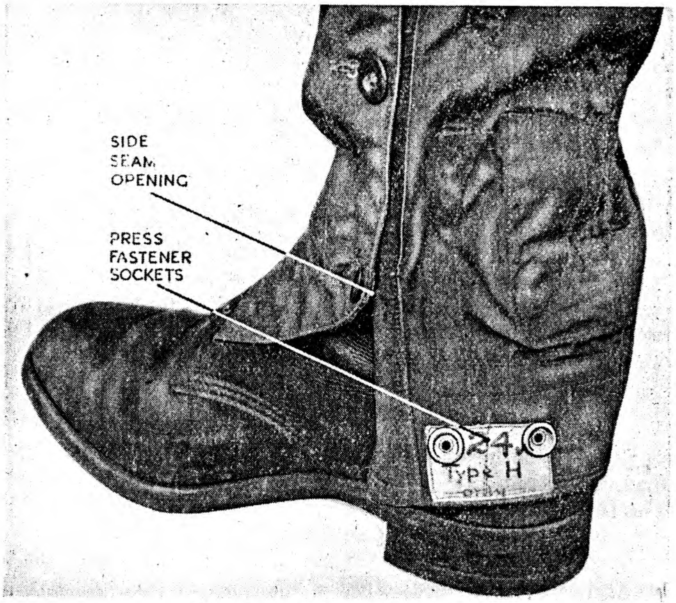

Fig. 4.—Lining, lower leg

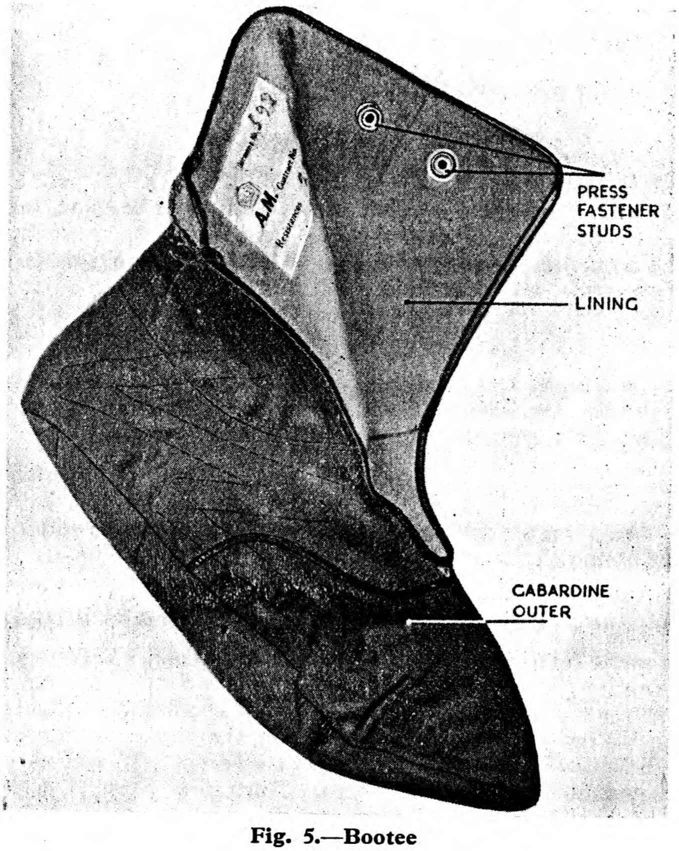

Fig. 5.—Bootee

Bootees, fig. 5

10. Each bootee has an outer of gabardine, to which the heating element is attached, and a lining of stockinette fleece, and can be used under an "escape boot" as it is put together in such a way that the leg part can be speedily detached from the shoe part with the aid of a penknife. The heating element is of wire gauze, the ends being wrapped in copper gauze, and the whole encased in poplin or Union twill material, which is folded round the element. The ends of the element are riveted to press-fastener studs fitted to the inside leg lining and used for connection to corresponding sockets on the suit lining.

Gloves, fig. 6 and 7

11. Each glove consists of a leather outer, a side-opening cuff, and a heated lining of stockinette fleece, to the outside of which the heating elements are secured. The lining is attached to the outer at the wrist. The element is of the wire gauze type, the ends are encased in copper gauze, and the whole element is enclosed in poplin or twill material which is folded round the element. The ends of the elements are affixed to press-fastener studs on the inside of the inner glove, these studs are used for connection to corresponding sockets on the heated lining.

INSTALLATION

12. The lining should be fitted on first and adjusted to the comfort of the wearer, care being taken to ensure that the correct size is obtained. It is particularly important to avoid wearing a size too small. The bootees or socks should then be pulled on, and connection made by snapping the press-fastener studs at the bottom edge of the lining to the matching fitment on the bootee or sock. The gloves should be slipped on and connected by press fasteners to the sleeve of the lining. After ensuring that good electrical connection is made at all points, the three-pin plug may then be connected to the aircraft supply as required. Normally, in cold weather the lining should be worn with Type H bootees and gloves or, if these are not available, Type G socks and gloves, but if less heat is required, Type D socks and gloves may be worn. It is absolutely essential that these garments should be used in pairs, viz. a Type H glove may not be used on one hand and a Type G on the other, but it is not necessary to wear the same type of pair of gloves, and socks, i.e. a pair of Type H gloves may be worn with a pair of Type D socks.

SERVICING

13. The clothing should be stored in a warm dry place, and where practicable, the lining should be kept on a coat-hanger. At regular intervals, inspection should be made, and if any rent or damage to the fabric, fraying or loosening of the seams be noticed, the garments must be forwarded immediately to the appropriate depot for repair. Great care should be taken to ensure that the press fasteners are securely affixed to their pads, that they are not corroded, and that they make good electrical connection. The garments should also be examined for loose ends of element wire.

14. Tests for continuity and consumption should always be carried out before the clothing is worn. The Universal Test Table, Mk. II, should be used for these tests, and the limits of current consumption of the garments are given in table 2.

15. To avoid damage to ammeters, instructions regarding the operation of the ammeter given on the switchboard of the Test Table must be rigidly adhered to. The supply to the switchboard should be taken from the following accumulators connected in series with a centre tapping to give 14·0 volts nominal.

(i) 2 accumulators, lead acid, 20 ampere hours, 2 volts, Type B (Stores Ref. No. 5J/1387).

(ii) 2 accumulators, lead acid, 25 ampere hours, 12 volts, Type F (Stores Ref. No. 5J/3042).

The accumulators are to be trickle-charged by means of a Rectifier Unit, Type 20 (Stores Ref. No. 5P/2456). Before using the board, the measuring instruments should be calibrated against substandard instruments, or a calibrated "Ammeter". This calibration should be repeated at two-monthly intervals. In order to save time when using the board, the values in table 2 should be corrected to match with the calibrated instrument readings. If necessary, the pointer on the measuring instruments should be adjusted to zero. During every test, all garments should be flexed, when any faulty circuits will be indicated by incorrect consumption or sudden variations in ammeter readings.

Tests

Current consumption of body, arms and legs, heating element

16. (i) Connect the plug of the lining to socket P2 on board.
(ii) Switch main switch into 24-volt position.
(iii) Switch ammeter switch into 15-amps. position and the "Body Switch" into ON position.
(iv) Adjust volts with rheostat to 24·0.
(v) Read "warning note" on ammeter switch.
(vi) Press "push-button" switch to read correct amps. and re-adjust voltage to 24·0. The ammeter should then read the current consumption of the body, arms and legs heating elements. This current should be as in table 2.

Continuity of circuits of Type D and G glove, and sock connections

17. (i) Connect the plug of the lining to socket P2 on the board.
(ii) Connect the snap-fastener sockets marked "Type D or G 12 volts", on the wrists, to the D portions of P4 and P5, and the sockets marked "Type D or G 12 volts", on the legs, to the D portions of P6 and P7.
(iii) Switch main switch into 24-volt position.
(iv) Switch ammeter switch into 3 amps. position and the "Hands and Feet" switch into ON position.
(v) Adjust volts with rheostat to 24.
(vi) Read "warning" note on ammeter switch.
(vii) Press "push-button" switch to read correct amps. and re-adjust volts to 24·0, when the current should read as in table 2.

Continuity of either circuit separately

18. Proceed as in para. 17, but disconnect sleeves from either P4 and P5 if continuity of sock connectors is to be checked, or disconnect legs from P6 and P7 if continuity of glove connectors is to be tested. The current should be as shown in table 2.

Continuity of circuits to Type H glove and bootee connections

19. Proceed as in para. 17, except—
(ii) Connect the snap fastener sockets marked "Type H 24 volts", on the wrist, to the H portions of P4 and P5, and the sockets on the legs, marked "Type H 24 volts", to the "H" portion of P6 and P7.
(iv) Switch ammeter switch into 15 amps. position.

Continuity of individual circuits and resistance of connector elements to Type H gloves and bootees

20. (i) Construct a connector consisting of two snap-fastener studs attached to a pad of gabardine and connected by a 4 in. length of cable capable of carrying 4 amps. (e.g. Unisheath small 4 or 3/·029 V.I.R. cable).
(ii) Take each arm or each leg separately and short-circuit the press fasteners marked "Type H 24 volts" with the fasteners of "(i)" above, the snap-fastener sockets marked "H" on the arm or leg being tested.
(iii) Connect plug lining to P2 on the board.
(iv) Switch main switch into 12-volt position.
(v) Put rheostat arm in its "all-in" position (i.e. operating handle "down").
(vi) Switch ammeter switch into 3 amps. position and "Hands and Feet" switch into ON position.
(vii) Adjust volts with rheostat to 6·0.

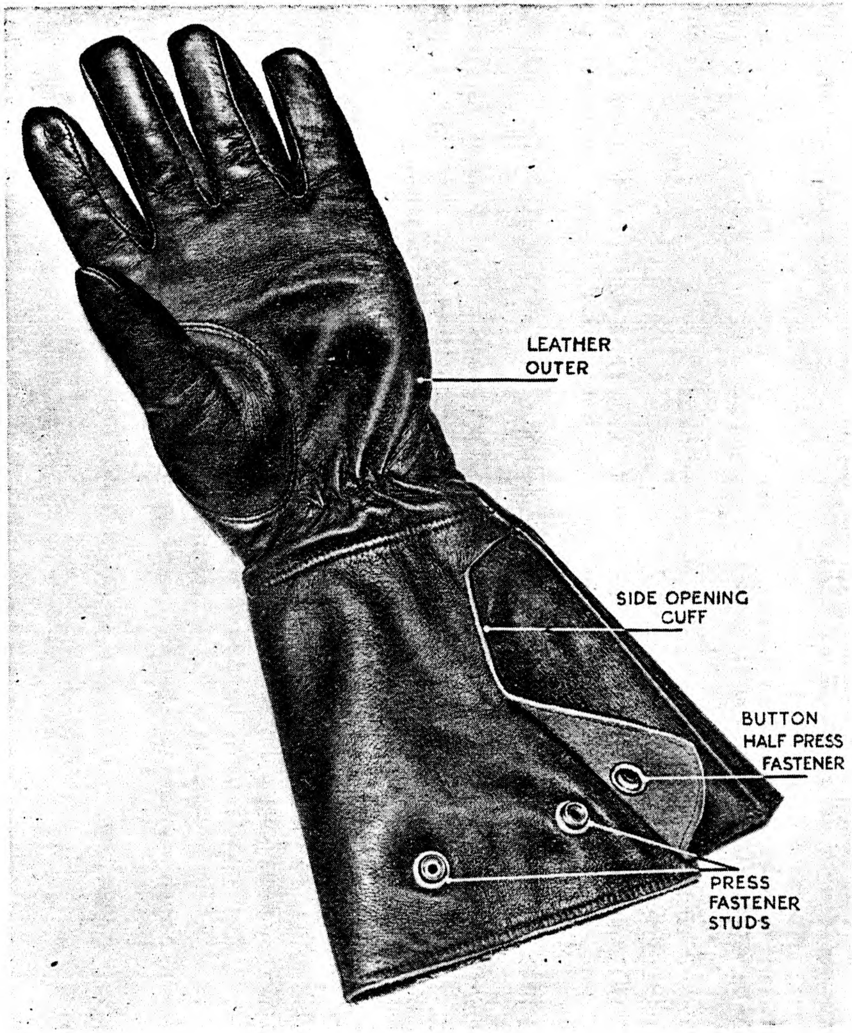

Fig. 6.—Glove

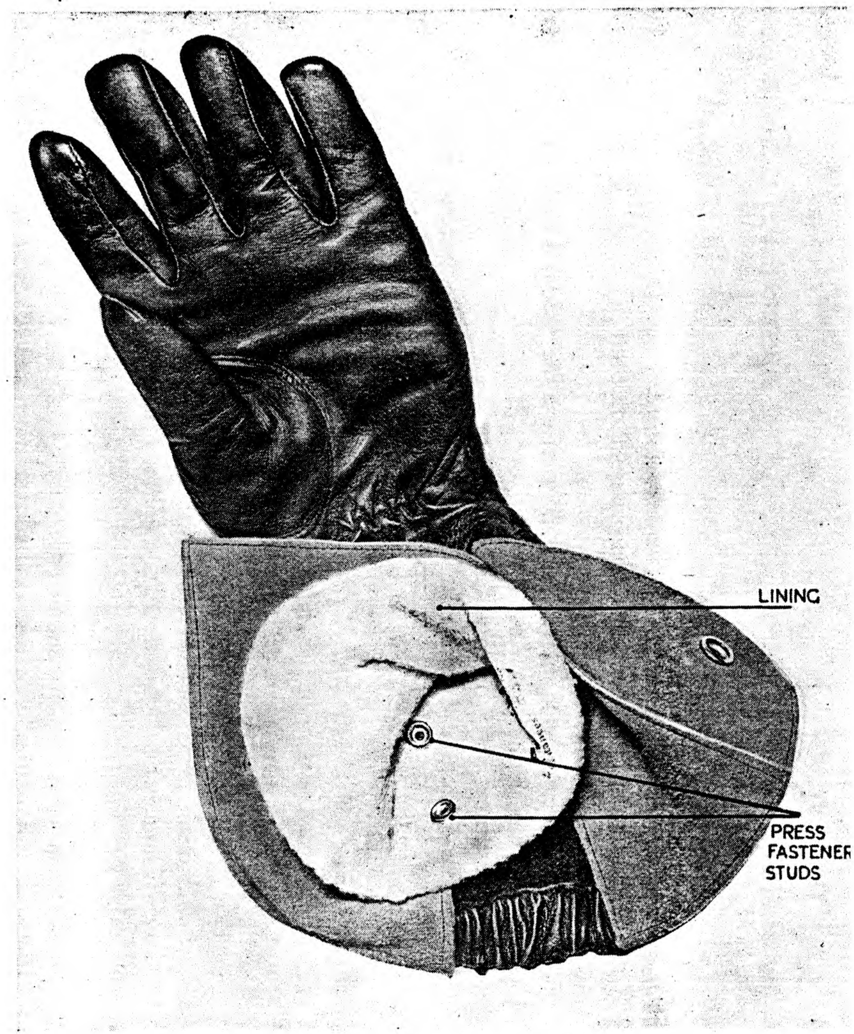

Fig. 7.—Glove, view of lining

(viii) Read "warning" note on ammeter switch (as this test is on 6 volts the current should not exceed half that given for tests on 12 volts, e.g. 0·65 amps. on 0–3 meter or 2·05 on 0–15 meter).

(ix) Press "push-button" switch to read correct amps. and re-adjust voltage to 6·0. This current should be as in attached schedule.

Continuity of circuits to oxygen mask heater

21. Before connecting the oxygen mask supply plug, all other circuits except main supply *must* be disconnected.

(i) Connect plug of lining to P2 on the board.

(ii) Switch main switch to 24 volts position.

(iii) Connect oxygen mask heater plug to P9.

(iv) Switch ammeter switch into 3 amps. position and "Hands and Feet" switch into ON position.

(v) Adjust volts on the rheostat to 24·0.

(vi) Read warning note on ammeter switch.

(vii) Press "Push-button" switch to read correct amps. and re-adjust voltage to 24·0. This current should be as in table 2.

TABLE 2

Stores Ref.	*Item*	*Test*	*Test Voltage*	*Current consumption*		
				Nominal	*Minimum*	*Maximum*
22C/1012—1014	Lining, Type H	Current consumption of body, arms and legs	24	7·0	6·4	7·65
		Continuity of circuit to Type G and D glove and sock connectors	24	2·4	2·16	2·64
		Continuity of circuit to Type G and D glove or sock connectors	24	1·2	1·08	1·32
		Continuity of circuits to gloves and bootees Type H	24	4·05	3·64	4·45
		Resistance of connector elements to Type H gloves	6		1·56	2·0
		Resistance of connector elements to Type H bootees	6		1·36	1·74
		Continuity of circuit to oxygen mask heater	24	2·4	2·16	2·64
22C/1015—1020	Bootees, Type H	Current consumption of bootee elements	24		0·74	0·94
22C/1021—1026	Gloves, Type H	Current consumption of glove elements	24		1·03	1·31

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CHAPTER 6

BAGS, CASUALTY, ELECTRICALLY-HEATED

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This equipment is designed to provide a suitable surrounding temperature for a casualty during airborne transportation. The casualty is totally enclosed by a heat insulated bag with the exception of the face which is exposed, and the temperatute of the interior of the bag is maintained at a suitable level by means of an electrically heated lining which is supplied with current from the aircraft supply. Carrying handles are provided and provision made for attachment to a stretcher.

Leading particulars

2. One type of outer bag is available. An electrically heated lining suitable for either 12- or 24-volt aircraft supplies is attached to the interior by means of press fasteners. The stores reference numbers of the bag and linings are as follows.

Bags, casualty, outer, heat insulating (suitable for either 12- or 24-volt linings) ...	Stores Ref. 5C/3679
Bags, casualty, electrically heated, lining, 12 volts ...	Stores Ref. 5C/3680
Bags, casualty, electrically heated, lining, 24 volts ...	Stores Ref. 5C/3681

3. *Electrical rating of linings*

Bags, casualty, E.H., lining		*12 volts*	*24 volts*
No. of elements ...		10	5
Nominal resistance of each element ...		7·82 ohms	15·64 ohms
Nominal resistance of network ...		0·782 ohm	3·13 ohms
Current consumption of lining.	Nominal ...	15·3 amps. (see para. 4)	7·65 amps.
	Limits ...	14·2 to 16·5 amps.	7·1 to 8·3 amps.
Wattage dissipation of lining.	Nominal ...	184 watts	184 watts
Note.—11 to 13 watts are dissipated in the hood and the remainder evenly over the rest of the lining.			

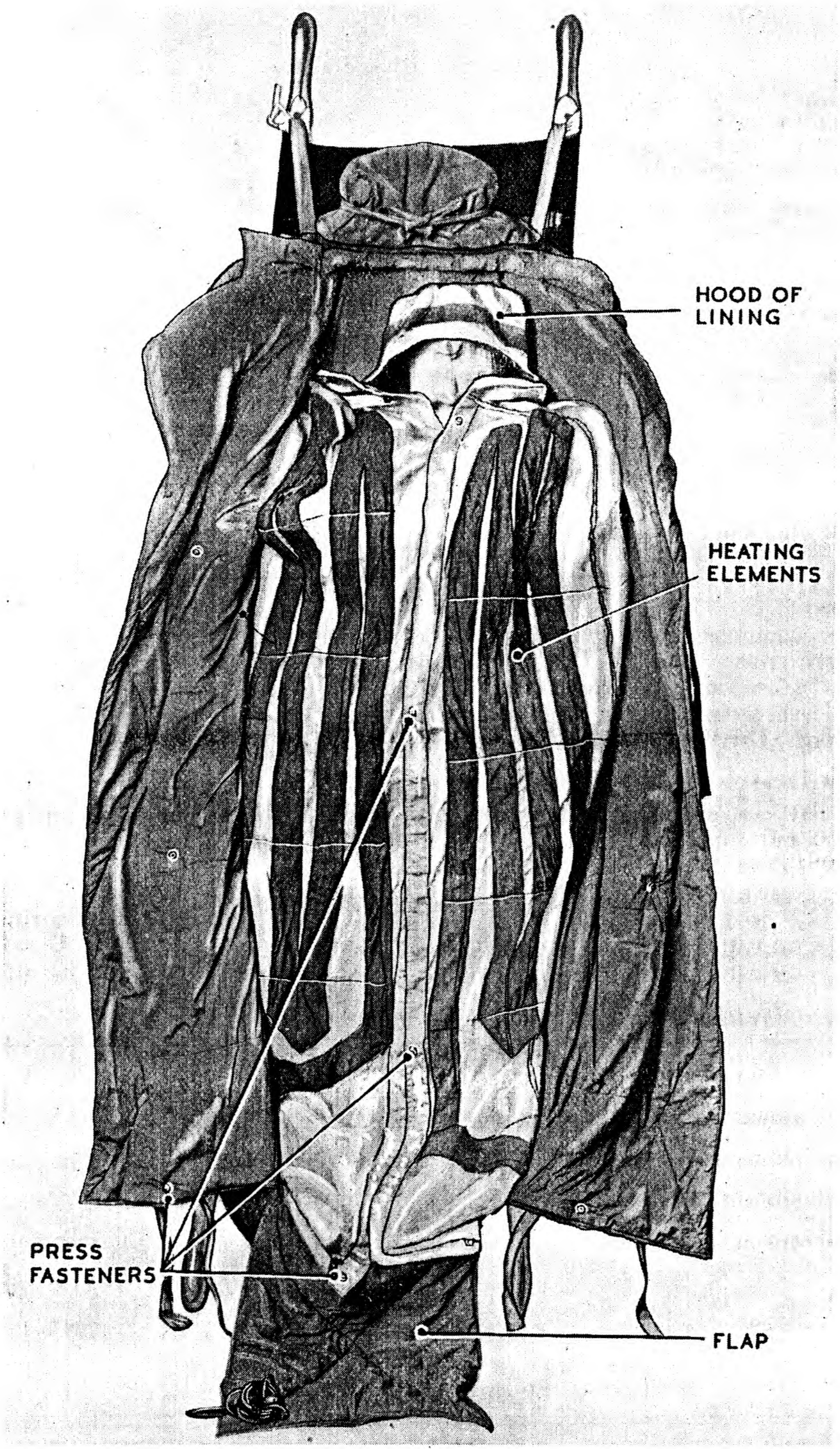

Fig. 1.—Heated casualty bag shown open

Special rating under test

12-volt lining only

4. When this lining is tested for current consumption using the Universal test board Mk. II, 10 volts only must be applied to the circuit in order that the resultant current may be within the range of the ammeter. Current consumption of 12-volt lining at 10 volts. Limits—11·8 to 13·75 amps. The 24-volt lining is tested at 24 volts. It should be noted that the above test board is at present available at Maintenance Units only.

DESCRIPTION

Bags, casualty, outer, heat insulating

5. The bag, illustrated in fig. 1, is made of brown flameproof Poplin or similar material interlined with flameproof quilted Kapok to provide heat insulation. It encloses the whole body of the casualty with the exception of the face and is provided with an opening along the top side from the neck to the foot to allow of the insertion of the casualty in the bag. The sides of this opening are equipped with two sets of four Poplin fastening tapes, an additional pair of tapes being attached to the hood which is provided for the head of the casualty.

6. The underside of the bag is reinforced with heavyweight flameproofed gabardine, or like material, and has an additional layer of Kapok interposed. The handles, loops, carrying straps and press fastener stays are of the same reinforcing material.

7. A square flap is provided at the foot of the bag, affixed so as to lie centrally inside the front opening when the bag is closed. Also at the foot of the bag is a three-inch slot for the purpose of bringing out the supply lead from a 24-volt type wired lining. When a 12-volt type lining is used the lead is brought out between the opening flaps.

8. Socket portions of press fasteners are provided to allow of the attachment of the electrically heated linings. Press fasteners are also provided to fasten up the complete assembly when it is rolled up from the foot to the head end. A pair of sockets are located on the upper side of each shoulder loop and a corresponding pair of studs are on the underside at the base of each handle midway along the base of the bag.

Bags, casualty, lining, electrically heated

9. These are available to suit either 12-volt or 24-volt supply systems, the two types being similar except for the heating elements and positioning of elements and connecting cables. The linings are marked with the appropriate voltage rating. The 12-volt lining in addition carries a yellow label marked with the voltage and attached to the supply lead. The casualty bag, complete with a 24-volt lining, is illustrated in fig. 2.

General

10. The linings are constructed of waterproofed Poplin, Gabardine, or similar material, the heating elements being covered with brown flameproofed Poplin and the connecting pads and interlining of the edges being of flameproofed heavy Gabardine. The connecting pad covering and press fastener reinforcing stays are of the heavier material. The element coverings are sealed with adhesive tape.

Electrical data

11. The heating elements are of wire gauze with 43 S.W.G. stainless steel as warp, and Constantan of the same gauge as weft. The ends of these are covered with copper gauze and connected to eyelets, the connections between elements being either of copper tape, Uniflex rubber 4, or additional lengths of element. The elements are so placed that they supply an even distribution of heat over the whole of the lining except for the hood, where the heat is applied to the sides of the head only.

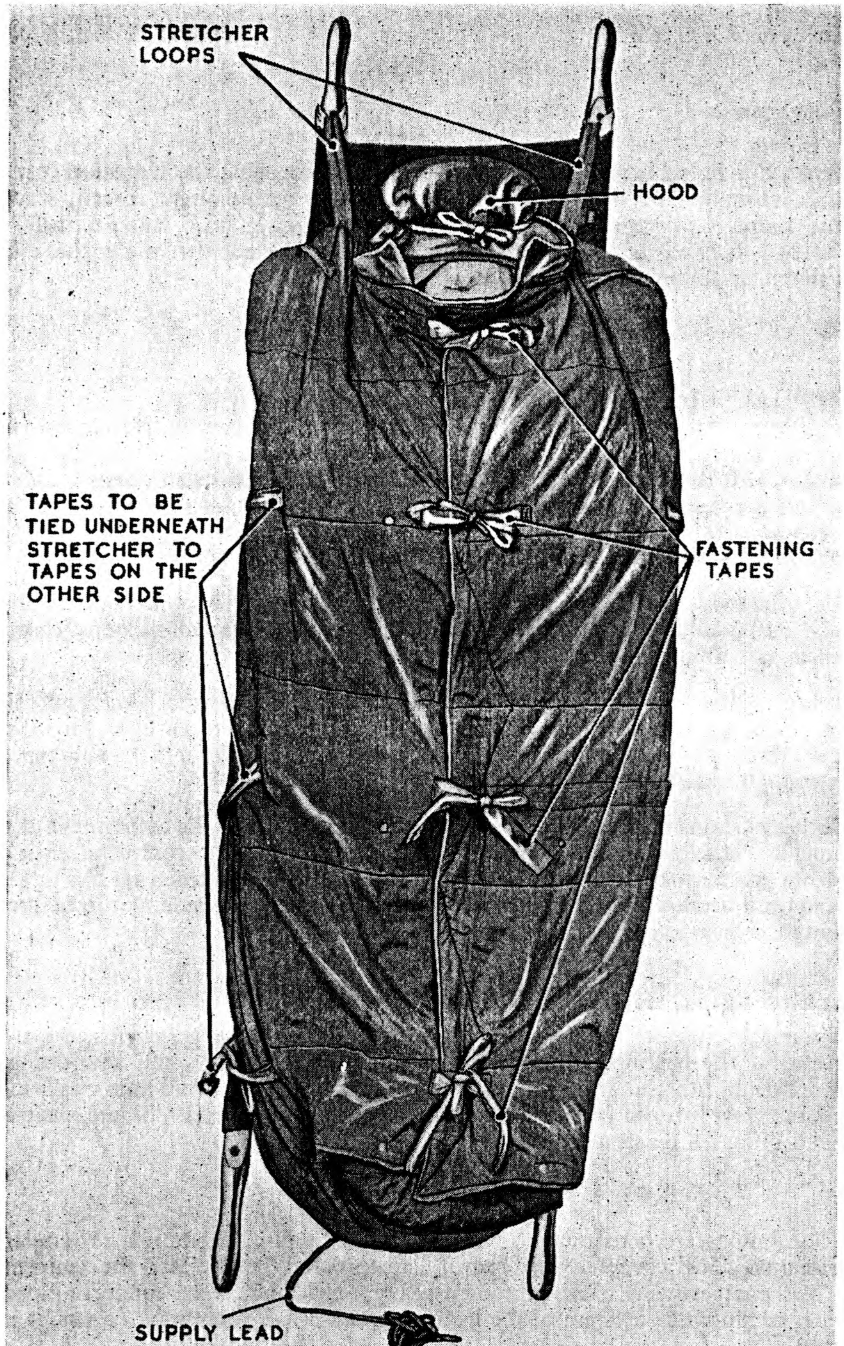

Fig. 2.—Heated casualty bag shown closed

12-volt system

12. Ten elements are used, each of a nominal length of eleven feet, wired in parallel and so disposed that five elements heat the upper half of the body and five the lower half.

13. The main supply leads are taken from a connecting pad on the outside of the right side flap (looking from above) and consist of four leads of Uniflex rubber 4, two leads for the positive and two for the negative. One pair of leads are connected to each pin of a 2-pin plug. These cables are anchored to the lining to prevent a direct pull on the electrical connections.

24-volt system

14. Five elements are used in 22 ft. lengths, connected in parallel. All these elements pass along approximately the whole length of the lining. The single supply lead, taken from a connecting pad at the foot of the lining, is of Dusheathsmall 4 connected to a 2-pin plug.

OPERATION

15. The bag, containing the lining affixed by the press fasteners, is unfolded and the casualty inserted, the head of the casualty being placed in the hood provided. The lower flap is then brought squarely over the feet and the opening and hood secured by the tapes provided. The electrical supply may then be connected and switched on as required. *Care must be taken that a lining is used that has the same voltage rating as the aircraft supply.* Before it is used the lining must be tested for electrical serviceability as described under "Care and Servicing." After use, for the purpose of storage, the bag with lining complete may be rolled up from the foot and fastened with the press-fasteners provided.

CARE AND SERVICING

16. The complete assembly, when not in use, should, if necessary, be dried, be rolled up, and stored in a warm, dry place. Inspection of the bag, lining and supply leads must be carried out at regular intervals. If any rent or damage to the material, or loosening of the seams or press fasteners is evident, the bag must be forwarded immediately to the appropriate Maintenance Unit. Careful examination must also be made to ensure that there are no loose ends of element wire protruding through the material.

17. It is important that, before the assembly is put into use, tests for electrical serviceability are made. All connections should be examined and tests for electrical continuity and consumption effected. The necessary data are given under the "Leading particulars" in this chapter.

18. For the purpose of testing, the Universal test board, Mk. II, described in Chapter 4 of this Section may be used after suitable modification.

Modification of the test board to take E.H. lining

19. Socket Type G (Stores Ref. 5C/599) and Socket Type F (Stores Ref. 5C/597) are to be fitted to the test board, and each wired in parallel with the red and green pins of the 3-pin cylindrical socket on the board, using wire of a suitable current carrying capacity. The wiring should be taken to the terminal block feeding the 3-pin socket. The socket Type G is to take the 12-volt lining and the Socket Type F the 24-volt lining. It is advisable that the board be marked accordingly. The circuit will be made to these sockets when the switch marked BODY is closed.

20. Before using the test board the ammeter and voltmeter should be checked against sub-standard instruments and, if necessary, zero-adjusted. The instructions given on the switchboard

regarding the operation of the ammeter are to be observed in order to avoid damage to the meter. These instructions read as follows:—

WARNING

Before pressing push button check ammeter readings as follows:—

0–3 AMMETER—

If reading exceeds 1·3 amps. on 12 volts, or 1·8 amps. on 24 volts, switch over to 15 amp. meter.

0–15 AMMETER—

If reading exceeds 4·1 amps. on 12 volts or 6·5 amps. on 24 volts, Switch off.

Testing, 12-volt lining

21 (i) Connect the plug on the supply lead to the Type G socket of the test board.

(ii) Switch the main switch to the 12 VOLT position.

(iii) Switch the ammeter switch to the 15 AMPS. position and the BODY switch to the ON position.

(iv) Adjust the rheostat until the voltmeter reads ***10 volts.*** Note the ammeter reading, if the reading exceeds ***3·60 amps*** the lining is faulty. ***Switch off if faulty.***

(v) Press the push-button switch. Re-adjust the rheostat until the voltmeter reads ***10 volts.*** with the push-button pressed. The current consumption of the lining is now indicated by the ammeter, which should remain at a steady value. If the consumption is outside these limits the lining is faulty.

(vi) Keeping the push-button switch pressed, the lining should be moved, shaken, and bent to a reasonable amount about the elements, connecting leads and supply leads. Any fluctuation in the reading of the ammeter indicates an intermittent fault in the lining.

(vii) While the previous test is being undertaken the lining should be felt with the hand. Any tendency to local overheating also indicates a fault.

In case of failure to pass the tests in (iv), (v), (vi) and (vii), the lining is unfit for use and must be returned to the appropriate Maintenance Depot for repair or replacement.

Testing, 24-volt lining

22. (i) Connect the plug on the supply lead to the Type F socket of the test board.

(ii) Switch the main switch to the 24 VOLT position.

(iii) Switch the ammeter-switch to the 15 AMPS. position and the BODY switch to the ON position.

(iv) Adjust the rheostat until the voltmeter reads 24 volts.

(v) Read the warning note above the ammeter switch.

(vi) Press the push-button switch. Re-adjust the rheostat until the voltmeter reads 24 volts with the push-button pressed. The current consumption of the lining is now indicated by the ammeter, which should remain at a steady value. This should be between 7·1 and 8·3 amps. If the consumption is outside these limits the lining is faulty.

(vii) Keeping the push-button switch pressed, the lining should be moved, shaken, and bent to a reasonable amount about the elements, connecting leads and supply leads. Any fluctuations in the reading of the ammeter indicates an intermittent fault in the lining.

(viii) While the previous test is being undertaken the lining should be felt with the hand. Any tendency to local overheating also indicates a fault.

In case of failure to pass the test in (vi), (vii) and (viii), the lining is unfit for use and must be returned to the appropriate Maintenance Depot for repair or replacement.

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SECTION 5

SUPPRESSORS

LIST OF CHAPTERS

Note:—A List of Contents appears at the beginning of each Chapter

CHAPTER 1

Suppression of Electrical Interference

LIST OF CONTENTS

Introduction

1. Many of the various items of equipment used in aircraft electrical installations are liable to interfere with the operation of radio equipment and it is necessary to provide means for suppressing this interference.

2. The causes of interference due to the electrical installation, may be classified as follows:—

(i) High tension discharge, e.g., engine ignition systems.

(ii) Sparking at brushes, e.g., generators, motors, etc.

(iii) Sparking at contacts, e.g., relays, switches, etc.

(iv) Intermittent or rubbing contacts, e.g., loose connections.

(v) High frequency alternating current, e.g., electronic equipment.

3. The disturbance set up by these causes is due to the emission of electro-magnetic waves containing a wide range of frequencies and gives rise to high frequency alternating currents which may flow in all the circuits connected to the system and cause energy to be radiated in the form of electro-magnetic waves. The energy of these waves is distributed continuously, though not uniformly, over a wide range of radio frequencies. In consequence, a radio receiver can be affected by them whether or not the receiver power supply is derived from the same source of supply as the interfering apparatus.

4. Interference can be radiated from apparatus which is inadequately screened, or it can be conducted along and radiated from unscreened wiring connected to the apparatus, unless a suppressor is interposed between the interfering source and the unscreened wiring (see para. 13). This interference can be picked up by a receiver aerial or by inadequately screened parts of the receiver, by conduction along the power supply leads to the receiver, or by a combination of these effects.

5. There are two methods which may be adopted for the suppression of radio interference in aircraft. One method is to enclose the whole of the electrical and ignition installation in a complete and electrically continuous metallic sheath or screen. This method, which relies solely on the screen to prevent radiation, must be carried out with the utmost thoroughness to be successful, and if the receiver should be fed from the same supply as the electrical installation, provision must be made to prevent interference entering the receiver by way of the power supply leads.

6. The other method of suppression is to confine the interference to a local circuit at, or near the source. This involves completely screening the apparatus which produces the interference and inserting a suppressor between the screened apparatus and the unscreened wiring. The suppressor should be fixed as near as possible to the apparatus and connected to it by screened cable. This latter will ensure that the apparatus, the suppressor and its connecting cable form one complete interference screen.

Ignition system

7. Interference caused by an aircraft ignition system can only be suppressed by effective screening of the whole ignition system, including the magneto (with armature), contact breaker, distributor, H.T. and L.T. cables, sparking plugs, ignition switches and junction boxes. A possible exception may be made in the case of the starting ignition equipment. The screening must form a continuous metallic sheathing of low and unvarying resistance. The sheathing must be securely bonded at each end, and at intermediate points to the engine frame and main earth system of the aircraft. Two approved methods of screening are available, involving in one case metal-braided cables and in the other a screening harness.

8. Screened cables are braided with copper or phosphor-bronze wire, suitable end fittings being provided to connect the braid to the screen of the magneto, sparking plug, or other apparatus.

9. The term screening harness is applied to the system employing metallic conduits, partly rigid and partly flexible, in which unbraided high tension cables are enclosed. The connections to the magnetos and sparking plugs are made by means of flexible conduits comprising a metallic tube of interlock section covered with a woven braid of copper or phosphor-bronze wire. In the harness system the magneto switch lead and the H.T. cable of the starting magneto or booster coil may be similarly screened, but the general practice is to use metal-braided cables for these circuits.

10. In many modern aircraft, the starting magneto or H.T. booster coil and its associated switches and cables are only partially screened. In order to prevent interference from the main magnetos being conducted to, and therefore radiated from this partially screened portion of the ignition system, an isolating spark gap is inserted in each starting magneto or booster H.T. lead. This gap is enclosed in a cylindrical metallic screen and is mounted as near as possible to its associated magneto and earthed or bonded to the airframe by a rigid support. When this method of suppression is employed screened cable is used between main magneto and isolating gaps, and unscreened or plain cable between isolating gaps and starting magnetos or booster coils.

11. Starting booster coils of the low tension type, operated from the aircraft d.c. supply are now being extensively used. The connections between the L.T. booster coil, which is fully screened, and the L.T. circuits of the main ignition system are by means of screened cables. In order to prevent ignition interference being transferred to, and radiated from, the aircraft electrical wiring a suppressor is inserted between the booster coil and the electrical supply.

12. It is essential that all joints in the screening system remain thoroughly tight under conditions of vibration and temperature fluctuation. The contact surfaces must be electrically perfect and free from paint, enamel or grease. Where cables, conduits and such items as isolating spark gaps are bonded to the engine or airframe, all paint, enamel, anodizing or similar protective coating must be removed from beneath the bonding clamps. Intermittent vibratory contact between screened cables or conduits and any metal part of the airframe must be avoided, and such parts must be either bonded or definitely insulated using insulating bushes or sleeves where necessary.

Electrical system

13. The most satisfactory method of suppressing interference from aircraft electrical systems, and that normally used in British aircraft, is described in para. 6. Each interfering source is enclosed in a metal screen and a suitable suppressor connected between each source and the unscreened wiring system. The connection is between suppressor and source of interference by screened cable. The metal screen of the cable must be efficiently connected to the suppressor case and the apparatus screen, and the whole bonded to earth.

14. The general service wiring on certain types of aircraft is enclosed in metal conduit or channel. In some cases this enclosure is mainly for mechanical protection and electrical screening of the wiring is not complete, and such cases must be regarded as unscreened wiring.

15. The suppressors used are of the "Low Pass" Filter Type and the essential considerations in their design are:—

(i) The suppressor should provide adequate suppression of interference over the frequency range in Service use.

(ii) The operation and reliability of the apparatus to which the suppressor is connected must not be affected in any way. It is of particular importance that the resistance, and therefore the d.c. voltage drop, should be of a low order.

(iii) The weight and dimensions should be as small as possible, whilst satisfying considerations (i) and (ii).

(iv) The suppressor must be sound mechanically and capable of operating continuously under all conditions of service.

16. Effective suppression over the required frequency is provided by choosing suitable values of inductance and capacitance and avoiding, as far as possible, the introduction of stray capacitances and inductances. The effect of the inductance of a condenser lead on the capacity of a condenser can be very considerable at high frequencies and it is necessary that condenser leads should be as short as possible. In this connection condenser leads are those parts of the internal wiring of a suppressor which carry only condenser currents. In most suppressors the condenser lead is kept short by arranging that the d.c. current-carrying conductor, to which the condenser is connected, passes as close as possible to the point where the connection emerges from the condenser case.

17. The design of the inductances varies with the type of suppressor. In order to obtain the required inductance with minimum d.c. resistance use is made of iron dust cores, or laminations of silicon iron.

18. When a suppressor is fitted to an engine driven generator screened cable is used between the generator and suppressor and the carbon pile type voltage regulator connected to the unscreened side. In this case the metal body of the generator forms the screen against direct radiation from the interference source. The cables between the generator and suppressor must also be screened. In cases where the regulator itself produces interference, e.g. Tirrill types, it must be screened and connected between the generator and the suppressor.

19. In some cases, particularly heavy current suppressors, the input choke of the suppressor is omitted, the impedance of the interfering source and wiring being utilised in its place. This, however, is only possible where condensers of relatively high capacity are used in the suppressor. This type of suppressor is referred to as π Section.

Types available

20. The following chapter contains a table into which are condensed the salient features of the various types of suppressor in Service at the present time.

INSTALLATION

Suppressors

21. Suppressors are to be installed as near as practicable to the source of interference, and where the suppressor case is labelled, the end marked "Screened" is to be connected to the source of interference. Care must be taken that all screening, electrical and earthing connections are of low and unvarying resistance. Screening of the cables from the interfering source to the suppressor is usually by means of metal braiding, and care should be taken in the assembly of the screening glands to ensure that the screen is complete, that the contact between the metal braiding and the screens is of low resistance, and that no ends of braiding are unclamped.

22. Cable fittings for use with suppressors are to be demanded separately to suit the cables being used.

SERVICING

Ignition systems

23. Servicing routine should be carried out at each aircraft inspection period. The joint surfaces between the connectors and the sparking plugs and between the connectors and the H.T. cables or harness flexible conduits should be thoroughly cleaned. All the remaining joints in both the H.T. and L.T. circuits of the ignition system should be inspected and tightened where necessary.

Tests and methods of locating interfering sources in ignition systems

24. Tests for the efficiency of the ignition and electrical screening in aircraft should be made

using the normal aircraft radio receivers and aerials. Where radar equipment is installed, that equipment must also be used for such tests. The radar equipment should preferably be operated from a ground testing alternator driven by a suitably screened engine.

25. The engine should be run at a speed sufficiently high to cause the generator to charge the aircraft battery. On multi-engined aircraft each engine must be run up in turn.

26. If any interference is detected it will be necessary to determine whether it is from the electrical or ignition systems. This can usually be determined by switching off each magneto in turn. If this does not give sufficient indication, the engine speed should be reduced to approximately 1,000 r.p.m. and both magnetos switched off together.

27. If the interference ceases immediately the source of the interference is the ignition system. If the interference persists the source is in either the generator or in other engine driven electrical apparatus such as the engine r.p.m. indicator generator (if of the d.c. commutator type) or any other electrical apparatus that is switched on.

28. If the interference is from the ignition system a test should be made to determine whether the interference is from the H.T. or L.T. circuits by disconnecting the primary or L.T. wires from the main magnetos. If the interference ceases check the tightness of all the joints in the screening of the L.T. circuits and clean the bonding surfaces in the joints if necessary.

29. If the interference persists the source is on the H.T. side and each magneto should be switched off in turn in order to ascertain, if possible, which of the magneto systems is causing the interference. The source may be localised approximately by consideration of the frequency of the interference pulses in the radio output from the radio receiver. If the impulses are of a comparatively low frequency the interference is most probably due to one or two loose joints in the sparking plug cables or flexible conduits. If, however, the interference impulses are of a high frequency corresponding to the magneto spark frequency the source will be in that part of the system common to all the sparking plugs, i.e. the magneto, the main harness flexible conduits and the starting magneto or booster coil circuits.

30. Detach the starting magneto or booster coil H.T. leads from the main magnetos. If the interference ceases, examine the centre of the isolating spark gap and ensure that the spark points are correctly spaced. Reassemble the spark gap, and ensure that it is correctly bonded. Attach the H.T. cables to the main magnetos and test again.

31. If, however, the interference persists after detaching the H.T. starting cables from the main magnetos, check the tightness of all the joints on the magnetos and harness main conduits.

Suppressors

32. It is essential that the efficiency of all circuit connections as well as all bonding and screening arrangements, should be maintained. In particular, great care should be taken to ensure that internal connections of suppressors are perfectly tight and securely locked. Inspection should also be made for any signs of seepage of wax from the condensers. Normally, no repairs other than the rectification of small obvious faults, such as a broken wire, can be undertaken in the Service, and a faulty suppressor should be renewed immediately. An exception may be made in the case of certain recent types which have easily renewable tubular condensers.

33. When testing the insulation resistance of a circuit which includes a suppressor, an erroneous result will be obtained unless the test voltage is kept constant and a reading taken when the indicator has reached a steady value. In the case of an insulation tester, the handle speed controls the voltage of the tester and this speed must be kept constant during the period of the test. The insulation resistance of a suppressor must not be tested with an insulation resistance tester rated at more than 250 volts, and if an unmodified miniature or type B combined tester and Wheatstone bridge is employed when checking the insulation resistance of an aircraft electrical installation, it is most important to limit the speed of the tester so that the voltage does not exceed 250.

P5592 M /G2131 11/44 8500 C & P Gp. 1

CHAPTER 2

SUPPRESSORS

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LIST OF ILLUSTRATIONS

1. Metal case
2. Fixing lugs
3. Partitions
4. Terminal
5. Input union
6. Output union
7. Earthing connection
8. Inductances

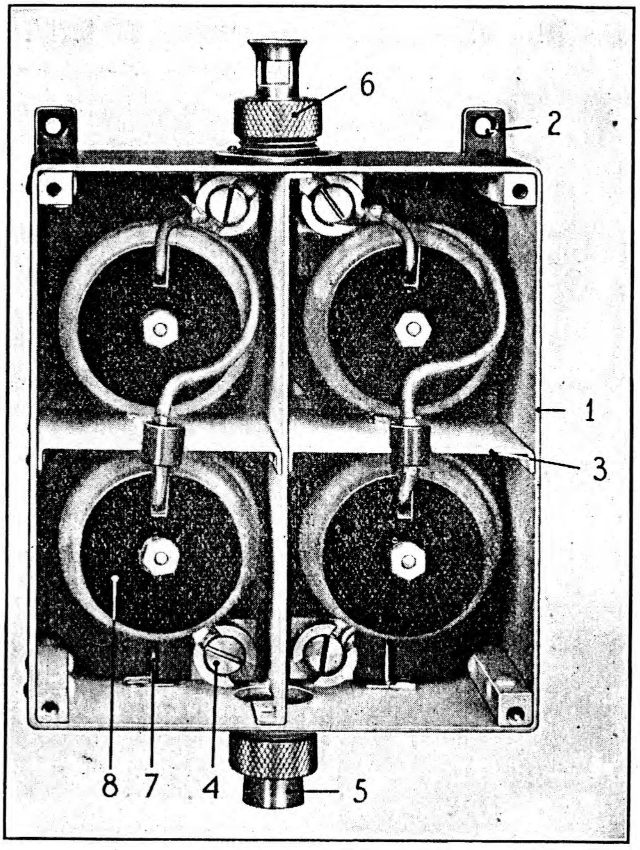


Fig. 1.—Suppressor, type B

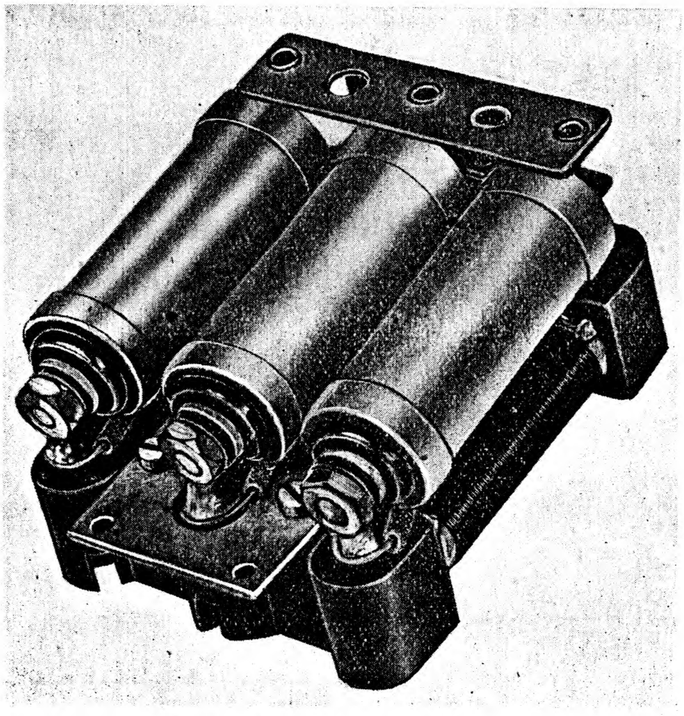


Fig. 2.—Suppressor, type F2

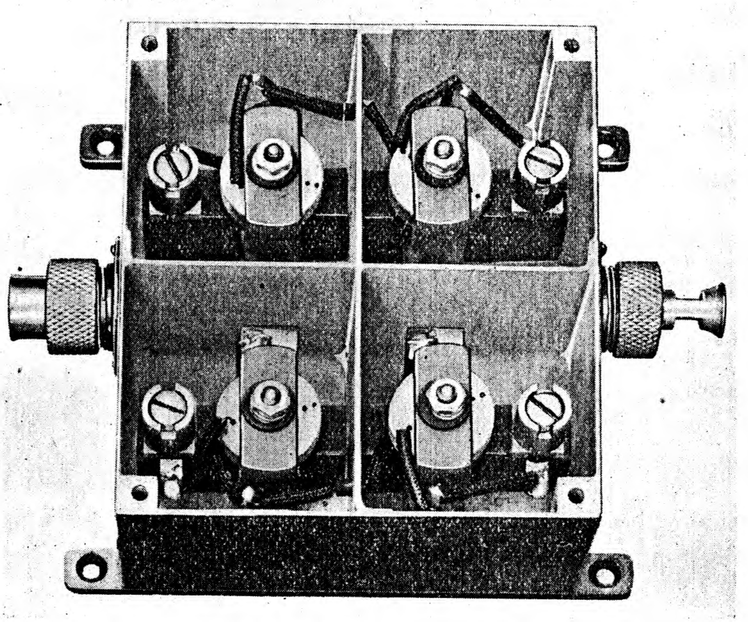


Fig. 3.—Suppressor, type G

CHAPTER 2 SUPPRESSORS

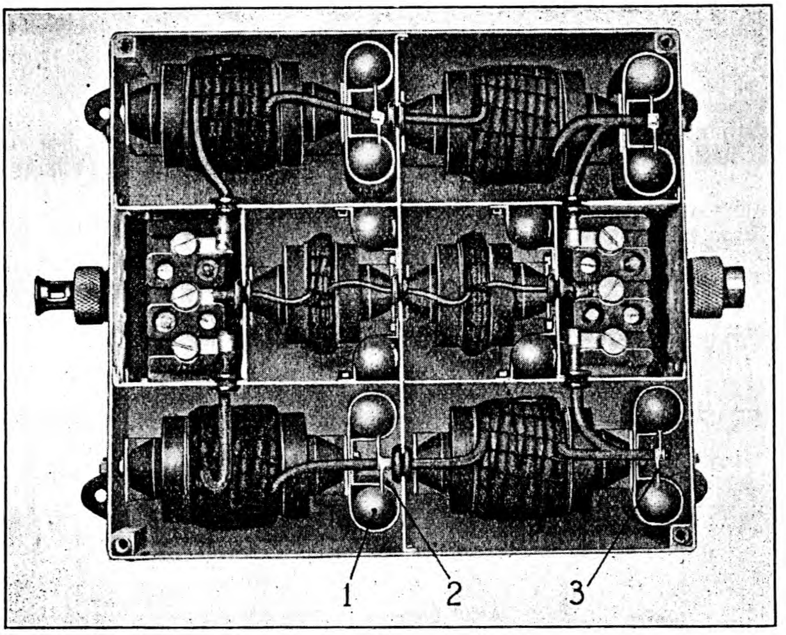
Details of types available

1. A large number of radio interference suppressors is available, but they practically all conform to the basic design referred to in the previous chapter. Later types have units, comprising coils and condensers, which can be removed *en bloc* from the housing for repair or inspection. Some suppressors which carry a high current have no input choke, the impedance of the interfering source and wiring being utilised in its place.

2. Below is a table which gives details of the various types of suppressors which are available, together with notes on their usual applications. The suppressors are divided into two general types, incorporating L-section filters or π-section filters.

TABLE 1

Type	*Stores Ref. No.*	*Stages*	*Legs*	*Max. current (amps.)*	*Approx. weight lb.*	*Volt drop per leg at I max.*	*Approx. size over projection ins.*	*Remarks*
B No. 1	5C/870	2	2	10	2·0	0·39	5½×4×2¼	
B No. 4	5C/2860	1	1	10	0·75		3¾×3×1¼	
C	5C/872	2	3 1	40 5	16·75	0·295 0·44	10½×13×4¾	
D	5C/873	2	2 1	10 2·5	3·5	0·39 0·59	5¼×4½×3½	
E	5C/874	2	2	2·5	1·75	0·6	4½×4¼×1¾	
F No. 1	5C/875	1 and A.F. Stage in H.T. Leg	2	0·03	3·0	0·011	6¾×4¾×3¼	
F No. 2	5C/2682	1	3	1·0	1·0	0·65	4½×2¾×2	
G	5C/876	2	2	2·5	1·5	0·6	4¼×4×2	
H No. 1	5C/926	2	2 1	20 5	3·5	0·22 0·21	7¼×6¼×2¾	L-section filter
H No. 2	5C/1005	2	2 1	20 5	4·5	0·22 0·21	8×6¼×2¾	
H No. 4	5C/3092	2	2	20		250 volt A.C.		
J	5C/927	2	2 1	20 5	6	0·22 0·21	8¼×8¼×2½	
K	5C/928	2	1	5	2·25	0·21	7¼×2½×2½	
L	5C/924	2	3 1	40 5	8·5	0·2 0·035	10×8 ×2½	
M	5C/932	3	2	5	1·75	0·55	7¾×4 ×1¾	
O	5C/968	2	1 2	5 40	6·75	0·2	9 ×7¼×2¼	
O2		1	2	2·0			7×2¾×2½	π-section filter
P1	5C/1002	2	2	5	1·0	0·45	5×3½×1½	L-section filter
P3	5C/2857	2	1	5	0·5	0·45		
S	5C/2220	2	2	2·5	2·25	0·85	13¼×3¼ dia.	For 250 v. circuits
U	5C/1307	2	3	20	6·25	0·22	10¼×6¼×2½	L-section filter
V No. 2	5C/2158	2	4 2	20 100	11·0	0·22 0·39	11¼×8½×4¾	L-section filter
W No. 1	5C/1614	2	1 2	5 100	9·5	0·15 0·085	10½×7¼×3¼	L-section filter
W No. 2	5C/3001	1	1 2	5 200	7·25	0·073	10½×5×3	
X No. 1	5C/2100	1	1 2	15 200	12·5	0·22 0·08	14½×6×3½	
X No. 2		1	1	200	6·5	0·08 0·120	13¾×3×3¾	
X No. 3	5C/3084	1	1 1	15 200		0·22		π-section filter
Y No. 1	5C/2605	1	1 2	7 60	4·25	0·370	8×4×4	
Y No. 2	5C/2741	1	2	60	4·0	0·10 0·120	8×4×4	
Y No. 3	5C/3085	1	1 1	5 60		0·37		



1. Condenser 2. Mounting strap 3. Condenser connection

Fig. 4.—Suppressor type H2

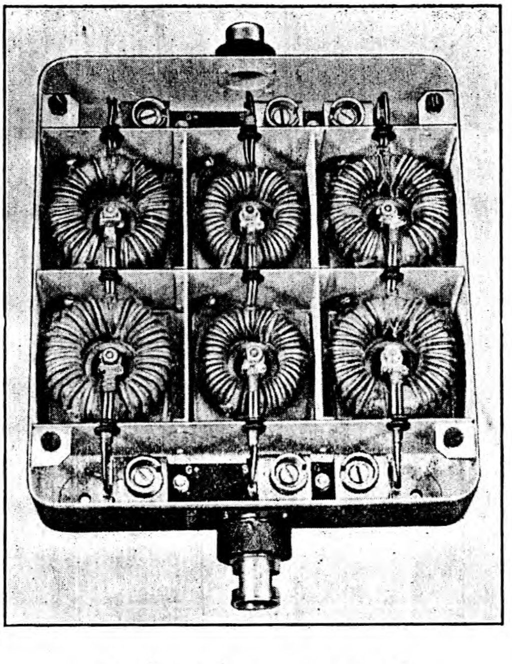
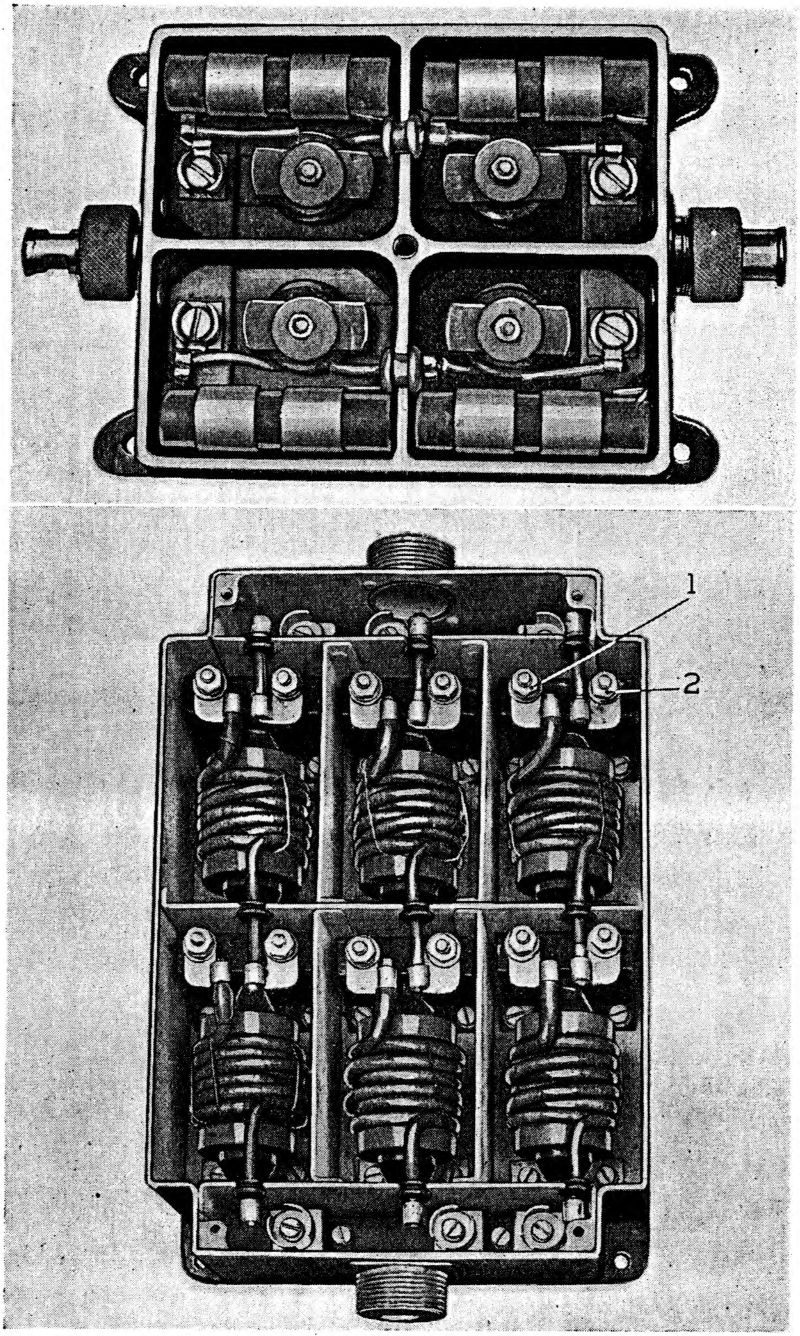


Fig. 5.—Suppressor, type O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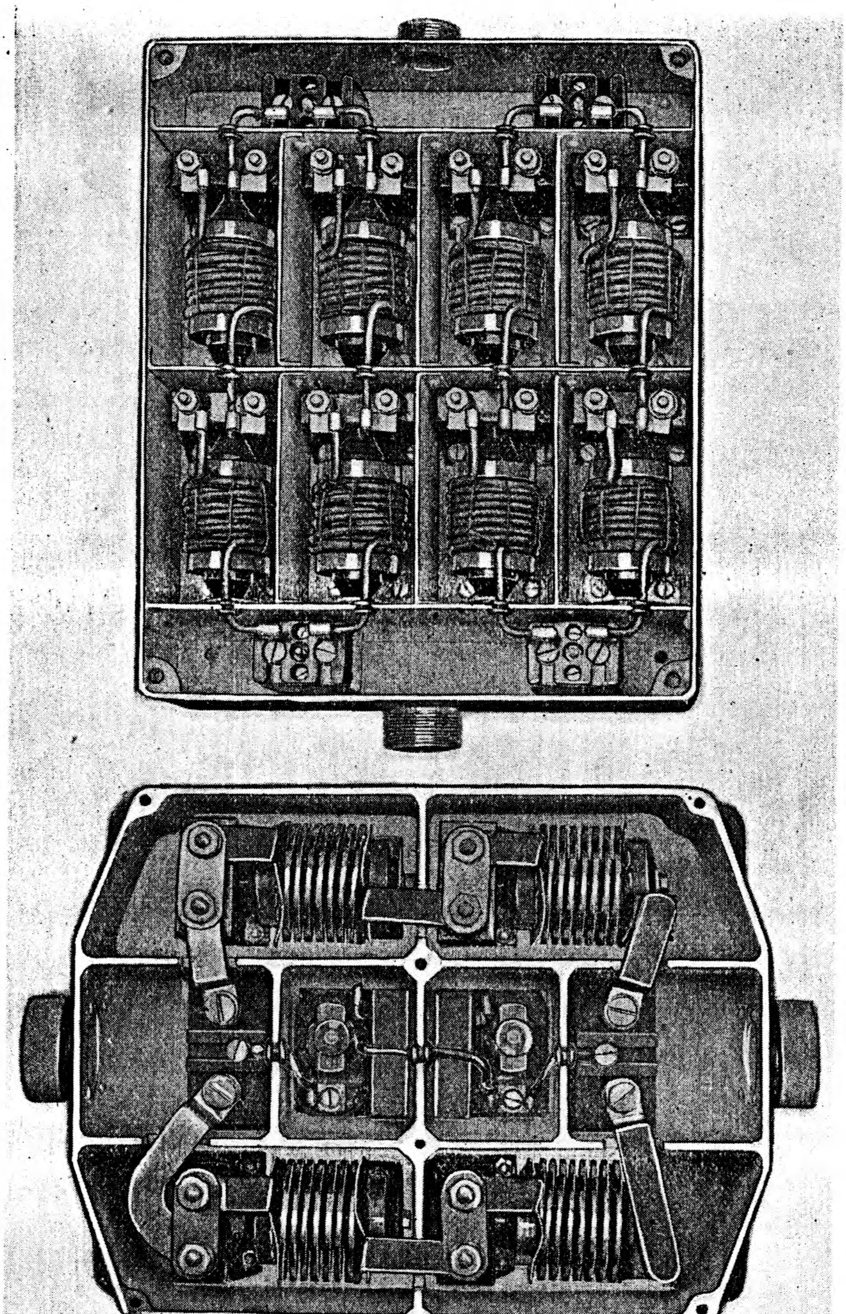

Fig. 7.—Above: Suppressor, type V; below: Suppressor, type W1

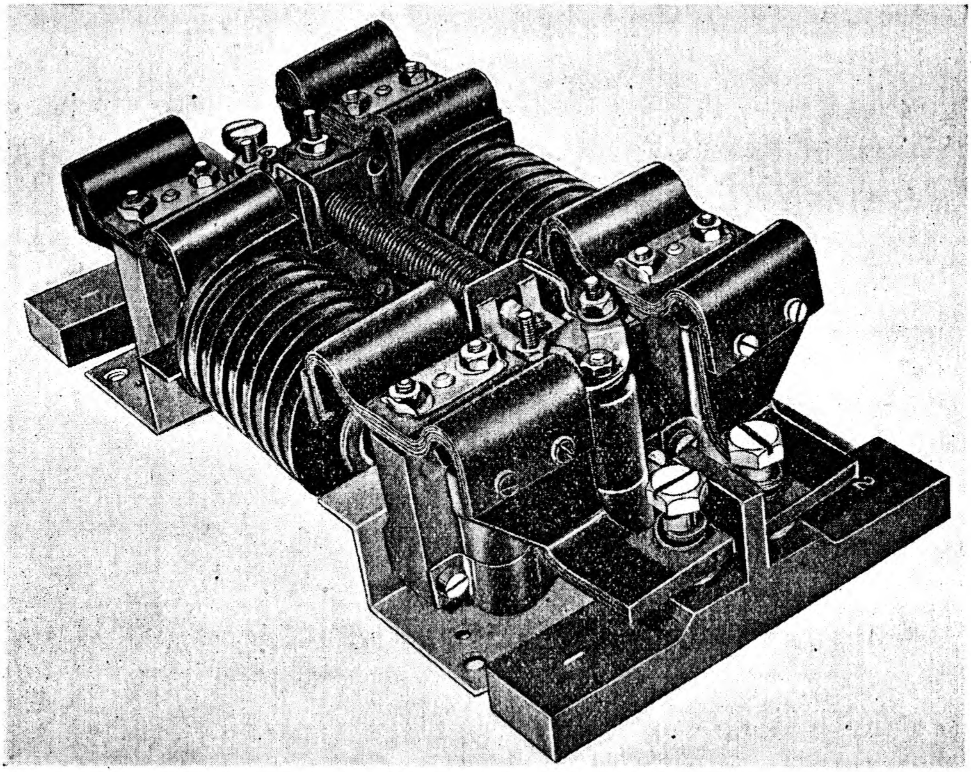

Fig. 8.—Suppressor, type X1

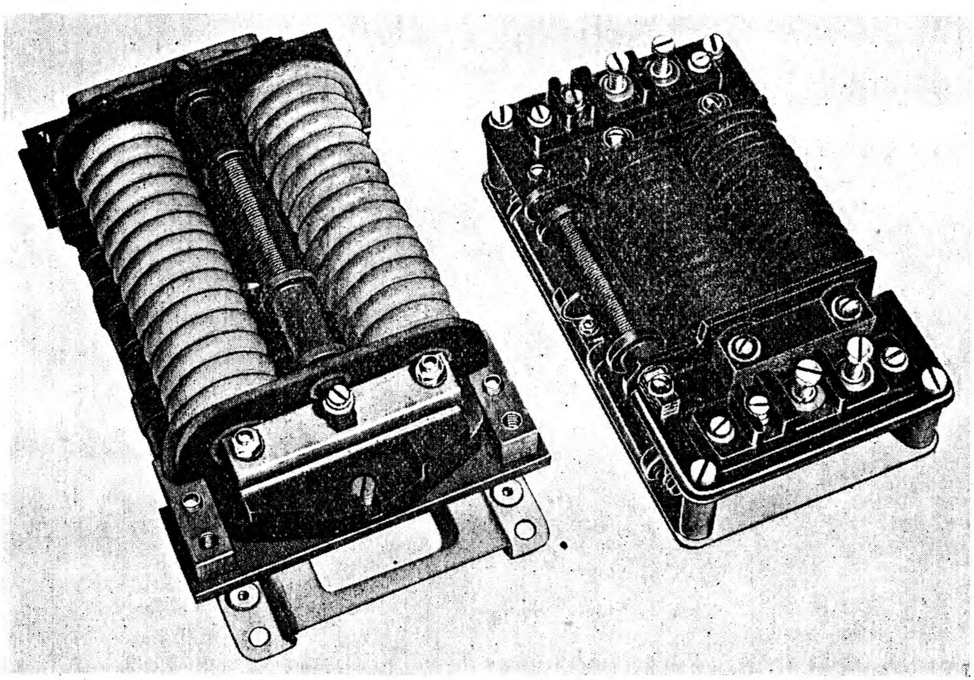

Fig. 9.—Suppressors, types Y1 ~~(left)~~ and W2 (LEFT).

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SECTION 6

MISCELLANEOUS

LIST OF CHAPTERS

Note.—A list of contents appears at the beginning of each chapter

CHAPTER 1

ELECTRIC WARNING HORNS, TYPES A, B, AND C

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. Electric horns are used on aircraft in connection with the undercarriage warning system. The horns employed are all of the vibrator type employing a "resonator" or "tone" disc which vibrates at a higher frequency than the diaphragm assembly.

2. The various horns in use are the same in principle and differ only in mechanical details. Briefly, the horns comprise an electro-magnet with interrupter contacts, which is used to cause a diaphragm to vibrate. The principle of operation is similar to that of an electric bell.

3. The diaphragm vibrates at a relatively low frequency and the corresponding low note emitted from this source is inadequate for the purpose. A high-pitched penetrating note is obtained by fitting a light circular disc, usually aluminium, on the front of the diaphragm. This is referred to as the tone disc.

4. The complete diaphragm assembly, including tone disc, is designed to vibrate at a given fundamental frequency. The tone disc has a natural frequency which is some multiple of this, i.e. its natural frequency is equal to one of the harmonics of the fundamental of the diaphragm. In operation a resonant vibration is set up in this disc provided that the fundamental frequency is correct.

5. The frequency of the fundamental can be varied over small limits by adjusting the armature air gap, or alternatively, as in practice, by varying the pressure between the interrupter contacts by means of an adjuster screw. The current in the coil of the electro-magnet does not rise to a maximum instantaneously, and it will be appreciated that with given electrical and magnetic characteristics the time period of the vibration is proportional to the time required for the operating current to reach a strength sufficient to attract in the armature to the position at which the interrupter contacts break.

6. Horns may be provided with either a condenser or a resistance connected across the interrupter contacts for spark quench purposes. In the horns described in this chapter, no spark quench is provided with the 12-volt types. In the 24-volt horn, partial suppression is provided by connecting a non-inductive resistance winding across the interrupter contacts.

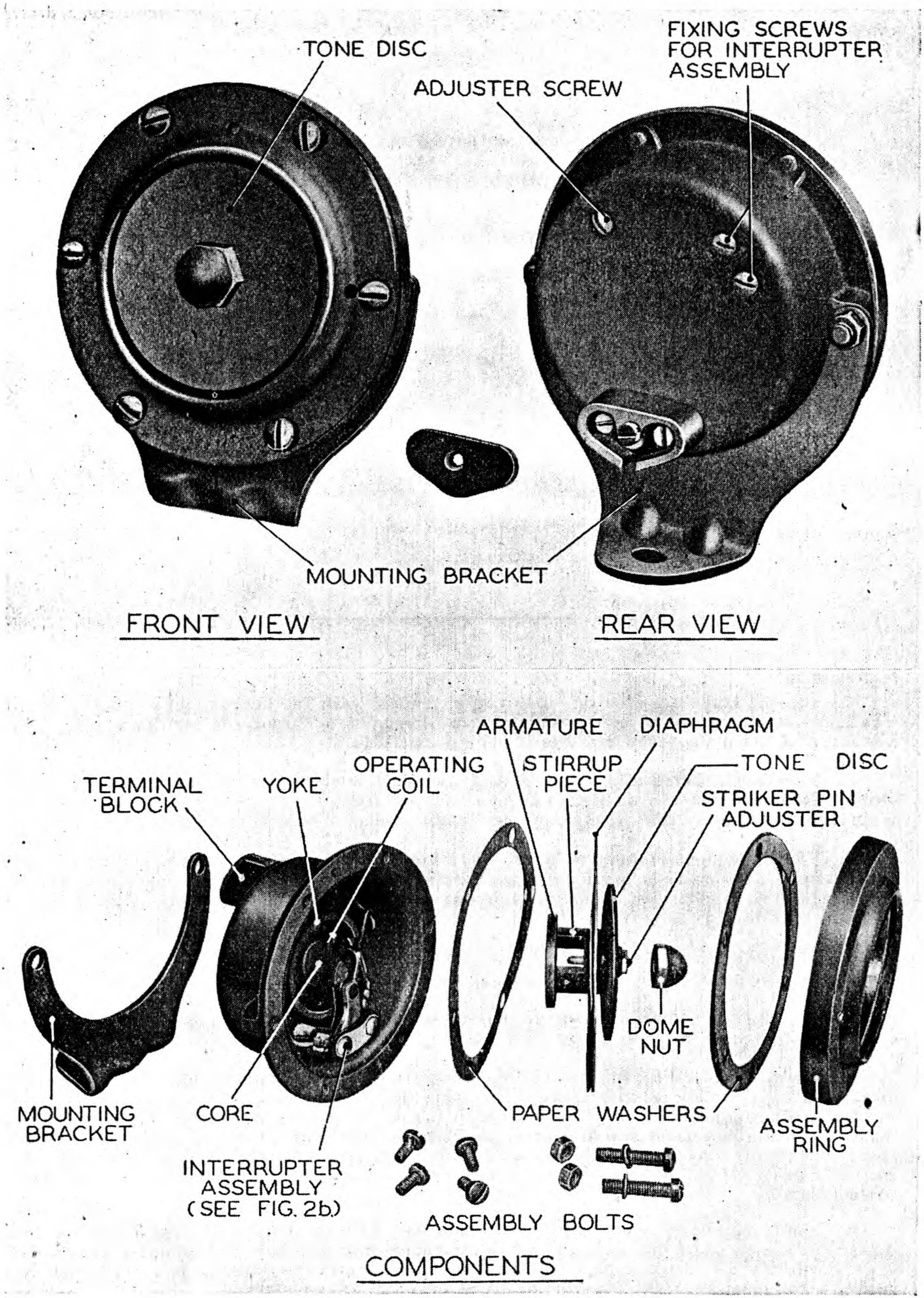


Fig. 1.—Electric horn, type C

Types available

7. It is intended to standardize the 12 and 24-volt horns, type C and these should be used as replacements for existing types. Where a horn of smaller dimensions is essential, types A (12v) and B (24v) may be used. The following table gives details of the various types:—

Type	*Stores Ref.*	*Volts*	*Winding*	*Spark quench*	*Overall dimensions*	*Weight*	*Remarks*
A	5C/989	12	0·83 to 0·89 ohm	NIL	3·8 in. dia.	23 oz.	In later 24-volt horns, type C, the winding resistance is 5·7 to 6·0 ohm
B	5C/990	24	6·5 to 7·0 ohm	50 ± 5 ohm	by 2½ in.	23 oz.	
C	5C/1960	12	0·83 to 0·89 ohm	NIL	4·7 in. dia.	37 oz.	
C	5C/1961	24	6·5 to 7·0 ohm	50 ± 5 ohm	by 3⅛ in.	37 oz.	

DESCRIPTION

(Type C)

8. The 12-volt horn, type C, is illustrated in fig. 1. The 24-volt horn, type C, is similar in appearance. It differs from the 12-volt horn in that a resistance winding is connected across the interrupter contacts as a spark quench. No spark quench arrangements are provided on the 12-volt horn.

9. The body of the horn is an iron casting approximately cylindrical in form, closed at one end and open and flanged at the other. The magnet system is cast integral with the body of the horn and consists of a cylindrical core and yoke, concentric with the body as shown in fig. 1 and 2. The coil is located in the annular space between core and yoke. On the 12-volt horn it consists of 110 turns of 24½ s.w.g. enamelled s.c.c. copper wire sealed in the magnet cup with bitumen-asbestos compound. The latter is injected into the magnet cup under pressure to surround the coil as shown in fig. 2.

10. The interrupter contacts are secured by means of rivets and suitable insulating washers and bushes to a bridge piece as shown in fig. 2 (b). The bridge piece is fixed at one end and adjustable at the other by means of a spring-loaded screw. By turning the latter, the contacts can be raised or lowered. The head of the adjusting screw is countersunk and serrated on its inner surface to prevent the adjustment slipping. The spring carrying the moving contact is provided with a fibre plate at its free end.

11. The diaphragm of the horn carries a stirrup piece, an armature, a tone disc, and a striker pin as shown in figs. 1 and 2 (a). In the assembled position of the components, the diaphragm is clamped over the flange of the horn casing by means of an assembly ring and six bolts. Paper washers are inserted on each side of the diaphragm, those between the diaphragm and the flange being of a total thickness sufficient to give the correct air gap (0·018 to 0·022 in.) between armature and pole face.

12. The stirrup piece has a threaded shank at its outer end and is provided with a nut for fixing it to the diaphragm, while a domed nut fixes the tone disc. The stirrup piece is also threaded internally and carries an adjustable striker pin which protrudes into the opening on the coil side. When in the assembled position, the stirrup piece fits over the interrupter contacts and the striker pin exerts a slight initial pressure on the fibre insulating plate carried by the moving contact spring. This initial pressure of the striker pin is adjustable and varies the pressure between contacts.

13. The armature consists of a soft iron disc and is welded to a flange on the stirrup piece. A thin layer of copper is sandwiched between armature and stirrup piece to retain the flux, as far as possible, within the short magnetic circuit indicated in fig. 2.

•14. No provision is made for "spark-quench" on the 12-volt horn, but on the 24-volt horn a non-inductive winding is shunted across the interrupter contacts. The main operating winding of the 24-volt horn consists of 300 turns of 31 s.w.g. enamelled s.s.c. copper wire. The winding incorporated as a spark-quench consists of 8 ft. 4 in. of 37 s.w.g. d.c.c. "Ferry" wire, wound non-inductively over the operating coil as shown in fig. 2 (a). The coil resistances are given in the diagrams shown in fig. 2 (c).

OPERATION

15. In operation the armature is attracted towards the core face against the tension of the diaphragm and the contact spring. The contacts break and subsequently remake. This action is repeated causing the diaphragm to vibrate at a comparitively low frequency. The familiar high-

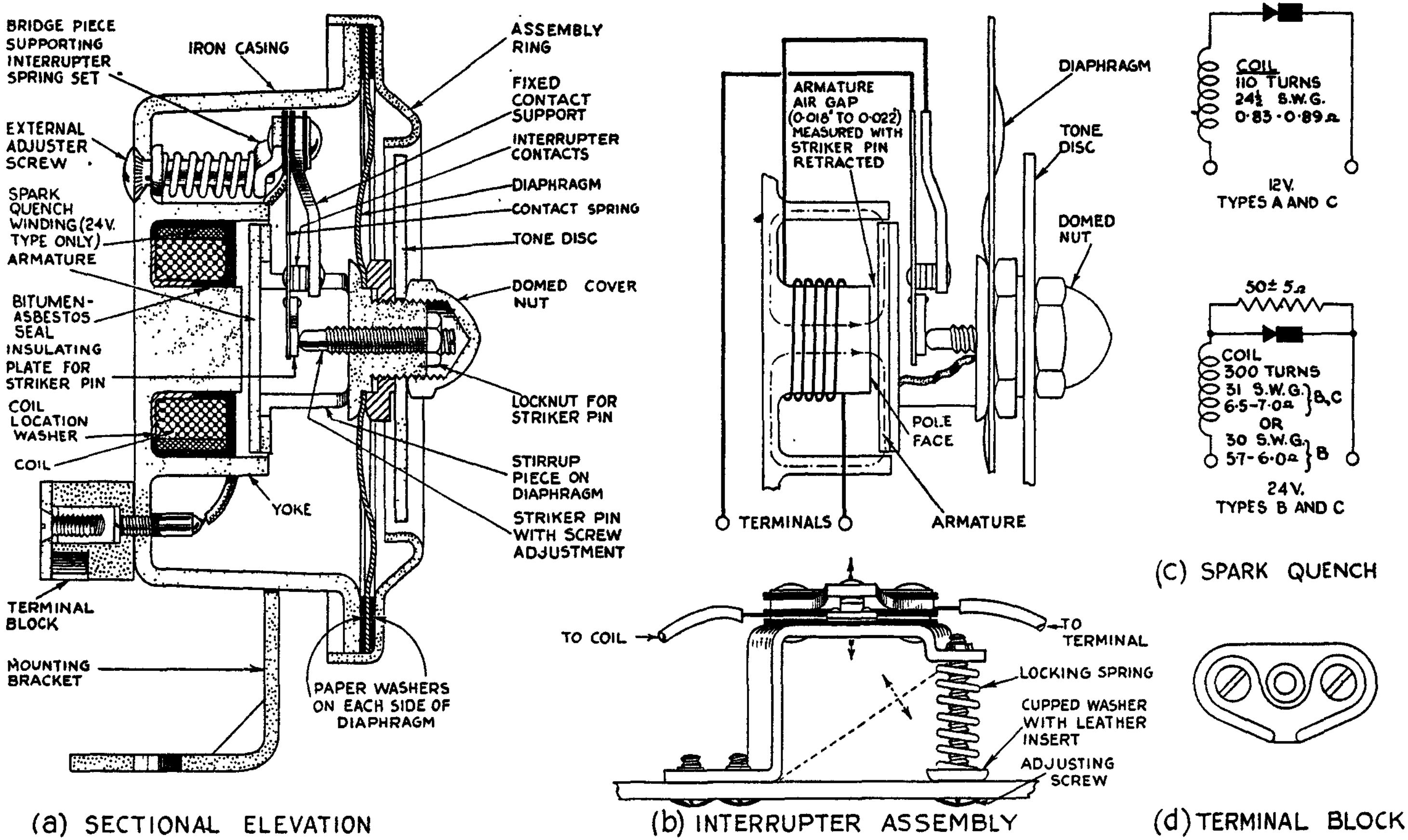


Fig. 2.—Details of horn, type C

pitched note of the horn is produced by the circular aluminium tone disc carried on the front of the diaphragm. This disc has a natural frequency which is an exact multiple of the frequency at which the diaphragm assembly is designed to vibrate, as explained in the introductory paragraphs.

INSTALLATION

16. The installation and the circuit wiring of the horn are given in Vol. I, Sect. 6 of the appropriate aircraft handbook.

SERVICING

17. If the note of the horn is unsatisfactory, possible causes are as given in the following paragraphs.

Loose fixing bolts

18. The horn may be loose on its mounting bracket or alternatively the bracket itself may be insecure. If necessary, the fixing bolts should be tightened. The possibility of the horn assembly bolts being loose should also be borne in mind. Loose fixing bolts will be evidenced by a harsh chatter in the note of the horn. Horns, types A and B, are secured to a flexible laminated mounting strip, whilst the horns, type C, are fixed to a rigid bracket.

Clearance of tone disc

19. Dirt or foreign matter may have collected between the tone disc and the front cover ring. An inspection should be made to ascertain that everywhere there is clearance between tone disc and ring. Any foreign matter which may have lodged between the two parts should be removed. The tone disc should *not* be removed for cleaning purposes.

Routine adjustment, type C

20. The horn may be out of adjustment. No attempt at re-adjustment should be made until all other possible faults have been investigated (see para. 21). Adjustments should be made by means of the adjuster screw at the back of the casing. This screw gives a fine adjustment which is normally all that is necessary. On the aircraft, a push-button is provided for testing the horn, and trials should be made until the optimum setting is obtained. During test, a moving-iron ammeter should be connected in the horn circuit and the adjuster screw should be turned slowly until the best performance is obtained, noting that the current must not exceed 3 amp. on 12-volt horns or 2 amp. on 24-volt horns. A fully charged 12-v. or 24-v. battery should be used, as appropriate.

Wiring faults

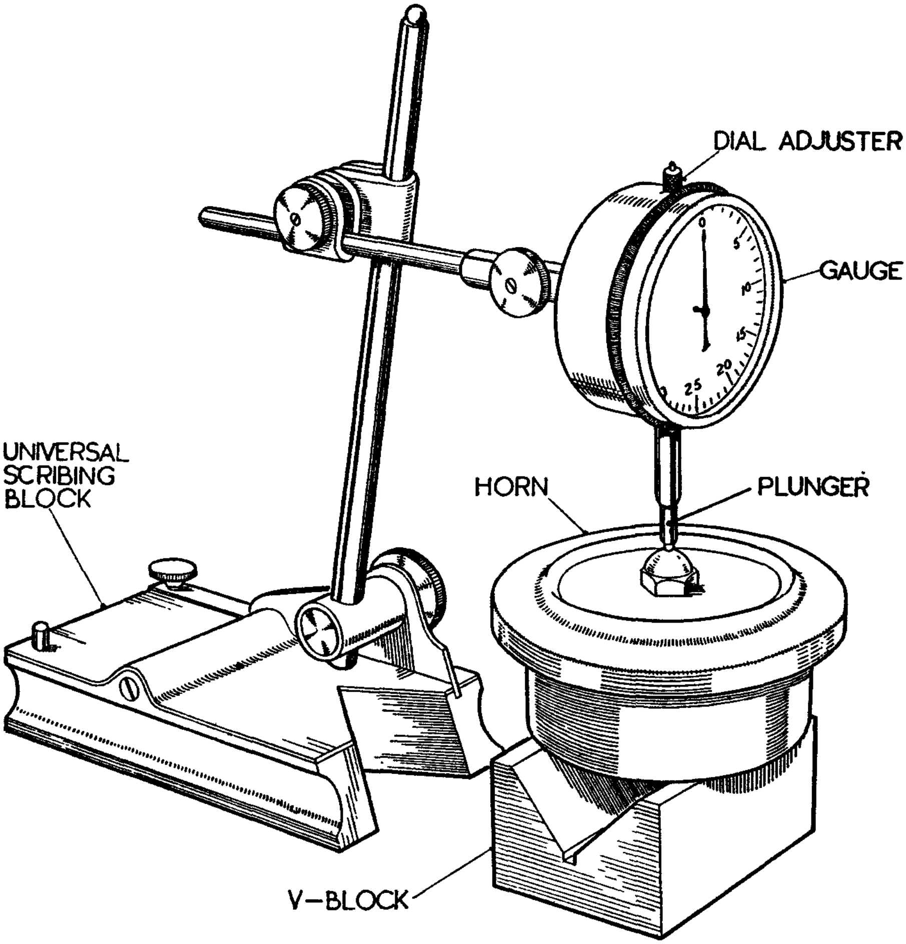
21. Failure of the horn to operate, or intermittent operation, may be due to a fault in the wiring, or to the fact that the adjuster screw has been turned so far in the counter-clockwise direction that the interrupter contacts are left permanently open. Evidence of a complete circuit will be shown by a movement of the horn diaphragm when the test button is pressed. This can be detected by placing the fingers in light contact with the tone disc. If the circuit is complete, and the horn fails to function after an attempt at adjustment, it is possible that the interrupter contacts are either dirty or have become welded together. The horn terminals should be inspected for security and cleanliness.

22. Persistent attempts to operate a faulty horn may result in burning out the insulation of the coil winding. Consequently, if the horn fails to operate, it should be replaced by a new one and attention given to the interrupter contacts on the faulty horn when convenient.

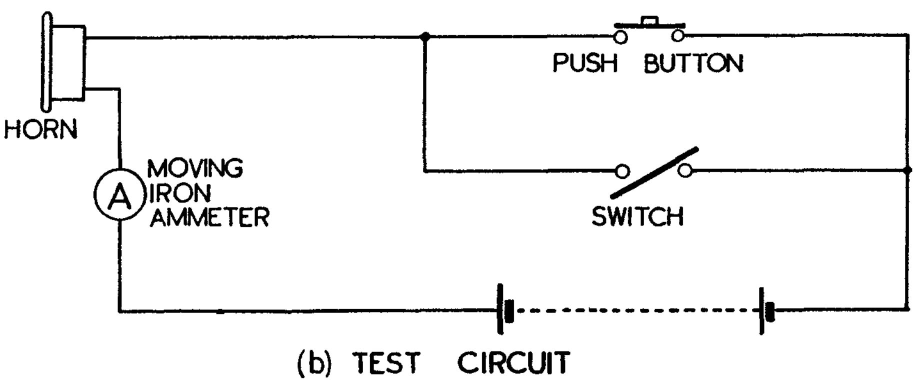
Dismantling, type C

23. If it is necessary to inspect the interrupter contacts, the horn should be dismantled as follows:—

- (i) Remove the mounting bracket.
- (ii) Remove the six assembly screws and the front ring of the horn.
- (iii) Loosen the two screws securing the interrupter assembly and the adjuster screw at the rear of the case. This will be necessary to enable the stirrup piece to be pulled clear of the interrupter spring.
- (iv) Withdraw the diaphragm assembly, taking care not to tear or displace the paper washers.
- (v) Mark the paper washers which are assembled on the rear side of the diaphragm, so that they can be distinguished from those on the front side as *it is essential that they should be reassembled in the same place.*



(a) MEASUREMENT OF ARMATURE AIR GAP



(b) TEST CIRCUIT

Fig. 3.—Testing arrangements

(vi) Remove the screws securing the interrupter assembly and also the adjuster screw complete with spring, capped washer and leather insert.

Cleaning the contacts

24. When the horn is dismantled, the contacts should be cleaned with a rag moistened with petrol. If, after cleaning in this manner, the contacting surface has a matt grey appearance, no further cleaning is necessary.

25. If the contacting surfaces are burnt and pitted, they should be cleaned by means of a piece of fine emery cloth. Fold the emery cloth with abrasive surface outside and insert it between the two contact points. The contacts can then be cleaned by moving the emery cloth to and fro, after reducing the contact pressure by pressing on the contact spring. After cleaning with emery cloth, all traces of emery must be removed from the contact surfaces by cleaning with petrol, as in para. 24.

Reassembly, type C

26. The horn should be reassembled as follows:—

(i) Put the interrupter assembly in position and engage the securing screws and the adjuster screw by a few threads only. The spring and the cupped washer are fitted as shown in fig. 2 (b).

(ii) Put the appropriate number of paper washers (see para. 23 (v)) on the flange of the horn body and place the diaphragm assembly in position. To do this the stirrup piece on the diaphragm must be inserted over the contact spring and the interrupter assembly must be loosely fixed for this purpose.

(iii) Tighten the two screws securing the interrupter assembly and screw the adjuster screw in a clockwise direction as far as it will go. Then turn the adjuster screw counter-clockwise for one turn.

(iv) Place the outer paper washers and the front assembly ring in position over the outside of the diaphragm. The long bolts are of a larger diameter than the remainder and corresponding holes are provided in the cover ring. These holes should be located opposite the lugs on the rear face of the flange.

(v) Replace all assembly bolts, tightening down diametrically opposite bolts alternately.

Adjustment after reassembly, type C

Armature air gap.

27. This should be 0·020 $\pm$ 0·002 in. when the horn is assembled with *no tension on the contact spring*. The correct number of paper washers between the diaphragm and the body flange to give this air gap are fitted by the manufacturers when the horn is first assembled and adjusted. Consequently, if the horn is dismantled, the washers should be marked so that they can be replaced in their original position, as mentioned in para. 23 (v).

28. If the washers have not been marked, or have been misplaced, the correct air gap should be obtained as follows:—

(i) Remove the domed cover nut, loosen the striker pin lock-nut, and turn the striker pin until it is well clear of the contact spring. The domed cover nut should be removed by means of a box spanner ($\frac{1}{2}$ in. B.S.F.) with the diaphragm assembly secured to the body of the horn.

(ii) Estimate the number of paper washers required as follows. Remove the bolts securing the diaphragm and, with the diaphragm in correct alignment and with no paper washers between diaphragm and flange, push the diaphragm assembly lightly towards the pole face. The interrupter securing screws should be tight. If the armature makes contact with the pole face without deflecting the diaphragm, add a number of paper washers sufficient to take up any clearance between diaphragm and flange. Afterwards, add a further number of washers of a combined thickness of 0·020 in. This latter measurement can be ascertained by means of a micrometer. If, with the circumference of the diaphragm in contact with the flange, there is a clearance between armature and pole face, add paper shims between armature and pole face to take up this clearance. Remove the shims and measure their total thickness. Add a number of paper washers between diaphragm and flange of a combined thickness equal to 0·020 in. *minus* the thickness of the shims. Thus, if the shims are 0·005 in. thick, the paper washers should have a total thickness of 0·020 $-$ 0·005 $=$ 0·015 in. Usually there will be no air gap when all washers are removed from between flange and diaphragm.

(iii) Place the remaining paper washers over the outside of the diaphragm and reassemble the cover ring and bolts as described in para. 26 (iv) and (v).

(iv) Test the armature air gap by means of a dial gauge (Stores Ref. 1B/4240) graduated in thousandths of an inch. To do this, the horn and gauge must be set up on a surface plate as shown in fig. 3. The procedure is as follows:—

(*a*) Rest the horn on its back on a V-block, taking care that it is resting flat. The three screws at the back of the case should be clear of the V-block.

(*b*) Adjust the position of the gauge so that the plunger is depressed to deflect the pointer by at least one revolution, then adjust the pointer reading to zero.

(*c*) Taking care not to disturb the position of the horn or the gauge, press the armature into contact with the pole face. To do this, the tips of the fingers should be placed on the tone disc, in close proximity to the dome nut, to apply a strong vertical pressure. The pressure should be applied gradually and the reading of the gauge noted at the same time. When the gauge pointer has apparently reached its maximum deflection, apply a sudden extra pressure to ensure that this is so. The maximum pointer reading gives the armature air gap. If the pointer was not set to read zero in the first place, the air gap is given by the difference in the two readings. The air gap required is 0·020 ± 0·002 in. and, when making this measurement, it is preferable that the tolerance is on the negative side, i.e. the air gap should be between 0·018 in. and 0·020 in.

(*d*) If the air gap is not within the limits, the total thickness of the paper washers between diaphragm and flange should be adjusted accordingly. The final air gap should always be checked. Ensure that the six assembly bolts are secure before measuring the air gap.

29. The dial gauge mentioned in the preceding instructions forms part of the cylinder gauge (Stores Ref. 1B/4221) held by squadron workshops.

30. The armature air gap is entirely independent of the contact adjustments and it is important that it should be correct if the horn is to function efficiently. To avoid the necessity of resetting the air gap, as described in para. 28, it is obviously important that the paper washers are carefully marked.

Striker pin.

31. The setting of the striker pin should not normally be disturbed, but if it has been necessary to adjust the armature air gap, this is unavoidable. The adjustable striker pin and the adjuster screw at the rear of the horn are both contact adjustments. The striker pin provides a coarse adjustment and the external adjuster screw provides a fine adjustment. It should be appreciated that each time the striker pin is adjusted, it will be necessary to remove the domed nut and loosen the locknut. It will also be necessary to relock the striker pin and replace the domed nut each time the horn is tested after an adjustment. Consequently, all routine adjustments should be confined to the external adjuster screw as described in para. 20.

32. To re-adjust the striker pin proceed as follows:—

(i) Ensure that the horn has been reassembled with the interrupter contacts set as described in para. 26 (iii). Remove the tone disc and fix the horn rigidly by its mounting bracket.

(ii) Screw in the striker pin sufficiently to ensure that the interrupter contacts are broken.

(iii) Connect the horn in series with a moving-iron ammeter and a switch to a 12-volt or a 24-volt battery, whichever is appropriate. It is convenient to have a push button in the circuit, as shown in fig. 3 (b), in addition to the switch.

(iv) Switch on the battery and screw the striker pin counter-clockwise until the interrupter contacts are just made. The point at which the contacts first make can be observed on the ammeter. Continue to screw out the striker pin by about one eighth of a turn until the current consumption of the horn is approximately 2·9 to 3·0 amp. for a 12-volt horn and approximately 1·9 to 2·0 amp. for a 24-volt horn. Having done this, switch off the battery.

(v) Lock the striker pin and replace the tone disc and the domed cover nut. Tighten the domed nut by means of a box spanner (½ in. B.S.F.)

(vi) Press the push button to test the performance of the horn. If this is unsatisfactory, re-adjust the striker pin until a satisfactory performance is obtained. After a final adjustment has been obtained, note that the current consumption does not exceed 3 amp. with a 12-volt horn or 2 amp. with a 24-volt horn.

Final adjustment.

33. The final adjustments made to the horn may, providing that it is of a small amount, be made on the external adjuster screw at the rear of the horn. In general, however, if it has been necessary to adjust the striker pin at all, it is preferable to leave a full adjustment available with the external screw for use during service.

Adjustment, types A and B

34. Numbers of these horns are in Service but they will eventually be replaced by the horn, type C, described in preceding paragraphs. The horns are of a smaller size than the type C and for this reason it may be essential to use them in certain cases until new provision for installation has been made.

35. The horn should not be dismantled unless some actual failure has occurred. Mal-adjustment of the horns can usually be rectified by means of the serrated adjusting screw at the rear of the case.

36. In order to dismantle these horns, it is necessary to remove the tone disc, release the diaphragm clamping nut, slacken the band clip and then remove the diaphragm from the bayonet slots.

37. On reassembly, the armature cup must be positioned with the contact spring in the centre of the gap and with the diaphragm towards the bottom of the bayonet slots. The diaphragm must be correctly seated on the armature spigot and the nut tightened hard while the armature is prevented from turning by means of a large screwdriver.

Armature air gap.

38. The air gap is obtained by rotating the diaphragm so that the bayonet slots ride up the pins in the body. An air gap of 0·016 to 0·018 in. is required. This should be measured by a dial gauge as described in para. 28 (iv). The band clip must be tightened after any adjustment.

Interrupter contacts.

39. The two securing screws on the back of the body must be tight. The serrated adjusting screw should be turned fully clockwise until it reaches the stop and then slackened back by one turn.

40. The contacts should then be adjusted by means of the striker pin adjuster screw on the front of the horn as described in para. 32. The adjustment should be such that the horn gives an optimum output at the nominal design voltage and is also capable of operating over a range of 8 to 16 volts for the 12-volt horn, type A, and 18 to 30 volt for the 24-volt horn, type B. The nut securing the tone disc should be tight and any subsequent adjustment should be made on the serrated adjusting screw at the back of the horn.

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CHAPTER 2

OIL DILUTION VALVES

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Introduction

1. The oil dilution system is employed to reduce the effort required to start aero-engines in cold weather. The system is based on the principle that satisfactory lubrication can be obtained by cold oil thinned with fuel, so long as the correct lubricating viscosity is preserved. In addition to easier starting, the system ensures a flow of lubricant to all parts of the engine practically at normal working pressure, immediately after the start.

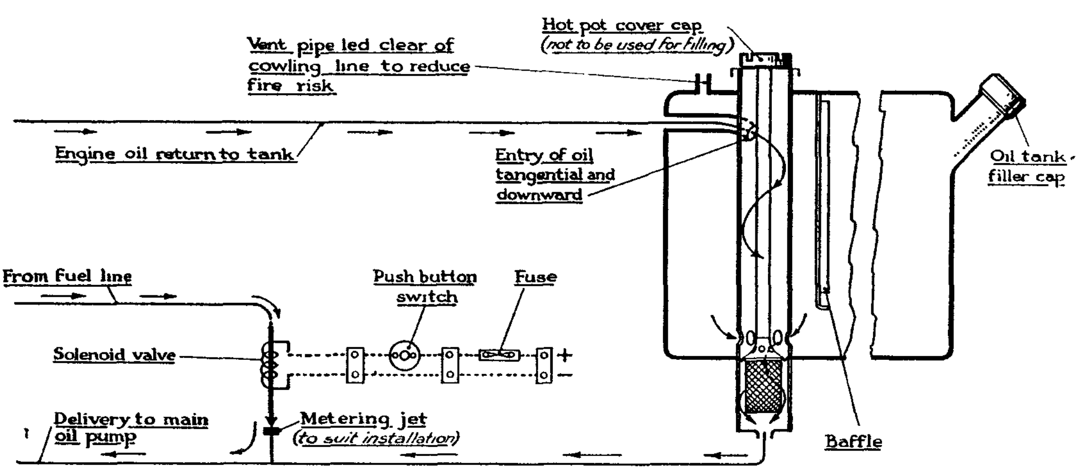

Fig. 1.—Typical layout of oil dilution system

2. The equipment consists of a pipeline from the delivery side of the fuel pump or reducing valve through a solenoid valve to the suction side of the oil pump. The valve, which is controlled by a press button switch from the cockpit, incorporates a metering jet, so that when the switch is operated a regulated flow of fuel is admitted to the engine oil in circulation.

3. If the operating instructions as to the dilution period are correctly followed, over-dilution can only occur if the solenoid valve leaks or if the push button switch sticks in the ON position. It is, therefore, vital to keep these two items in good working order.

DESCRIPTION

4. The various types of solenoid valves are illustrated in figs. 2 and 3. The later model of the type C valve has been modified to include a terminal block for connection to the aircraft electrical system instead of the original internally connected length of cable. These modified valves are known as type D.

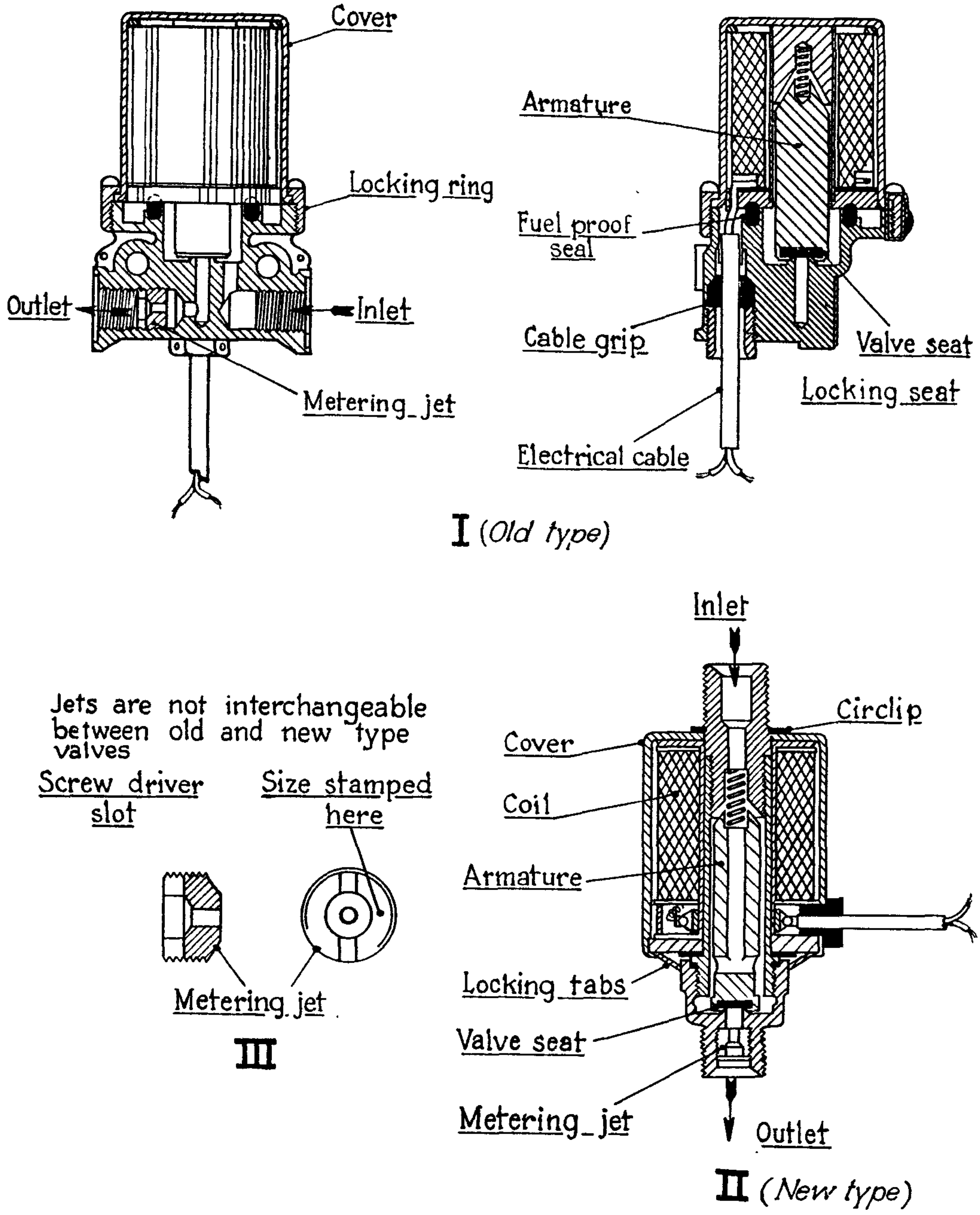

Fig. 2.—Old and new types of solenoid valve

5. The old type oil dilution solenoid (Stores Ref. 5U/1513, for 12 V., and 5U/1514, for 24 V.) has the fuel line arranged at a right angle to the solenoid and armature, while the metering jet is

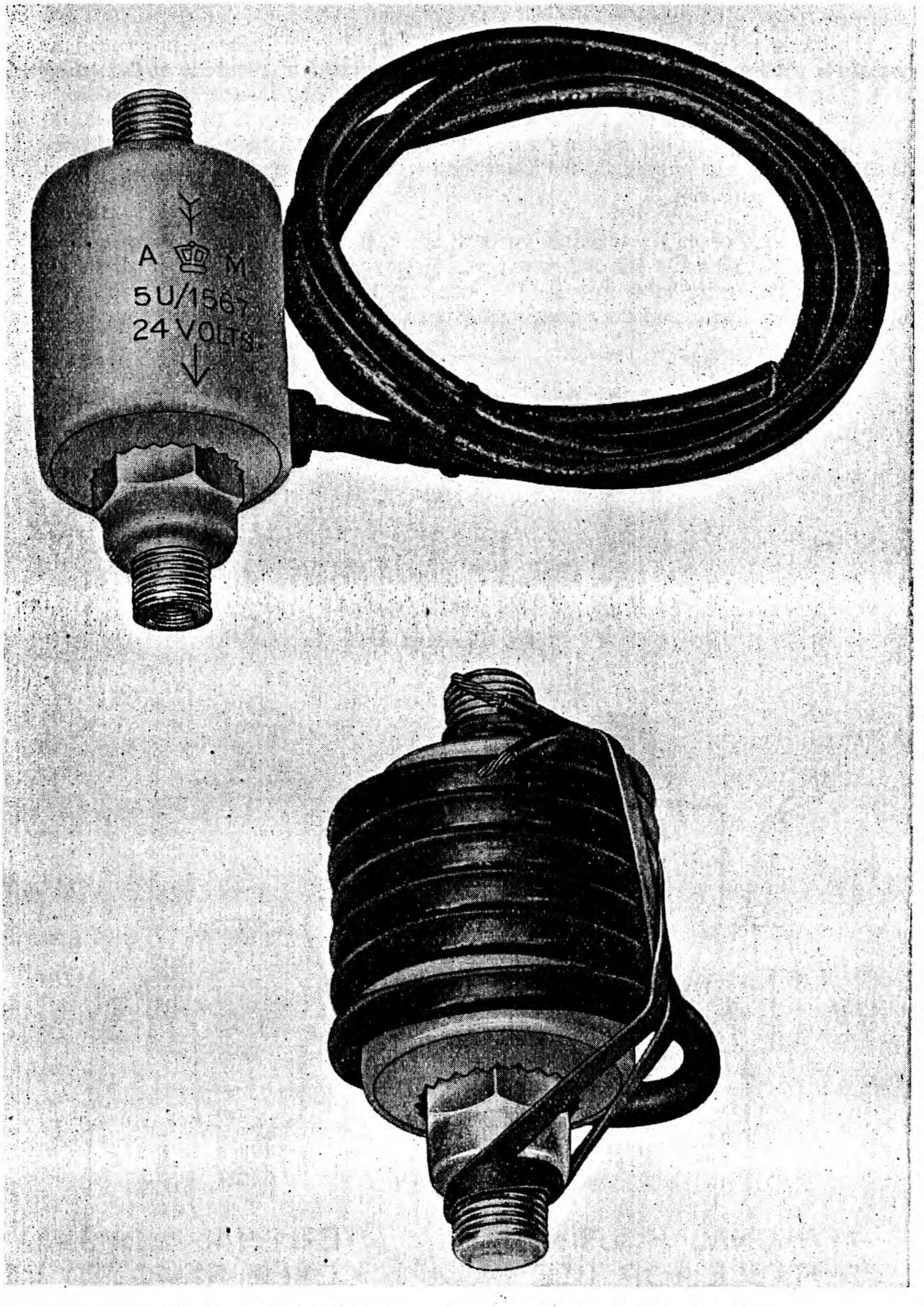

Fig. 3.—Oil dilution solenoid valve, later model, type C

set in the delivery end of the fuel pipe at the side of the assembly. The construction of the solenoid valve assembly can be seen from the sectional drawing, fig. 2. The armature to which the valve is attached is spring-loaded to the closed position. When current is switched on and the solenoid energised, the armature complete with valve is drawn up into the body of the coil pot, thus opening the fuel duct and allowing the fuel to pass into the oil circulatory system.

6. In the later type of solenoid valve, Types C and D, the fuel pipe-line runs axially through the armature with the metering jet fitted in the delivery end at the base of the assembly, Fig. 2, 3 and 4. Again, the armature with the valve attached is spring-loaded to the closed position, and the operation of the solenoid lifts the valve from its seating to allow the flow of fuel to the lubricating system. In the earlier models and in type C the electrical connection to the solenoid coil is made inside the assembly, but in type D, the latest model, there is a terminal block at the point of entry. This type is shown in Fig. 4.

7. Three sizes of jet are available for each valve, but it is important to note that jets are not interchangeable between the old and new types of valve. The correct jets available for each type of valve are set out in the table in para. 13. The armature and coil assembly are wound either for 12 or for 24 volt circuits, and the operating voltage for each valve is stamped on the cover.

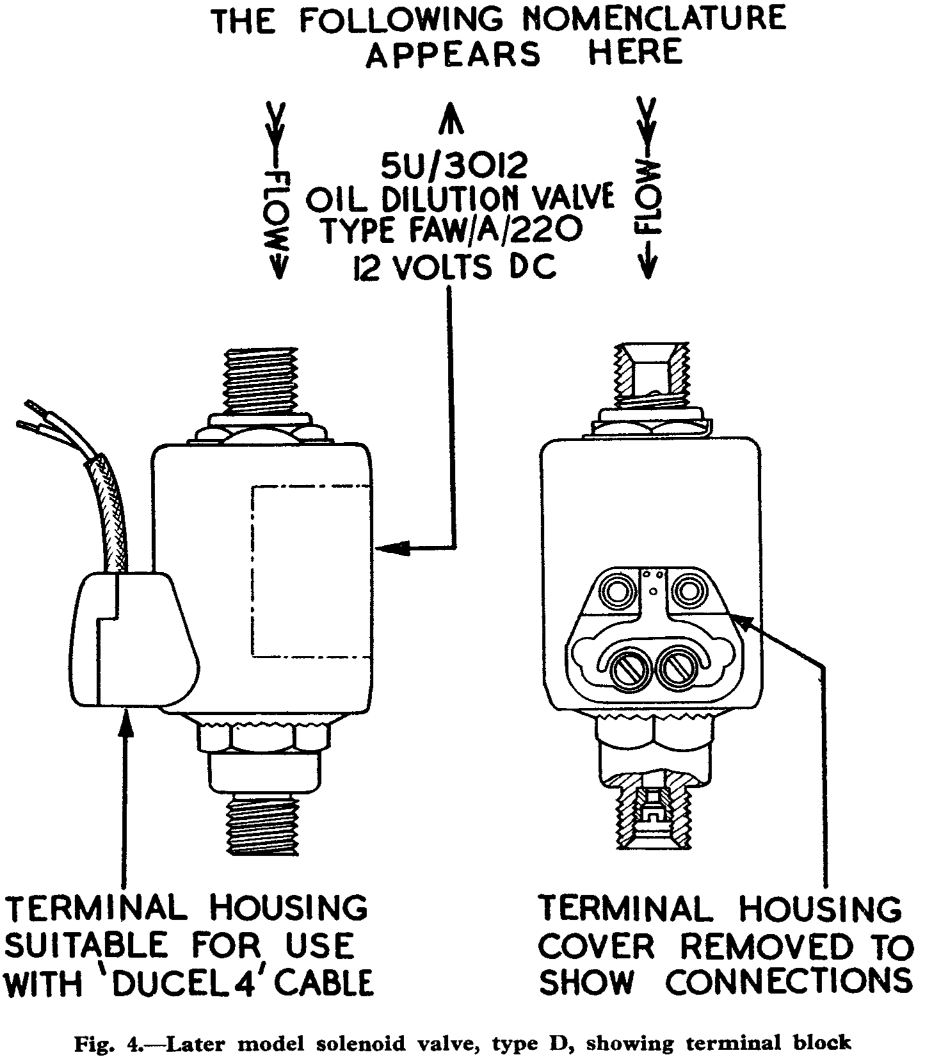

Fig. 4.—Later model solenoid valve, type D, showing terminal block

INSTALLATION

8. When the solenoid valve assembly is first drawn from stores, there is a screwed dust cap at each end of the armature to keep dust and dirt from getting into the fuel duct and valve. When these dust caps are removed, the entry point of the fuel duct running through the centre of the armature is connected to a pipe-line running from the delivery side of the fuel pump or reducing valve, and the delivery end, that is, the valve outlet, of the solenoid is connected to the suction side of the oil pump. The solenoid is connected to the electrical circuit of the aircraft either by the cable provided, or by cable to the terminal block on the side of the valve, while a spring-loaded push-button switch is included in the circuit to enable the valve to be controlled from the pilot's cockpit.

SERVICING

9. Servicing of the oil dilution valve consists chiefly in regular examination to ensure that it operates with an audible click when the switch is pressed. The valves cannot be repaired in service.

10. Routine testing should include a test for continuity through the windings, and an insulation resistance test taken by connection through the leads or terminals. Insulation resistance should not be less than 30 megohms when tested with a 250 V. insulation resistance tester.

11. An inspection of the switch should verify that the push-button moves freely in its guide, and that there is no tendency for it to stick in the ON position.

12. A solenoid valve which appears to be defective should be replaced by a new or reconditioned one. In removing faulty valves of the cable attached type, that is, the older type and type C, remember that the Ducel cable MUST NOT BE CUT, as any shortening of the 36 in. cable renders the valve non-standard, and so unsuitable for re-issue.

13. The following table gives the various types of valve available, and their associated jets:—

			Stores Ref.
Solenoid valve—type A, without jets		12 volt	5U/1513
		24 volt	5U/1514
Jets for type A valve	No. 1	0·046 in.	5U/10
	No. 2	0·070 in.	5U/11
	No. 3	0·089 in.	5U/12
Solenoid valve—type C, with 36 in. length of Ducel cable attached		12 volt	5U/1566
		24 volt	5U/1567
Type D, with terminal block		12 volt	5U/3012
		24 volt	5U/3013
Jets for type C and D valves	No. 1	0·046 in.	5U/1559
	No. 2	0·070 in.	5U/1560
	No. 3	0·089 in.	5U/1561

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CHAPTER 3

MOTOR AND GEARBOX FOR OIL COOLER SHUTTER CONTROL

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LIST OF ILLUSTRATIONS

Introduction

1. The complete unit, see fig: 1, is designed as an electrical remote control for operating the oil cooler shutters of aircraft engines.

2. Simply explained, it consists of a small motor (1) suitably geared to control the oil cooler shutters by means of a crank and linkage, the motor being operated by a switch on the engine instrument panel or automatically by means of a thermostat in the oiling system.

3. An indicator, which is operated by a transmitter of the Desyn type and which is adjacent to the manual operating switch on the instrument panel, records the position of the cooler shutters at all openings. At the motor end, the transmitter is connected mechanically by linkage to a crank (2) fitted to the same shaft that carries the crank (3) operating the cooler shutters.

DESCRIPTION

General

4. The motor and gearbox control unit as shown in fig. 2 consists of a small 24-volt motor (1) attached to the gearbox (2) which operates the quadrant (3), through a worm (4), and worm wheel (5), and reduction wheels (6).

5. Incorporated in the worm wheel is an adjustable clutch (14) and attached to the motor there is a metal cup (7) known as a diverter pot which houses a diverter coil, the latter acting as a dynamic brake.

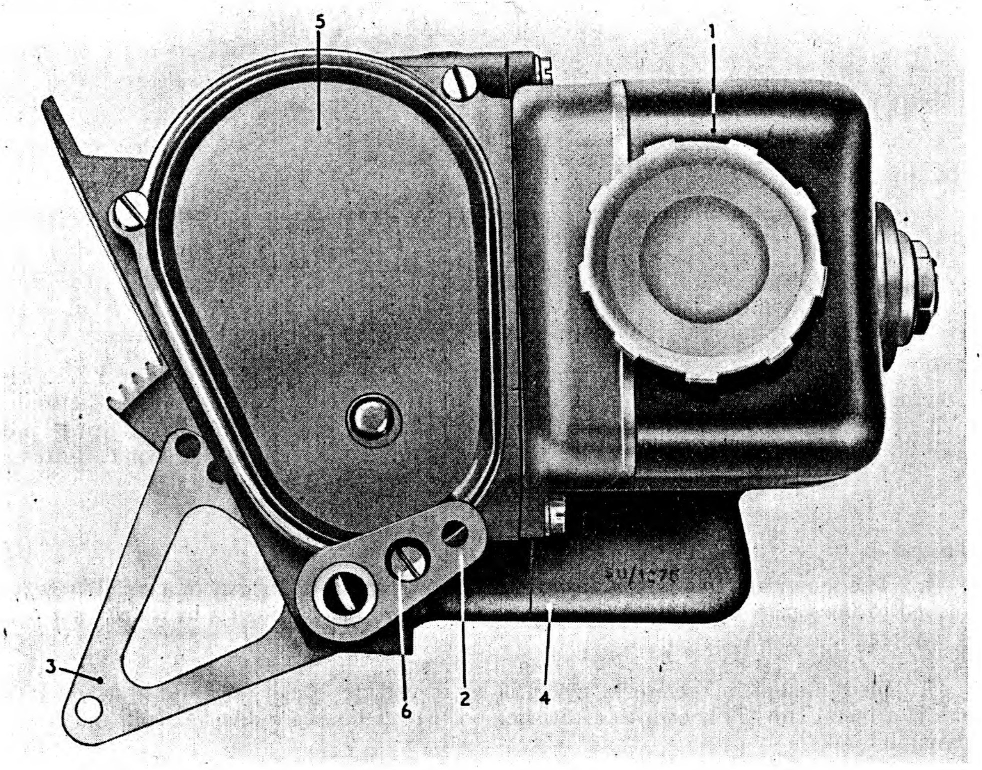
6. On the reverse side of the gearbox and under a bakelite cover is an adjustable limiting switch mechanism, the function of which is to limit the extreme ends of the movement. Fig. 3 illustrates this mechanism, the "fully open" limiting switch (1), the "fully closed" limiting switch (2), and the operating arm (3) are clearly seen. Attached to the side of the gearbox is a four pin plug (4) for connection to the electric supply and controlling switch.

7. Attached to, and integral with, the quadrant is an operating arm or crank (5) and riveted to the quadrant shaft is another small crank (6). The former crank is linked to the oil cooler shutter and the latter to the transmitter of the oil shutter indicator.

The motor

8. The motor is a two-pole split series wound machine having one field winding on each pole. One field gives clockwise rotation and the other anti-clockwise. Across the armature is connected a diverter coil or dynamic brake, the coil itself being housed in a metal pot, fig. 2 (7), fixed to the

outside of the bakelite yoke casing. The armature shaft is provided with ball bearings at each end and a single ball at the extreme end of the shaft at the commutator end, acts as a thrust bearing against a steel disc. The latter is adjustable by means of a screwed bush and when adjusted to the correct clearance, the bush is locked in position by means of a dished washer. The driving end frame is of metal but the yoke casing and commutator end frame, which are integral, is of bakelite. The yoke complete with the field coils is a sliding fit into the yoke casing and is secured by two studs and nuts. Brass brush-holders are secured in position in the bakelite end frame by means of grub screws and the brushes and brush springs in the holders by brass brush caps. Connections to the brush-holders from the winding are by phosphor bronze coil springs round the outside of the holders, the latter having turned grooves to accommodate them. The brush connections and those of the field coils pass through the bakelite yoke casing, a rubber grummet preventing damage to the insulation of the leads. The diverter coil leads pass from the brush-holder connections to the diverter coil directly through the yoke casing under the diverter coil pot. The driving end shaft has a worm drive machined on it.

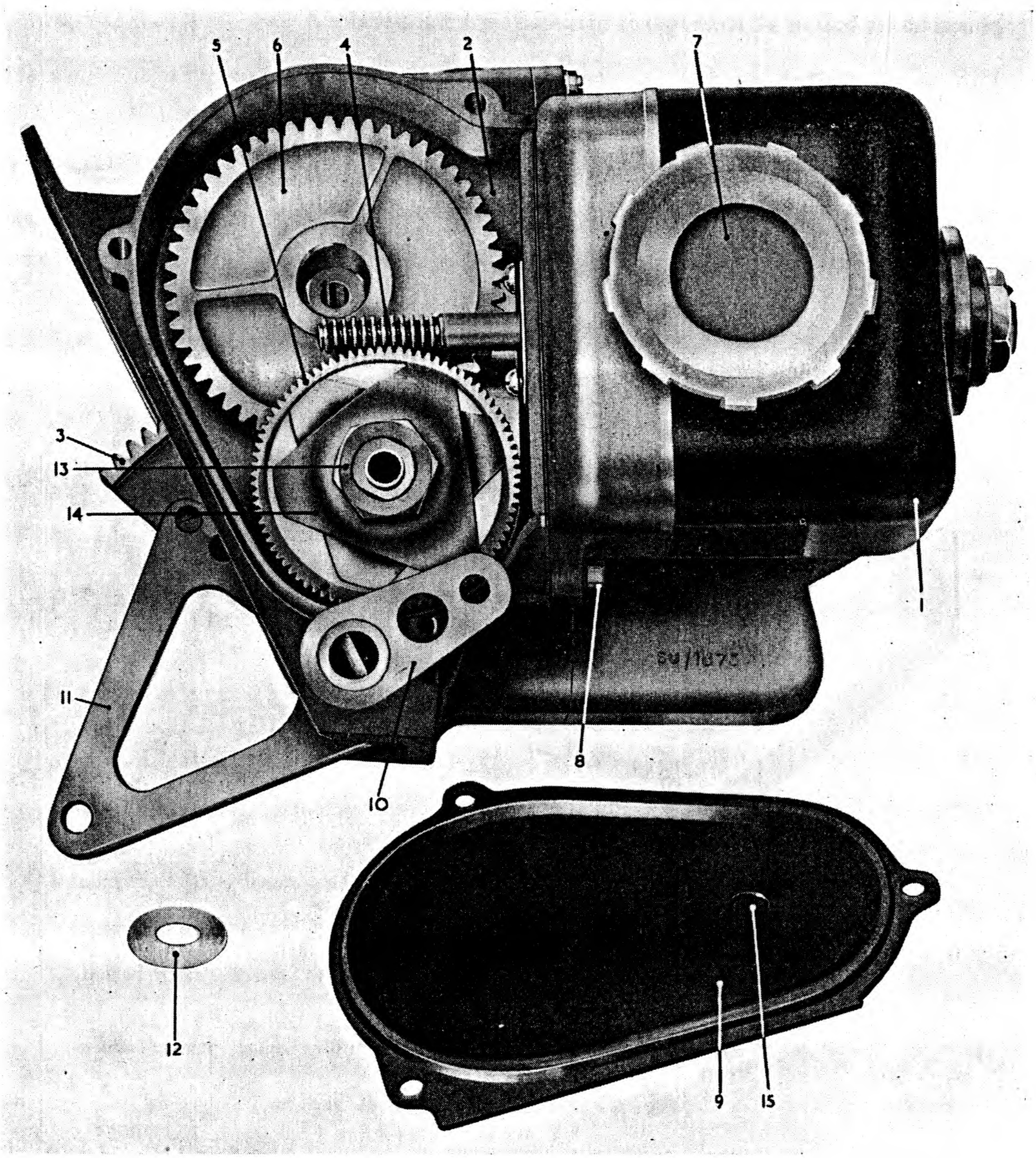


1—Motor
2—Indicator crank or arm
3—Oil cooler shutter crank or arm
4—Gearbox
5—Gearbox cover
6—Gearbox cover screw

Fig. 1.—Motor and gearbox for oil cooler shutter

Gears

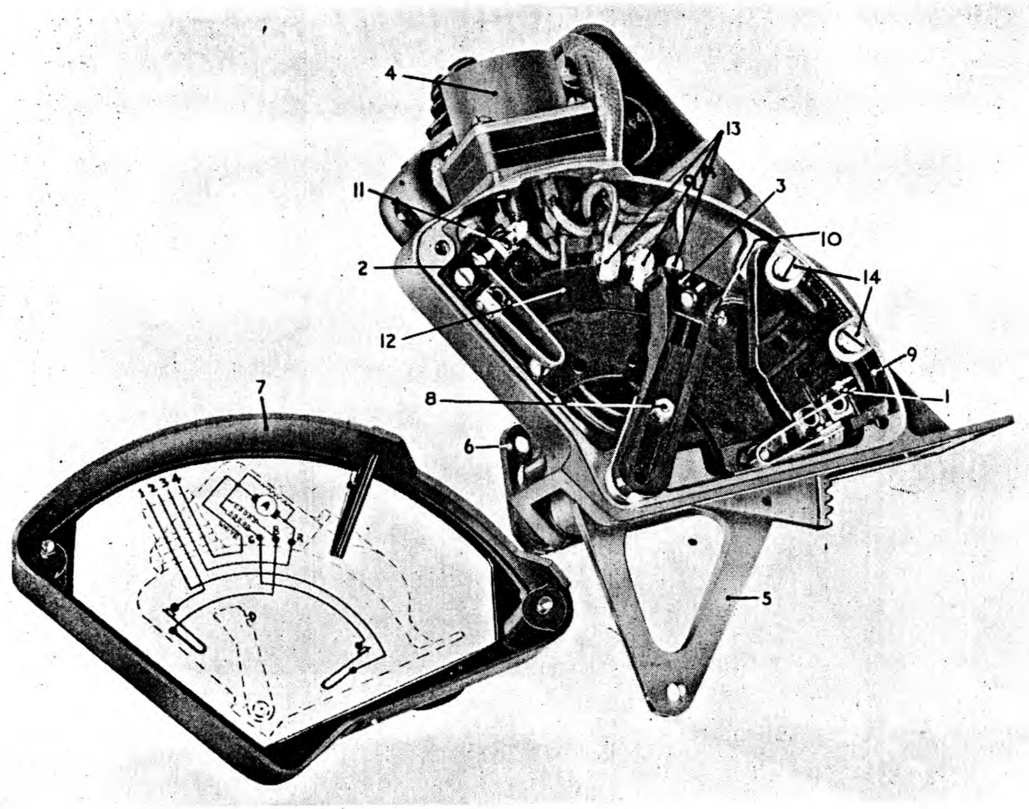
9. The worm drive acts on a bakelised fabric helical or worm wheel fig. 2 (5). To this worm wheel is assembled a friction clutch (14) through which the gears are driven. The clutch is adjustable by means of a nut (13) the latter being drilled and tapped to accept a grub screw for locking purposes. The clutch is set to a pre-determined torque, and if this torque is exceeded the clutch slips, allowing the motor to run on, thus preventing any damage to the motor or the mechanical moving parts of the installation.



1—Motor
2—Gearbox
3—Quadrant
4—Motor shaft worm drive
5—Worm wheel
6—Intermediate gear wheel
7—Diverter pot
8—Screw fixing motor
9—Gearbox cover
10—Indicator crank or arm
11—Oil cooler shutter crank or arm
12—Thrust washer
13—Clutch adjusting nut
14—Clutch plate
15—Recess to accept worm wheel spindle

Fig. 2.—Gearbox with cover removed

10. The ratio of the worm and worm wheel is 84 to 1. To the same hub as the worm wheel is fitted a chrome steel pinion having 14 teeth. The worm wheel and pinion revolve on a fixed shaft and are kept in place by a steel thrust washer (12) bearing against the gearbox cover plate (9) the latter being dished outwards to accept the end of the hub of the shaft (15). The worm wheel pinion engages with an intermediate gear wheel (6) having 52 teeth. The intermediate gear wheel has a pinion on its hub of 14 teeth and is mounted on a fixed shaft.



1—"Fully open" limiting switch
2—"Fully closed" limiting switch
3—Operating arm
4—Four pin plug
5—Oil cooler shutter crank
6—Indicator crank
7—Bakelite cover
8—Operating arm fixing nut
9—"Fully open" switch bakelite insert
10—"Fully open" fine adjustment stud
11—"Fully closed" pin adjustment contact
12—"Fully closed" switch bakelite insert
13—Terminal tags
14—"Fully open" coarse adjustment screws

Fig. 3.—Switch control, cover removed

11. The pinion of the intermediate gear drives directly on to a quadrant (3) having the equivalent of 110 teeth for a full circle. This gives an overall ratio of approximately 2,450 to 1 between the motor and quadrant. The gearing and shafts are housed in a light alloy casting in which provision is made to attach the motor by two cheese headed screws (8).

12. The quadrant has an operating arm or crank (11) riveted to it to which the oil cooler shutters are linked. Attached to the quadrant shaft is another operating arm or crank (10) for operating the indicator on the engine instrument panel through the medium of the transmitter. Both the quadrant and indicator operating crank are fitted to a common shaft by means of splined rivets; set screws being provided to fix the relative positions on the shaft whilst the shaft is being drilled and the splined rivets fitted.

Limiting switches

13. Under the bakelite cover on the side opposite the gears are housed the limiting switches, fig. 3 (1) and (2). The moulded operating arm (3) is attached to a short metal arm this being a part of, and integral with, the shaft carrying the quadrant. It is attached by means of a small screw, nut and spring washer (8). Moulded inserts (9) and (12) carry the "fully open" limit switch and the "fully closed" limit switch respectively. The "fully open" switch and moulded insert is coarsely adjustable by means of the two screws (14). Fine adjustment is obtained by varying the length of the small stud (10) on the moulded operating arm for the open setting and by an adjustable contact (11) for the closed position. On the moulded insert carrying the closed switch there are three tag terminals (13) to which are soldered the incoming leads from the motor and outgoing leads to the limiting switches and plug. These are again shown in the wiring diagram fig. 4 at G, B and R. A four-pin plug fig. 3 (4) for connection to the electric supply and controlling switch is fitted to the gear case by means of four cheese headed screws and spring washers.

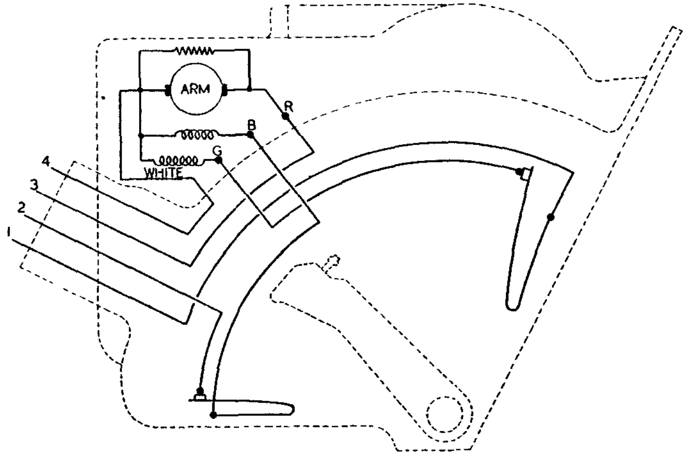


Fig. 4.—Wiring diagram

OPERATION

14. When the control switch is operated in the "open" or "closed" positions, the motor rotates clockwise or anti-clockwise respectively, operating the cooler shutters accordingly. If the shutters are required to be "fully open" or "fully closed" the switch is left in the desired position and the limiting switch applying, which is in series with the main switch, is opened by means of the operating arm coming in contact with it at the end of its travel, thus breaking the circuit. The indicator arm or crank on the quadrant staff operates the transmitter, the latter transmitting its motion electrically to the visual indicator on the instrument panel. The control switch can be manually placed in the OFF position at any point of opening and the cooler shutters will remain in that position.

15. To avoid the inertia of the motor running the mechanism past the desired opening after the current is switched off, the diverter coil is connected across the armature and acts as a brake. The revolving armature, due to residual magnetism, generates an electric current and the diverter coil acts as a load on the "generator" and rapidly decelerates the armature. Across the armature is also connected an indicator lamp, the latter situated adjacent to the control switch on the instrument panel, and when the motor is running, that is, a current is applied to it, the indicator lamp automatically lights up and indicates the fact. Should one of the limiting switches fail to operate at the end of the travel, the connecting mechanism is prevented from strain and the motor from stopping by slipping of the clutch incorporated in the worm wheel. The fact can be seen on the instrument panel by reason of the indicator showing the shutters fully open or fully closed as the case may be and the indicator lamp showing that the motor is still running.

16. On some aircraft the control of the cooler shutters is not manually operated but is carried out by means of a thermostat in the oil circuit, keeping the oil temperature approximately constant. Full particulars of this type of control is given in Chapter 4 of this Section.

INSTALLATION

Adjustments

17. When the control unit has been fitted to the aircraft by means of the screws and bolts provided and after the oil cooler shutter linkage, the indicator linkage, and electrical connections are made, adjustment must be carried out.

18. It is assumed the linkage to the cooler shutters has been adjusted to the shut position with the control arm, fig. 3 (3) just braking the limit switch (2). Operate the unit electrically to the "fully open" position and when the shutters are fully opened, switch off if this has not already been done automatically by the open limit switch. Roughly adjust the latter by loosening the two screws (14) and sliding the bakelite insert to the approximate position and securely tightening the screws. Fine adjustment must then be made by the adjusting screws (10) and (11) for the "fully open" and "fully closed" position respectively.

19. Tests should be carried out by operating the unit to the "fully opened" and "fully closed" positions from the normal switch allowing the motor to switch off automatically by means of the limiting switches and so take into account the slight overrun of the motor.

SERVICING

20. The unit, as a whole, requires very little attention. Periodically check the contacts and contact springs of the limit switches for serviceability. The contacts may be cleaned with fine glass paper or lightly with a fine file. The complete limit switch and bakelite insert must be renewed if a fault occurs, no attempt to remove the switches from the bakelite should be made.

21. Inspect the gears for faults and add a little anti-freezing grease (Stores Ref. 34A/49) if necessary. To inspect the gears, the cover, fig. 1 (5) must be removed. To do this the unit should be operated until the hole in the indicator crank or arm (2) is opposite the screw (6) and stopped in that position by manually switching off.

22. The motor bearings are packed with grease when received and no attention is required. The complete motor has to be dismantled for the re-lubrication of the bearings and this must only be carried out by a Maintenance Unit.

Technical data

23. The following are technical details.

(i) Normal operating torque available in 150–170 lb./in. pre-set by the friction clutch incorporated in the worm wheel. This clutch is adjusted by the manufacturer and must not be altered except in an emergency, when adjustment of the clutch should be carried out in the following manner. Remove the complete motor and gearbox unit from the aircraft and rig it up in a bench vice with the shutter operating arm or crank horizontal and clear of the bench to enable weights to be suspended from it. Unlock the adjusting nut, fig. 2 (13), by unscrewing the grub screw and tighten the adjusting nut fairly tight. Suspend a weight of 80 lbs. in the linkage hole of the shutter operating arm and gradually slacken off the adjusting nut until the clutch shows signs of slipping and the weight starts to descend. The actual adjustment is when the clutch just holds the weight of 80 lbs.

(ii) The radius of the shutter operating arm is 2 in.

(iii) The available radial movement of the shutter operating arm is approximately 80 degrees.

(iv) The four-pin plug is marked internally on the bakelite 1, 2, 3 and 4, and the connections are "open", "close", "common wire" and "indicator lamp" respectively.

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CHAPTER 7

MULTI-BREECH for Coffman starters

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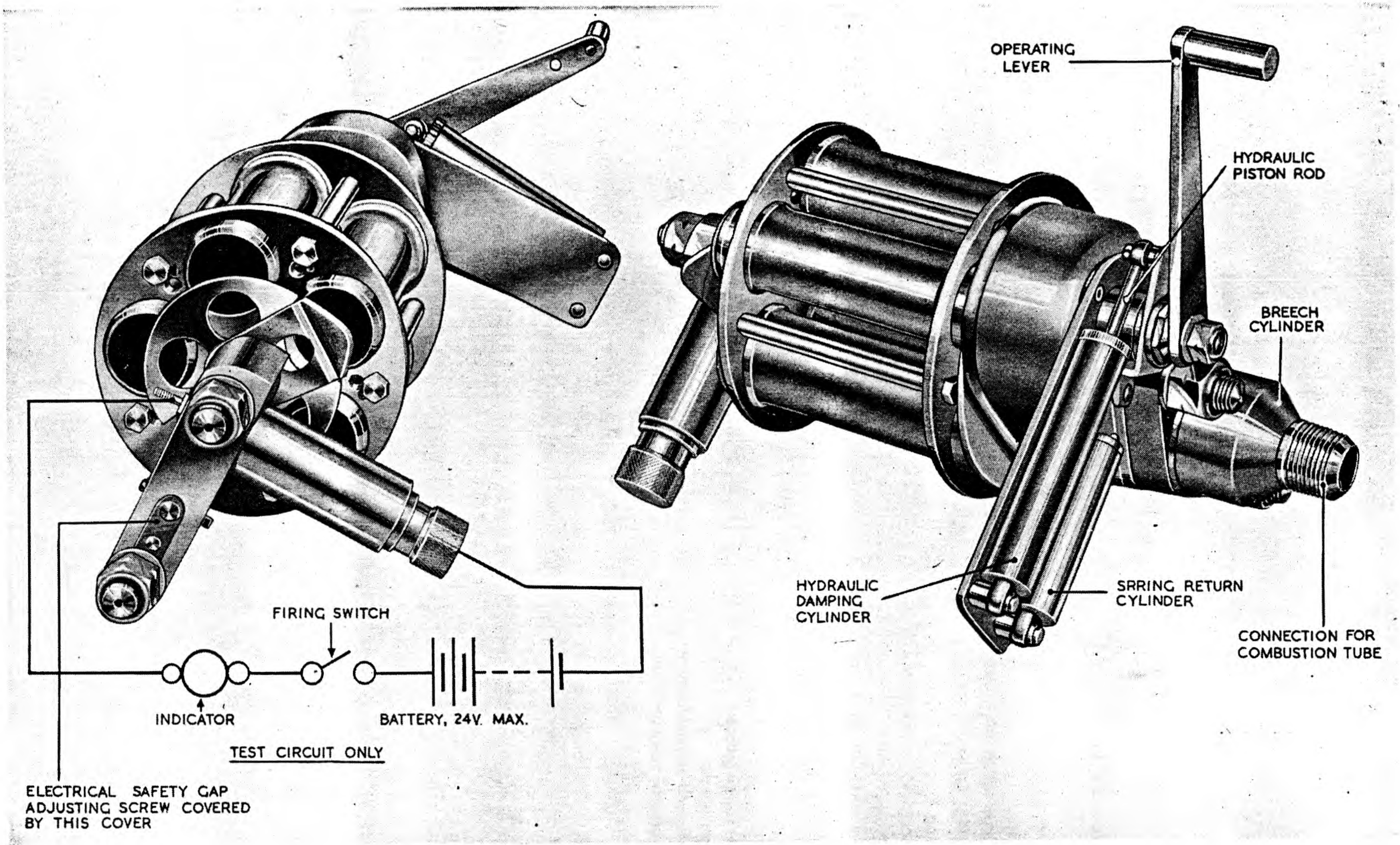

Fig. 1.—Typical multi-breech

CHAPTER 7

MULTI-BREECH for Coffman starters

Introduction

1. The multi-breech is a mechanically operated, remotely controlled breech, and is used with Coffman engine starters. The purpose of this chapter is to describe the electrical wiring and apparatus connected with the breech, and no attempt will be made to deal with mechanism that is not directly connected with the electrics.

DESCRIPTION

2. The multiple breech, which accommodates five cartridges at one loading, may be operated either directly or remotely, and is similar in principle to the mechanism employed in a revolver breech. The Mk. I, V, VIII, and VIIIA type breeches are spring return, and the Mk. II and VI push-pull operated. The complete breech unit consists of a barrel assembly indexing mechanism, operating lever, loading door, firing mechanism, and an electrical safety device. It is illustrated in fig. 1, a diagram of the electrical wiring appearing in fig. 2 and is the same for all marks.

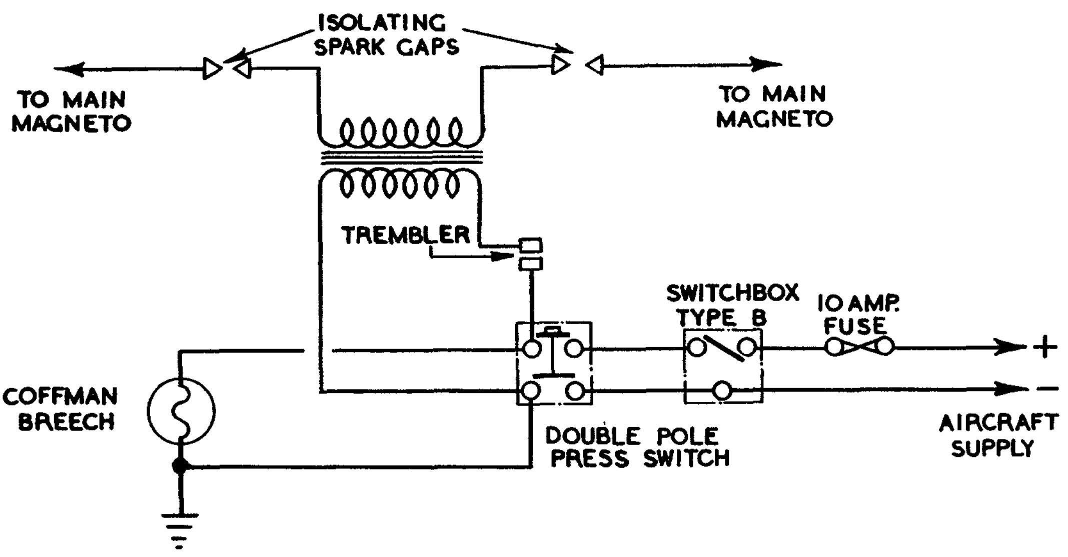

Fig. 2.—Wiring diagram

3. The firing mechanism is operated electrically, a lead from the double pole firing switch, fig. 2, being connected to a 10 ohm resistance shown in fig. 3 located in an insulating sleeve, in a tubular housing screwed into the rear end casing. There is an insulating bush at each end of the resistance which is retained by a plug screwed into the resistance housing. The connecting cable passes through a terminal bush of insulating material which is tapped for a terminal screw. This screw provides electrical contact between the cable and the resistance. A split clamp bush secures the cable and is in turn retained by a knurled metal cap screwed on the resistance housing plug. An earthing screw is screwed into the opposite side of the end casing, for the earth return.

4. The 10 ohm resistance is incorporated to limit the current passing through the breech. The breech resistance plus the resistance of the cartridge is approximately 12 ohms, therefore the current when using 12 or 24 volt supplies is 1 and 2 amps respectively.

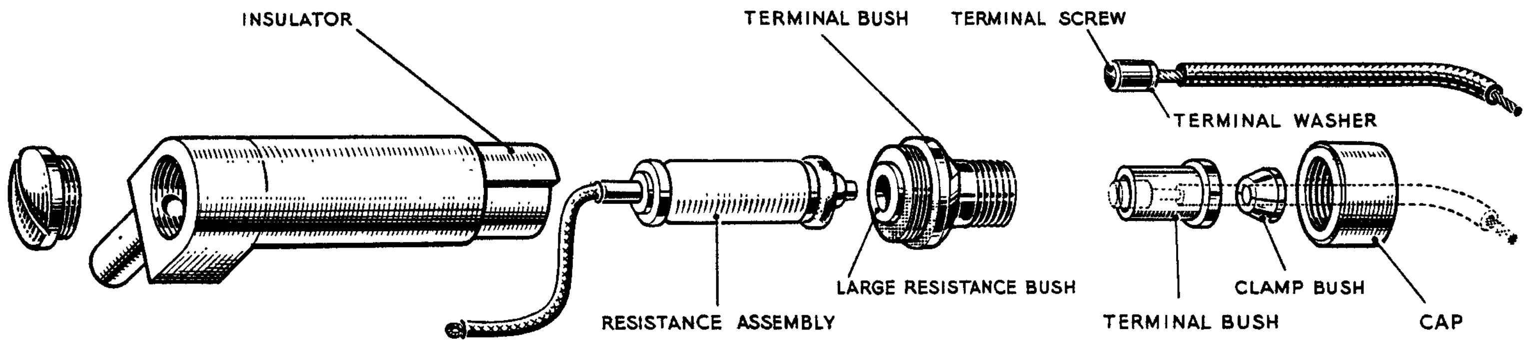

Fig. 3.—Multi-breech, exploded view

Safety device

5. A safety device is added to the firing pin operating mechanism to prevent the firing of a cartridge when the sealing piston is not properly bedded on the barrel. Attached to the sealing piston is a push-pull datum rod running to the rear beam of the breech. Should the sealing piston have left the cartridge barrel seat by more than a predetermined and safe amount, the safety mechanism is brought into operation by a system of levers, thus preventing the igniting of a cartridge.

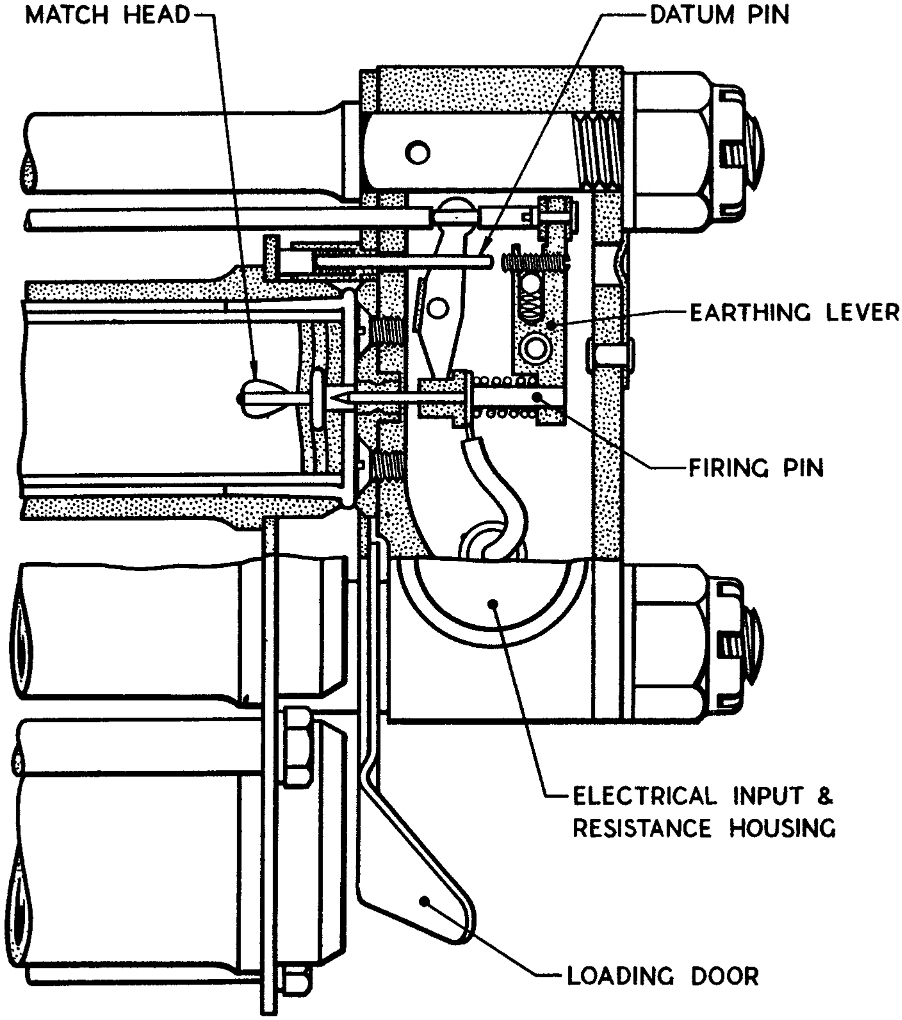

Fig. 4.—Multi-breech, sectional view

6. The maximum permissible gap between the sliding piston and cartridge barrel seating before the safety mechanism operates is 0·015 inch. It will be appreciated that the inclusion of any foreign body likely to prevent the seatings from sealing will, if large enough, be detrimental to the operation of the breech, and automatically cause the safety device to function. If, through incorrect indexing, or for any other reason, the sealing is still not correctly effected the same conditions will obtain and the breech will fail to fire.

OPERATION

Electrical circuit

7. The electrical circuit fig. 2 within the mechanism consists of a firing pin which is in electrical contact with a safety arm, both of which are insulated from the frame of the breech. When the firing switch is depressed the cartridge is fired by the current flowing through the firing pin which is in electrical contact with the cartridge, the outer casing of which is the return contact. At the same time the booster coil is energised and will remain energised as long as the firing switch is depressed.

Safety device

8. Should the adjusting screw be in contact with the datum rod any current that tends to flow through the firing pin will be short circuited to the frame via the datum rod. As, however, the adjusting screw will have been adjusted to a suitable gap when the seatings are in contact, see para. 5, this short circuit will not be produced if the gap between the seatings is between the limits set by the safety gap.

SERVICING

Electrical continuity test

9. For testing the breech, the circuit shown in fig. 1, comprising a battery, single-pole switch, and an indicator bulb or meter connected in series with the breech should be used. The normal resistance of the breech when short circuited is 10 ohms. ***Do not carry out tests with live cartridges in the breech, spent cartridges only must be used.*** The breech must be closed, with a barrel in the correct firing position or the firing pin will be short-circuited and the test circuit closed. With the switch closed, the indexing mechanism should be operated when, in every fully closed position of the breech after indexing, the lamp or meter should indicate a short circuit, thus showing electrical continuity between the firing pin and the cartridge.

Insulation test

10. The insulation test between the circuit and earth should be not less than 10 megohms using a standard insulation resistance tester type A.

Precautionary note

11. At the end of the multi-breech remote from the combustion tube or in the case of the Mk. VIII and VIIIA remote from the coupling to the starter combustion head is located a small spring latch door. The adjusting screw housed beneath this door must never be touched except by qualified personnel who are familiar with the working of the breech.

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CHAPTER 8

FIRE EXTINGUISHER CIRCUITS IN AIRCRAFT

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Introduction

1. All British aircraft are now fitted with fire extinguisher equipment which is brought into operation either automatically or by central control if a fire should break out in certain parts of the aircraft. The various electrical components forming parts of the fire extinguisher system are described in detail in other chapters in this volume of A.P.1095A, and full details of the systems are given in A.P.957C, with particulars of spray-pipe layouts and extinguisher bottle installation. This chapter describes the electrical control of the fire extinguisher circuit and shows the link up of the various components of the system. Instructions are given for the procedure to be adopted in testing such circuits: tests for specific components will be found in the chapters describing these items, which are as follows:—

A.P.1095A, Vol. I
Sect. 2, Chap. 5—Switches magnetic relay, type P
7—Switches, magnetic relay, Waymouth type RD3
Sect. 7, Chap. 9—Flame switches
10—Inertia switches
21—Delayed action switch

2. Originally, fire extinguisher systems were installed in the engines, and these are still standard in a number of aircraft. A later system is the installation of a combined circuit for engines and wing-tanks, and this, besides being installed in a new type multi-engined aircraft, is introduced as a modification on some multi-engined aircraft already in production. This combined system is referred to in this chapter as the new system and is easily identified from the original installation as it calls for two extinguisher bottles on liquid-cooled engines as in fig. 1, and three bottles on air-cooled engines as in fig. 2; in the old system, one bottle was fitted on both types of engine, except on a few radial types, where two bottles were installed.

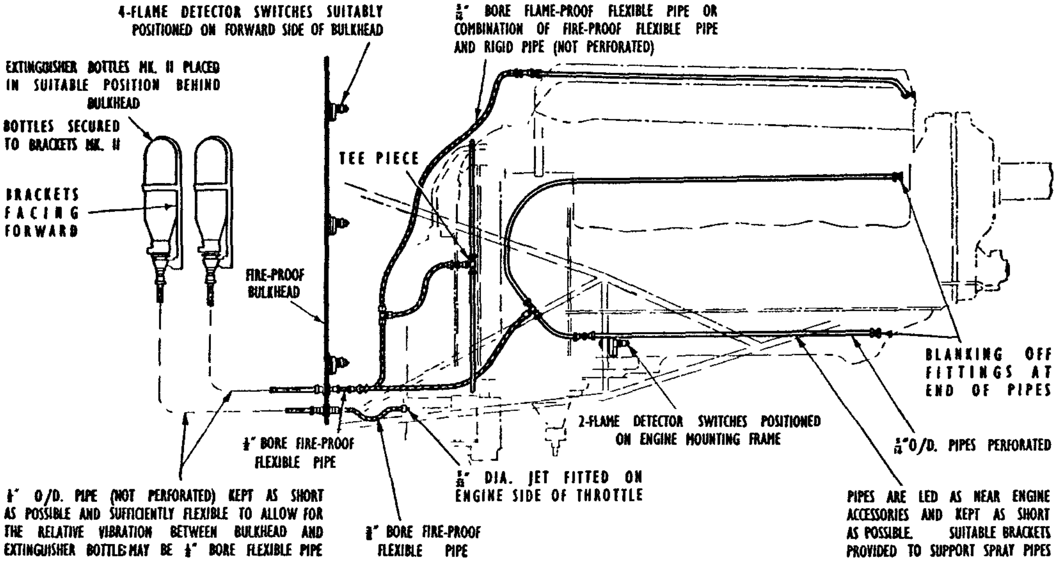


Fig. 1.—Typical layout of fire extinguisher equipment for "in-line" engines

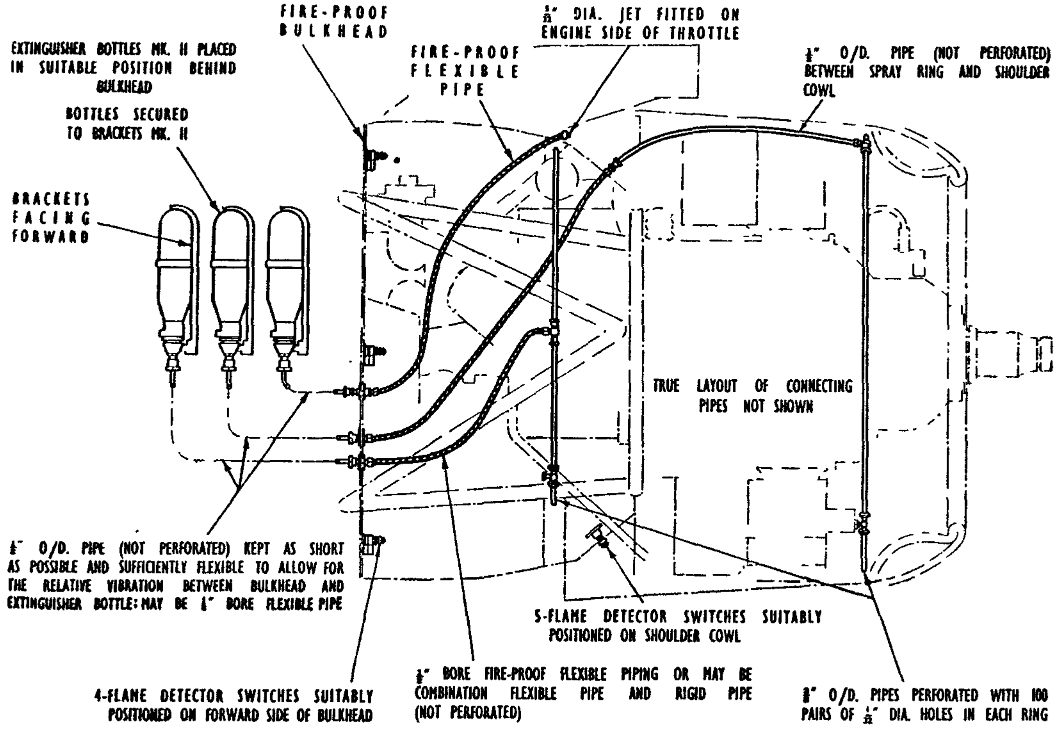


Fig. 2.—Typical layout of fire extinguisher equipment for radial engines

DESCRIPTION

Fire extinguisher system on engines

3. The new system operates on the same principle as the old method, in that the extinguisher agent is methyl bromide, which is stored in copper bottles and is distributed over the engines by means of spray piping. The bottles are electrically controlled, and are operated either by the pilot manually or through the medium of the feathering switch should a fire break out while the aircraft is in the air, or by an inertia switch in the event of a crash-landing.

4. Fig. 3 and 4 show typical wiring circuits for electric and for hydraulic or hydromatic propellers. Flame detector switches are fitted on each engine, six switches on liquid-cooled engines and nine on the air-cooled types. All the flame switches on an engine are connected in parallel, to a warning light in the pilot's cockpit, one light for each engine; this warning system is interconnected with the extinguisher system in such a way that as soon as any one of the flame switches has operated, the warning light is switched on, and the extinguisher system on the appropriate engine

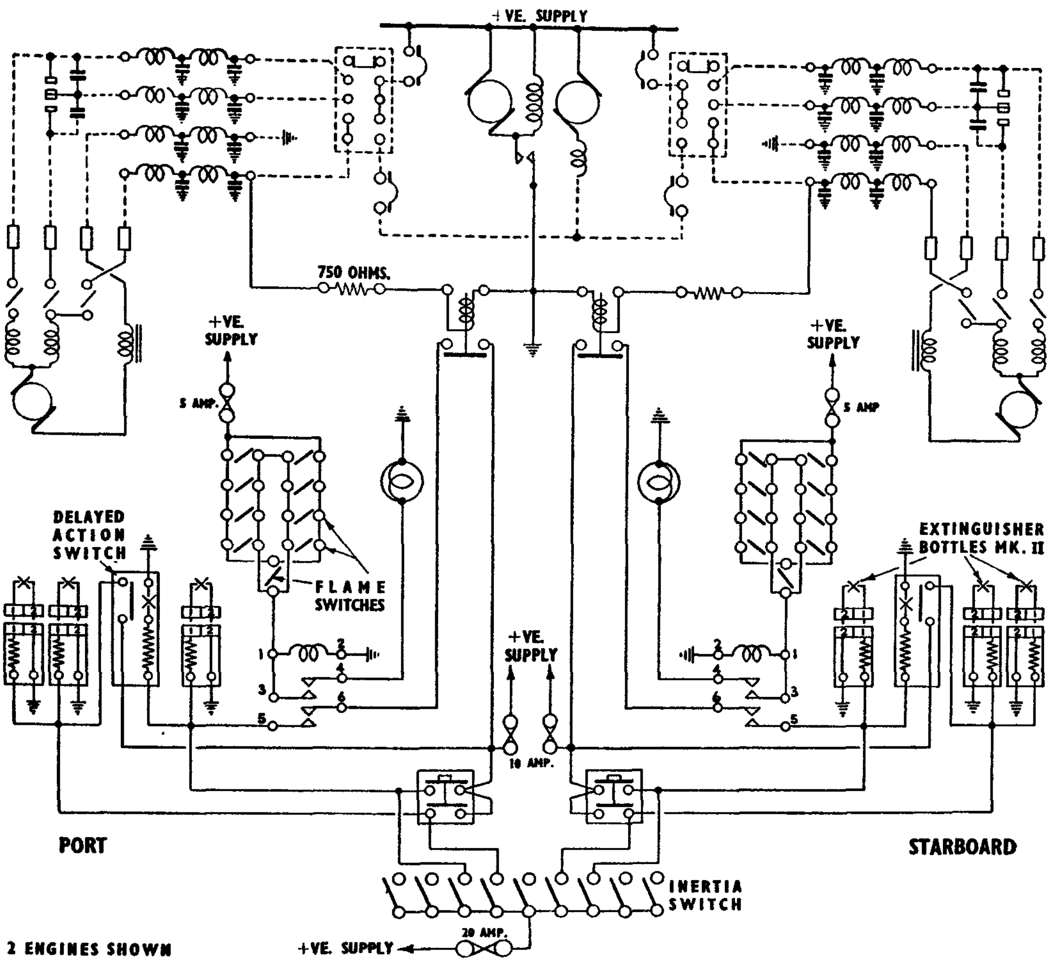
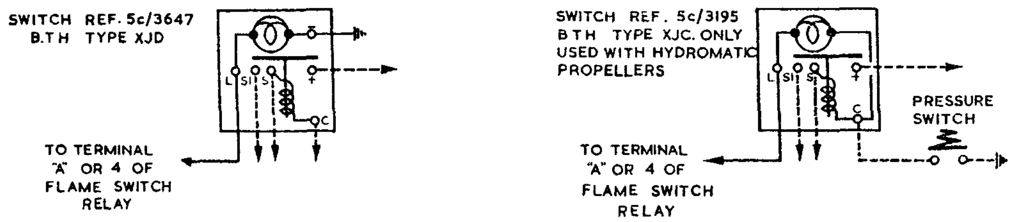


Fig. 3.—Theoretical wiring diagram of fire extinguisher circuit used with electric propellers



PROPELLER FEATHERING PUSH BUTTONS
(WITH COMBINED FIRE WARNING LAMPS)

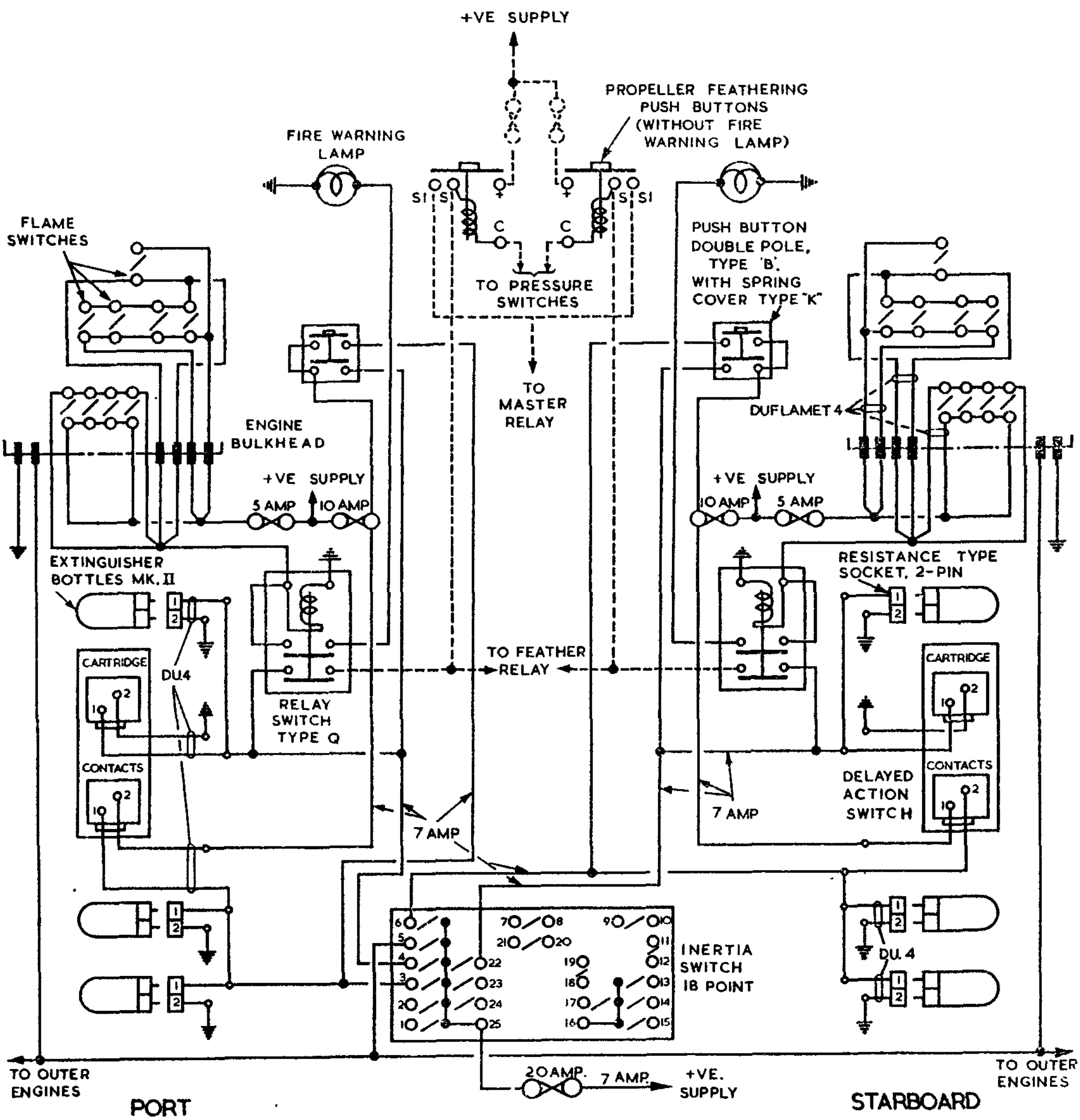


Fig. 4.—Theoretical wiring diagram for use with hydraulic and hydromatic feathering

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is connected, ready for the discharge action which follows automatically when the pilot initiates the feathering of the propeller. When the pilot sees the warning lamp illuminated, he will act in accordance with the drill laid down in "Pilot's Notes General":—

(i) Warn the crew to prepare to abandon the aircraft
(ii) Throttle back the engine concerned
(iii) Feather the propeller
(iv) Turn off the fuel
(v) Switch off the ignition
(vi) When the propeller has stopped, or nearly stopped, press the appropriate fire extinguisher button.

5. As soon as the pilot carries out operation (iii), i.e. initiates the feathering of the propeller, the fire extinguisher system is put into operation, and one methyl bromide bottle is immediately discharged into the air intake of the engine, to assist in choking the engine, and to stop flames issuing from the exhaust or from a fractured induction manifold. At the same time, a delayed action switch is set in motion which will operate the remaining bottles, causing them to discharge into the spray piping round the engine precisely 10 seconds later. The object of the time delay is to ensure that the engine has stopped, so that the source of the fire has been removed before the methyl bromide spray is exhausted: if the engine were allowed to continue running, the fire would almost certainly re-ignite immediately the spray has ceased. The circuit of operations may be traced in fig. 3 and 4.

6. It will be seen that if the automatic system fails to function, the fire extinguisher equipment will be operated manually when the pilot, in operation (vi) of the drill, presses the fire push-button in the cockpit. These push-buttons are double-pole switches (Stores Ref. 5C/540), one switch being fitted for each engine. One pole of each switch is connected to the circuit containing the extinguisher bottle feeding into the induction system and the delayed action switch, and the other pole to the independent circuit containing the remaining bottles, feeding into the spray piping. When the pilot presses the switch, all the bottles discharge simultaneously, since those normally controlled by the delayed action switch are directly connected to the second pole of the push-button, A red spring cover on the push-button marked ENGINE FIRE EXTINGUISHER prevents inadvertent operation. This push-button can be used if a fire occurs in an engine when the aircraft is on the ground: in this case there is of course no need to wait for the warning light, or to feather the propeller.

7. The fire extinguisher system on all aircraft is operated automatically by the inertia switch in the event of a crash landing: as with the cockpit push-button, in the circuit controlled by the inertia switch the discharges into the induction and from the spray rings will be simultaneous.

8. All new fire extinguisher bottles are charged with dyed bromide so that there shall be definite visual evidence if a bottle has been discharged, either inadvertently or deliberately.

Fire extinguisher system on wing fuel tanks

9. Fig. 5 shows a typical circuit and layout for the fire extinguisher system for the wing fuel tanks. The flame switches used on these tanks are of the ignition cord type. The cords are carried round the tanks, two round small tanks, and four round large tanks. Each cord is attached at one end to the explosive head of a flame switch. A fire breaking out in or near the tanks will ignite a cord and the fire will rapidly burn along the ignition cord, in both directions, to the flame switches at its ends. The operation of any one of the flame switches will initiate the discharging of the fire extinguisher bottles in that section. It will be seen from the circuit diagram that this tank extinguisher system is connected to the same inertia switch as the engine fire extinguisher circuit. In the event of a crash landing, therefore, both systems would operate automatically and simultaneously. In addition, the circuit can be manually operated by push-button switches from the pilot's position

INSTALLATION

10. Installation of the electrical circuit for the fire extinguisher system must be carried out in A.D.M. "Flamet" cable in front of the bulkhead; aft of, and within 4 in. of the bulkhead, "Flamet" or cores covered with glass silk sleeving must be used. Elsewhere, unless otherwise stated on the installation instructions for the appropriate type of aircraft, 4 amp. cable should be used. Approved type flameproof bulkhead connections are to be used throughout. On aircraft fitted with 2-pole wiring systems, the earth connections shown in the diagrams are replaced by connections to the negative supply.

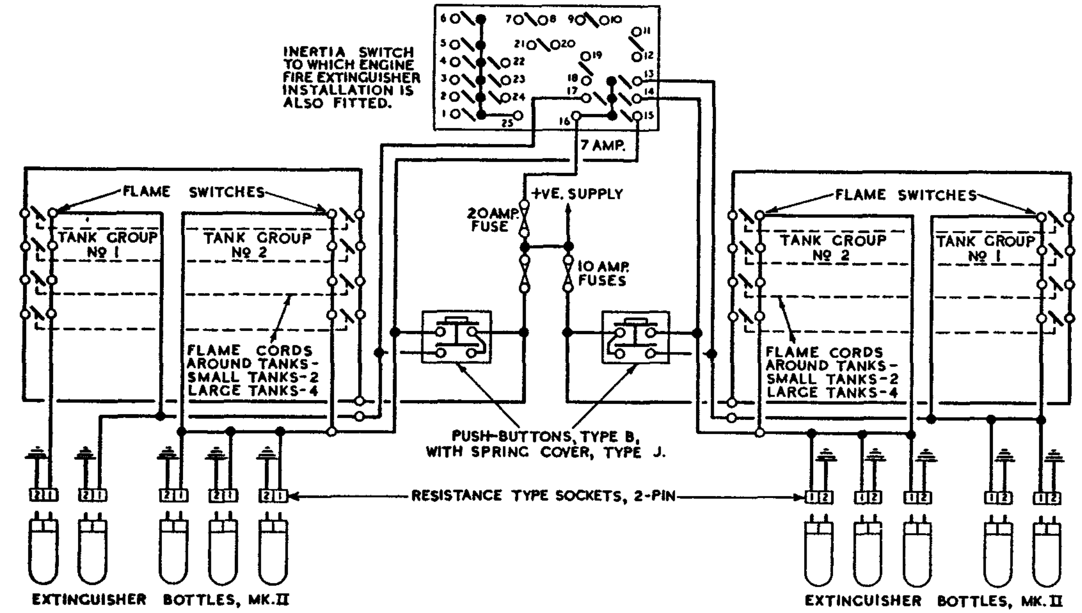

Fig. 5.—Typical wiring diagram of fuel tank fire extinguisher system for 2-tank group scheme

SERVICING

11. The servicing of the individual items which make up the fire extinguisher system will be found in the chapters listed in para. 1 describing the components.

12. The bottles should be inspected regularly to make sure that there has been no discharge, inadvertent or otherwise. Where bottles marked with an orange band are fitted, discharge can be easily checked, as an orange stain is left when the dyed methyl bromide evaporates. This can usually be seen round the joints in the engine cowlings, and in the vicinity of the spray pipings on the engine. If stains are seen, all bottles should be checked for content by weighing. Bottles marked A in black, with a band of red paint round the neck, are filled with undyed methyl bromide, and weigh approximately 10¾ lb. full or 4½ lb. empty. Bottles marked with a ½ in. wide band of orange paint round the neck contain dyed methyl bromide, and weigh approximately 9¾ lb. full or 3½ lb. empty. Both types of bottle bear the Stores Ref. 27N/14, and they are interchangeable. At least one of the bottles supplying the spray rings should contain dyed methyl bromide.

13. If any bottle is found to be wholly or partially discharged, electrical tests must be carried out. When a bottle is discharged, the plug from the bottle neck is trapped in the discharge cup on the bracket supporting the bottle: this plug must be removed before a new bottle can be fitted.

Electrical tests

14. The filaments of the warning lamps in the cockpit must be tested regularly.

15. The following drill must be carried out before proceeding with the electrical tests:—

(i) Put ground/flight switch to FLIGHT position.

(ii) Remove the electrical sockets (Resistance type, Stores Ref. 5C/3230) from all extinguisher bottles in each engine nacelle, and also all bottles in the wing tank fire extinguisher system when fitted.

(iii) Insert a test lamp (Inspection lamp, Stores Ref. 5C/369) in each of the sockets.

(iv) Disconnect the supply leads to the cartridge in each delayed action switch at the "cartridge" terminal block on the switch, and connect a test lamp across the disconnected leads.

16. Press the cockpit fire extinguisher push. If none of the lamps lights, check the source of supply, and carry out the complete minor inspection test described in para. 25–36.

17. If all the bottles in a particular engine nacelle have discharged, and the only test lamps that light up are those fitted into the sockets for the bottles feeding the spray piping, it is clear that the fire push switch has been operated, either inadvertently or otherwise. The cause of operation should be investigated. It should be noted that the circuit to the spray pipe bottles is closed permanently once the delayed action switch has been operated, but the circuits to the delayed action switch cartridge and the bottle supplying the induction spray are only closed while the fire extinguisher button is pressed.

18. Remove discharged delayed action switch. Make sure that the fire extinguisher push-button switch is functioning, by noting that all test lamps, including the one connected across the supply to the delayed action switch, light up when it is pressed. If the push-button switch is in order, fit a new delayed action switch, and connect leads to spray bottle sockets only, leaving the leads to the "cartridge" terminals still disconnected. Test the delayed action switch by inserting a screw-driver in the slot of the contact testing cam spindle, and turning it through an angle of 45–60° anti-clockwise. This closes the contacts in the switch and should cause the lamps in the spray bottle sockets to light up: the spindle must be returned to its normal position, if it does not spring back of its own accord when released. Test the fuze element of the new delayed action switch using fuze tester, Stores Ref. 5G/1142.

19. When the delayed action switch is in order, re-connect the supply leads to the "cartridge" terminals. Replace the fire extinguisher bottles in their brackets, fitting new bottles in place of any faulty or discharged ones, and testing the fuze element in each bottle with fuze tester, Stores Ref. 5G/1142. Re-connect the sockets to the appropriate bottles and return the ground/flight switch to the GROUND position.

20. If all the bottles in an aircraft have discharged, *all* lamps will light up, showing that the inertia switch has tripped. In this case, all the delayed action switches, and the bottles in all engine systems and wing fuel tank extinguisher installations, where fitted, will have discharged.

21. Re-set the inertia switch by pressing down the re-setting lever on the side of the switch case to its lowest position: rotate the SET-TRIP knob on top of the switch case until the arrow points to SET, then press the knob firmly and hold it down. Allow the re-setting lever to rise slowly as far as it will go, which should leave it lining up exactly with the indicator rib on the side of the switch case. Release the pressure on the TRIP knob. The inertia switch should now be set for action, and all test lamps should be out.

22. If any lamp fails to go out when the inertia switch has been correctly re-set, the inertia switch itself is faulty and must be replaced by a new one. Set the new switch in the manner described in the last paragraph, checking that all lights go out when the inertia switch is correctly re-set. Replace discharged bottles and delayed action switches, testing each new item with the fuze tester as described in para. 18 and 19. Finally, return ground/flight switch to GROUND position.

23. If a two-pole or earthed negative general services electrical system is used, and the system appears to have operated without the use of any of the control switches, earth faults on the wiring should be suspected, and a complete insulation test should be carried out in accordance with standard procedure.

24. When the system has been operated as the result of a fire, the whole installation must be examined for damage.

Minor inspection

Electrical tests

25. Before proceeding with electrical tests, the drill set out in para. 15 must be carried out.

Test No. 1. Open circuit

26. If the wiring is correct and the inertia switch is properly set, the circuits to each bottle and delayed action switch will be open, and no test lamps should light up.

Test No. 2. Push-button switches

27. Operate each push-button switch in turn, and ensure that all test lamps light up in the appropriate engine system.

Test No. 3. Inertia switches

28. Rotate the set-trip knob on top of the inertia switch case till the indicator arrow points to the TRIP position. Press the knob down firmly: this should cause the mechanism to operate

with a definite and audible movement, closing all contacts and lighting up *all* test lamps in the whole of the engine and wing-tank fire extinguisher system. When this test is satisfactory, re-set the inertia switch in the manner described in para. 21.

Test No. 4. Flame switches

29. Test each flame switch in turn by unscrewing the sensitive head at least two complete turns with a spanner; this should loosen the pressure in the switch sufficiently to allow the switch contacts to close, so that the appropriate warning lamp in the cockpit lights up. Re-tighten the sensitive head of the switch, and the pilot's warning lamp should go out. Lock the head in this position with locking wire through the holes provided in the head and body. Each flame switch must be tested separately, and the sensitive head properly re-tightened and locking wire fitted before proceeding with the next flame switch.

30. If the warning lamp fails to light up when any particular flame switch is tested, the leads to the flame switch must be disconnected, the flame-sensitive head completely removed, and the switch tested for continuity. If the test shows an open circuit install a new switch. If the flame switch itself is normal, then the wiring is at fault. If all the flame switches in one engine bay fail to operate the warning lamp, it is probable that the magnetic relay switch is not functioning.

Test No. 5. Switches magnetic relay (Waymouth Type RD3)

31. Select one switch in an engine system, and repeat Test No. 4. While the pilot's warning lamp is alight, operate the appropriate propeller feathering switch: check that the test lamp in the socket for the bottle feeding into the induction system lights up, and also the lamp connected in place of the cartridge of the delayed action switch. As the supply to the delayed action switches has been disconnected, these switches will not operate, and the test lamps fitted in the sockets for the bottles feeding into the spray piping will not light up.

32. Repeat this test on each engine system, making sure that the heads of the flame switches are properly tightened and locked after completing the test.

33. If either of the lamps fails to light in any of these tests, the fault is either in the wiring or in the magnetic relay switch.

34. When the tests are complete, ensure that the propellers are returned to their normal pitch.

Test No. 6. Delayed action switches

35. Rotate the slotted contact testing cam spindle by inserting a screw driver or coin in the slot and turning through an angle of 45–60° anti-clockwise: this should cause the test lamps fitted in the sockets for the bottles feeding the spray piping to light up. Ensure that the spindle is returned to its normal position when released. Test the fuze elements of the cartridge for continuity, using fuze tester (Stores Ref. 5G/1142).

Test No. 7. Extinguisher bottles

36. Having refitted the bottles and secured them in their brackets, test the fuze element in the head of each bottle for continuity, using fuze tester 5G/1142. Replace faulty bottles with new ones. When all are correct, re-connect all sockets to the appropriate bottles, connect the supply leads to the "cartridge" terminals of the delayed action switches, and finally put the ground/flight switch to the GROUND position.

Major inspection

Electrical tests

37. Carry out the drill set out in para. 14, then proceed with the electrical tests described in para. 25–36.

38. Examine all electrical wiring and connections; make insulation tests, if the aircraft is wired with a 2-pole or earthed negative wiring system.

Cleaning the spray piping

39. Remove the bottles fitted into the spray pipes from their brackets. Remove the blanking plugs from the special tees or connections provided on the spray piping and connect an air pressure line with pressure at 100 lb. per sq. in. to blow out any sand, dirt, etc., that may have collected. Replace the bottles in their brackets, and so force the air to pass through the spray holes in the piping for a period of not less than one minute, to ensure that all spray holes are free from obstructions.

40. When the test is completed, replace the blanking plugs, making sure that they are properly secured.

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CHAPTER 9

AUTOMATIC ELECTRICAL DE-ICING EQUIPMENT

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This chapter describes the electrical equipment used for the automatic detection of icing conditions on aircraft, and also the electrical control system for energising the pumps supplying the de-icing fluid, either to porous metal (T.K.S.), or woven overshoes (Dunlop) distributors for the wing and tail surfaces. The equipment consists of an ice detector head, which is similar to a pitot head, fitted to the aircraft in a position known to be most susceptible to icing. An associated relay may be used to indicate to the pilot that icing conditions prevail, or to automatically switch on the de-icing fluid pump control circuits, causing the pumps to run according to a pre-arranged cycle of pumping operations, thus economising in the use of fluid while effectively de-icing. Alternatively the pumps may be operated manually by the pilot.

2. The following paragraphs deal with the T.K.S. de-icing system consisting of the ice detector head, S.S. and S. ice detector relay, T.K.S. control unit, and the electric pumps. Details of the mechanical part of the equipment may be found in A.P.1464D, Vol. I, Part 2, Sect. 4, Chap. 6. The T.K.S. control unit is described in A.P.1095A, Vol. I, Sect. 6, Chap. 10, and the electric pumps are described in A.P.1095C, Vol. I, Sect. 4, Chap. 7.

DESCRIPTION

Automatic ice detector

3. The ice detector is composed of two units, the detector head which is mounted on the wing or fuselage, and the ice detector relay unit which is mounted inside the wing or fuselage; the latter unit is electrically connected to the T.K.S. de-icing control unit.

4. The detector head is a heated pressure head fitted vertically in the air stream; it has a number of small holes on the leading side, and a smaller number of similar holes

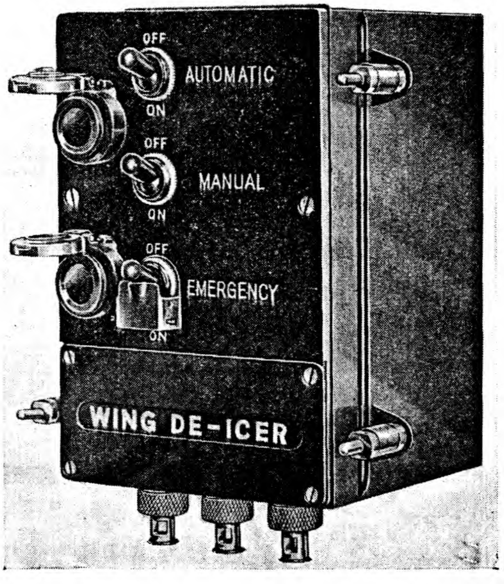

Fig. 1.—Controller, Type A

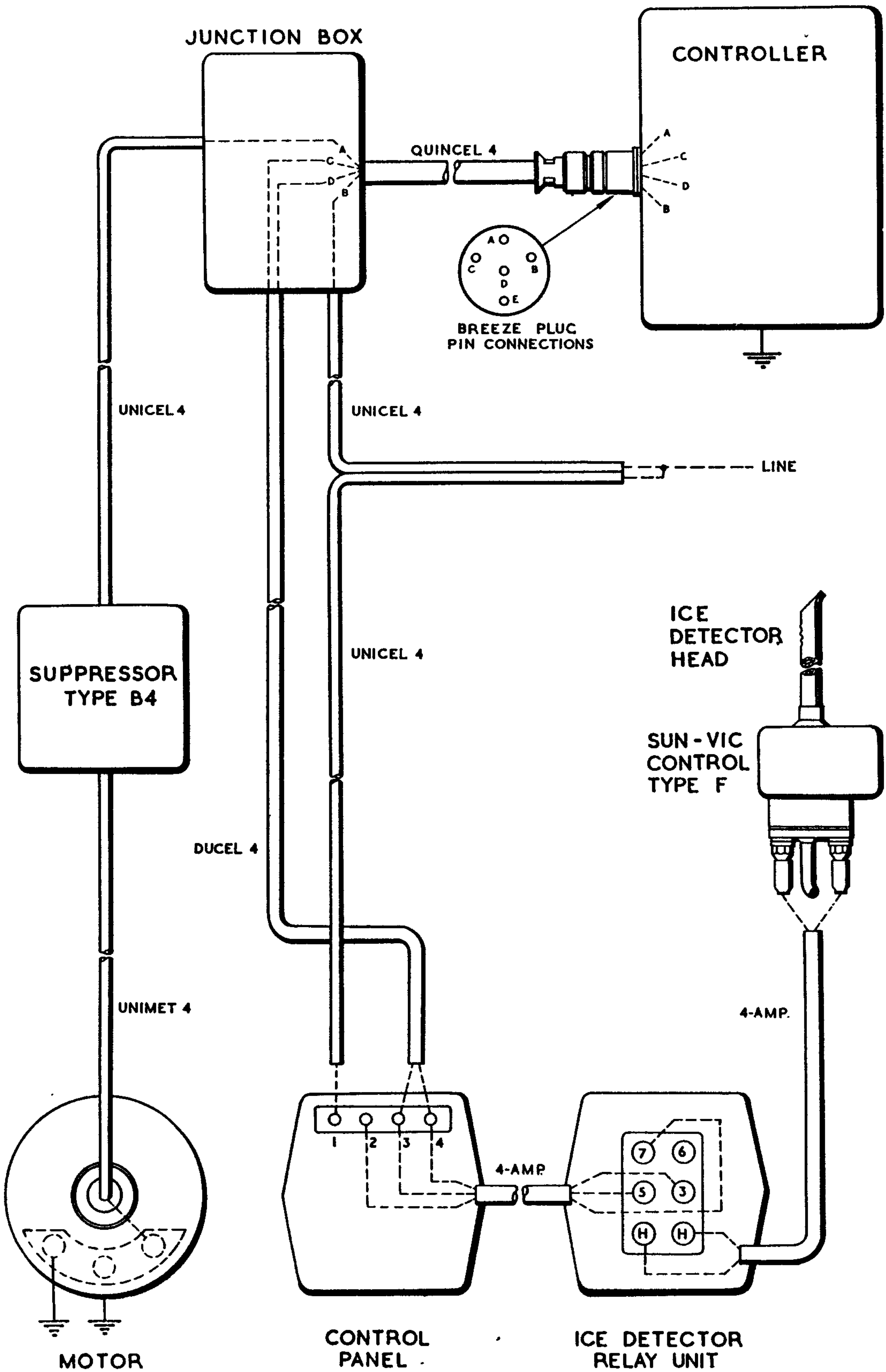

FIG. 2.—GENERAL ARRANGEMENT OF DE-ICING SYSTEM

on the sheltered side. The holes are so proportioned that in normal conditions of flight a positive pressure is built up inside the head, but if the leading holes get blocked, as they would be by the formation of ice, the pressure condition inside the head swings over to negative, or suction. This controls the detector relay and a few seconds after ice forms, the heater is automatically switched on, clears the ice from the leading holes and is automatically switched off again, so that the cycle can be repeated continuously as long as icing conditions prevail.

5. The pressure and suction pulses from the detector head are transmitted by flexible pipe line to the detector relay unit, which contains a sensitive pneumatic switch. As soon as the suction impulse is received, the switch contact closes and approximately three seconds afterwards the relay, operated by the contact, closes, too, and remains closed until a period of three to four minutes has elapsed since the last ice warning suction pulse. This time delay is achieved by using the intermittent switching of the de-icer pump motor as a time pulse, actuating the detector relay unit. This is set to switch off after four timing pulses have been received, but if the unit has counted a number of these timing pulses, and then received a further suction pulse from the ice detector head, the relay will be set back to its starting point again, and will take a full count of a further five time pulses before switching off.

6. The intermittent switching pulses from the control unit are due to the fact that the de-icer pump motor does not run continuously, but only for a short period in each minute to control the rate of liquid flow. It must be noted that the relay in the ice-detector unit will not break circuit until the four timing pulses have been received. If, therefore, the de-icer equipment is cut off by the master switch before the relay's circuit is completed, the de-icer gear would come into operation again immediately if the switch were closed at a later time. In order to accelerate the switching off of the relay, as for instance during ground tests, the emergency switch on the T.K.S. control panel may be switched on and off several times, and these switching pulses will simulate the timing pulses normally received from the motor circuit.

7. The cycle of operations can be followed by referring to fig. 3. The pressure or suction inside the detector head is piped to a pneumatic switch (11) inside the ice detector unit, and the switch closes if suction in the line exceeds ·9 in. water. Battery voltage will be applied to the heater (12) of a Sun-Vic Vacuum switch through a limiting resistance (13) which determines the closing time of the contacts (14). The contacts (14) close after approximately three seconds and switch on the heater in the detector head, thereby freeing the head of ice and preparing it for a new detection cycle. After the head has been cleared of ice, the switch (11) will open, and after approximately eight seconds the Sun-Vic contact (14) will again break and switch off the heater. Ice can now form again, and the cycle will be repeated until such time as icing conditions cease. The three seconds delay between the closing of contact (11) and the closing of contact (14) prevents the unit being switched on for temporary stoppages of the holes such as might occur in heavy rain. The eight-second delay in switching off the heater is intended to ensure complete de-icing of the detector head, and avoids water with a very high ice content clinging to the head and freezing immediately the heater is switched off. Item (16) in this figure is a surge suppressor having a negative co-efficient of resistivity against voltage, and its purpose is to prevent arcing across the contacts of the vacuum switch.

De-icing control apparatus

8. The T.K.S. de-icing system consists of a motor-driven, positive displacement, multi-outlet pump, a de-icing fluid filter, a motor controller, a supply of de-icing fluid, and porous leading edge distributors. The de-icing fluid is supplied from a storage tank to the pump via the filter, each individual pump outlet being piped to one or more of the porous metal distributors inset at the leading edges of the wings, tail-planes and fins. The individual pump outlets are calibrated to distribute the correct quantity of fluid to the surface served. The fluid is then carried by the air stream over all the surfaces of the wings, tail-planes, fins and controls for protection against ice formation.

9. The system provides two rates of flow of the fluid, one for normal and the other for emergency use. The motor controller which

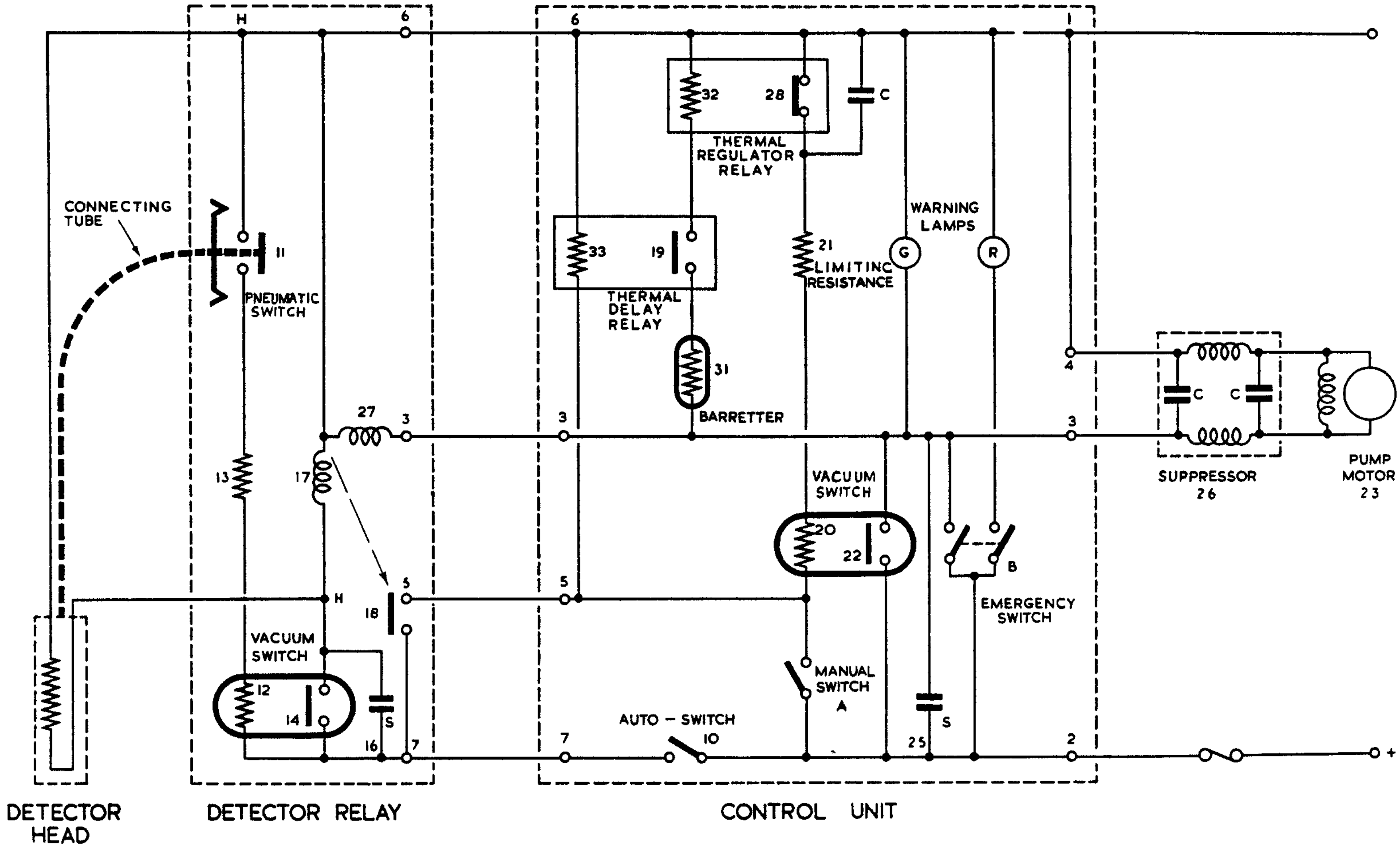

FIG. 3.—CIRCUIT DIAGRAM

runs the pump is normally set for a time cycle of one period ON to four periods OFF for normal flow, and a continuous ON for emergencies. The controller can be brought into normal operation either manually or automatically; the emergency operation is controlled by a manual switch only. When the system is first switched on, the normal intermittent flow is always automatically preceded by an initial flood period of continuous running, to wet the surface quickly.

10. The majority of service installations use the T.K.S. de-icing pump Type A: 6, 8 or 10 unit pumps. For this type, the pump motor is a 4-pole machine rated for continuous operation at 0·171 h.p. at 4,000 r.p.m. on a 29 v. supply with a maximum current consumption of 8·7 amps. Normal current consumption is 3·5 amps. during normal running at day temperature. The motor is air-cooled by a centrifugal fan fitted on the driving shaft. For a full description of these pumps, see A.P.1095C, Vol. I, Sect. 4, Chap. 7.

11. The controller unit controls the rate of flow of the fluid from the pump to the distributors. Two basic rates of flow are provided, a low rate for normal use and a very high rate for emergency operation, the pump being operated intermittently for normal flow and continuously for emergency conditions. The control panel has three switches and two indicator lamps. The first switch, marked AUTOMATIC, puts the ice detector unit in circuit, and the controller will be automatically brought into operation when ice forms on the detector. The second switch, marked MANUAL, brings the controller into operation independently of the ice detector. With the controller operating on either of these switches, the green indicator lamp will light whenever the pump is running. The third switch, marked EMERGENCY, can only be operated when a seal is broken; it then by-passes the relays on the controller and operates the pump continuously. The red indicator lights when the emergency switch is on.

OPERATION

12. The electrical circuit is shown in the schematic diagram, fig. 3, and the ice detector relay mechanism in fig. 4. The components are given the same numbers in these two drawings and "Position A," "B" and "C" refer to those shown in fig. 4. The operation of the ice detector system has been described in para. 6. Voltage applied to the heater in the detector head is simultaneously applied to the winding of a desynn type rotary impulse relay (17) and closes contact (18). The electro / mechanical device incorporating windings (17) and (27), and contact (18), provides the necessary delay to keep contact (18) closed during the whole period of icing and for four minutes after icing has ceased. The assembly, fig. 4, consists of a ratchet wheel, a cam, and a return spring, secured to a common spindle, and a "knock out" device is provided on the co-axial spindle of the impulse relay, which can lift the pawls off the ratchet wheel. The arm of contact (18) rides on the cam, and impulses to the relay (27) drive the ratchet wheel, one tooth at a time, tensioning the return spring and rotating the cam until the contact arm drops off the cam and contact (18) opens (POSITION A). The rotary impulse relay operates the "knock out" gear, lifting the driving and the locking pawl off the ratchet wheel, which is driven back by the return spring to the energised position (B). At this position the cam, which is secured to the ratchet, has lifted and closed contact (18). When relay (17) is de-energised, the pawls drop back into position as shown at (C).

13. Before ice is detected, contact (18) is open and off the cam, and the return spring is under tension (POSITION A). When the rotary impulse relay (17) is energised, the spring rotates the cam and contact (18) is closed (POSITION B), and the switches on the T.K.S. unit will operate in the following sequence. Voltage has been supplied to the heater winding (33), fig. 3, of the thermal delay relay, and to the heater (20) of the Sun-Vic control through limiting resistance (21). After three seconds, contact (22) of the Sun-Vic control closes, switching on the de-icer pump motor (23) and the green indicator lamp.

14. The thermal delay relay is so timed that its contact (19) will close after approximately forty-eight seconds to permit an initial running period of approximately one minute, and the following cycle is started. When the contact (19) closes, current flows through the barretter (31) and the heater (28) of the thermal regulator relay. The normally closed contact (28) of this relay will break after approximately five seconds and switch

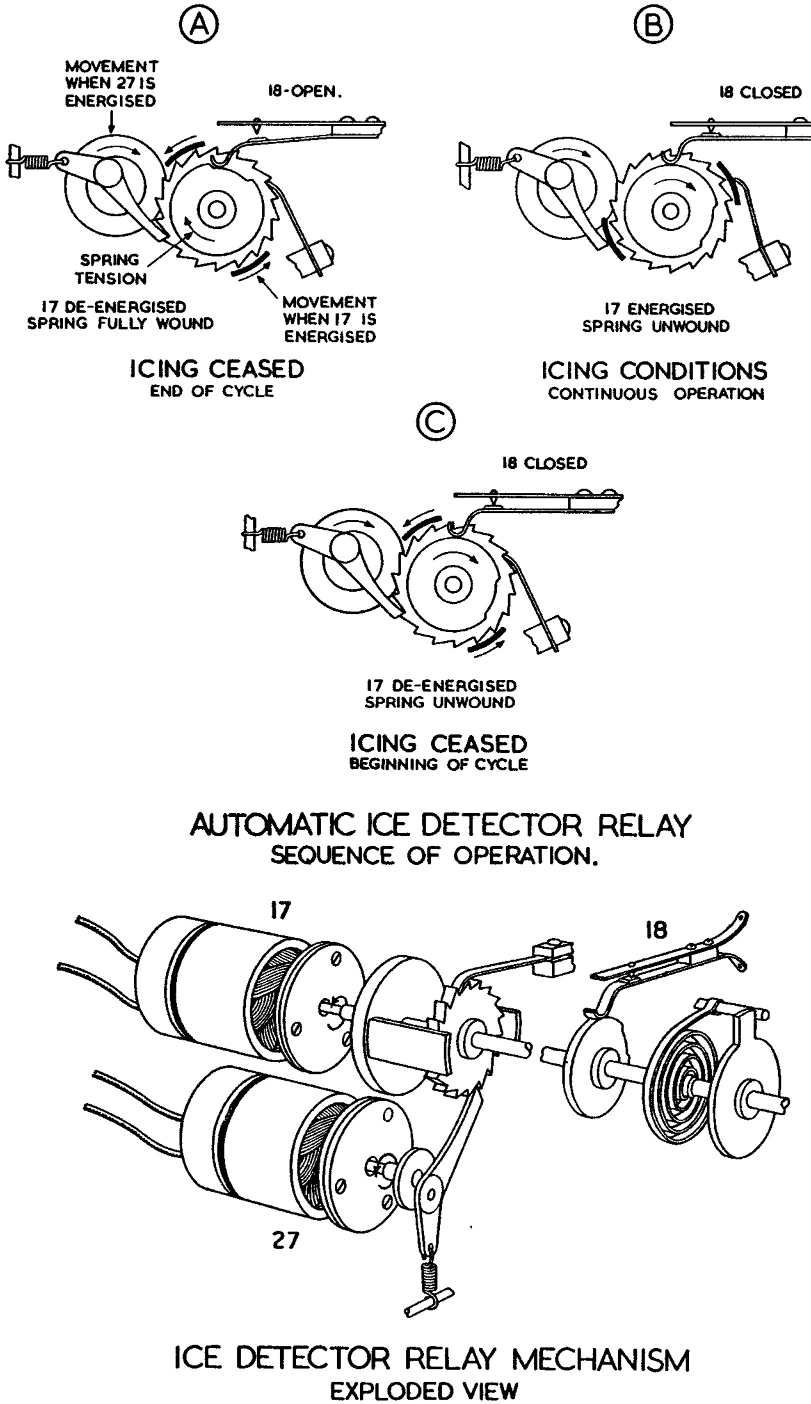

FIG. 4.—DETECTOR RELAY MECHANISM

off the heater (20) of the Sun-Vic control. Seven seconds later contact (22) will open and switch off the motor (23) and the heater (32) of the thermal regulator relay. After cooling for approximately forty-five seconds, the contact (28) of the thermal regulator relay will close again, switching on the heater (20) of the Sun-Vic control, which will close contact (22) after three seconds, thereby again switching on the de-icer motor (23) and the heater (32) of the thermal regulator unit, the cycle of operation being repeated, and continuing to operate until switch (18) is opened.

15. The same cycle of operations will take place if the manual switch (A) is closed. The sequence of events may be summarised as follows:—

(1) Close manual switch A, or detector relay contact (18).

(2) (20) and (33) energised.

(3) 3 seconds later, (22) closes, motor starts, green light on.

(4) 45 seconds later, (19) closes, (32) energised.

Note.—(19) will remain closed until some time after the manual switch or contact (18) is opened.

(5) 5 seconds later, (28) opens, (20) de-energised.

(6) 7 seconds later, (22) opens, (32) de-energised, motor stops (after running for 57 seconds), green light off.

(7) 45 seconds later, (28) closes, (20) energised.

(8) 3 seconds later, (22) closes, motor starts (after stopping for 48 seconds) (32) energised, since (19) will be closed.

(9) 5 seconds later, (28) opens, (20 de-energised.

(10) 7 seconds later, (22) opens, (32) de-energised, motor stops (after running for 12 seconds).

(11) as (7) above.

The cycle of 48 seconds off and 12 seconds on is repeated indefinitely, while the manual switch or contact (18) is closed.

16. The ratio of running time to stopped time is adjustable, but is normally set for an initial period of approximately one minute running time and thereafter for a recurrent 1 to 4 on-off cycle. The total time period of this cycle is also adjustable between approximately 50 and 100 seconds. The figures quoted above apply to a 60 seconds cycle. Details of the adjustment are contained in A.P.1095A, Vol. I, Sect. 6, Chap. 10.

17. Every time the de-icer motor is switched on, a pulse is transmitted to the winding of the rotary impulse relay (27), which operates a driving pawl, and advances the ratchet wheel by one tooth against the action of the spring. If four such impulses are received without the relay (17) having been energised, the cam will have reached a position at which contact (18) opens; but if the relay (17) is energised at any time during these four pulses, the ratchet-wheel will be returned to its starting position, so that the apparatus can continue to function for four minutes after each warning pulse from the ice detector head. From this it will be seen that the de-icing gear will continue to operate for four minutes after the last ice has been detected.

18. The time intervals quoted are only approximate and will vary slightly with voltage and temperature, but it can be seen from the principle of operation that the timing need not be very critical.

INSTALLATION

19. The ice detector unit in its anti-vibration mounting must be installed in a vertical position with the terminal block on the under side. Where practicable, the inspection window in the relay should remain unobscured.

20. The detector unit should be mounted above the level of the detector head, and the tube connecting the two must not have any dips along its length in which liquid could accumulate. In certain types of aircraft, as for example in flying boats where the head has to be on a high level to clear spray, it may not be possible to mount the unit above the head. In such cases a suitable water trap must be provided which can be drained at regular intervals. Six inches of the tubing adjacent to the ice detector unit should be of flexible rubber.

21. The terminals on the terminal block of the detector unit are numbered to coincide with the terminals on the T.K.S. unit, and like numbered terminals must be connected

together. Terminals "H" and "H" are connected to the detector head.

22. The minimum suction required to be produced by the detector head to operate the detector relay pneumatic switch is approximately 0·7 in. to 0·9 in. of water. Excessive suction or pressure should never be applied to the pipe connection or the switch will be damaged.

23. It is essential that the polarity of the battery supply to the whole installation is correct: the automatic control units will not function if these connections are reversed.

SERVICING

24. The following test routine should be carried out daily in conjunction with the fitter responsible for mechanical de-icing equipment. The de-icer fluid tank must be full when the tests are made.

Control equipment

25. The control equipment should be tested as follows:—

(1) Switch on emergency switch: pump motor should run continuously while switch is on. Both red and green lights should go on.

(2) Switch off emergency switch: pump motor should stop.

(3) Switch on manual switch: pump motor should run for about 1 min., then go off; after about 50 sec. pump motor should come on again for about 10 sec., then go off again for 50 sec. and this cycle of 10 sec. ON and 50 sec. OFF should continue as long as the manual switch is ON. When the motor is running, the green light only should be on.

Note.—Unless the manual control operates correctly, the automatic section CANNOT function.

Ice detector equipment

26. The ice detector equipment should be tested as follows:—

(1) Switch off manual switch, and allow equipment to remain off for 2 to 3 min.

(2) Unscrew metal union in the air line connecting the detector head to the relay unit.

(3) Connect a tee-piece to the relay unit side of the break in the air line.

(4) Connect an air speed indicator to the second side of the tee-piece (static nipple).

(5) Switch on automatic switch.

(6) Apply suction to the third side of the tee-piece, so that the air speed indicator reads not less than 40 m.p.h. and not more than 45 m.p.h.

Note.—If suitable test equipment is available, it is not necessary to disconnect the air line. See A.P.1275A, Vol. I.

(7) After a few seconds delay the pump motor should start; release the suction. The motor should run for about 1 min., then go off for 50 sec., on again for about 10 sec., off again for about 50 sec., and this cycle of 10 sec. ON and 50 sec. OFF should occur three or four times; the motor should then stay off until suction is applied to the air line again. The last cycle will be recognised by the motor coming on and going off again almost immediately (caused by contact (19) opening). Wait for 3 to 4 min., and if nothing further happens, the equipment may be regarded as functioning correctly.

(8) Replace the pipe line connection between the detector head and the detector relay.

Ice detector head

27. When testing the ice detector head proceed as follows:—

(1) Apply suction at the equivalent of 40 m.p.h. to 45 m.p.h. to relay side of break in air line, and maintain it for 8 to 10 sec.

(2) Release the suction: if the detector head is functioning correctly, the metal sheath with the small holes in it will be quite hot.

(3) Allow the equipment to run its full course of 4 cycles, or reset the detector relay by closing and opening the emergency switch 4 times. This should always be done after the automatic section has been started, after which the automatic switch must be switched OFF.

(4) Check that the holes in the front and rear of the detector head are not blocked.

Note. — The equipment for performing these tests is described in A.P.1275A, Vol. I.

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SECTION 7

SWITCHES AND SWITCHBOXES

LIST OF CHAPTERS

Note:—A List of Contents appears at the beginning of each Chapter

CHAPTER 1

MISCELLANEOUS SWITCHES AND SWITCHBOXES

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The switches and switchboxes described in this section are of simple, straightforward design, and of general purpose application.

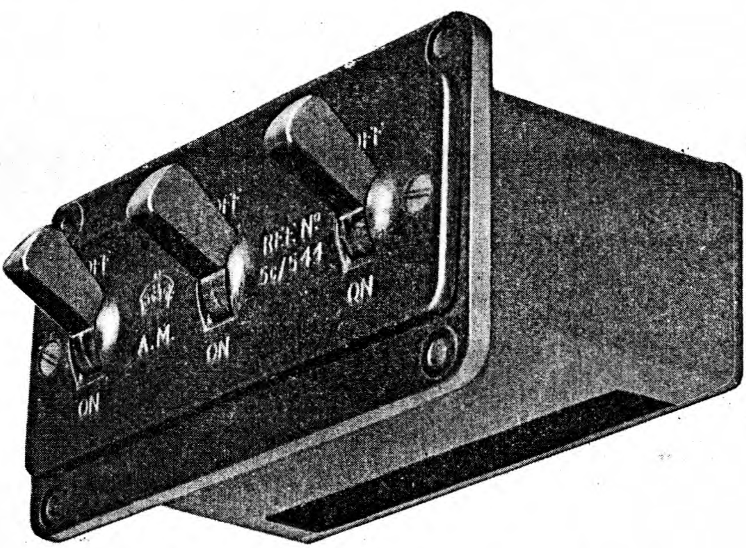


Fig. 1.—General purpose switchbox, type B, 3-unit

2. The following types are available:—

	Stores Ref. No.
General purpose switchboxes, type B—1-unit	5C/543
3-unit	5C/544
5-unit	5C/545
Starting switch	5C/695
Switch, type 49	10F/7540
Double-pole push switch, type B	5C/540
Three-way switch, type A	5C/930

DESCRIPTION

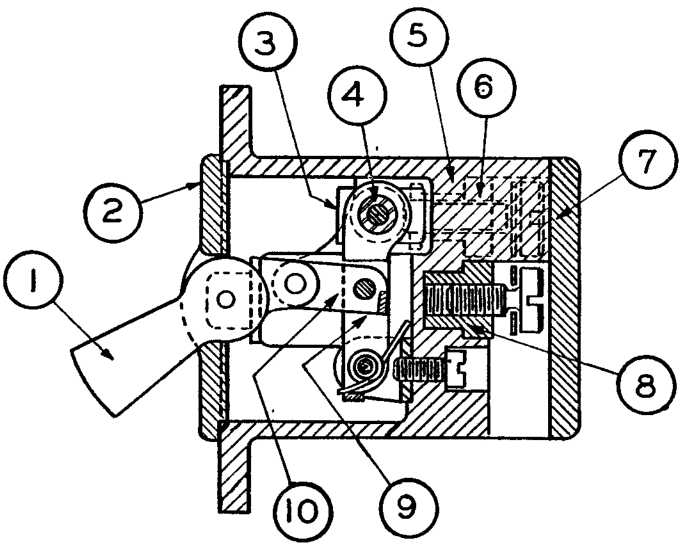
General purpose switchboxes, type B

3. These switchboxes consist of single-pole switches mounted one or more in a box arranged for flush mounting on a panel, and are for use in aircraft to control circuits in which the current does not exceed 20 amperes.

4. A 3-unit switchbox is shown in fig. 1, and fig. 2 gives a section of the switch mechanism. The body, front cover and terminal cover are of black moulded insulating material. The two contacts of each switch are of phosphor-bronze and are secured by means of the terminals. The contact blade is pivoted at the lower end and carries the copper contact stud at the upper end. This stud is insulated from the blade and bridges the contacts when the switch is on.

5. The dolly is of nickel-plated brass in switches of later manufacture, and is pivoted on a bridge at the front of the switch. A link connects the inner arm of the dolly to the switch blade and forms the usual toggle mechanism. Two springs at the pivot of the blade hold the switch in both the "on" and "off" positions and help to give a quick action when breaking the circuit.

6. The terminals pass through to the back of the switch, where screws and washers are fitted. A third terminal is provided for each switch for connecting the pole of the circuit that is not switched; in the multi-unit switchboxes these terminals are connected together by a link inside the body moulding. The switchboxes are provided with flanges for flush mounting on the instrument board or other panel, four holes being drilled at the corners for 6 B.A. screws or No. 4 wood screws. The internal circuits are given in fig. 3.



1. Dolly
2. Front cover
3. Contacts
4. Contact stud
5. Switch body
6. Terminals
7. Terminal cover
8. Third terminal
9. Contact blade
10. Link

Fig. 2.—Switch mechanism, type B

7. Particulars of the types are given below.

Type	*Weight*	*Size of flange*
1-unit	2·25 oz.	1·9 in. × 1·32 in.
3-unit	6·25 oz.	1·9 in. × 3·5 in.
5-unit	10·12 oz.	1·9 in. × 5·68 in.

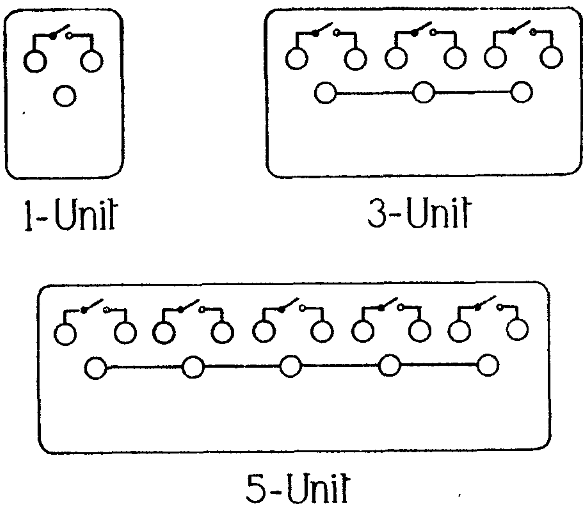
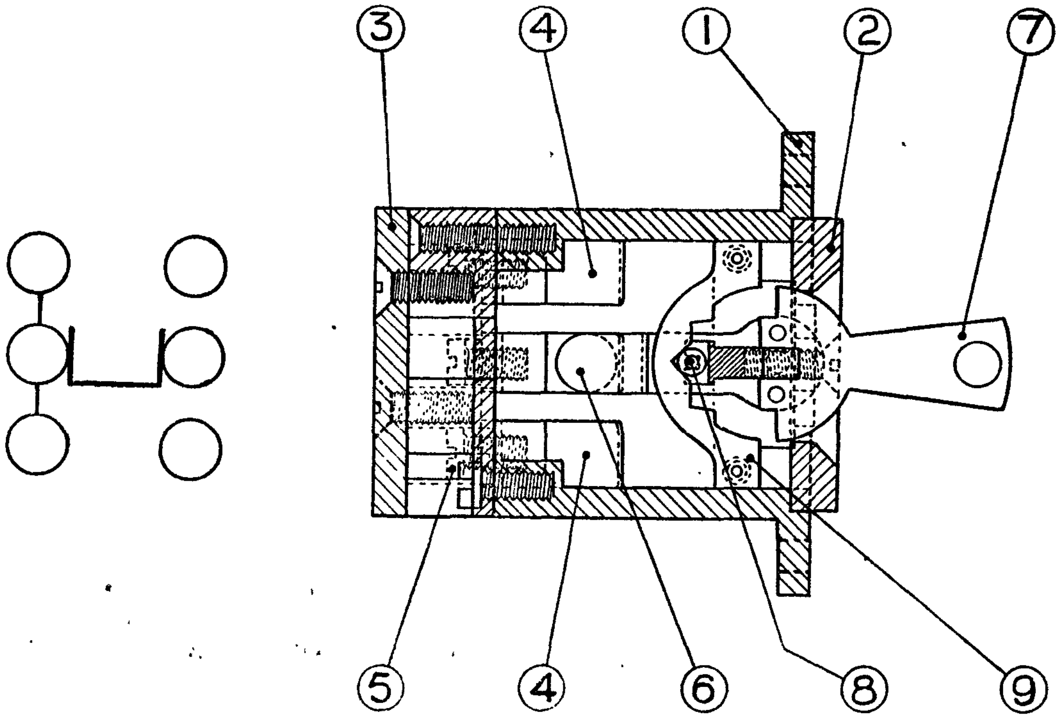


Fig. 3.—Circuits, type B switch

Three-way switch, type A

8. The three-way switch, type A, is used in aircraft for selecting one of three circuits where the current does not exceed 4 amps. Examples of the circuits it is used in are the landing lamps, downward identification lamps or similar circuits where it is necessary to select one of three lamps. When used in the landing lamp circuit the centre position is not connected up and is used as an "off" position.



1. Switch body
2. Front cover
3. Terminal cover
4. Contacts
5. Terminals
6. Contact stud
7. Dolly
8. Spring-loaded roller
9. Locating strip

Fig. 4.—Type A switch theoretical circuit and sectional view

9. A section of the switch mechanism is shown in fig. 4. The body, front cover, and terminal cover are of black moulded insulating material. The contacts are of phosphor-bronze and are secured by means of the terminals. The copper contact stud is carried on the end of the dolly, but is insulated from it.

10. The dolly is of nickel-plated brass and is pivoted on a bridge at the front of the switch. A spring-loaded roller holds the switch in any of its positions when it falls into one of the three recesses in the locating strip attached to the bridge. The spring-loaded roller helps to give a quick action when breaking the circuit.

11. The terminals pass through to the back of the switch, where screws and washers are fitted. The terminals in one bank are linked together to give a common feed. A theoretical circuit diagram is given in fig. 4, and shows the contact in the mid-position.

12. The switchboxes are provided with flanges for mounting on a panel, four holes being drilled at the corners for 6 B.A. screws or No. 4 wood screws. The overall depth of the switch is 2·44 in., and the weight is 2¾ oz.

Starting switch

13. This is a push-button switch designed to pass heavy currents such as occur in starting an auxiliary power unit by means of the dynamotor.

14. The construction of the switch is shown in fig. 5. The body, base, terminal cover and push-button are of black moulded insulation. The contact plate, which is circular, is moved by the button, and the V-section rim on it engages with the outer and inner contacts. There are two of each of these contacts, each forming nearly a semi-circle, and they are slotted to ensure even contact. The upper pair are connected to one terminal and the lower pair to the other, and when the button is pressed the terminals are thus bridged. The switch is designed for a nominal load of 100 amperes, and is fitted with spring return when the button is released.

15. The switch is mounted on the panel by means of the flange, which is 2·25 in. square and has four countersunk holes for 6 B.A. bolts or No. 4 wood screws. The overall depth of the switch is 2·65 in., and the weight is 6·5 oz.

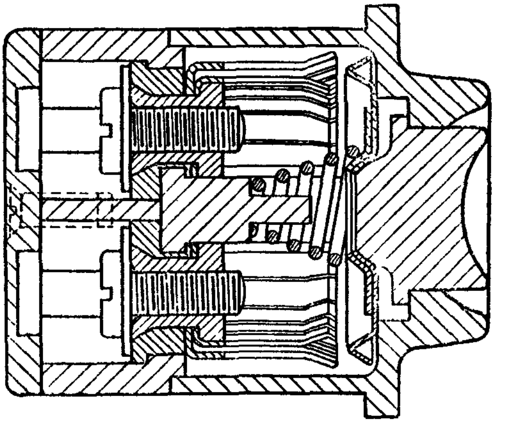


Fig. 5.—Starting switch

Switch, type 49

16. The type 49 switch is for use in aircraft for starting the 12-volt, 80-watt motor generators. It consists of two 3-position tumbler switches mounted on a base and mechanically coupled. The base contains a resistance which is connected in series with the motor armature in the intermediate position of the switch, and is short-circuited in the position for normal running.

17. The switch is shown in fig. 6. The two tumbler switches are mounted side by side on a base built up or moulded of insulating material, and the dollies are coupled by a wooden bar. The resistor is mounted in the base and is protected by a flat cover; it consists of nichrome ribbon wound on a mica former, and has a resistance of 0·4 ohms ± 10 per cent. The base is 5·625 in. by 2·6 in. and the weight of the switch is 1 lb. 3 oz.

18. In each tumbler switch one of the upper contacts is connected to the lower contact on the same side by a strip inside the switch. All other connections are made underneath the base. The circuit for each of the three positions is shown in fig. 6.

19. In operation, the handle of the switch should be moved from OFF to START, left there for two or three seconds, and then moved to RUNNING. The motor-generator must not be left running with the switch in the START position.

Double-pole push switch, type B

20. The double-pole push switch, type B is arranged to make circuit on both the positive and negative leads. It is spring-loaded and returns automatically to the "off" position.

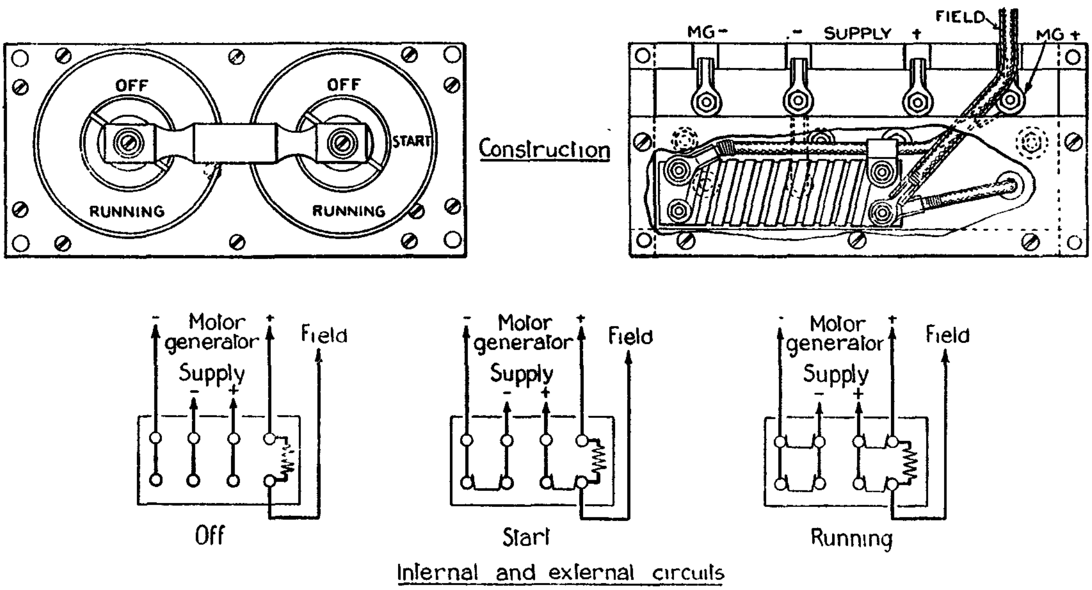


Fig. 6.—Switch, type 49

21. As shown in fig. 7, four terminals, two for the negative leads and two for the positive are mounted on a base, and each is connected to a leaf-spring contact. Two bridging pieces are mounted on a conical plunger fixed to the back of the button; one of these bridges the two negative terminals and the other the two positive terminals. The body, terminal cover, push-button, contact carrier and cap are of black moulded insulation. The contact pieces are of brass and the contact springs of phosphor-bronze.

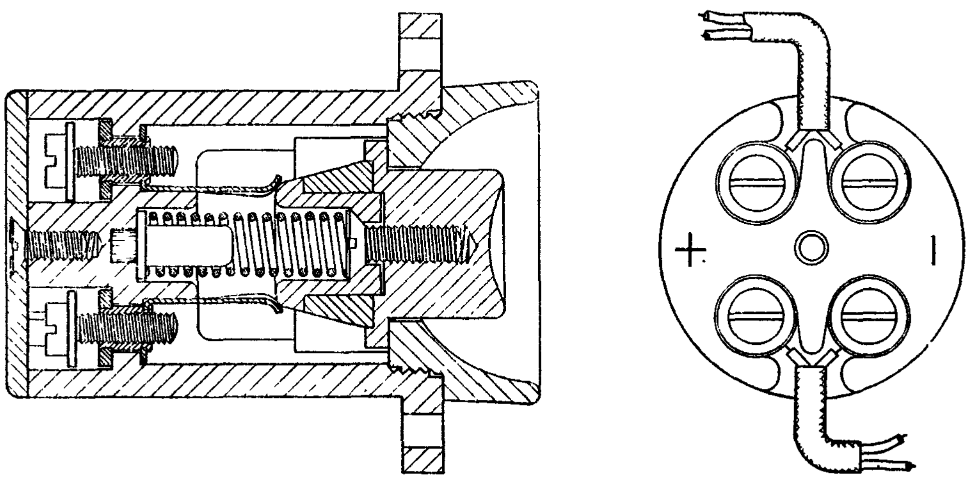


Fig. 7.—Double-pole push switch, type B

22 The mounting flange of the switch is 1·25 in. square and has four holes for 6 B.A. bolts or No. 4 wood screws. The overall depth of the switch is 1·9 in., the weight is 1⅜ oz. and the maximum current carrying capacity is 8 amp.

INSTALLATION

23. The switches and switchboxes described in this section may be mounted in any convenient position. Details of the screws or bolts requiied are given in the individual descriptions of each type.

SERVICING

24. No regular maintenance is required. Switch movements should be slick and definite. Slow or sticky switches should be replaced by new ones.

P3519 M46393/1552 1/44 8500 C & P Gp. 1

CHAPTER 2

CHARGE-REGULATING SWITCH, Type B

(Stores Ref. 5C/651)

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LIST OF ILLUSTRATIONS

Introduction

1. The charge-regulating switch, type B, is provided to control the accumulator charging current in aircraft installations in which the supply is obtained from an engine-driven generator having a control winding carrying the charging current.

2. In such installations the switch provides three circuit positions, viz. FULL CHARGE, HALF CHARGE, and OFF.

(i) In the FULL CHARGE position the shunt field is connected directly across the generator terminals and the negative of the accumulator is connected through the control winding to the negative of the generator.

(ii) In the HALF CHARGE position a resistance is inserted in the shunt field circuit.

(iii) In the OFF position the shunt field circuit and the generator control field circuit are broken, and the negative of the accumulator is connected directly to the negative of the generator.

The switch is designed to carry 20 amperes from terminals 1 to 2 and 2 to 3, and 3 amperes from 1 to 4 or 5. The type of resistance used for the field circuit in conjunction with this switch will depend on the type of generator and is given in the chapter on the generator.

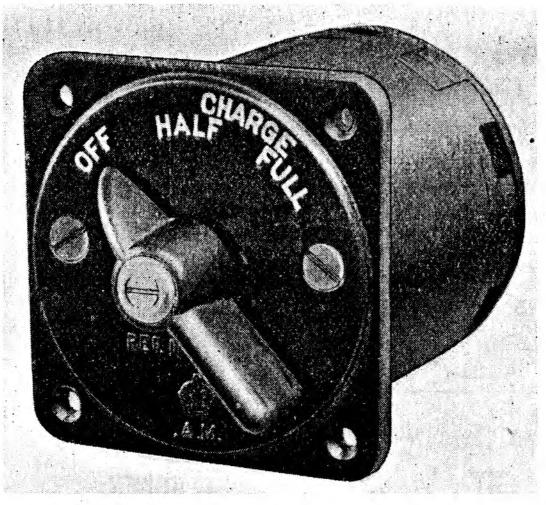

Fig. 1.—Charge-regulating switch, type B

DESCRIPTION

3. The complete switch is shown in fig. 1 and the internal construction in fig. 2. The terminal base, terminal cover, outer cover, and handle are of black moulded material. A spindle carrying the brushes turns in bearings held in the terminal base and front plate. A locating device is fitted round the spindle between the front plate and the brushes. It consists of two arms pivoted at one

end and carrying rollers at the other which bear on the edge of a serrated disc fixed on the spindle. The rollers are pressed against the disc by a spring and hold the spindle securely in any one of the three positions. The disc is so shaped that the switch cannot over-run the end positions.

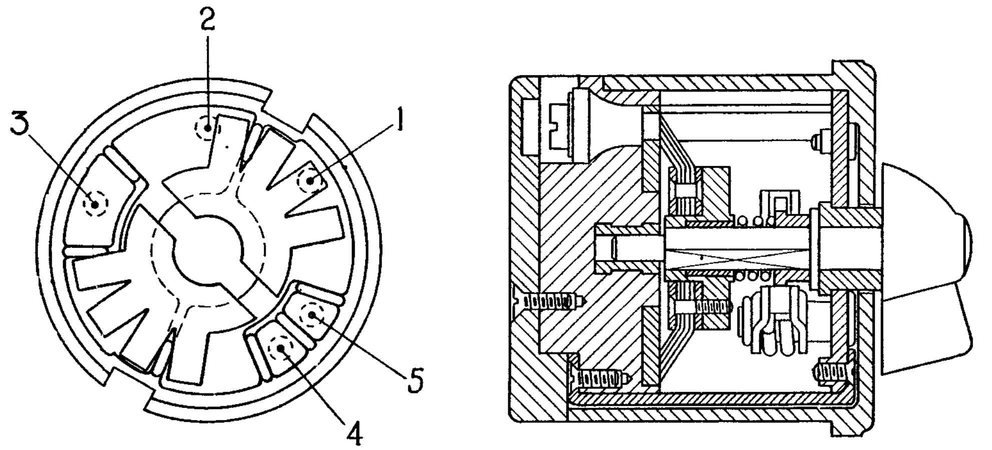

Fig. 2. Construction

4. The terminal base carries five contact plates shaped as shown in the left-hand sketch in fig. 2. The sketch shows them as they would appear if looked at from the front. Each of these plates is connected to a terminal at the back of the base, and the various connections are made by means of two separate laminated brushes, each of which has four arms. The brush clamps and spindle are omitted in the left-hand sketch of fig. 2. The brushes are shown in the OFF position, and for the HALF CHARGE and FULL CHARGE positions are turned clockwise through 45° and 90° respectively. It will be seen that the internal connections are as shown in fig. 3. The external connections (when used with a 12-volt, 500-watt engine-driven generator) are also indicated

5. The switch cover has a flange 2·25 in. square for flush mounting on a panel, and four countersunk holes are provided for 6 B.A. bolts or No. 4 wood screws. The overall depth of the switch is 2¾ in. and the weight is 7¼ oz.

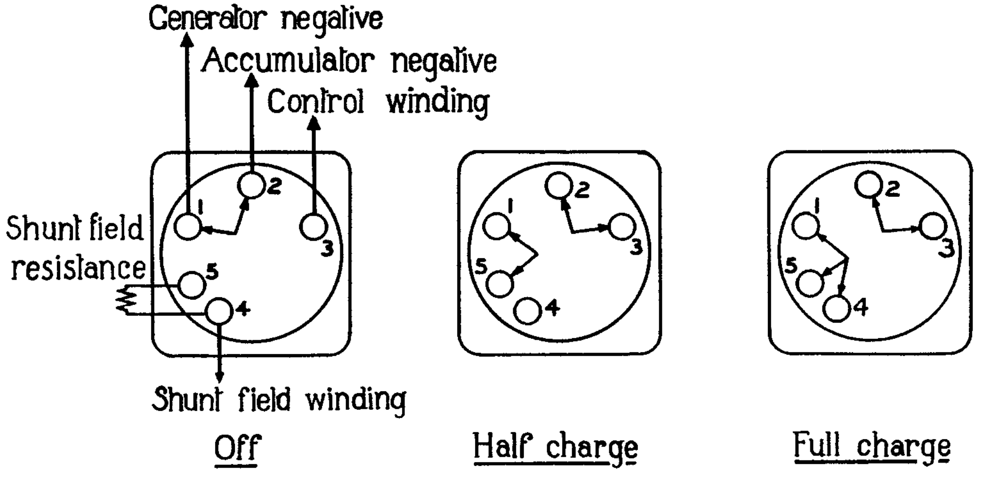

Fig. 3.—Circuits

SERVICING

6. No regular servicing is required, but on overhaul or if the movement of the switch becomes harsh, the bearing surfaces should be greased and the contact surfaces cleaned and lightly smeared with vaseline.

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CHAPTER 3

CHANGE-OVER SWITCH, Type B

(Stores Ref. 5C/694)

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LIST OF ILLUSTRATIONS

Introduction

1. The type B change-over switch is used in aircraft equipped with an engine-driven generator with a control winding, and also with an auxiliary power unit with a dynamotor for supplying electrical energy when the aero-engine is not running.

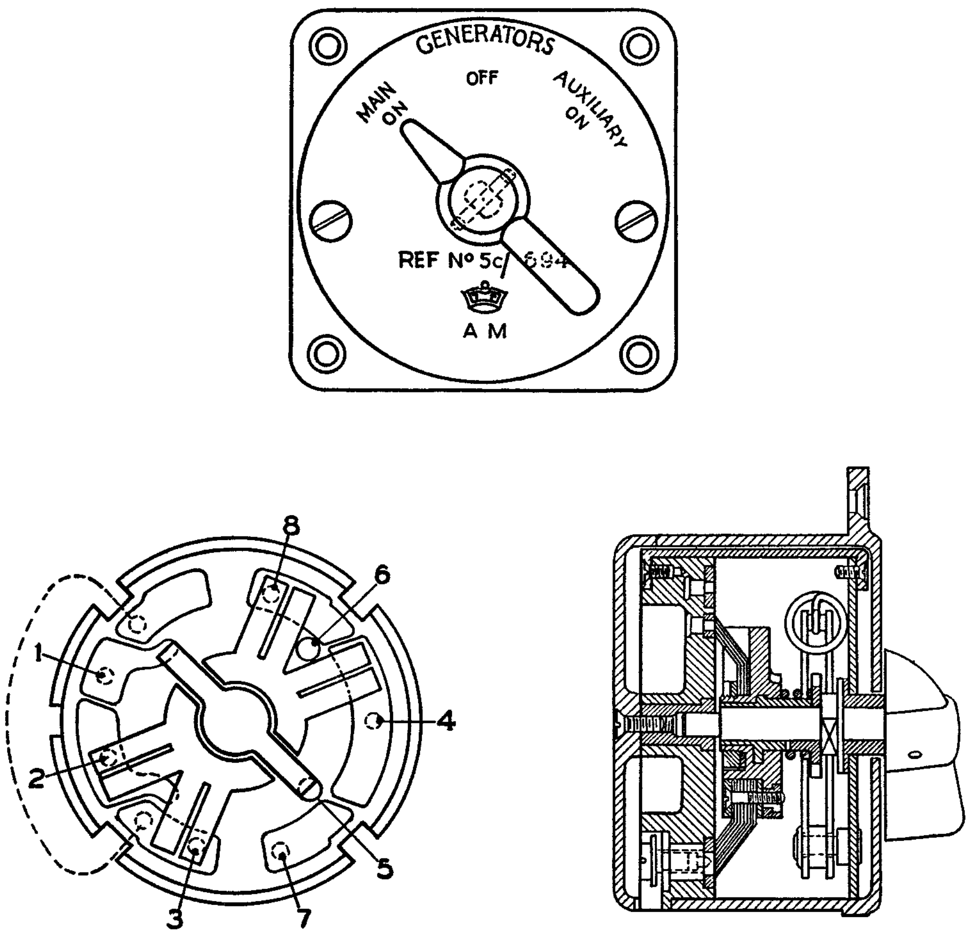


Fig. 1.—Change-over switch, type B

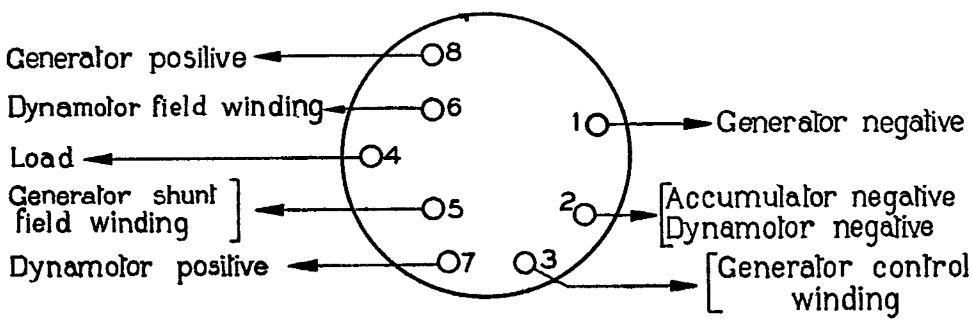
2. The switch has three positions. In one position the engine-driven generator is excited and is connected to the load and the accumulator. In another position the dynamotor is similarly connected instead of the engine-driven generator, and in the central position both generators are switched off, and the accumulators connected to the load. The switch is designed to carry 40 amperes from terminals 2 to 3, 4 to 8, 1 to 2, and 4 to 7, and to carry 3 amperes from 1 to 5 and 2 to 6.

DESCRIPTION

3. The construction of the switch is shown in fig. 1. The section for the right-hand drawing is taken vertically for the lower half and at 45° for the upper half. The left-hand drawing is diagrammatic and shows the arrangement of the brushes, contact plates, and terminals as seen from above.

4. The case, terminal base, terminal cover, and handle are moulded in black insulating material. The terminals are mounted on the back of the terminal base, and the contact plates, connected to the terminals, are on the front of the base. A locating device is arranged between the brushes and the front plate of the switch; it consists of two parallel arms pivoted at one end and pulled together at the other end by a helical spring. A roller mounted at the centre of each arm bears on the edge of a shaped disc and holds the switch securely in any of the three positions. The disc is so shaped that the switch cannot over-ride the end positions.

5. In fig. 1 the brushes are shown in the MAIN GENERATOR ON position. For the OFF and AUXILIARY GENERATOR ON positions they are turned 45° and 90° clockwise respectively. The resulting internal connections are shown in fig. 2, in which the normal external connections are also indicated.



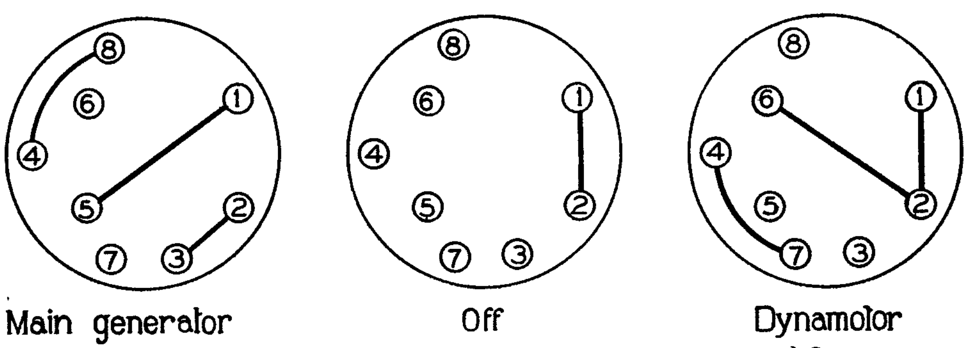


Fig. 2—Circuits

6. The mounting flange of the switch is 3 in. square and the overall depth is 2·8 in. Four countersunk holes are provided in the flange to take 4 B.A. bolts or No. 6 wood screws for fixing the switch to the panel. The weight of the switch is 12·6 oz.

SERVICING

7. No regular attention is required, but on overhaul or if the movement of the switch becomes harsh, the bearing surfaces should be greased and the contact surfaces cleaned and lightly smeared with vaseline.

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CHAPTER 4

MASTER CHANGE-OVER SWITCHES

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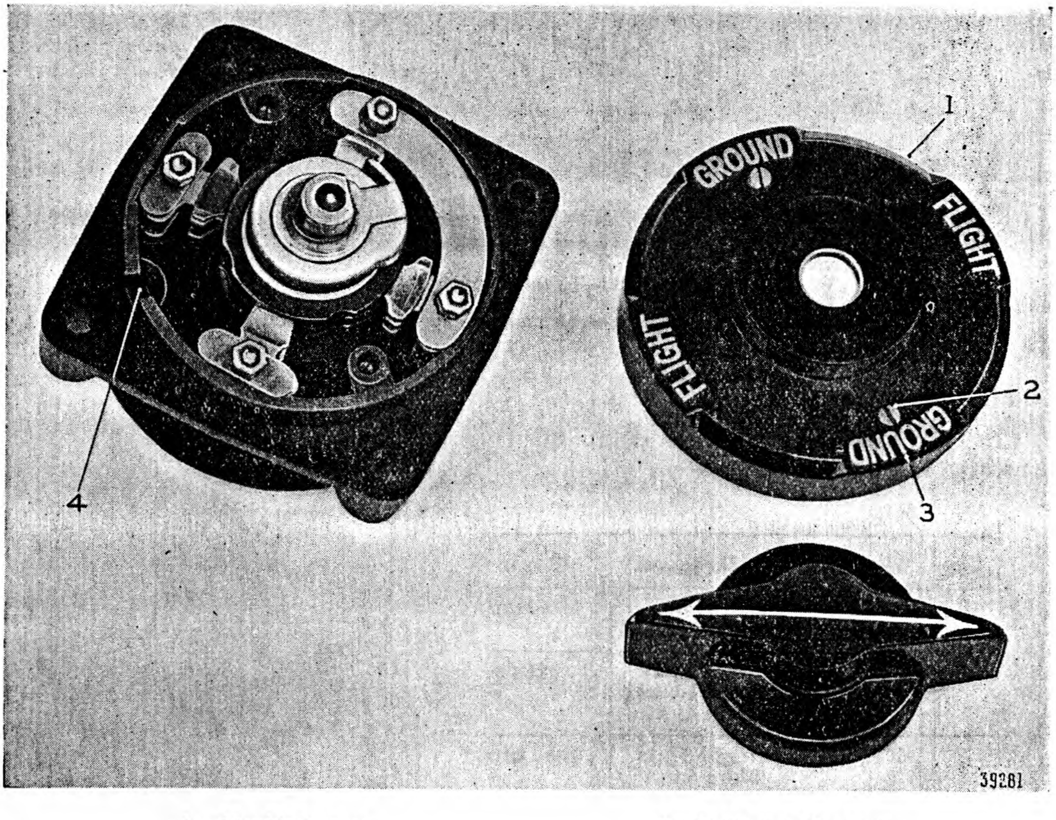
LIST OF ILLUSTRATIONS



1.—Moulded cover
2.—Fixing screws
3.—Position indications
4.—Locating groove

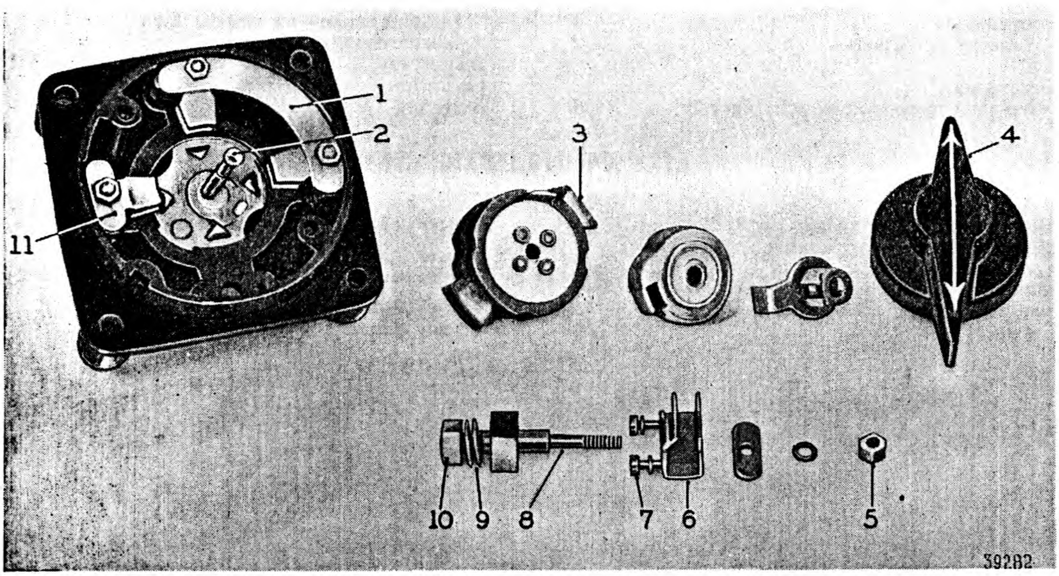
Fig. 1.—Master change-over switch, Type B

CHAPTER 4

MASTER CHANGE-OVER SWITCHES

Introduction

1. The master change-over switches, Types B, C, and D, generally known as Ground/Flight switches, are designed to carry currents of up to 500 amps. for short periods. The switch, when in the GROUND position, isolates the aircraft battery from the general services circuits, and connects the battery in circuit when placed in the FLIGHT position. This allows ground testing of equipment to be carried out using a starter trolley accumulator as a source of supply.



1.—Contact link
2.—Centre pillar
3.—Moving contacts
4.—Knob
5.—Clamping nuts
6.—Fixed contracts
7.—Screws
8.—Terminal pillars
9.—Spring washers
10.—Terminal nuts
11.—Fixed contacts

Fig. 2.—Master change-over switch, Type B, exploded view

Leading particulars

2. The following table gives details of the master change-over switches:—

Type	*Stores Ref.*	*Dimensions*	*Weight*
B	5C/1877	Dia. $4\frac{1}{4}$ in. Depth $3\frac{7}{8}$ in.	1 lb. 14 oz.
C	5C/2828	Height $5\frac{1}{5}$ in. Width $1\frac{7}{16}$ in. Depth $4\frac{3}{4}$ in.	14 oz.
D	5C/3043	Height $5\frac{7}{16}$ in. Width 5 in. Depth $4\frac{3}{4}$ in.	2 lb. 4 oz.

Fig. 3.—Master change-over switch, Type C

DESCRIPTION

Master change-over switch, Type B

3. The switch, a rotary type, is illustrated in fig. 1 and 2. The base, handle, and cover are constructed of plastic material. The cover (1), fig. 1, is held in position by two captive, countersunk, fixing screws (2), and has the switch positions (3) engraved on the top. There is a locating device inside the cover, in the form of a raised segment that fits into a groove (4) in the base. The cover can, therefore, be fitted in one position only. The knob (4), fig. 2, screws into the centre pillar (2), and is secured by a spring locking device. It may be removed by lifting and turning it in an anti-clockwise direction. The switch mechanism is housed in the base. The moving contacts (3), and the fixed contacts (6) are of copper, their design being such that the moving contacts may be rotated in either direction with a quick make and break action.

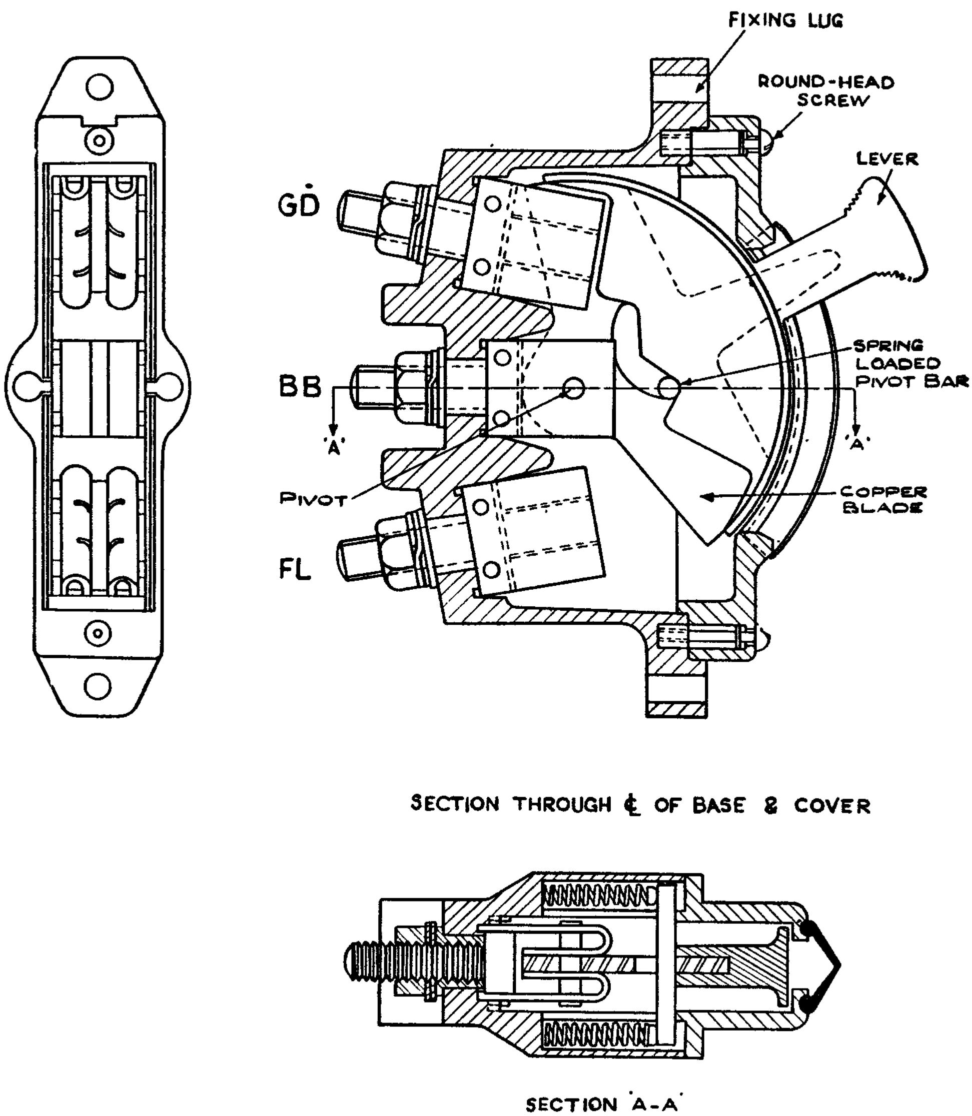


Fig. 4.—Sectional view, master change-over switch, Type C

4. The terminals are located in the base. They are connected to the fixed contacts by terminal pillars (8), which are retained in position by clamping nuts (5). The latter are locked to the terminal pillars with solder. The two terminals marked BB— are connected together electrically by a copper contact link (1); only one BB— terminal is normally used, a rubber cover being fitted over the other. The brass hexagonal terminal nuts (10) are locked by spring washers (9). Raised lettering indicates the terminal designations. The screws (7), holding the fixed contacts (6) in position, are located one on each side of the terminals, and are locked with plastic filling. The terminal shield, which is secured to the base by four countersunk, captive screws, is circular in shape and is cut away to provide clearance for the switch fixing bolts.

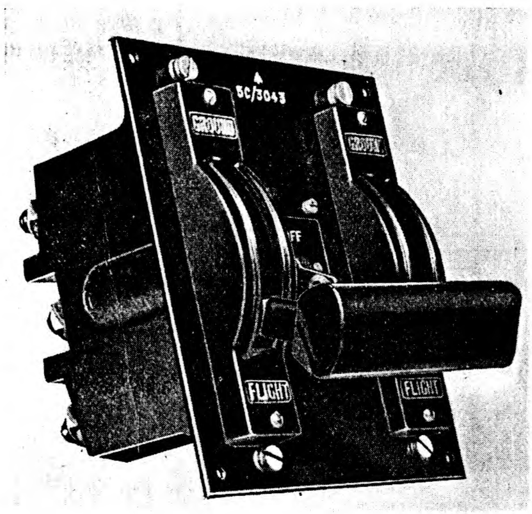


Fig. 5.—Master change-over switch, Type D

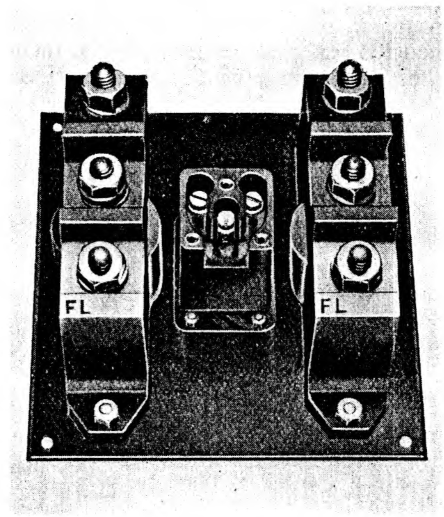


Fig. 6.—Master change-over switch, Type D (rear view)

Master change-over switch, Type C

5. The switch is of the single-pole tumbler type. It is designed to carry 120 amps. continuously in either position, and 500 amps. for three successive cycles of $\frac{1}{2}$ minute on and one minute off. The latter condition may occur during engine starting.

6. The switch is illustrated in fig. 3 and 4. The base, lever, and cover are of moulded bakelite construction, a blade of 10 S.W.G. high-conductivity copper being inserted in the lever. The cover is secured to the base moulding by two round-headed screws.

7. The switch lever and contacts move about a pivot, bridged across the two clips of the centre contact. Snap action is ensured by a spring-loaded bar bearing on the top side of a vee-shaped aperture in the lever. The bar is depressed against the action of two springs when the switch is actuated. As the bar passes the lowest point in its depression, corresponding to half the full travel distance of the lever, the spring pressure accelerates the movement of the lever, snapping it smartly into the knife contacts. As may be seen from fig. 4, there are three pairs of contacts, the blade and lever alternating between the common centre one, and either of the outer contacts as desired.

8. The terminal studs and fixed contact blocks are made of copper, while the fixed contact blades, which are riveted one to each side of the contact blocks, are of phosphor-bronze. The terminals and contacts are assembled from, and can be withdrawn through, the front of the switch.

9. Raised lettering on the base moulding indicates the terminal designations. To prevent short circuiting of the connecting leads, two raised barriers are incorporated between the terminals. Each lead is secured to its terminal stud by a nut and a spring washer.

Master change-over switch, Type D

10. This triple-pole switch, illustrated in fig. 5 and 6, consists of two master change-over switches, type C (Stores Ref. 5C/2828), and one single-pole, general-purpose switchbox, type B (Stores Ref. 5C/543). The switches are screwed to a mounting plate of zinc-plated mild steel, $5\frac{7}{16}$ in. long, 5 in. wide and 0·08 in. thick.

11. The master change-over switch, type C is described in this chapter, para. 5–9 and the single pole, general-purpose switchbox, type B in Chap. 1, of this section.

12. The switches are mechanically coupled by a bar which fits over the lever heads of the two type C switches. An extension link is employed to connect the dolly of the single-pole, general-purpose switch to the coupling bar. The bar is made in two halves and can be dismantled to allow removal of individual switches.

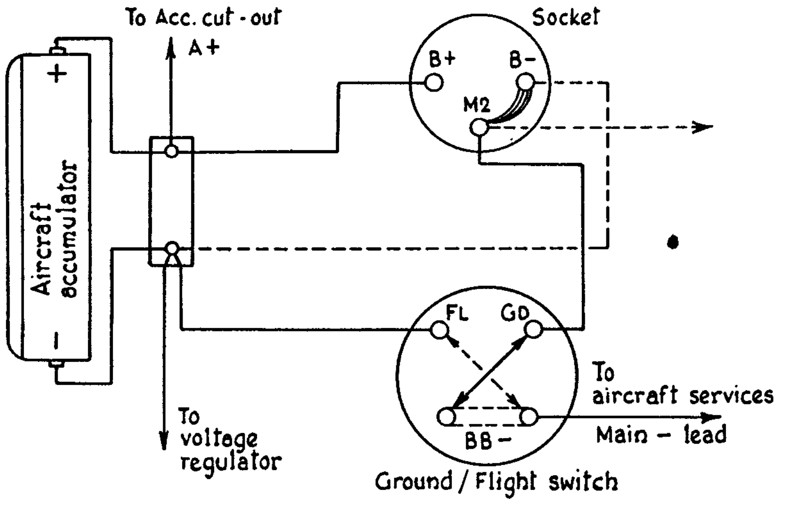


Fig. 7.—Circuit diagram, Type B

INSTALLATION

13. The switches may be mounted in any position that is convenient for wiring and accessible for operation. They are used in conjunction with the external supply socket described in Section 3, Chap. 10 of this volume. When fitted in aircraft on which the socket already exists, certain modifications to the wiring must be made. The connection from accumulator negative to the terminal marked B— on the socket must be removed, and the general services negative connection, originally made to M2 on the socket, must be disconnected and reconnected to the terminal marked BB— on the switch.

14. Fig. 7 and 8 illustrate the wiring and terminal connections for switches, Type B and Type C respectively. Dotted lines indicate the cables to which alterations are to be made. The method of connecting the Type D switch is illustrated in fig. 4, A.P.1095C, Vol. I, Sect. 6, Chap. 6, the switch being referred to as the master switch.

OPERATION

15. When the aircraft is on the ground with the switch in the GROUND position, the aircraft battery is isolated from the general services circuits.

16. With the switch in the GROUND position and the ground accumulator trolley plug inserted in the socket, the aircraft electrical services may be ground tested from the starter trolley accumulator.

17. When the aircraft engine is run up, and the switch is placed in the FLIGHT position, the electrical services are supplied by the engine-driven generator and the battery in the normal manner. It is essential that before take-off, the switch is placed in the FLIGHT position.

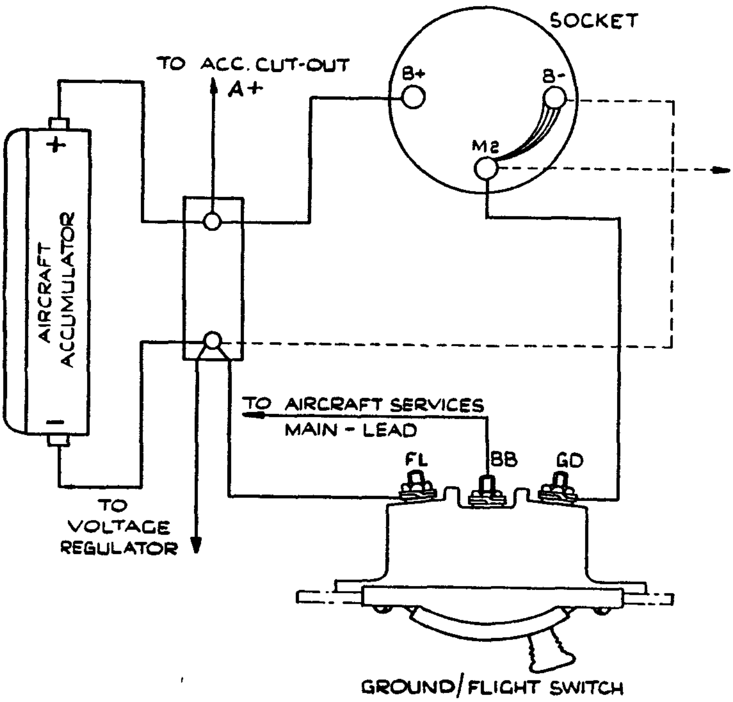


Fig. 8.—Circuit diagram, Type C

SERVICING

18. Little servicing is normally required. During inspection, the switch blades and contacts should be lightly smeared with grease (Stores Ref. 34A/190). An indication that the switch contacts are in good condition is given by a millivolt drop test. With a current of 80 amps. flowing, the drop between the terminal studs should not exceed 25 millivolts. The minimum permissible insulation resistance is 20 megohms.

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CHAPTER 5

IGNITION SWITCHBOXES

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Introduction

1. The ignition of an aero-engine is controlled by switches connected to the primary circuits of the magnetos. Each switch is arranged so that when it is closed it short-circuits the contact breaker of the magneto and so prevents the high tension voltage being generated in the secondary winding.

2. The switches are constructed in the normal manner so that the circuit is closed when the knob is in the downward position, but this position is designated OFF. Thus when the knob is down the magneto is out of action, and when it is up the magneto is on. It should be borne in mind that if the switch is disconnected and the lead left open-circuited the magneto is on, and not off, and it is, therefore, advisable always to earth the lead when an ignition switch is removed.

DESCRIPTION

Type A 2-way ignition switchbox (Stores Ref. 5C/548)

3. This switchbox consists of two ignition switches mounted side by side in a screening metal box. As shown in fig. 1 the switches have the ordinary toggle mechanism. The mounting plate, cover,

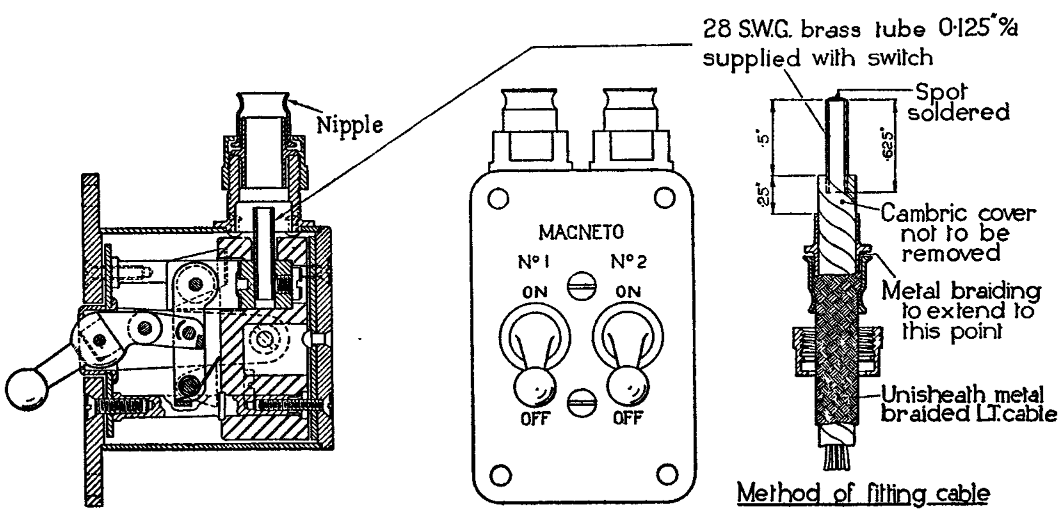

Fig. 1.—Type A 2-way ignition switchbox

and base plate are of aluminium, and with the duralumin nipple at the cable entry form the electrostatic screen. The terminals are mounted in moulded insulation and one is connected to the outer contact of each switch. The inner contacts, which are made in one piece, are connected to the case, which is earthed when the switch is installed. The contact stud on the switch-arm bridges the contacts and earths the single leads connected to the terminals.

4. The switches are intended to be wired with Unisheath 7 metal-braided L.T. cable, and a special union is provided to ensure continuity between the braiding of the cable and the screen of the switch. The construction of this union and the method of fitting the cable are shown in fig. 1. The cambric tape lapping should extend to the end of the rubber covering, and the metal braiding should be securely gripped between the two sleeves.

5. The mounting plate of the switch is 1·5 in. by 2·55 in. and the overall depth of the switch is 2·23 in. The weight is 4·25 oz. Four holes are provided in the mounting plate for 4 B.A. bolts or No. 6 wood screws.

Type B 1-way ignition switchbox (Stores Ref. 5C/547)

6. This is a single switch mounted in a box of black moulded material. It is primarily intended for use in controlling the hand-starting magneto and does not, therefore, require screening. The construction of the switch and the method of preparing the end of the cable from the magneto are shown in fig. 2. The earth lead is connected to the cable lug fixed under the terminal at the centre of the back.

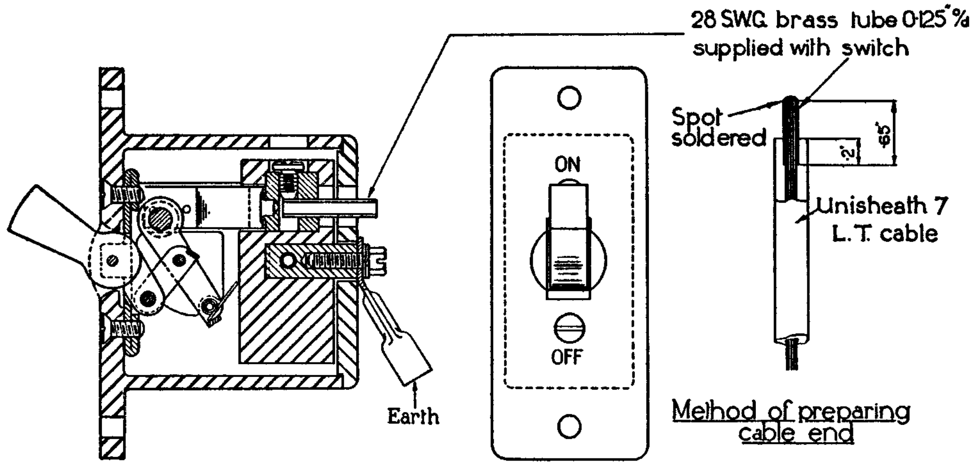

Fig. 2.—Type B 1-way ignition switchbox

7. The mounting flange is 2·25 in. by 1 in. and has two holes for 4 B.A. bolts or No. 6 wood screws for fixing the switch to a panel. The overall depth of the switch is about 2·75 in. and the weight is 2·13 oz.

Multiple master control ignition switch No. 3 (Stores Ref. 5C/715)

8. This consists of two 2-way switchboxes assembled side by side, with a device by which all four switches can be operated simultaneously, and is used for controlling the magnetos of twin-engined aircraft. The switchboxes are identical with the two-way ignition switchboxes type A, except that they are fitted with special elongated dollies to engage with a multiple handle.

9. The assembly is shown in fig. 3. The switchboxes and the fixed plate of the multiple attachment are secured to the panel by the same screws. The ends of the fixed plate project through slots in the panel and the multiple handle is pivoted at the ends of these arms. The multiple handle has three positions. In the upper position all the magnetos are ON, and in the lower position they are

all OFF. In the central position each switch may be operated independently to any position, for testing or for any other special reason. The multiple handle will automatically take up this central position if any switch is operated independently. A spring-loaded ball at each side holds the multiple handle in any of the three positions by engaging in pits in the arm of the fixed plate.

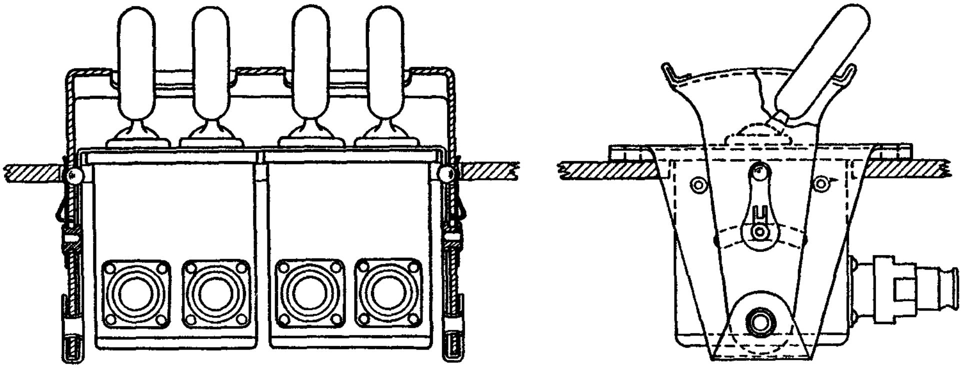

Fig. 3.—Multiple master control ignition switch No. 3

10. The fixed plate of the multiple switch is 2·55 in. by 3·36 in. overall and the overall depth is 3·18 in. The weight of the complete assembly is 11½ oz.

Multiple master control ignition switch No. 4 (Stores Ref. 5C/716)

11. This is similar to the multiple master control ignition switch No. 3 but consists of 3 two-way switchboxes with a longer multiple handle. It is used for controlling the magnetos of three-engined aircraft.

12. The fixed plate of this multiple switch is 2·55 in. by 4·73 in. and the weight of the complete assembly is 16½ oz.

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CHAPTER 6

DIMMER SWITCHES

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Introduction

1. Dimmer switches are used to control various internal lights in aircraft. It is undesirable for such lights to be brighter than necessary, since the brighter the light the greater is the contrast with external light at night and the greater is the danger of the position of the aircraft being betrayed on active service.

2. A dimmer switch is, therefore, usually connected to each internal lamp. It consists of a variable resistance with an OFF position and serves both as a switch and a control for the brightness of the lamp connected to it. The resistance is continuously variable, and the light may, therefore, be dimmed to any amount within the range provided.

Types available

3. Particulars of these types are given below:—

Stores Ref.	*Type.*	*Total resistance.*	*Primary use.*
5C/367	A	25 ohms	Cockpit lamp, Mk. II, 12-volt, 6 watts
5C/482	B	70 ohms	Instrument lamp, 12-volt, No. 2 or 3
5C/537	C	12 ohms	Chart-board lamp, 12-volt, 10 watts
5C/724	E	90 ohms	Cockpit lamp, Mk. II, 24-volt, 6 watts
5C/725	F	340 ohms	Instrument lamp, 24-volt, No. 2A
5C/726	G	50 ohms	Chart-board lamp, 24-volt, 10 watts

The weight of each dimmer switch is 2·5 oz.

4. The windings are as follows:—

Type.	*Approx. number of turns each side.*	*Wire.*	*Total resistance.*
A	75	·0136 in. enamelled eureka	25 ohms ± 5 per cent.
B	—	·010 in. enamelled eureka	70 ohms ± 5 per cent.
C	56	·018 in. enamelled eureka	12 ohms ± 5 per cent.
E	125	·0092 in. enamelled eureka	90 ohms ± 5 per cent.
F	128	·0071 in. enamelled nichrome	340 ohms ± 5 per cent.
G	95	·0108 in. enamelled eureka	50 ohms ± 5 per cent.

Dimmer switches, type A, B, C, E, F, and G

5. These types are all similar in construction. They differ only in the resistance value, which is chosen to suit the characteristics of the filament lamp to be dimmed. A type A dimmer switch is shown in fig. 1, and the construction is shown in fig. 2. The resistance is wire-wound on a ring former. Two separate resistance elements are wound on each former, and one end of each is connected to a terminal. Contact is made on the wire by two steel balls in the ends of a tube which is held in a metal block turned by the knob. The insulation is removed from the wire along the track of the balls. The two points of contact are thus short-circuited, joining the two resistance elements in series, and the resistance between the terminals will depend on the position of the knob.

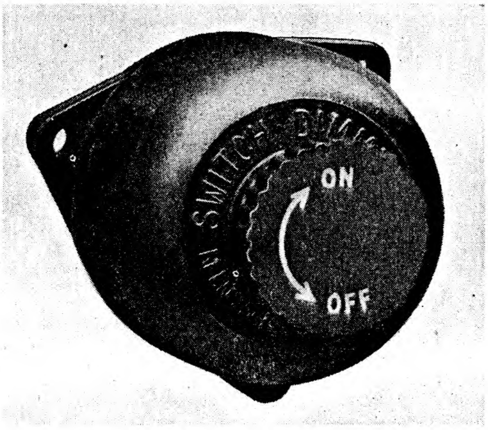

Fig. 1.—Dimmer switch, type A

6. The ends of two screws form stops for the contact tube, and when the tube is in the extreme counter-clockwise position, against the stops, the balls are not in contact with the wire and the circuit is open. A small clockwise movement closes the circuit with all the resistance in series, and further movement progressively decreases the resistance till none is in circuit. Thus the lamp connected in series with the dimmer switch will first light dimly and will then increase steadily to full brightness. The switch will normally be set in some intermediate position at which the illumination is just sufficient.

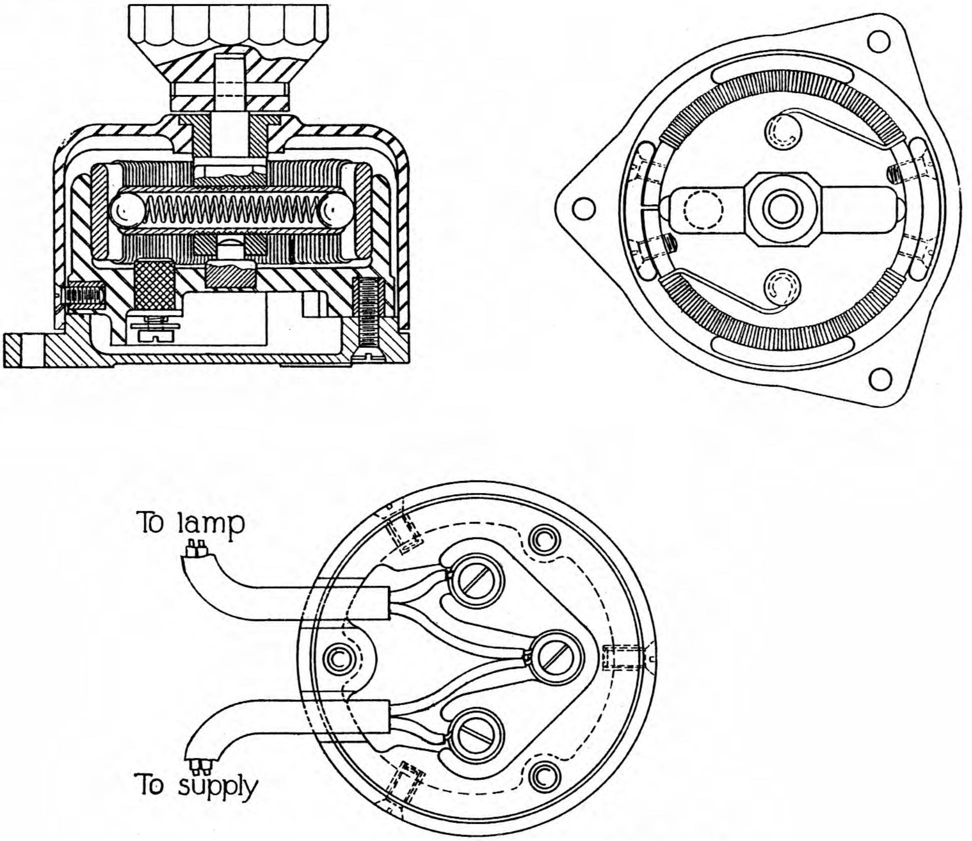

Fig. 2.—Construction of dimmer switch, type A

7. The base, terminal plate, cover, and knob are moulded in black insulating material. The base has three lugs with 0·125 in. dia. holes on a 2 in. pitch circle for mounting. The method of wiring is shown in the lower sketch of fig. 2. The centre terminal has no internal connection but is used as a junction point for the direct connection from the lamp to the supply.

Dimmer switch, type D

8. The type D is similar in general construction to the above types. It is arranged so that either of two lamps of different power can be switched on. The construction and the circuit are shown in fig. 3. When the knob is turned clockwise from the OFF position the low-candle power lamp is lighted, and is dimmed if the knob is turned further. When the knob is turned counter-clockwise from the OFF position the high-candlepower lamp is lighted. This lamp cannot be dimmed.

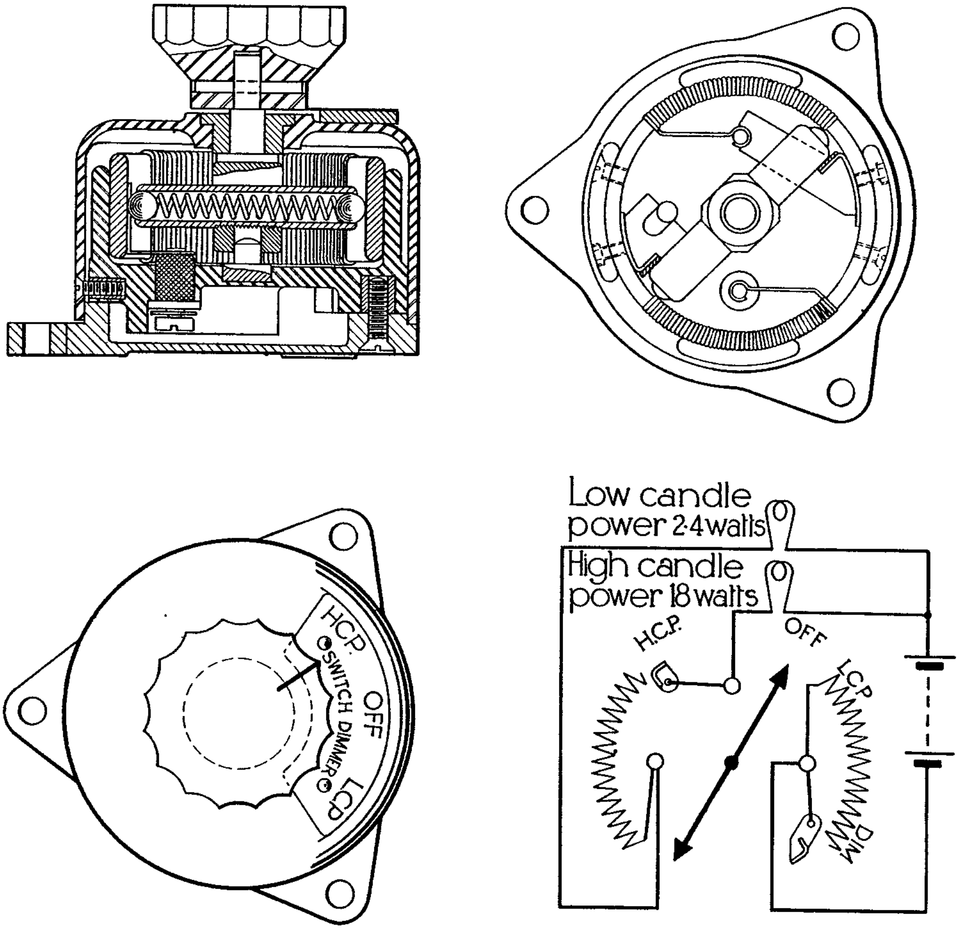

Fig. 3.—Dimmer switch, type D

9. The winding consists of 72 turns on each side, of ·0136-in. enamelled concordin A1 wire and the total resistance is approximately 54 ohms.

10. The type D dimmer switch is designed for use with an 18-watt filament lamp in the high-candlepower circuit and a 2·4-watt filament lamp in the low-candlepower circuit, the supply being at 12-volts.

CHAPTER 7

IDENTIFICATION SWITCHBOX, No. 2, Mk. III

(Stores Ref. 5C/372)

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CHAPTER 7

IDENTIFICATION SWITCHBOX, No. 2, Mk. III

(Stores Ref. 5C/372)

Introduction

1. This switchbox provides a means of control of the upward and the downward identification lamps of an aircraft. It incorporates two 3-position switches, one for each lamp, and a signalling key by which visual signalling may be carried out from either or both lamps.

DESCRIPTION

2. The complete switchbox is shown in fig. 1. It consists of a circular base of moulded insulation and a body ring and hinged cover of aluminium. The two switches are mounted on the base and are operated by handles in front of the cover. Each handle is attached to a spindle turning in a bush in the cover, and an arm beneath the cover, also attached to the spindle, carries a pin which engages in a hole in the switch arm. Thus, when the cover is opened the handles are disengaged from the switches.. A projection on the handle engages in indentations on the front of the cover in each of the three positions and holds the handle in place.

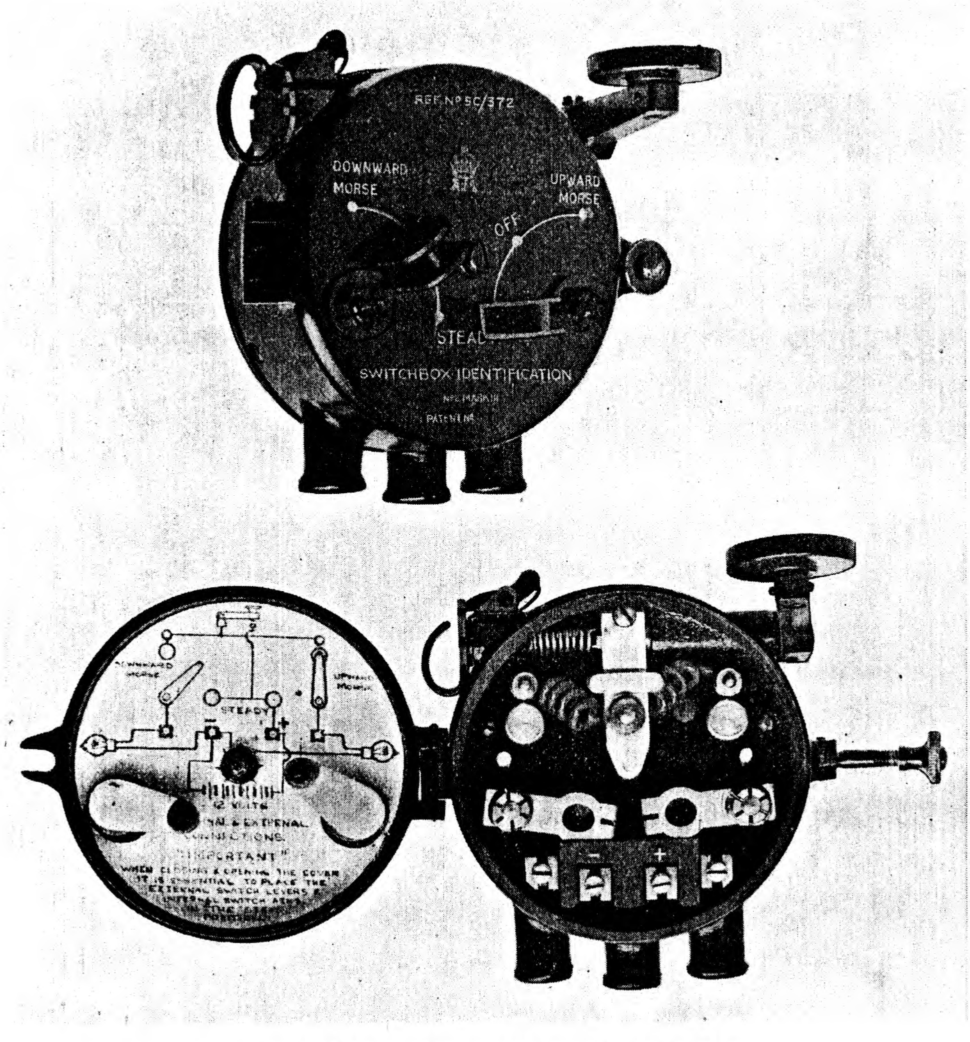

Fig. 1.—Identification switchbox, No. 2, Mk. III

3. The signalling key is built into the upper part of the box. The spindle projects through the side of the box and the knob is carried at the end of an arm fixed to the spindle at right angles. The contacting arm is fixed to the spindle inside the box, projecting downwards, and the fixed contact is mounted on the base near the centre. An adjustable stop in the cover limits the movement of the contacting arm. The return spring is a helical spring in torsion, and is anchored to a spindle connected to an external adjusting ring and lock.

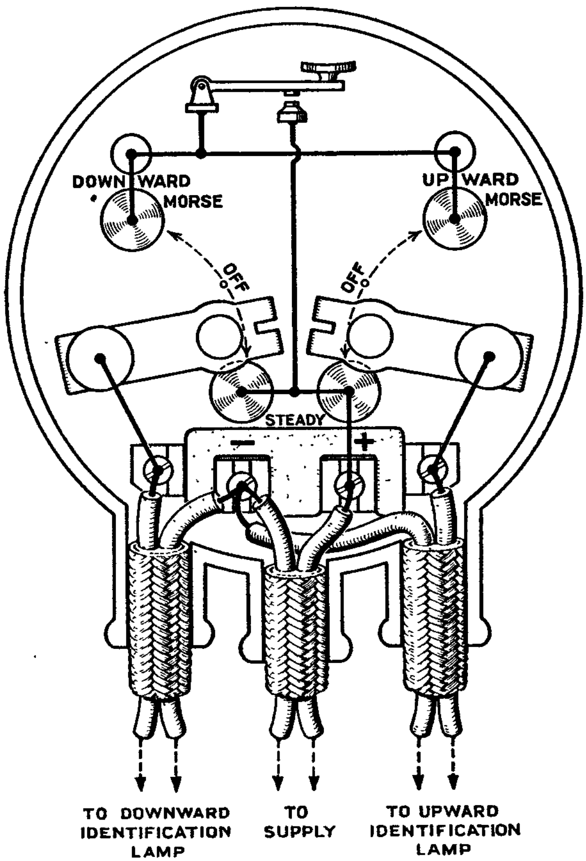

Fig. 2.—Internal and external connections

4. The four terminals for the external connections are arranged along the lower edge of the base. The internal connections are made by means of strips moulded into the base, except for the connection to the key arm, which is made by coiled wire. The internal circuit of the switchbox is shown in fig. 2.

5. The overall height of the box is 3·8 in. and the depth is 2·75 in. The weight is about 13½ oz.

INSTALLATION

6. The switchbox is mounted in the cockpit in a position convenient for the operation of the signalling key. Two countersunk holes are provided in the base for No. 6 B.A. screws or No. 4 wood screws for fixing.

7. The external connections are indicated in fig. 2. The three 2-core cables complete with outer covering are pushed into the metal sleeves at the bottom of the box and the conductors are connected as shown. The cables and sleeves are then wrapped with four turns of 1-inch black adhesive tape bound in position on sleeves and cables with twine.

OPERATION

8. Each identification lamp may be lit continuously by turning the corresponding switch to the STEADY position, or either or both may be flashed by turning the appropriate switch or switches to the MORSE position and operating the signalling key.

9. The range of movement of the key may be adjusted to suit the operator by turning the screw in the centre of the cover. The spring pressure on the key may be adjusted by disengaging the lock at the upper left-hand corner and turning the ring till the required pressure is obtained, when the lock should be released to engage in one of the slots.

SERVICING

10. The switch and key contacts should be kept smooth and flat. If they become pitted or burned they should be flattened with a smooth file or fine emery cloth. The switch contacts may be wiped with a cloth lightly smeared with vaseline. The rocking spindle of the key should occasionally be lubricated with a little thin machine oil introduced through the hole at the top of the switchbox, and a little oil should be applied to the cover hinge, the latch screw, and the bearings of the switch levers. The joint between the cover and the box should be smeared with vaseline before the cover is closed to render the joint weatherproof.

11. When the cover is to be opened the two switch levers should first be turned to the STEADY position, and when the cover is closed care must be taken to engage the operating pins in the holes in the switch arms. The cover must be firmly secured after it has been opened by screwing up the latch screw finger tight.

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CHAPTER 8

MICRO-SWITCHES

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Introduction

1. These switches are used on aircraft for various purposes, their primary application however, being for the operation of undercarriage warning lights. In this connection reference should be made to Sect. 1, Chap. 3, fig. 1, which shows typical wiring for an undercarriage warning system; the micro-switches are the small 2- and 4-way switches shown schematically in the lower half of the illustration. In general the switches are suitable for inductive loads of 5 amp. at 30 volts.

2. A switch may have from two to five terminals and is provided with a push-button mechanism for changing the internal electrical connections of the terminals. When the switch is in the normal, or un-operated position, certain terminals are connected and others open-circuited; pressure on the push button switch will open-circuit some of the original connections and connect a different set of terminals. At present, there are many different types of switch in service and it is not practicable to examine each one in detail. As shown in Table 1, at the end of this Chapter, certain switches are now standardised and these will eventually replace all other switches in service.

Types available

3. Switches in service may be divided into three main groups, which may be known as Burgess, Pye, and Standard Type micro-switches respectively. These switches serve similar purposes but differ in respect of external dimensions and actuating mechanism. Similar types in the three groups are not necessarily interchangeable, owing chiefly to their variation in size. When the Standard types are fitted universally this minor inconvenience will be obviated. The types of switch available are shown in Table 1.

DESCRIPTION

4. Typical Burgess and Pye switches are shown in Fig. 1, and a Standard type switch in fig. 4. These illustrations should facilitate recognition of the various types in service. The switch shown at (a) is an early type Burgess switch, of the short plunger type and is now obsolescent. It is fitted with soldering tags under the base as shown in fig. 3 (b). Other types of this switch are fitted with a leaf spring or a long plunger similar to the later types shown at (b) and (d). Apart from the fitting of short plunger, long plunger or leaf spring, the early type Burgess switches are marked with a red, a green or a blue spot on the top surface. This denotes the number of outlets (soldering tags) and the electrical circuit arrangements as follows:—

Red spot = 2 terminals normally closed
Green spot = 2 terminals normally open
Blue spot = 3 terminals with changeover action (*see* fig. 3 (b))

The soldering tags are not marked with letters on the switch body and differ from later types of switch in this respect (*see* fig. 3).

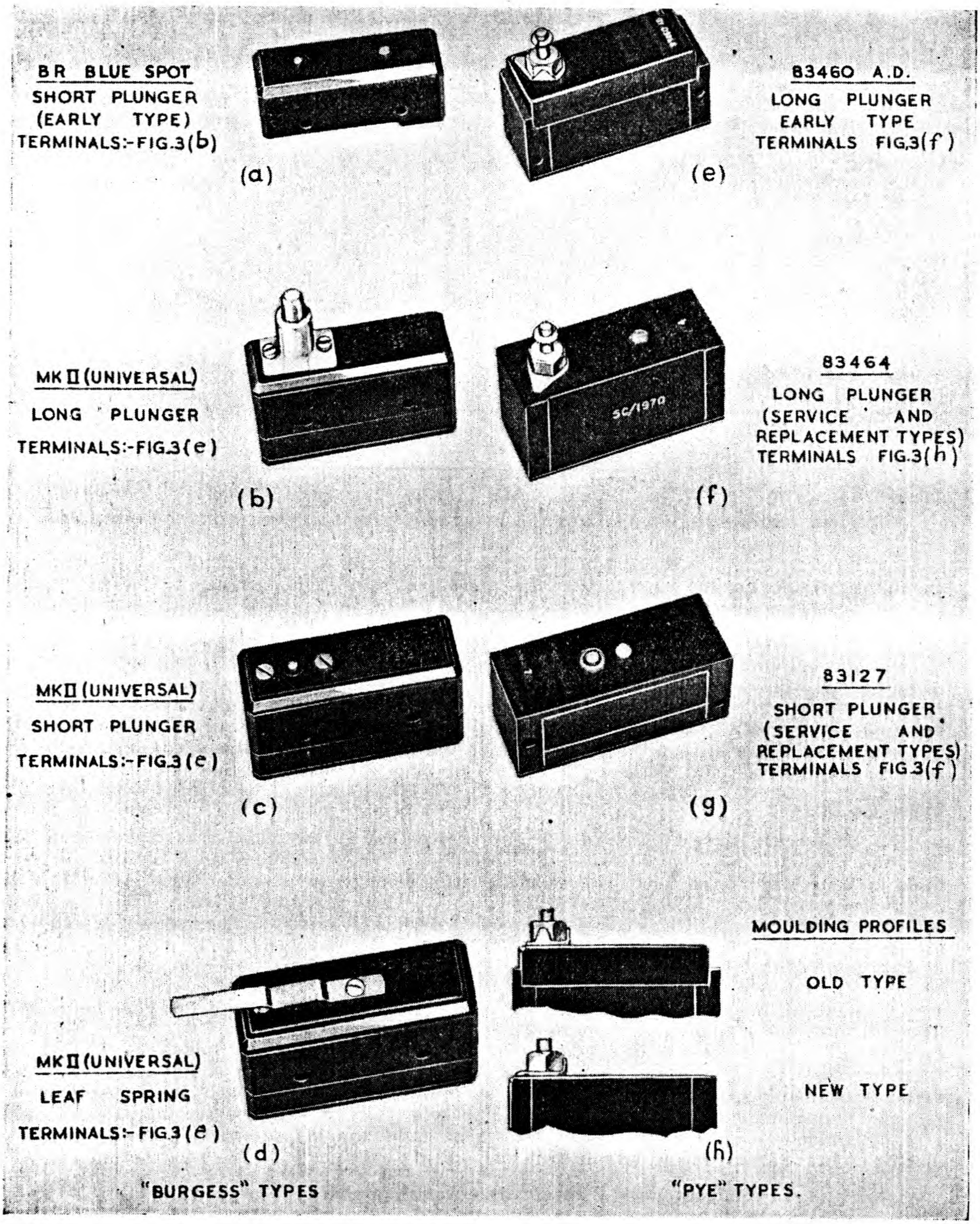

Fig. 1.—Typical micro-switches, Burgess and Pye types

5. The Burgess Mk. II switches shown in fig. 1 at (b), (c) and (d) are of the "universal" type but externally they have the same appearance as all Burgess Mk. II switches. Each switch is basically the same as the short-plunger switch shown at (c). The switch shown at (b) is provided with an additional spring-loaded plunger while that at (d) is provided with a leaf spring. The spring-loaded plunger and the leaf spring are extra fittings secured by screws to the top cover of the switch, and if removed, the switches are identical with the short plunger type shown in fig. 1 (c), i.e. the short plunger is present on all switches.

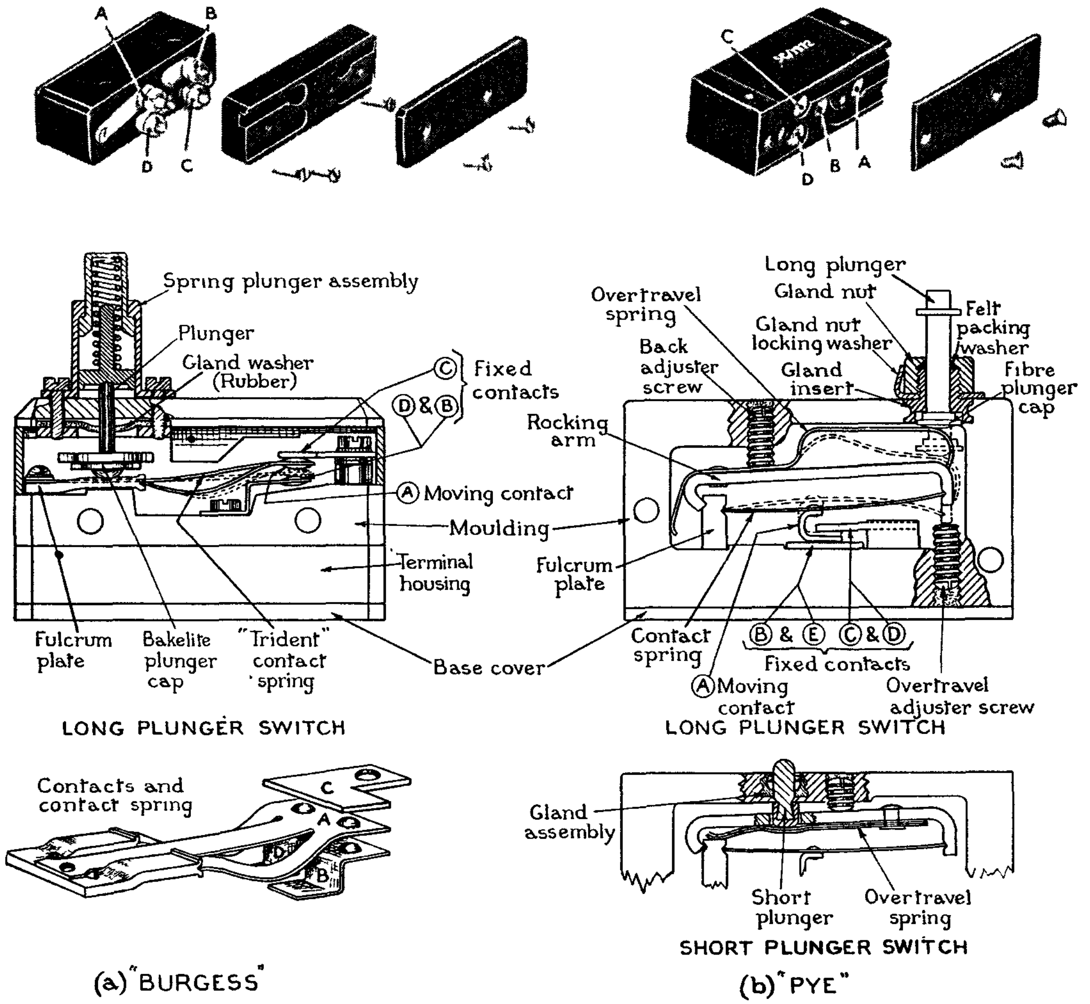

Fig. 2.—Burgess and Pye switch mechanisms

6. Typical Pye switches are shown in fig. 1 at (e), (f) and (g). The switch shown at (e) is an early type now obsolescent. If in use, this type should be replaced as soon as possible. In external appearance it may be distinguished from the later types shown at (f) and (g) by the shape of the moulding, as shown in fig. 1 (h). The long plunger and short plunger switches shown in fig. 1 at (f) and (g) are specific switches as indicated, but, in external appearance, all other switches are similar. Switches will, however, have individual contact and terminal arrangements as illustrated in fig. 3.

7. The Standard type micro-switch is shown in fig 4. This is slightly larger than the majority of the Burgess and Pye switches. It will be noticed that the plunger, which is of the long type, has a rubber cowl to render its connection to the switch, oil- petrol- and water-proof, an important point for these switches which are usually installed in positions liable to weathering and splashing.

SWITCH MECHANISMS AND OPERATION

8. The switch mechanisms described in the following paragraphs are those present on later type and replacement switches. Earlier types of Pye switch will differ in this respect but are either obsolete or obsolescent. In this connection it should be noted that the switches should not be dismantled to effect repairs, and that normally no adjustment of the mechanism is possible. The two types of mechanism are illustrated in fig. 2. This illustration also shows the terminals on the underside of the switches. The terminals and the contact arrangements are typical only but the operating mechanism is similar on all standardized switches.

Burgess

9. The mechanism of this switch is illustrated in fig. 2 (a). The photograph at the top of the illustration shows the base cover and the terminal housing removed from the main moulding. The construction of the switch is illustrated in the lower diagrams. The contact spring is a flat trident-shaped piece of beryllium copper fitted with domed silver contacts. In fig. 2 (a), the spring is shown in its normal position in the switch. When not under tension the three arms of the spring are in the same plane. As fitted in the switch body, the spring is secured with a forked fulcrum plate, by means of a single 6 B.A. screw. The two short arms of the spring pivot in the V-section grooves in the two arms of the fulcrum plate and take up the bowed contours shown in the illustrations. With this arrangement the contacts A are forced into firm contact with the flat plate C. In the "normally made" and the "universal" types of switch the contact C is of copper with a silver contact surface. In the "normally open" type of switch it is an insulating stop.

10. When the operating plunger is pressed, the central arm of the spring is moved beyond its equilibrium position and the spring system moves over with a snap action to the lower contact or contacts. In fig. 2 (a), two contacts are shown, as present in the "universal" switch; on the "normally made" switch there are no contacts in the operated position, while in the "normally open" switch there is only one contact. This is connected to the terminal D. The lower fixed contacts are secured to spring strips and when the switch is operated, are pressed down on to the moulding. This ensures that both contacts are properly made should the moving element be slightly out of alignment.

11. After a switch has operated, any further movement of the operating plunger is termed overtravel. Very little overtravel is present on the short plunger switches but the long plunger and leaf spring fittings give appreciable overtravel as shown in Table 1. No adjustment of the mechanism is provided on these switches.

Pye

12. The principle of operation of a Pye type switch is similar to a Burgess, but the design details are different as shown in fig. 2 (b). This illustration shows a long plunger switch complete and also the different arrangements for overtravel on the short plunger switch.

13. The control spring and the rocking arm are of flat material and the latter is shaped as shown in fig. 2 (b). The spring carries the moving contact near its centre and is held between the fulcrum block and the free end of the rocking arm. In this position, with the switch unoperated, the spring is under compression and bows downwards so that the moving contact is in firm engagement with the lower fixed contact (or contacts).

14. The plunger operates *via* a leaf spring attached to the rocking arm. When the plunger is depressed the rocking arm moves down. The effect of this is momentarily to increase the pressure between the moving and the lower fixed contacts thus tending to bow the spring in the opposite direction. The spring snaps over to the other position just before the end of the rocking arm engages with the forward stop screw. The moving contact thereby engages with the upper fixed contact (or contacts). The overtravel spring rides over the end of the rocking arm for any further movement of the plunger. The amount of overtravel obtainable with the switches is given in Table 1.

15. The double fixed contacts provided on some Pye switches are not flexible as they are on the corresponding Burgess types. This means that if the moving contact is misaligned it will not make proper contact on both sides. Eventually, switches employing split "up" and/or "down" contacts will fall into disuse as far as possible, and switches embodying the least possible number of contacts (or terminals) should be used when replacements are made. Down-lock switches used for undercarriage warning systems will, however, require split up or down contacts according to the method of operation. The use of five-terminal switches will eventually be discontinued.

16. Pye switches are provided with two adjusting screws, as shown in fig. 2 (b). The upper screw adjusts the amount of travel of the rocking arm which is required before the contact spring snaps over to the operated position. The lower screw limits the total travel of the rocking arm. Both screws are adjusted and sealed before the switch goes into service and no further adjustment should be made.

Standard

17. Three types of Standard micro-switch have now been approved and as these come into service, all other types will eventually become obsolete. From a comparison of figs. 2 and 4, it will be seen that the principle of operation of the Standard type micro-switch is similar to that of the long plunger Burgess type. One or two points of difference may be emphasized. The rubber cowl on the plunger of the Standard type has a lifting movement which gives 0·024 in. free movement before the plunger takes position for its stated total travel of 0·25 in. from the NORMAL to the OPERATED position. The pressure required to operate the switch has been increased to 45 ozs. while the pressure on the point of release is now not less than 1 lb.; the actuating movement is 0·013 in. both on the 3-terminal and the 4-terminal types.

18. In general, the Standard type micro-switch may be said to be a much improved type for all purposes. The case has been redesigned and is a good deal more robust than in the earlier types, and is also slightly larger than the majority. It is this slight increase in size which may make it necessary to continue using the earlier types of switch in certain replacements where space is strictly limited. The Pye type of Standard switch is made to the same specification as the Burgess type illustrated; its external dimensions and operation requirements are therefore similar, but the internal construction is somewhat different.

INSTALLATION

19. The switches are secured where required by means of 4 B.A. bolts passed through the holes provided in the moulding. When fitting a new switch it will be necessary to open up the ends of the channels in the moulding. This should be done by pushing *in* the thin walls at the end of the channels leading to the terminals required. When secured in position on an aircraft the switch plunger should not be in contact with the operating lever in its un-operated position; it should not be expected to lift any additional load. The switch plungers should not be loaded in any way when in their OFF positions. The switch must be fixed in a position in which no distortion of the case occurs, and the flexible cowl must not foul any fixed or moving point either in the normal position or when fully depressed.

SERVICING

20. The Burgess and Standard types of switch require no servicing. The short plungers on these switches are provided with a rubber gland washer and consequently should not be oiled.

21. On Pye switches a felt packing washer is provided with the plunger gland assembly. If the plunger is at all stiff in operation the packing washer should be lubricated with oil, anti-freezing (Stores Ref. 34A/43). To do this the gland nut should be removed after turning down the tags of the locking washer slightly. When replacing, care should be taken to ensure that the gland nut is not so tight that the plunger is stiff in operation. It is preferable to engage the gland nut by the same number of threads as before removal.

P.T.O.

P8967 M /G2573 11/45 8500 C & P Gp.1

TABLE 1
TYPES AVAILABLE

Type	*Stores Ref. No.*	*Type of plunger*	*No. of terminals*	*Circuit*		*Approximate overall dimensions in inches*			*Actuating movement in ins.*	*Over-travel in inches*	*Terminal arrangement*	*Early type switches superseded*
				Plunger normal	*Plunger depressed*	*Length*	*Width*	*Depth*				
*Burgess Mk. II A/RR	5C/1788	short	2	A to D	open	1·94	0·69	1·22	0·004	0·009	Fig. 3(d)	Burgess A/RR (N.I.V.)
*Burgess Mk. II B/RR	5C/1573	leaf spring	2	A to D	open	2·45	0·69	1·38	0·25	0·5	Fig. 3(d)	Burgess B/RRL (5C/1119)
*Burgess Mk. II C/RR	5C/1723	long	2	A to D	open	1·94	0·69	2·02	0·06	0·25	Fig. 3(d)	Burgess C/RRS (5C/1629)
*Burgess Mk. II A/GR	5C/1771	short	2	open	A to D	1·94	0·69	1·22	0·004	0·009	Fig. 3(d)	Burgess A/GR (5C/1728)
*Burgess Mk. II B/GR	5C/1790	leaf spring	2	open	A to D	2·45	0·69	1·38	0·25	0·5	Fig. 3(d)	Burgess B/GRL (5C/2113)
*Burgess Mk. II C/GR	5C/1724	long	2	open	A to D	1·94	0·69	2·02	0·06	0·25	Fig. 3(d)	Burgess C/GRS (5C/2079)
Burgess Mk. II A/BR	5C/1789	short	3	A to C	A to D	1·94	0·69	1·22	0·004	0·009	Fig. 3(e)	Burgess A/BR (N.I.V.)
*Burgess Mk. II B/BR	5C/1791	leaf spring	3	A to C	A to D	2·45	0·69	1·38	0·25	0·5	Fig. 3(e)	Burgess B/BRL (N.I.V.)
Burgess Mk. II C/BR	5C/1792	long	3	A to C	A to D	1·94	0·69	2·02	0·06	0·25	Fig. 3(e)	Burgess C/BRS (N.I.V.)
†Burgess Mk. II A/ Univ.	5C/1618	short	4	A to C	A to D & B	1·94	0·69	1·22	0·004	0·009	Fig. 3(f)	Burgess D4387A, D4388A (5C/1729) (5C/1730)
*Burgess Mk. II B/ Univ.	5C/1617	leaf spring	4	A to C	A to D & B	2·45	0·69	1·38	0·25	0·5	Fig. 3(f)	Burgess D4387B, D4388B (N.I.V.) (N.I.V.)
†Burgess Mk. II C/ Univ.	5C/1591	long	4	A to C	A to D & B	1·94	0·69	2·02	0·06	0·25	Fig. 3(f)	Burgess D4387C, D4388C (N.I.V.) (N.I.V.)
*Burgess Mk.II/GR49	5C/1599	special 0·70 spring	2	open	A to D	1·94	0·69	1·34	0·02	0·08	Fig. 3(d)	Burgess GR 49(5C/1565)
Pye 83467	5C/1971	long	3	A to B	A to (C, D)	2·07	0·8	1·8	0·06	0·25	Fig. 3(g)	Pye 83460–2(5C/1696)
Pye 83467	5C/2081	long with mushroom head	3	A to B	A to (C, D)	2·07	0·8	1·8	0·06	0·25	Fig. 3(g)	—
Pye 83127	5C/1972	short	3	A to B	A to (C, D)	2·07	0·8	1·07	0·02	0·06	Fig. 3(g)	Pye 83128–9(5C/1695)
Pye 83464	5C/1970	long	5	A to B & E	A to (C, D)	2·07	0·8	1·8	0·06	0·25	Fig. 3(j)	Pye 83463(5C/1697)
Standard type 1	5C/2126	long	3	A to B	A to C	2·07	0·8	1·13	0·013	0·187	Fig. 4	
Standard type 2	5C/2127	long	4	A to B & C	A to D	2·07	0·8	1·13	0·013	0·187	Fig. 4	
Standard type 3	5C/3146	long	4	A to D	A to (B, C)	2·07	0·8	1·13	0·013	0·187	Not shown	

* = Obsolete † = Obsolescent *Note.*—Where terminals C and D are shown in brackets they are permanently connected within the switch

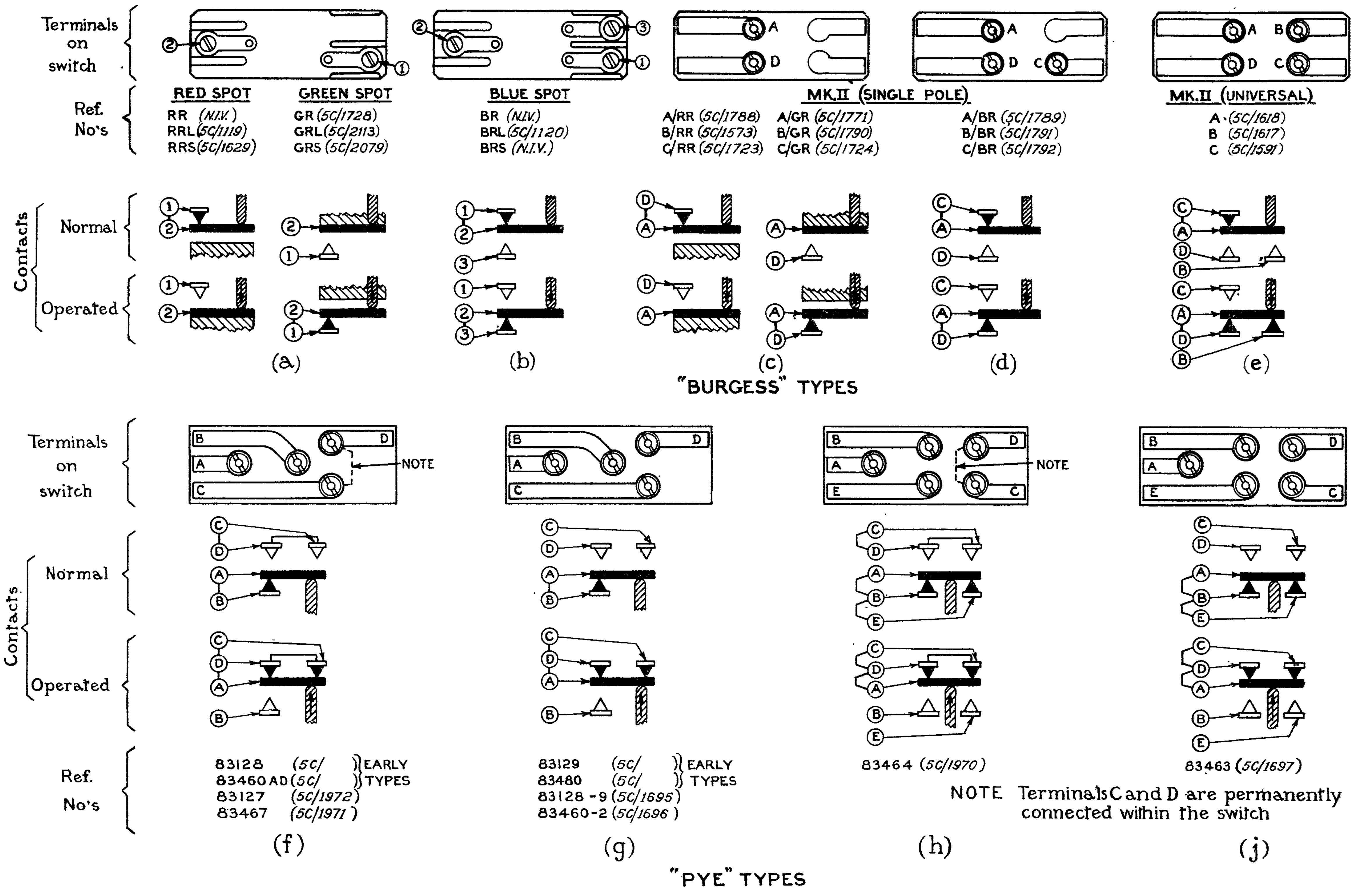

FIG.3 TERMINAL AND CONTACT ARRANGEMENTS FIG.3

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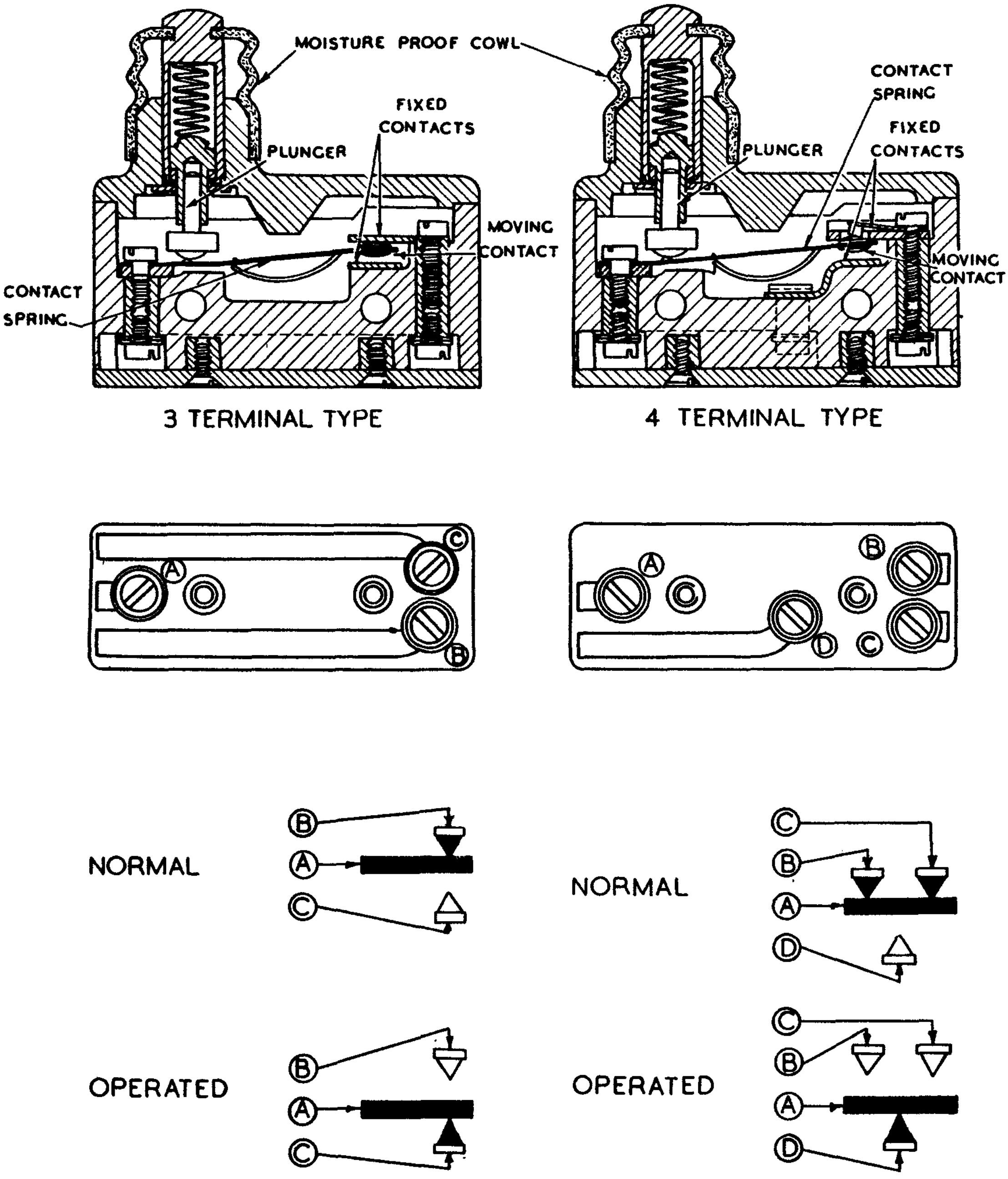

STANDARD TYPE MICRO-SWITCH

FIG. 4

FIG. 4

CHAPTER 9

FLAME SWITCHES

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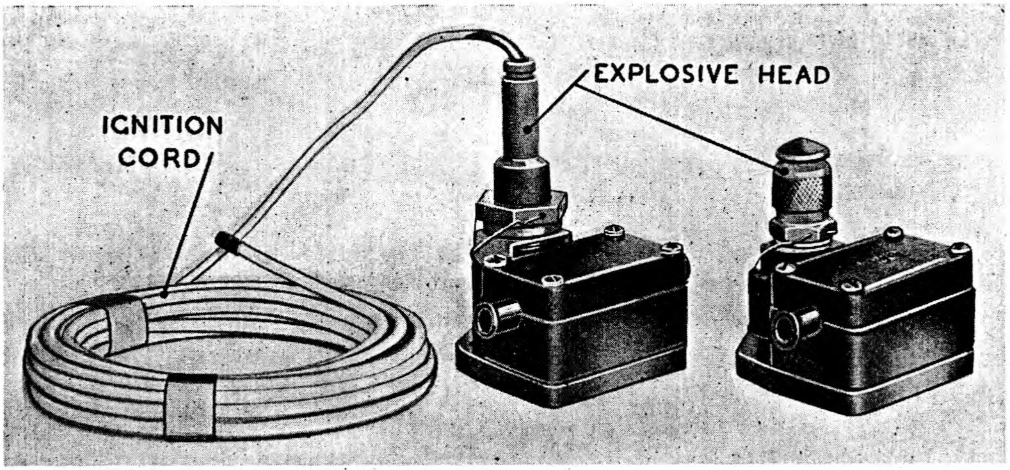

Fig. 1.—Ignition cord flame switch and flame switch Mk. II

CHAPTER 9

FLAME SWITCHES

Introduction

1. Flame switches are used in fire-extinguishing circuits as automatic controls for the electrically operated extinguishers. The switches are designed to operate either from the action of direct flame or from excessive heat. Flame switches are fitted in suitable positions on each engine and on the wing fuel tanks, so that if a fire or excessive over-heating occurs in these parts of the aircraft, the fire-extinguishing service comes into immediate operation and the extinguisher fluid is sprayed over the fuel supply and the engine concerned. A full description of the fire extinguishing apparatus and its operation is given in A.P.957C, Vol. I, Sect. 3, Chapters 2 and 3.

Principles of operation

2. Several types of flame switch are in use in the Service, but all work on the same principle. A spring-loaded rod held down by a metal rim controls the movable contacts of the switch. The head of the switch is combustible; when the head element burns, a powder train sets off the detonator housed below the metal rim, and the explosion breaks the metal rim, allowing the spring-loaded rod to rise, so that the movable contacts controlled by the rod make contact with the fixed contact points connected to the terminals of the switch, thus completing the electrical circuit and bringing into operation the associated equipment. A temperature of 200 deg. C. or over will operate the switch without actual fire or explosion, by melting a soldered portion in the head of the switch, and so releasing the spring-loaded rod.

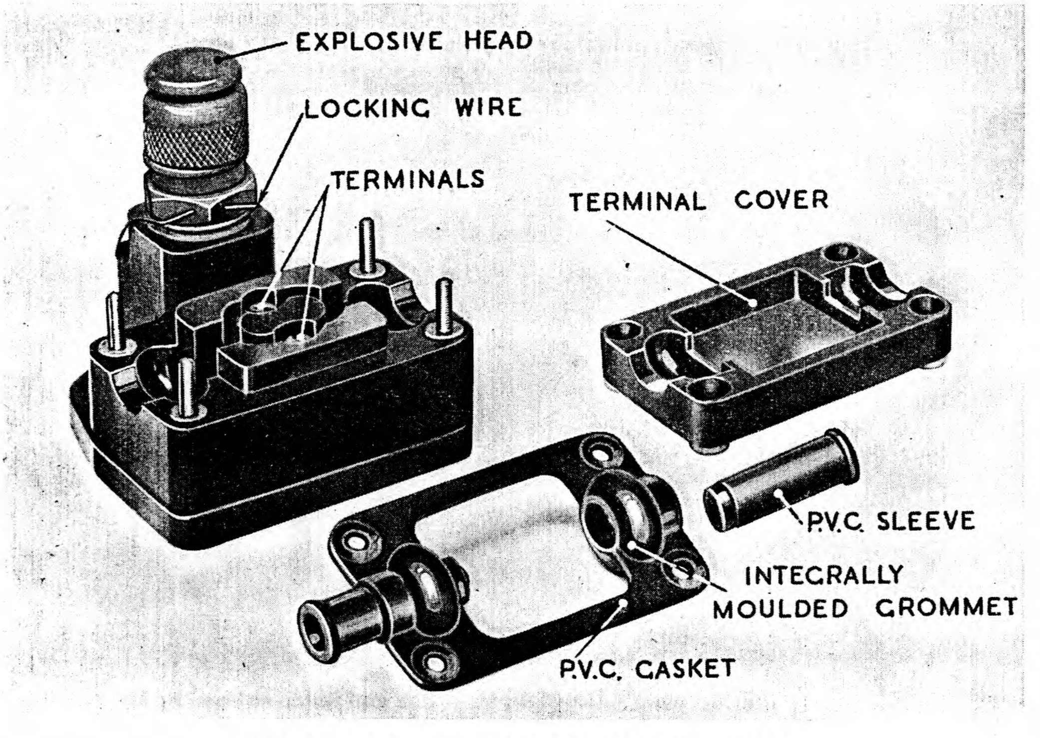

Fig. 2.—Flame switch Mk. II partially dismantled

DESCRIPTION

Original type

3. The original type of flame switch (Stores Ref. 27N/18) shown in fig. 3, is still in use in many service installations. The illustration shows, first, a sectional drawing of the switch mechanism before the charge is ignited, and secondly, the completion of the electrical circuit when the explosive

charge has "blown off". It will be noticed that there is a fusible joint in the charge-head. This is the soldered portion which melts at a temperature of 200 deg. C., whether flame is present or not. The switch is fitted with a length of metal braided connecting cable.

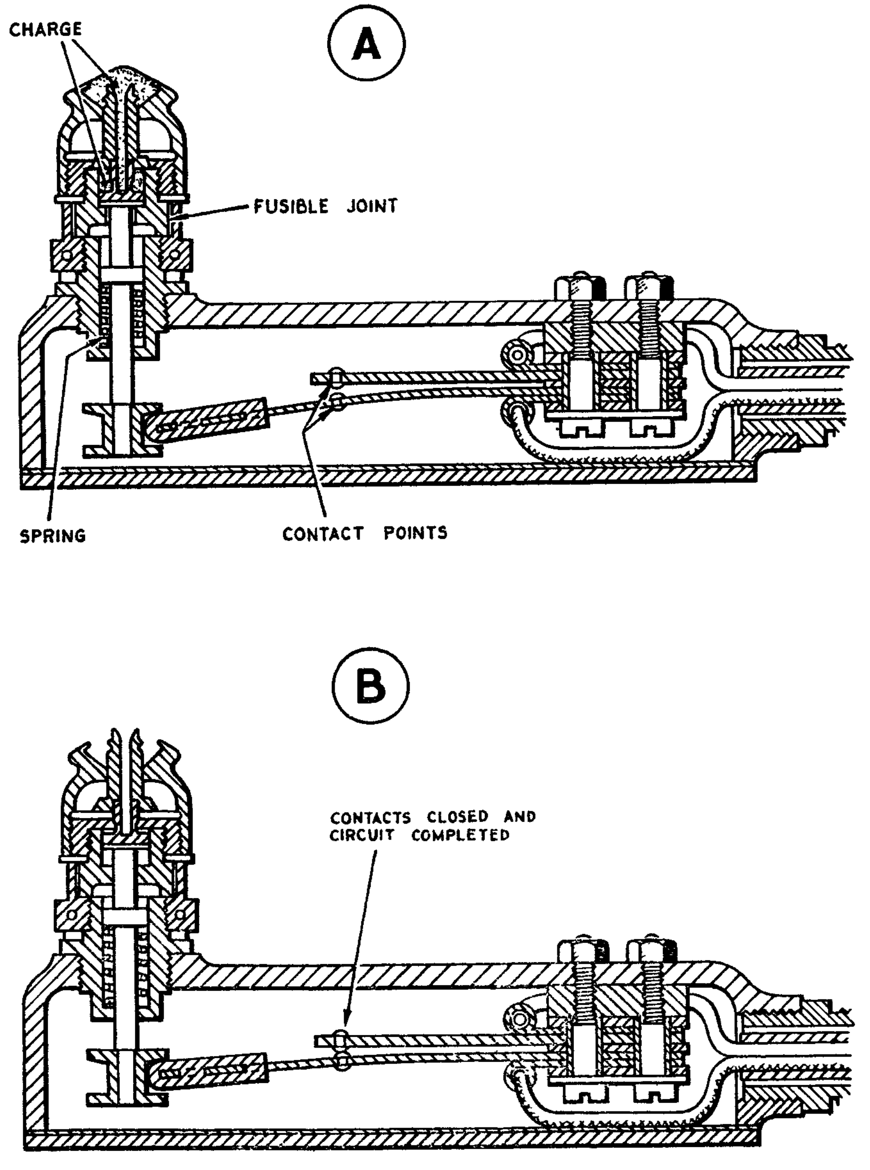

Fig. 3.—Original type flame switch before and after operation

Flame switch Mk. I

4. Flame switch type 2 (Stores Ref. 27N/18), is the same as the original type, except that a terminal block is fitted at the end away from the explosive head. The switch is the same internally as the original type, and has the same fixing centres and reference number.

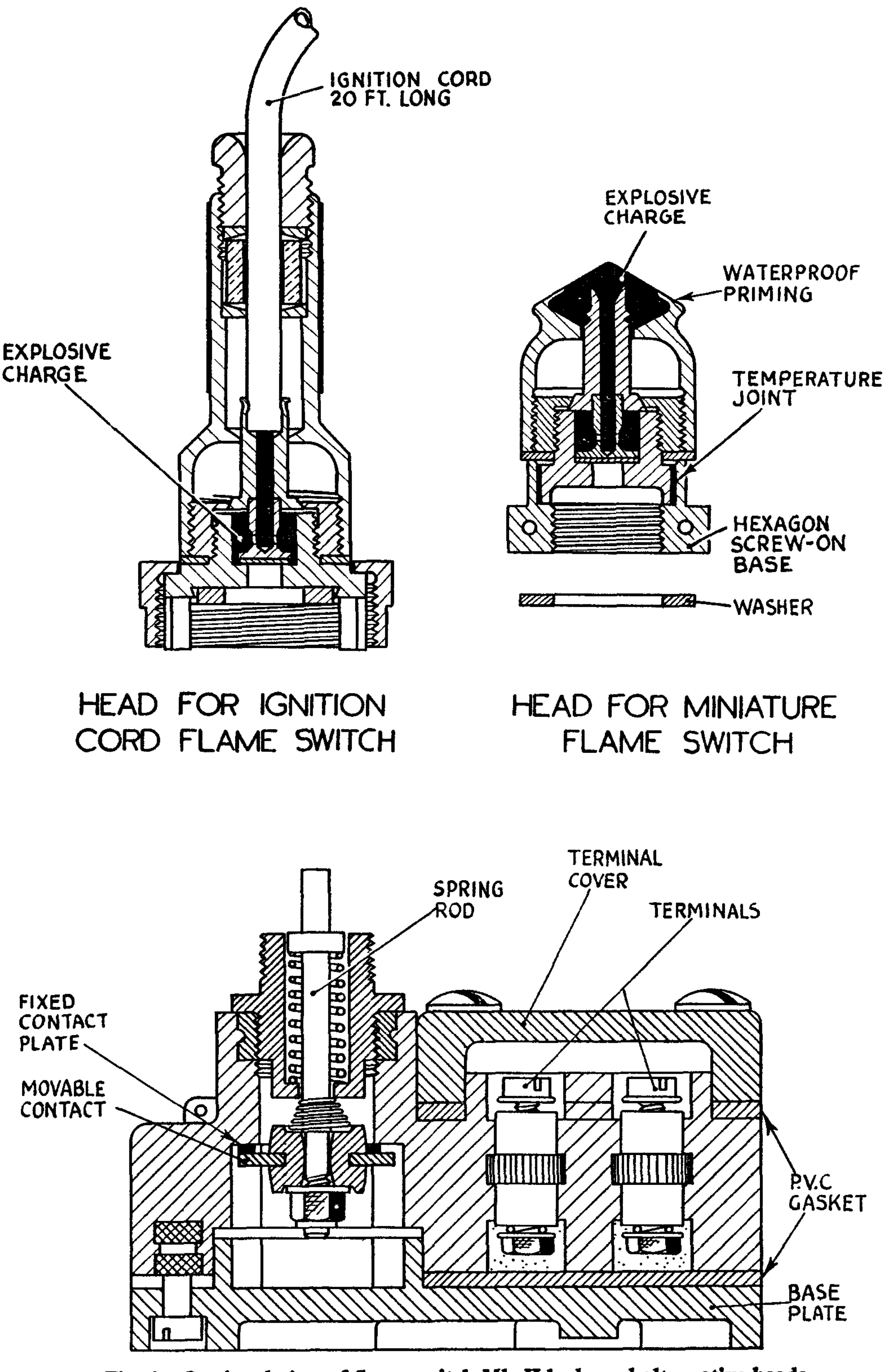

Fig. 4.—Sectional view of flame switch Mk. II body and alternative heads

Flame switch Mk. II

5. The third type (Stores Ref. 27N/47) is shown in detail in fig. 2. The principle of operation is the same as in the earlier types, but the body of the switch has been re-designed for easier positioning when mounted on an engine. The explosive head (Stores Ref. 27N/48) is of the same design as in previous types.

Ignition cord flame switch

6. The fourth type in use (Stores Ref. 27N/49) is an adaptation of the above, specially designed for use on wing fuel tanks. The body of the switch is identical with that of flame switch Mk. II but the explosive head is provided with a 20 ft. flame detector cord, fig. 1. If this flame detector cord catches fire at any position along its length, the fire travels quickly in both directions and sets off the detonator in the explosive head.

SERVICING

7. A switch that has been operated, so that the combustible head is blown off, can be renewed by replacing the old head with a new, fully charged one. The exhausted head can be removed with a spanner, working on the flats provided on the knurled nut. Fig. 4 shows the point at which the head screws off. On Type 4, the continuous cord type, a union nut is fitted, and this is the only part which should be turned in screwing down the head. In all types, make sure that the head is screwed down far enough to ensure that the pressure on the spring rod is enough to hold the switch contacts open. This can be checked by putting a test lamp in the extinguisher plug socket before replacing the head. While the head is off, the switch contacts are closed, and the lamp should be alight. Put on the head, and screw down until the lamp goes out, indicating that the circuit is now open, then fully tighten head to ensure a safe distance between the switch contacts.

8. The replacement parts mentioned are as follows:—

Part	*Stores Ref.*
Switch body only	27N/43
Replacement head, miniature flame switch Mk. II	27N/48
Replacement head, ignition cord flame switch	12D/1061
Adapter nut, ignition cord flame switch	27N/50
Locking washer, ignition cord flame switch	27N/51
Miniature flame switch Mk. II, body and head complete	27N/47
Ignition cord flame switch, body, head and cord complete	27N/49

9. Replacement of the switch is a simple matter of connecting the two cables to the terminals under the terminal cover and fixing the two screws in the base plate. When a new flame switch is installed, it is important to ensure that it is weather-proofed. The flame switch type 2 (Stores Ref. 27N/18) is supplied painted all over with an oil and water resisting paint. It is therefore only the terminal box which needs special attention. Enough P.I.C. No. 2 should be pressed round the terminals to allow for spare P.I.C. to be squeezed out when the terminal cover is replaced, so that a thin film is left as a washer between cover and box edges. Additional P.I.C. No. 2 should be built up round the cable entry to the switch.

10. In the later types (Stores Ref. 27N/47 or 27N/49) there are P.V.C. gaskets between the base and switch-body, and between switch body and terminal cover; no further weather proofing is necessary. Fig. 2 shows a switch of this type partially dismantled, so that the gasket between terminal cover and switch body can be seen, with grommets moulded integrally, and separate close-fitting P.V.C. sleeves for the cable ends.

TESTING

11. The explosive charge in the switch head prevents direct functional testing, but the following electrical test should be made regularly to ensure that the mechanism will operate without delay in an emergency.

12. All fire extinguisher bottles should be removed from their sockets, and test lamps, Inspection Lamp Mk. II (Stores Ref. 5C/369) should be plugged in, in their place. Delayed action switches should be disconnected and test lamps wired across their disconnected leads. Each flame switch cap in turn should then be unscrewed two turns with a spanner; this should loosen the pressure in the head sufficiently to allow the switch contacts to close, so that the appropriate test lamp lights up. Re-set the switch by turning the screwed head back till the test lamp goes out, then fully tighten head to ensure a safe clearance between the contacts. Where holes are provided, the screw-cap should be locked in position with suitable locking wire.

P8500 M /G1774 9/45 8500 C & P Gp. 1

CHAPTER 10

INERTIA SWITCHES

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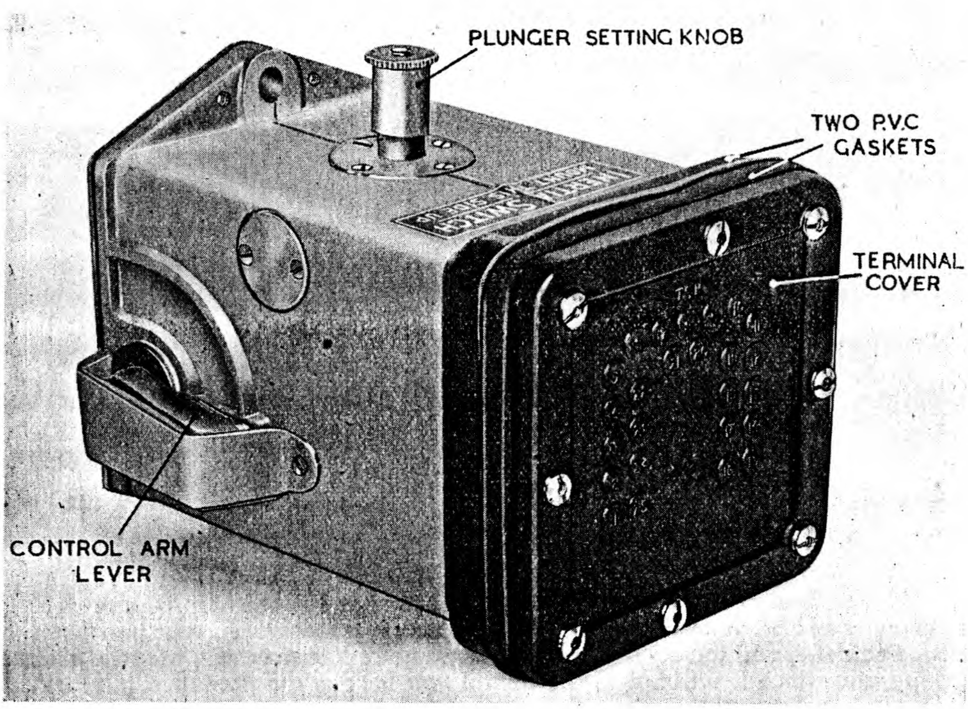

Fig. 1.—Graviner inertia switch—general view

CHAPTER 10

INERTIA SWITCHES

Introduction

1. The Graviner inertia switch described in this chapter, is one of the controlling devices used in the aircraft fire extinguishing circuits, described in A.P.957C, Vol. I, Sect. 3, Chapters 2 and 3. The inertia or impact switch ensures that if the aircraft loses speed at a rate exceeding 6 times the rate that would be caused by the normal force of gravity, (6.G) as for example, in the event of a crash landing, the switch operates to complete the fire extinguisher circuit, and the automatic fire extinguisher devices on the engines and wing tanks come into action. The inertia switch is included in both the engine and wing-tank fire circuits, so that only one such switch is required in each aircraft, the number of terminals being adequate to include all the fire circuits.

DESCRIPTION

2. Two types of inertia switch are in general use, the earlier type (Stores Ref. 27N/20) is now more or less confined to old type aircraft. The later type (Stores Ref. 5C/3521) is used in the new Fire Extinguisher schemes laid down in S.1.60(Engine) and S.1.62 (Engines and Fuel tanks) and allows for 18 point connection. The method of operation of the two types is similar. The Graviner inertia switch (Stores Ref. 5C/3521) is shown in fig. 1, 2 and 3. The switch contains a pendulum mounted on bearings which allow it to swing in any direction. The weight at the end of the pendulum is shaped like an inverted saucer, and when the switch is set for action a control arm, held by a spring, engages the weight at the deepest point of its concave depression, and stops it from swinging. Any shock or impact over 6.G will jolt the pendulum away from the control arm; the arm, released, springs up through an angle of 60° to 80°, and allows the contact points, shown in fig. 2 and 3, to complete the electrical circuit, thus switching on the associated electrical equipment.

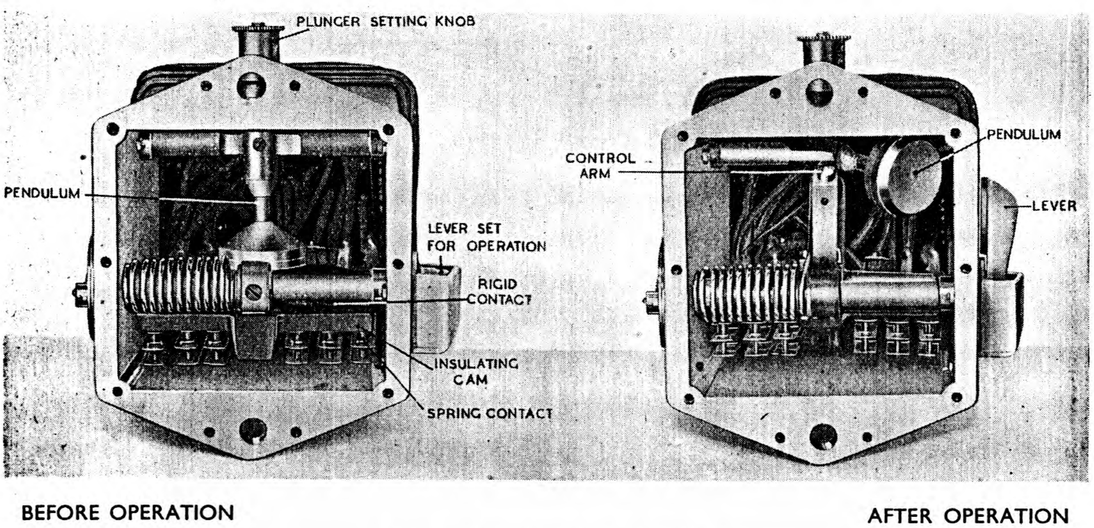

Fig. 2.—Interior view of switch

3. The mechanism of the circuit-closing switch is shown in the open position in the left-hand view of fig. 2 and 3. It consists of a rigid member and a leaf spring, each provided with contact points. The leaf-spring contact is normally held away from contact with the rigid member, by the insulating cam which is attached to the control arm holding the pendulum in place. An impact sufficient to jerk the pendulum free of the control arm, releases the arm which in turn relieves the cam's pressure, and the leaf-spring springs back so that the contacts meet and complete the circuit. The right-hand views of fig. 2 and 3 show the inertia switch after operation.

4. After operation, the switch must be re-set. Press down the re-setting lever on the side of the switch case to its lowest position, and hold down. Rotate the SET-TRIP knob on top of the switch case until the indicating arrow points to the SET position. Press this knob down firmly and hold down. Allow the re-setting lever to rise slowly as far as it will go and finally release the pressure from the set-trip knob. The re-setting lever should now line up exactly with the indicator rib on the switch case: if it does not line up exactly, the switch is incorrectly set, and the re-setting procedure must be repeated. When the inertia switch is correctly set, all test lamps should be out. If test lamps fail to go out when the switch has been tested and is found to be set correctly, it is evident that the inertia switch itself has developed a fault: it must therefore be removed for examination, and a new switch fitted in its place.

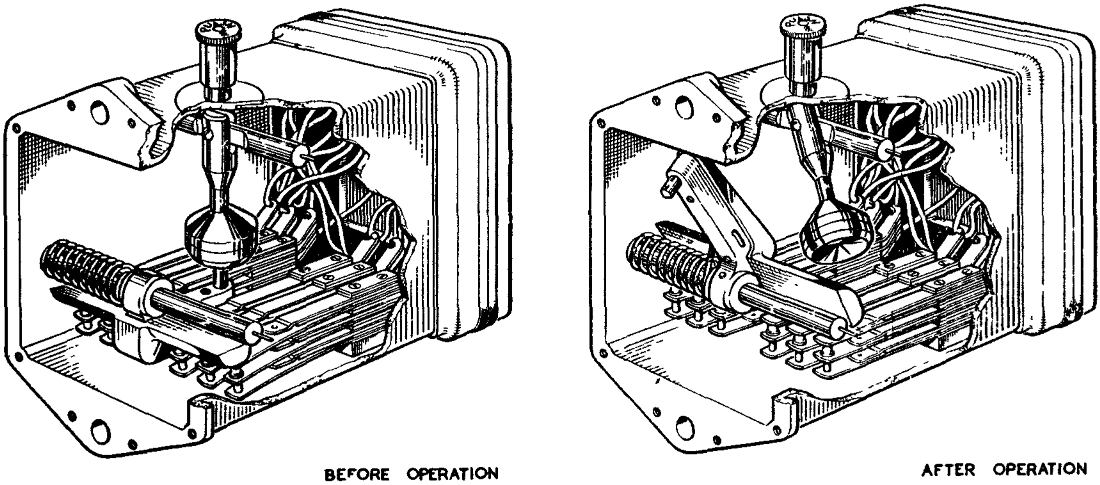

Fig. 3.—Illustration of operation

SERVICING

5. It is vitally important that this inertia switch shall work smoothly and instantly when it is required; it is therefore necessary to ensure that it is kept in good working condition. It has been found that the older types of this switch (Stores Ref. 27N/20) which differ from the later models in having a terminal block the same size as the body, are liable to corrode as a result of the entry of moisture or damp air into the mechanism. Weather proofing of these earlier switches therefore is an important part of the servicing. The possible points of entry for moisture are by way of the terminal box, at the cover plate joints, and particularly the end plate which has a breathing action. When the switch is installed, the terminal space should be completely filled with P.I.C. No. 2, which should be pressed firmly round the screws and cable ends, and into all corners, spaces and channels. Enough compound should be used to allow for the excess to squeeze out when the terminal cover is replaced, leaving a thin film as a washer between cover and switch body. The switch setting knob and lever should be well smeared with P.I.C. No. 1, or if this is not available, with Lanolin. The base plate should be removed, its inner edges should be coated with lacquer (Lanolin-resin pigmented solution, Stores Ref. 33C/584) and the plate immediately fixed in place to make a sealed weather-proof joint. The same lacquer should be used for coating all joints, plates and screws in the assembly. Finally, additional P.I.C. No. 2 should be built up round the cable entries to the terminal box. Fig. 4 illustrates this procedure. This weather-proofing should be checked regularly, and renewed when necessary.

6. In the later types, which allow for 18 point connection and have a terminal block larger than the body, P.V.C. gaskets are provided between the back plate in which the terminals are fitted, and the moulded terminal cover, as shown in fig. 1. These two gaskets are moulded to fit, and are slightly channelled where necessary to ensure good weather-proof entries for the cables. No further weather-proofing is necessary.

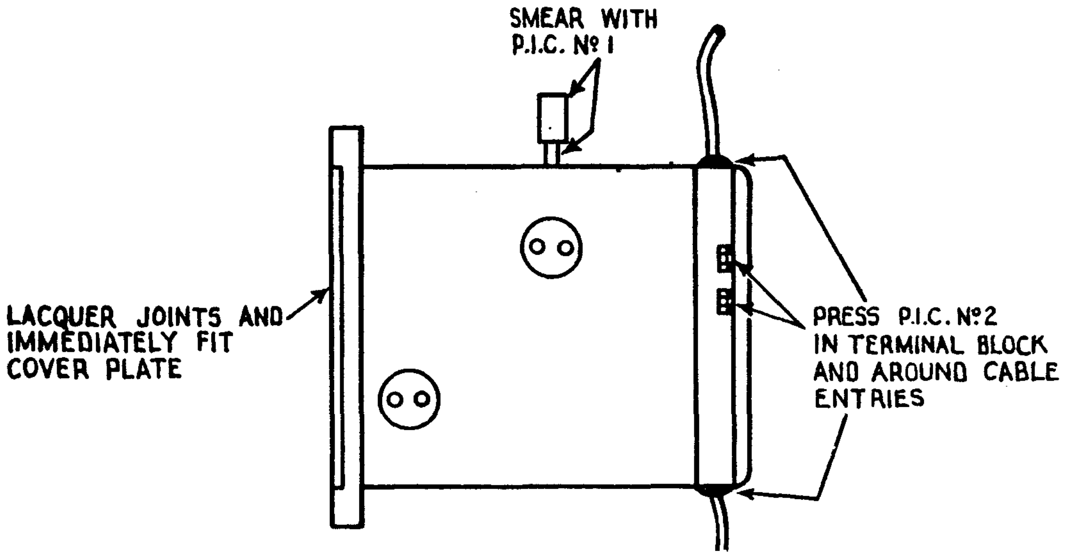

Fig. 4.—Instructions for weather-proofing the earlier type inertia switch

7. The diagram in Fig. 5 shows the wiring up of an 18 point inertia switch in the engine and wing-tank fire extinguisher circuit. The terminal numbers given in the diagram will be shown either on or inside the moulded terminal cover of the switch.

Electrical test

8. Remove all extinguisher-containers, disconnect delay switches and insert a test lamp, Inspection lamp Mk. II (Stores Ref. 5C/369) in the extinguisher plug-in sockets. Rotate the indicator knob until the arrow points to TRIP. Press the knob firmly, and the contacts should close with a movement that is definite and audible, and all the test lamps inserted in the extinguisher plug-in sockets should light up.

9. The switch must be re-set after this test in the manner described in para. 4. If this has been done correctly the switch is in the SET position, with the electrical contacts open, and the test lamps in the extinguisher plug-in circuits are not alight.

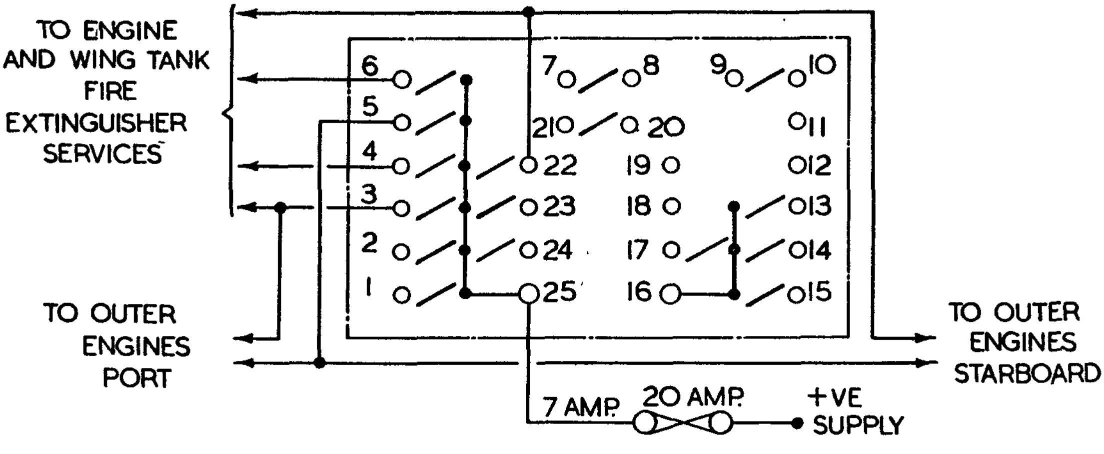

Fig. 5.—Diagram to show wiring connections

P8026 M /G1032 7/45 8500 C & P Gp. 1

CHAPTER 11

IMMERSION SWITCH for emergency dinghies

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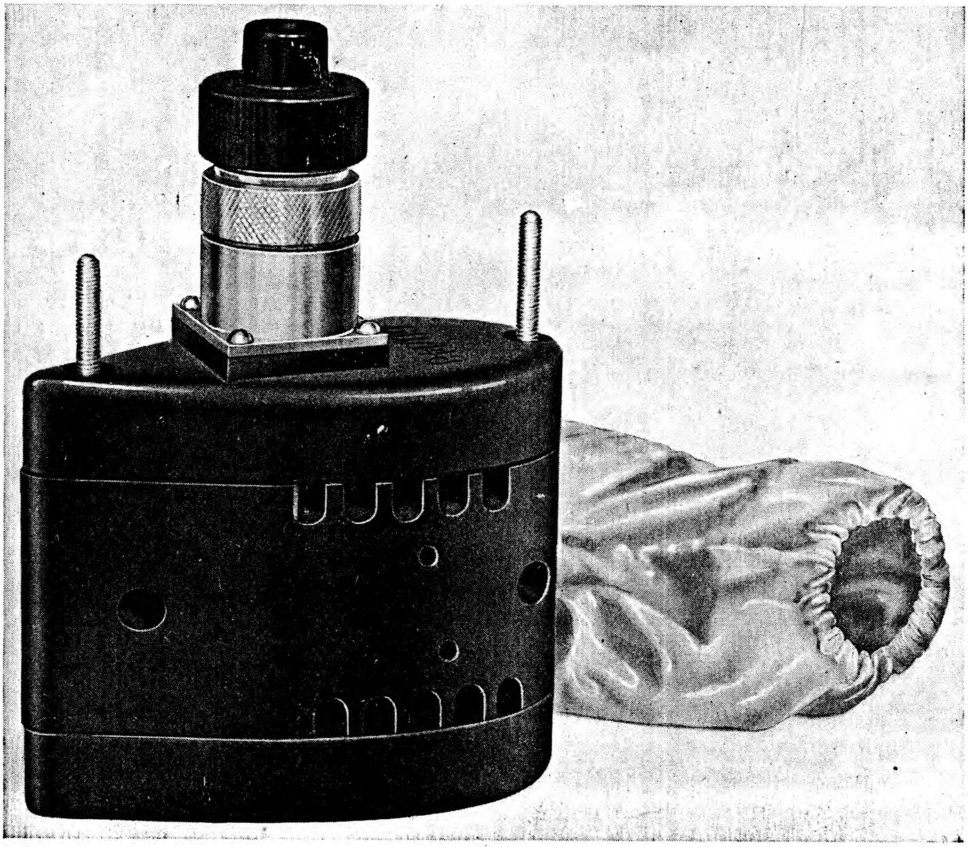
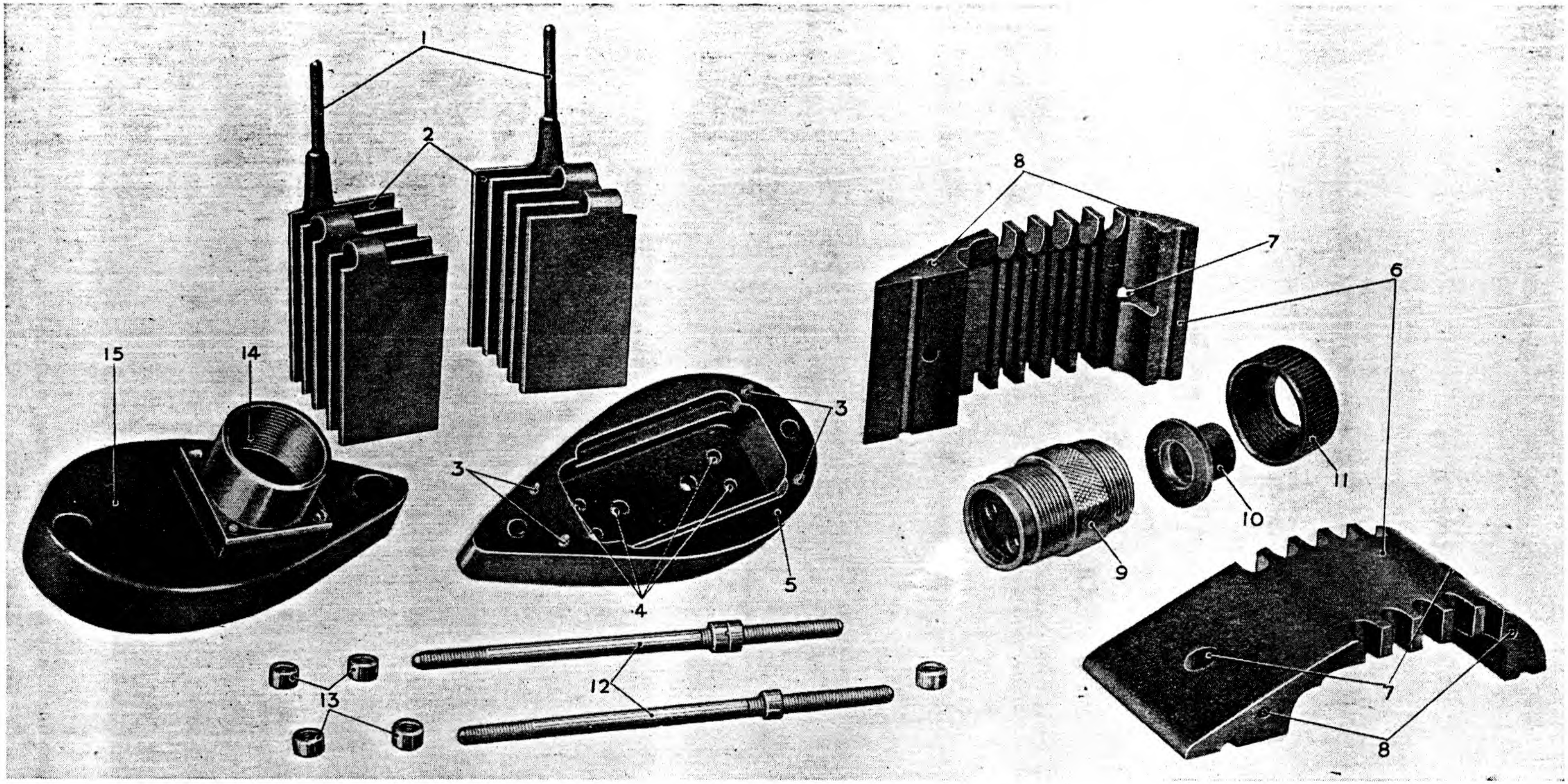


Fig. 1.—Immersion switch, general view, with fabric bag removed



1.	Connections to plug sockets	6.	Side pieces	11.	Locking ring
2.	Contact plates	7.	Testing holes	12.	Attachment bolts
3.	Spigots	8.	Spigot holes	13.	Attachment nuts
4.	Drain holes	9.	Socket	14.	Socket base
5.	Bottom cover	10.	Ferrule	15.	Top cover

Fig. 2.—Dismantled components of the immersion switch

CHAPTER 11

IMMERSION SWITCH for emergency dinghies

Introduction

1. The immersion switch, (Stores Ref. 6D/148), has been developed for installation on all aircraft carrying emergency dinghies, as an automatic device for completing the electric circuit which inflates the dinghy as soon as the aircraft reaches the water. The switch consists of a housing for two sets of plates not normally connected together. The moulded casing of the switch has slots to allow the water to enter the body of the switch the moment it is immersed, and the water, filling the spaces between the two sets of plates, completes the electrical circuit, automatically firing the electric cartridge of the dinghy cylinder operating head.

DESCRIPTION

2. The immersion switch is shown in fig. 1, and its dismantled components in fig. 2. Internally, the switch consists of two sets of plates, one set being connected through a protective fuse to positive supply, and the other set connected through the plug and socket provided in the dinghy stowage to the centre contact of the cartridge which operates the dinghy-inflating apparatus. The two sets of plates are interleaved but not connected until the flow of water into the switch fills the spaces between them and completes the circuit. The plates are housed in a moulded casing built up of four parts which are held together by spigots and by the two bolts which are also used for attaching the switch to the aircraft. Finally, a fabric bag (Stores Ref. 6D/800) with an elastic opening, covers the whole switch to prevent the entry of foreign matter. A Breeze type plug and socket is attached to the case to take the supply cable; a moulded type ferrule and nut is used where "cel" cable is used, but when the switch is fitted externally, as in the Hudson, a metal casing encloses the switch complete with fabric bag, the cable attached is metal braided, and the plug, socket, ferrule and nut are also metal.

SERVICING

3. If the switch is fitted in a position subject to constant sea-spray, it should be examined regularly for salt deposit. When necessary, it should be detached from the cable socket, and washed in hot water, care being taken to avoid wetting the plug, and to dry the switch thoroughly before replacing it.

4. At the inspection periods laid down in the relevant aircraft Maintenance Schedule, the switch should be dismantled, examined for oil, moisture or dust, and washed with warm water and soda. It should then be rinsed well in clean water and thoroughly dried before it is re-assembled. All signs of corrosion should be cleaned off the parts, but they should not be treated with Lanoline, P.I.C., paint or dope, as any of these would reduce the effective contact area of the plates. If corrosion occurs in the plug and socket connection, it should be cleaned off, and the affected parts smeared with P.I.C. No. 1 or Lanoline.

5. The linen fabric bag with which the switch is covered should be renewed if it becomes torn, oily, or dirty. The replacement bag (Stores Ref. 6D/800) has had all the dressing washed out of the material, so that there is nothing to prevent the free flow of the water through the fabric the moment the switch is immersed.

Continuity test

6. Holes are drilled in the casing of the switch to enable a continuity test to be taken across the two sets of plates. The test may be made with a lamp battery, and two $\frac{3}{16}$ in. diameter testing rods. The wattage of the lamp must not exceed $\frac{1}{4}$th the voltage. Plug the testing rods

either into two holes on the same side of the switch, or into one hole and the adjoining water entry slot, and if the circuit is satisfactory, the lamp will light. If it does not, remove the plug, and inspect the sockets and contact plate pins for signs of corrosion. If the test is still unsatisfactory, the other components of the circuit should be checked.

7. No repairs are to be undertaken on the immersion switch. Broken or unserviceable parts must be removed and new or serviceable items fitted. No spare parts are available from Stores, but replacements can be obtained from switches which have been reduced to produce them. Failing this, a new switch should be drawn from Stores and fitted in place of the faulty one.

P8731 M /G2182 11/45 8500 C & P Gp. 1

CHAPTER 12

PROPELLER PRESSURE CUT-OUT SWITCHES

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Introduction

1. The Rotax pressure cut-out switches, Types D2303, D2304, and D2305, are employed in hydromatic propeller feathering pump motor circuits to break indirectly the relay circuits controlling the feathering pump motor when the propeller is fully feathered. The switches are automatically operated by the oil pressure of the system, and are installed on special mountings provided on the constant-speed units. The Type D2303 switch is of the differential pressure cut-out type, and Types D2304 and D2305 are direct acting, for single line use only.

2. The feathering pump installation is an individual pump system, each engine being fitted with its own gear type feathering pump, driven independently of the engine by an electric motor. On installations where the Type D2303 switch is employed the pump delivers oil to the propeller from the main oil tank of the aircraft and when the oil pressure in the propeller line exceeds the engine oil pressure by a predetermined amount, i.e. when the propeller is fully feathered, the differential pressure cut-out switch operates, thus de-energising the hold-in coil of the feathering push-button which automatically disconnects the pump motor from the electrical supply. The Types D2304 and D2305 are operated by the oil pressure in the propeller line only, and break the hold-in circuit of the feathering push-button when this pressure reaches a predetermined amount corresponding to the fully-feathered position of the propeller.

Leading particulars

3.

Type ...	D2303	D2304	D2305
Stores Ref. ...	5C/2017	5C/2328	5C/3153
Maximum current rating at 24 volts	5 amp.	2 amp.	2 amp.
Pressure setting (lb. per sq. in.) (with low pressure at zero) ...	450	660–675	500–520

DESCRIPTION

4. As the three types of switches are identical apart from the setting of the spring pressures, the following description will apply to all types. A sectional view of the switch is shown in fig. 1; the switch components are assembled in a body casting which incorporates a Breeze plug. Four fixing bolts passing through holes located at each corner of the casting are used to attach the switch to the mounting of the constant-speed unit and are wire-locked when the switch has been installed. The base of the switch body casting is specially finished to ensure an oil-tight joint with the mounting. A metal cover plate is employed to protect the base during transit and until the switch is actually installed. This plate is fitted to the base of the switch and held in place by means of four nuts attached to the fixing bolts. The cover plate should not be removed until it is required to fit the switch to the constant-speed unit, and must be replaced immediately on detaching the switch from its mounting.

5. The interior of the switch is sealed at the top by means of a metal cap and gasket which are held in place by the four fixing bolts. On early models a hexagon screw-in type of cap was used for this purpose. Two fixed contacts are mounted in a moulding of insulating material which is secured to the inside of the switch by means of a countersunk screw. A strip connection from each contact is soldered to a plug pin connection lug of the Breeze plug, the plug being held in place against an oil seal by means of an internal plug retaining nut.

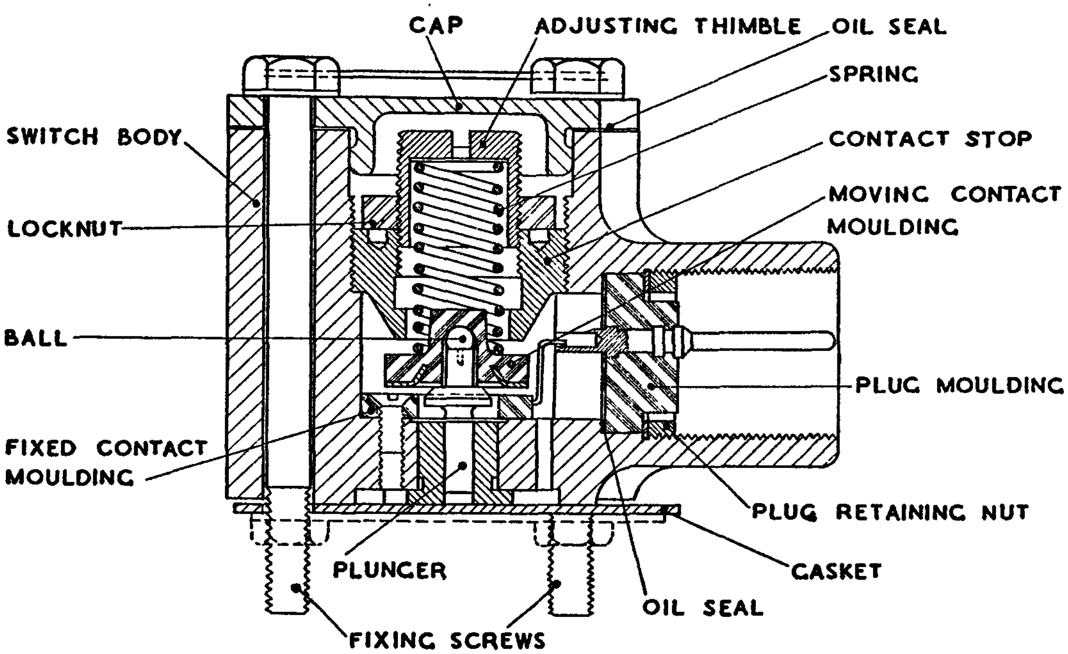

Fig. 1.—Sectional view of Rotax type propeller pressure cut-out switch

6. A vertical brass sleeve is incorporated in the base of the switch body and accommodates a steel plunger. When in use the external end surface of the plunger is subject to the oil pressure in the propeller line (or high oil pressure in the case of the switch, Type D2303). An $\frac{1}{8}$ in. diameter ball is located at the internal end of the plunger and provides a mounting for the moving contact moulding, the contact being in the form of a flat metal ring in the base of the moulding. This moulding is spring-loaded, and a contact stop, screwed into the switch body above it, limits its movement. The upper end of the spring is located in a cylindrical adjusting thimble which is secured in position by a lock-nut. A small oil hole is drilled through the centre of the thimble so that when the assembly is used as the Type D2303 switch the low pressure oil will completely fill the switch body.

7. The base of the switch is recessed externally to provide a low pressure oil channel and a small hole situated in this channel allows low pressure oil to enter the interior of the switch.

PRINCIPLE OF OPERATION

Type D2303

8. The special mounting of the constant-speed unit for these switches is designed so that, when in operation, the high oil pressure of the propeller oil line is applied to the base of the plunger, and the low pressure, or engine oil line, to the low pressure channel in the switch base.

9. Engine oil enters through the small hole situated in the low pressure oil channel and fills the interior of the switch. The engine oil pressure, assisted by the switch spring, acts on the moving contact moulding, tending to keep the contacts closed; but this pressure also acts on the

underside of the contact moulding so that the effective closing pressure is only that acting on the cross-sectional area of the plunger.

If a = cross-sectional area of the plunger
P_1 = propeller line oil pressure
P_2 = engine oil pressure
L = spring loading with contact made.

Then $(P_1 - P_2) \times a = L$.

10. The spring loading L therefore governs the differential action of the switch by permitting the contacts to be broken when the load due to the difference between the propeller line and the engine oil pressure, acting on the plunger cross-sectional area, is equal to or greater than this loading.

Types D2304 and D2305

11. With these switches the high pressure or propeller line pressure only is applied to the plunger. When the load due to the pressure in the line becomes greater than the value at which the spring is set, the plunger will be lifted and the contacts opened. If the load on the plunger exerted by the line pressure falls below the value at which the spring is set, the contacts will close.

INSTALLATION AND OPERATION

12. Reference should be made to the appropriate aircraft handbook for detailed instructions on the installation of these cut-out switches.

13. In installations incorporating either the differential or the single-line switches the pump motor circuit is controlled by a solenoid switch, the solenoid coil being in series with a push-button switch incorporating a hold-in solenoid. This switch is closed manually by the pilot, then held in the closed position by its solenoid which is in series with the pressure cut-out switch. Therefore, when the cut-out switch is operated by the oil pressure the whole electrical system is disconnected from the supply.

14. During unfeathering, the circuit is maintained manually by the pilot, as the oil pressure considerably exceeds the value required for feathering and the pressure cut-out switch is inoperative, its contacts remaining open until the pressure, or in the case of the differential Type D2303, the pressure difference, falls below the value at which the switch is set.

SERVICING

15. At mid-major inspections (approx. 240 hours) or at other times if they are suspected of faulty action, the switches should be tested by means of a dead weight tester. An adapter enabling the switches to be fitted on to the tester can be made from the adapter already fitted on the head of the constant-speed unit, and a lamp must be included in the circuit to show the cut-out position of the switch.

16. Tests of switch, Type D2303, should show the pressure given in para. 3, *less* the engine pressure, which will be about 70 lb. Actual engine pressures can be obtained from the Aircraft handbook or from the Publication referring to the particular propeller with which the switch under test is used.

17. In the case of Types D2304 and D2305, which are operated by single-line pressure, the engine pressure does not have to be considered, and the test should therefore show the pressure setting quoted for these types in para. 3.

18. Pressure can be adjusted by the addition or removal of shims, fitted in the head of the adjusting thimble, and increasing or decreasing the pressure on the spring. Shims for these switches are available in one size only, Stores Ref. 5C/3747.

19. Switches in which the pressure cannot be corrected by the insertion or removal of shims, or those which are faulty in other respects, must be returned to Stores, and new switches must be drawn and tested for correct pressure for installation in their place.

P9956 M /G4450 4/46 8500 C & P Gp. 1

CHAPTER 13

PROPELLER FEATHERING SWITCH, Type XJD

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LIST OF ILLUSTRATIONS

Introduction

1. The propeller feathering switch Type XJD described in this chapter, supersedes all other types of 24V propeller feathering switches for existing and new production aircraft. The mechanism of the switch incorporates a solenoid which holds the switch in the ON position until automatically switched off as the propeller reaches the fully feathered position. A warning light in the plunger-knob is in circuit with the fire-extinguisher system, and lights up automatically when the operation of any one of the flame switches in the engine-bay concerned brings the fire extinguisher circuit into action. Loss of fuel, low oil pressure, loss of coolant, and torque reaction are also shown on this warning lamp, but these faults will result in a flickering light instead of the steady light which indicates the operation of a flame switch.

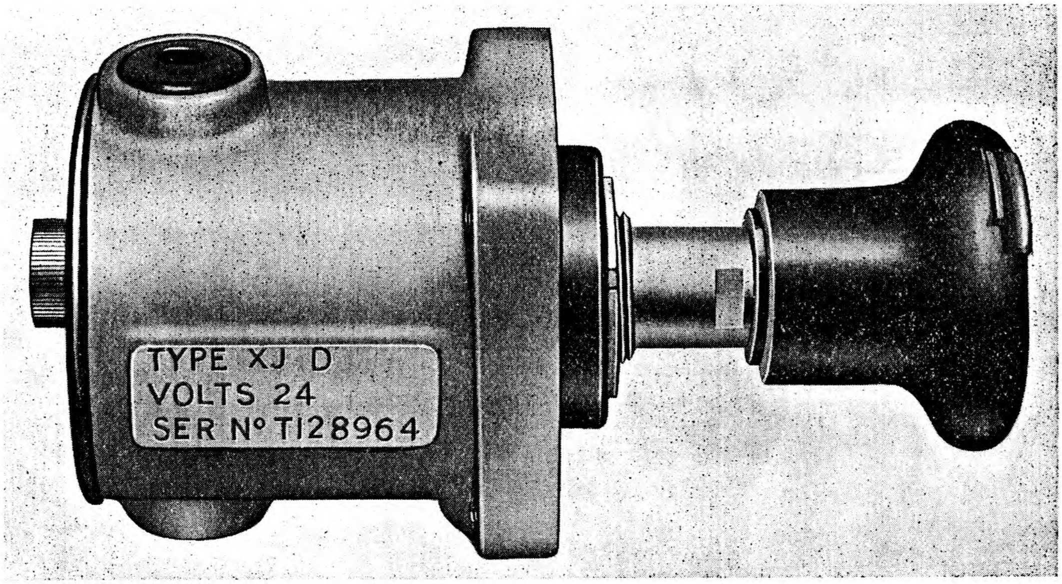
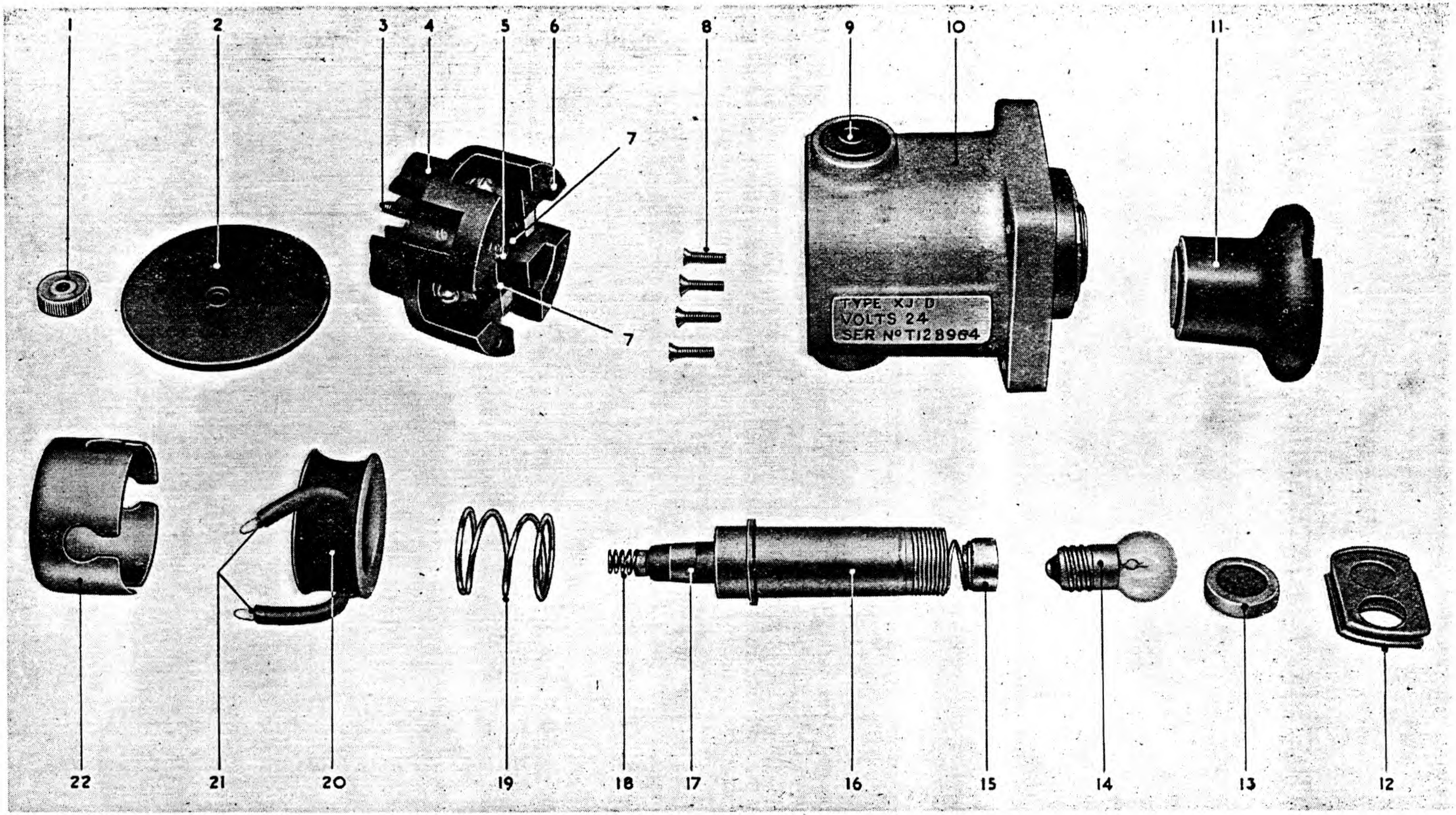


Fig. 1.—Propeller feathering switch, Type XJD



1. Terminal cover nut
2. Terminal cover
3. Cover locating stud
4. Terminal block
5. Warning lamp contact
6. Holes for fixing screws
7. Leaf spring contacts
8. Terminal block fixing screws
9. Cable entry with rubber grommet
10. Switch body
11. Plunger knob
12. Blanking screen
13. Amber screen
14. Warning lamp
15. Lampholder
16. Plunger
17. Contact sleeve
18. Spring contact for warning light circuit
19. Plunger return spring
20. Solenoid
21. Solenoid coil terminals
22. Solenoid cover

Fig. 2.—Switch, Type XJD, dismantled

DESCRIPTION

2. Propeller feathering switch Type XJD (Stores Ref. 5C/3647) is illustrated in fig. 1. A sectional drawing of the switch is shown in fig. 3 and the dismantled components in fig. 2.

3. The switch consists of a light metal body housing a plunger which, when depressed, makes contact with leaf-spring contacts attached to the terminal studs. Two circuits are completed through these contacts. First, the circuit operating the feathering of the propeller, and secondly, a solenoid switch which holds the plunger in the depressed position until the propeller reaches the fully feathered position. As soon as the propeller reaches the fully feathered position, the circuit controlling its pitch variation is broken, and the solenoid is de-energised.

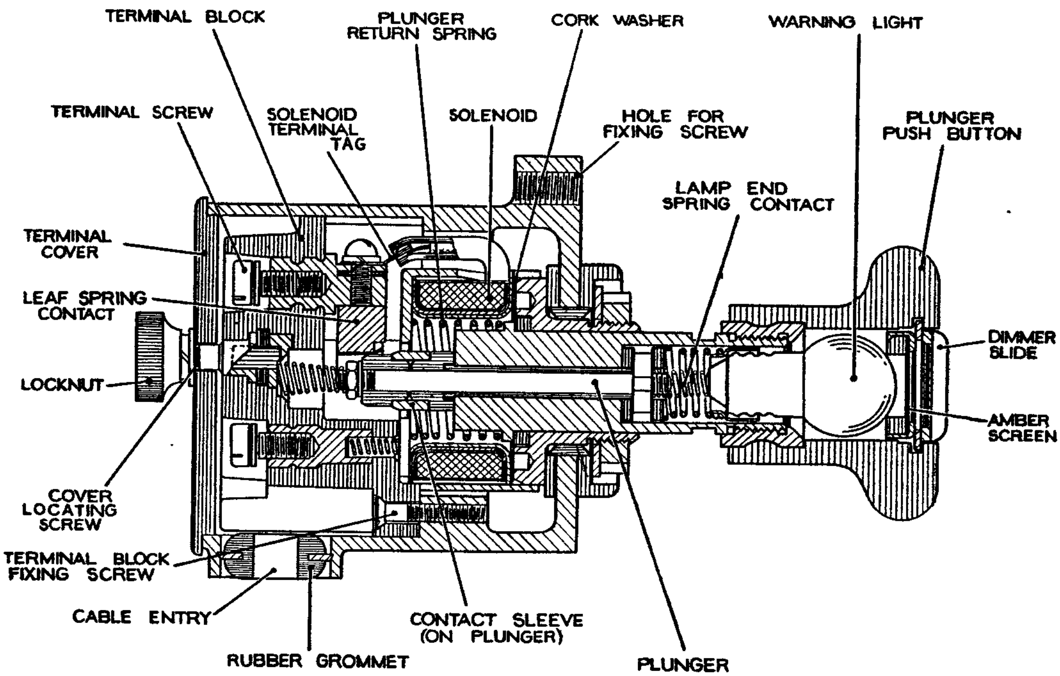


Fig. 3.—Sectional view of switch, Type XJD

4. In fig. 2, the components of the switch are dismantled and annotated. The plunger knob (11) screws on to the plunger (16) and houses the warning light (14), which slips into the lampholder (15) making end-contact with a rod running through the centre of the plunger to the contact spring (18). The filament lamp is covered by an amber screen (13), and the blanking screen (12) sliding into grooves in the plunger knob holds the filament lamp and amber screen in position. When the plunger is depressed the contact sleeve (17) makes contact with three leaf-spring contacts (7), two on the inboard end of the terminals marked S and S1, to which the ends of the solenoid coil (21) are attached, and one on the terminal for the +ve supply. A diagram of the connections is given in fig. 4, and a view of the terminal block moulding, showing the leaf-spring contact connections to terminals, in fig. 5. The terminal block is held in place in the metal switch-cover by four small screws (8). A threaded stud (3) moulded into the terminal block, locates the terminal cover (2), which is locked on by the nut (1) and washer (not shown). The cable entries in the switch cover are fitted with rubber grommets (9) to ensure weather-proof connection.

SERVICING

5. The filament lamp should be examined regularly. To remove the lamp from the knob, the blanking screen should be put so that the open section is over the amber screen. Press in the amber screen with the end of a pencil, or some other suitable implement. This releases the spring pressure on the blanking screen, which will then slide out of its grooves in the plunger knob. Take care that the amber screen and the filament lamp do not spring out as the blanking screen is removed. To replace, put the filament lamp into the spring holder, hold it in position with the amber screen, the rubber washer side next to the bulb, then slide the blanking screen into the grooves of the knob and over the top of the amber screen.

6. To dismantle the switch for internal inspection, unscrew the terminal cover nut and washer, and take off the terminal cover. Unscrew the four small screws holding the terminal block into the switch body. Holding the cover locating stud in one hand, press the plunger knob with the other, and the terminal block with the soleniod coil attached will come away together. Take care not to drop the plunger-return spring, which is housed loosely inside the solenoid coil.

7. Inspect the leaf-spring contacts for signs of corrosion, and the contact sleeve on the plunger for pitting or burning. Clean, if necessary, and smear very lightly with P.I.C. No. 1. Check the spring contacts for the warning light circuit.

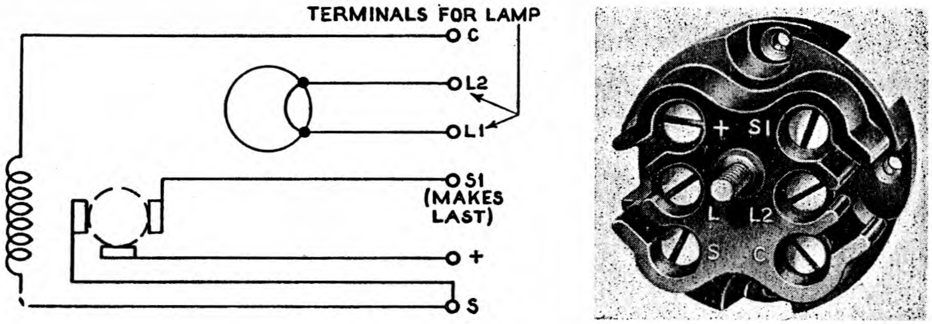


Fig. 4.—Diagram of terminal connections

8. Test the plunger movement to ensure that it runs freely and easily in its guide. If necessary, lubricate very lightly with Grease, anti-freeze (Stores Ref. 34A/49). The lubricant should be applied to the plunger shaft *outside* the switch body and worked in. If more drastic treatment is required, hold the plunger shaft firmly, and unscrew the knob; the shaft can then be drawn out from the back of the switch body. The filament lamp and screens should have been removed from the knob before it is screwed off.

9. Examine the cable connections for rubbing or other trouble in the glands. If there are any signs of corrosion, smear the cable terminals with P.I.C. No. 1 and pack the glands well with P.I.C. No. 2. If local climatic conditions make it desirable, the whole of the terminal block and cable channels may be packed with P.I.C. No. 2; enough of the material being used to squeeze out into a thin film or washer between the terminal cover and switch body when the cover is replaced and screwed well down.

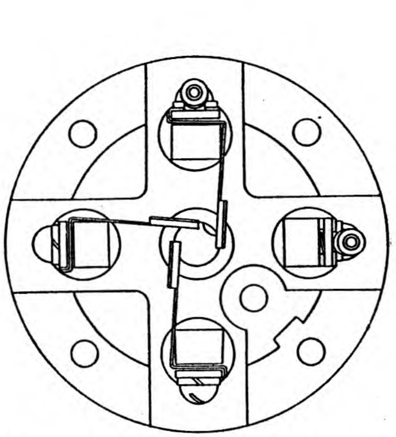


Fig. 5.—View of moulding showing leaf-spring contacts

P9271 M G3074 1/46 8500 C & P Gp. 1

CHAPTER 14

COMBINED SINGLE AND DOUBLE POLE CHANGEOVER SWITCH

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LIST OF ILLUSTRATIONS

Introduction

1. Designed for use with the undercarriage position indicator (Dowty type) which is described in A.P.1095A, Sect. 1, Chap. 7, the undercarriage ON–OFF changeover switch comprises two independently-operated switches in one housing, a single pole double throw ON–OFF switch controlling the supply of the indicating system, and a double pole double throw switch controlling a set of spare lamps which may be brought into circuit as and when required.

DESCRIPTION

2. An exploded view of the unit is given in fig. 1. The top mounting plate is retained in position by two roundhead screws and it will be seen that the switch positions are clearly indicated on the top of the plate. Four screw holes suitable for roundhead screws are provided for mounting the switch on the instrument panel. The plate also holds in position the sliding bar, which is of moulded insulating material, and the diecast distance piece. A metal case shrouds the switch mechanism. Both sections of the switch are of the slow make and break type, and silver plated contacts are employed. Tension springs located on either side of the unit hold the switch levers in the required position, the switch being so designed that failure of the spring does not necessarily render the switch mechanism inoperative. The two switch assemblies are held together by four long transverse screws and locknuts, the ends of the screws being riveted over to prevent looseness. Circlips are used to hold the transverse tension spring pivots in position, the looped ends of the tension springs resting in grooves in the pivot and they are thus easily removable should replacement be required. The end terminal plate which carries nine terminals for cable connection is retained in position by nine roundheaded slotted screws. A shroud of moulded insulating material fits over the cable terminals, a cover of the same material, which fits over both terminals and shroud, being retained in position by two roundhead screws.

INSTALLATION AND SERVICING

Installation

3. The switch should be so disposed on the panel that the sliding bar operating the ON–OFF section lever is interlocked with the aircraft ignition switches in such a manner that the undercarriage indicator system is always operative when the ignition is switched on, thus ensuring that the aircraft cannot be flown with the indicator switched off.

Servicing

4. All contacting surfaces are silver-plated and may be cleaned with a jeweller's cloth, care being taken to see that the phosphor bronze contact springs are not bent out of shape during the cleaning process. Broken or fatigued springs will cause loss of snap in the switch action and must be replaced immediately.

Dismantling

5. Should it become necessary to gain access to the switch mechanism, it is preferable to remove the unit from the instrument panel. The two screws holding the terminal cover in position must first be removed, when it will be found possible to slide this part along the cables passing through

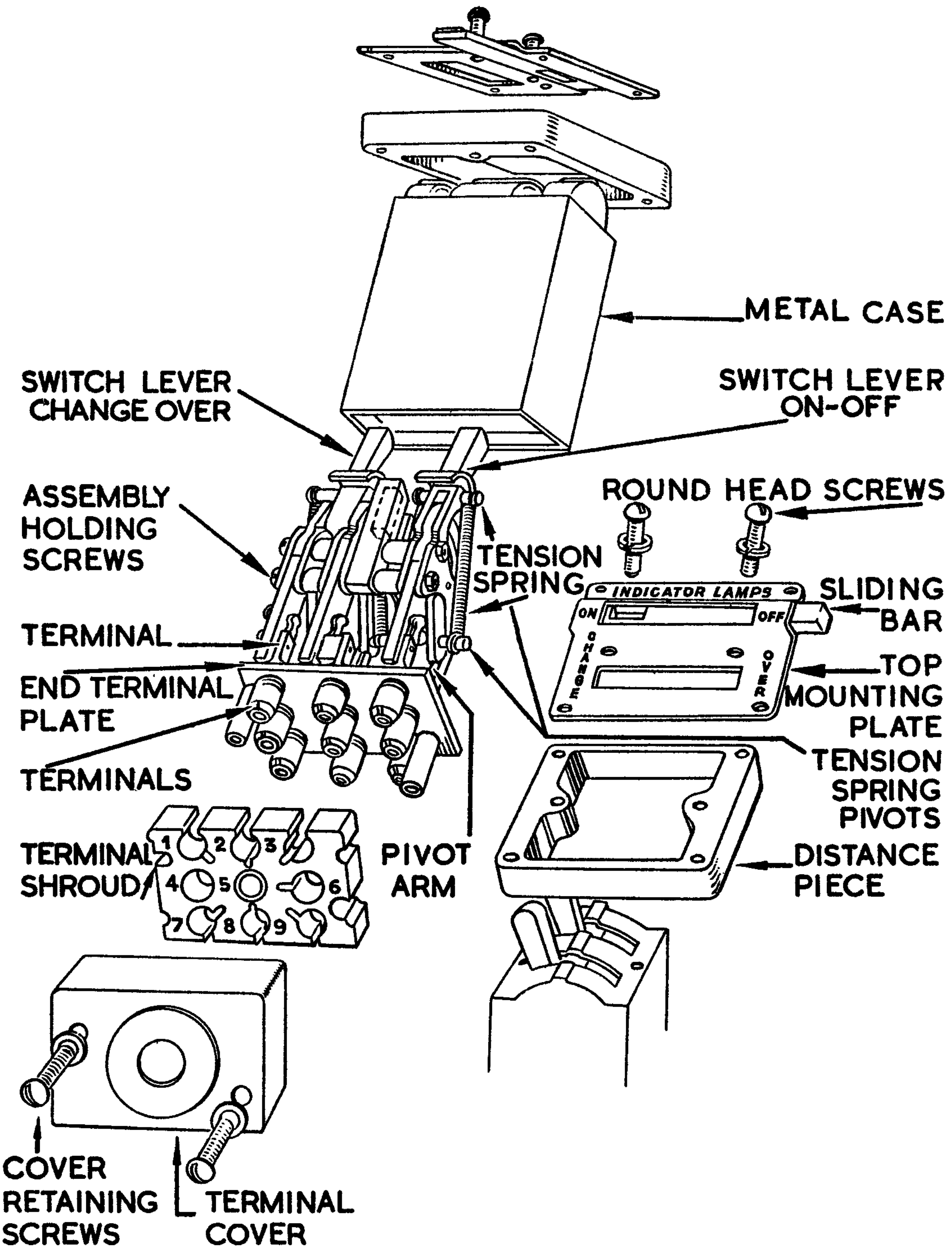

Fig. 1.—Exploded view of switch

the centre hole of the cover, so exposing the terminals and enabling the cable to be disconnected. The unit may now be removed from the instrument panel by withdrawing the four retaining screws located one at each corner of the top mounting plate.

6. Removal of the two screws retaining the top mounting plate in position will free the distance piece and also the sliding bar, the rectangular aperture of which is passed over the ON–OFF section lever. The metal case shrouding the switch may now be withdrawn and the switch mechanism exposed. The spade-ended terminals are riveted to their respective phosphor bronze contacting springs, but the end terminal plate is held in position by roundheaded slotted screws. The other sub-assemblies of the switch are riveted together, the tension spring pivots being held in position by circlips, the looped ends of the springs resting in grooves in the pivots.

Re-erection

7. When fitting new tension springs, it is necessary to place a small quantity of lubricant on the looped ends to minimize wear. The lever bearings may also be lightly lubricated, but the small dumb-bell shaped roller carried loose in a slot at the end of the insulated lever arm must not be lubricated, not should any of the silvered surfaces. When replacing the metal case, the two switch levers must be carefully held in the dead centre position to allow the levers to pass in the arc shaped slots in the end of the case, care being taken to avoid distortion of the springs. The terminal shroud may be fitted next and it should be so positioned that the slots marked 3, 6, and 9 read vertically downward and coincide with the three terminals associated with the ON–OFF section of the switch. The shroud is retained in position by friction only. After the case has been placed in position, the diecast distance piece may be positioned and the sliding bar placed in position by passing the ON–OFF section lever through the rectangular aperture in the same. The chamfered edges of the sliding bar must be outwards. When replacing the mounting plate it should be ascertained that the wording "Indicator lamps" on the plate is on the same side as the figures 3, 6 and 9 on the terminal shroud. The plate is secured by the two roundheaded screws and care must be exercised to see that the two spring washers are replaced with the screws.

P3440 M /1393 1/44 8500 C & P Gp. 1

CHAPTER 15

TOGGLE SWITCH, 3-WAY, TYPE D.3501

(Stores Ref. No. 5C/1979)

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LIST OF ILLUSTRATIONS

Introduction

1. This single pole 3-way switch is used for controlling the automatic or manual pitch change of the Rotol propeller, and is used in conjunction with the double pole single-throw switch, type D.3601.

2. In the OFF position the switch arm is central. In the AUTOMATIC position the switch arm is pushed up and remains there until it is pushed off again. By the design of the centre fixed contact, spring and contact plate assembly, the switch arm is spring returned to the central position after switching to either INCREASED or DECREASED r.p.m.

DESCRIPTION

3. The switch, which is illustrated in fig. 1 and 2, is 2·25 in. high, 1·375 in. wide, and weighs 4 oz. The cover and mounting plate are of aluminium, and riveted together by three brass rivets. The centre of the mounting plate is domed to allow for the switch's rotating movement. The centre of the domed portion has a clover leaf pattern cut out to enable the switch arm to engage the AUTOMATIC, INCREASED, and DECREASED positions. The switch arm is of brass incorporating the actuating whalebone fibre plunger, which is retained under pressure from a steel spiral spring. The moving contact plate assembly is of brass with silver contacts riveted to its extremities. The contact plate assembly is assembled so that the arm with the rounded head makes contact with the short terminals.

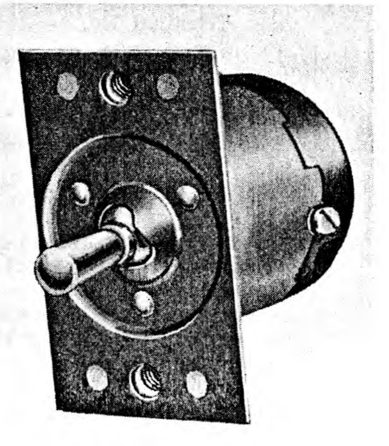

Fig. 1.
Toggle switch, 3-way, type D.3501

4. The base moulding is of black bakelite and contains the moulded-in silver tipped fixed contacts. The centre fixed contact is shaped to admit the contact plate assembly. Nos. 2 and 3 fixed contacts protrude more than No. 1, and in the former positions the switch arm has to be held down. The four terminals are provided at the back of the moulded base and protected by a removable bakelite cover which is secured to the base by two 6 B.A. brass countersunk screws.

5. The cover is slotted to fit on the base in its correct position, and is secured by three cup-head steel screws 6 B.A. × 0·187 in. long with steel spring washers screwed into brass inserts moulded in base.

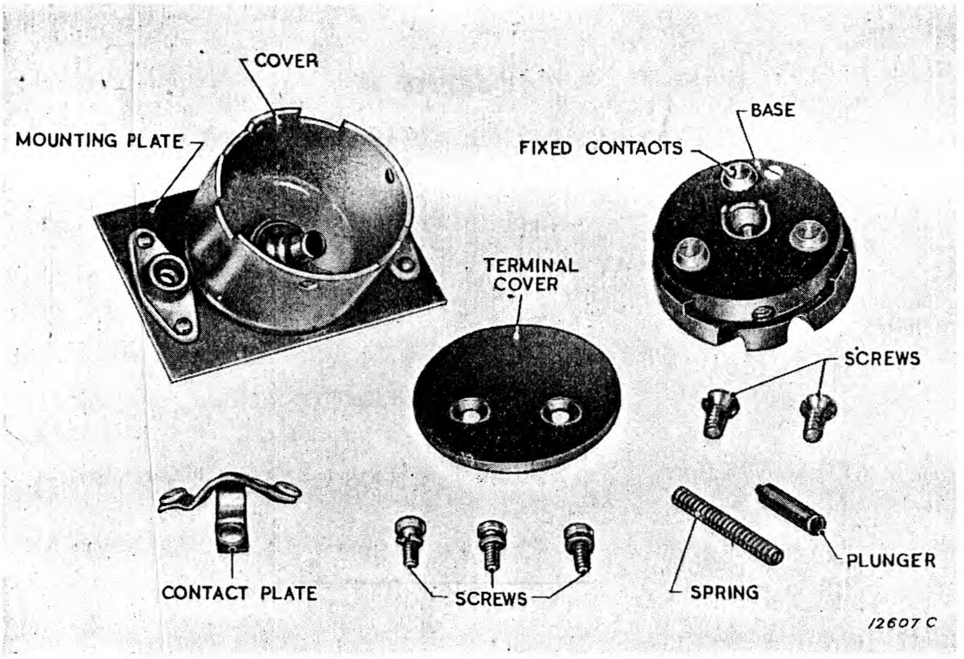

Fig. 2.—Exploded view of toggle switch

INSTALLATION

6. The switch is mounted on a panel in the cockpit within easy reach to the pilot and convenient for wiring. 2 B.A. Simmonds Anchor nuts are riveted to the mounting plate for fixing on the panel. Three grooves are cut in the back of the bakelite base leading to the terminals which are numbered 1 to 4, and are to be connected to the external circuit as follows.

Terminal No. 1—AUTOMATIC	White cable to suppressor unit.
Terminal No. 2—DECREASED r.p.m. ...	To feathering switch and blue cable to suppressor unit.
Terminal No. 3—INCREASED r.p.m. ...	Yellow cable to suppressor unit.
Terminal No. 4—Centre (spider contact)	To feathering switch NORMAL contact.

SERVICING

7. Normally no servicing is required, but during inspection, each contact, rocker, and base moulding assembly is to be checked with a dismantled body assembly. The minimum gap between pairs of contacts with the switch in the OFF position must not be less than 0·025 in. Contacts, if pitted or burned may be rubbed with fine emery cloth. On assembly grease the inside of the centre contact on the base with grease (Stores Ref. 34A/105). The plunger spring must be smeared lightly with vaseline.

P4258 M /113 5/44 8500 C & P Gp. 1

CHAPTER 16

DOUBLE POLE SINGLE THROW SWITCH, Type D.3601

(Stores Ref. No. 5C/1980)

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LIST OF ILLUSTRATIONS

Introduction

1. This double pole change-over switch is used for changing from normal to quick feathering action of the electrically operated Rotol propeller when it is desired to fully feather the blades rapidly. It has a quick make and break action. This switch is used in conjunction with 3-way toggle switch.

2. The switch cover is marked NORMAL and FEATHER, and when the switch arm is down it is in the NORMAL position, and in the up position it controls a voltage booster which is in series with the aircraft's accumulator which raises the voltage available from 19 to approximately 80 volts. The operation takes only a few seconds.

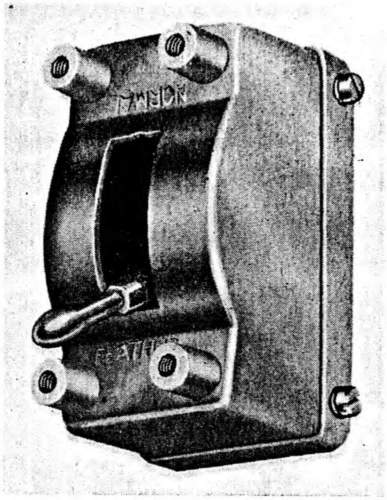

Fig. 1.—Double pole single throw switch, type D.3601

DESCRIPTION

3. The switch, which is illustrated in fig. 1 and 2, is 2·47 in. × 1·55 in., an overall depth of 1·593 in., and weighs 6 oz. The front of the cover is slotted to allow movement of switch arm and the mechanism is made totally enclosed by a brass case of semi-circular shape which moves with the switch action behind the slot in the cover. The cover is secured to the base by four 6 B.A. cup head screws with steel spring washers. Riveted on to the front of the cover are four panel fixing bosses tapped for 4 B.A. screws the centres of which are 1·875 in. × ·812 in.

4. The four terminals and the switch blades are disposed two at each end of the switch mounted on brass pillars, and are secured to a common bakelite plate. The pillars are secured to the base by four countersunk screws locked in with Golden Endolac varnish. The terminals are screwed into the pillars and each pair are separated by a double thickness of leatheroid and are provided with lugs for connecting the incoming cable. Rubber bushes line the cable exit holes in the brass base of the switch to which the mechanism and bakelite plate are held by two 6 B.A. screws. The contact assembly rotates on an axis and is pulled into position by the tension of two toggle springs, one on each side.

INSTALLATION

5. The switch is mounted in the cockpit on a panel within easy reach to the pilot and convenient for wiring. Four bosses are provided on the cover for fixing screws. The terminals are connected to the external circuit as follows:—

NORMAL terminals	Positive main, to No. 4 terminal 3-way toggle switch
FEATHERING terminals	No. 2 terminal 3-way toggle switch, to S+ terminal on voltage booster

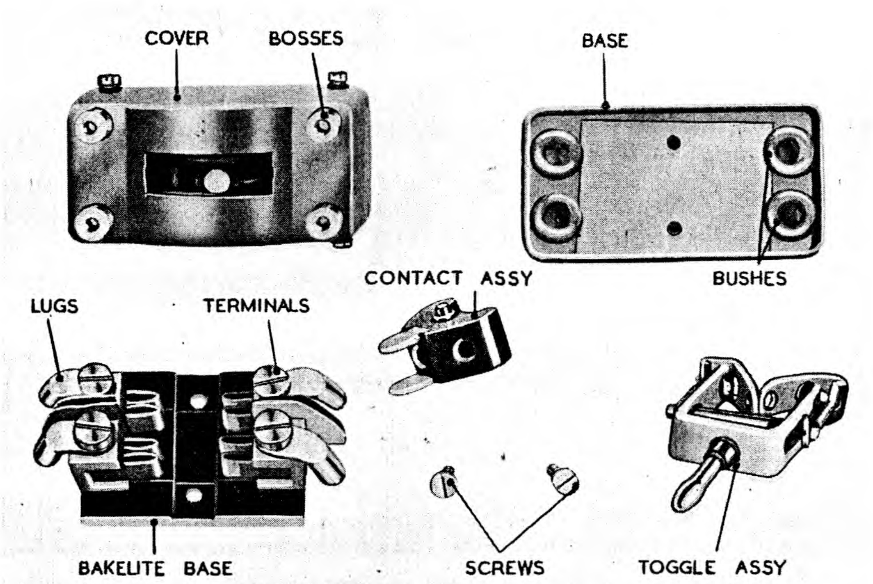

Fig. 2.—Exploded view of double pole single throw switch

SERVICING

6. Normally no servicing is required, but during inspection ensure that contacts are not pitted, and that the switch makes and breaks rapidly.

P4259 M /115 5/44 8500 C & P Gp. 1

CHAPTER 17

Combined SELECTOR and FEATHERING SWITCH, Type D.4601

(Stores Ref. 5C/2735)

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LIST OF ILLUSTRATIONS

Introduction

1. This switch has been designed to combine, within one switch, the control of the four operating conditions of the Rotol electrically-operated propeller. Its design also prevents two operations being selected simultaneously, there being only one switch lever for selection.

2. The top of the switch is indicated by a deep circular indentation on the cover plate and a provision for its acceptance on the moulded body. When installed on the dashboard, this marking must be uppermost. All references in this chapter to switch lever positions and component positions assume the switch is in this "upright" position. (Fig. 1.)

Principle of operation

3. When the selector switch lever is in the central or "off" position, the propeller is flown as a fixed pitch unit. In this position, the pitch changing motor circuit is open and the brake engaged, locking the blades in the pitch obtaining. When the switch lever is moved right or left, fine or coarse pitch circuits are closed respectively and whilst held in either of the two positions, the motor is turning the blades to fine or coarse pitch. Upon releasing the switch lever, it automatically returns to the central or "off" position, thus breaking the circuit of the motor, engaging the brake and locking the blades in the obtaining pitch setting. Feathering pitch can be obtained in this manner, which takes an appreciable amount of time but a minimum of current consumption.

4. To obtain feathering pitch quickly in an emergency, the switch lever is extended against its spring and depressed downwards. This method of feathering brings into operation a booster, the latter raising a pressure of 19 volts to approximately 80 volts. The switch lever remains in the downward position when released and the blades are turned to the full feathering pitch in a few seconds, but the current consumption is high.

5. The remaining movement of the switch lever in the upward direction brings into operation the constant speed unit. Again, the switch lever remains in this position when released, connecting the pitch control motor circuit directly to the constant speed unit.

DESCRIPTION

6. The switch consists of a moulded body incorporating four toggle type snap switches, each two diametrically opposite each other and at right-angles to the other two. There are two cover plates, one moulded and covering the terminals of the wiring connections at the rear of the main switch and the other of metal integral with the switch lever arm assembly complete. (Figs. 1, 2 and 3.)

7. The four internal switches have specially shaped moulded toggles to accept the action plate of the main switch assembly. Incorporated in, and part of the switch lever, is a spring-loaded locking sleeve which can pass the "gate" on the top cover in the up, right and left positions and so operate the desired toggle switch. Owing to the design of the "gate", the down position cannot be selected until the switch lever is extended against its spring to enable the locking sleeve to pass over the "gate" entry. (Fig. 1.)

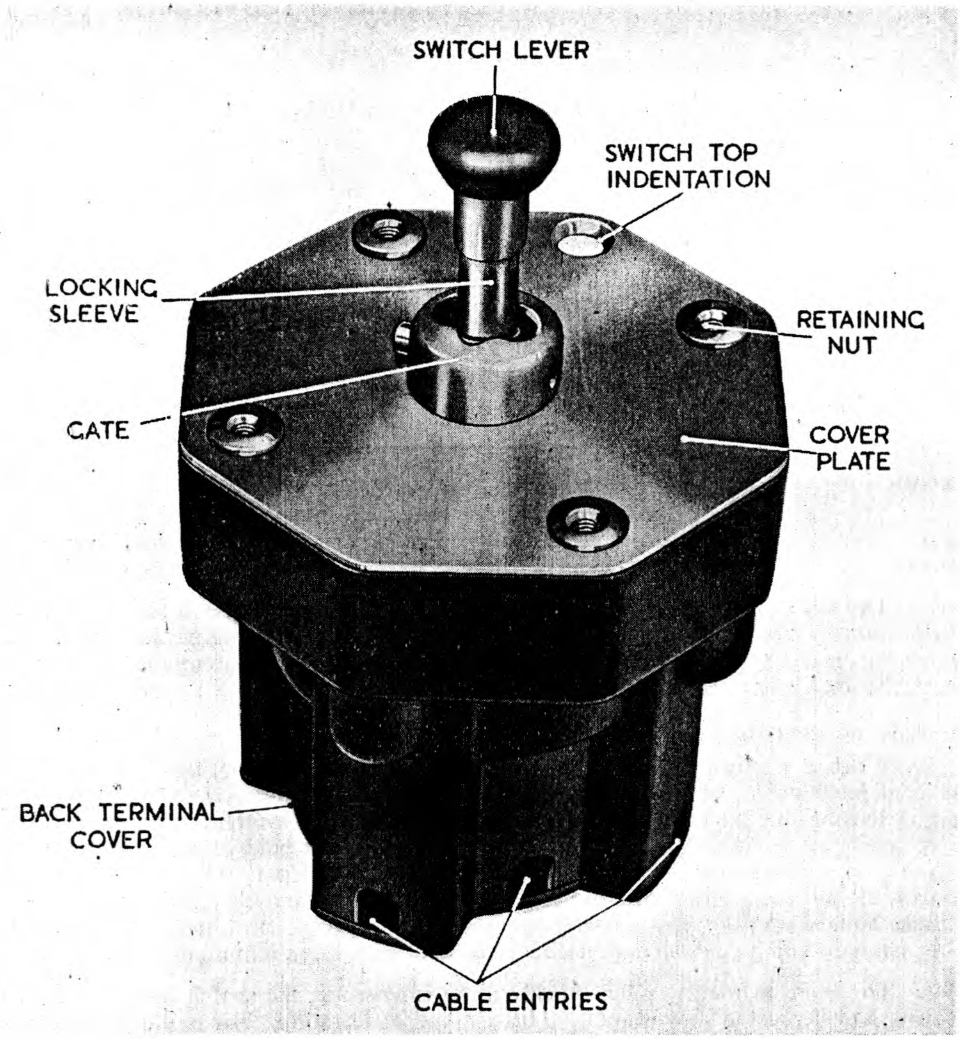


Fig. 1.—Combined selector and feathering switch, type D.4601

8. The positions of the switch lever as indicated on the dashboard are:—Up—AUTOMATIC. Left—DECREASE R.P.M. Right—INCREASE R.P.M., and Down—QUICK FEATHERING The circuits to which the rear terminals are connected are shown in Fig. 5.

SERVICING

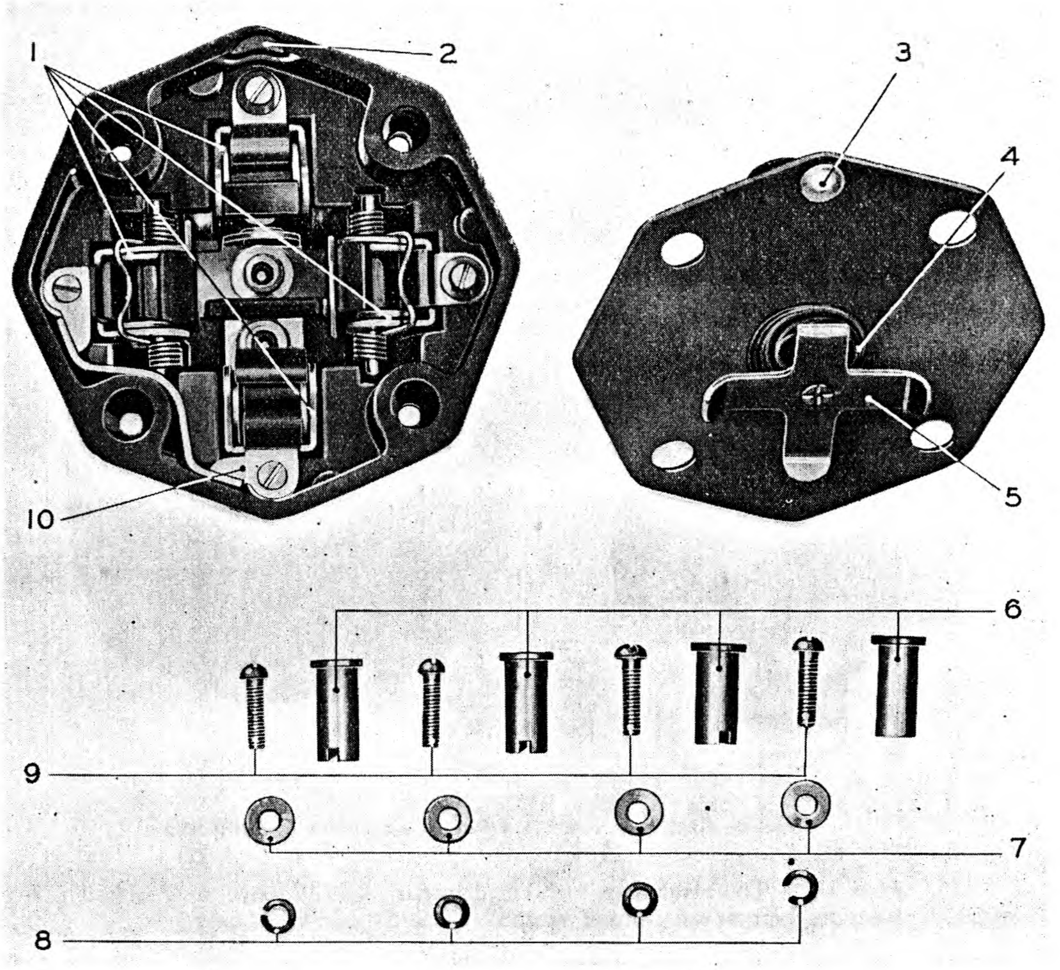
9. Check action of switch as follows:—

(i) Operate the switch 5–6 times in each position to ensure that the operation is correct.

(ii) In the "Inc. R.P.M." and "Dec. R.P.M." directions, i.e., right and left respectively, the switch handle after being pressed fully home, must on release spring back without hesitation and with no sign of sticking, to the centre "off" position.

(iii) On the "Auto" or upward direction, the action must be such that the switch lever snaps into the fully closed (or open if switching off) position as soon as the toggle mechanism is moved over its dead centre. This action must be quite positive with no tendency whatever for the lever to jump back in the reverse direction.

(iv) In the "feather" or downward direction, the action should be as in the "Auto" direction with additional provision that it must be impossible to operate the toggle mechanism over dead centre and so complete the circuit in the feather direction without first extending the lever against its spring and moving the locking sleeve over the "gate" entry. Further, when moving back to the centre "off" position, it must be impossible for the locking sleeve to drop back to its normal position before the internal toggle mechanism has operated in the reverse direction and broken the circuit.



1. Internal toggle switches
2. Top locating recess
3. Top locating indentation
4. Conical spring
5. Switch action plate
6. Cover plate retaining nuts
7. Plain washers
8. Spring washers
9. Cover plate fixing screws
10. Connecting strip

Fig. 2.—Top cover removed showing internal toggle switches

(v) The internal toggle snap action must be positive in all directions.

(vi) It must be impossible to connect any pair of terminals by the internal switches by moving the switch lever within the limit of its free movement in the centre "off" position.

General electrical tests

10. *Millivolt drop test.*—Pass a current of 15 amperes through the appropriate pair of terminals in each of the four "on" positions in turn. In no case should the millivolt drop between terminals exceed 75 millivolts at 15 amperes.

11. *Insulation resistance test.*—The insulation resistance measured with a 250 V. megger must not be less than 20 megohms.

(i) Between each terminal and each other terminal with the switch lever in the centre "off" position.

(ii) Between each pair of terminals and the switch cover plate in each of the closed positions of the switch lever.

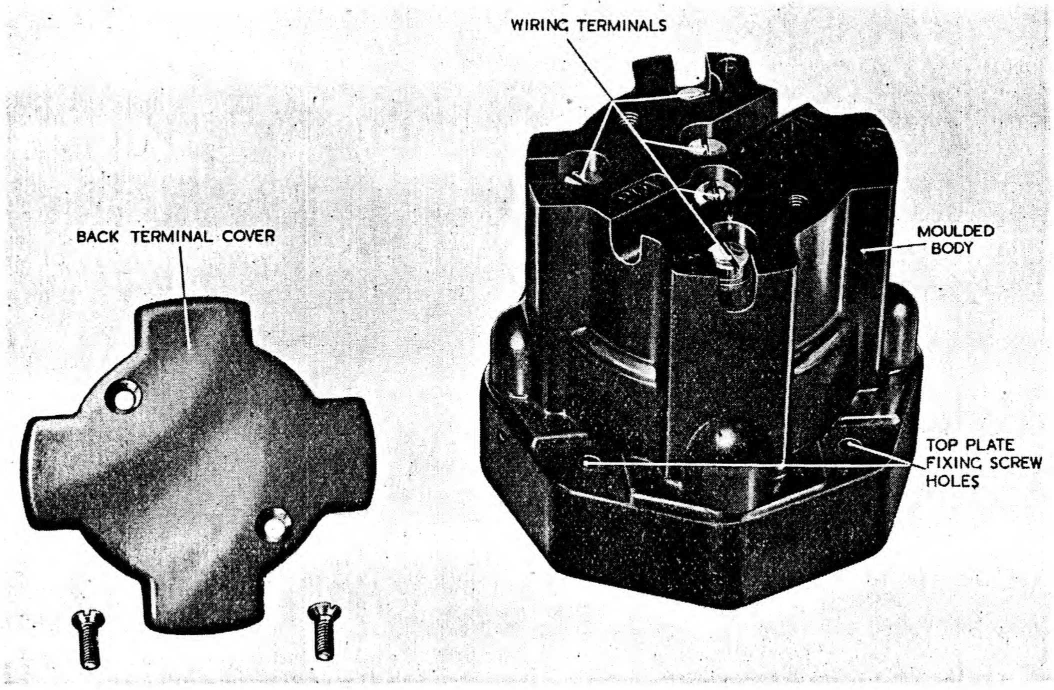


Fig. 3.—Back cover removed showing external connections

12. *Flash test.*—The insulations mentioned in para. 11 (ii) above must withstand a pressure of 500 V. 50 cycles 1-phase a.c. for one minute. (Maintenance Units only.)

Dismantling for inspection

13. Unscrew and remove the four fixing screws complete with plain and spring washers, and withdraw the four retaining nuts from the top cover side. The top cover, complete with switch lever assembly is then free to be removed. It is desirable in this and the following instructions, reference should be made to Figs. 1, 2, 3 and 4. Inspection should then be carried out in the following sequence.

14. Check the top cover switch lever assembly for correct functioning:—

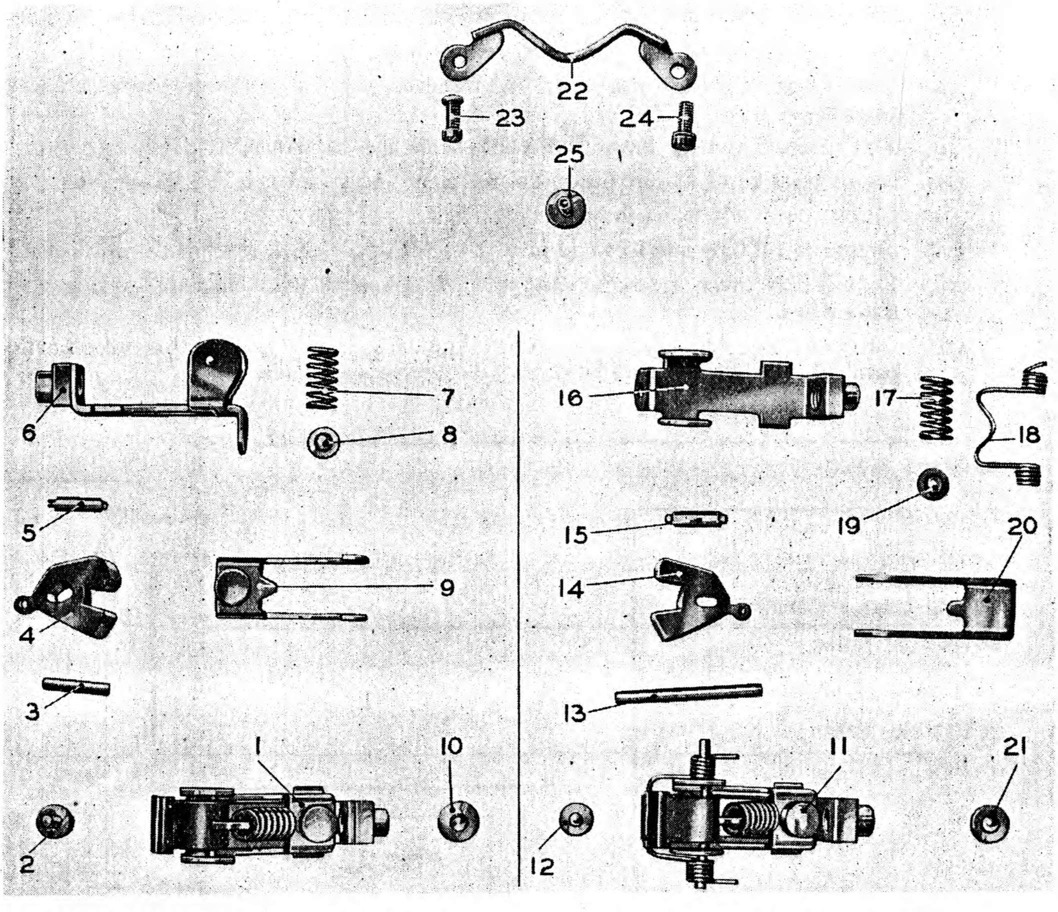
(i) Move the switch lever fully home in all directions and release. The lever should return to the centre "off" position by means of the conical spring. This also applies if the switch lever is extended and the locking sleeve passed over the "gate" entry in the feathering or downward position. Examine the conical spring for fracture.

(ii) Ensure that the locking sleeve is kept in its normal position by the internal spring, and does not pass over the "gate" entry in the downward position.

(iii) Check the tensions of the extending switch lever spring. This should return to normal positively and without any sticking when released after extending.

(iv) Examine the action plate for distortion and damage.

(v) Should any of the functional tests of the switch lever assembly show a fault, replace the complete cover and switch assembly; no attempt to renew parts must be made.



1. Toggle switch complete (Manual)
2. Fixing screw and washer
3. Toggle arm pivot pin (Manual)
4. Toggle arm moulding (Manual)
5. Contact arm pivot pin
6. Bearing bracket assembly
7. Toggle spring
8. Toggle spring cup
9. Contact arm assembly
10. Terminal screw and washer
11. Toggle switch complete (Auto)
12. Fixing screw and washer
13. Toggle arm pivot pin (Auto)
14. Toggle arm moulding (Auto)
15. Contact arm pivot pin
16. Bearing bracket assembly
17. Toggle spring
18. Toggle arm return spring
19. Toggle spring cup
20. Contact arm assembly
21. Terminal screw and washer
22. Connecting strip
23. Fixing screw and washer
24. Fixing screw and washer
25. Terminal screw and washer

Fig. 4.—Exploded view of internal toggle switches

15. Inspect the internal moulded switch toggles and ensure they are not broken, chipped or cracked.

16. Check the action of each of the four switches by hand operation and ensure that all springs are sound and the spring cups are in place. Faulty switches can be removed complete by removing the terminal screw at the base and the fixing screw inside the body. The left-hand and bottom of the latter screws also hold the connecting strip in position. In the case of the left-hand switch, only the internal screw holds this in place, there being no corresponding terminal screw in the base. It is obvious that the moulded rear cover plate must be removed to obtain access to the terminal screws. The internal switches, when removed, can be completely dismantled and any faulty or broken parts be renewed (fig. 4). It will be noted that opposite pairs of switches are alike though differing from the pair at right-angles to them. As there are two switches alike, it will be found advantageous when completely dismantling a switch, to keep one fully assembled to be used as a pattern when dismantling and assembling.

Assembling

17. When replacing individual internal switches ensure that:—

(i) Toggle springs and cups are in correct position.

(ii) Toggle arm return springs of the right and left-hand switches are in place and function correctly.

(iii) The connecting strip between the left-hand and bottom switch is in position.

(iv) All internal fixing screws are tight and plain and spring washers in position.

(v) Check the action of each switch by hand.

(vi) Grease all rubbing surfaces and pivot pins with pure clean vaseline (Stores Ref. 33C/655).

(vii) Replace top cover, retaining nuts and fixing screws with plain and spring washer and tighten up.

(viii) Carry out complete check as laid down in para. 9 (i) to (vi). The general electrical test—para. 10, 11 and 12 should be carried out where applicable.

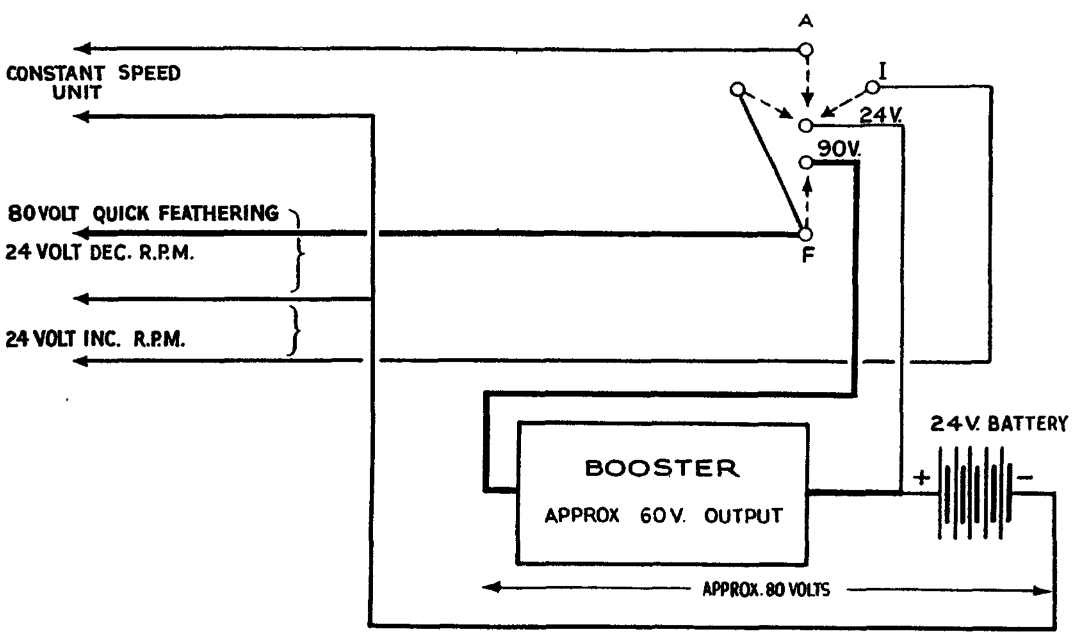


Fig. 5.—External circuit diagram

P5800 M /G2455 12/44 8500 C & P Gp. 1

CHAPTER 18

LIGHTING CONTROL PANELS for ABR and TBR aircraft

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The panels described in this Chapter are designed to centralise the control of all external lights on smaller aircraft. They are primarily intended for installation in aircraft used by the Fleet Air Arm.

Types available

2. Two types of the equipment are available, both for use on aircraft whose general services are supplied at 24 volts; one type (Stores Ref. 5C/3023) is for use on TBR (Torpedo-Bomber-Reconnaissance) aircraft; the other type (Stores Ref. 5C/3108) is for use on ABR (Amphibious Bomber-Reconnaissance) aircraft. Both types weigh approximately 4 lb.

DESCRIPTION

General

3. A general view of the TBR panel is shown in fig. 1. The ABR panel is exactly similar except that a steaming light switch is substituted for the tail light switch. It consists of a rectangular pressed steel case, the front of which carries the various switches and morse keys. On the bottom of the case is a 13-way terminal block, of which only 12 terminals are used on TBR panels. When the four captive screws (13), fig. 1, are undone, the panel as a whole may be removed from the back of the case which is attached to the airframe. Thus, the back of the panel is made accessible for servicing operations. This feature also facilitates renewal of panels on aircraft. Two screws (14) are provided for adjusting the travel of the morse keys.

4. The panel is fitted with a weatherproof fabric cover which completely encloses the lighting controls. The cover is retained in this position by two press studs on the side of the panel. When it is required to operate the switches etc., the cover may be rolled up and held in position on the top of the panel by a fabric strap which is secured by a further press stud.

5. Fig. 2 shows a back view of the panel and illustrates the various switchboxes, connections, and dimming resistors.

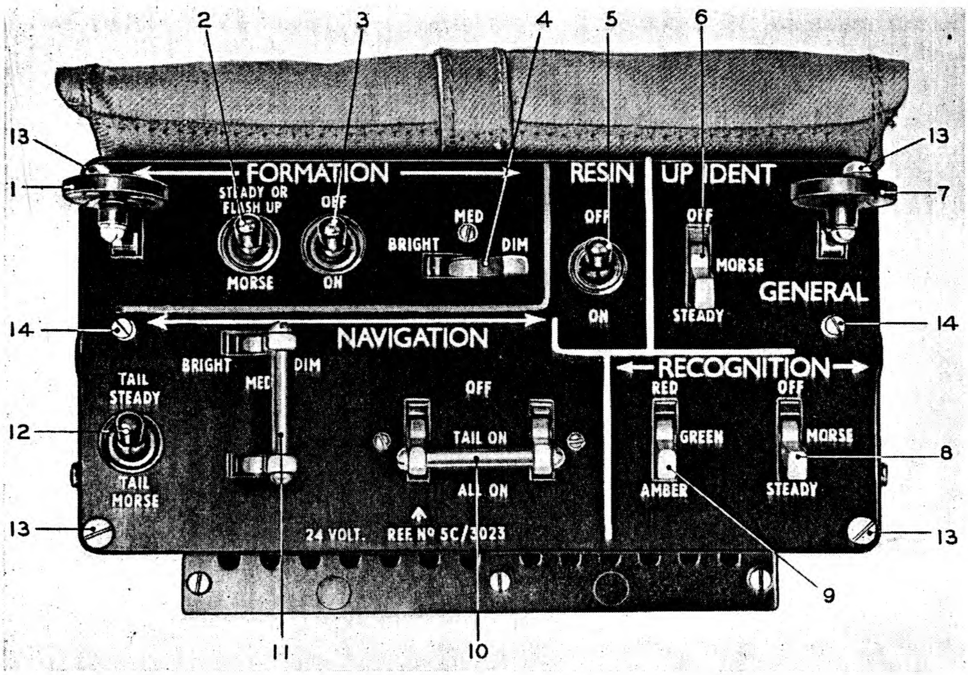


Fig. 1.—Front view of TBR panel

Key for fig. 1 and 2

1. Formation morse key
2. Formation morse, etc., switch
3. Formation main switch
4. Formation dimmer switch
5. Resin switch
6. Up ident. switch
7. Morse key, GENERAL
8. Recognition main switch
9. Recognition selector switch
10. Navigation main switch
11. Navigation dimmer switch
12. Navigation tail lamp switch
13. Panel fixing screws
14. Morse key travel adjusters

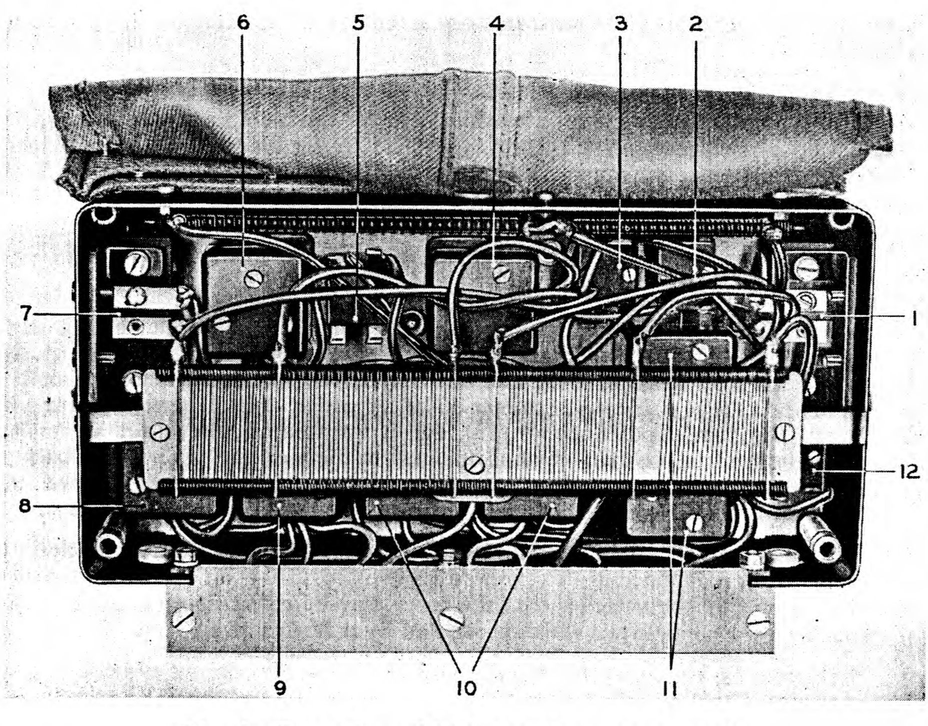


Fig. 2.—Rear view of TBR panel (back removed)

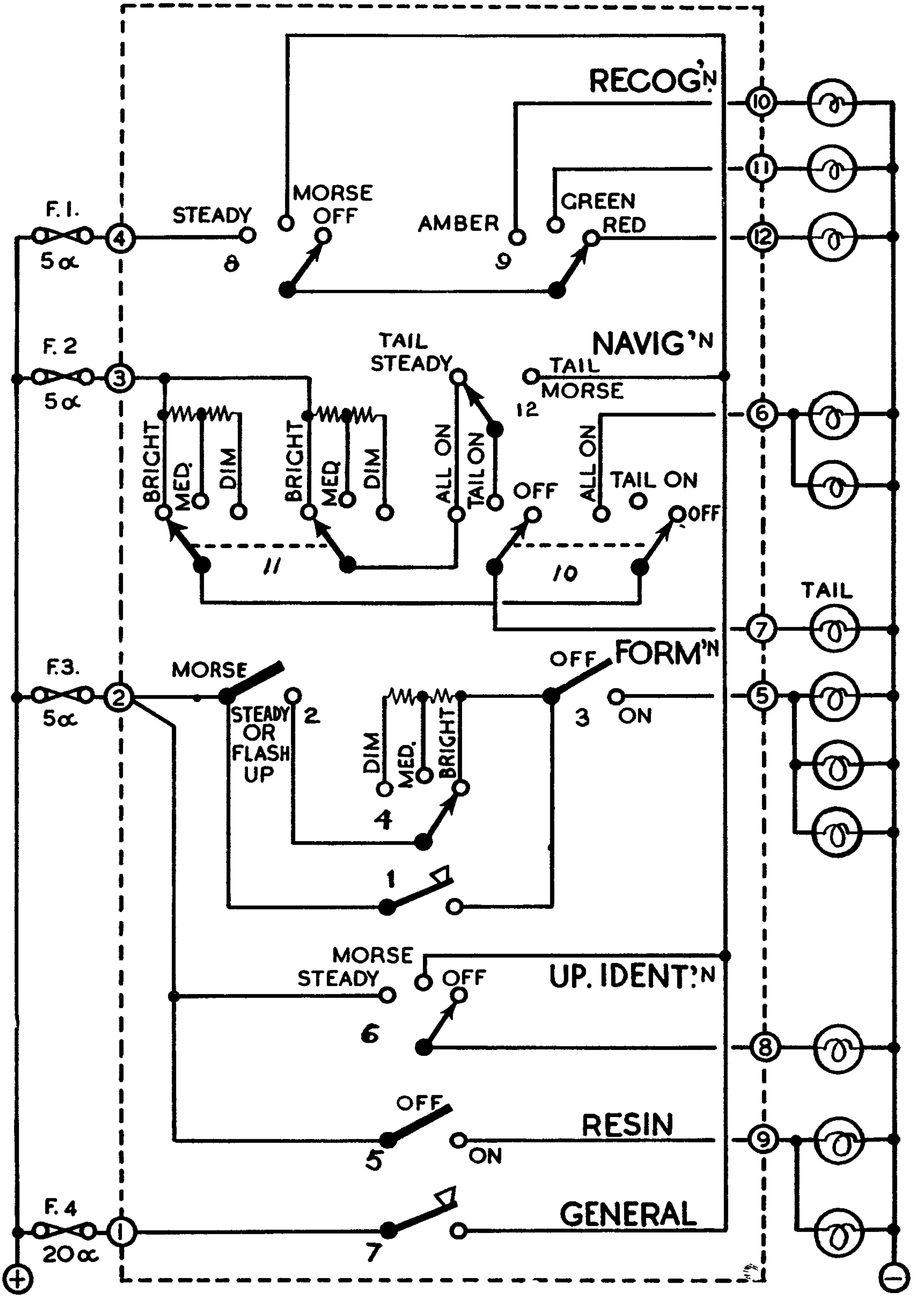


Fig. 3.—Schematic diagram (TBR panel)

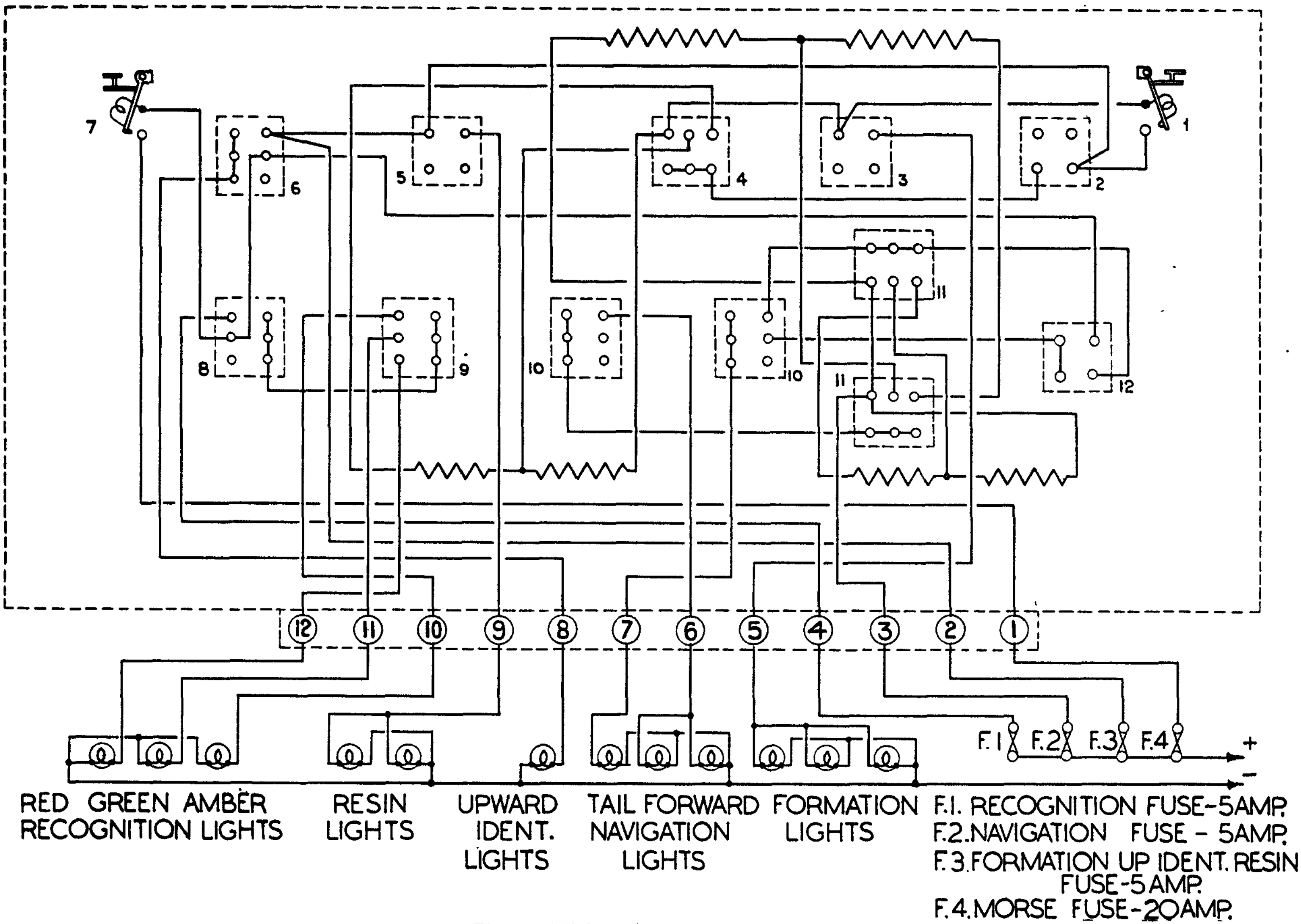


Fig. 4.—Wiring diagram (TBR panel)

Controls

Formation lights

6. These are controlled by two switchboxes (Stores Ref. 5D/531), a morse key (Stores Ref. 5C/3027), and a switchbox, type A (Stores Ref. 5C/930).

Resin lights

7. These are controlled by a single switchbox (Stores Ref. 5D/531).

Upward identification light

8. This is controlled by switchbox, type A (Stores Ref. 5C/930). The GENERAL morse key is used for signalling on this circuit.

Navigation lights

9. The main controls of this circuit are four switchboxes, type A (Stores Ref. 5C/930), which are mechanically linked together in two pairs. On TBR panels, a switchbox (Stores Ref. 5D/531) is fitted to provide further control of the tail navigation light which may be signalled by means of the GENERAL morse key.

Recognition lights

10. This circuit is controlled by two switchboxes, type A (Stores Ref. 5C/930). Signalling may be carried out by means of the GENERAL morse key.

Steaming light

11. This circuit is only fitted to ABR panels and is controlled by a switchbox (Stores Ref. 5D/531). This switch replaces the TAIL MORSE, TAIL STEADY switch which is fitted to TBR panels.

Circuit

12. Schematic diagrams and wiring diagrams are given in fig. 3 and 5, and 4 and 6, respectively. A full description of the working of the various circuits is given under the heading "Operation", which should be read in conjunction with the diagrams mentioned above. A wiring diagram is affixed to the back of the steel case of each panel.

OPERATION

13. The references given to the various items of equipment in the following paragraphs refer to fig. 1, 2, 3, 4, 5, and 6. Reference numbers are the same for each illustration. Numbers shown circled on fig. 3, 4, 5, and 6 are terminal numbers.

Formation lights

14. The controls for this circuit comprise three switches and a morse key. The main switch (3) is marked ON and OFF, the selector switch (2) is marked MORSE in the down position and STEADY OR FLASH UP in the up position; while the dimmer switch (4) is marked BRIGHT, MED. and DIM.

15. To obtain steady illumination, the dimmer switch must be in a position which gives the required brilliancy, the main switch must be set ON and the selector switch must be at STEADY OR FLASH UP. The lamps will now be lighted continuously.

16. When it is required to signal with these lights, from zero to maximum brilliancy, the selector switch must be set to MORSE and the main switch to ON. Signals may now be made by means of the morse key (1). Under these conditions the position of the dimmer switch is immaterial.

17. When flying in formation, it may be found necessary to make short signals, such as code letters, without ever completely extinguishing the lamps. This may be accomplished only if the dimmer switch is in the MED. or DIM position and the selector switch at STEADY OR FLASH UP. Signals may now be made by means of the morse key. Under these conditions, it is essential that signals should be made extremely slowly, as, when the morse key is depressed, the lamps assume

full brilliancy but when the morse key is released the lamp filaments take an appreciable time to cool to medium or dim, thus making for considerable difficulty in accurate reading of signals. For this reason it is preferable to carry out this type of signalling only when the dimmer switch is in the DIM position.

Resin lights

18. These lights are controlled by a switch (5) which is marked OFF and ON. There is no provision for signalling or dimming.

Upward identification light

19. This light is controlled primarily by the selector switch (6) which is marked OFF, MORSE and STEADY. When this switch is in the MORSE position, signals may be made by operating the morse key (7) which is marked GENERAL. When the selector switch is set to the STEADY position the light is illuminated continuously. No provision is made for dimming this light.

Navigation lights

20. Two pairs of mechanically coupled selector switches (10) and (11) are the main controls for this circuit. One of these pairs constitutes the dimmer switch (11) and is marked BRIGHT, MED. and DIM; the other pair constitutes the lamp selector switch (10) and is marked OFF, TAIL ON and ALL ON.

21. When the lamp selector switch is in the TAIL ON position, only the tail lamp is illuminated. A 2-way selector switch (12) marked TAIL STEADY and TAIL MORSE is provided on TBR panels to effect further control of the tail lamp when the lamp selector switch is in the TAIL ON position. When the switch (12) is in the TAIL STEADY position the tail lamp is continuously illuminated at a brilliancy according to the position of the dimmer switch (11). If the switch (12) is set to the TAIL MORSE position signals may be made on the tail lamp by operating the GENERAL morse key (7). This causes the tail lamp to flash from zero to full brilliancy.

22. When the selector switch (10) is in the ALL ON position, all the navigation lamps are illuminated at a brilliancy according to the position of the dimmer switch (11). Under these circumstances the tail lamp cannot be used for signalling.

Steaming light

23. Provision is made for this circuit on ABR panels, utilizing the switch (12) as an ON–OFF switch.

Recognition lights

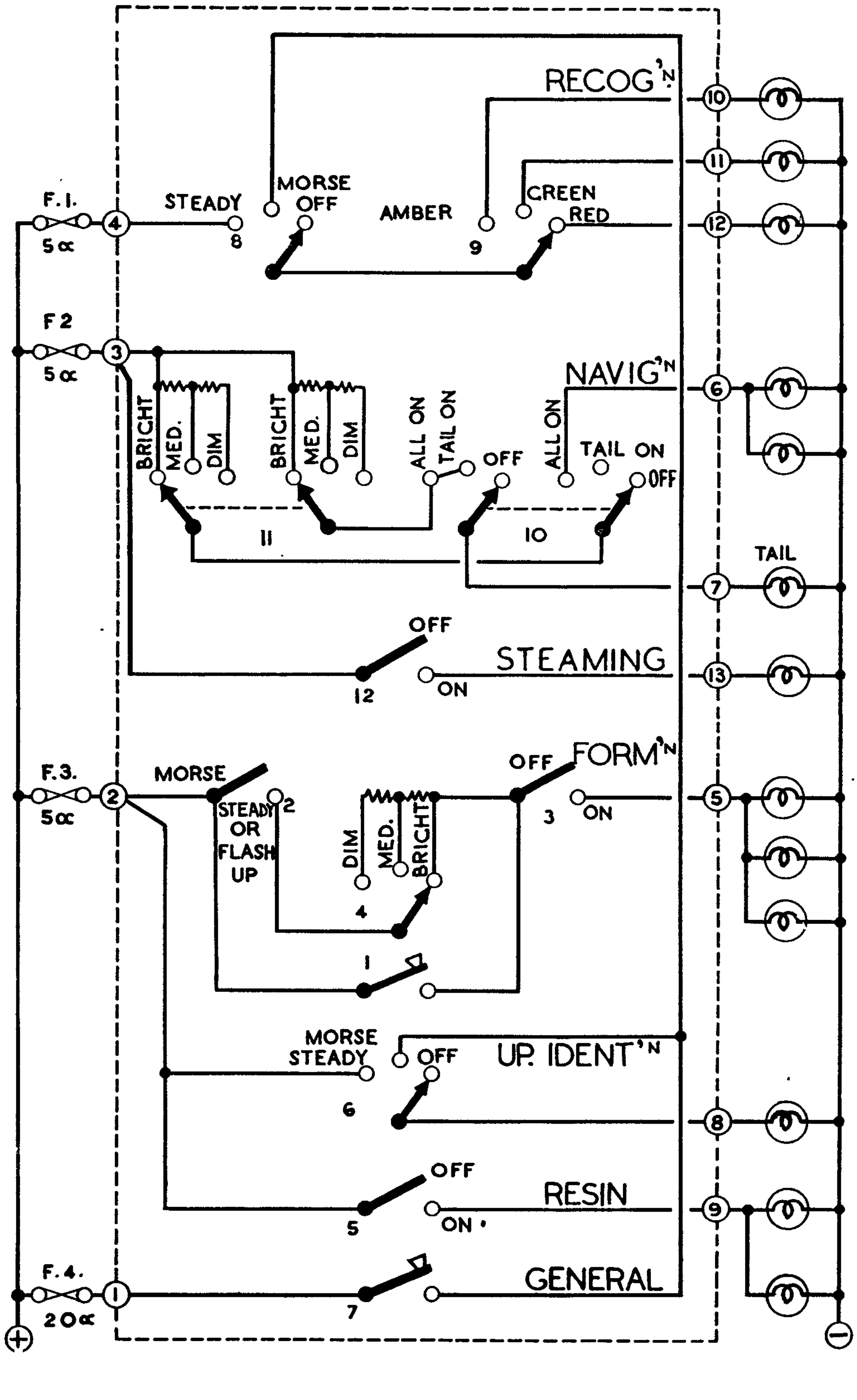
24. These are controlled by two selector switches. One switch (9) is marked RED, GREEN and AMBER, and is used to select the coloured lamp which is required. The other switch (8) is marked OFF, MORSE, and STEADY. When this switch is in the MORSE position, signals may be made on the lamp selected using the GENERAL morse key (7). When the switch (8) is in the STEADY position, the lamp selected is illuminated continuously. No provision is made for dimming these lights.

Morse key, GENERAL

25. This key (7), as explained in the foregoing paragraphs, may be used for signalling on the upward identification, tail navigation (in TBR aircraft), and recognition lights. These lights may be flashed either independently, collectively, or in any required combination, according to the position of the appropriate selector switches.

SERVICING

26. Periodic examinations must be carried out to ensure that all connecting cables are intact and that all screwed connections are tight. If the contacts of the morse keys are found to be burned or pitted they must be thoroughly cleaned with fine grade glass paper and lightly smeared with jelly, petroleum (Vaseline) (Stores Ref. 33C/655).


RECOG'N
10
11
12
MORSE
OFF
STEADY
AMBER
GREEN
RED
F.1.
5 A
4
8
9
F 2
3
NAVIG'N
6
BRIGHT
MED.
DIM
ALL ON
TAIL ON
OFF
11
10
TAIL
7
OFF
STEAMING
ON
12
13
F.3.
2
MORSE
STEADY OR FLASH UP
FORM'N
OFF
ON
3
5
4
1
MORSE
STEADY
UP. IDENT'N
6
8
RESIN
5
9
F.4.
20 A
1
GENERAL
7
+
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P7329 M /G14 5/45 8500 C&P Gp. 1

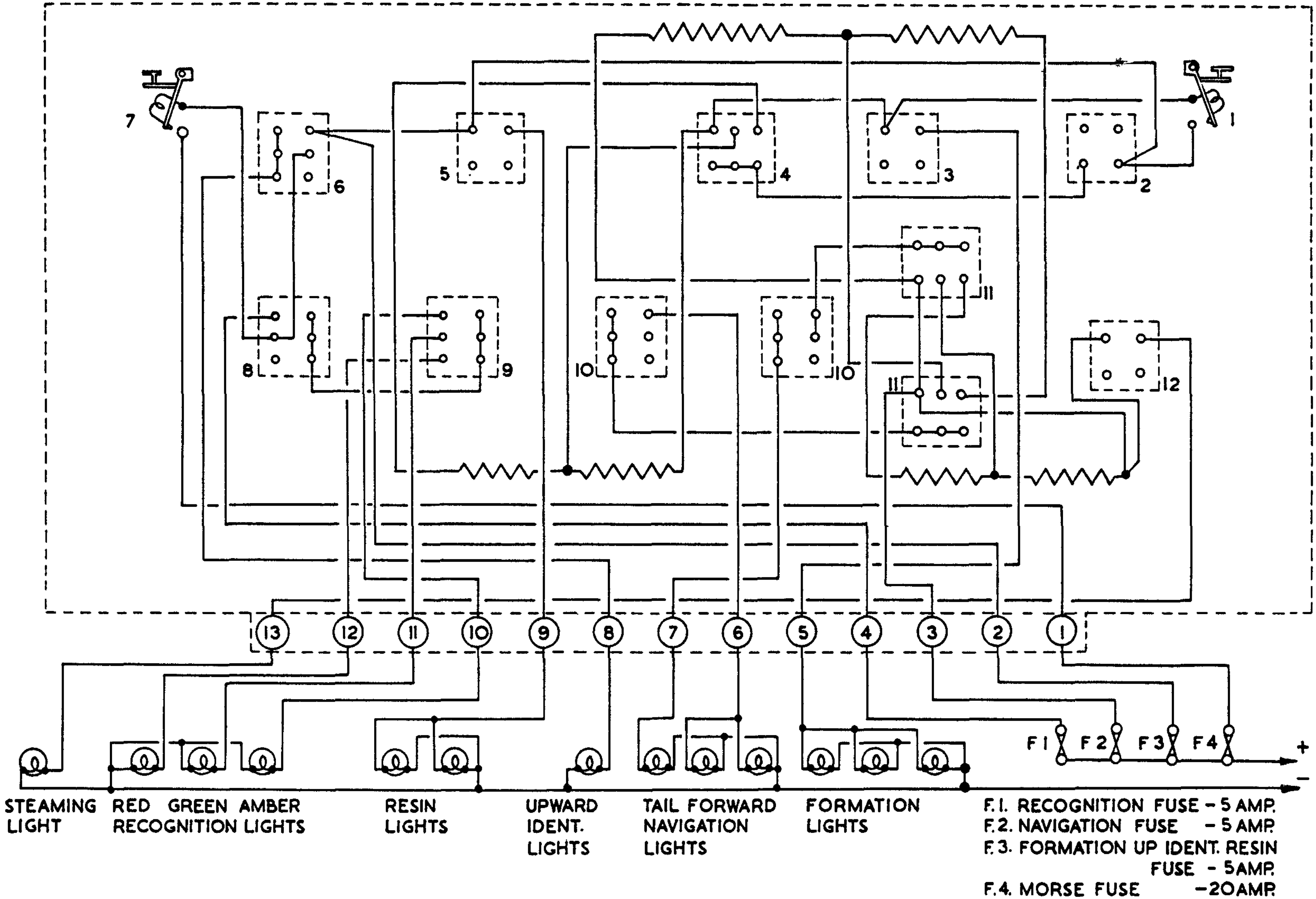

Fig. 6.—Wiring diagram (ABR panel)

CHAPTER 20

THERMOSTAT UNIT, Type A

(Stores Ref. 5C/3601)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The thermostat unit, type A, is designed primarily to control the circuit to an electrically-heated muff employed with the F.24 camera. The unit breaks the heater circuit automatically

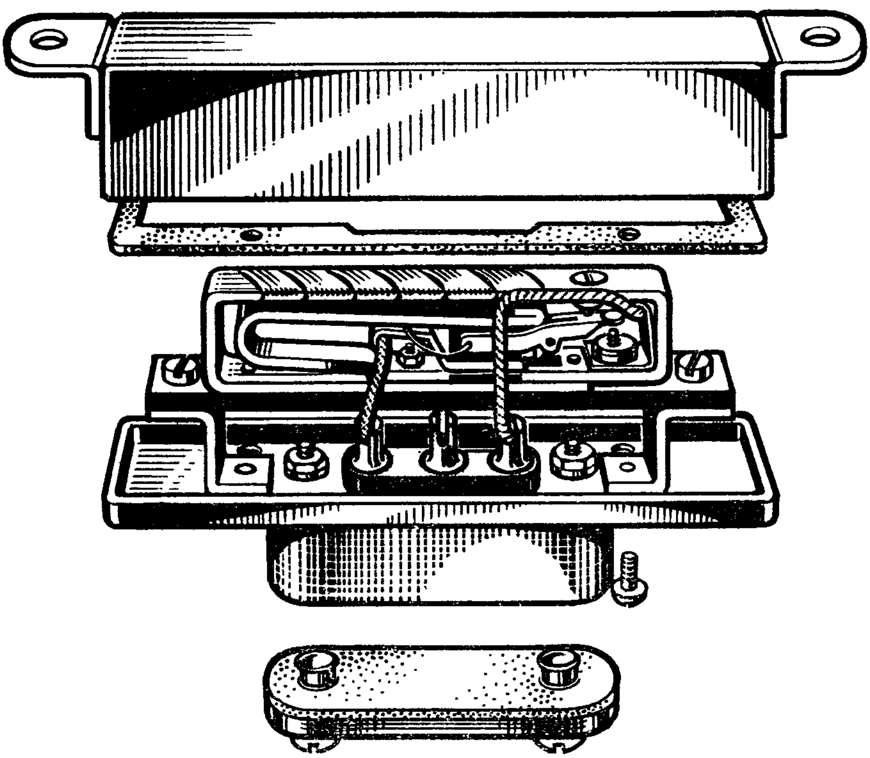

Fig. 1.—Exploded view of thermostat unit

when the atmospheric temperature is such that muff heating is not required. The operating voltage of the switch is 24, and the current-carrying capacity 1 amp.

DESCRIPTION

2. The unit comprises a thermostatic switch, type KV (Stores Ref. 5C/3677), housed in a metal container on the lid of which is located a terminal block. The metal container is fitted with two flanges for fixing purposes, these being riveted to the ends of the container. The terminal block is of moulded bakelite and is secured to the detachable lid of the container by two threaded pillars, nuts, and washers. The latter are accessible only after removing the lid which is secured to the main body of the container by four round-headed screws. A moulded bakelite cover, together with a rubber gasket, to exclude dirt and moisture, is fitted to the terminal block by two slotted captive nuts. Any abrasion of the leads at their point of entry into the terminal block is prevented by the inclusion of a pair of rubber cable grommets, which locate in slots in the moulding.

3. Although three terminals are located in the terminal block, only the outer two are used. Insulating shrouds, moulded integral with the terminal block, project between the terminal screws to prevent shorting. The terminal pillars, which the terminal screws engage, pass through the lid of the container and are slotted so that the switch leads may be soldered to them.

4. Two small double-angle brackets are riveted to the underside of the lid of the container and to these brackets is screwed a strip of insulating material upon which the thermostatic switch is mounted. The switch is thus adequately insulated from the lid of the container.

5. The switch itself is built up within a rectangular former of strip metal and is actuated by a U-shaped component of bi-metallic construction. The bi-metal consists of two dissimilar metals, with different rates of expansion, pressed together so that at certain temperatures the arms of the bi-metal contract inwards or expand outwards, tripping a spring-loaded cam that operates a contact arm. The latter then either makes or breaks the muff heater circuit as described in para. 9.

6. One end of the U-shaped bi-metal strip is secured to the metal former by a cheese-headed screw end nut whilst the other end is slotted to accept a pivot rod that is soldered in position. The pivot rod carries a spring-loaded trip cam, the spring being so arranged as to force the cam forward against a further rod fitted in the moving contact arm. The shape of the cam ensures that the moving contact arm is in one of two positions, according to the effect of the atmospheric temperature on the bi-metal. Firstly, it may rest against the contact arm stop, the switch then being in the open position or, alternatively, it may rest on the fixed contact, in which case the switch is closed. In the latter case the muff heater circuit is completed by way of the input terminal in the terminal block, a pressed tag on the contact arm mounting block, the moving contact arm, and thence through the contact points, and a second tag attached to the fixed contact to the output terminal.

7. It is emphasized that when handling this switch, care must be taken to avoid putting any thrust on the bi-metal which may tend to displace it sideways. The very small force required to actuate the switch should be applied vertically at the point X shown in fig. 2, i.e. directly above the bi-metal fixing screw.

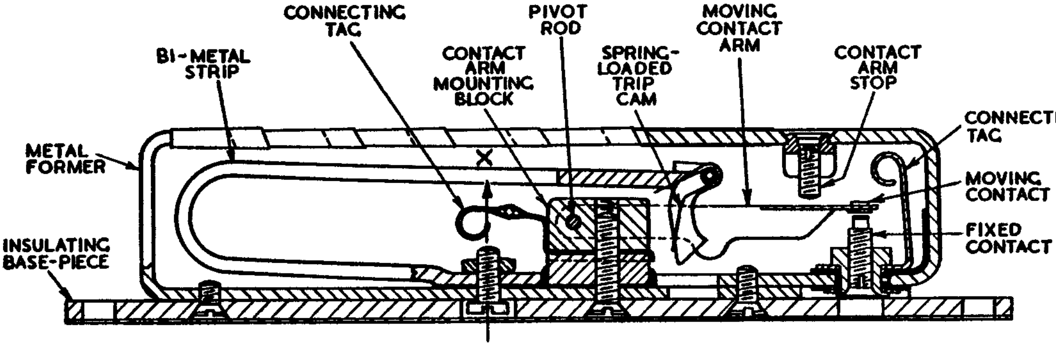

Fig. 2.—Details of thermostatic switch

INSTALLATION

8. The thermostat unit is provided with two fixing lugs for purpose of attachment. Before securing the muff heater circuit leads to the terminals of the unit, the ends of the rubber cable grommets may have to be pierced to allow the leads to pass through. If this is necessary, the holes

should be made as small as possible to prevent moisture entering the terminal block. Cable connections to the terminals should be made securely, and the terminal block cover afterwards screwed firmly down, so that the rubber gasket on the cover forms a complete seal against the ingress of dirt and moisture.

OPERATION

9. The operation of the thermostatic switch incorporated in the unit, is dependent upon the effect of atmospheric temperature upon the bi-metal strip. The bi-metal which, as previously stated, is in the shape of a U, is so designed and constructed that the arms of the U thrust outwards, actuating and closing the switch with a falling temperature at not less than 3 deg. Centigrade. Conversely, the arms of the U tend to draw together with a rising temperature until at not more than 16 deg. Centigrade the switch should open.

SERVICING

10. Periodically, the terminal block cover should be removed and the terminals examined. The cable connections should be secure and in a satisfactory condition. If the thermostat unit is unsatisfactory in operation, it is not desirable for a Unit to carry out inspection or repair and the equipment should, therefore, be despatched to a repair depot.

P9050 M /G2743 12/45 8500 C & P Gp. 1

AIR MINISTRY

October, 1943

A.L. No. 7 to A.P.1095A

Volume I

ELECTRICAL EQUIPMENT MANUAL
GENERAL (AIRBORNE)

SECTION 8

(1) List of Chapters. *Cut out* the following and *affix* to cover the existing references for Chapters 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12:—

(2) *Insert* the attached Chapter 1 after the list of Chapters.

When you have done this, make an entry in the Amendment Record Sheet at the beginning of the book.

AIR MINISTRY
February, 1945

A.L. No. 55 to A.P. 1095A
Volume I

ELECTRICAL EQUIPMENT MANUAL
GENERAL (AIRBORNE)

SECTION 8

(1) List of Chapters. *Cut out* the following and *affix* below Chapter 12.

....

....

(2) *Insert* attached chapter after Chapter 12.

When you have done this, make an entry in the Amendment Record Sheet at the beginning of the book.

SECTION 8

LIGHTING EQUIPMENT

LIST OF CHAPTERS

Note.—A list of contents appears at the beginning of each chapter

CHAPTER 1

NAVIGATION LAMPS, Types A and B

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. All aircraft flying at night must be equipped with lights to indicate their presence and position and as far as possible the direction in which they are heading. Such lights are called navigation lights. Their characteristics have been internationally agreed upon and will be found in the Statutory Rules and Orders for Air Navigation.

2. The requirements are briefly as follows:—

(i) Every flying machine in the air or on a land aerodrome shall display a green light on the right side and a red light on the left side both facing forwards and outwards, and a white light on the tail facing astern.

(ii) Every flying machine under way on the surface shall display the lights required in (i) above and in addition a white light facing ahead.

(iii) Every flying machine at anchor or moored on the surface of the water shall display in a forward central position a white light visible horizontally in all directions.

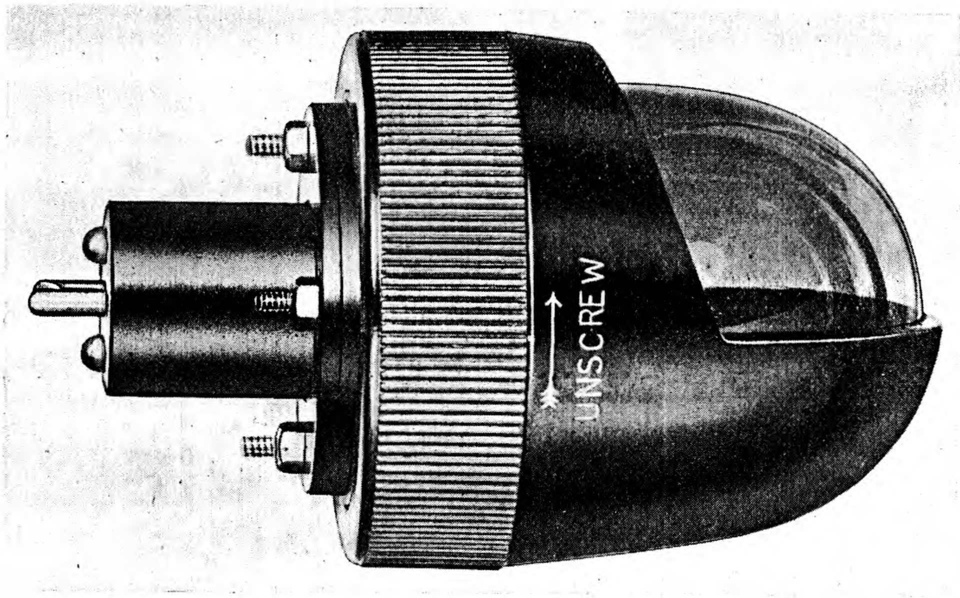

Fig. 1.—Starboard navigation lamp, type A

3. The lamps are electric, and the current is derived from the general 12-volt supply of the aircraft, being controlled by suitable switches in the cockpit.

DESCRIPTION

Port and starboard navigation lamps, type A (Stores Ref. 5C/492 and 5C/496 respectively)

4. These two lamps are identical in construction, the only difference being in the colour of the glass. The starboard lamp is shown in fig. 1, and fig. 4 is a sectional drawing showing the construction. The weight of each lamp is about 4 oz., and the overall length about 3¾ in. They are made mainly of moulded synthetic resin compound and consist of a socket for the filament lamp, with spring-loaded plunger contacts, a cap support, a screen cap, and a union for securing the screen cap, all of these parts being moulded. The glass is held in position by the screen cap, and a cork gasket (Stores Ref. 5C/490) is placed between the glass and the cap support to form a good joint. The spring-loaded plungers, which make contact with the filament lamp, pass through the socket and are hollow at the outer ends to receive the leads. The socket moulding and the mask support are not fixed to each other, but are both held in place by the four mounting screws.

5. The glass is a complete dome, partially masked by the screen cap (Stores Ref. 5C/494). A red glass (Stores Ref. 5C/493) is used in the port lamp, and a green glass (Stores Ref. 5C/497) in the starboard lamp. The screen cap is cut away between the vertical centre plane and a plane 110 deg. from this in the outboard direction, both planes passing through the filament of the lamp. There is a small hole in the inboard side of the screen to enable the pilot to see whether the lamp is alight during flight.

6. The light is provided by a 12-volt, 20-watt filament lamp (Stores Ref. ~~5A/1330~~ 5L/1330) which has a small bayonet cap. The filament is a small straight coil, arranged vertically in the lamp so as to give a sharp cut-off at the edges of the mask.

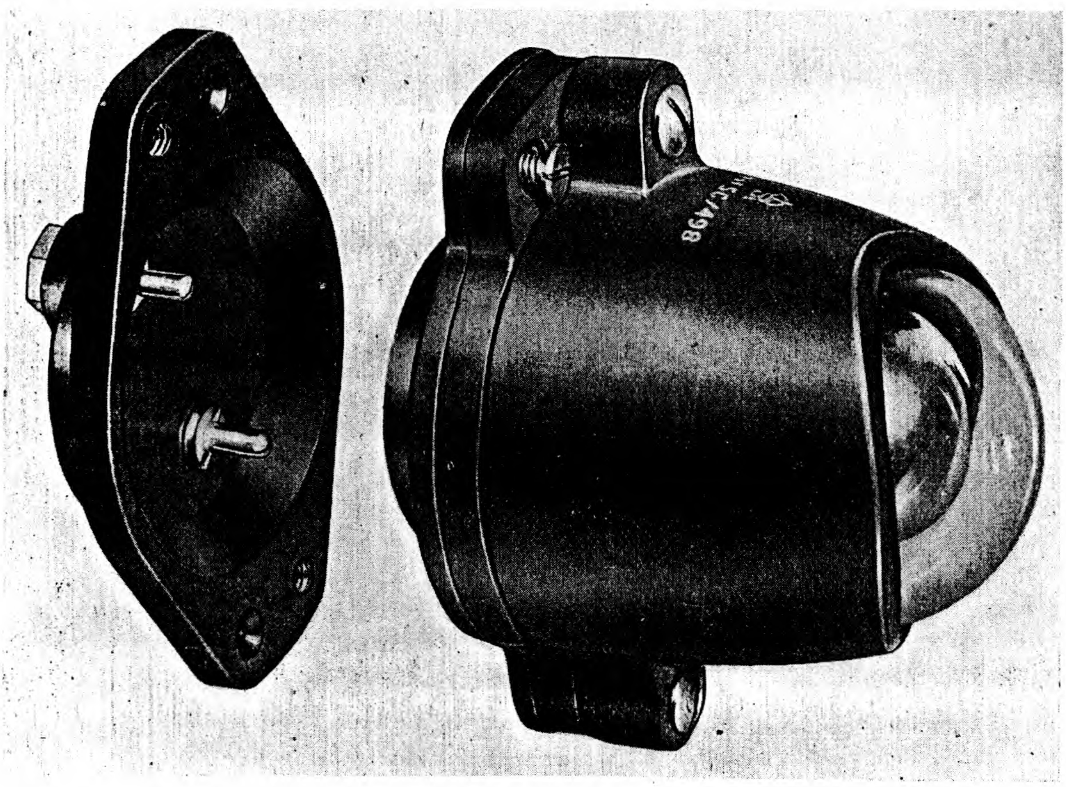

Fig. 2.—Tail navigation lamp, type A

Tail navigation lamp, type A (Stores Ref. 5C/498)

7. The type A tail lamp is also made of moulded synthetic resin compound. It consists of two parts, the lamp proper, and a base which is fixed to the airframe. The lamp is secured to the base by

two countersunk screws, and the electrical connection between the two is made by means of plug pins and socket tubes, the pins being on the base and the socket tubes on the lamp. The lamp and plug base are shown separated in fig. 2, and in fig. 5 is given a sectional drawing of the two fitted together. The weight of the lamp and base together is about 4½ oz. and the overall length about 3 in.

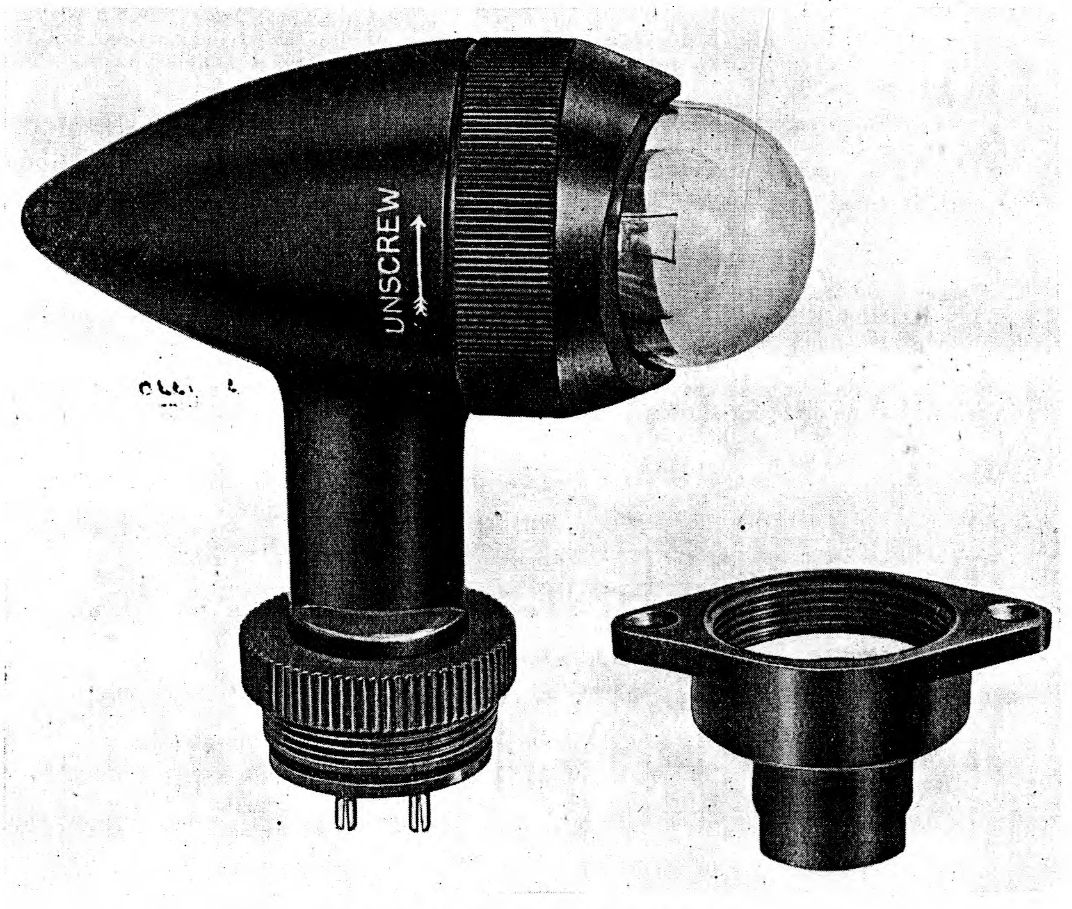

Fig. 3.—Head navigation lamp, type A

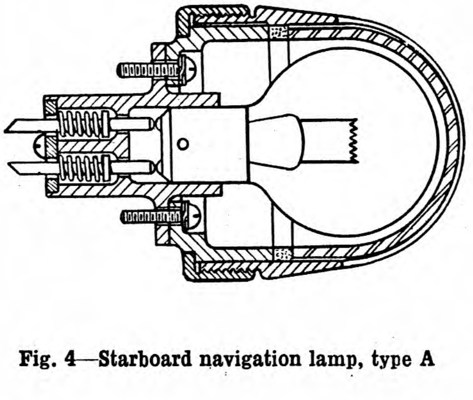

Fig. 4—Starboard navigation lamp, type A

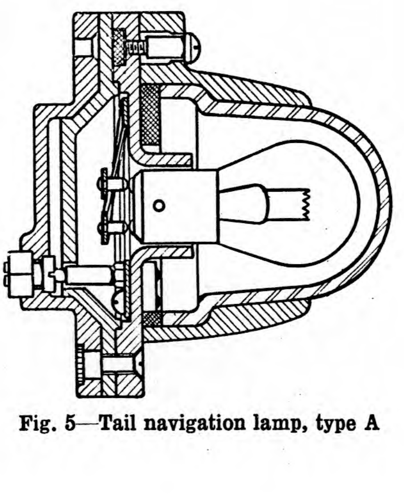

Fig. 5—Tail navigation lamp, type A

8. The socket for the filament lamp is formed in a base plate, with the contacts supported on flat leaf-springs behind it. The leaf-springs are C-shaped, and each is fixed at one end by a screw and a plug socket tube, the socket tube having a threaded foot screwing into the base, and a hexagonal collar. The socket tubes project through an inner cover, which is fixed behind the contact springs and is secured to the base plate by two countersunk screws not shown in the drawing.

9. The screen is secured to the base plate by two screwdriver-operated nuts screwing on to studs fixed in the base plate. The cap is cut away between two vertical planes 70 deg. on each side of the aft direction, the total angle thus being 140 deg. The glass (Stores Ref. 5C/500), which is clear, is a complete dome, and is held in position by the screen cap, a waterproof joint being made by means of a rubber gasket (Stores Ref. 5C/502).

10. The plug base (Stores Ref. 5C/501) is moulded and is shaped to fit the base of the lamp. The two plug pins are mounted loosely in it so that they can adapt themselves to the socket tubes. The ends of the pins are shaped to form shrouds round the terminal screws.

11. The light is provided by a 12-volt, 10-watt filament lamp (Stores Ref. 5C/1332). This has a small bayonet cap, and the filament is a small straight coil, arranged vertically when it is fitted in the lamp so as to give a sharp cut-off at the edges of the screen.

Head navigation lamp, type A (Stores Ref. 5C/485)

12. The type A head lamp is intended for fitting on the upper wing and is therefore raised above the surface on a stem so that the light may be as little obstructed as possible by the wing itself. The stem of the lamp fits into a socket fixed to the airframe, the electrical connection between the two being made by plugs and sockets. The lamp and socket are shown separated in fig. 3, and in fig. 6 is given a sectional drawing of the two fitted together. The weight of the lamp and socket is about 8½ oz. and the overall height is about 5½ in.

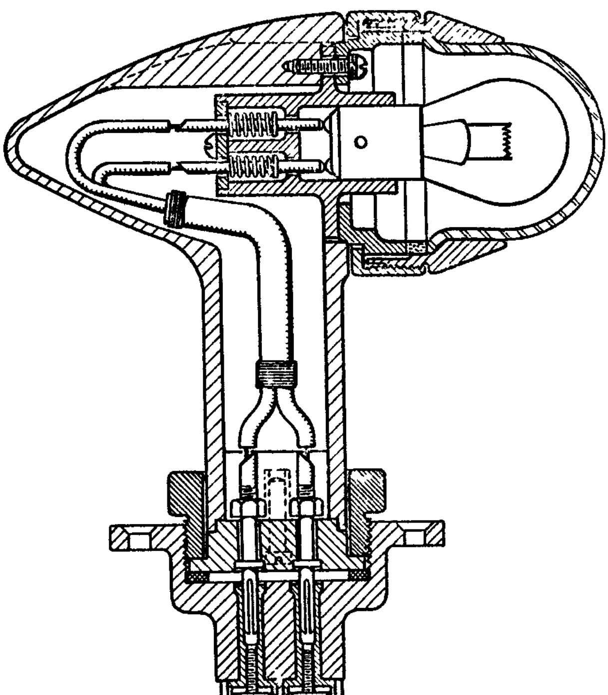

Fig. 6—Head navigation lamp, type A

13. The main parts of the lamp and socket are moulded synthetic resin compound. The glass (Stores Ref. 5C/487) is clear, and is held in position by the screen cap (Stores Ref. 5C/488), with a cork gasket (Stores Ref. 5C/490) between the glass and the cap support to form a watertight joint. The screen cap is cut away between two vertical planes at 110 deg. on each side of the forward direction, the total angle of visibility thus being 220 deg. The lower end of the stem is fitted with a pair of plug pins and has a threaded sleeve for securing it in the socket. The electrical connection between the plug pins and the pins of the lamp socket is made by a short piece of duflex 7 cable soldered in at each end.

14. The socket (Stores Ref. 5C/489) is provided with a mounting flange with two countersunk holes for the fixing screws. The two socket tubes are mounted at the bottom of the recess, of which the sides are threaded to take the union sleeve. A rubber washer (Stores Ref. 5C/491) is provided to make the joint between the lamp and socket waterproof. The leads to the socket are to be connected under the terminal screws at the lower end of the socket tubes, which are extended to form shrouded terminals.

15. The light is provided by a 12-volt, 10-watt filament lamp (Stores Ref. 5L/1332) which has a small bayonet cap, and in which the filament is a straight vertical coil to give a sharp cut-off at the edges of the mask.

Head navigation lamp, type B (Stores Ref. 5C/678)

16. This head lamp is identical in construction with the tail lamp, type A, except for the screen cap. The cap for the head lamp is cut away between vertical planes at 110 deg. on each side of the forward direction, giving a total angle of 220 deg. The same filament lamp is used, and the lamp fits on to the same plug base (Stores Ref. 5C/501).

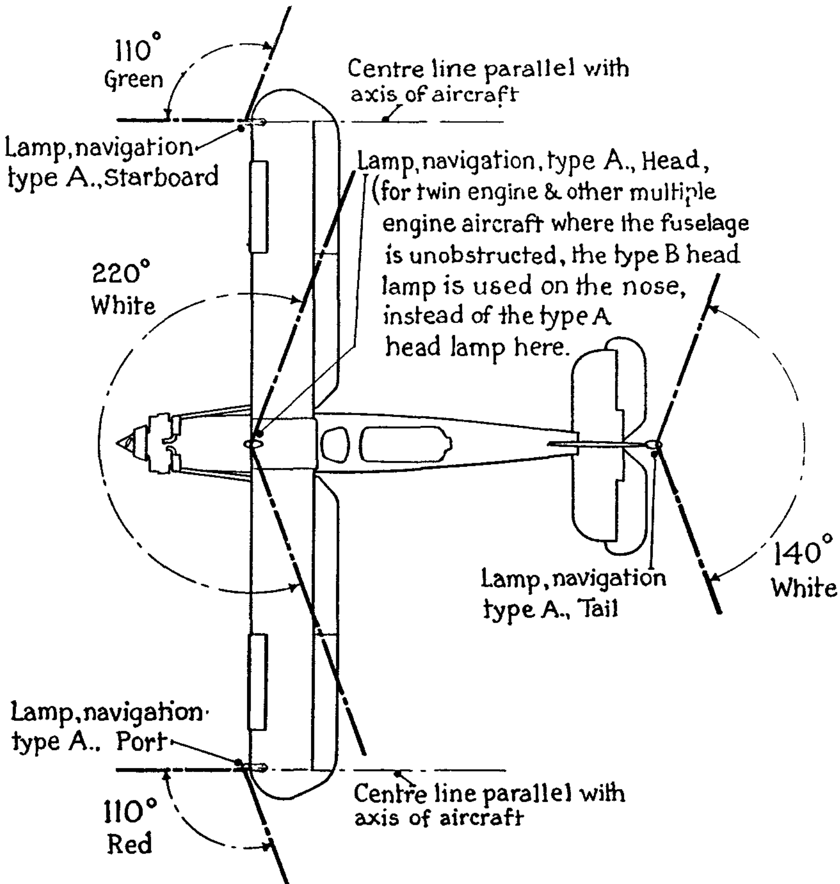

Fig. 7—Installation of navigation lights

17. The type B head lamp is intended for use at the nose of the fuselage, when the nose is unobstructed.

INSTALLATION

18. The navigation lamps are fixed on the aircraft in the positions shown in fig. 7. This diagram also shows the angular range of visibility of each light in the plan view. The distribution of light from the lamps themselves is approximately the same for all angles of elevation between

vertically upwards and vertically downwards, and the lamps are located on the aircraft so that the least possible obstruction is caused by parts of the airframe, although it is not always possible to eliminate obstruction completely.

19. The positions of the taxying light and the mooring light for seaplanes are shown in fig. 8. The type A head navigation lamp is usually used for the taxying light and is mounted as shown on the drawing. For the mooring light an upward identification lamp may be used, mounted on a detachable mast so as to be visible from all directions. The requirements as to the height of the mooring light, and also of the steaming light, are shown on the drawing.

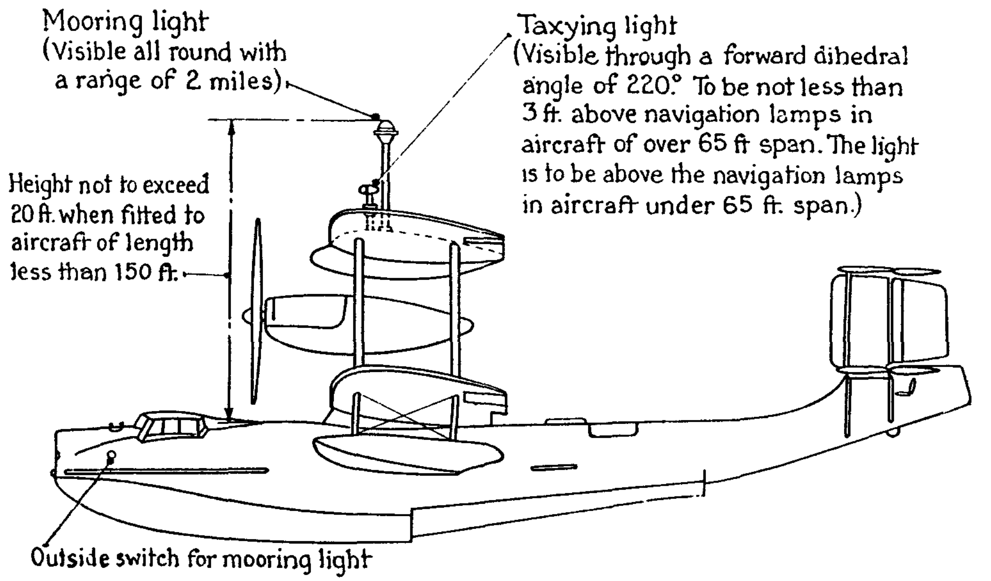

Fig. 8—Installation of taxying and mooring lights

20. The port and starboard lamps are mounted on bosses projecting forward from the leading edge of the wing as near to the wing tip as possible. The construction of these bosses is shown in fig. 9. The lamp is fixed to the vertical mounting plate at the end of the boss by means of the four 6 B.A. × ½ in. round-head steel screws provided with the lamp, a spring washer being placed under the head inside the lamp.

21. The tail lamp is mounted on the trailing edge of the tail, the socket being fixed by two 4 B.A. countersunk screws to a vertical mounting plate forming part of the airframe.

22. If a head lamp is fitted it may be the type A navigation head lamp mounted on the upper surface of the top wing close to the leading edge. The socket is mounted horizontally in the wing structure and is fixed by two 2 B.A. countersunk steel screws with nuts and spring washers. On multi-engined aircraft in which the nose of the fuselage is unobstructed the head lamp may be fitted in the nose, and will then be the type B head lamp. This is mounted in the same manner as the tail lamp.

23. The supply leads to the head and tail lamps are connected directly to the terminals of the sockets. The terminals are shrouded and consist of a screw with a washer held in position under the head. The wire is to be cleaned, the strands twisted together, and turned round the screw in a clockwise direction and tightened up.

24. The supply leads to the port and starboard lamps are connected to terminal blocks mounted as close as possible to the lamp, as shown in fig. 9. A short length of cable is used to connect the terminal block to the lamp, where the wires are soldered into the lugs.

SERVICING

25. The operation of the lamps should be checked before each flight by switching them on from the cockpit and seeing that they light. Periodically the glasses should be cleaned inside and out, and also the bulb of the filament lamp. Lamps fitted into sockets should be removed and the pins and socket tubes cleaned and the pins opened out, if necessary, to ensure a good fit in the sockets. The joint rings should be examined and must be replaced if they are perished or damaged.

26. Access to the filament lamp is obtained in the type A head lamp and the port and starboard lamps by turning the knurled ring in the direction indicated by the arrow. The cap itself does not turn, being located by a riser fitting in a groove, and should be held in one hand while the ring is turned with the other. The cap may then be taken off exposing the filament lamp. The cap of the tail lamp, type A, and of the head lamp, type B, is secured by two screwdriver-operated nuts. When these are undone the cap can be taken off together with the glass, and the filament lamp can then be taken out of its socket.

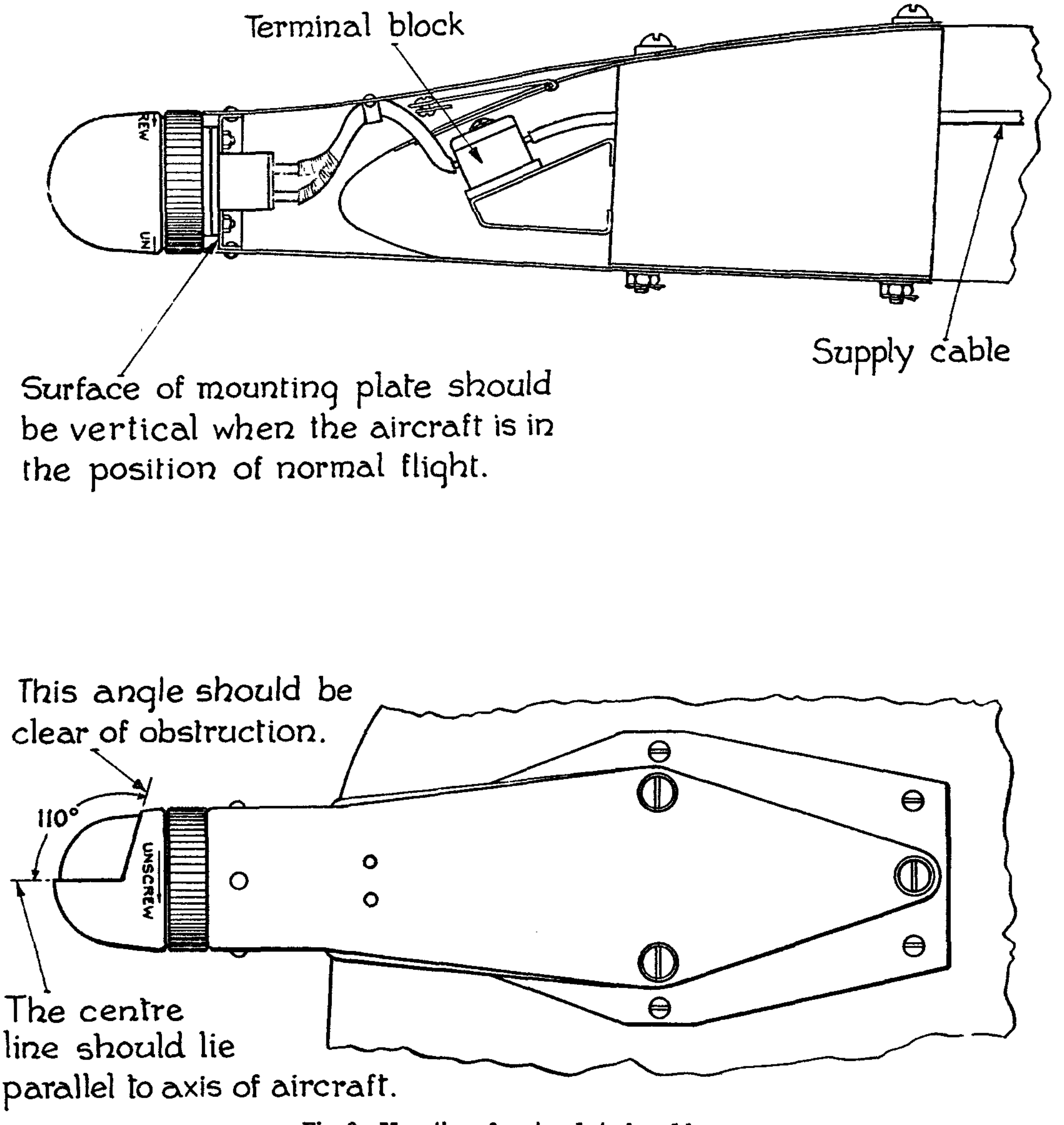

Fig. 9—Mounting of port and starboard lamps

27. Special blank caps are provided to cover the sockets when the lamps are taken off the aircraft, and these must always be fitted when the lamps are removed. For the type A tail lamp and the type B head lamp the blank cap (Stores Ref. 5C/499) is a flat plate of the same shape as the base of the lamp, and is fixed to the socket by the same screws as are used to fix the lamp. The blank cap (Stores Ref. 5C/486) for the type A head lamp is a threaded plug with a knurled head, and screws into the recess in the socket.

CHAPTER 2

IDENTIFICATION LAMPS

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LIST OF ILLUSTRATIONS

Introduction

1. Identification lamps are fitted on aircraft for the purpose of signalling to the ground or to other aircraft either above or below. The aircraft may show a steady light, white or coloured as previously determined, or may signal in code by means of the same lamp.

2. The lamps for signalling upwards are of a lower power than the downward lamps. They are visible from any position above the aircraft, whereas the downward lamps have reflectors to concentrate the light over a more restricted angle.

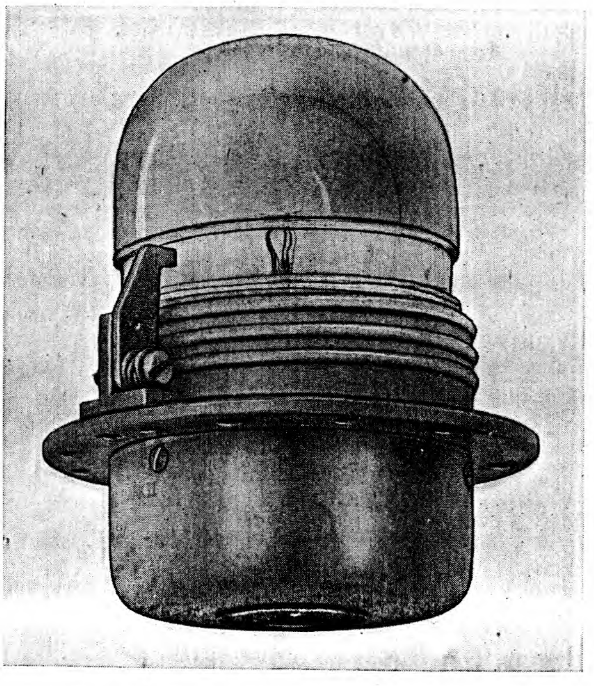

Fig. 1.—Upward identification lamp, Mk. II

DESCRIPTION

Upward identification lamp, Mk. II (Stores Ref. 5C/399)

3. This lamp is shown in fig. 1. The overall height is about 4½ in. and the weight about 9½ oz. The socket for the filament lamp is soldered to a flanged brass tube riveted inside a cup-shaped aluminium spinning. The edge of the spinning is secured to a flange on the mounting plate by three countersunk screws. The flange of another aluminium spinning is riveted to the upper surface of the mounting plate, and has a rolled thread into which the glass dome screws. A rubber seating is provided for the dome to make a waterproof joint. A locking device is provided to prevent the dome screwing out of the socket, and consists of a catch pivoted on a lug on the mounting plate and engaging in a recess in the dome above the thread. A pin fixed in the lug fits in a hole in the catch to hold it in the locking position, so that to release the catch the pivot screw must be unscrewed far enough for the catch to be drawn clear of the pin.

4. The lamp is secured to a horizontal part of the upper surface of the aircraft by means of the mounting flange. This has three equally spaced holes on a 3·35 in. pitch circle for 4 B.A. cheese-head screws or No. 6 round-head wood-screws.

Fig. 2.—Upward identification lamp, type C

5. The light is given by a 12-volt, 16-watt filament lamp (Stores Ref. 5L/376), which has a clear glass and a small bayonet cap.

Upward identification lamp, type C (Stores Ref. 5C/559)

6. This lamp is shown in fig. 2 and a sectional drawing is given in fig. 3. The overall height is about 3½ in. and the weight is about 6 oz. The body of the lamp consists of a moulded base of

synthetic resin compound, in which the bayonet-type lamp socket is formed, and a well glass held in position by a moulded bezel ring and bearing on a rubber ring (Stores Ref. 5C/644) to form a watertight joint. The contacts are mounted at the ends of curved leaf-springs attached to the underside of the base. The fixing screws for the leaf-springs form the electrical connections to the terminals, which are mounted on the upper side of the base so as to be accessible from the front of the lamp when the glass is removed. An insulating cover disc is screwed to the base underneath the contacts, and a hole is drilled in the base and another in the cover plate for the cable to pass through to the terminals.

7. The lamp is fixed to a horizontal surface of the aircraft by means of the flange on the base plate, which is drilled with three equally-spaced holes on a 3·35 in. pitch circle, for 4 B.A. screws or No. 6 round-head wood-screws.

8. The lamp is normally fitted with clear glass (Stores Ref. 5C/560) but a red glass (Stores Ref. 5C/613) and a green glass (Stores Ref. 5C/614) are also available and may be used in place of the clear glass for particular purposes.

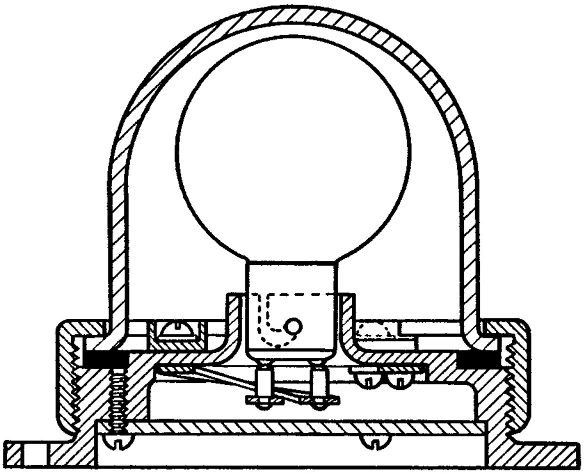

Fig. 3.—Upward identification lamp, type C, sectional view

9. The filament lamp used (Stores Ref. 5L/1449) is a 12-volt, 16-watt lamp with a small bayonet cap and frosted glass bulb.

Downward identification lamp, type B (Stores Ref. 5C/450)

10. The type B downward identification lamp is shown in section in fig. 4. The overall height is nearly 5 in. and the weight is about 1 lb. The body is an aluminium casting, or alternatively may be built up of a cast frame covered with a spinning. The reflector is of silvered copper and is fixed to the body by four instrument-head screws. It gives a beam with a divergence of 135°. The cover glass is cemented into a bezel of cast aluminium, which screws on to the front of the lamp. The lamp socket is of the standard spring-loaded plunger type, and is screwed on to a sleeve fixed into the frame by two steel set-screws. A machined cap is fitted over the cable entrance aperture at the apex of the body to provide a smooth edge for the cable.

11. The light is given by a 12-volt, 35-watt filament lamp (Stores Ref. 5L/1149), which has a special double spiral filament and which is fitted with a small bayonet cap.

12. The lamp is mounted in the airframe with the body within the fairing, and is fixed by three 2 B.A. screws or No. 9 wood screws through the lugs in the mounting flange, the holes being equally space on a 5·75 in. pitch circle.

13. The lamp is normally issued with a front (Stores Ref. 5C/452) fitted with clear glass. Other fronts are available, one (Stores Ref. 5C/453) having a green glass, and the other (Stores Ref. 5C/454) having a red glass. Either of these may be screwed on in place of the clear front when required. Boxes (Stores Ref. 5C/451) are available for storing the two fronts not in use.

Downward identification lamp, type C (Stores Ref. 5C/557)

14. This lamp is mainly of moulded synthetic resin compound. The overall height is about 3¼ in. and the weight is about 12¾ oz. It is shown in fig. 5 and a sectional drawing is given in fig. 6. The socket for the filament lamp is moulded in one piece with the body and the mounting flange. The contacts are mounted on curved leaf-springs which are each fixed by a rivet and a terminal. The terminal anchors the end of the spring and is almost surrounded by a shroud rising from the moulding. A moulded cover is fixed to the body by three countersunk screws, to protect the contacts and terminals, a slot being made in the edge of the body as shown in fig. 6, to accommodate the cable. A reflector of silvered copper is secured in the lamp by three screws, and a moulded front, with the glass cemented in, screws over the open end of the lamp. The reflector is designed to give a beam with a divergence of 135°.

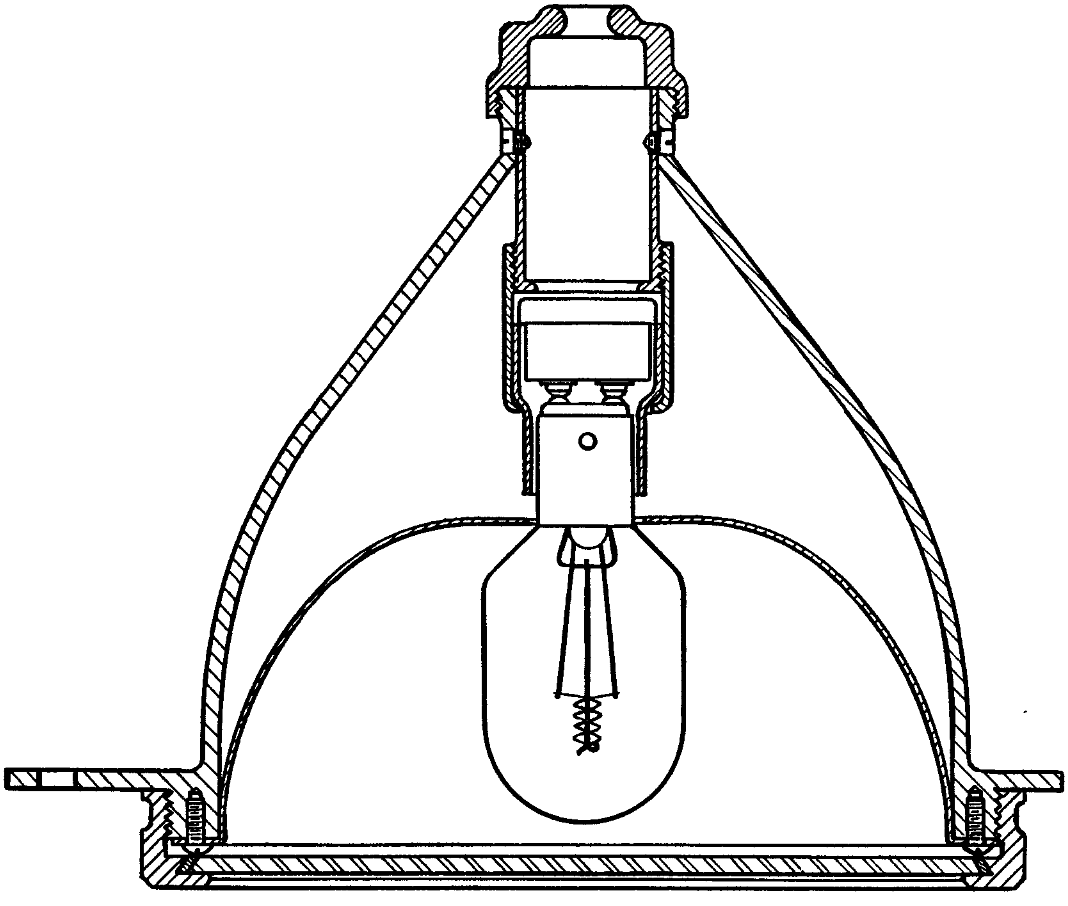

Fig. 4.—Downward identification lamp, type B, sectional view

15. The filament lamp (Stores Ref. 5L/1149) is a 12-volt, 35-watt lamp with a small bayonet cap and a filament specially shaped in a double spiral.

16. The lamp is mounted in the airframe facing downwards, with the body within the fairing. It is fixed with three 2 B.A. screws or No. 9 wood screws, equally spaced, through the lugs on the mounting flange, the holes being on a 5·75 in. pitch circle.

17. The front normally fitted (Stores Ref. 5C/558) has a clear glass. Two other fronts are also available and may be screwed on in place of the clear front when required. One (Stores Ref. 5C/615) has a green glass, and the other (Stores Ref. 5C/616) has a red glass. Boxes (Stores Ref. 5C/451) are provided for storing the fronts not in use.

Fig. 5.—Downward identification lamp, type C

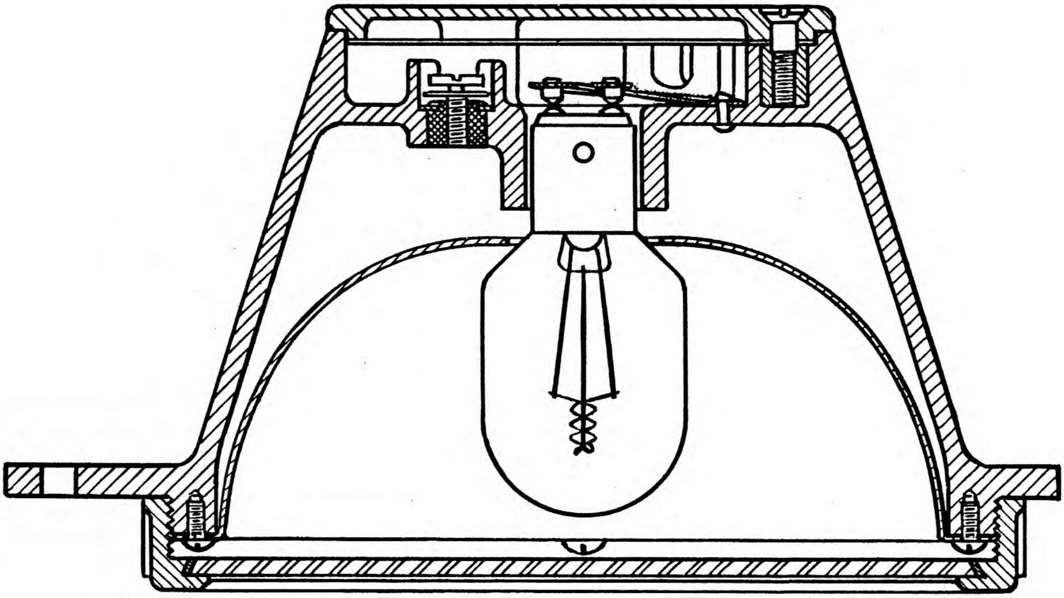

Fig. 6.—Downward identification lamp, type C, sectional view

INSTALLATION

18. The identification lamps are mounted in any convenient position in the upper and lower surfaces of the aeroplane. The upward lamps must be as clear as possible of obstruction in all directions so as to be visible from any point above the level of the aeroplane. The downward lamps give a beam with a divergence of 135° and should therefore be placed so that there is no obstruction at an angle greater than 22½° below the horizontal.

19. The whole or part of the upward lamps projects above the surface of the airframe, but the downward lamps are mounted flush with the fairing, the body of the lamp being within the airframe. Special arrangements may be necessary to replace the normal bracing by some other approved method, owing to the obstruction of the lamp body, and the fairing may be replaced by a plywood panel or some suitable framework on which to mount the lamp.

OPERATION

20. The lights are controlled by an identification switchbox arranged in an accessible position in the cockpit. By means of the switchbox, either upward or downward lamps may be kept on, to give a steady light, or they may be connected separately or together to a signalling key.

21. The range at which signalling can be carried out depends on the angle of elevation of the observer from the aeroplane and on the colour of the glass used, as well as on the weather conditions. In clear weather in the dark the greatest distance at which satisfactory signalling by the upward lamps can be carried out with certainty is as follows:—

	Mk. II	*Type C*
Clear glass	3 miles	3 miles
Red glass	1½ miles	2¼ miles
Green glass	1½ miles	2 miles

The range of the type C lamp in horizontal directions is ¼ to ½ mile greater than those shown here. The increased range of the coloured lights on the type C lamp is obtained by the use of special glass which has a transmission of about 25 per cent. as against about 12 per cent. for the glass in the Mk. II lamp.

22. Signalling by the downward identification lamp is limited to points within the beam, which has a divergence of 135°, so that an aircraft cannot signal to a point from which it has an elevation of less than 22½°. The range of the lamps for points vertically below the aircraft is as great as is likely to be required in normal circumstances, but owing to the distribution of intensity the horizontal distance, or the plan range, is limited to about 4½ miles for clear glass and 3 miles for coloured glass. Curves showing the plan range for different heights are given in fig. 7. For example, at 20,000 feet (clear glass curve) a plan range of 4½ miles is indicated. This means that a certain minimum conspicuity is available to an observer situated at any point on the circumference of a circle having a radius of 4½ miles, the centre of the circle being beneath the aeroplane. The minimum conspicuity has been taken as that which is found necessary for reliable signalling.

23. A rate of signalling of about eight words a minute, which is the greatest rate that can be read without confusion, can be obtained with any of these lamps.

SERVICING

24. No routine servicing of identification lamps is required, but their operation should be checked before each flight by switching them on from the cockpit and seeing that they light.

25. The metal reflectors may occasionally need cleaning. This should be done by washing with soap and water and rubbing lightly with a soft cloth. No metal polish of any kind must be used. The glasses and lamp bulbs should also be kept clean.

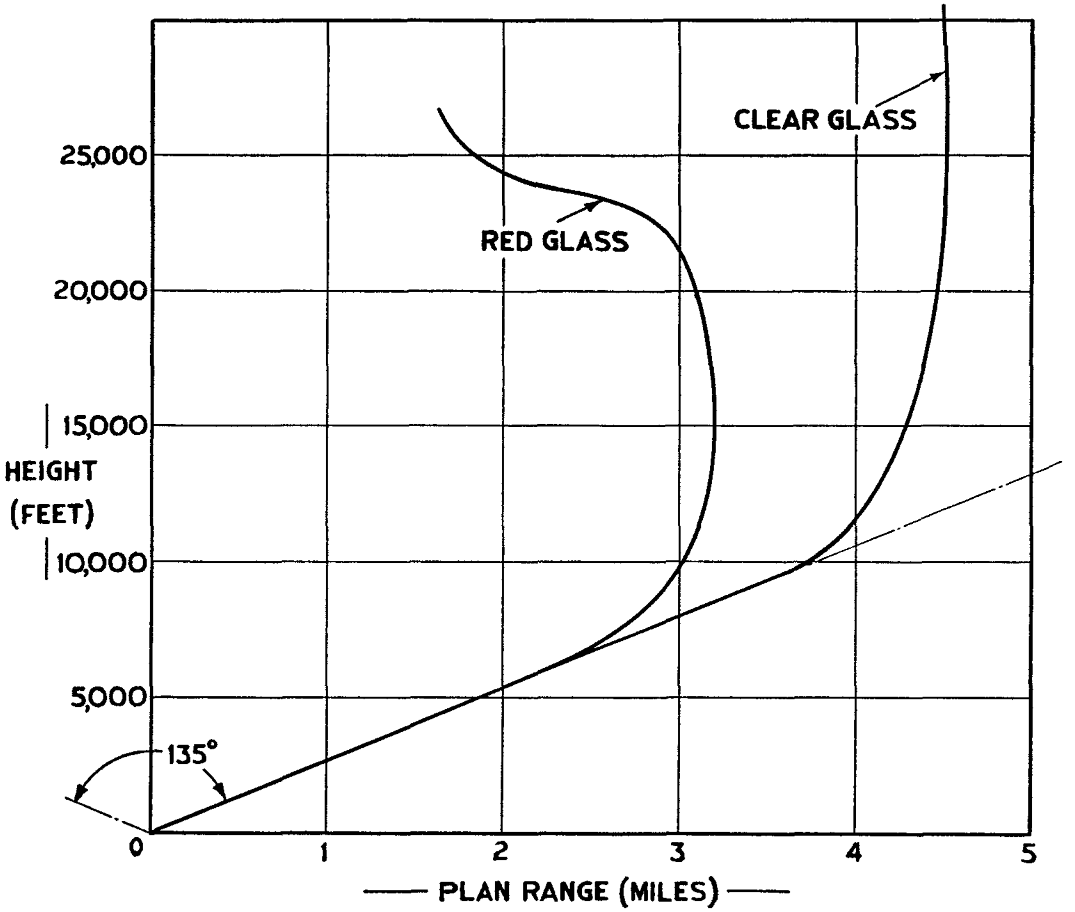

Fig. 7.—Range of downward identification lamps

Note.—The curve for Green glass is similar to that for Red glass

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CHAPTER 3

COCKPIT LAMPS, Mk. IA and II

(Mk. IA, Stores Ref. 5C/446

Mk. II. Stores Ref. 5C/366)

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LIST OF ILLUSTRATIONS

Introduction

1. The amount of illumination in cockpits should be only sufficient to allow the instruments and controls to be seen easily. Excess of light is undesirable for two reasons, firstly, if the pilot looks from a brightly lighted interior to comparative darkness outside, his eyes will take time to adapt themselves to the difference, and he will not at first see as well as would otherwise be possible. Even if he has not looked directly at the brightly lit interior the glare from it would be troublesome. Secondly, the light reaching the outside should be as little as possible so as to reduce the possibility of its betraying the presence of the aircraft when in action.

2. The cockpit lamps are therefore arranged so that the light they give can be used as effectively as possible and so that a minimum of stray light is produced. Means are generally provided for dimming the light and adjusting the brightness to suit the prevailing conditions.

DESCRIPTION

Cockpit lamp, Mk. IA

3. The Mk. IA cockpit lamp is shown in fig. 1. It is designed to give a general illumination in the cockpit and has a domed front of opal glass. A switch is incorporated in the lamp and a socket is fitted in the top of the case for supplying an inspection lamp or similar circuit. The lamp weighs about 7 oz., and the case is 3 in. in diameter.

4. The case is of light metal, and the glass dome is secured to it by a bezel ring with bayonet slot attachment. A rubber ring is placed between the glass and the case to make the joint waterproof, and three short leaf-springs riveted to the ring bear against the glass to keep it against the rubber.

5. The interior of the lamp is shown in fig. 2. A small bayonet socket is fixed on a bracket riveted to the back of the case, the socket being tilted forward. The switch consists of two leaf-springs mounted on an insulating piece secured to the back at the left side. These springs are bridged by a brass bobbin mounted on a switch rod but insulated from it. The switch rod passes right across the case and terminates in a button outside the case on each side. The circuit is closed when the rod is pushed to the left, and when it is pushed to the right an ebonite bobbin takes the place of the brass one. The leaf-springs engaging in the bobbins locate the switch in either position.

6. The two plug socket tubes are mounted in an insulating block screwed to the back of the case and partly projecting through the top. The terminal stampings, which are riveted to the tubes, are fixed to the block by countersunk screws from the back, and an insulating sheet is interposed between the block and the back of the case to insulate the heads of these screws.

7. The left-hand socket tube is connected to the upper switch spring by a connecting strip screwed on to each, and the lower spring and the right-hand socket tube are connected to the lamp socket by insulated wire. The supply leads to the lamp are to be connected under the screws on the socket terminals. The socket is therefore supplied directly from the leads and the lamp is controlled

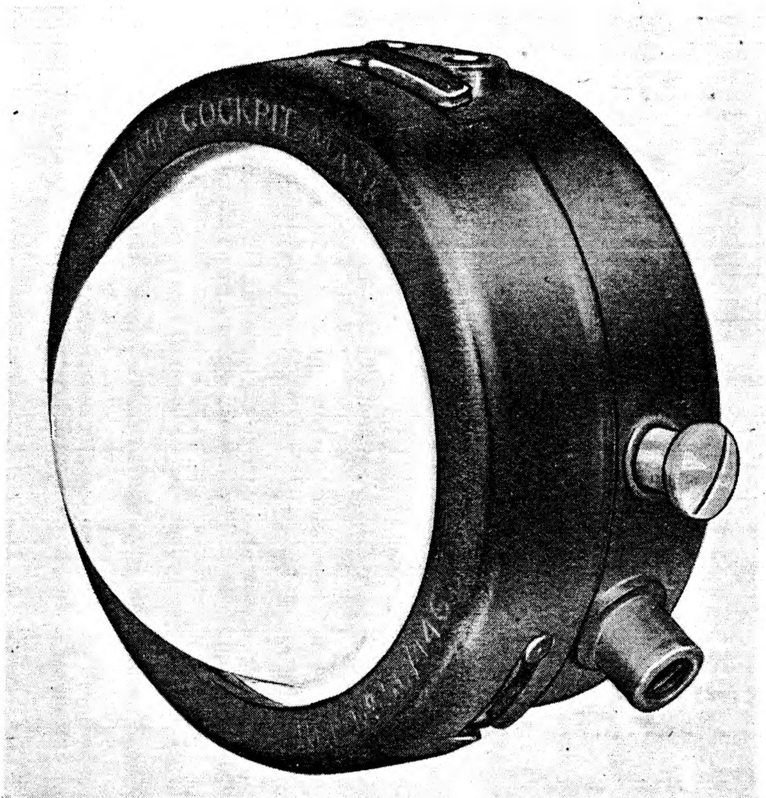

Fig. 1.—Cockpit lamp, Mk. IA

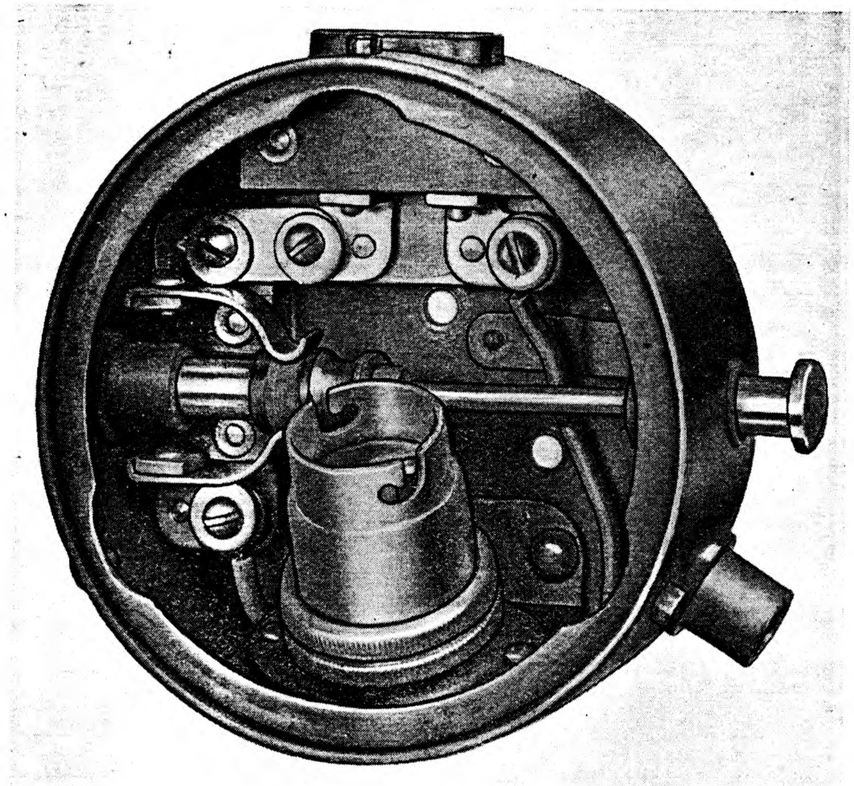

Fig. 2.—Cockpit lamp, Mk. IA, interior

by the switch. A metal bush is fitted in the right-hand side of the case below the switch, for the entry of the supply cable.

8. When the lamp is connected up the cores of the cable should be separated and the end of the braiding tightly bound with waxed thread. A piece of systoflex tubing of 3 mm. bore and 1·25 in. long should be slipped over each lead up to the binding. The end of the cable should then be passed through the bush in the lamp case, and the terminating rings supplied with the lamp clipped on to the ends of the leads, one lead being 2·5 in. and the other 1·75 in. long. Both wires should be passed under the clip at the back of the case, and the shorter one connected to the right-hand socket terminal and the longer one to the left-hand terminal.

9. The back of the case is drilled for three 4 B.A. screws or No. 6 round-head wood screws for mounting the lamp.

10. The filament lamp (Stores Ref. 5L/792) intended for this lamp is a 12-volt, 6-watt lamp with a small bayonet cap, to British Standard Specification E.12.

Cockpit lamp, Mk. II

11. This lamp is intended for floodlighting instrument boards. It is designed for mounting on the board itself and can be adjusted in any direction so that the light can be used in the most effective way. It gives an orange light. The complete lamp is shown in fig. 3; the overall extended length is 4¾ in. and the weight is about 5¾ oz.

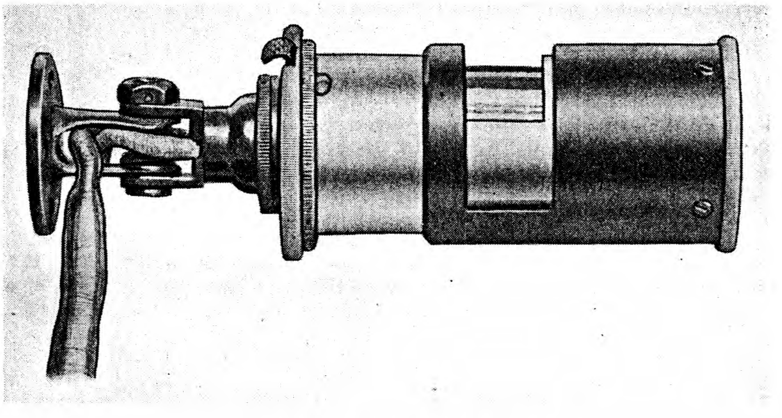

Fig. 3.—Cockpit lamp, Mk. II

12. A standard small bayonet lamp socket is screwed on to a mounting stirrup, and this is hinged to the mounting bracket as shown in fig. 4. A special bolt serves as a pivot pin and on it is a steel spring to provide a strong friction control on the joint. A sleeve is screwed on to the thread on the

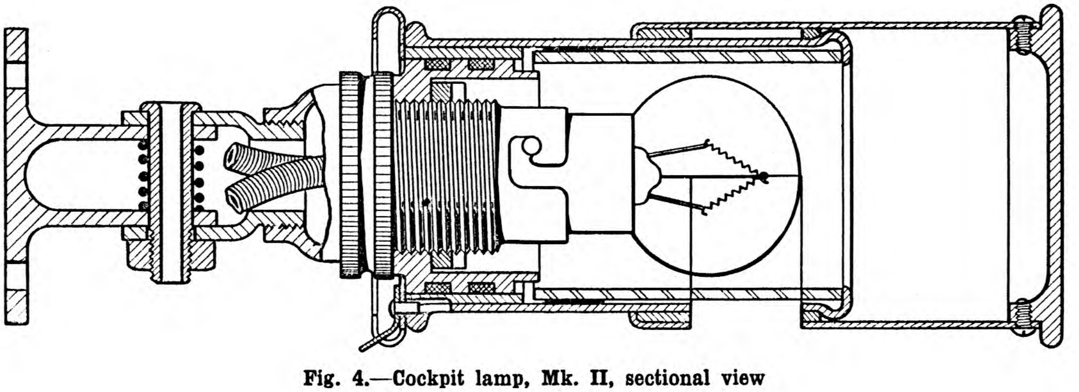

Fig. 4.—Cockpit lamp, Mk. II, sectional view

lamp socket and is locked by the shade ring, which is modified by machining and slotting. The clamping ring of the lamp holder is spot-soldered to the base to prevent its working loose. An outer sleeve is fitted over the inner sleeve and is free to turn on it; leather rings are fitted between the two to give a smooth friction movement. A knurled ring is attached to the outer sleeve to facilitate turning it.

13. The inner mask tube slips over the outer sleeve and engages in three bayonet pins on it. A locking pin, mounted on a semi-circular flat spring, engages in one of the bayonet slots in the tube, which thus cannot be taken off without first pressing back the knurled projecting end of the spring. A tube of orange glass is fitted inside the inner mask tube and is fixed by a binding of adhesive tape. The outer mask tube slides on the inner. It is closed at one end by an aluminium cap fixed by four instrument-head screws, and a leaf-spring is fitted inside the other end to grip the inner tube. A stop ring inside the outer tube prevents it from sliding off beyond the position of full aperture. Each tube has an aperture extending half way round it, so that by sliding one on the other an effective opening of any length and width can be obtained and this can be directed in any way by turning the mask on the lamp holder and pivoting the holder on the mounting bracket.

14. A 12-volt, 6-watt filament lamp (Stores Ref. 5L/792) is used, which has a small bayonet cap and satisfies the requirements of British Standard Specification E.12.

15. The lamp is mounted by four 6 B.A. round-head bolts or No. 4 round-head wood screws, through four equally spaced holes in the mounting bracket on a pitch circle 0·875 in. in diameter. It is supplied with a six-foot length of duflex 4 cable connected to it. Each end of the cable is bound with twine and terminated in soldered thimbles.

SERVICING

16. No routine maintenance of the lamps is required. The glasses should be kept clean, and the movement of the Mk. II lamps should be such that the adjustments can be easily made by hand but will not be disturbed by vibration. Access to the filament lamp in the Mk. II lamp is obtained by pressing back the catch spring and disengaging the mask from the bayonet pin. Spare orange glasses (Stores Ref. 5C/643) are available for this lamp.

17. The end cap of the outer tube of the Mk. II lamp is fixed by four small screws, which are liable to be loosened by vibration. They should be tightened up and locked, if this is not already done, by centre-punching the edge of the head so as to expand it into the adjacent metal.

P3281 M44596/1159 12/43 8500 C & P Gp. 1

CHAPTER 4

INSTRUMENT LAMP and COWL

(Instrument lamp, Stores Ref. 5C/462

Cowl, Stores Ref. 5C/510)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This lamp is provided for the local illumination of instruments which cannot be satisfactorily lighted by a general lighting system. It consists of a special lampholder, taking a filament lamp of the telephone signalling type. The cowl may be used with the lamp to mask and direct the light where provision for doing this is not made in the instrument.

DESCRIPTION

2. The lamp, cowl, and filament lamp are shown in fig. 1. The lampholder consists of an insulating piece fitting into a metal sleeve. The insulating piece is hollowed out to receive the filament lamp, and two flat contact springs are fitted inside the cavity. The ends of these springs are secured to the insulation by screws which are used as terminals for the flexible lead supplying the lamp, and a strip of oiled silk is wrapped round the insulating piece over the terminals to prevent accidental contact with the sleeve. The insulating piece is introduced from the back of the metal sleeve, and a cap, with a hole through the centre for the entrance of the flexible lead, is screwed into the end of the sleeve. A single bayonet pin is fitted into the side of the sleeve, and a ring is fitted over it loaded with a spring to keep the pin in engagement with a bayonet slot. The weight of the lamp alone is $1\frac{1}{4}$ oz. and the length is about $1\frac{1}{2}$ in.

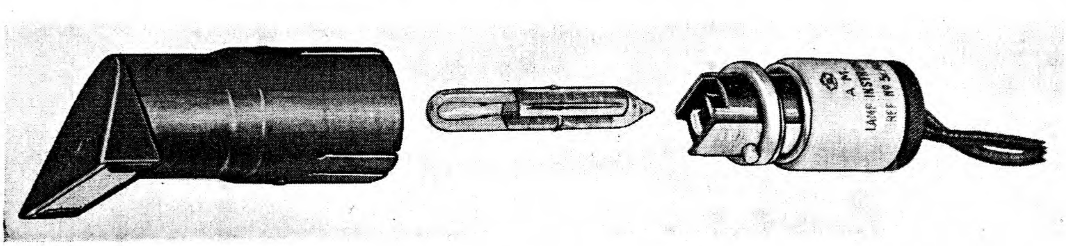

Fig. 1.—Instrument lamp and cowl

3. The filament lamp (Stores Ref. 5L/1150) is of the type used for telephone signalling and is known as the P.O. No. 3 jack type lamp. It consists of a tubular glass bulb having contact plates fixed on opposite sides connected to each end of the filament. When it is inserted in the holder the springs make contact with these plates and also hold the lamp in position. It is a 12-volt lamp with a nominal wattage of one.

4. The cowl is of brass. It is shaped as shown in the illustration and fits over the sleeve of the lampholder. A strip of opal glass is fitted over the mouth and the inside is finished white so as to reflect as much light as possible. A ring is riveted inside the tube of the mask and has two bayonet slots to take the pin of the lampholder, the spring-loaded ring on the lampholder bearing on the ring to keep the pin in one of the slots.

INSTALLATION

5. The instrument lamp, without the cowl, may be fitted to an instrument having special provision for it in the form of a bayonet socket and suitable arrangements for directing the light; or the lamp may be used with the cowl and supported in a convenient position to illuminate the instrument. The lamp is supplied with a length of Instruflex cable connected to it, the other end of which is to be connected to some supply point in the aircraft lighting circuit or to terminals on the instrument. Access to the terminals of the lampholder is obtained by withdrawing the insulating piece from the sleeve after unscrewing the cap.

6. A bayonet ring (Stores Ref. 5C/484), identical with that fitted in the cowl, is available for adapting the No. 3 compass lighting bracket to take this instrument lamp.

P3282 M44598/1760 12/43 8500 C & P Gp. 1

CHAPTER 5

CHART BOARD LAMP, Type A

(Stores Ref. 5C/538)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This lamp is primarily intended for illuminating maps and chart boards. It may also be used in wireless cabins and for other similar purposes. It clips on to the edge of the chart board or any convenient member and can be quickly adjusted to direct the light to the required place. The current supply is carried to the lamp by a flexible cable connected to some suitable supply point.

DESCRIPTION

2. The lamp is shown in fig. 1. The weight is about 1 lb. 6 oz. and the overall extended length is about 12 in. The lamp standard is mounted on a robust clip with a strong spring and felt-lined jaws. The base consists of two vertical semi-circular plates side by side, with a square-section arm pivoted between them. A bolt with a wing-nut and spring washer passes through the arm and runs in arc-shaped slots in the plates, so that the arm can be clamped at any angle. At the other end of the arm is pivoted a stirrup supporting the lamp socket, and this is also clamped up with a wing-nut and spring washer.

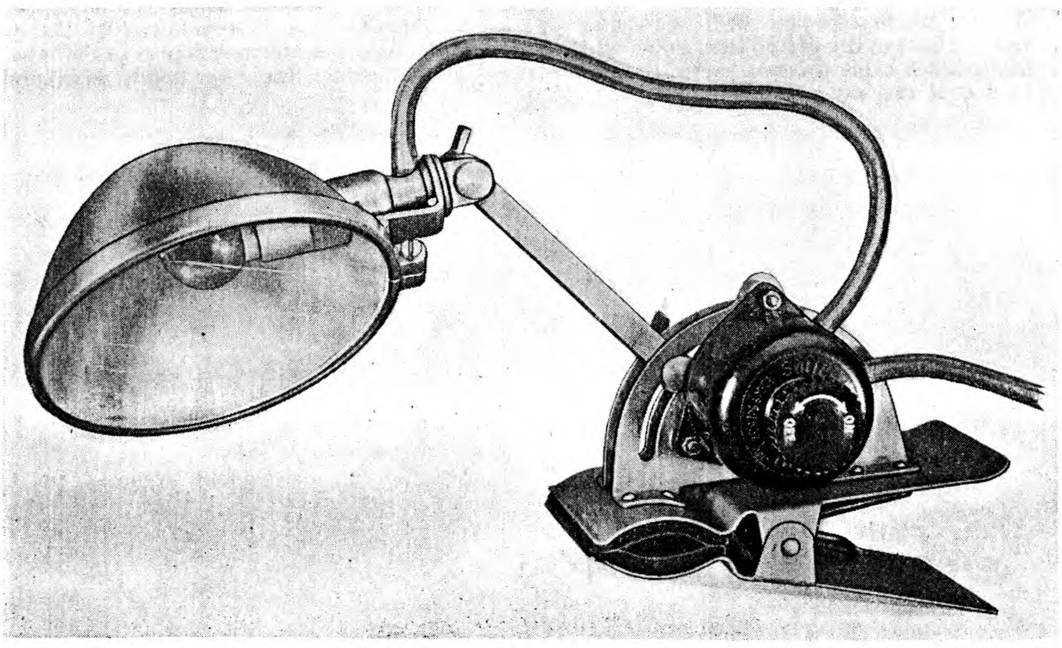

Fig. 1—Chart board lamp, type A

3. The lamp socket itself is rigidly attached to the stirrup, but the reflector, a cup-shaped spinning silvered on the inside, is riveted to a bracket which turns on the circular stem of the stirrup, against its shoulder. The lamp socket passes through a clearance hole in the reflector. Thus the reflector is free to turn round the lamp and can be adjusted to the required angle.

4. The contacts are rigidly mounted in an insulating block which is free to slide in the socket tube but is restrained from turning by an inward projection of the tube engaging in a slot in its side. A spring under the block keeps it in contact with the filament lamp.

5. The lamp normally used is a 12-volt, 6-watt filament lamp (Stores Ref. 5L/792) which has a small bayonet cap, and satisfies the requirements of British Standard Specification E.12. A 12-volt 10-watt filament lamp (Stores Ref. 5L/1332) may also be used.

6. The glass is attached to the front of the reflector by a split ring drawn up by a bolt. Two glasses are available for use in the lamp. One (Stores Ref. 5C/679) is clear, and the other (Stores Ref. 5C/680) is orange.

7. A dimmer switch, type C (Stores Ref. 5C/537), for controlling the brightness of the light, is supplied with the lamp and is mounted on one of the plates as shown in the illustration. A short length of duflex 4 cable connects the lamp socket to the dimmer switch, and the same type of cable is used to connect the dimmer switch to the supply.

OPERATION

8. The lamp is normally used with the clear glass front and the 6-watt filament lamp. In circumstances when the white light is undesirable, for instance when a pilot has to look alternately at a chart and at his surroundings, the orange glass should be fitted, and it may then be found necessary to use the 10-watt filament lamp to obtain adequate illumination. Whichever glass and lamp is fitted the dimmer should be used to reduce the amount of light to the minimum required. The lamp is switched off by turning the dimmer switch knob to the extreme counter-clockwise position.

SERVICING

9. No routine servicing of the lamp is required. It should be examined from time to time for mechanical damage and the wiring and connection should also be examined. The junction of the cable to the lamp socket is made accessible by drawing out the contact insulating block from the top of the socket after removing the glass. The withdrawal of the block may be assisted by pushing the cable into the base of the holder. To obtain access to the connections in the dimmer switch the switch must first be detached from the sector plate by removing the three nuts and spring washers, and the base of the switch then taken off by removing the three countersunk screws in the base. One lead of each cable is connected to the middle terminal, and each of the other two leads is connected to one of the outer terminals.

P3283 M44599/1763 12/43 8500 C & P Gp. 1

CHAPTER 6

INSPECTION LAMP MK. II

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LIST OF ILLUSTRATIONS

Introduction

1. The Mk. II inspection lamp (Stores Ref. 5C/369) is a light-weight hand lamp intended to be carried in aircraft and to derive its current from the aircraft electrical supply. A flexible lead terminating in a 2-pin plug forms part of the lamp, and an additional length of cable terminating in a plug at one end and a socket at the other is available for use as an extension lead (Stores Ref. 5C/370). The lamp and the extension lead in its pocket is shown in fig. 1. The weight of the lamp is 8 oz. and of the leads and pocket 3½ oz. The lamp is about 9 in. long.

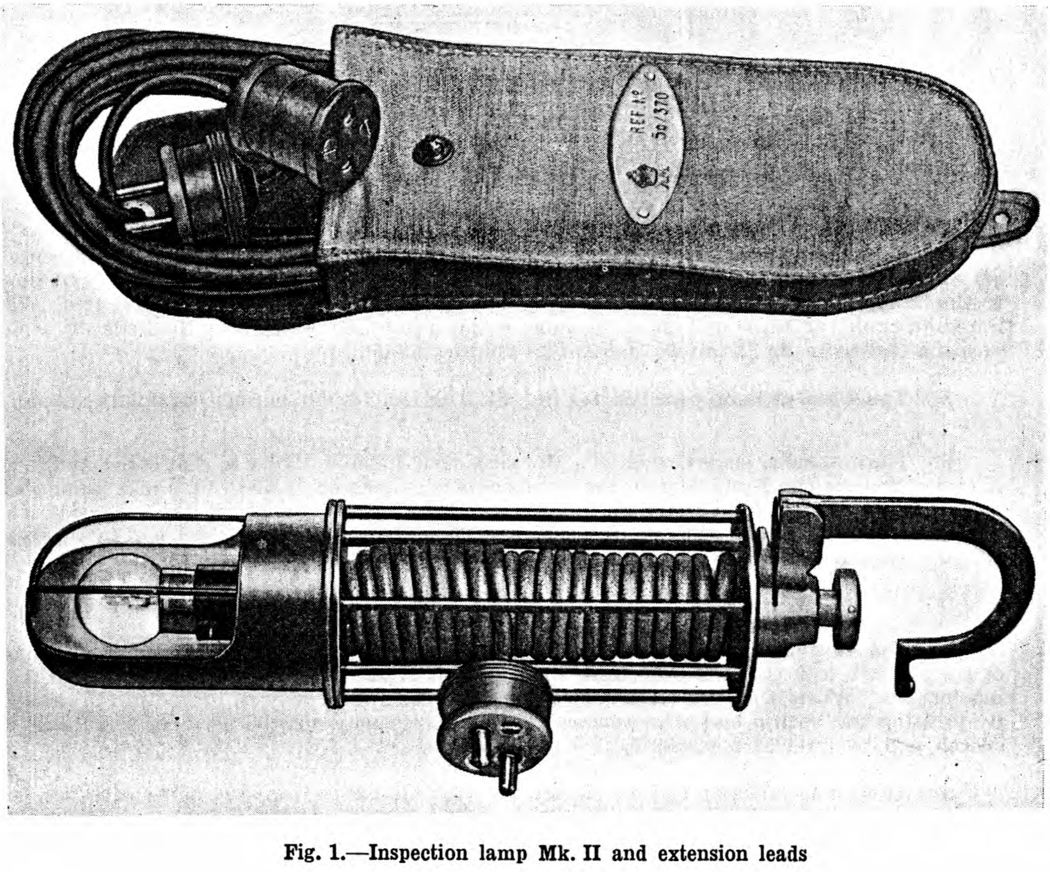
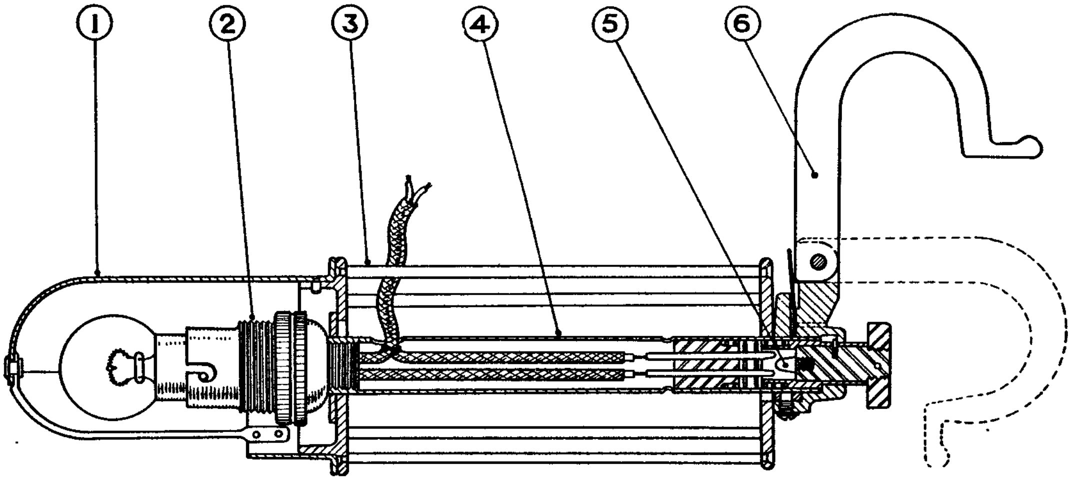


Fig. 1.—Inspection lamp Mk. II and extension leads

DESCRIPTION

2. The lamp is shown in section in fig. 2. A small bayonet lampholder (2) is attached to a tube (4) at the end of which is fitted a push-button switch. The contact bridge (5) of the switch is mounted on an insulating block fitted into a spring-loaded sleeve and carrying a push-button on the outer end. It bridges two contacts mounted on insulation inside the tube (4). A pin fixed in the side of the plunger limits its movement and, when the button is pressed and turned, locks it in the ON position. The hook (6) is provided on a bush keyed to the end of the tube (4) and is held by a flat spring in either of the two positions indicated in fig. 2.

3. The whole of the assembly comprising the tube, lampholder, switch and hook is free to turn in the outer frame, which consists of two circular end plates joined by bars to form a cage. The plate at the lamp end has a flange with three bayonet slots, to which a mask, formed as shown in fig. 1, is fitted to shade the light from the operator and reflect it on to the part under observation.



1.	Shield	3.	Frame	5.	Contact bridge
2.	Lampholder	4.	Tube	6.	Hook

Fig. 2.—Inspection lamp Mk. II, in section

4. The cable enters between the bars of the outer frame and passes through a hole into the tube (4) where one lead runs direct to the lampholder and the other passes to the switch and thence back to the lampholder. The cable is 10 ft. long, and a 2-pin plug is connected to the end. The whole length of cable can be wound on to the tube, within the frame, by turning the hook (6), which in the position shown in fig. 2 can be used as a winding handle.

5. The filament lamp used (Stores Ref. 5L/370) is a 12-volt, 8-watt lamp with a small bayonet cap.

6. The extension leads consist of a 10-foot length of cable similar to that connected to the lamp. A socket to take the 2-pin plug on the lamp cable is connected at one end, and a 2-pin plug similar to that on the lamp is connected at the other end. Thus by connecting the extension lead to the lamp cable a total length of 20 ft. is obtained. The extension leads are supplied in a canvas pocket closed with a snap fastener and provided with flaps at the top and bottom for fixing it to the airframe.

OPERATION

7. The lamp may be connected to any suitable socket connected to the general electrical supply of the aircraft, and the extension leads may be used if the length of cable attached to the lamp is insufficient. When it is used as an inspection lamp the switch may be locked in the closed position by pressing the button and then turning it. The lamp may also be used for signalling, when the switch will be used as a spring-loaded push-button.

8. As soon as the lamp is disconnected the cable should be rewound on the tube, using the hook turned at right-angles to the tube as a handle. The extension leads should be carefully coiled and replaced in the pocket after use.

P3593 M47921/1635 1/44 8500 C & P Gp. 1

CHAPTER 9

LANDING LAMPS

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LIST OF ILLUSTRATIONS

Introduction

1. Landing lamps are fitted to aircraft primarily to assist landing at night in cases where ground lighting has to be reduced to a minimum, or where, as in the case of forced landings, ground lighting is non-existent. The lamps are also used for taxying on airfields and manoeuvering on water, being particularly useful for picking up moorings, etc. The leading edge type of lamp, when fitted with a control may also occasionally be found useful for picking up some well-defined landmark from heights up to about 1,000 ft., or for determining whether the aircraft is over sea or land.

2. Any landing lamp, to function satisfactorily, must have the beam set correctly in relation to the axes of the aircraft. The setting likely to give the best results is decided for each particular type of aircraft after night flying trials on the prototype, and this setting is used on the subsequent aircraft Individual pilots may, however, wish to alter the settings slightly to suit their own particular methods of landing, and all landing lamps are therefore provided with adjustments to enable this to be done.

3. The setting of the beam in the horizontal plane, *i.e.* the angle between the axis of the beam and the vertical plane through the longitudinal axis of the aircraft, depends on the field of view of the pilot. The setting of the beam in the vertical plane, *i.e.* the angle between the axis of the beam and the horizontal when the aircraft is at rest on ground or water, depends mainly on the total change in attitude of the aircraft from the beginning of the approach to touch. This change in attitude differs considerably, depending on whether the aircraft is a landplane with conventional undercarriage, a landplane with a tricycle undercarriage, a flying boat or seaplane. In order that the effect of these factors on the setting should be appreciated, a brief description of the method of landing most usually employed is given below.

Method of landing

4. Under ordinary atmospheric conditions, the beam of a landing lamp will show up obstructions such as houses, fences, small boats, etc., at a distance of about 1,400 ft. measured along the axis of the beam. With the beam pointing forwards and downwards at a suitable angle (which has been found by experience to be about 12 deg. below the horizontal), the pilot during the approach may therefore expect to see such objects at a height of about 250 ft. (see fig. 1). At about 100 ft., bushes, hummocks in the ground, and other objects of low reflectivity begin to appear. These objects

rapidly become more distinct and at about 60 ft. the actual surface of the landing ground begins to emerge, so that the pilot can watch carefully for the appearance of detail which will enable him to judge his height. At about 40 ft., tufts of grass begin to stand out, the pilot flattens out, and as he does so, the beam is thrown more and more upwards, finally becoming horizontal at the moment of touch. The pilot does not require to make any adjustment to the control during the whole of the approach and landing, unless the weather is misty, in which case the beam may be depressed at the beginning of the approach and raised later.

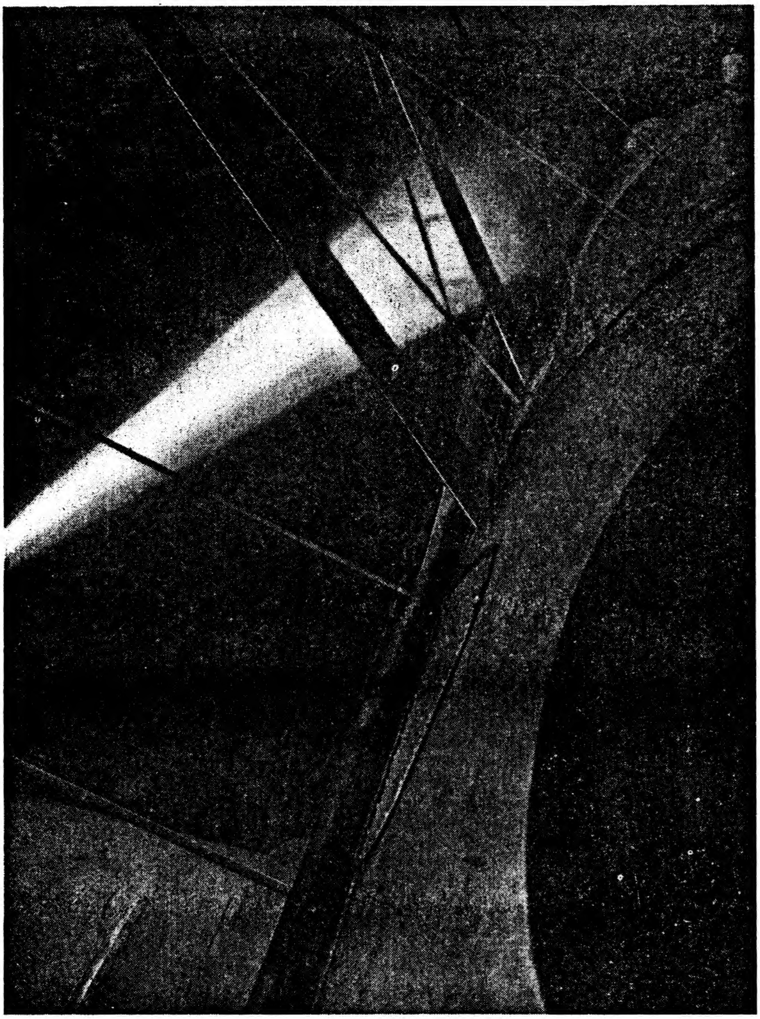


Fig. 1.—Beam in landing position at 300 ft.

5. The above description applies to all types of aircraft if "touch" is taken to mean the following :

(i) In landplanes with conventional undercarriages, the moment the tail wheel touches the ground.

(ii) In landplanes with tricycle undercarriages, the moment the main wheels touch the ground.

(iii) In flying boats and seaplanes, the moment when the hull or floats touch the water.

The position of the beam in which the axis is horizontal at "touch" will be referred to in this Chapter as the "landing position".

Use of lamp for taxying

6. For taxying on airfields or manoeuvring on the water, the axis of the beam should be horizontal or slightly downward. In nearly all modern types of aircraft the change in attitude from the beginning of the approach to touch is about 12 deg., so that if the axis of the beam is 12 deg. below the horizontal at the beginning of the approach, it will be horizontal at touch. In landplanes

with conventional undercarriages there is no further change in attitude after touch, and the positions of the beam for landing and taxying are therefore the same. In such aircraft a lamp with a fixed beam will meet all requirements for landing in ordinary weather, and at present all American aircraft have been fitted with single position lamps. Such lamps may, however, be adjustable on the ground, the position being set before flight.

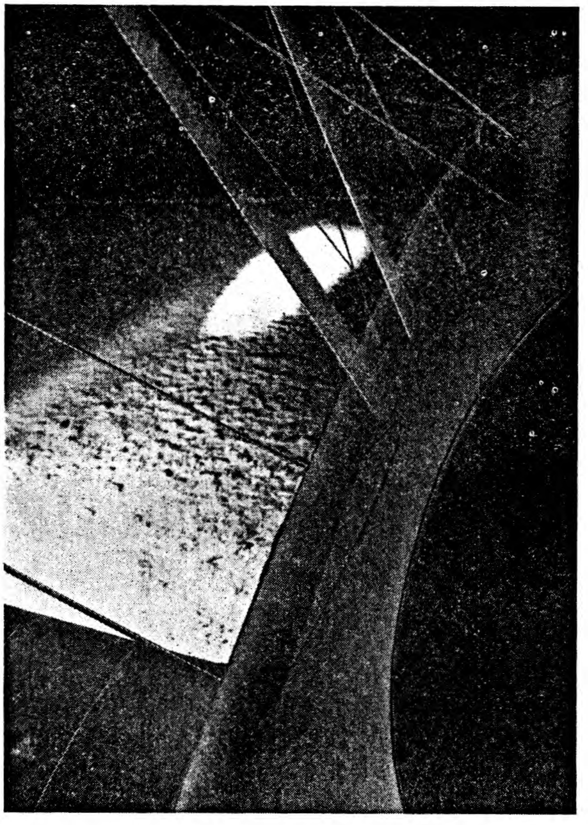


Fig. 2.—Appearance of lighted area with aircraft on the ground

7. In the case of landplanes with tricycle undercarriages, and also in flying boats and seaplanes, the nose drops after touch, thus causing a change in attitude in the reverse direction to that which took place during flattening out, and in consequence the full change in attitude from the beginning of the approach to rest may be only about 6 deg. If the beam were set horizontally with the aircraft at rest, during the approach the beam would only be 6 deg. below the horizontal, and just before touch the beam would be thrown upwards into the air. In these types of aircraft different positions are therefore necessary for landing and for taxying, the landing position being about 6 deg. below the taxying position.

Use of lamp for purposes other than landing and taxying

8. Even the landing position is too near the horizontal to enable the ground to be seen from a safe height when flying level. If ground reconnaissance is to be attempted, a control must be fitted to the lamp to depress the beam 30 deg. or more below the horizontal. Furthermore, the axis of rotation about which the lamp moves must lie in a plane making an angle of about 35 deg. with the horizontal. The reason why the axis of rotation must be set at this angle, which may be called the "angle of cant", is made clear in fig. 3. The shaded portion in this diagram shows the area on the ground which is obscured from the view of the pilot by the nose of the fuselage, that is, assuming that the pilot is looking out of the left side of the aircraft. If the axis of rotation lies in the horizontal plane, as in the case of the retractable types of lamp, types J, K and Grimes, the path of the beam is not as shown in fig. 3, but is a strip radiating from a point vertically underneath the aircraft at

an angle to the fore-and-aft line depending on the angle of offset. The beam therefore begins to be obscured as soon as it is depressed by more than about 6 deg., and it is for this reason that none of these types of retractable lamp has more than two extended positions.

Beam setting adjustments

9. All the British and most of the American types of landing lamp are capable of being adjusted for beam setting after installation. These adjustments are as follows.

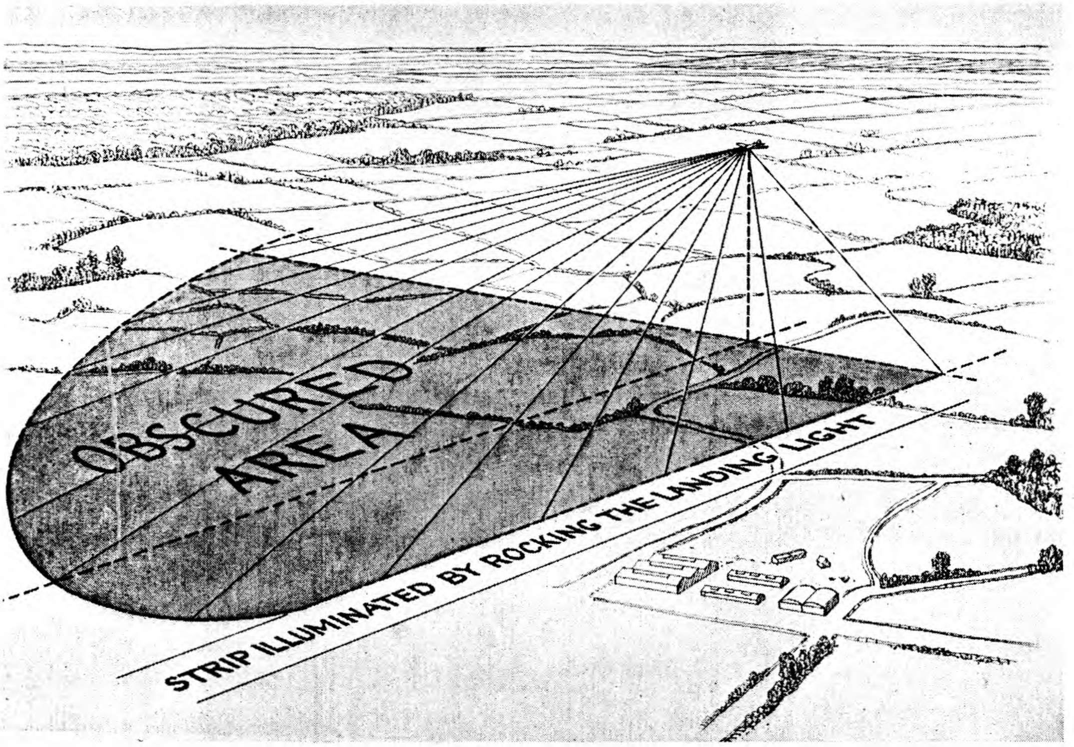


Fig. 3.—Area obscured from port-side view by nose

Upward limiting position

10. As beam positions higher than that used for taxying are not useful, it has been found advantageous in controllable-type lamps to fit a stop to limit the upward motion. The best illumination for taxying is obtained with the beam horizontal or slightly below horizontal when the aircraft is at rest on ground or water, and the control should be arranged so that the beam is in this position when the control lever is pulled hard back against the stop.

Angle of offset

11. When the aircraft is at rest on the ground and the pilot's head is in the position in which it would be at the moment of touch, it will usually be found that the whole of the ground illuminated by the beam cannot be seen unless the beam is turned outboard. The angle by which the beam is turned outboard, *i.e.* the angle between the axis of the beam and the vertical plane through the longitudinal axis of the aircraft, may be called the angle of offset. In single-engined fighters or any type of aircraft with a long length of fuselage in front of the pilot this angle is usually of the order of 15 deg. In multi-engined aircraft it usually varies from zero to 8 deg.

Angle of cant

12. Only the types G and H lamps have an angle of cant, and only in the type H lamp is the angle adjustable. The purpose of the angle of cant is described in para. 8.

Types of landing lamp in service

13. There are two sizes of lamp, the smaller having a reflector about 7 in. in diameter and a loading of 240 watts, and the larger having a reflector about 9 in. in diameter and a wattage of 350 in

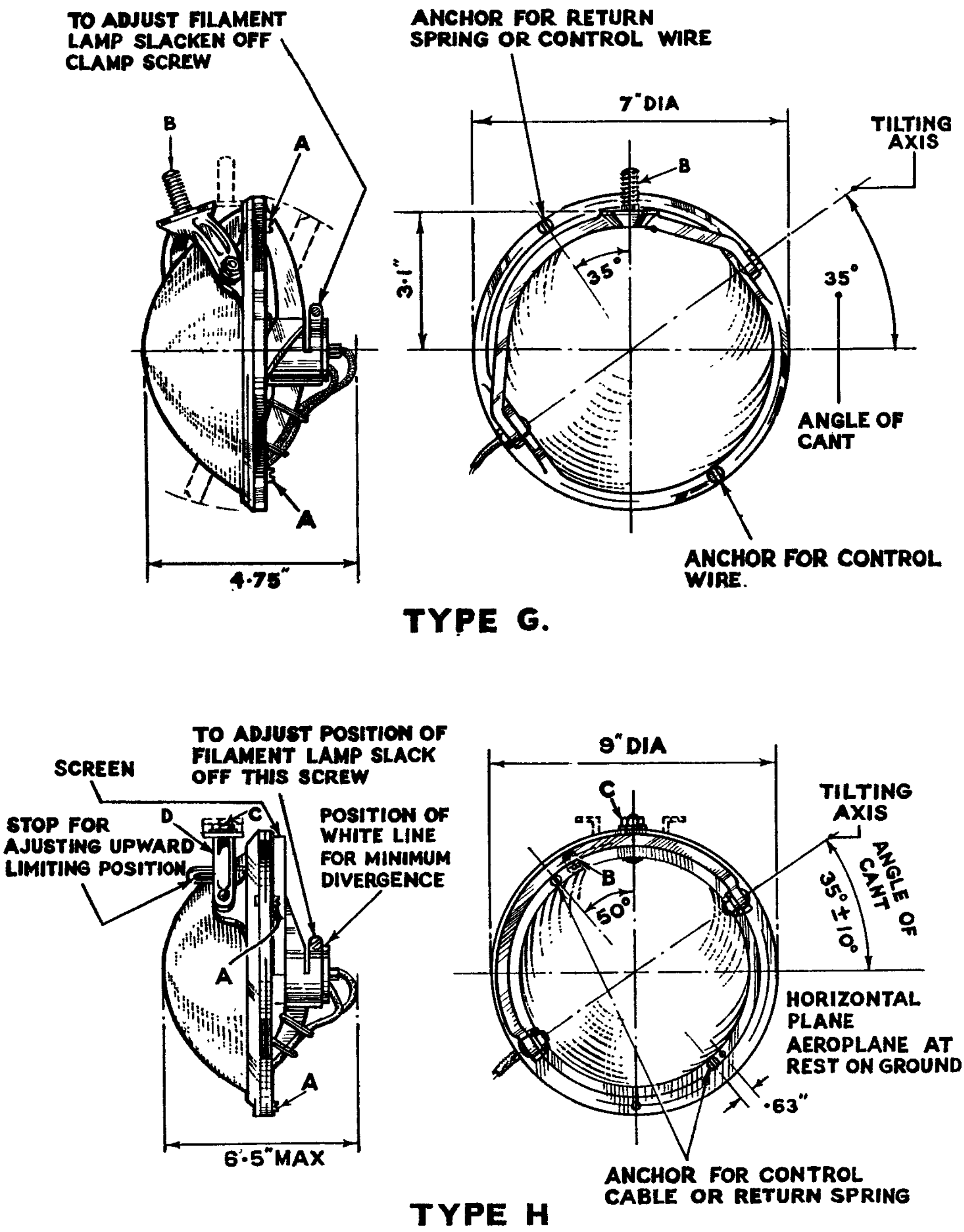


Fig. 4.—Landing lamps, types G and H.

the case of the British types, the respective wattages being 350 and 420 in the case of American lamps. The larger size is used wherever possible, but where space is restricted, as in fighter aircraft, the smaller size has to be fitted. The divergence of both sizes is about 9 deg. The larger size gives a maximum intensity of about 350,000 candle-power and the smaller about 230,000 candle-power.

14. Landing lamps fall into two main classes according to whether they are (*a*) mounted in the leading edge of the wing, or (*b*) retracted into the underneath side of the wing or fuselage. The types G and H and some American lamps are fitted into the leading edge of the wing and the type J, K, Grimes ST.250 and Grimes ST.1220 are retractable.

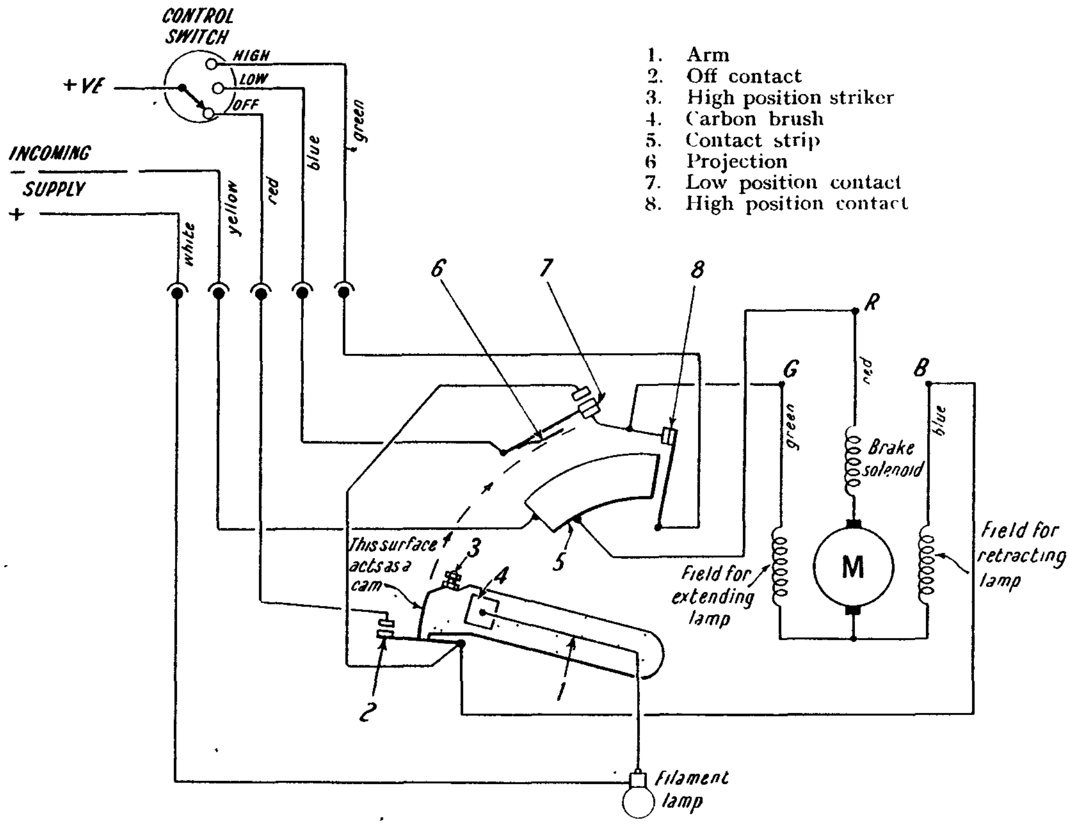


Fig. 5.—Circuit diagram of landing lamps, types J and K

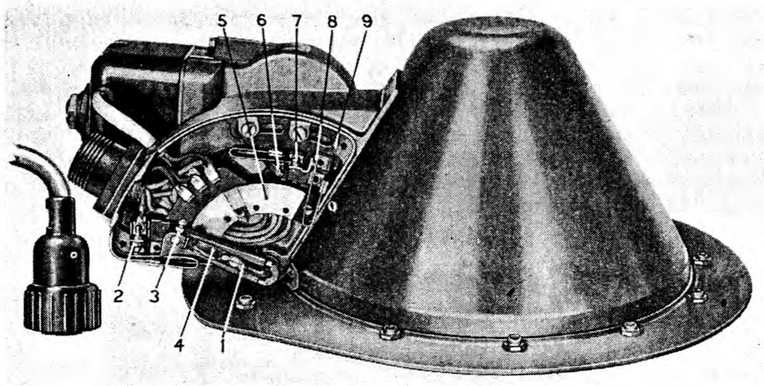
Leading edge types G, H, and American

15. The landing lamp types G and H are fitted with a mechanical control and, since they have an angle of cant, can be used for ground reconnaissance. In the type H lamp the upward limiting stop is fitted in the mounting bracket and the angle of cant may be varied between 25 and 45 deg. The angle is set initially at 35 deg. and is unlikely to require adjustment. In the case of the type G the stops may form part of the structure of the aircraft or may be fitted to the control. The American lamps have no control and differ from the British types in that the filament lamp is mounted from the back and louvres are fitted in order to make the lamp less noticeable from the air. The angle of offset of a landing lamp type G or H may be adjusted after slackening the fixing nut at the top of the mounting bracket.

16. The landing lamp, type G is shown in fig. 4 used in a right-hand position. In order to change a filament lamp the three screws (A) should be removed and the spider bracket swung back. The method of altering the upward limiting position will be different on different installations, a stop on the control lever being the usual method. In order to alter the angle of offset, slacken the nut on the stud (B) and twist the stirrup bracket. The beam with the smallest divergence, about 9 deg. and highest intensity is obtained when the white line on the lampholder is just showing. Beams of up to 11 deg. divergence but of progressively smaller intensity may be obtained by moving the filament lamp outwards.

17. The landing lamp, type H is also shown in fig. 4 in a right-hand position. In order to change a filament lamp, remove the three screws (A) and swing back the spider bracket. The upward limiting position may be controlled by slackening the screw (B) and sliding the stop to a

new position. The contro cable should be adjusted if necessary. In order to adjust the angle of offset, slacken the nut (C) and twist the stirrup bracket; to adjust the angle of cant, slacken the nut (C) and slide the block (D) to its new position.



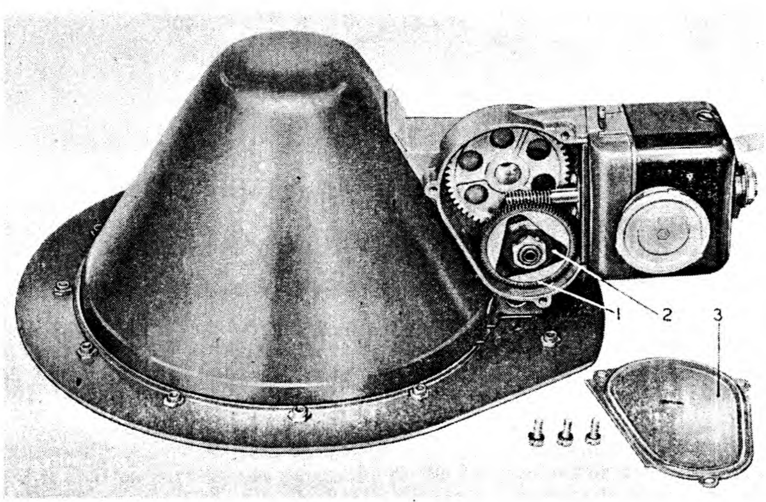
1. Arm
2. Off contact
3. High position striker
4. Carbon brush
5. Contact strip
6. Projection
7. Low position contact
8. High position contact
9. Mounting plate

Fig. 6.—Landing lamp, type J, showing switch mechanism

18. The beam of smallest divergence (about 9 deg.) and highest intensity is obtained when the white line on the lampholder is just showing. Beams up to about 12 deg. divergence but of progressively smaller intensity may be obtained by moving the filament lamp outwards.

Retractable types J and K

19. The retractable type of landing lamp has been introduced because it is becoming increasingly difficult to provide a window in the leading edge for the G and H type lamps, and it is intended that the J and K types shall ultimately be used for all types of aircraft. These types are retracted and extended electrically, and have the same operating unit, the reflectors being the same size as those in lamps types G and H. The electric motors used for the drive are series wound and fitted with an automatic brake.



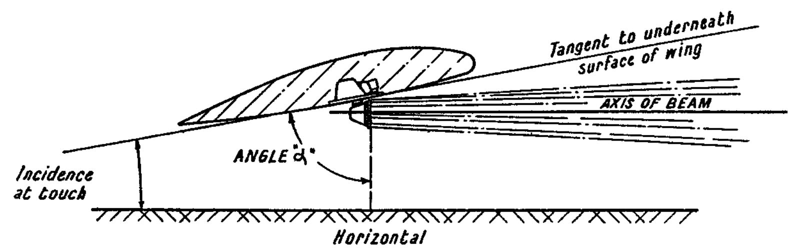
1. Driving wheel
2. Clutch
3. Cover plate

Fig. 7.—Reduction gear on landing lamp, type J

20. The operation of the lamp is explained with reference to the circuit diagram fig. 5 and the photograph fig. 6, the same reference numbers being used in each figure. When the lamp is not in use, the control switch is in the "off" position and the lamp is retracted flush with the underneath surface of the wing or fuselage. When the switch is moved to either the "low" or "high" positions, the lamp begins to extend. After about four seconds the filament lights up automatically and

about two seconds later the lamp reaches the position corresponding to the control switch position and stops. The "low" position is normally set at 7 deg. below the "high" position, but may be adjusted to any angle between 5 deg. and 9 deg. as explained in para. 25.

21. Fig. 6 is an illustration of the landing lamp, type J in the retracted position with the switch-box cover removed. In this position the contact (2), which is in the armature circuit of the motor, is open and the filament lamp is off. When the switch is placed in the "low" position, the circuit is made through the bottom contact (7), which is then closed, to the motor, and through the solenoid operated brake to the negative pole. The arm (1) of insulating material carries a carbon brush (4) which slides along until it reaches the copper contact strip (5) when the circuit to the lamp is completed. When, however, the arm reaches the projection (6) on the "low" contact (7), the motor field circuit is broken, the automatic brake operates and the movement of the lamp ceases. If the switch is now placed in the "high" position, the circuit is made to the motor via the contact (8). The arm thus continues to move up into position, the lamp contact still being made by sliding contact between the carbon brush and the copper strip (5). When the moving arm touches the arm of the contact (8), the motor circuit is broken and the lamp remains fixed.



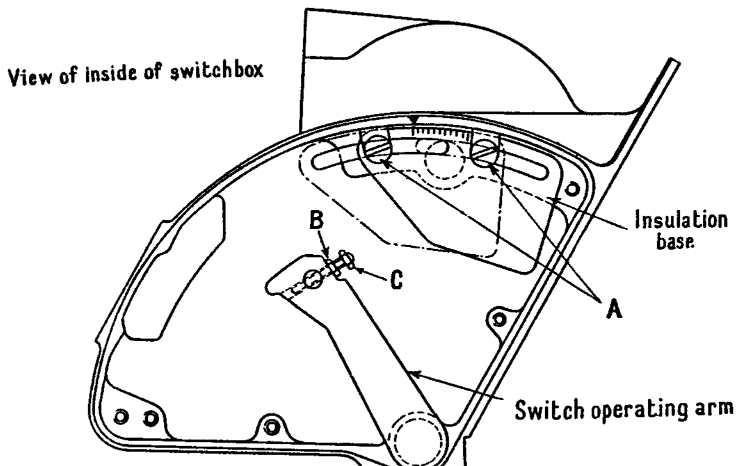
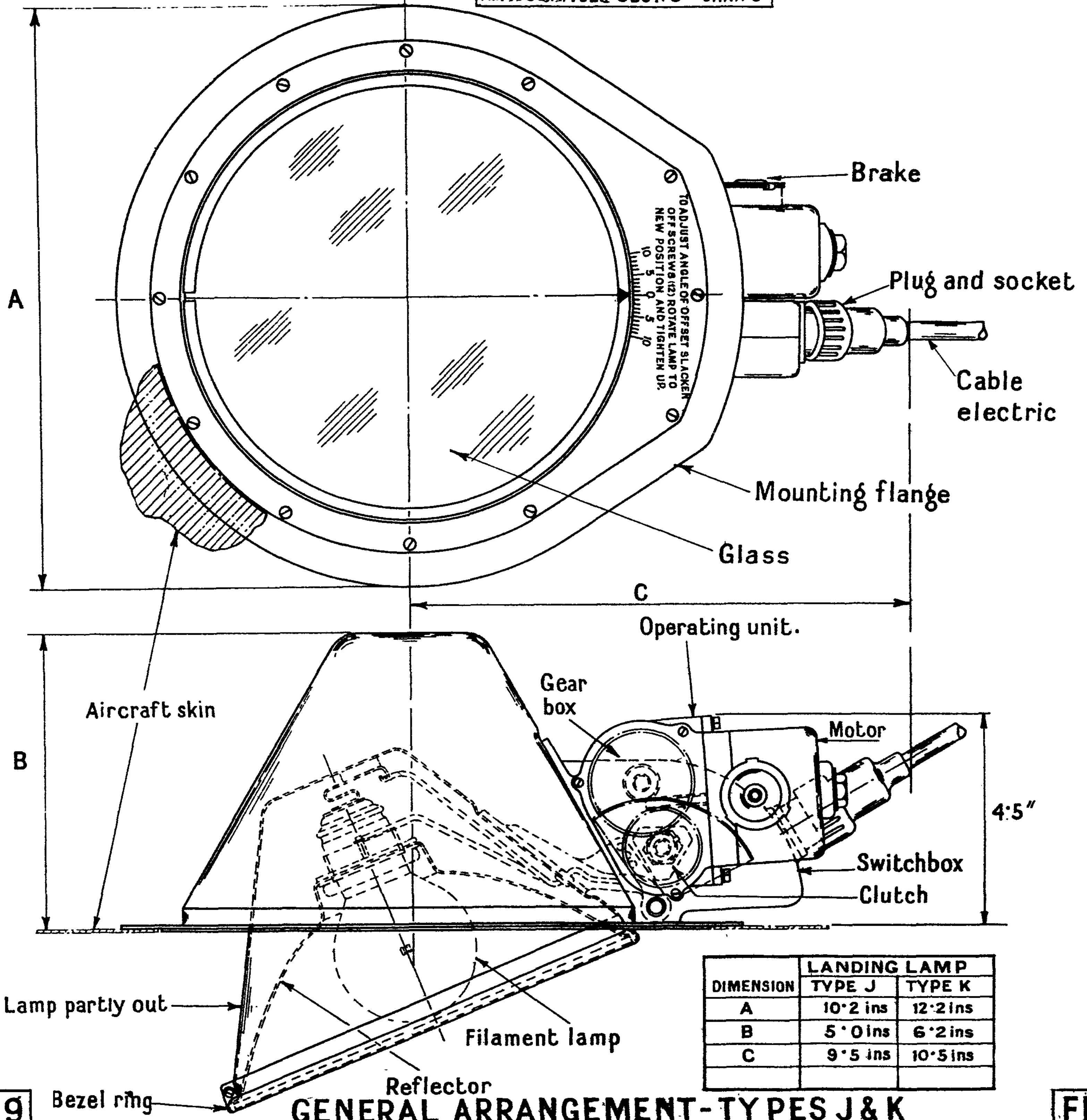


Fig. 8.—Method of achieving vertical adjustment on landing lamps, types J and K

22. When the switch is placed in the "off" position, the closing field of the motor is energized and the motor returns the lamp to the closed position, switching off the lamp when the brush leaves the copper strip (5). The motor supply is broken when the arm touches the contact spring and separates the contacts (2) thus arresting the movement of the lamp.

23. An illustration of the gearbox of the landing lamp, types J and K appears in fig. 7. It will be observed that a worm drive from the motor is transmitted to a bakelized fibre pinion and thence by means of reduction gearing to the lamp itself. A clutch (2) is provided so that if the lamp is switched on when the air speed of the aircraft is above 180 m.p.h., approximately, the clutch will slip and prevent large forces from acting in the wing structure The gearbox may be inspected after removing the cover plate (3).

24. As has already been mentioned, a brake operated by a solenoid is incorporated in order to prevent overrun of the motor. The brake plunger has a rubber pad which bears directly on the armature of the motor when the current ceases. The pad is attached to the armature of an electro-magnet, the solenoid of which is connected in series with the armature of the retracting motor of the landing lamps, so that when the motor is switched on the brake is automatically lifted off the motor armature.



DIMENSION	LANDING LAMP	
	TYPE J	TYPE K
A	10·2 ins	12·2 ins
B	5·0 ins	6·2 ins
C	9·5 ins	10·5 ins

FIG. 9 GENERAL ARRANGEMENT - TYPES J & K FIG. 9

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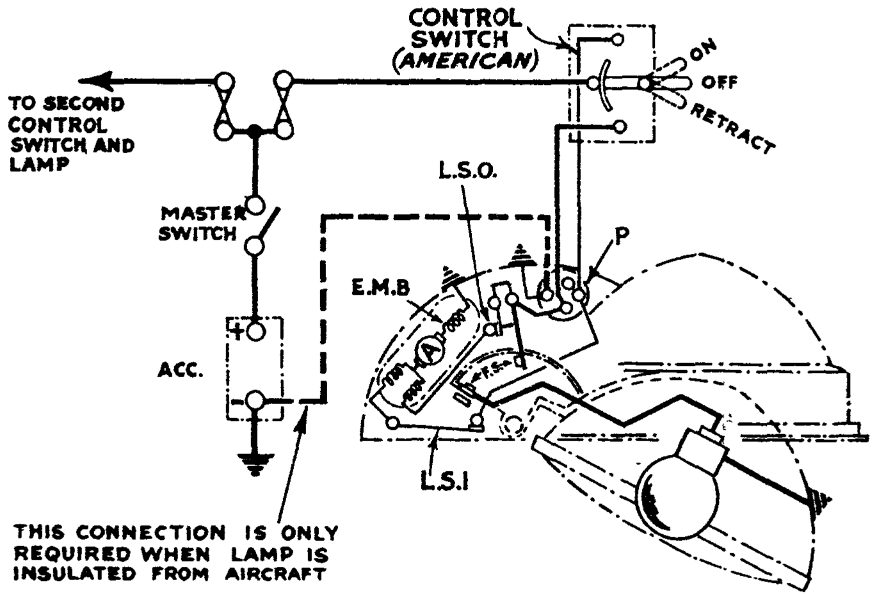
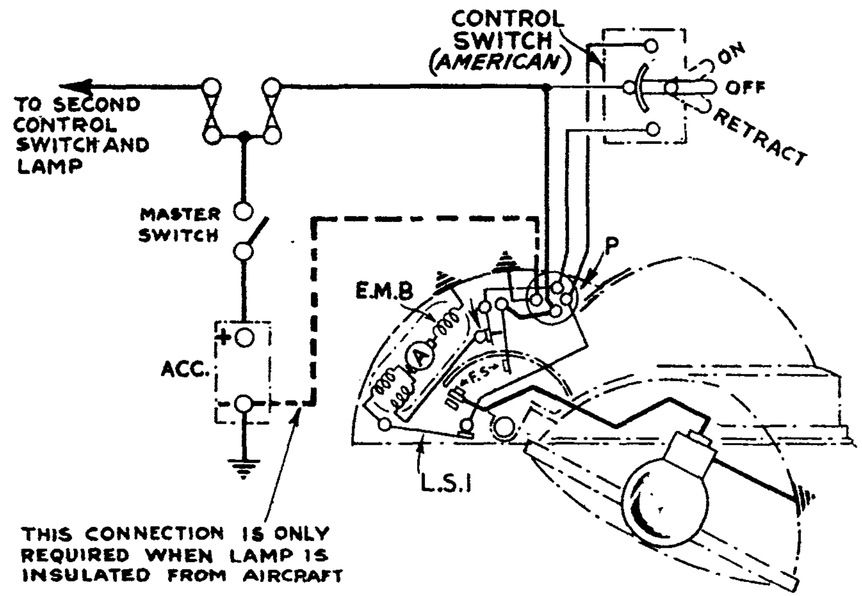
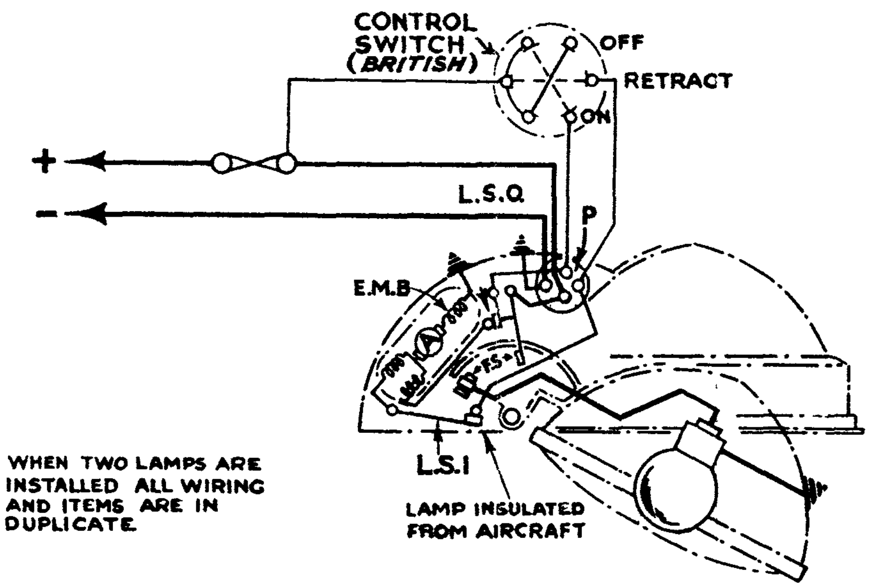


Ⓐ FILAMENT CIRCUIT BROKEN BY CONTROL SWITCH AND FILAMENT SWITCH (AMERICAN AIRCRAFT)



Ⓑ CIRCUIT BROKEN BY FILAMENT SWITCH ONLY (AMERICAN AIRCRAFT)



Ⓒ CONNECTIONS FOR BRITISH AIRCRAFT

DESCRIPTION

A ~ MOTOR ARMATURE	L.S.I ~ LIMIT SWITCH "IN"
E.M.B. ~ ELECTRO-MAGNETIC BRAKE	L.S.O ~ LIMIT SWITCH "OUT"
F.W ~ FIELD WINDINGS	M.S ~ MASTER SWITCH
F.S. ~ FILAMENT SWITCH	P.S. ~ PLUG & SOCKET
F. ~ FUSES	~ ~ ~ ~ ~

ONE CONTACT OF FILAMENT SWITCH IS ATTACHED TO, BUT INSULATED FROM, TOOTHED QUADRANT

THE ABOVE CONTACT DOES NOT MAKE CONTACT WITH "IN" LIMIT SWITCH.

FILAMENT LAMP IS REPLACED, AND ANGLE OF OFFSET IS ADJUSTED IN A SIMILAR MANNER TO TYPES J & K LAMP.

"OUT" LIMIT SWITCH IS MECHANICALLY COUPLED BUT INSULATED (EXCEPT BY WIRING) FROM FILAMENT SWITCH

FIG. 10 — METHODS OF CONNECTING GRIMES LANDING LAMP, TYPE ST. 1220 — FIG. 10

25. *Adjustments.* When undertaking adjustments of the beam in a vertical plane, reference should be made to fig. 8. In order to adjust the angle α, first remove the lamp from the aircraft by taking out the twelve fixing screws and disconnecting the plug. Next remove the moulded cover over the switchbox and make the adjustment by slackening the two screws (A) and moving the insulated base to the new position. The range of movement permits the angle α to be adjusted to any value between 73 deg. and 85 deg. After making the adjustment all screws should be tightened up securely.

26. The angular adjustment between the "low" and "high" positions is set at 7 deg. but it may be adjusted between 5 and 9 deg. by screwing the striker pin (C) out or in respectively. After making any adjustment, the striker pin must be locked by tightening the nut (B).

27. The method of adjusting the angle of offset is clearly indicated in fig. 9, which also shows the general arrangement of the lamps, types J and K. The angle of offset is adjusted by slackening the innermost ring of fixing screws and twisting the lamp bodily with respect to the mounting plate.

28. *Contacts.* The various contacts in the retractable lamps should be inspected and cleaned periodically. It is important to ensure that all the adjusting nuts are tight and where the lamp is fitted with a plug and socket, the soldered connections should be inspected periodically.

Grimes model ST.250

29. The Grimes model ST.250 is an early type of electrically retractable lamp, but is still fitted to some types of American aircraft. It is not provided with any means for adjusting the setting of the beam. The outline of the lamp and the wiring diagram are shown in fig. 11 from which it will be observed that the earth return system of wiring is used. It is not fitted to any types of aircraft with 24-volt electrical systems. In this lamp the retraction is effected by a series wound motor and a train of gears, the operation of the contacts being achieved by rotating cams.

Grimes model, ST.1220

30. The Grimes landing lamp, model ST.1220 is a more recent and larger development of ST.250, and, although originally designed for aircraft wired on the earth return system, it has been used on some British types of aircraft. A two-field series wound electric motor with an electro-magnet brake is used to extend and retract the lamp, and the contact arrangement and method of adjustment are similar in principle but not in detail to those of the landing lamps, types J and K. The filament lamp is also replaced in a similar manner to the types J and K. The diagrams in fig. 10 indicate the alternative methods of wiring which have been used with this type of lamp.

Filament lamps

31. There are two sets of British filament lamps, one set rated at 10 and 22 volts for use on aircraft with the self-regulating voltage system, and the other set rated at 12 and 26 volts for use on aircraft fitted with the carbon pile regulators. In American aircraft the voltage regulating system approximates closely to the carbon pile system. The wattages and reference numbers of the filament lamps are as follows:—

Type of landing lamp	*Watts*	*Filament lamp reference numbers*			
		12 volts nominal		*24 volts nominal*	
		Self Reg.	*Carbon pile*	*Self Reg.*	*Carbon pile*
E and G	240	5L/1818	5L/2372	5L/1815	5L/2345
H and K	350	5L/1819	5L/2345	5L/1817	5L/2344
J		None	None	None	5L/ or 10SL/10
Grimes ST.1220— Small American leading edge	240	None	105L/34	None	105L/10
Large American leading edge	350 or 420	None	5L/2343 or 105L/75	None	5L/2344 or 105L/13
Grimes ST.250	180	None	105L/12	—	—

Servicing

Filament lamps

32. The wattages of the filament lamps are very high for their size, and the heat may occasionally cause cracking of the glass seals after the lamps have been in service for a time. This does not cause immediate failure, but when the lamp is switched off, a small quantity of air is drawn into the bulb as it cools, and when the lamp is next switched on this air oxidises the filament and a streak of white tungsten oxide is deposited on the bulb above the filament. The bulbs should therefore be scrutinised at frequent intervals and the lamps replaced as soon as traces of white oxide become visible.

33. The bulbs blacken progressively throughout their life and the filaments may sag slightly but they should last for at least 1,000 landings. All the filament lamps, except that with Stores Ref. 105L/12, have prefocus caps and no adjustment to the focus is necessary after changing a lamp.

Reflectors

34. Anodised aluminium is now used for the reflectors and the reflectivity, even in sea-going aircraft, falls off very little with time. If the reflectors become dusty or dirty, they may be wiped with an ordinary cloth, or washed with water and soap containing no free alkaline.

Mechanical controls

35. The usual attention should be given to mechanical controls to ensure that the control wires do not become slack. After adjusting the tension, a check should be made to see that the beam setting is still correct.

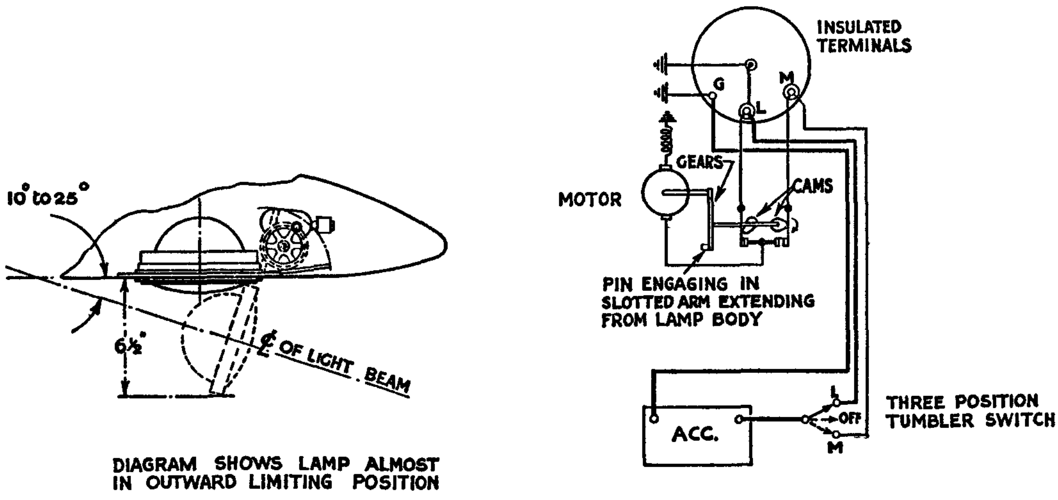


Fig. 11.—General layout and circuit diagram of Grimes landing lamp, type ST.250

Electrically retractable lamps

36. The motors are the most likely cause of failure in these lamps. In the event of this occurring, the whole lamp should be detached for examination by removing the fixing screws, dropping the lamp down and disconnecting the plug. If the fault cannot be repaired, the lamp should be returned to maintenance unit. In the case of the landing lamp, type J, a blanking plate (Stores Ref. 5C/1518) is available. The clutch and brake mechanisms must not be interfered with but the contacts may be adjusted in the manner laid down in the previous paragraphs. They should also be cleaned occasionally.

37. In the case of the Grimes lamp, model ST.1220, fitted to British aircraft, it should be remembered that the body of the lamp is "live" and care should be taken when fitting other apparatus to ensure that no part of this touches the body of the lamp.

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CHAPTER 10

IDENTIFICATION LAMP, Type D

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LIST OF ILLUSTRATIONS

Introduction

1. The identification lamp, type D, is intended for use in aircraft for signalling purposes, and it is so designed that, by fitting a filament lamp of the correct wattage, it is suitable for either

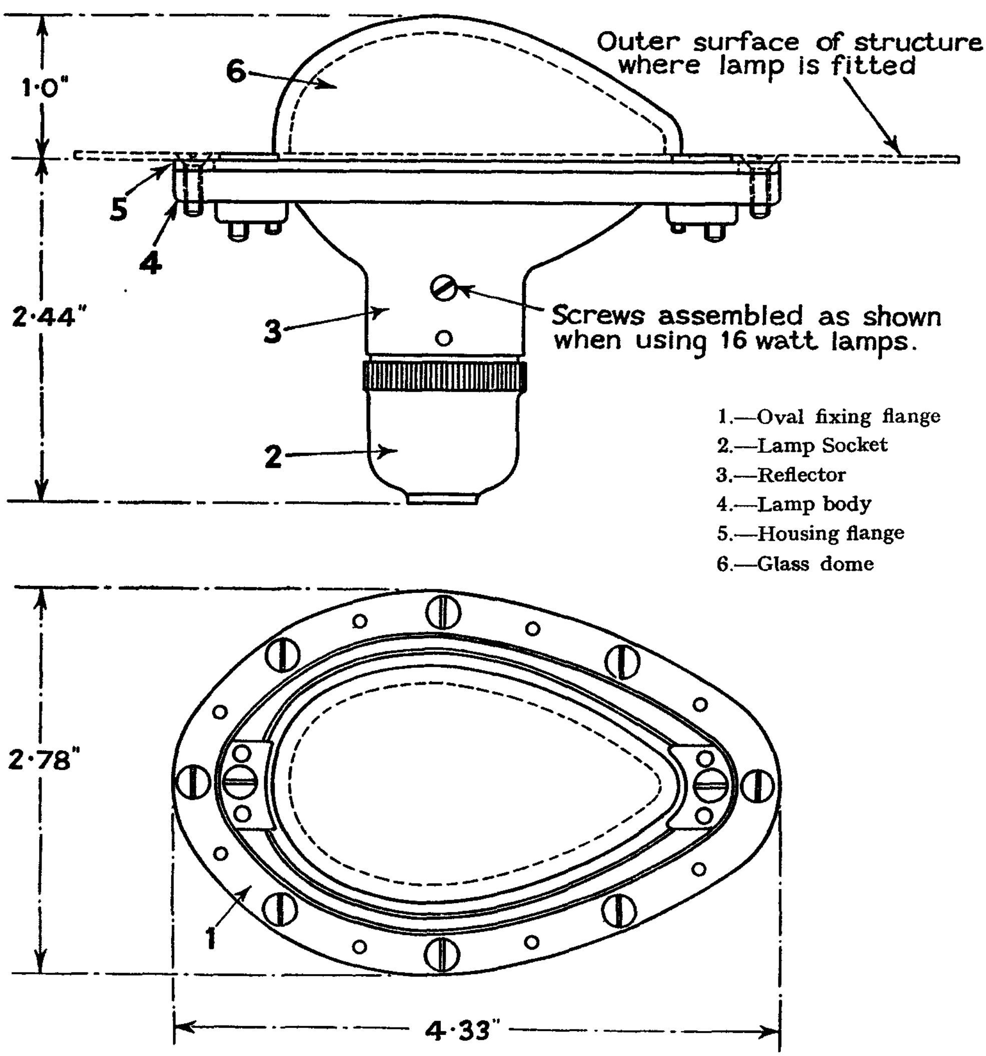

Fig. 1.—Identification lamp, type D

upward or downward identification. By means of appropriate switching, the aircraft may use a steady light or signal in code, and the colour of the light may be varied by changing the glasses on small aircraft or by the use of more than one lamp on large aircraft. The lamp is normally used for upward identification by the Fleet Air Arm, and on certain types of D.R.s in use with the Fleet Air Arm.

Types Available

2. The following identification lamps and accessories are available.

Identification lamp, type D	Clear	Stores Ref. 5C/914
	Red	Stores Ref. 5C/912
	Green	Stores Ref. 5C/909
Spare glasses	Clear	Stores Ref. 5C/910
	Red	Stores Ref. 5C/915
	Green	Stores Ref. 5C/913
Filament lamps	12 v. 16 w.	Stores Ref. 5L/1449
	12 v. 30 w.	Stores Ref. 5L/1149
	24 v. 16 w.	Stores Ref. 5L/1697
	24 v. 30 w.	Stores Ref. 5L/1698
Reflectors	Aluminium	Stores Ref. 5C/909
Lamp holders	Bakelite	Stores Ref. 5C/793
Washers	Langite	Stores Ref. 5C/911

DESCRIPTION

3. An illustration of the lamp, which is streamlined, is 4·33 in. long, 2·78 in. wide, 2·83 in. high and weighs 4 oz. is given in fig. 1. The lamp socket (2) is constructed of moulded composition, is of the standard spring loaded plunger type and is a sliding fit in the frosted aluminium reflector (3) to which it is secured by two 6 B.A. round head screws. Two pairs of fixing holes are provided in the reflector enabling the holder to be fixed in alternative positions, so that a 16-watt filament lamp can be used for upward, or a 30-watt filament lamp for downward identification. In the illustration, the holder is shown assembled for use with a 16-watt lamp for upward identification. When used with a 30-watt lamp for downward identification, the two round head fixing screws should first be removed, the lamp socket should then be moved until the second pair of holes in the reflector are opposite the two tapped holes in the socket, and the screws replaced. The reflector is fitted to the body of the lamp (4) and is secured at its ends by two 6 B.A. countersunk screws. The glass dome (6) is held in a housing flange (5) of aluminium by two metal clips and the joint is made waterproof by means of a plastic compound thereby also avoiding strain on the glass. The glass mounting flange is screwed to the body of the lamp by two 6 B.A. countersunk screws, a langite washer being fitted between the body and the flange to render the joint watertight. The complete lamp assembly is fitted to an oval fixing flange which is shown at (1).

INSTALLATION

4. For upward identification, the lamp is fixed in any convenient position on the upper surface of the aircraft, it should be as clear of obstruction as possible, and be visible from any point above the level of the aircraft. The downward lamp is fixed on the lower surface of the aircraft and should also be free from obstruction. Only the glass dome projects below the surface of the airframe, the body of the lamp being contained within the airframe. The mounting flange is fitted inside the structure of the plane and secured with eight $\frac{3}{32}$ in. countersunk rivets, and the lamp is screwed to the flange with the eight 4 B.A. countersunk screws provided. Should it become necessary to fit a new lamp socket, the locating key on the body of the socket should be removed before attempting to insert the socket in the reflector.

OPERATION

5. An identification switchbox, mounted in a position convenient to the operator, is used for controlling the lights. By this means the upwards and downwards identification lamps may be used to give a steady light together or singly, or be operated together or singly by a morse key. Clear, green, or red glasses may be fitted to individual lamps on small aircraft, and for larger machines three lamps may be mounted together, so wired that they can be used individually or in any desired combination. When viewed from a point vertically below the aircraft the range of the downward identification lamp is as great as is normally likely to be required; but the horizontal distance, or plan range for reliable signalling is limited to about 2½ miles for clear glass, the range being reduced when using coloured glasses. The range at which signalling can be carried out with the upward identification lamp will depend on the angle of elevation of the observer and will be less when using coloured glass than with clear. These distances will vary according to the prevailing visibility, and a signalling speed in excess of eight words per minute is inadvisable when signalling in code.

SERVICING

6. The correct operation of the lamps should be checked before each flight, and the lamp socket connections should be inspected periodically. The filament lamps should be renewed before they are completely burnt out, and should they show any signs of blackening they should be replaced with bulbs of the correct voltage and capacity.

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CHAPTER 11

COLOURED RESIN RECOGNITION LAMPS, Types A and B

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LIST OF ILLUSTRATIONS

Introduction

1. When flying at night, aircraft must be equipped with some means of formation-keeping and identification that is visible to other aircraft at approximately the same level, but invisible from the ground. Coloured recognition lamps, types A and B, sometimes known as "Resin" lamps, are designed for this purpose.

Types available

2. The following table gives a list of the accessories and spare parts available.

Recognition lamp, type A	Less filter screen	Stores Ref. 5C/1914
Recognition lamp, type A	With clear screen	Stores Ref. 5C/918
Recognition lamp, type B	With blue screen	Stores Ref. 5C/803
Filter screens	Red	Stores Ref. 5C/1917
	Green	Stores Ref. 5C/1916
	White	Stores Ref. 5C/1918
Adapter	For type B lamp	Stores Ref. 5C/1919
Lamp socket	Bakelite	Stores Ref. 5C/793
Filament lamp	4 watt 12 volt	Stores Ref. 5L/2075
	4 watt 24 volt	Stores Ref. 5L/2076

DESCRIPTION

Type A

3. An illustration of the type A lamp, which is 2·75 in. long, 1·18 in. in diameter, and weighs 2 oz. is given in fig. 1, and fig. 2 shows the range of visibility of the lights together with the position in which they are mounted on the aircraft. A bakelite lamp socket (2) of the standard spring loaded plunger type is employed, the skirt being drilled and tapped at diametrically opposite points to take two 6 B.A. fixing screws for securing the fitting to the airframe (4). The brass filter screen holder (5) fits over the lamp socket to which it is attached by two 6 B.A. countersunk screws (3). The filter screen (7) is a sliding fit in its holder, and has three small raised punchings which engage behind the recessed end of the holder and act as a snap fastening. A raised portion (6) fits into a slot cut in the holder, thus ensuring assembly in one position only. The glass is secured by a circular spring clip which fits into a groove in the end of the filter screen (1).

Type B

4. The coloured recognition lamp, type B, is a modification of the formation-keeping lamp, type B (Stores Ref. 5C/803), and is used on existing types of aircraft, new types being fitted with the type A lamp described in the preceding paragraph. To convert existing lamps, it is necessary to remove the blue glass dome and the screen cap by withdrawing the two 6 B.A. fixing screws and substituting a metal adaptor and a filter cap similar to that used with the type A lamp, after which the fixing screws should be replaced. The 6-watt filament lamp should also be removed and replaced with a 4-watt lamp of the correct voltage.

5. The lamps are mounted on the trailing edge of the wing tip, either externally, or behind transparent windows in the position indicated in fig. 2. The angular range of visibility may also be seen in this illustration, and the lamps are so positioned that obstruction by the air-frame is reduced to a minimum. Two holes, tapped to take 6 B.A. screws, and situated on either side of the lamp socket, are used for securing the type A lamp to the aircraft. When this method of fixing is employed, care should be taken to see that the fixing screws do not project through the skirt of the lamp socket, or difficulty will be experienced when inserting the filament lamps.

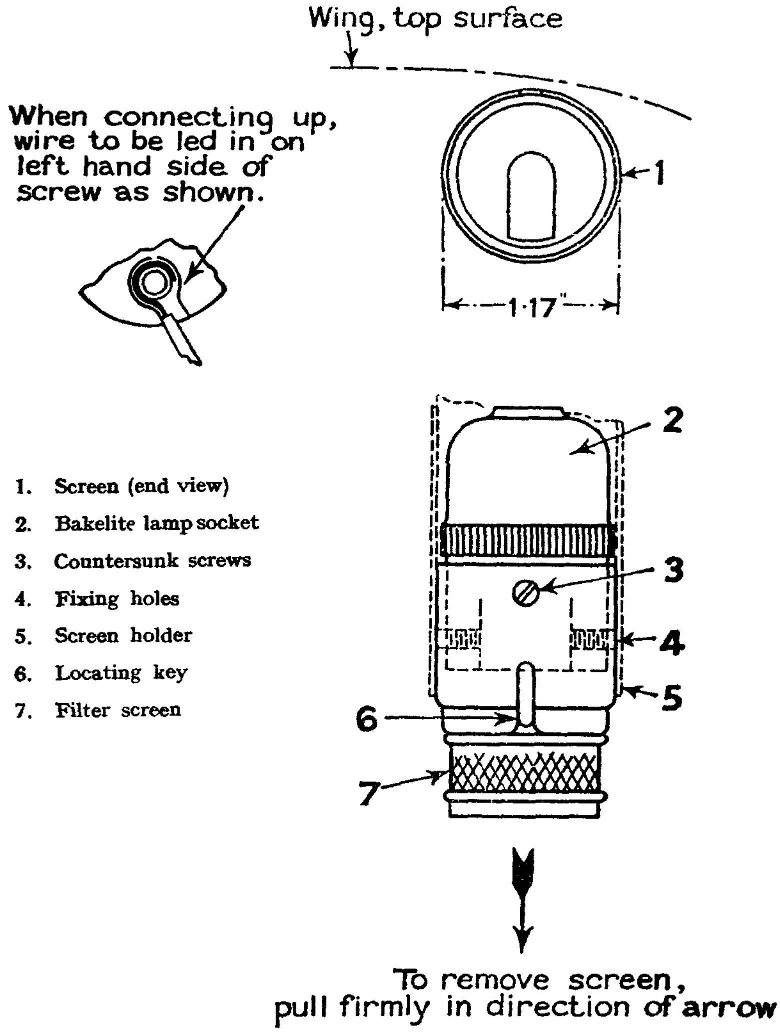

Fig. 1.—Resin lamp, type A

6. With the coloured recognition lamp, type B, the bracket with which the old formation-keeping lamp, type B, is equipped is still retained, and the method of fixing will remain the same Where this lamp is fitted externally, care should be taken to see that all sharp corners are removed on the cable entry holes. There is one lamp fitted in each wing tip on small aircraft, positioned as shown in fig. 2, and as three screens, clear, red, and green are required for each lamp, stowage will be needed for the screens that are not in use. Stowage boxes for filter screens are provided in which the spare screens can be kept and these should be mounted in a convenient position, two holes to take 4 B.A. fixing screws being provided for this purpose. Larger aircraft have three lamps mounted on each wing.

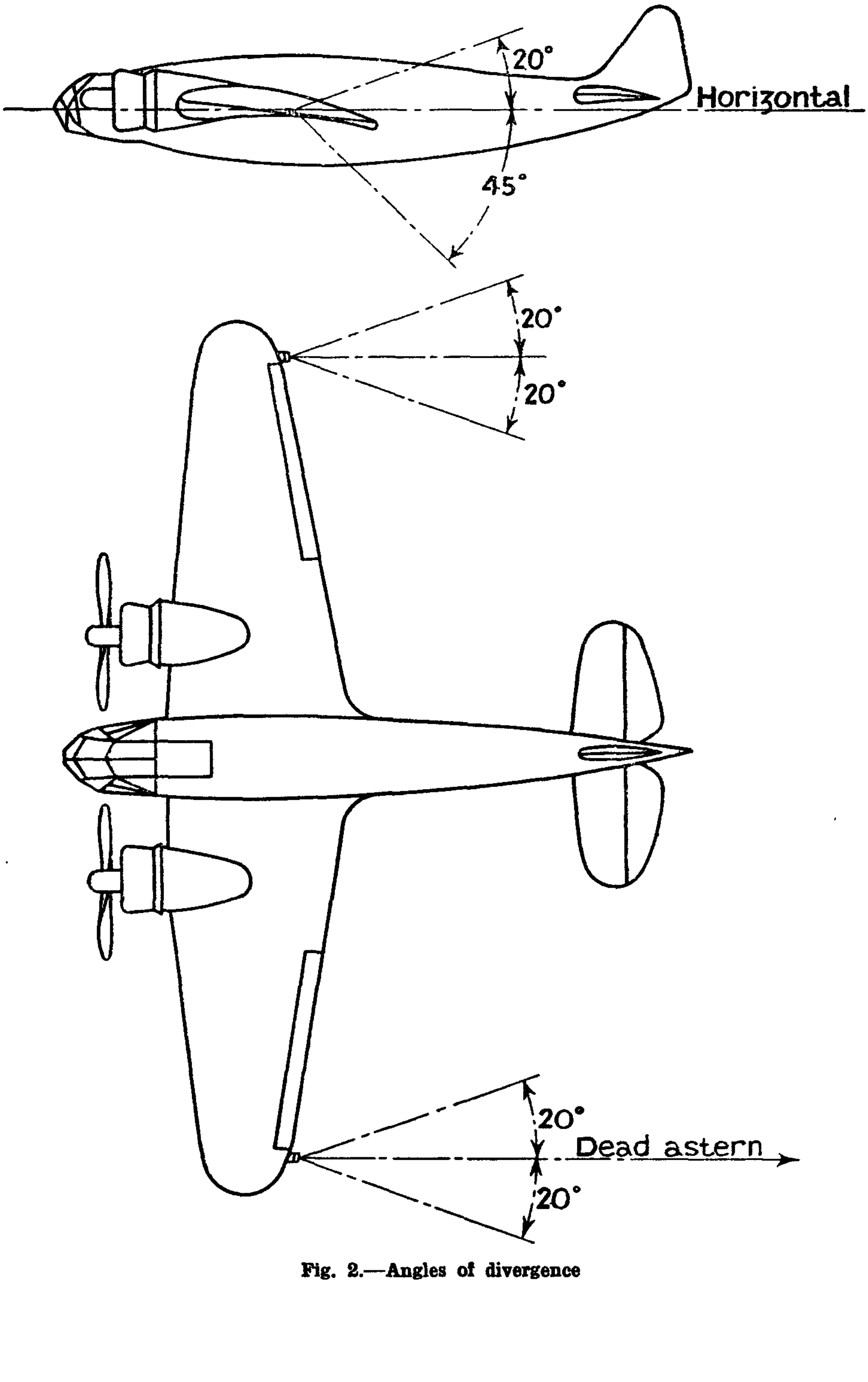

Fig. 2.—Angles of divergence

OPERATION

7. A switch box, type B, is used for controlling the lamps, and by use of the appropriate screen, a clear or coloured light may be shown or, on aircraft where three lamps are fitted on each wing, the desired colour may be selected by means of a selector switchbox, type A, the circuit being so wired that only one colour can be employed at a time.

SERVICING

8. The operation of the lamps should be checked by switching them on and ascertaining that they light and the glasses and bulbs should be kept clean. Access to the filament lamp is obtained by removing the filter screen, and the lamp should be replaced when the glass shows signs of discolouration. The lamp socket plungers must be kept clean and should show no signs of sticking.

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CHAPTER 12

ULTRA-VIOLET INSTRUMENT LIGHTING EQUIPMENT USING MERCURY VAPOUR DISCHARGE LAMPS

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LIST OF ILLUSTRATIONS

Introduction

1. In the ultra-violet system of instrument panel lighting, the markings on the instruments are made with a special paint (paint, fluorescent, type N) which gives off an orange glow, i.e. fluoresces, when it is irradiated by ultra-violet radiation. The ultra-violet radiation is obtained from a 24-volt. mercury vapour discharge lamp. This lamp produces both visible light and invisible ultra-violet radiation, but the visible light is excluded by means of a black glass ("Woods" glass) filter which passes the ultra-violet radiation only.

2. Ultra-violet systems of instrument lighting have been introduced to overcome the disadvantages of the self-luminous compound used for instrument markings. The chief disadvantages of the luminous compound are as follows:—

(i) The bluish green light radiated by the compound does not enable the markings to be sharply focussed, the effect being as though the markings were floating in space. The continual effort to obtain a sharp focus is a possible cause of eye strain and fatigue.

(ii) The self-luminous markings are too bright for dark nights and cannot be dimmed to extinction. This makes it difficult for the pilot's eyes to remain accustomed to the dark.

(iii) When looking out of the cockpit, both the markings and their reflections can be seen in the "tail of the eye" and are very distracting.

3. Owing to their orange colour the fluorescent markings used with ultra-violet lighting systems can be sharply focussed, and the distracting effect of the markings and their reflections is considerably reduced. In any case, the brightness of the markings can be reduced to zero at will, since the lamp source of ultra-violet radiation is provided with a shutter as explained in para. 12.

DESCRIPTION

4. A complete equipment consists of the following items:—

(i) Four cockpit lamps (Stores Ref. 5C/1878).

(ii) One resistance box (Stores Ref. 5C/1879).

(iii) One push button, with partial screening (Stores Ref. 5C/1880).

(iv) Screen (Stores Ref. 5C/1956) as required.

(v) Discharge lamp, 24 v. (Stores Ref. 5L/40).

A lamp, the resistance box and the push-button are shown in fig. 1. The latter item is a standard push-button (Stores Ref. 5C/998) secured within a light alloy mounting shell for screening purposes. All components are provided with gland nuts and sleeves for use with metal-braided cable.

5. Additional standard equipment, which is required for the complete installation, is as follows:—

(i) Suppressor, type P (Stores Ref. 5C/1002).

(ii) Switchbox, type B (Stores Ref. 5C/543).

(iii) Fuse box, type A (Stores Ref. 5C/445).

(iv) Fuse, type B, 10 amp. (Stores Ref. 5C/463).

(v) Cable, trimet 4 (Stores Ref. 5E/1351)
(vi) Cable, dumet 7 (Stores Ref. 5E/1348)
(vii) Cable, ducel 7 (Stores Ref. 5E/1363)
} quantity as required.

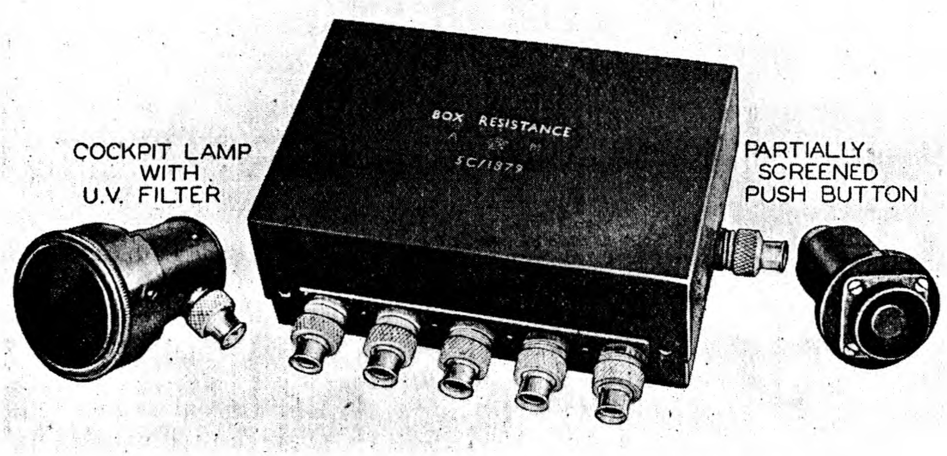


Fig. 1.—U.V. lighting equipment (with Mercury vapour lamps)

6. The mercury vapour lamps are supplied from the 24-v. aircraft battery. The filament consumes approximately 0·7 amp. at 2 volts. This is obtained by using a 30-ohm resistance in series with the battery. The striking voltage for the lamp is 24 v. but to limit the current, which would otherwise be excessive, a stabilizing resistance of 24 ohms is used in series with the anode. The anode current is approximately 0·7 amp.

7. The theoretical wiring diagram for the complete installation is shown in fig. 2. The resistance box provides for a maximum of four lamps. A suppressor, type P, is used in series with the supply leads and the whole system, with the exception of the face of the push-button, is completely screened to prevent interference with the aircraft radio equipment.

8. To start the lamps the main switch (switchbox, type B) is closed and the push-button depressed. This heats the filaments and vaporizes the mercury contained in the discharge tube. Once the discharge between anode and cathode (filament) has started, the filament circuit can be broken by releasing the press-button.

Lamp

9. Details of the lamp are shown in fig. 3. The mercury vapour tube is provided with a small bayonet cap. The filament is connected to the two insulated electrodes and the anode to the metal shell. The lamp holder is insulated from the body of the lamp and is provided with three terminals. A view of the terminal block is included in fig. 5.

FIG. 2

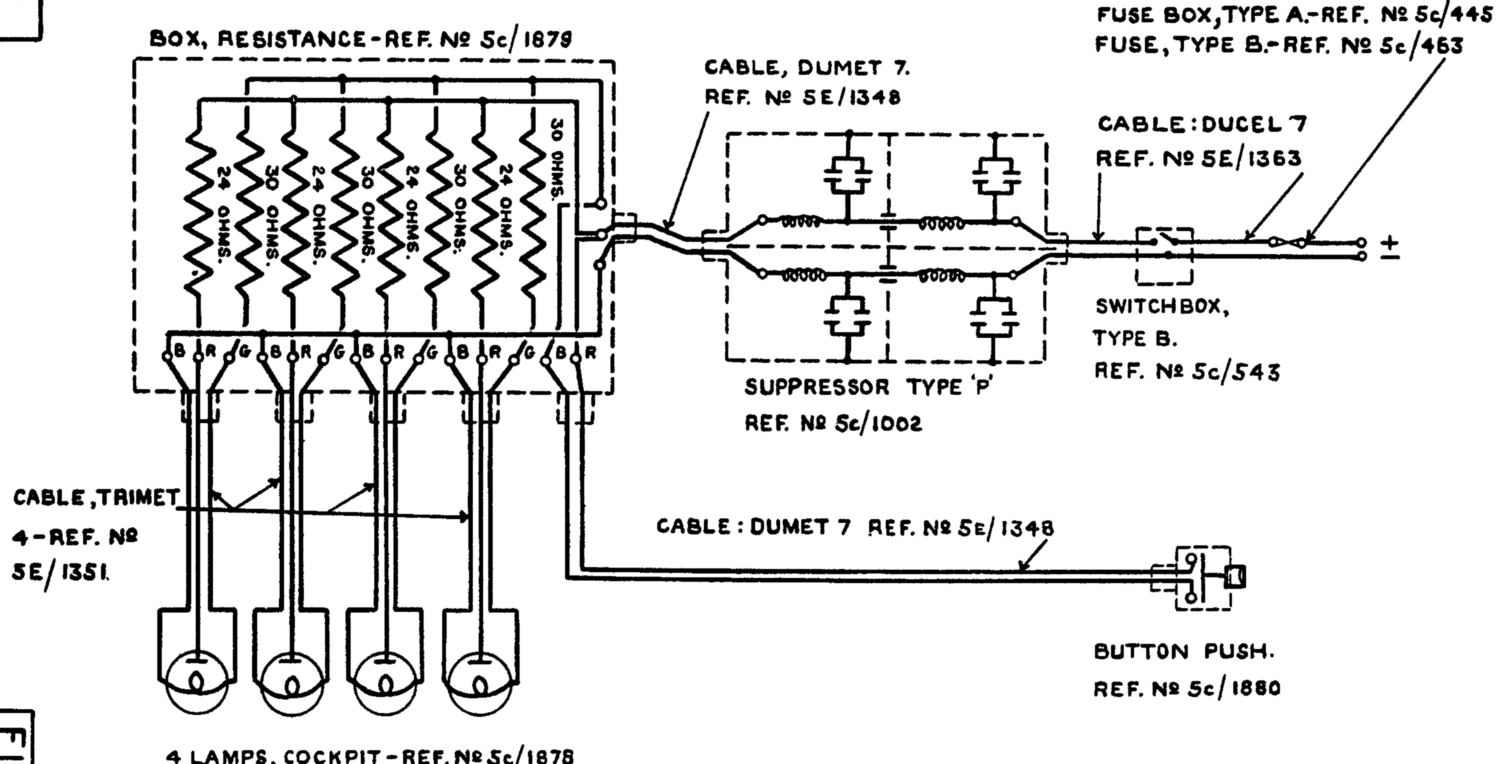
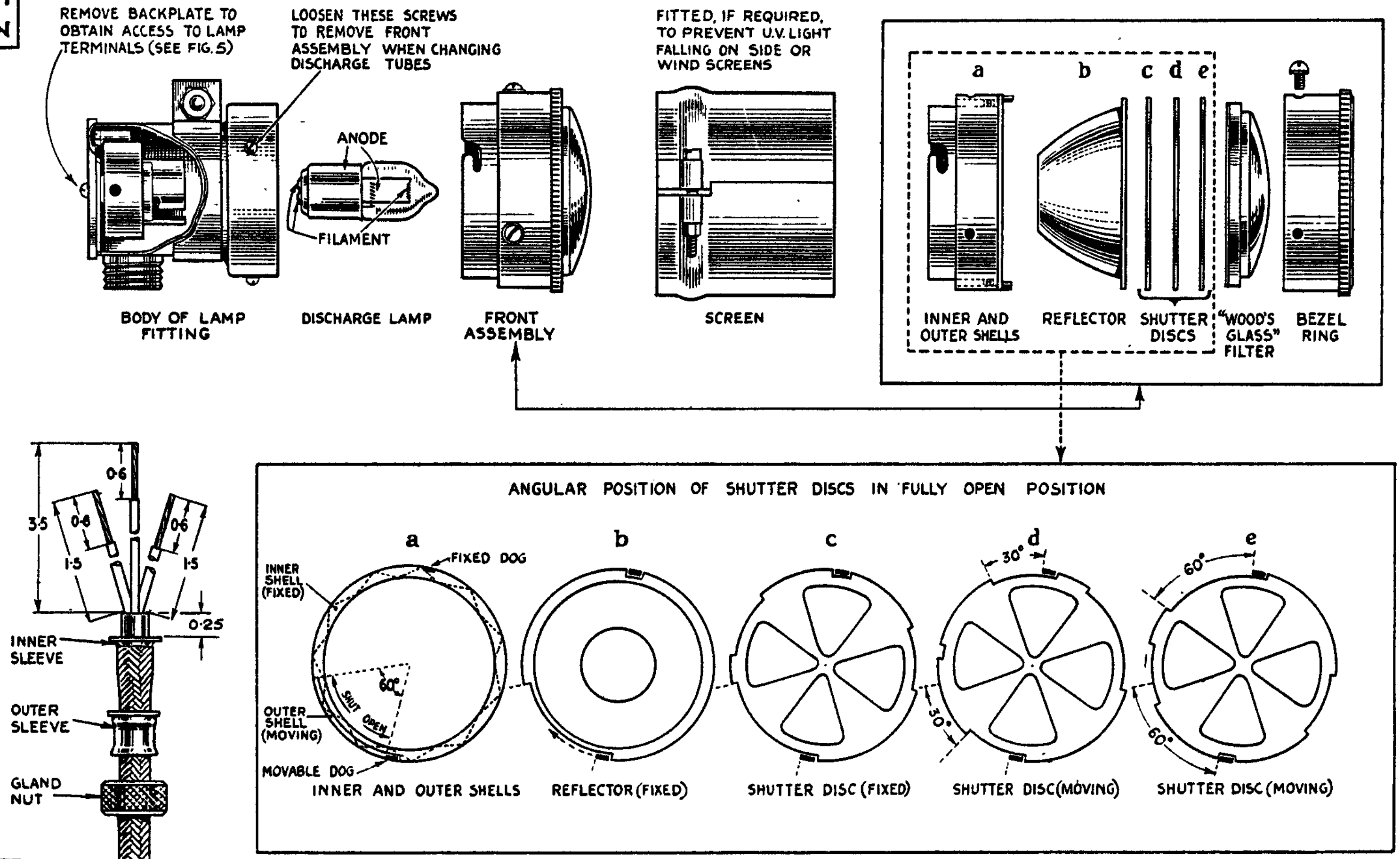


FIG. 2

THEORETICAL CIRCUIT DIAGRAM

FIG. 3



DETAILS OF LAMP

FIG. 3

10. Access to the terminals is obtained by removing the cover plate and the bakelite terminal housing plate from the rear of the lamp. The terminal housing is most easily removed by pushing it through from the front of the lamp. When assembling the leads to the terminals, care should be taken to ensure that the loop in the wire follows the screw rotation.

11. The front of the lamp is secured to the body by means of three screws engaging with bayonet slots. To remove the front for the purpose of changing the discharge lamp the three screws should be slackened off a few turns only.

12. The component parts comprising the front assembly of the lamp are shown in the inset sketches in fig. 3. The reflector and the shutter discs are held in position between the filter glass and the shells by means of three screws inserted through the bezel ring and engaging with the outer shell. The lamp shutter is opened by turning the lamp front in a counter-clockwise direction and closed by turning it in a clockwise direction. In the closed position, light is completely shut off. The three assembly screws should not be removed provided that the shutter is functioning correctly.

13. The inner and outer shells shown at (a) in the insets in fig. 3 are of the relative diameters shown. They are spaced by a split ring of rectangular section, which is located between the two shells and receives the three assembly screws. This ring rotates with the outer shell. A circular spring with zig-zag contours (*see* (a) in lower inset) is enclosed in the annular space between inner and outer shells. In its assembled position, the undulations in the spring are under slight compression to provide additional friction between the two shells.

14. The shutter discs are thin metal stampings of the form shown. They are assembled in the order shown in the insets in fig. 3. The reflector (*see* fig. 3) and the three discs are provided with locating slots and clearance slots as shown. In the "fully-open" position the correct angular relationship of the discs is shown in the lower inset. This diagram is provided to enable a correct re-assembly of the discs to be made after dismantling. The inner, or fixed, shell has a dog which locates the reflector (b) and the first disc (c). The outer, or moving, shell also carries a dog which locates the disc (e), and also the disc (d) while the two shells are in the "fully-open" position.

15. The action of the shutter is as follows. When the bezel ring is rotated the lower dog in the illustration moves through 60 deg. This causes the disc (e) to rotate through 60 deg. The disc (d) does not rotate until the dog has moved through 30 deg. when, as can be seen, the dog engages with the shoulder at the end of the clearance slot and carries the disc round until the upper dog (on the fixed shell) abuts against the "trailing" shoulder of the upper slot in the disc. The effect of the rotation of discs (d) and (e) is that the "trailing" halves of the apertures in disc (c) are covered first by disc (e) and then by the disc (d), when the disc (e) rotates further to cover the "leading" halves of the apertures.

16. The shutter assembly should not be dismantled, normally, but if this is necessary the items should be reassembled in the order shown in fig. 3. It will be appreciated that each disc is a similar stamping of sheet metal, the cut-away portions in some cases being redundant. For the shutter to function they should, however, be assembled in the relative angular positions shown in fig. 3. The disc (e) which turns through 60 deg. should be adjacent the filter glass to avoid friction between the shutter disc and the paper washer on the inside edge of the filter glass.

Screen

17. The screen is not normally fitted, but in any particular installation, if trouble is experienced with fluorescence of components, such as wind or sidescreens, it should be clamped over the bezel ring to restrict the divergence of the ultra-violet radiation.

Resistance box

18. The resistance box, with cover removed, is shown in fig. 4, the terminal arrangements also being shown in fig. 5. It houses four 30-ohm and four 24-ohm resistance units of nichrome wire wound on flat "mycalex" formers. Terminals for wiring are provided as shown. The box itself is of brass and provides a screen for the contents. Fittings, similar to those on the lamp, are provided for the metal-braided covering of the cable used for wiring purposes.

INSTALLATION

19. The installation is given in Vol. I, Sect. 6 of the appropriate aircraft handbook. The wiring is shown in fig. 5. At present this lighting system is in use on "Mosquito" F. Mk. II aircraft, some "Fulmar" aircraft and "Beaufighter" aircraft.

SERVICING

20. The only servicing normally required is the renewal of the mercury discharge lamps if they are faulty. It may be necessary to add a little grease anti-freezing (Stores Ref. 34A/49) to the rotatable shells of the shutter mechanism should they be stiff in operation. The whole assembly can be dismantled after the three short screws holding the bezel ring have been removed. When re-assembling ensure that the shutter is functioning correctly (see paras. 12 to 16).

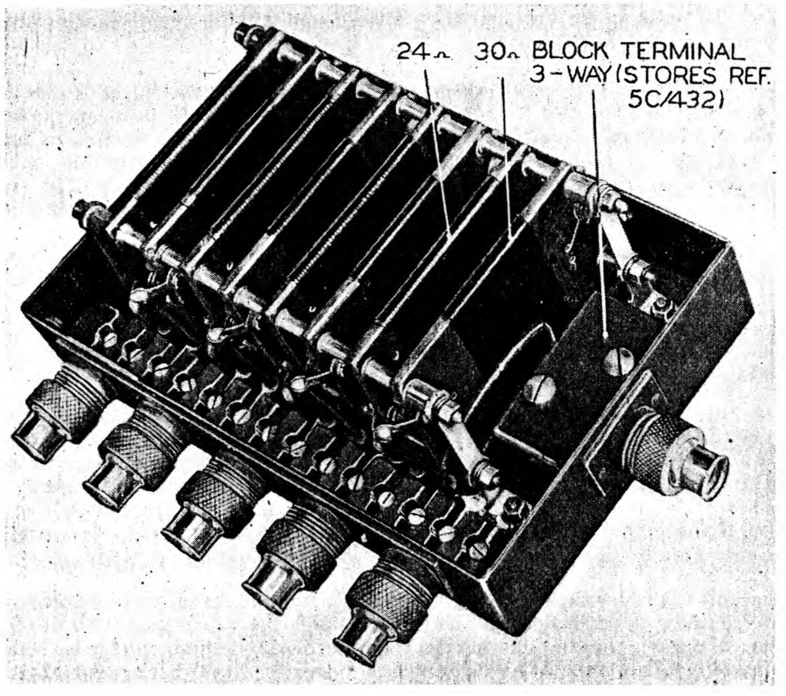


Fig. 4.—Resistance box with cover removed

21. Spare mercury-vapour lamps *should not be tested on a 24-V. battery.* It should be remembered that although the lamp cap is marked "24 v." the filament is designed to function in series with a 30-ohm resistance and that the actual filament potential is approximately 2 volts. The total potential of 24 volts is only used in starting the discharge, and thereafter the lamp functions with a series resistance of 24 ohms in the anode circuit.

1.—Resistance box
2.—Suppressor
3.—Cockpit lamp
4.—Switch
5.—Push button
6.—Trimet 4 cable
7.—Dumet 7 cable
8.—Ducel 7 cable
9.—Fuse box, type A

FIG. 5

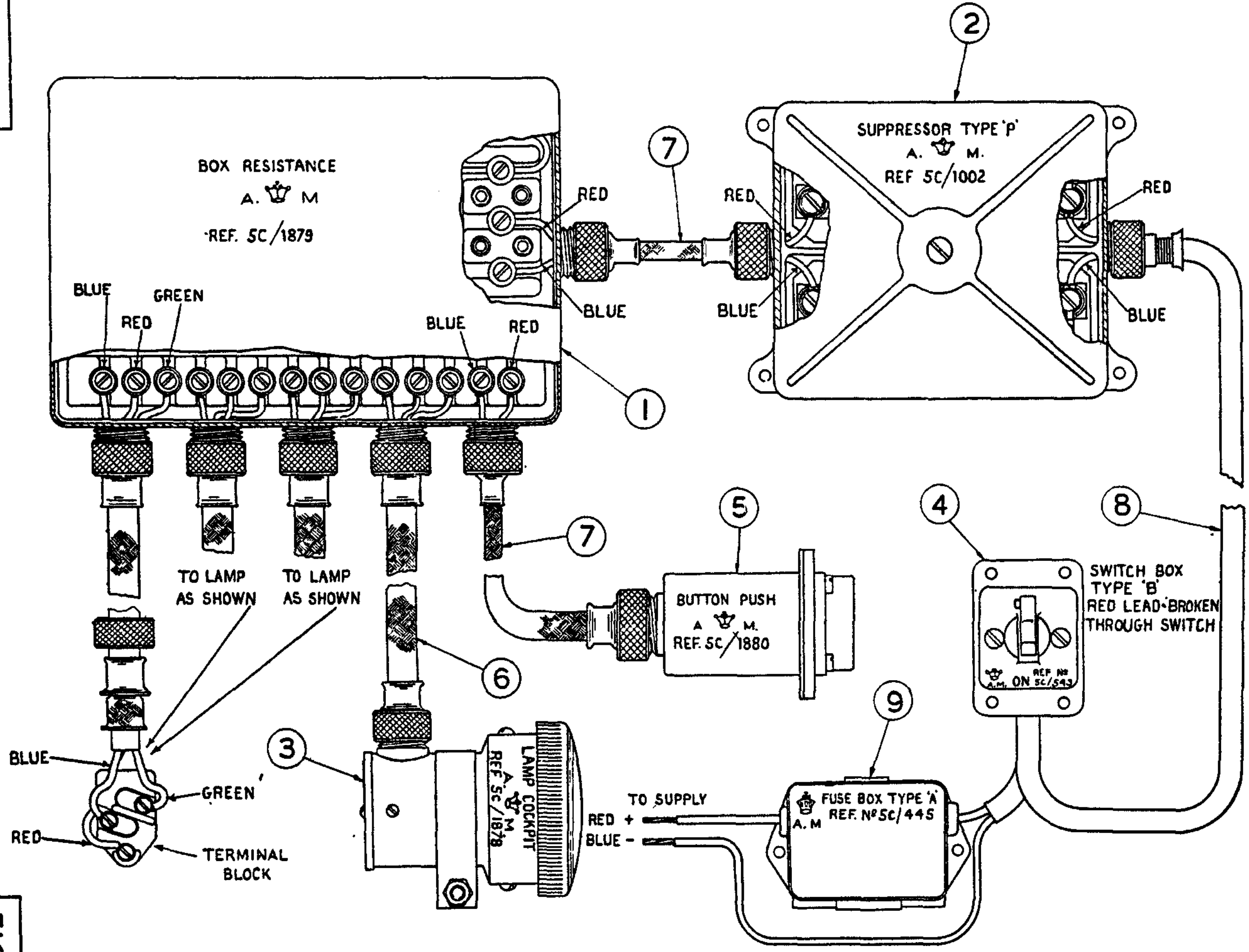


FIG. 5

INSTALLATION WIRING DIAGRAM

CHAPTER 13

Dual system of cockpit lighting

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Introduction

1. When an aircraft is in flight at night, the pilot's attention is divided between observation of the instruments and observation of objects outside the aircraft. If the markings on the instruments are too bright, after observing them, the pilot's ability to see objects outside the cockpit will be impaired for a time, and his attention will be distracted by the presence of these bright markings just below his normal line of sight. On the other hand, if the markings are not sufficiently bright and distinct, the pilot will lose time in observing the instruments and will suffer additional eye-strain and general fatigue. As these times may be critical for the success of a night operation, or for the safety of the aircraft, particularly when landing, it follows that every care must be taken both in the layout of the cockpit and in the method of illumination to ensure that the instruments can be read at a glance without the pilot's vision being impaired or his attention distracted.

2. It is with these objects in view that the new system of lighting, known as the Dual system of cockpit lighting, has been developed. It is so called because two kinds of illumination are used in the same cockpit, fluorescent lighting for the instrument panel, and red lighting for the whole cockpit. An emergency system operated from an entirely independent battery is provided for use in case of a failure in the aircraft supply system.

PRINCIPLES OF THE DUAL SYSTEM

Elimination of reflections

3. For good lighting, it is essential that the layout of the cockpit is such that it lends itself to the suitable installation of the lighting fittings, and is so arranged that it is possible to screen both the lamps and the instruments so that reflections can be avoided. In all modern aircraft the cockpit is enclosed by transparent material having highly polished surfaces which act like mirrors in reflecting any bright sources of light. These reflections can be eliminated only by applying the principle of the reflectionless shop windows, that is, by arranging that the windscreen and those parts of the sidescreen immediately next to it shall reflect some surface which is painted black. For this purpose,

a black coaming is fitted underneath the windscreen, as shown diagrammatically in fig. 1. As the coaming cannot extend round the sides of the cockpit, reflections in the sidescreens cannot be entirely prevented, but their brightness can be much reduced if the inside of the cockpit is painted matt black, and if all light-coloured objects are removed. The clothing, particularly the gloves, of the pilot and co-pilot should also be black. If the lamps are mounted as high as or higher than the top row of instruments, the pilot will not see reflections of the lamps in the instrument cover glasses. Fig. 1 shows how, when all these conditions exist, reflection is reduced to a minimum.

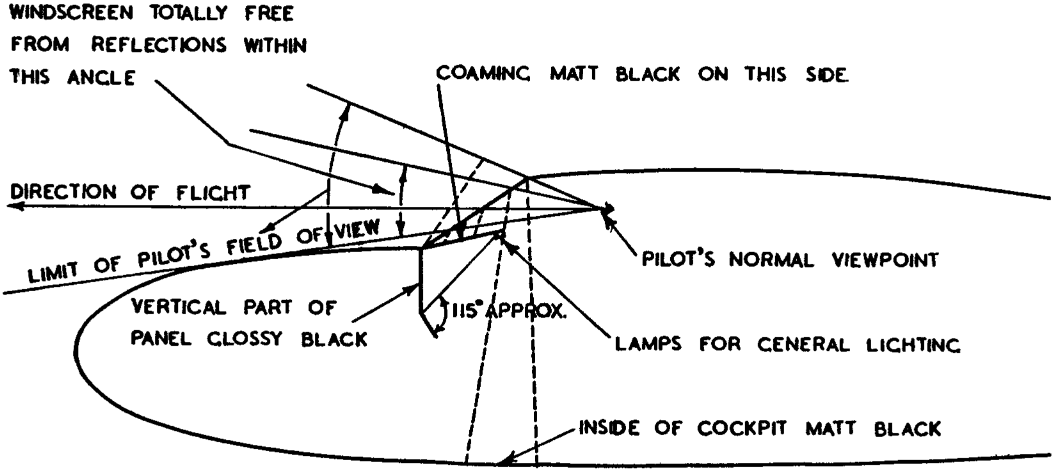


Fig. 1.—Diagram showing anti-reflection coaming

General lighting—Red

4. It has long been known that for equal intensities, red light impairs dark adaption less than light of any other colour. The "tail of the eye" is less sensitive to red than to any other colour, the actual ratio of the sensitivity being about 500 for blue, 200 for green, 10 for yellow-orange and 1 for red, so that when the pilot is looking out of the window, the red instrument lighting disturbs him 200 times less than would green. It follows that red light of low intensity is the most difficult of all colours to pick up if the observer does not know in which direction to search. Experiments have shown that with the red lights turned down to the level for comfortable working, the red glow from the cockpit lighting is visible only in directions more or less immediately above the aircraft, at a distance of 50 yards or less. As this is less than the distance at which the silhouette of the aircraft can be seen against the ground, the red lighting does not increase the risk of detection by the enemy.

Instrument lighting—Fluorescent

5. In order to increase the visibility of the instruments without raising the general illumination to a high level, the instruments required for night flying are marked with a paint which fluoresces orange when activated by ultra violet radiation. Orange is used rather than red because it is more efficient in its response to ultra violet, so that a lower intensity of ultra violet is required. In order to cut down the number of bright markings, only those which experienced pilots require at night are made fluorescent. Extra markings which might be required by a pilot learning to fly in the day-time are marked in green paint. These green markings do not show up under either red light or ultra violet radiation. Research on the size and shape of the markings has resulted in the introduction of more legible numerals; for example, the figures 3, 5, 6, and 9 now have open tails.

DESCRIPTION

6. In describing this system, the lighting of the cockpit may be divided under four headings:—

(i) *General lighting*.—The whole cockpit, that is, the instrument panel and sides, is floodlit with red light obtained usually from two filament lamps of small wattage, coloured red, and fitted in lamps of the cockpit floodlight type. These are mounted underneath the coaming as shown in fig. 1. These two lamps are normally controlled by a single dimmer switch.

(ii) *Instrument panel lighting.*—The panel is irradiated with ultra violet obtained from two filament lamps in a small cockpit, or from four such lamps in a large one. The lamps are controlled by dimmer switches independently of the general cockpit lighting.

(iii) *Ancillary lighting.*—Instruments such as the magnetic compass which cannot be adequately lighted by (i) or (ii) are illuminated by separate red lights, each controlled by its own dimmer switch.

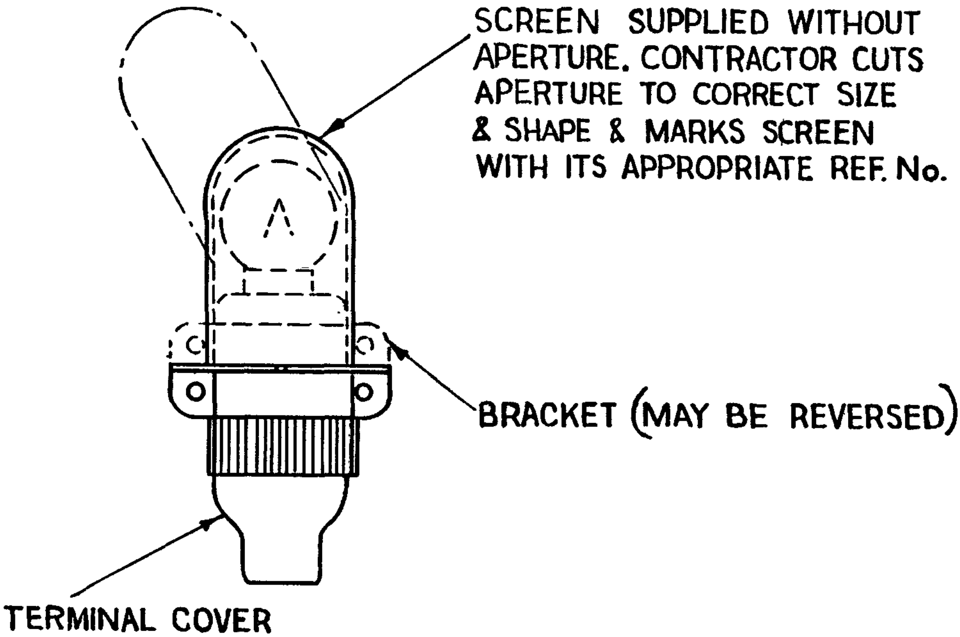


Fig. 2.—Sectional drawing of lamp, cockpit, floodlight, type C

(iv) *Emergency lighting.*—As (i), (ii) and (iii) are all supplied from the general aircraft supply, a failure in this would mean that the pilot was left in complete darkness. One additional lamp, supplied from a separate alkaline accumulator is therefore mounted over the flying instrument panel. As orange filters transmit more light than red, an orange light is used here to conserve the charge in the accumulator. A switchbox type B, marked with a luminised spot is used with this emergency lighting.

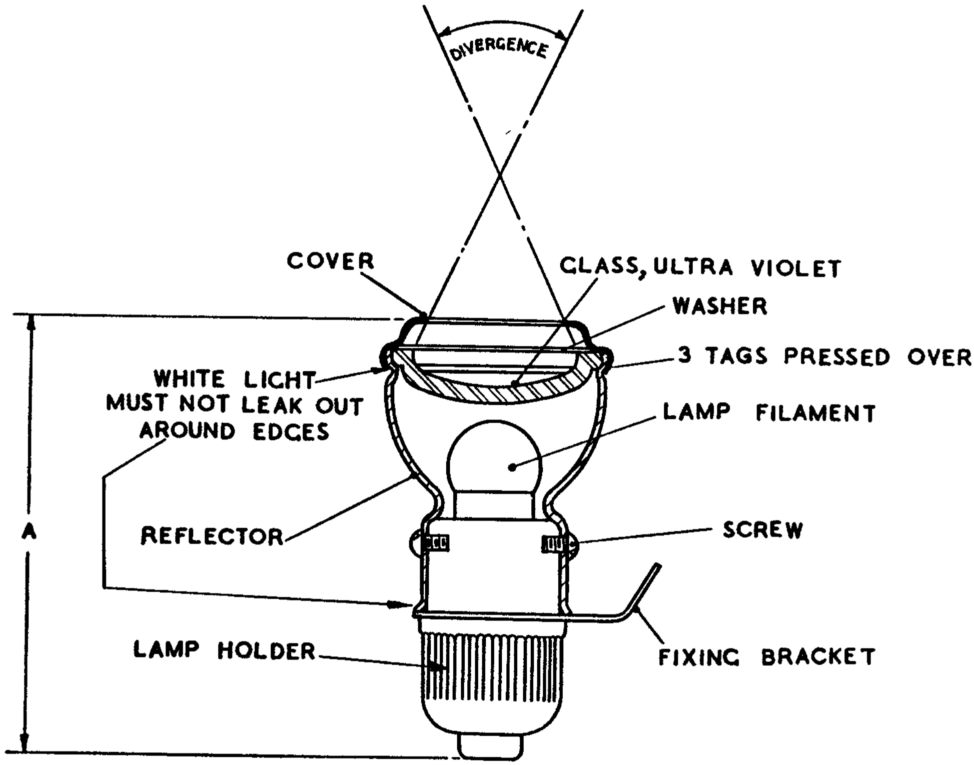
OPERATION OF THE DUAL SYSTEM

Cockpit lighting

7. In a well laid-out cockpit, the red general lighting, if used at the lowest level at which the markings can be read, causes no measurable interference with vision outside the cockpit, but the markings appear flat and are not instantly readable. Ultra violet, on the other hand, causes some slight interference with vision outside the cockpit, but makes the fluorescent markings stand out very distinctly. The best way of using the Dual system is therefore to turn up the red general lighting until the controls and markings can just be dimly seen, and then to turn up the ultra violet until the markings stand out sufficiently clearly for comfortable working. The ultra violet should be used sparingly in conditions where seeing out of the cockpit is of the first importance, but may be turned full on when flying is mainly by instruments, and vision of objects outside the cockpit is not required.

Lighting at crew stations

8. The lighting requirements at other crew stations differ from those of the cockpit in that the crew member does not have to keep close watch both outside and inside the aircraft at the same time. In general it may be said that at most stations red light offers the most practicable and satisfactory solution, mainly because it is the least distracting colour, and has little effect on dark adaption if used at a reasonably low level. If colour discrimination is required, orange light may have to be used instead of red. Ultra violet is seldom suitable because it does not show up anything which is not coated with fluorescent paint.



Nº 1 – 50° DIVERGENCE, A – 3·32, REF. Nº 5C/2454

Nº 2 – 90° DIVERGENCE, A – 3·4 REF. Nº 5C/2676

Fig. 3.—Sectional drawing of lamp, cockpit, ultra violet, type B

EQUIPMENT USED IN DUAL SYSTEM

Red lighting

9. The lamps used for general and ancillary lighting are lamps, cockpit floodlight, type C, shown in section in fig. 2. The metal screen is cut to suit each particular position in each type of aircraft. This means that a particular set of screens is associated with each aircraft, and a particular screen with each lamp. The filament lamps used are coloured by being dipped in red lacquer. This lacquer becomes brittle when the lamps have been in use for some time, and great care must be taken when replacing the screen not to allow the locating pip to scratch the lacquer.

10. The following equipment is used for this red lighting:—

	Stores Ref.
Lamps, cockpit floodlight, type C	5C/2278
Screens, uncut	5C/2279
Lamps, filament, 12V Circuits M.E.S. cap. 2·2 watt	5L/105
24V Circuits M.E.S. cap. 2·8 watt	5L/112

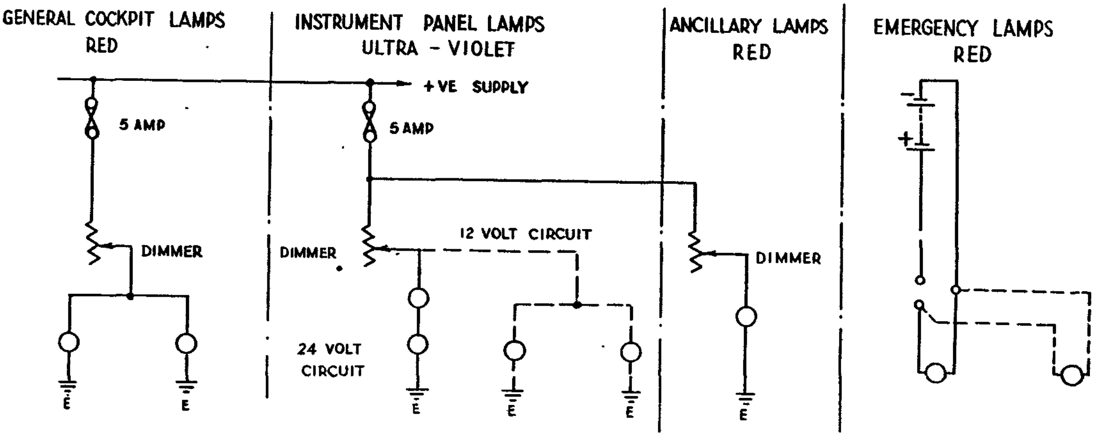
Ultra violet radiation

11. The light source for the ultra violet radiation is a gas-filled tungsten filament lamp used in a Lamp, cockpit, Ultra violet type B, shown in fig. 3, and described in Chapter 14 of this section. This lamp consists of a moulded lampholder with an anodised aluminium reflector and an ultra-violet filter held in place by a bezel ring, which extends in front of the lamp so as to prevent any stray ultra-violet radiation entering the pilot's eyes. This stray radiation does not damage the eyes in any way, but it causes slight fluorescence of the eye-balls, giving the effect of a faint blue mist, which slightly interferes with vision. The lamp is made with two different reflectors giving divergencies of 50° and 90°, known as types B, No. 1 and No. 2 respectively.

U.V. LAMPS MUST BE CONNECTED AS FOLLOWS:—

FOR 12V. CIRCUITS—Two lamps in parallel using 4·5 ohms dimmer. Not more than two lamps may be connected to one dimmer.

FOR 24V. CIRCUITS—Two lamps in series using 22-ohm dimmer, or two pairs of two lamps in series using 13-ohm dimmer. One, three, five or more lamps must not be connected to dimmer.



On aircraft where additional U.V. and ancillary lamps are required, separate fusing should be employed.

EMERGENCY LIGHTING

When one lamp only is fitted, use accumulator, Alkaline 2·4 V., 1·2 amp.-hr. (Stores Ref. 5J/3082).
When two lamps are fitted, use accumulator, Alkaline 2·4 V., 3 amp.-hr. (Stores Ref. 5J/1961).

Fig. 4.—Wiring diagram for the dual system

12. 12V filament lamps are used in the Lamps, cockpit U.V. type B, because they are more capable of withstanding shock and vibration, and stand up better to the temperature conditions inside the fitting than would lamps of a higher rating. On aircraft with 24V electrical systems, therefore, the ultra-violet lamps have to be used in pairs, the two lamps of a pair being connected in series and controlled by one dimmer switch. On 12V aircraft the lamps are connected in parallel to dimmer switches in the normal way. This is shown in fig. 4. The following equipment is used for ultra-violet radiation:—

	Stores Ref.
Lamps, filament, 12V 7w., gas filled ...	5L/302
Lamps, cockpit floodlight, type B, No. 1 ...	5C/2454
No. 2 ...	5C/2676
Spare Reflector Unit for No. 1 (50° divergence) ...	5C/2677
No. 2 (90° divergence) ...	5C/2678

N.B.—These spare units include the ultra-violet filters.

Emergency lighting

13. The lighting fitting used in the emergency standby installation is identical to that used for the red lighting equipment, described in para. 9 and 10, but a 2·5V. filament lamp coloured yellow may be used instead of the red lamp where extra illumination is required. The circuit, which is supplied by a small alkaline accumulator, is controlled by a single-pole switch, switchbox type B, marked with luminous spot on the switchplate, so that it may be easily picked out and quickly brought into action in the event of a failure of the general lighting system. In addition to the lighting equipment mentioned in para. 9 and 10, therefore, the following items are used in this circuit.

	Stores Ref.
Switchbox, type B, 20 amp. or 7 amp.	5C/543 or 5C/2497
with	
Plate, luminised, spot	5C/3189 or 5C/3613
Accumulator, alkaline, 2·4V 1·2 a.h.	5J/3082
or	
Accumulator, alkaline, 2·4V 3 a.h.	5J/1961
Lamps, filament, Red, 2·5V 0·3 amp.	5L/1952
Lamps, filament, Yellow, 2·5V 0·3 amp.	5L/1953

Dimmer switches

14. A special type of dimmer switch, known as type R, has been developed for use with this system. The switches will be described in detail in A.P. 1095 A, Vol. I, Sect. 7, Chap. 19. The following switches will be used in Dual lighting installations:—

Position	*Circuit voltage*	*Dimmer switch*	*No. of lamps*	*Resistance*	*Stores Ref.*
General cockpit lighting	12V	Type R	2	50 ohms.	5C/2449
	24V	„	2	135 ohms.	5C/2452
	24V	„	3	115 ohms.	5C/2531
	24V	„	4	75 ohms.	5C/2530
Ultra-violet radiation	12V	„	2	4·5 ohms.	5C/2448
	24	„	2	22 ohms.	5C/2451
	24V	„	4	13 ohms.	5C/2525
Ancillary lighting	12V	„	1	115 ohms.	5C/2531
	24	„	1	275 ohms.	5C/2453

SERVICING

15. No special servicing is necessary beyond replacing filament lamps which have failed or have lost some of their lacquer through being scratched or overheated. When renewing red lamps, the screen must be removed to permit the old lamp being taken out and the new one screwed in its place; particular care must be taken not to scratch the red lacquer coating of the lamp when replacing the screen. It should be noted that the locating pip on the screen is on the side away from the bracket. The filament lamps used for ultra-violet radiation can be removed by undoing the two screws which secure the neck of the reflector to the lampholder. The glass front must *not* be removed by bending back the clips which hold it to the reflector.

16. The mounting brackets of both red and ultra-violet lamps are split, and the lamps may be removed by undoing the moulded terminal covers and pushing the lamp forward until the leads pass through the split.

17. It is essential that damaged or worn-out lamps, switches and fittings shall be replaced by new ones of the type specified for that particular position. This is particularly important in the case of dimmer switches.

18. The black coaming in each aircraft has been especially designed for that particular type, and damaged coaming should therefore be renewed with the utmost care exactly as it was originally.

APPENDIX 1

ADAPTATION OF OTHER LIGHTS AND INSTRUMENTS

1. During the transitional period, before the dual system becomes universal, aircraft may be fitted with instruments which are either fluorescent or luminous. Arrangements have been made to ensure as far as possible that aircraft not equipped with UV lamps will be supplied with luminous instruments. If, however, it is necessary to use fluorescent instruments on aircraft not equipped with UV, the arrangements for reading these instruments by means of red lighting should be made in one of the following ways.

(i) A suitable portion of the existing lighting may be converted to red by fitting red filament lamp, 12-volt, 6-watt, reference 5L/474, or 24-volt, 6-watt, reference 5L/260. Additional red lamps may be installed under normal Command Modification procedure to illuminate the instrument or instruments concerned.

(ii) Instruments requiring only occasional observation may be read with the aid of a torch fitted with a red filament lamp.

(iii) Some American instruments will be supplied with a Rose filter to prevent excessive luminosity of the markings when used under UV activation. When these instruments are used on aircraft not equipped with UV, filters should be removed. (See Leaflet A.P.2533A/3—W or Leaflet A.P.2533C/1—W and A.P.1186B).

(iv) Certain radio apparatus has external markings in luminous paint. When this apparatus is used in aircraft equipped with the dual system, the luminosity should be destroyed by the application of red dope as described in C.D.0850A Leaflet 12 and C.D.0333A Leaflet 7.

2. In all cases where essential flying instruments having fluorescent markings are fitted, and a full dual lighting system is not installed, an emergency lighting system following the general design as described in para. 13 of this chapter must be provided. Such a system should be installed under normal Command Modification procedure.

P9854 M04170/G4302 3/46 8500 C & P Gp. 1

CHAPTER 14

Ultra-violet COCKPIT LAMP, Type B

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Introduction

1. Ultra-violet cockpit lamp type B has been developed to provide a source of U.V. radiation for cockpits fitted with fluorescent instruments. Two types are available at present, Nos. 1 and 2, their only difference being in the shape of the reflector upon which the angle of divergence depends.

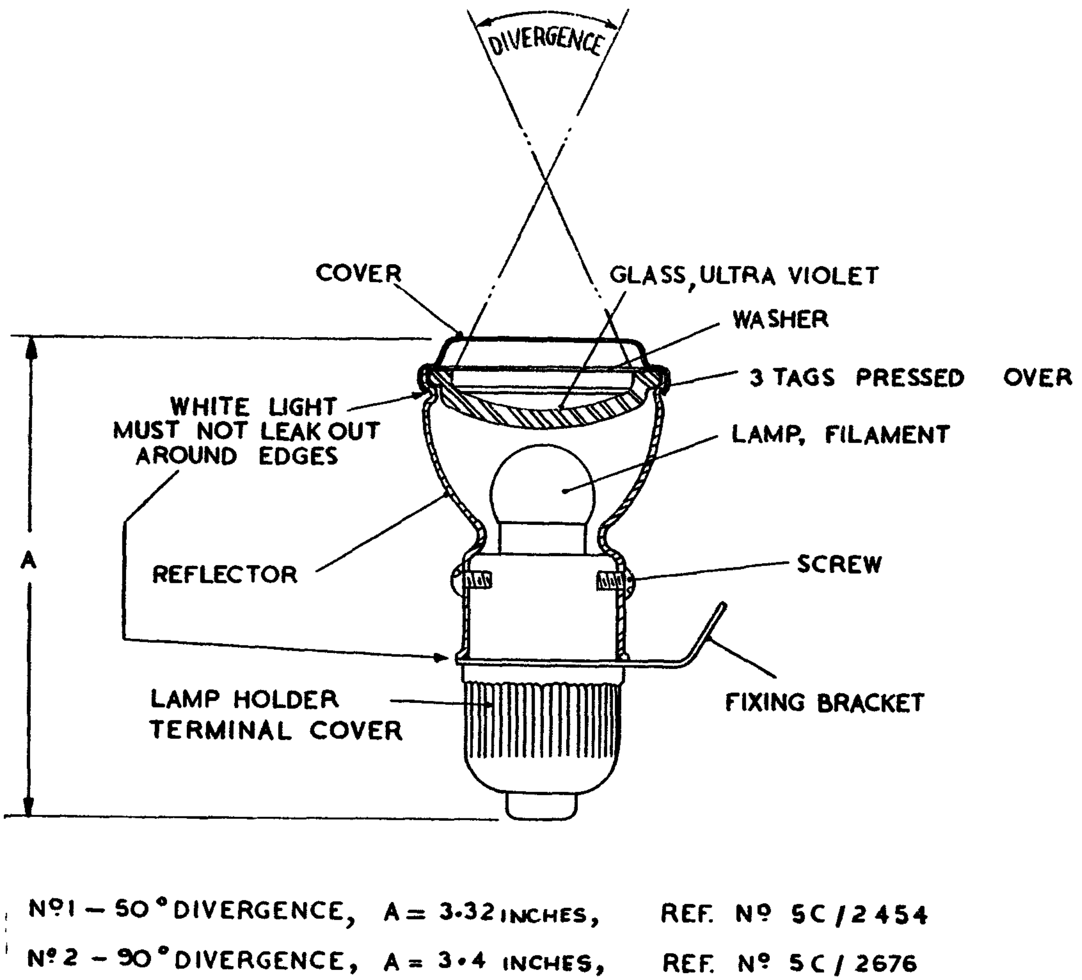

Fig. 1.—Ultra-violet cockpit lamp, Type B

DESCRIPTION

2. An ultra-violet cockpit lamp type B is shown in outline in fig. 1. The lighting source is a 12V. 7W. gas-filled filament lamp (Stores Ref. 5L/302). This is fitted into a lampholder, SBC type B (Stores Ref. 5C/2680) carrying a reflector designed to give a convergent beam. The reflector is covered by a glass which transmits ultra-violet radiation, but not visible light.

3. The reflector is of aluminium, finished externally with black enamel, and internally with a chemically protected diffusing surface. In U.V. cockpit lamp type B, No. 1 (Stores Ref. 5C/2454) the reflector is designed to give a beam whose divergence is 50°. The design of the type B No. 2 Stores Ref. 5C/2676) gives a beam whose divergence is 90°.

4. The ultra-violet filter glass is concave, and has a flange which fits into the reflector. A paper washer lies between the glass and the black metal cover which has three tags, pressed under the rim of the reflector to keep the glass in place. This cover also acts as a screen to prevent the leakage of light round the edge of the U.V. filter.

INSTALLATION

5. The cockpit lamp should be installed in such a position that it is completely screened from the pilot, its rays being directed to the fluorescent markings which require irradiation. A drilled fixing bracket, which may be used either way up, is held in place between the lampholder terminal cover and the reflector. When wiring up, bare no more of the wire than is necessary, and insert the wire on the left side of the terminal screw.

6. It should be noted that since this U.V. cockpit lamp is designed for use with a 12V. filament lamp, two cockpit lamps *in series* must be installed when used on a 24V. supply.

SERVICING

7. It is important to ensure that no light leaks through at the points indicated in fig. 1; that is, round the U.V. filter glass, and at the bracket connection. The metal cover must be a good tight fit over the reflector, and the terminal cover must be kept screwed well home on to the lampholder body.

8. When it is necessary to change the filament lamp, unscrew the terminal cover slightly, and rotate the lamp until the two screws holding the reflector to the body of the lampholder become accessible. Take out these screws, remove the reflector, and the filament lamp is then exposed. *On no account* should the filament lamp be reached by opening the three metal tags and removing the metal screen and U.V. filter glass.

9. Spare reflector units are available as follows:—

No. 1 (50° divergence) Stores Ref. 5C/2677.

No. 1 (90° divergence) Stores Ref. 5C/2678.

P7054 M /G4701 4/45 8600 C & P Gp. 1

CHAPTER 16

SODIUM INSTRUMENT LIGHTING

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LIST OF ILLUSTRATIONS

Introduction

1. The day-night sodium electrical discharge lamp used for this lighting system provides an orange-yellow light over 90 per cent. of which is of the yellow sodium wavelengths. It is employed to illuminate the instrument panel of aircraft used for instructional purposes under the day-night single-stage (flarepath) scheme for simulation of night flying during the daytime.

2. Under this scheme, which is described in A.P.4163A, the pilot under instruction wears goggles designed to admit light of the sodium wavelengths emitted by this type of lamp whilst considerably reducing the intensity of all other colours. It is therefore necessary, in order to provide instrument visibility, for the instrument panel of the aircraft to be illuminated by means of a sodium lamp. The lamp used is similar to, though of a lower wattage than, that used in the flare-path unit described in Section 5 of A P.1095G.

3. The equipment consists of a discharge tube with vacuum-jacket, a metal reflector to direct the light upon the instrument panel, and the associated cabling, switch and fuse. It is supplied with alternating current from a power unit incorporating a rotary converter, leak transformer, choke and condenser. The power unit is fed from the 12- or 24-volt aircraft electrical supply, and is to be described in Section 8 of A.P.1095C.

Leading particulars

4. Table 1 gives a list of components comprising the equipment, other than those involved in the power unit. The latter will be dealt with under Section 8 of A.P.1095C.

Note.—The stores references given are correct at time of issue but, before submitting demands, the correct section of A.P.1086 should be consulted.

TABLE 1

Item	*Stores Ref.*
Lamp, day-night, 60-watt, tube, discharge	5L/21
Lamp, day-night, 60-watt, jacket, vacuum	5L/22
Reflector, complete with brackets, endshield and lampholder	5L/1750
Blocks, terminal, Type B, 2-way, No. 3	5C/516
Boxes, fuse, Type A	5C/445
Fuse, Type A, 20 amp.	5C/204
Switch, G.P., Type B	5C/543
Adapters, lampholder, dummy stowage	5C/1989
Sockets, large, with sleeve and gland nut	5X/1579
Sockets, small, with sleeve and gland nut	5X/1578
Cable, Dusheath 4	5E/135
Cable, Unicel 19	5E/1360

Lamp circuit

Power consumption of lamp, nominal	60 watts
Power consumption, actual, of lamp with leak transformer	82 watts, approx.
Current, nominal	0·6 amp., approx.
Lamp voltage, striking	450 volts, approx.
Lamp voltage, running	110 volts, approx.
Overall dimensions of lamp, including vacuum-jacket—	
Length	300 mm.
Diameter	50 mm.

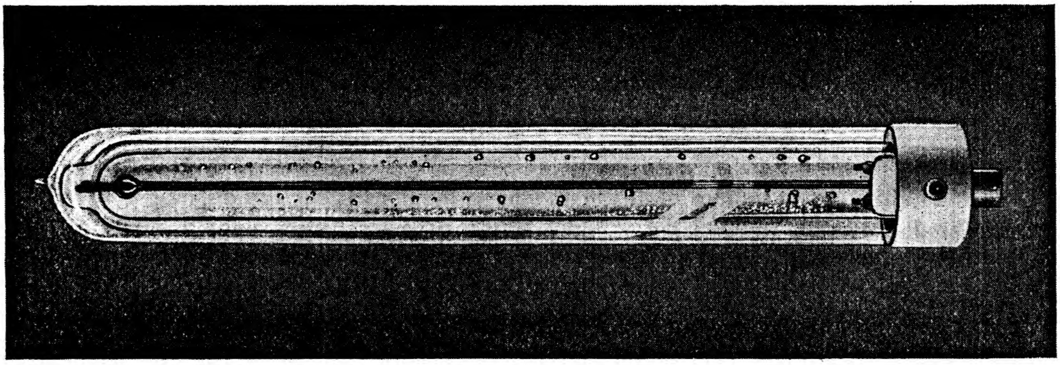

Fig. 1.—Day-night lamp

DESCRIPTION

5. The Day-night lamp, illustrated in fig. 1, is a sodium vapour electric discharge lamp emitting an orange-yellow light, over 90 per cent. of which is of the sodium wavelengths.

6. It consists of a U-shaped tube of lime-borate glass having a double metal electrode at each end. These electrodes are connected with the pins of a porcelain two-pin bayonet cap which takes the electrical supply from the power-unit. The glass envelope, although appearing as one piece when viewed by the naked eye, is formed of two layers of glass of different types but having the same co-efficient of expansion in order that the tube may be able to withstand internally the chemical action of sodium vapour and, externally, atmospheric conditions at the relatively high temperature involved. During manufacture the tube is exhausted of air, and Neon gas under low pressure, together with a small amount of sodium metal, is introduced.

7. Upon switching on, an alternating electrical potential is applied to the electrodes, the Neon gas is ionised and an electrical discharge takes place through the tube which then emits the normal red Neon glow; as the temperature of the tube rises, however, the sodium metal liquefies and a

small quantity is subsequently converted into vapour. This vapour assists the electrical discharge and causes it to assume the characteristic vivid orange-yellow colour of the Day-night lamp.

8. A metal strip, terminating in a fork, is located between the two arms of the tube, the fork acting as a mechanical support for the closed end of the "U". The other end of the strip is connected electrically with one of the contacts of the bayonet cap, thereby making the strip "live" and facilitating the rapid "striking" of the discharge by assisting the ionisation of the Neon.

9. The lamp works at a high temperature, and it is necessary to prevent the too rapid dissipation of heat. The discharge tube is, therefore, housed in a transparent vacuum-jacket which conserves the heat generated in order that the requisite operating temperature necessary to vaporize the sodium may be maintained even when the outside temperature is as low as approximately 15 deg. F. This vacuum-jacket also provides mechanical and electrical protection to the tube, and the jacket should always be in position when the lamp is switched on, as the metal strip supporting the discharge-tube is "live", and the voltage necessary to strike the discharge is in the region of 450 volts. When the lamp is used with the power unit described in Section 8 of A.P.1095C, the inherent regulation of the rotary-converter and the absence of a voltage regulator cause the voltage generated with the lamp disconnected to be approximately 300 volts, resulting in a voltage of approximately 600 volts at the lampholder. Due precautions should therefore be taken if it is necessary to run the power unit with the lamp disconnected.

10. The lamp operates on alternating current only, and as on most aircraft only low-voltage direct current is available, the supply for the lamp is taken from a power unit incorporating a rotary-converter drawing current from the aircraft electrical system. As the lamp depends on a discharge through gases and the electrodes are not preheated, it requires a striking voltage higher than the

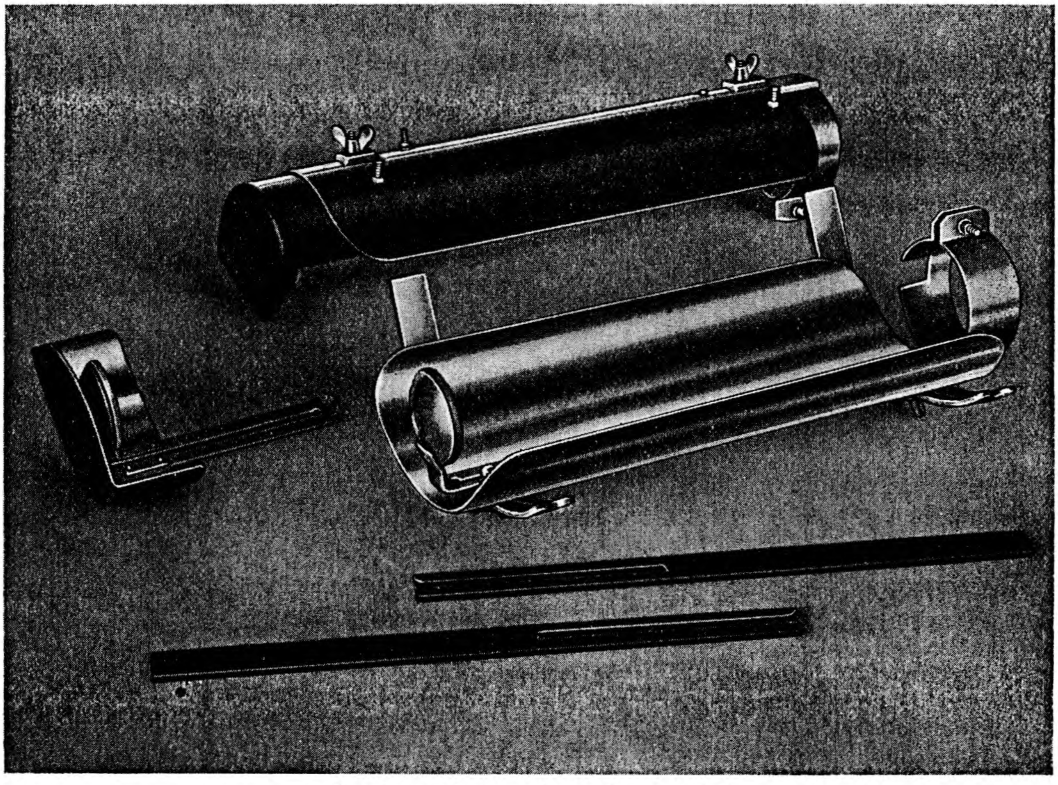

Fig. 2.—Reflector shown dismantled

normal running voltage, and also a choke in the circuit to ensure stable operation. These requirements are provided by the use of a special automatic ballast leak transformer and choke which form part of the power unit described in Section 8 of A.P.1095C.

11. A metal reflector is provided to direct the light upon the instrument panel, the reflector being positioned so that no direct light can reach the eyes of the pupil-pilot or the instructor. This is illustrated in fig. 2.

INSTALLATION

12. The Day-night lamp is designed for horizontal operation, but it may be used in any position up to vertical provided that the cap is uppermost. It must NOT be used with the cap downwards or the liquid sodium will tend to move towards the electrodes, causing diminution of light output, blackening of the tube, and ultimate complete failure of the lamp.

13. Notes on the installation of the lamp and power unit are contained in the Air Publication covering the official modification of the aircraft concerned. Fig. 3 shows a typical installation and the theoretical circuit of the lamp supply is illustrated in fig. 4.

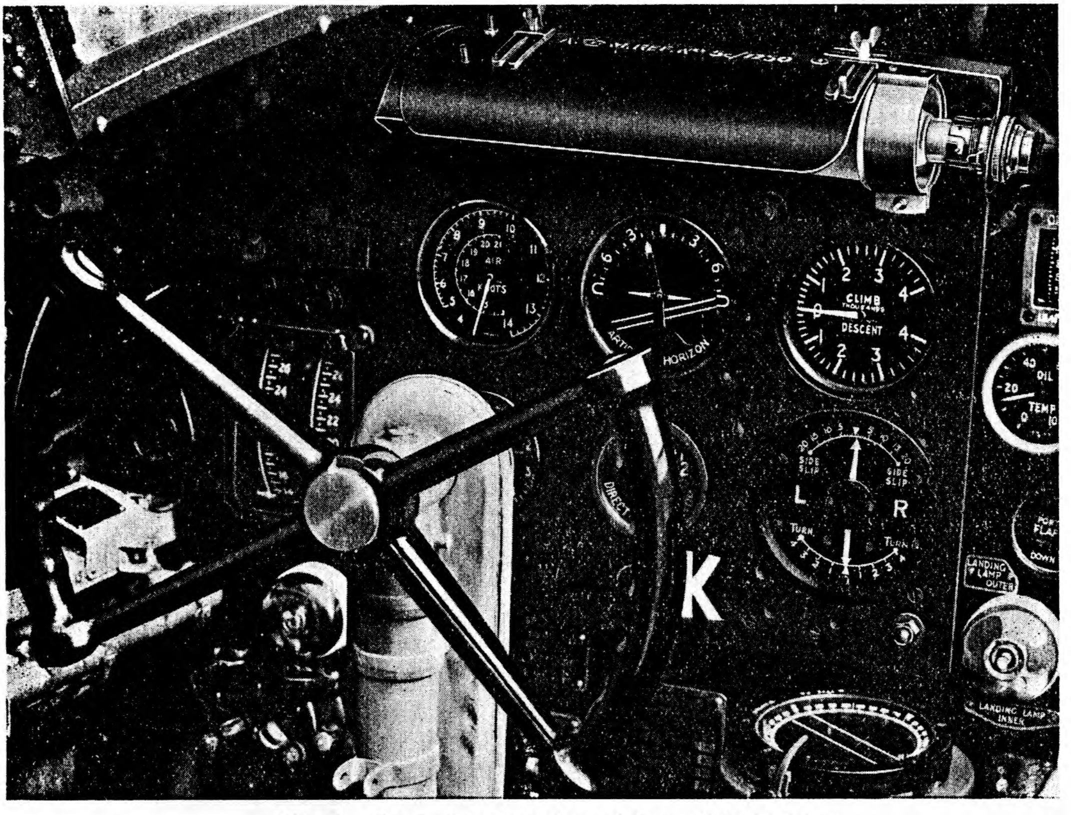

Fig. 3.—Typical installation of Day-night lighting

OPERATION

14. The starting switch provided is in the d.c. circuit and, as the power unit does not require a starting resistance, it is switched straight across the aircraft supply. A separate switch in the a.c. circuit of the lamp is not required, as the rotary converter in the power unit is designed for operating one lamp only.

15. When the current is switched on, an initial potential is applied to the lamp from the leak transformer, of a voltage sufficiently high to produce ionisation of the Neon and the discharge commences, emitting light of the usual red colour associated with Neon lamps. When current is being drawn from the power unit the magnetic leak in the transformer comes into operation and the voltage drops to the steady working value of 110 volts. The operation of the leak transformer is described in the chapter on the power unit.

16. After 10 to 15 minutes the lamp has attained the normal operating temperature and the sodium metal enclosed in the tube has melted and partly vaporized. The lamp now emits the required orange-yellow light at full brilliance. Should the lamp, on switching on the current, be still warm following a previous operation, the warming-up period will, of course, be shortened.

17. ***Note.—In view of the comparatively heavy current taken by the power unit, it is advisable that a starter trolley should be used to provide the current for the warming-up period, unless the aircraft accumulators are of large capacity or additional internal accumulators are provided.***

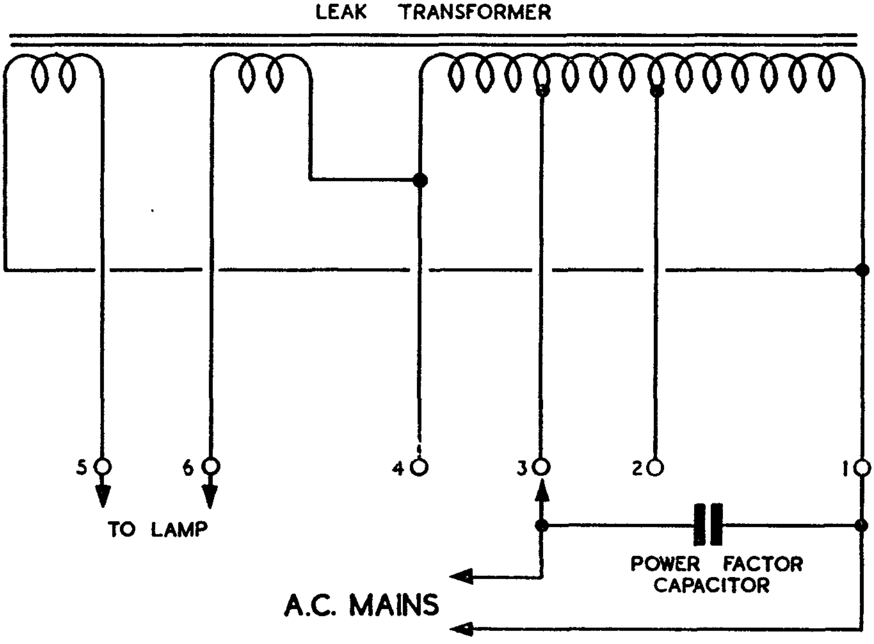

Fig. 4.—Theoretical circuit of lamp supply

CARE AND SERVICING

Connections

18. Plug pins and sockets should be examined periodically and, if necessary, cleaned to ensure good contact. All connections must be securely screwed home, to prevent loosening under vibration.

Discharge tubes

19. The lamps do not burn out, and the average life of a discharge tube should not be less than 1,000 operating hours. In some types of aircraft, vertical operation is necessary, and under these conditions the useful life of the tube may be slightly reduced.

20. Discharge tubes must be replaced if they become blackened, "hesitate" when switching on, or if the brilliance of light produced falls off.

21. To renew a faulty tube, first lift the spring-loaded pin in the side of the porcelain cap of the vacuum-jacket, when the old tube may be carefully withdrawn. When inserting the new tube

ensure that the fork at the end of the central metal electrode strip enters smoothly into the recessed portion of the end of the jacket. Until this is done, the spring-loaded pin should be kept raised.

22. If possible, a period of 10 minutes after switching off should elapse before the lamp is removed from the reflector, to allow time for the lamp to cool down and the globules of sodium metal to solidify. If it is necessary to remove a lamp whilst hot, care should be taken not to lower the cap of lamp below horizontal and to avoid jarring.

23. When renewing a discharge tube it is advisable to examine the vacuum-jacket for minute cracks or damage to the small pips at the end of the jacket. If damaged it should be renewed.

Vacuum-jackets

24. These should not require replacement under normal circumstances, and unless mechanically damaged, they will last the life of several discharge tubes. A damaged vacuum-jacket, resulting in the vacuum being destroyed, is indicated by the refusal of the lamp to warm up, the light emitted remaining red. Lamp parts produced by different manufacturers are not interchangeable.

Lampholders

25. As these are not exposed to the weather, little servicing is required. The contacts should be examined periodically for cleanliness. A faulty contact in the lampholder is usually indicated by flickering of the lamp.

Importance of correct voltage

26. Adequate illumination of the aircraft instrument panel is essential for the successful operation of the flare-path in conjunction with the single-stage scheme. This depends on the lamp being in good condition, the reflector clean and correctly positioned, and the aircraft electrical supply providing the full nominal voltage.

27. The Day-night lamps may safely be operated at voltages up to 10 per cent. higher than the rated value, but they are sensitive to under-voltage, and under the latter conditions considerable diminution in the light output will ensue and the lamp may flicker of fail to "strike".

28. Whilst the engine-driven generator is supplying the energy, no difficulty should be experienced, but if, during the period immediately prior to take-off of the aircraft, the aircraft accumulators have been allowed to become discharged, visibility of the instruments for the pupil-pilot will be seriously impaired due to the reduced voltage applied to the lamp. See also para. 17 under "Operation".

29. Under Table 2 will be found some possible faults, together with the cause and remedy.

TABLE 2

Fault	*Possible cause and remedy*
(i) Lamp fails to "strike" on switching on	(*a*) Supply voltage may be low. Test input voltage to power unit and output at lampholder. ***Warning.—The latter may be up to 600 volts*** (*b*) Discharge-tube may be faulty. Replace tube with new a one (see para. 21).
(ii) Lamp "hesitates" when switching on	(*a*) Replace discharge-tube.
(iii) Light supplied is orange-yellow but of insufficient brilliance	(*a*) Supply voltage may be low. See (i) (*a*) above. (*b*) Discharge-tube may be faulty. Replace tube with new one (see para. 21)
(iv) Lamp flickers	(*a*) Faulty contact in lampholder. Try new discharge-tube. If flickering still continues, replace lampholder with new one.
(v) Lamp strikes, but light remains red after 15 minutes	(*a*) Faulty vacuum-jacket. Replace vacuum-jacket with new one.

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SECTION 9

CIRCUIT-BREAKERS

LIST OF CHAPTERS

Note.—A list of contents appears at the beginning of each chapter

CHAPTER 1

GENERAL NOTES ON THERMAL CIRCUIT-BREAKERS

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. Thermal circuit-breakers are employed in electrical power installations to protect the equipment from damage which might otherwise be caused by overloading, misuse or other fault conditions. The types used in aircraft electrical installations are also usually designed to control the operation of this equipment, in other words, they combine the functions of fuse and switch in one unit.

2. They possess several outstanding features of design which make them more suitable than other forms of control and protection for use in conjunction with most types of driving equipment used in aircraft electrical power installations.

3. Detailed descriptions of individual types of thermal circuit-breakers used in aircraft, will be found in later chapters of this section, together with notes on their installation and servicing. Individual thermal circuit-breakers vary in design but there are certain features and principles of operation which are common to all, and these will be dealt with in the following paragraphs.

Principle and operation

4. The construction of this type of circuit-breaker consists essentially of a switch and an automatic tripping device assembled as a unit. The operation of the switch may be mechanical or electrical but the general principle of the automatic tripping component is the same for all types and its action is dependent upon the distortion produced in a bi-metal strip by an increase of its temperature. This bi-metal or thermal strip, sometimes referred to as the thermal element or thermal trip, in its simplest form, is composed of two flat strips of different metals which are firmly secured to each other side by side. The two metals employed have different coefficients of expansion and if the temperature of the thermal strip is raised, the metal strip having the greater coefficient of expansion will expand more and the consequent distortion of the strip will be proportional to the rise in temperature.

5. In practice, the electrical equipment which is to be controlled and protected by a thermal circuit-breaker, is normally connected in series with the circuit-breaker and the supply. When the switch contacts of the circuit-breaker are closed, the thermal strip carries the full line current supplied to the associated equipment, and the heating of the strip is produced by this current.

6. When the thermal strip has been distorted to a pre-determined degree, i.e. as soon as the current for which the circuit-breaker is set has been exceeded for a certain time, it will operate a trip lever, which in turn will release the switch contacts, allowing them to be opened by means of a spring, thus interrupting the supply to the equipment.

7. The current rating of a thermal circuit-breaker is determined by the composition, thickness and shape of the thermal strip and various current ratings can therefore be obtained by utilizing different combinations of these factors.

Application

8. The rise in temperature of the thermal strip and consequently the amount of distortion produced in it will be proportional to the value of the current and the length of time that it is applied. It should be noted that a slightly excessive current applied to the circuit for a long period may produce the same rise in temperature of the thermal strip as a very high current applied for a much shorter period, and therefore graded protection can be afforded to electrical equipment which is subject to varying load currents, such as starter motors under cold and under warm ambient conditions. Fuses and magnetically-operated circuit-breakers on the other hand, are designed to operate on a maximum permissible current basis, and in general are not suitable for limiting light over-loads of long duration.

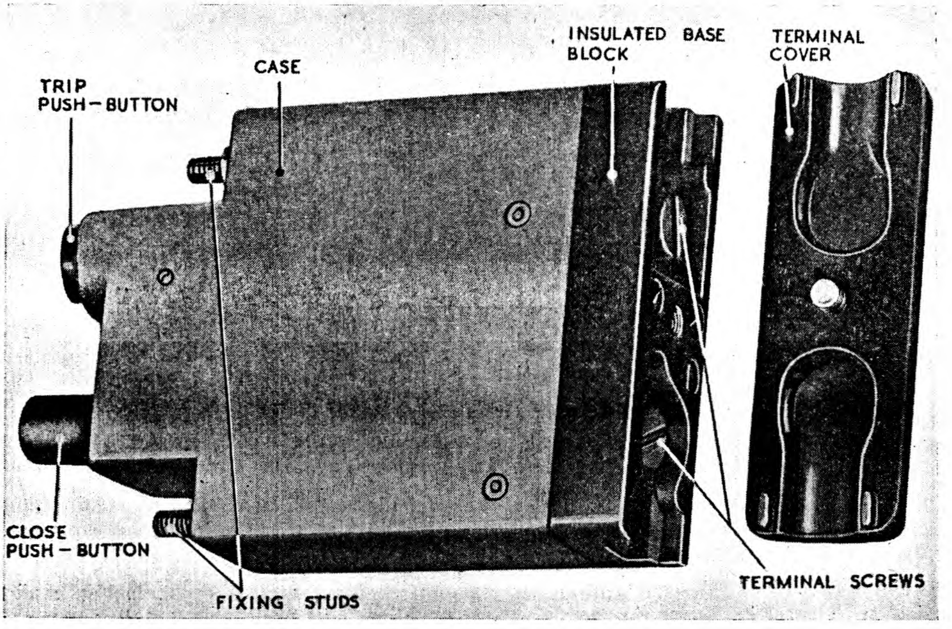

Fig. 1—Typical hand-operated thermal circuit-breaker

9. Much of the electrical apparatus installed in aircraft is designed mainly for operation over brief periods, i.e. it is short-time rated, and is operated with currents which would cause damage if maintained over a long period. Short-time rated operation is possible because the rise in temperature lags behind the current and therefore takes some time before it exceeds the safe limit. Thermal current-breakers are specially suited for use with this type of equipment, as they will only automatically interrupt the supply current when the apparatus approaches a dangerous temperature.

10. They are also particularly applicable for use with vital equipment such as turret, undercarriage, flap and propeller pitch control motors as they can be reset almost immediately when automatic tripping occurs, by simply re-switching. The equipment can thus be restored to use with only a delay of seconds after a temporary overload whereas the replacement of fuses would not only take very much longer but might prove difficult when the aircraft is airborne.

Types of thermal circuit-breaker used in aircraft

11. Some idea of typical thermal circuit-breakers may be gained from the illustrations in fig. 1 and 2. Both types shown incorporate automatic tripping devices based on the principles of operation already described.

12. A hand-operated model, having a mechanical switch movement is shown in fig. 1. Two push-buttons embodied in the circuit-breaker assembly, provide the control for opening and closing the contacts. This particular design is only suitable for use in circuits of fairly low current rating, and for higher current installations the electrically operated circuit-breaker similar to that illustrated in fig. 2 is usually employed. The switch in this type is controlled by means of a solenoid incorporated

in the circuit-breaker housing. The solenoid may be operated from a distant point through push-buttons, auxiliary switches, or other circuit control apparatus, thus allowing the circuit-breaker to be installed near to the controlled equipment with the minimum length of large section cable. The current taken in the push-button switch circuit will be small and only need light cables. This is an improvement over other forms of control such as fuses and switches as they must be located in easily accessible positions to facilitate the re-wiring of blown fuses.

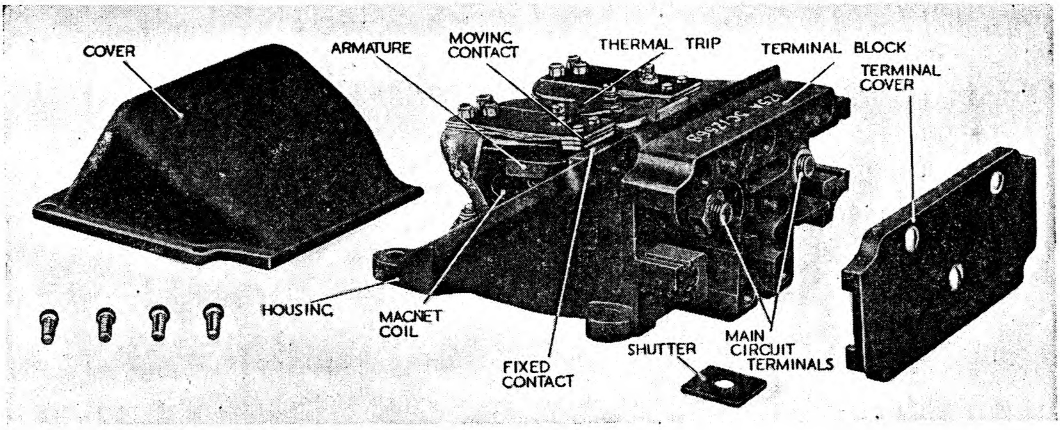

Fig. 2—Typical electrically-operated thermal circuit-breaker

13. The weight of a thermal circuit-breaker may be greater than the combined weight of a switch and fuse, especially in the lower current ranges though for the larger current ranges where the alternative includes a separate fuse box and the wiring to this box, a reduction in overall weight is very often obtainable.

Servicing

14. Servicing instructions will be found in the chapters dealing with individual units; it should be borne in mind that in general, all terminals must be kept free from corrosion and firmly tightened down, and all gap settings as given in the servicing instructions rigidly maintained. Should any fault arise which requires specialized attention, the faulty unit must be removed, replaced with a new one, and returned to the appropriate repair depot.

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CHAPTER 2

THERMAL CIRCUIT-BREAKERS, Type A (Hand-operated)

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LIST OF ILLUSTRATIONS

Introduction

1. The circuit-breakers type A are operated manually by means of push-buttons incorporated in the breaker and automatically by a thermal overload tripping device, separate push-buttons being provided for closing and tripping. They combine the functions of switch and fuse in one unit and are designed to ensure quick make and break, so that the risk of the contacts becoming welded together or the surfaces burnt, is reduced to a minimum.

2. The use of these circuit-breakers affords protection to electrical equipment against overheating arising from excessive operation, this occurs without limiting their normal use, by interrupting the supply automatically only when the rise in temperature of the equipment is likely to become dangerous. Re-setting can be carried out by simply re-switching, a few seconds after automatic tripping has occurred.

3. The mechanism is enclosed in a flame and weatherproof case which can be mounted in any position on the fuselage of service aircraft, including gun turrets.

4. The circuit-breakers type A, Nos. 1 to 6 are single pole, single break units, suitable for use in circuits carrying currents of 5–45 amp. At 25°C ambient temperature they will carry 115 per cent of their assigned rating continuously, without tripping, at 57°C ambient they will carry 100 per cent without tripping, and at 138 per cent rating they will trip within one hour.

5. The design is such that the circuit-breaker will trip on overload while the finger is still pressing on the "close" push-button.

Types available

6. Details of the types available will be found in the following table:—

Type	*Stores Ref.*	*Rating (Nominal Capacity)*
A.1	5C/2559	5 amps. continuous
A.2	5C/2560	10 „ „
A.3	5C/2561	15 „ „
A.4	5C/2562	25 „ „
A.5	5C/2563	35 „ „
A.6	5C/2564	45 „ „

DESCRIPTION

7. The type A circuit-breaker is illustrated in fig. 1 and sectional views showing the construction and the method of operation are included in fig. 2 to which reference should be made.

8. The insulated base block carries the fixed and moving contacts with their respective external connection terminal screws and washers. It is recessed to house the helical compression spring (24) fig. 2, which has two functions, one to provide contact pressure, and the other to open the breaker.

9. A fixed silver contact (1) is attached to a terminal extension (4) which is screwed into the insulated block, and locked in position by means of a small filister head screw. The head of the locking screw engages in semi-circular slots cut into a flange which forms the base of the terminal. The terminal extension is threaded internally to take a terminal screw for the external connection.

10. The upper contact arm (5) is swivelled at a point near its centre and has a silver contact at the top (3), and a locating button for the compression spring (24) at the bottom.

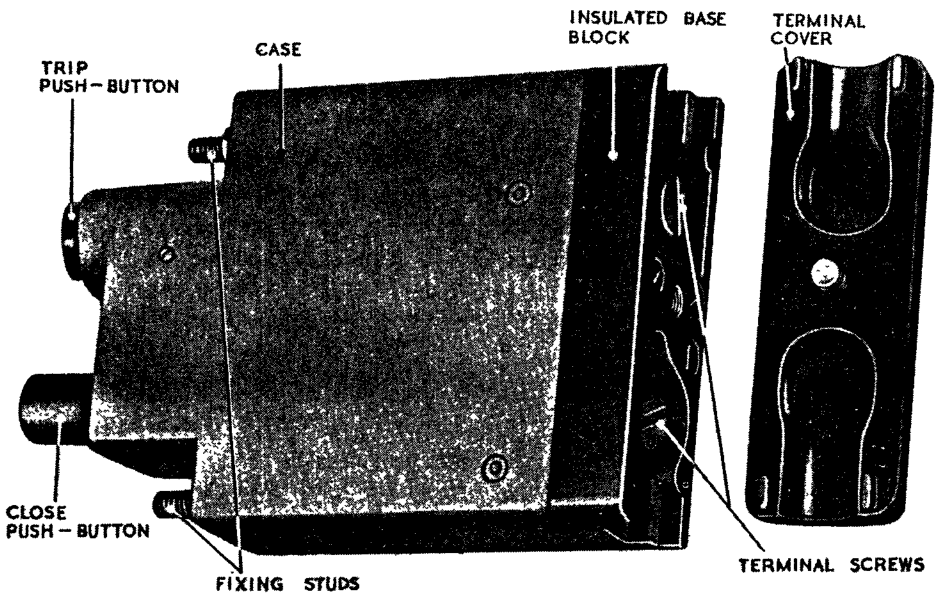


Fig. 1.—General view of thermal circuit-breaker, type A

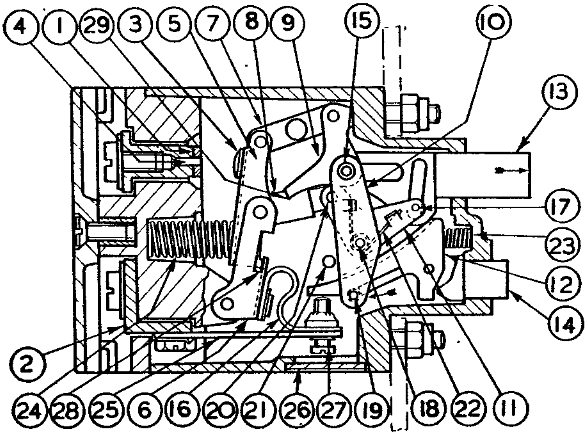
11. The lower contact arm (6) is pivoted in the insulated base while the top end is attached to the swivel point of the upper contact arm and to the operating link (8).

12. The insulated link (7) connects the upper contact to the latch (9) and its function is to hold the contact (3) open until the "close" push-button has almost finished its closing stroke.

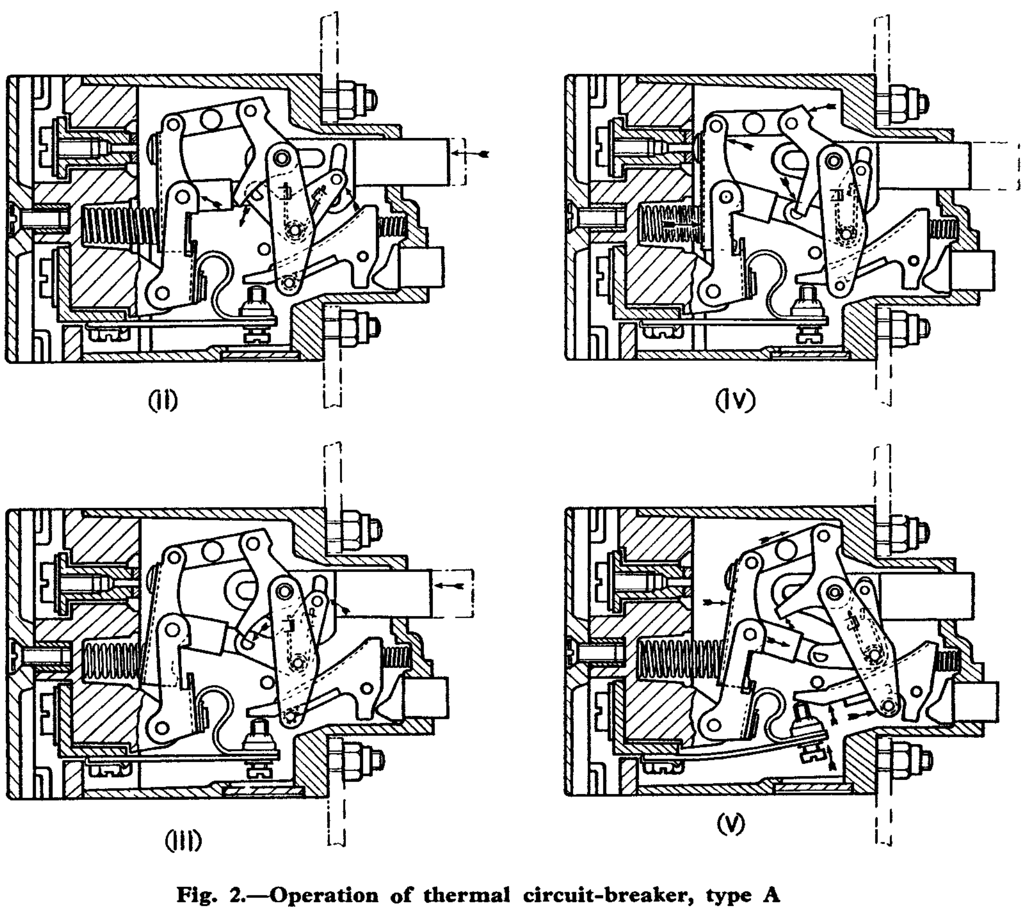
13. The latch is pivoted on the fixed centre (15) and is under the control of the latch pin (20) during the closing stroke of the "close" push-button (13), but at the end of the stroke the latch pin passes the latch end (29) when the spring (24) takes control and the contact (3) closes on to the fixed contact (1).

14. The re-setting lever (10) is also pivoted on the fixed centre (15) while the re-setting pin (19) at its lower end is latched on the trip lever (12) thus holding it in a fixed position during the closing stroke and when the breaker is closed. The bell crank lever (11) is pivoted in the re-setting lever. One end of the former is attached to the operating link and the other end carries the closing pin (17) which passes through the cross slot in the "close" push-button. Re-setting springs (22) on the pivot of the bell crank lever give it a clockwise bias.

1. Fixed silver contact
2. Bracket
3. Moving silver contact
4. Terminal extension
5. Upper contact arm
6. Contact arm
7. Insulated link
8. Link
9. Latch
10. Re-setting lever
11. Bell crank lever
12. Trip lever
13. Close push-button
14. Trip push-button
15. Fixed centre
16. Flexible connections
17. Closing pin
18. Pivot for re-setting spring
19. Re-setting pin
20. Latch pin
21. Stop pin
22. Re-setting springs
23. Spring
24. Compression spring
25. Thermal trip
26. Inspection cover
27. Trip screw
28. Stop for upper contact arm
29. Latch end



(I)



(II)

(IV)

(III)

(V)

Fig. 2.—Operation of thermal circuit-breaker, type A

15. The fixed pivot extends through the housing of the breaker and through the end of the re-setting lever. The stop pin (21) limits the forward movement of the re-setting lever and also extends through the case of the breaker.

16. The trip lever is pivoted in the housing independent of the other mechanism. The spring (23) biases the trip lever in a counter-clockwise direction so that under normal conditions it latches on the re-setting pin. The depression of the "trip" push-button turns the trip lever clockwise and releases the re-setting pin. The extended end of the trip lever is in the path of the trip screw (27) for overload tripping.

17. The "close" push-button has a flat metal insert with two closed slots, one disposed axially and the other at an angle to it. The axial slot encloses the fixed pivot and acts as a guide for the push-button as well as limiting the stroke. The cross slot encloses the closing pin and its function is to close the breaker by rotating the bell crank lever counter-clockwise when the button is depressed. The thermal trip (25) is fixed to the bracket (2) which is also one of the terminals. The other end is connected by flexible connections (16) to the lower contact arm by the trip screw (27). The thermal trip is a strip of thermal metal incorporating layers of different metals each with its own temperature coefficient.

18. When an excessive current passes through the strip its temperature is raised and the strip bends owing to the difference in expansion of the metal layers, causing the trip screw to engage the end of the trip lever which operates and releases the moving contact. The current rating of each breaker is the same as the rating of its thermal trip.

19. The case is of box form and fits on the insulated base block. The fixed pivot and the stop pin together with two pins (not shown in the sectional drawing) through the insulated block, pass through the case and are riveted over on both sides, therefore the breaker cannot be dismantled.

20. The external connection terminal screws are protected by a moulded terminal cover which is recessed internally at both ends to provide clearance for the external connection cables. The cover is secured to the insulated base by a countersunk screw.

21. A circular inspection cover of insulating material is pressed into the side of the case over the trip screw. This cover is fitted after calibration and should not be removed. Two studs are fixed in the shouldered faces of the metal case for mounting the breaker on a sheet-metal panel or mounting strips.

INSTALLATION

22. The circuit-breaker should be installed in series with the equipment which it is required to protect, the connections being made to the two terminals at the base. It can be panel mounted, having the two push-buttons extending through the front of the panel, with the larger part of the case and the insulated terminal block at the rear of the panel using the two studs in the shoulder faces to secure it.

23. Alternatively, as the case is flame and weatherproof, the circuit-breaker may be installed in any position on the fuselage of the aircraft but it must not be fixed on rigid mountings, subjected to direct engine vibrations or directly mounted on the engine. Where such locations are unavoidable, some form of damped mounting should be used, and even then it will be necessary to make frequent inspections to ensure that the cables attached to the terminal connections have not worked loose.

24. If hand-tripping is not normally required, a guard can be fitted over the "trip" push-button to prevent unauthorised or accidental operation. A small hole $\frac{1}{8}$ in. dia. is located in the centre of the guard so that it can be operated in an emergency by using a small rod.

OPERATION

25. It should be noted that the "close" push-button is marked with a white circle recessed in its end, to distinguish it from the "trip" push-button. When the "close" push-button is pressed the following operational stages are passed through before the contacts actually close and these are illustrated by the series of sectional drawings in fig. 2, to which reference should be made.

(i) Breaker open.

(ii) Push-button partly depressed with the cross slot acting on the closing pin (17) and rotating the bell crank (11) counter-clockwise, thus depressing the lower contact arm (6) through the link (8). The contact is held off by the latch pin (20) engaging on the curved face of the latch (9) which pulls on the link (7).

(iii) The continued movement of the push-button and the counter-clockwise movement of the bell crank bringing the latch pin (20) beyond the latch end (29) thus releasing the latch (9). The spring (24) now turns the upper contact arm (5) counter-clockwise and closes the contacts.

(iv) The contact (3) is closed and the latch pin (20) is beyond the latch end (29). It will be noted that the latch pin is the centre of a toggle joint formed by the bell crank lever (11) and the operating link (8). The breaker is held in by the re-set lever (10).

(v) The thermal strip (25) has been heated by an excessive current and has been bent upwards to move the "trip" lever (12) and release the re-setting pin (19). The re-set lever (10) is now free and the throw-off spring (24) forces the contacts apart.

26. The re-set spring (22) now turns the bell crank clockwise which pushes the "close" push-button out and also turns the re-set lever clockwise until the re-setting pin re-engages on the "trip" lever. When the circuit-breaker has tripped on a heavy overload a few seconds must be allowed for the straightening of the thermal strip before the breaker is again closed.

27. If the circuit-breaker trips while the push-button is held in, it is necessary to push the "trip" button separately to re-set the mechanism before the unit can be re-closed.

Tripping the circuit-breaker from the closed position

28. The depression of the "trip" push-button turns the trip lever clockwise to release the re-setting pin. The circuit-breaker then opens and re-sets as already described.

SERVICING

Inspection and testing

29. The interior of the breaker is inaccessible as the pins and shafts passing through the case are riveted over, therefore the inspection can only be operational.

30. Check the closing and tripping operations a number of times and make sure that the re-setting is correct after tripping. If the internal levers do not re-set, the "close" push-button will not operate the contacts.

31. Remove the terminal cover and make sure that the cable ends and the terminal ends are clean and the screws tight.

32. Pass 200 per cent. normal rated current through the breaker and check that it trips in the time stated below, for the ambient temperature prevailing.

Ambient	*Time*
10°C.	14–40 seconds
20°C.	12–32 seconds
30°C.	11–23 seconds
40°C.	10–24 seconds

33. With a 250-volt insulation resistance tester, the breaker in the open position, test between terminals. With the breaker closed, test between the terminals and the case, or the mounting studs where units are in moulded housings. The minimum insulation resistance in both tests should be 20 megohms.

34. The thermal trip adjusting screw is set and sealed by the manufacturers, and, therefore, MUST NOT be altered. Should the breaker fail to satisfy the requirements laid down in the preceding paragraphs, it should be disposed of in accordance with current instructions.

CHAPTER 3

THERMAL CIRCUIT-BREAKERS, TYPE B (ELECTRICALLY OPERATED)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. This type of thermal circuit-breaker is an electrically operated unit designed for the remote control of circuits that carry not more than 500 amp. for 20 seconds or up to 100 amp. continuously. The range includes circuit-breakers operating from 12 and 24 volt d.c. supplies, which may be used to control either a.c. or d.c. circuits up to 110 volts a.c. and 24 volts d.c., the maximum permissible short-circuit current being 1500 amp. a.c. or d.c.

2. They may be installed near the controlled equipment and operate from a distant point by means of push-buttons.

3. The thermal circuit-breaker, type B embodies a thermal overload release which has a thermal storage characteristic similar to that of an electric motor. When the temperature of the controlled equipment approaches an excessively high temperature, the circuit-breaker is automatically tripped. The circuit-breakers bear assigned ratings which they will carry continuously at sea level at an ambient temperature of 57° C., without tripping. They will carry 115 per cent. of their assigned rating continuously without tripping and at 138 per cent. rating they will trip within one hour with an ambient temperature of 25° C.

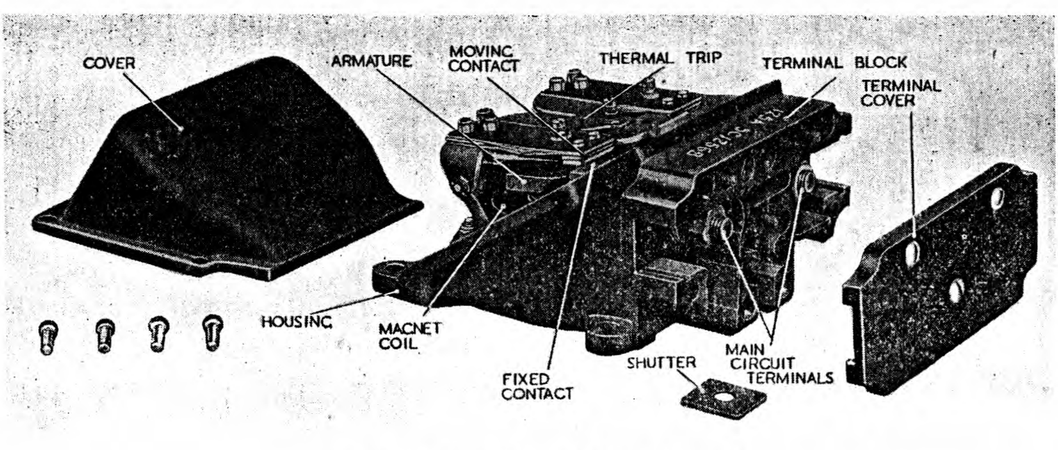


Fig. 1.—Thermal circuit-breaker, type B

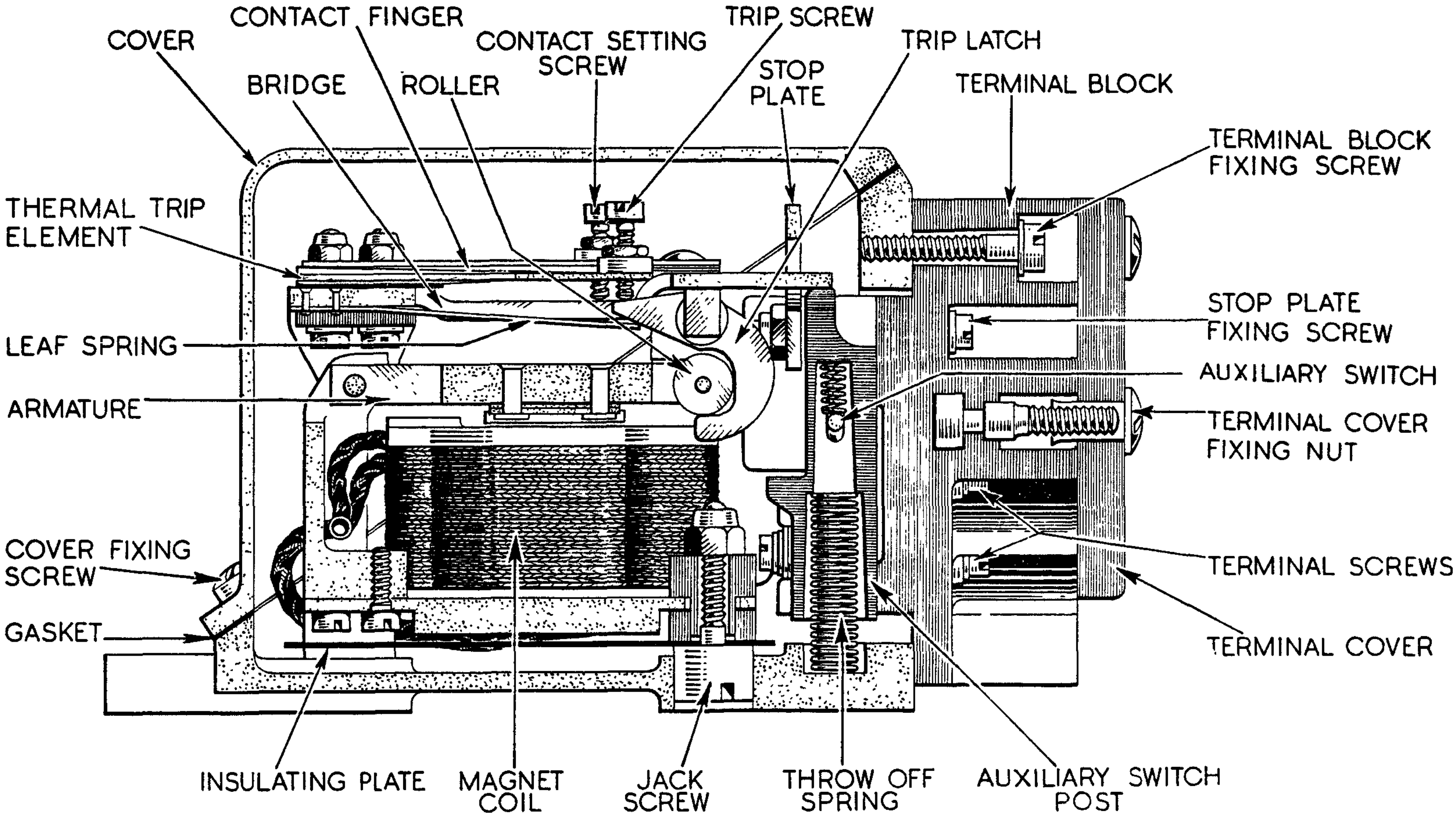


Fig. 2.—Sectional view of thermal circuit-breaker, type B

4. If the thermal circuit-breaker is to be used in conjunction with continuously rated equipment, an external economy resistance must be included in the operating circuit to prevent overheating of the magnet coils. A single pole auxiliary switch, actuated by the movement of the armature is incorporated in the circuit-breaker. The economy resistance is wired up so that it will be connected in series with the magnet coils by means of this auxiliary switch, when the circuit-breaker closes, and the "close" push-button is released.

Types available

5.

Stores Ref. 24-volt coil	*12-volt coil*	*Continuous Rating (Amps.)*
5C/2568	—	100/125(*)
5C/2567	5C/2734	100
5C/2566	—	80
5C/2565	—	65

Note (*). The 125 amp. rating is the maximum obtainable on this unit, which is intended only for short time applications up to a maximum of 5 min. The unit can be given a non-standard setting that permits loads up to 500 amp. for 20 seconds.

6. The auxiliary switch should not be allowed to carry a current of more than 2 amp. The normal closing current is 1·5 amp. at 24 volts or 3 amp. at 12 volts. When the economy resistance is used with continuously rated circuit-breakers this current is reduced after closing to 0·35 amp. for the 24 volt unit and 0·7 amp. for the 12 volt unit. The resistance values of the economy resistances are as follows:—

Stores Ref. 5C/2742, 57 ± 3 ohms for use with 24 volt units.
Stores Ref. 5C/2743, 13.75 ± 0·75 ohms for use with 12 volt units.

DESCRIPTION

7. The type B thermal circuit-breaker is illustrated in fig. 1 and a general arrangement perspective drawing in fig. 2. Referring to fig. 2 it will be seen that this type of circuit-breaker comprises a stationary electro-magnet, a pivoted armature, a pivoted contact assembly, and a thermal overload device built into the contact assembly.

8. The closing electro-magnet is energised by two series connected bobbin windings. The armature is hinged at one end, carries a roller at the other end, and bridges the two stationary magnet poles. The two stationary poles are recessed and house throw-off springs to re-set the armature after its release and also to open the breaker. The face of the armature is covered by a thin beryllium copper sheet to prevent magnetic sticking when the coil is de-energised. The duralumin contact bridge incorporates the two main contact fingers and the thermal trip element. The bridge is hinged on the same shaft as the armature and also carries a trip latch which normally engages with the roller on the armature.

9. The latch is biased to the engaging position by a small leaf spring riveted to the moving bridge but the latch can be rotated to the trip position by the thermal trip element which is in series with the two contact fingers. Each finger consists of a silver tungsten tip with silver-plated copper laminations, backed by a flat spring of beryllium copper. The components are riveted together at the contact ends.

10. The thermal trip element is a composite sheet, the top layer having a higher temperature coefficient of expansion than the lower one. Heat is generated in the element by the main current passing through it. The effect of such heating on overload is to deflect the element downwards until it disengages the latch from the roller.

11. Insulation is interposed between the bridge and the fixed ends of the contact fingers to ensure that the current passes through the thermal trip and not through the duralumin bridge. This insulation is not of the same value as that between live parts and the earthed frame because the bridge itself is fully insulated from earth.

12. The thermal element has a trip screw and locking nut fitted to the centre of the U portion (see fig. 3(iv)). This screw can be adjusted when the circuit-breaker is calibrated.

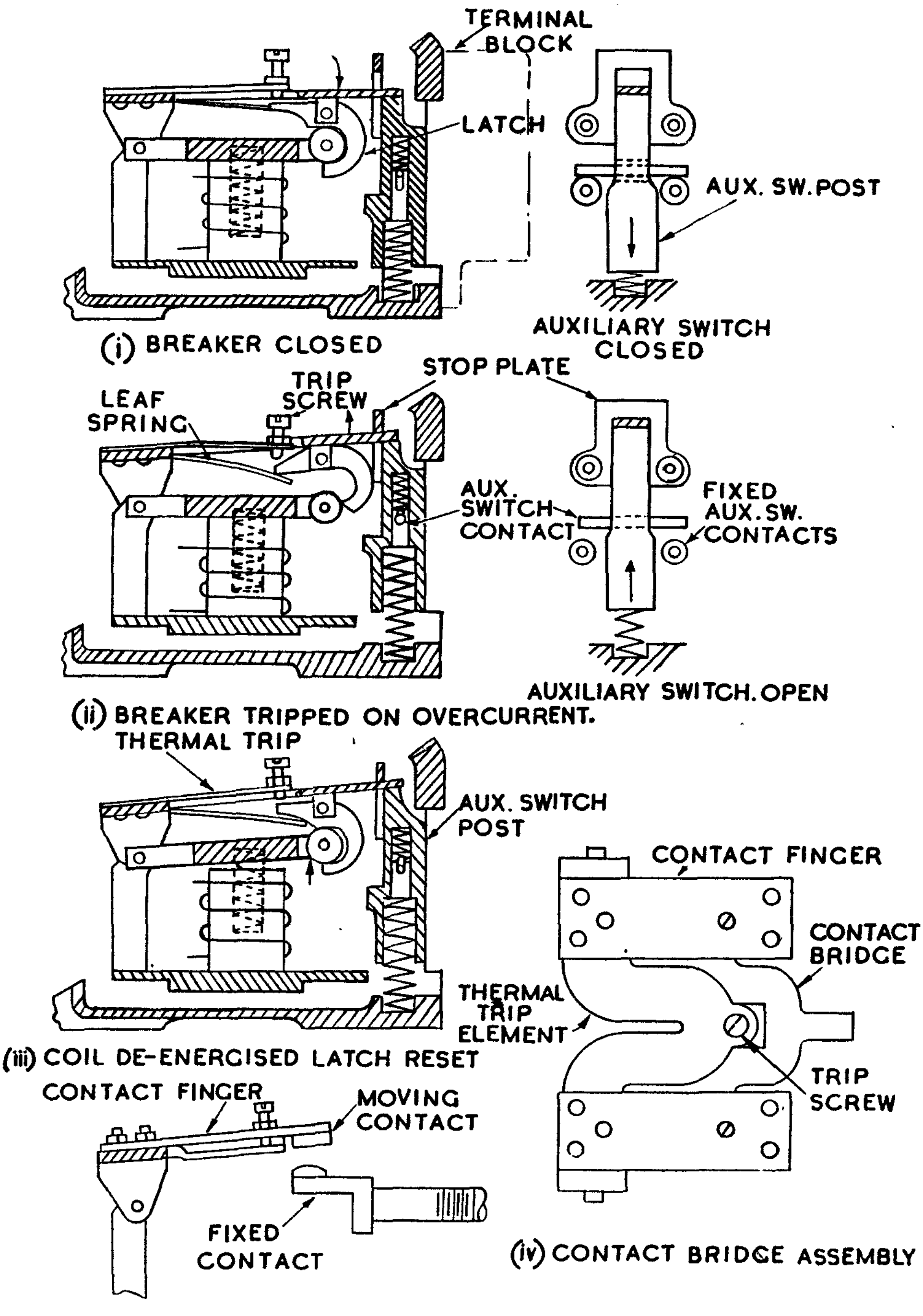


Fig. 3.—Operation of the thermal circuit-breaker, type B

13. The breaker contacts are biased to the open position by the throw off springs in the poles and by a compression spring located in the lower end of the auxiliary switch post, which bears upwards against the extended tip of the contact bridge.

14. The moving contact of the auxiliary post is a loose pin contained in a closed slot in the auxiliary switch post. A separate spring in the post holds the pin down to the bottom of the stop. When the post is depressed the pin connects the two fixed contacts of the auxiliary switch and further depression of the post compresses the small spring, giving resilience to the contact. The two fixed contacts of the auxiliary switch are of silver and are moulded into the terminal block.

15. The whole of the circuit-breaker mechanism is mounted in the metal housing on three adjustable and insulated jack screws. The coils are secured on the magnet poles by circlips, and spring loading washers are inserted between the coils and the base plate of the magnet.

16. The fixed contacts for the main circuit are located in rectangular slots in the moulded terminal block and are keyed to prevent rotation, Ioco varnish being used to fill up any small clearances. The fixed contacts are dome-shaped to a large radius, thus affording self-aligning point contact.

17. All terminals are housed in recesses moulded in the terminal block which is attached to the breaker housing by means of six cheese head screws. Combined screws and washers (4 B.A.) are used for the coil terminals to accommodate two cables, Ducel 7 (Stores Ref. 5E/1363) or four cables, Unicel 7 (Stores Ref. 5E/1359). The main circuit terminals consist of two $\frac{5}{16}$ in. B.S.F. studs fitted with nuts and lock-washers, suitable for cables up to Unistartvin, No. 2 (Stores Ref. 5E/2129) adapted for terminal lug, No. 8 (Stores Ref. 5C/1901).

18. Identification numbers are moulded in the terminal block adjacent to the appropriate terminals and recessed outlets are provided for the external connection cables. Alternative outlets from the main terminals are included, being fitted with removable shutters so that the outlet not in use can be closed.

19. One operating coil terminal is connected to one of the auxiliary switch terminals by a short wire link which can be removed if not required. The terminals and connections are protected by a moulded terminal cover which is held in position by three hollow nuts with slotted heads.

20. A metal cover is attached to the circuit-breaker case by means of four filister head screws. A gasket is fitted into the joint to provide weatherproof protection for the unit. The case has four drilled lugs cast integral at each corner for mounting purposes. Each complete circuit-breaker weighs 2 lb. 10 oz. irrespective of its rating.

INSTALLATION

21. The circuit-breaker will operate satisfactorily in any position in which accelerations do not exceed 10g. The best position is with the machined base of the breaker mounted on a vertical panel with the terminal block underneath so that the ingress of moisture to the terminal recesses is avoided. Maximum accelerations are usually vertical and the breaker will resist considerably more than 10g in this direction when installed in this manner.

22. Although the circuit-breaker is weatherproof it should be located, as far as possible, in positions free from direct splash, such as wheel spray, leakage from windows, condensation or where possible leakage or overflow of Glycol or petrol from tanks may drip on to the unit.

23. If the circuit-breaker has to be installed in a location which is subject to continued vibration such as in engine nacelles, a suitable rubber pad or a flexible damped mounting must be used. In such cases provision must be made to ensure that the main circuit leads cannot vibrate independently from the circuit-breaker, causing wear on the terminals or loose connections. The circuit-breaker must not be mounted on the engine direct.

24. Make sure that the space surrounding the breaker will permit the unrestricted use of a $\frac{5}{16}$ in. B.S.F. box spanner on the main circuit terminal nuts, a small screw driver for the screws on the terminal cover and the control circuit terminal screws and also for the screws in the cover.

25. Space must also be allowed for mounting the economy resistance adjacent to the circuit-breaker, when the unit is to be used in conjunction with continuously rated equipment.

26. As the closing coils are designed to operate down to 66 per cent. of the nominal voltage, suitable control cables must be used to ensure that excessive voltage drop does not occur in the cable.

27. The maintenance of maximum voltage across the operating coils is particularly important. If the circuit-breaker is to be used for engine starters or other equipment, where the supply accumulator voltage may be reduced considerably by the starting surge of current, the cables from the control circuit should be taken direct to the distribution centre or as near to the accumulators as possible and not tapped off the heavy cables to the motor.

28. Typical wiring circuits are illustrated in fig. 4 the main circuits being shown in heavy lines. For short-rated, non-reversing motors the auxiliary switch connections are not required and the motor will operate only as long as the controlling push-button is held down.

29. In the case of continuously rated non-reversing motors, two push-buttons are installed, one to make the closing circuit and the other for tripping purposes, as shown in fig. 4.

30. Two circuit-breakers will be required for the protection of short-rated reversing motors one being connected in the circuit to each field coil.

31. The push-buttons may be installed on the pilot's or mechanic's control panel or any other convenient position as required.

OPERATION

32. The operation of the circuit-breaker, type B, is illustrated in fig. 3. It will be seen that the circuit-breaker is normally biased to the open position by the throw-off springs in the auxiliary switch and in the magnet poles. Since the thermal element is normally at the local ambient temperature, the latch is engaged on the roller. When the magnet coils are energised by the control switch, the armature is attracted to the closed position, pulling the contact bridge with it by means of the roller and latch. This movement compresses the throw-off springs in the auxiliary switch post and in the magnet poles (fig. 3 (i)). Just before the breaker reaches the fully closed position, the auxiliary switch circuit is closed and this may be used as a lock-in circuit to maintain the magnet coil circuit and hold the breaker closed.

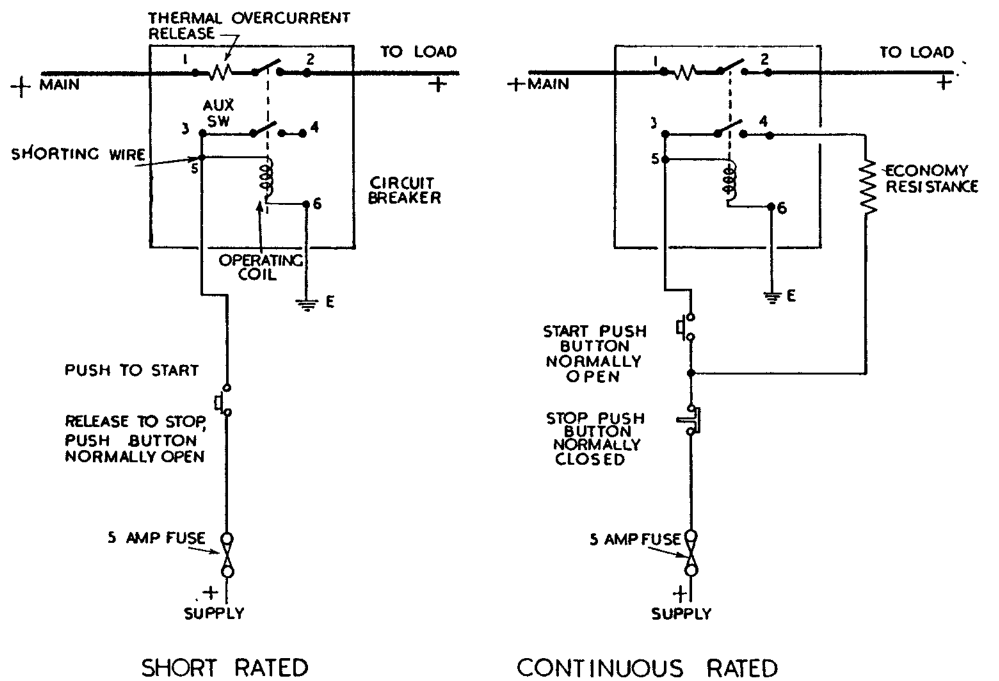


Fig. 4.—Typical circuit diagrams

33. Two alternative methods of operation are permissible depending on whether the unit is to be used in conjunction with short-rated or continuously rated equipment. If the magnet coils are to be energised for a maximum period of three minutes the full voltage may be applied to the coils, and under these conditions the drop-out voltage is 21½ on a 24 volt circuit. If the breaker is

to be closed for more than three minutes an external economy resistance must be inserted as shown in the diagram (ii) in fig. 4. This will reduce the hold-in current and consequently the temperature rise of the coils. Under this arrangement the drop-out voltage is approximately 16 on a 24 volt breaker.

34. When the circuit-breaker is closed the main circuit is completed through the moving contacts and the U-shaped thermal unit which commences to heat (fig. 3 (i)), normally this heat is carried away by radiation and convection, the mean result being a slight deflection of the thermal element. If the current is sufficiently great, the deflection of the element will release the latch from the roller of the armature and the contacts will be forced to the open position by the throw-off spring in the auxiliary switch post (fig. 3 (ii)). The armature will remain attracted by the magnet so long as its coil is energised.

35. In the event of an external economy resistance having been inserted by the closing of the auxiliary switch, the release of the contact bridge will also open the auxiliary switch, thus breaking the coil circuit, and releasing the armature immediately, unless the coil circuit is completed by other external means.

36. When the armature is released its throw-off springs cause it to rise and re-engage its roller on the latch in the contact bridge (fig. 3 (iii)). The circuit-breaker is then ready for reclosure under remote control, but it will not reclose on its own.

37. The thermal element requires a certain time to trip the circuit-breaker, this time being shorter on greater overloads. Similarly, the thermal element will take time to cool off after tripping, therefore a cooling time of 20 seconds approximately is necessary before the circuit-breaker can be re-closed with certainty or unnecessary burning of the contacts will result.

SERVICING

Inspection and testing

38. It is important that *no attempt be made to adjust the breaker when installed in the aircraft.*

Mechanical inspection

39. After removing the breaker from the aircraft carry out the following inspection:—

(i) Remove the front cover which exposes the breaker and its mechanism. Examine the contacts and, if any fused beads of metal appear on the contacts remove them with a thin, dead-smooth file. In this operation care should be taken to remove the minimum material and to blow away any particles of metal which may otherwise collect on the insulators. Under normal conditions the contacts should be in good condition, and no filing should be necessary.

(ii) Close the breaker electrically and measure the gap between the contact setting screw and the duralumin bridge. This screw is situated in the backing spring near the moving contact as shown in fig. 2. The manufacturer's setting for the gap is 0·015 in. to 0·018 in., but the breaker may be considered serviceable if the gap is not less than 0·010 in. If the gap is less than 0·010 in. burning of the contacts may develop, and the screw should, therefore, be adjusted as necessary.

(iii) Open the breaker and measure the gap between the main contacts which should be 0·1 ± 0·010 in.

(iv) Check the contact pressure by closing the breaker electrically and pulling off each main contact in turn, using a spring balance and a loop of string round the Berrylium spring adjacent to the moving contact. Connect a battery with a lamp or bell across the main terminals during this test to give an indication when the contacts have separated. The pressure given by the spring balance should read between 3½ and 4½ pounds when the contacts separate. If the contact pressure is below 3½ pounds excessive heating of the contacts may occur; if above 4½ pounds the breaker will not close at 66 per cent. normal voltage. *No attempt should be made to bend the contact fingers to correct any such errors.*

(v) Check the operation of the auxiliary switch if it is included in the circuit (in some cases this switch is not incorporated). The auxiliary switch should make contact at least 0·015 in. before the end of the closing stroke of the breaker. To measure this, first connect a lamp, or bell, and battery in series with the terminals of the auxiliary switch and then close the breaker electrically. Release the breaker, slowly restraining it by hand. Measure the movement between the tip of the bridge to the stop in two positions, i.e. when the breaker is closed, and when the lamp is extinguished or the bell ceases to ring. The difference between the two measurements should not be less than 0·015 in. for reliable operation.

(vi) To obtain greater access to the contacts and mechanism, remove the stop plate that bears against the extension of the contact bridge when the breaker is open. To do this, remove the two screws that hold the stop plate to the terminal block. The heads of these screws are located in an external recess in the terminal block. When the stop plate is removed the contact bridge and armature assembly can be swung open revealing the mechanism. Care should be taken not to loose the two springs from the magnet poles. In their present position the contacts are more accessible for trimming if necessary. See that the latch is free and that the leaf spring keeps the latch in the "engaged" position. Take care not to damage the Berrylium sheet on the face of the armature. When the internal inspection is complete replace the armature; throw off the springs and see that they are correctly located in the armature. Replace the stop plate by placing it over the bridge extension and closing the breaker by hand. Put the stop plate in position and insert its fixing screw through the terminal block and screw down tightly.

Special note.—The Twi-clips on the ends of the small shaft through the armature are not safe for use after they have been taken off. They should not, therefore, be removed unless new ones are available. A special pair of pliers is necessary for their removal.

Electrical inspection

40. Carry out the following electrical inspection.

(i) With a 250-volt insulation resistance tester check that the insulation resistance between the main terminals, or auxiliary terminals, and the earth case exceeds 20 megohms.

(ii) Check the operation of the breaker on the minimum closing voltage of 16 volts for the 24-volt, and 8 volts for the 12-volt breaker. These operating voltages refer to breakers with their coils cold, i.e. at 20 deg. C.

(iii) Check that the voltage drop across the terminals does not exceed 180 milli-volts at the normal rated current.

(iv) Ensure that, when carrying 200 per cent. normal rated current, the breaker trips within the times quoted below at the ambient temperature prevailing.

Ambient	*Time*
10 deg. C.	60–200 sec.
20 deg. C.	50–150 sec.
30 deg. C.	40–120 sec.
40 deg. C.	35–100 sec.

(v) If the breaker fails to satisfy the requirements laid down in the foregoing paragraphs it should be disposed of in accordance with current instructions.

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CHAPTER 5

THERMAL CIRCUIT BREAKERS, Type D
(Electrically operated)

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LIST OF ILLUSTRATIONS

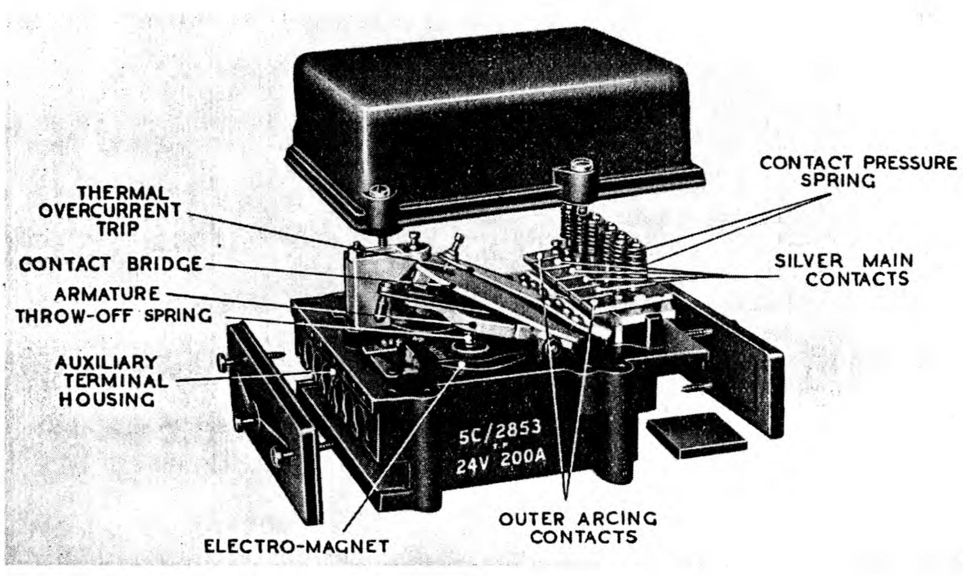

Fig. 1.—Circuit breaker, Type D

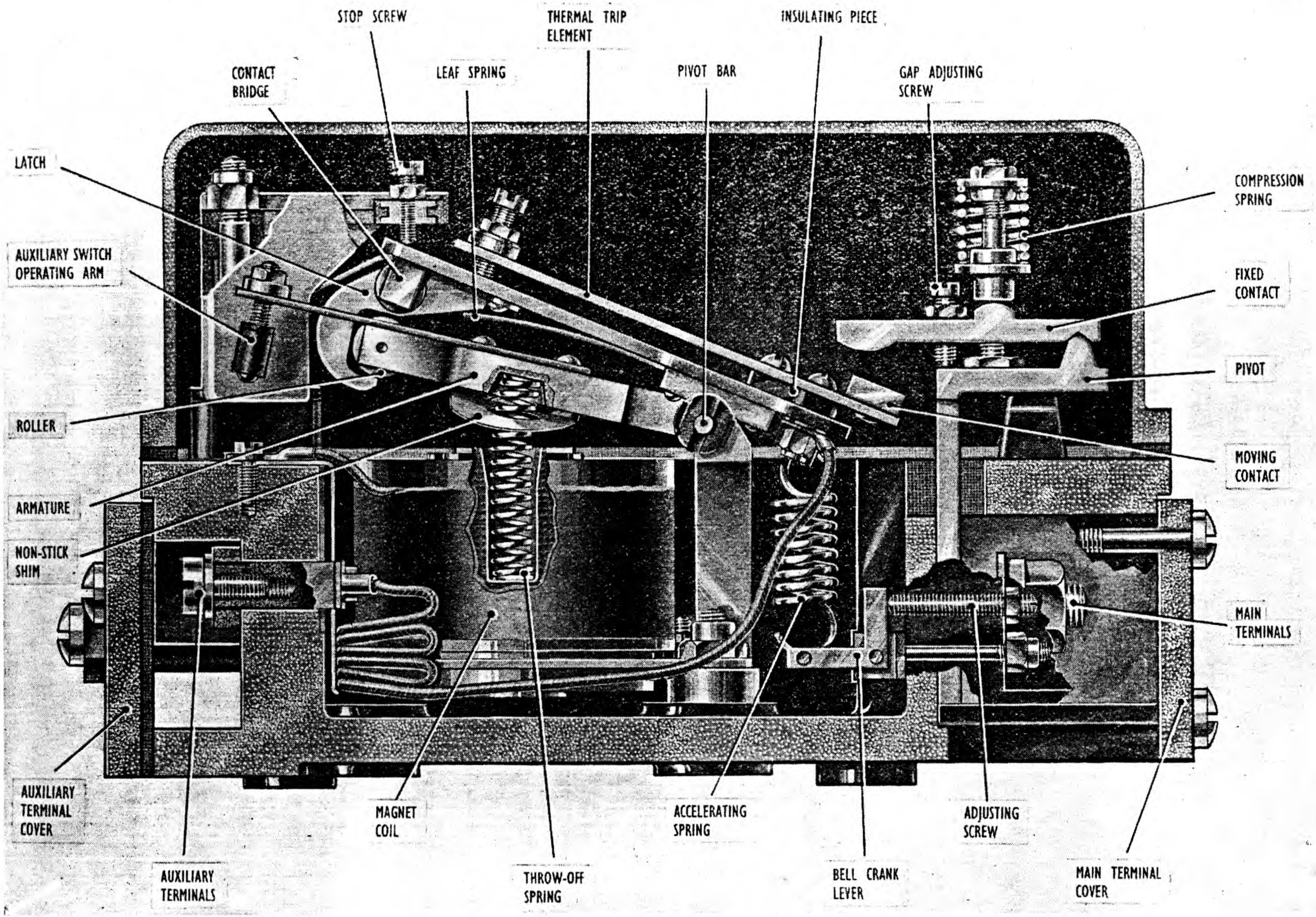

Fig. 2.—Circuit breaker, Type D, sectional view

Introduction

1. The thermal circuit breaker, Type D, Stores Ref. 5C/2853, is an electrically-operated unit employed for the remote control of circuits that carry up to 200 amps. at 29 volts continuously. It is designed for use in conjunction with the cut-out, Type J, in Type P2 generator circuits as an overload circuit breaker.

2. The breaker embodies a thermal overcurrent release, and at any overload likely to cause damage to the generator the circuit breaker is tripped automatically. The relation between the load current and the time taken for the breaker to trip is shown in the form of a graph in fig. 6. As the circuit breaker, Type D, is designed primarily for use with the engine-driven d.c. generator, Type P2, the overlap tripping characteristics are particularly suited to this generator.

DESCRIPTION

3. Fig. 1 shows a general view of the breaker, and a general arrangement perspective drawing is given at fig. 2. From reference to fig. 2 it will be seen that the breaker comprises a stationary electro-magnet, a pivoted armature, a pivoted contact assembly, latching components between the armature and the moving contact assembly, and a thermal overcurrent release built into the contact assembly.

4. The closing electro-magnet is energised by two bobbin windings connected in series. Each bobbin has a double coil, one of high resistance and the other of low resistance, which are connected in series when the breaker is closed and enable the circuit breaker coils to be energised continuously from a 29-volt supply. The armature, which is hinged at one end, and which carries a roller at the other end, bridges the two stationary magnet poles. Two throw-off springs are located in recesses in the magnet poles, their function being to re-set the armature after its release. The face of the armature is covered with a thin beryllium copper sheet to prevent the armature holding closed when the coil is de-energised.

5. The contact bridge is made of duralumin and carries a U-shaped bi-metal thermal element and also the two main moving contacts. The bridge is hinged on the same shaft as that of the armature and carries a trip latch which normally engages with the roller on the armature. The latch is biased to the engaging position by a small leaf spring riveted to the moving bridge. The latch can, however, be released by the thermal trip element.

6. The thermal tripping element is of composite metal sheet construction, the top layer of which has a higher temperature co-efficient of expansion than the lower layer. This element carries the line current and heat is generated in the element by the current passing through it. The heat produced on overload is such that the end of the element is deflected downwards until it disengages the latch from the roller. To ensure that the current passes through the thermal element and not through the duralumin bridge, insulation is interposed between these two components. The thermal element carries an adjusting screw in the centre of the V-portion for calibration of the over-current release.

7. The breaker moving contacts are biased to the open position by an accelerating spring, one end of which is attached to the contact end of the bridge, the other end being secured to a small bell crank lever. The pull of the spring may be adjusted by a screw which bears on the vertical arm of the bell crank lever. This adjustable stop screw is situated between the two main terminals adjacent to a 6 B.A. stiffnut, and is accessible when the terminal cover is removed.

8. Two auxiliary switches, which are normally closed, are provided, one for the operation of the warning lamp, and the other for inserting the high-resistance coils when the armature is closed. When viewed from the end opposite the contacts, the left-hand switch controls the warning lamp, and that on the right hand is the economy switch. Each auxiliary switch consists of a flat strip of beryllium copper spring, to one end of which is fixed a silver contact, the opposite end being secured to the base. The signal lamp auxiliary switch is operated by an arm fixed to the contact bridge, whilst the economy auxiliary switch is actuated by an arm attached to the armature. An adjusting screw, with an insulated cap at its lower end, is fitted on each arm to control the open position of the auxiliary switches.

Main contacts

9. The fixed contacts are carried by contact fingers that have a vee-shaped slot at their opposite ends. The fingers are pivoted on a rounded fulcrum which engages with the vee-shaped slots, and each finger is held in position by an adjustable compression spring. The latter is mounted on a pin which passes through a hole in the finger. An adjusting screw at the contact end of each finger locates the finger when the breaker is open.

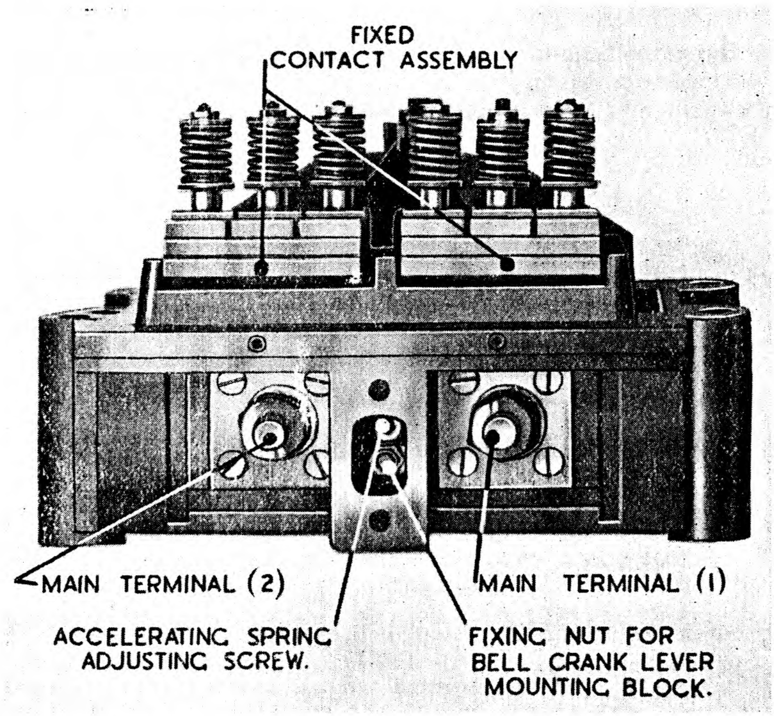

Fig. 3.—Circuit breaker, viewed from contact breaker end

10. The two sets of three contacts are arranged in a row with the two arcing contacts at the outer ends. The fixed contact tips are domed; those on the four centre contacts are of fine silver and the arcing tips are of high melting point, high rupturing capacity alloy. The moving contacts consist of two flat bars, the portion of each bar that lies beneath the two inner contacts is of fine silver, whilst that part under the outer arcing contacts is of high melting point alloy.

Terminals

11. The two main terminals are situated at one end of the breaker and the five small terminals of the auxiliary circuits at the other. The two terminal covers are fixed by captive screws. Cable access to the side or rear of each main terminal is provided by a small shutter that may be placed in either of two positions to suit the entry of the main cables. The leads to the small terminals enter through a slot in the side of the terminal chamber. A synthetic rubber gasket is fitted between the auxiliary terminal cover and the base. Provision is also made for sealing the small cables by means of synthetic rubber grommets.

12. The terminals (*see* fig. 5) are numbered and connected as follows:—

(i) 1 and 2 are the main terminals in series with the two sets of contacts and the thermal element.

(ii) 3 and 5 are connected in series with the warning lamp auxiliary switch.

(iii) 4 and 7 are in series with the two closing coils and the closed economy auxiliary switch when the breaker is de-energised. When the breaker is closed the economy switch opens to insert the high resistance economy windings.

(iv) 8 is connected through a 2-ohms resistance to the main moving contact assembly, and thus, when the breaker is closed, terminal 8 is connected through the 2-ohms resistance to terminals 1 and 2. This connection is employed to energise the Londex relay in the radio power units when the main circuit breaker closes. The 2-ohms resistance limits the circulating currents on installations with generators operating in parallel.

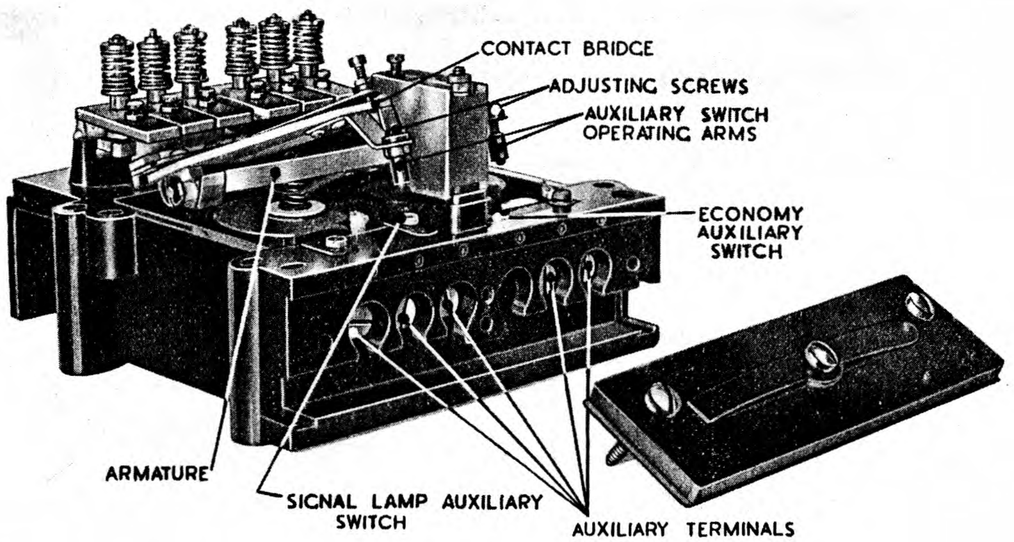

Fig. 4.—Circuit breaker, showing auxiliary terminals

INSTALLATION

13. The circuit-breaker will operate satisfactorily in any position in which the accelerations do not exceed 10g. If mounted with the base vertical, the main terminals should be located underneath.

14. Although the circuit breaker is substantially weatherproof it should be located, as far as possible, in a position where it is free from moisture of any kind, such as wheel spray, leakage from windows, condensation, and glycol or petrol, that may drip on to the unit.

15. The maintenance of maximum voltage across the operating coil is of particular importance, and the cables, from the control circuit should be taken directly to the distribution centre, or as near to the accumulators as possible. They should not tap off heavy leads supplying the load which would introduce large voltage drops in the circuit breaker coils circuit.

OPERATION

16. The circuit breaker is normally biased to the open position by the accelerating spring and by the two throw-off springs in the magnet cores. Since the thermal element is normally at local temperature the latch is engaged on the roller, as shown in fig. 2.

17. When the magnet coils are energised, the armature is attracted to the closed position, pulling the contact bridge with it by means of the roller and latch. This movement compresses the springs in the magnet cores and extends the accelerating spring. Just before the armature reaches the closed position the two auxiliary switches are opened; one opens the signal circuit, and the other inserts the economy windings so that the armature is held in the closed position with reduced current.

18. In the event of an overload, the thermal unit deflects downwards, the latch is disengaged from the roller, and the main contacts, thus released, are opened by the accelerating spring. The armature remains attracted to the magnet, the economy coils are left in circuit, and the warning lamp contacts are closed. When the control switch is opened the throw-off springs push the armature off until the roller re-sets on the latch. The opening of the main contacts disconnects terminal 8 from the main terminals 1 and 2.

19. The circuit breaker may be re-closed after allowing a short lapse of time for the thermal unit to cool and to revert to its original position.

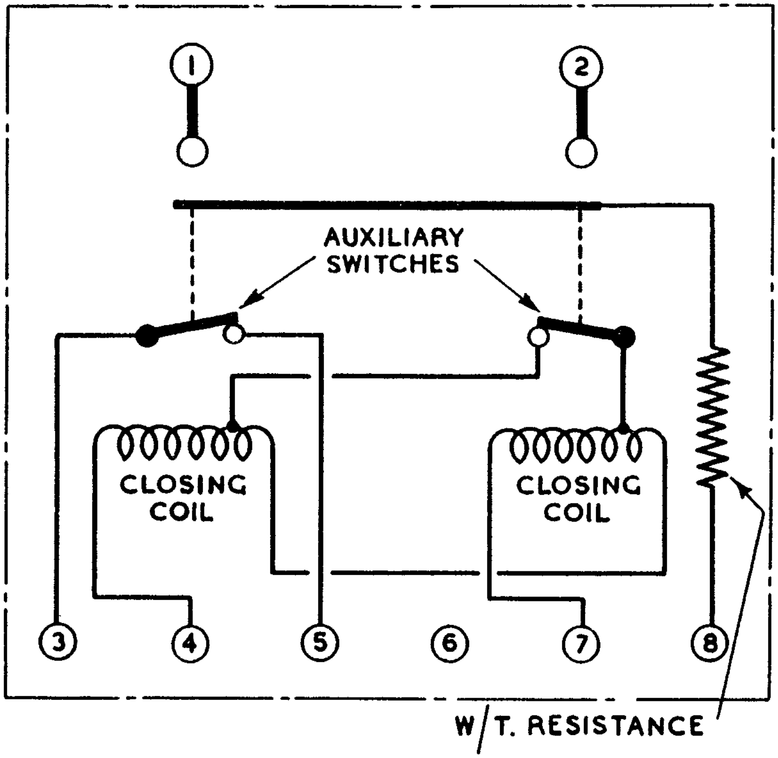

Fig. 5.—Circuit diagram

SERVICING

General

20. Only visual inspection and minor fault correction may be carried out by user units, and no attempt must be made to adjust the breaker in situ. Sealed screws and nuts must not be tampered with and adjustments to the breaker must be only be carried out by Maintenance Units in accordance with the instructions given in Vol. II, Part 3 of this publication.

Checking breakers installed in aircraft

21. Little or no servicing can be done whilst the unit is installed in the aircraft and only the items outlined in this paragraph should be attempted. For all other adjustments the circuit breaker must be taken from the aircraft and removed to the workshops.

(i) Examine the contacts for signs of burning. The outer (arcing) contactor will invariably show some signs of blackening. It should be appreciated that the breakers are examined to obtain an indication of condition and reliability only, any remedial action can only be taken when the breaker has been removed for attention at a Maintenance Unit.

(ii) Check all cable connections ensuring that they are clean and that the terminal screws are firmly tightened down.

Checking breakers in workshops

22. To inspect the breaker, the front cover should first be removed, and the following procedure carried out:—

(i) Examine the surface of the arcing contacts to ensure that there are no beads of fused metal present, see (i), para. 21.

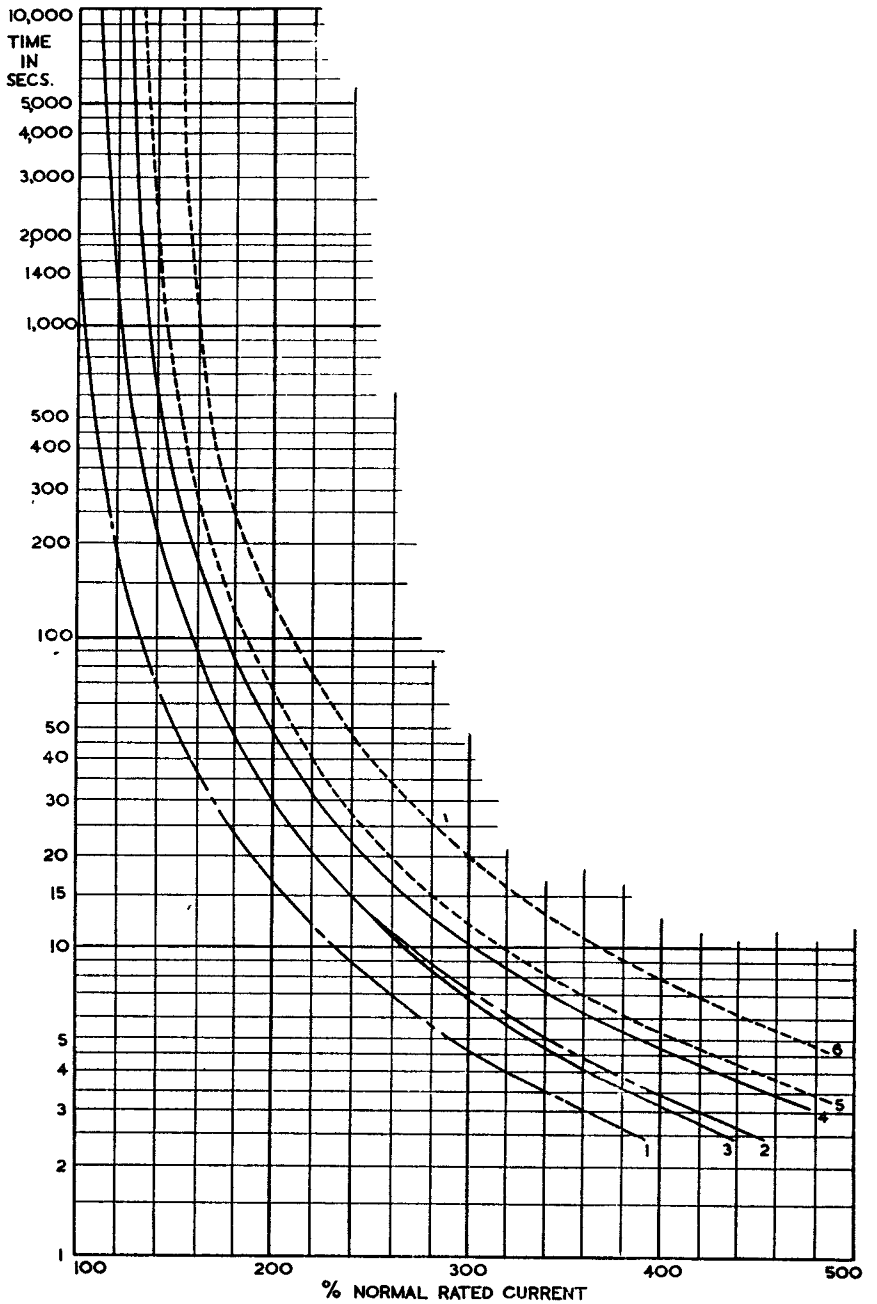

Fig. 6.—Graph showing time/load rating

(ii) If the contacts are in good condition, check the gap between the outer stationary (arcing) contacts and their respective moving contacts, which should be not less than 0·095 in.

(iii) Check the gap between the four inner stationary contacts and their respective moving contacts. To enable the arcing contacts to break the circuit and carry the arc, this gap setting should be greater than that of the arcing contacts.

(iv) Check the auxiliary contact operating buttons for security in their brackets.

(v) Re-install the circuit breaker in the aircraft.

23. Do not attempt to close the circuit breaker manually except by pressing on the armature. The auxiliary contact buttons and brackets must be handled with great care, and only when absolutely necessary. Do not tamper with sealed screws and nuts, and if the unit proves faulty, remove, replace with new, and send the faulty breaker to the appropriate depot for repair.

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CHAPTER 7

4-WAY AUTO-SELECTOR SWITCHES, Type B and C

Leading particulars

1.	Length (over glands)	5 in. approx.
	Width	4½ in. approx.
	Depth	3 in. approx.
	Weight	2 lb.
	Stores Ref. No. Type B (12 volt)	5D/609
	Type C (24 volt)	5D/632
	Type B, No. 2 (12 volt)	5D/1296
	Type C, No. 2 (24 volt)	5D/1297

Introduction

Type B and C

2. The 4-way auto-selector switch, Type B or C, is used to energize four circuits in sequence, the circuits being controlled by a single selector switch. The type B switch is for use on 12-volt circuits, and the Type C is for use on 24-volt circuits.

3. The switch is secured in any convenient position on the bomb carrier, and the output circuits are connected to the E.M. release units. The input circuit is energized by the operation of the firing switch, and the mechanism of the switch connects each of the output circuits in turn to the input circuit.

Type B, No. 2, and Type C, No. 2

4. The 4-way auto-selector switch, Type B, No. 2 or Type C, No. 2 is similar to the Type B or C switch, but has been modified for use on R.P. installations, see para. 20. The Type B, No. 2 switch is for use on 12-volt circuits, and the Type C, No. 2 switch is for use on 24-volt circuits.

5. The switch is secured in any convenient position in the aircraft, and the output circuits are each connected to a pair of R.P.'s, one in each wing installation. The input circuit is energized by the operation of the firing switch after the PAIRS-SALVO switch has been switched to PAIRS.

4-WAY AUTO-SELECTOR SWITCHES, TYPE B and C

Description, fig. 1, 2 and 3

6. The components of the switch are mounted in a light alloy case having a detachable cover. A rubber ring accommodated in a groove in the cover seals the switch when the cover is fitted. The five connecting cables to the switch are of Dusheathsmall 4 cable, and enter the case through five knurled sleeves and glands. The glands are marked IN, 1, 2, 3 and 4 to correspond with the respective circuits.

7. An electro-magnet having two windings is fitted to a mounting plate screwed to the back of the case. A flat armature, pivoted at one end, is positioned above the electro-magnet, and is normally maintained away from the magnet pole face by an armature restoring spring, while a cranked armature stop bracket limits the movement of the armature in an upward direction. A residual plate is fitted to the armature face to prevent the armature sticking in after operation.

8. The two electro-magnet windings are known as the main and retaining windings, and are connected in parallel to energize the electro-magnet sufficiently to attract the armature. A pair of interrupter contacts are mounted at the side of the armature, and are connected in series with the main winding. These contacts are actuated by the movement of the armature through an insulating buffer attached to the lower contact spring. The interrupter contacts are closed with the armature in the unoperated position, but are opened when the armature is attracted to the electro-magnet, disconnecting the main winding. The outer winding provides sufficient energization to maintain the armature in the operated position once it has been attracted to the magnet pole face. In the Type B switch, the resistance of the main and retaining windings is 6 and 15 ohms respectively. In the Type C switch, the resistance of the main and retaining windings is 23 and 60 ohms respectively.

9. Five separate pairs of spring contacts are mounted together in a bank above the electro-magnet assembly. The four lower pairs of these contacts are connected in series with the four output circuits, whilst the fifth or top pair is connected in series with both electro-magnet windings.

10. The opening and closing of the five pairs of contacts to connect each output circuit in turn is controlled by the actuating mechanism of the switch. This mechanism consists of five fibre cams, and a 12-tooth ratchet wheel mounted on a cam shaft, which is rotated one tooth at a time by a feed pawl attached to a bracket arm at the free end of the armature.

11. The feed pawl engages the teeth of the ratchet wheel so that each time the armature is operated, the pawl is stepped over one of the teeth. When the armature returns to the unoperated position, the ratchet wheel is rotated $\frac{1}{12}$th of a revolution by the movement of the pawl. The pawl is maintained in engagement with the ratchet wheel by a spring and a pawl stop, and the ratchet wheel is prevented from rotating in the reverse direction by a detent spring.

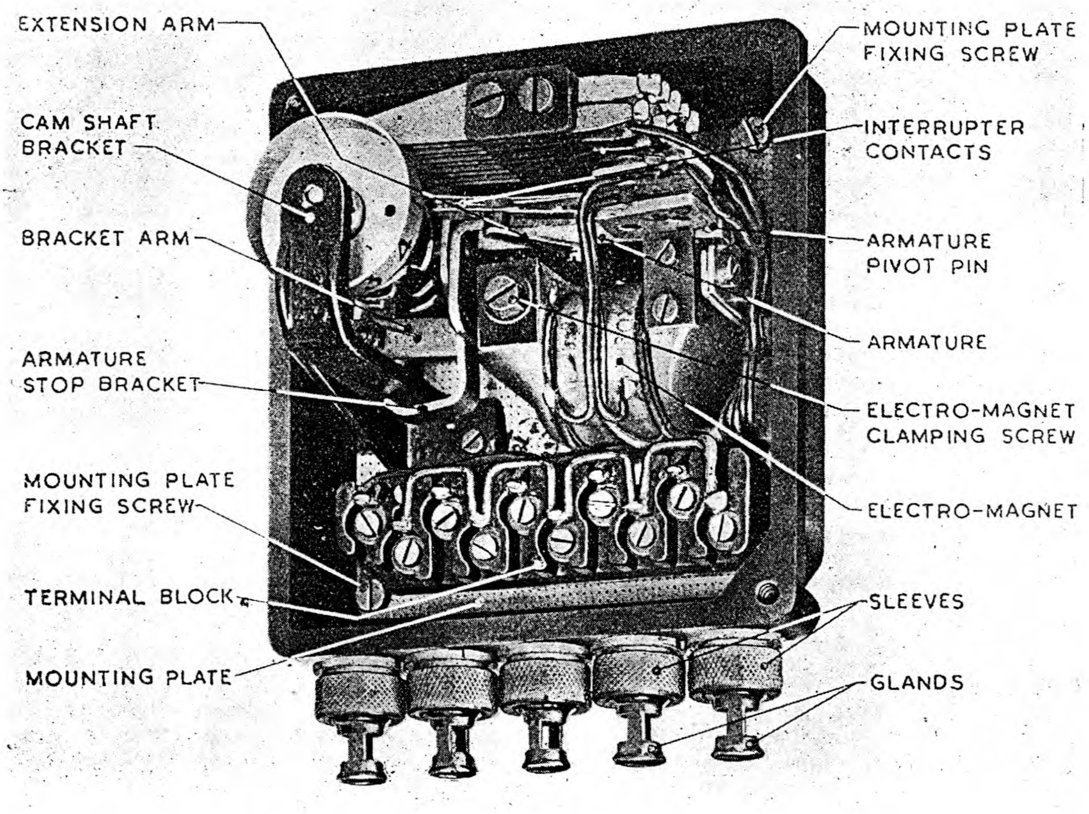

Fig. 2.—4-way auto-selector switch, type B or C, less cover

12. The movement of the ratchet wheel rotates the five fibre cams which are so positioned that the edge of each is between the lips of one of the five pairs of contacts thus holding the contacts apart. Three slots are cut in each cam so that when a slot is between the lips of a pair of contacts, the contacts are closed. The positioning of the slots in the cams is such that, as the cams are rotated, the four pairs of contacts close successively, connecting each output circuit in turn. The fifth pair of contacts are normally closed, but are opened when the fourth pair of contacts close, thus disconnecting the electro-magnet windings and preventing further operation of the switch.

13. A number dial, fitted to the cam shaft, has the numbers 1, 2, 3, 4 repeated three times on its circumference. One figure at a time is visible through an inspection window in the cover, and the figure shown indicates the particular output circuit which is connected to the input circuit.

14. A terminal block having ten terminals is provided at the bottom of the case for the external connections. The terminals are in pairs diagonally, the left-hand pair being for the input circuit, the next pair for No. 1 output circuit and so on.

15. A spring-loaded re-setting button is fitted to the case to enable the switch mechanism to be moved round mechanically for setting purposes. When the re-setting button is depressed and released, it moves the armature and pawl to rotate the camshaft to the required position.

Operation, fig. 3

16. The switch must first be set, if necessary, by depressing and releasing the re-setting button until the figure 1 is visible through the inspection window.

17. After switching ON the appropriate selector switch, the auto-selector switch is actuated when the firing switch is closed, two parallel circuits being completed as follows:—

(i) Through the closed pair of contacts (marked 1 in fig. 3) to No. 1 output circuit, actuating the release unit controlled by this circuit.

(ii) Through the main and retaining windings of the electro-magnet, via the closed pair of contacts (marked M in fig. 3) and the interrupter contacts, thus attracting the armature. When the armature reaches the operated position, the interrupter contacts are opened, disconnecting the main winding and leaving the retaining winding in circuit to maintain the armature in the operated position.

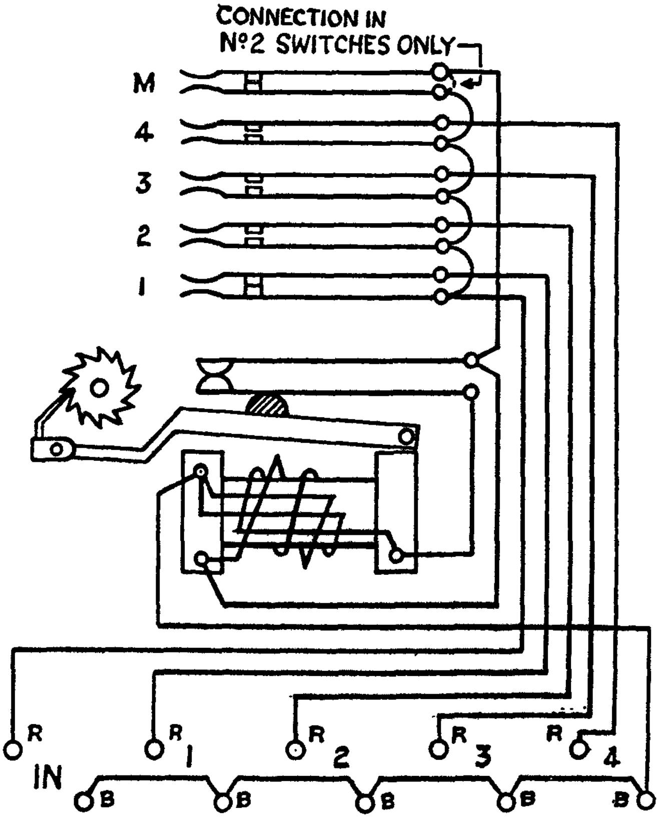

Fig. 3.—Circuit diagram of the 4-way auto-selector switch, type B or C

18. When the firing switch is released, the armature returns to the unoperated position under the action of the armature restoring spring. As the armature moves upwards, the feed pawl rotates the ratchet wheel, fibre cams, and number dial. The movement of the cams opens the contacts in the No. 1 output circuit and closes the contacts in No. 2 output circuit. Subsequent operations of the firing connect and energize each output circuit in turn. With the fourth operation of the firing switch, the No. 4 output circuit is energized and the fifth pair of contacts (marked M in fig. 3) are opened, disconnecting the electro-magnet windings and preventing further operation of the switch.

19. When operating the firing switch, firmly press the switch once only each time it is required to release the store. Intermittent pressure will cause the switch to operate twice and so effect dual release.

4-WAY AUTO-SELECTOR SWITCHES, Type B, No. 2 and C, No. 2

Description

20. The 4-way auto-selector switches, Type B, No. 2 or C, No. 2 are similar to the Type B or C switches described in para. 6 to 15, but the fifth or top pair of contacts in the contact bank are shorted out. The electro-magnet windings are thus not disconnected after No. 4 output circuit has been energized, and subsequent operations of the firing switch repeats the successive connections to the output circuits.

Operation

21. The switch must first be set if necessary by depressing and releasing the re-setting button until the required number is visible through the inspection window according to the instructions for any particular aircraft R.P. installation.

22. After switching the PAIRS-SALVO switch to PAIRS, the auto-selector switch is actuated as stated in para. 17 and 18 except that a pair of R.P.s are connected and fired each time the firing switch is operated, and that the switch is not prevented from further operation after reaching the No. 4 position.

SERVICING

23. The servicing instructions given in the following paragraphs are for all types of 4-way auto-selector switches.

24. The switch mechanism should be inspected periodically for cleanliness, damage and security, and tested for correct functioning. The contacts should be cleaned if necessary, with a contact cleaner or a strip of smooth spring steel.

Note.—When replacing the cover, ensure that the rubber ring is in position in the groove in the cover flange.

Lubrication

25. The following parts should be lubricated periodically with oil, lubricating, anti-freezing (Stores Ref. No. 34A/43):—

(i) Cam shaft bearings
(ii) Detent bearing
(iii) Armature pivot pin
(iv) Feed pawl bearing
(v) Tip of the armature restoring spring.

Note.—Lubricate very sparingly, ensuring that no oil is allowed to get on the contacts or on the internal wiring.

P6044 M /G2981 1/45 6750 C & P Gp. 1

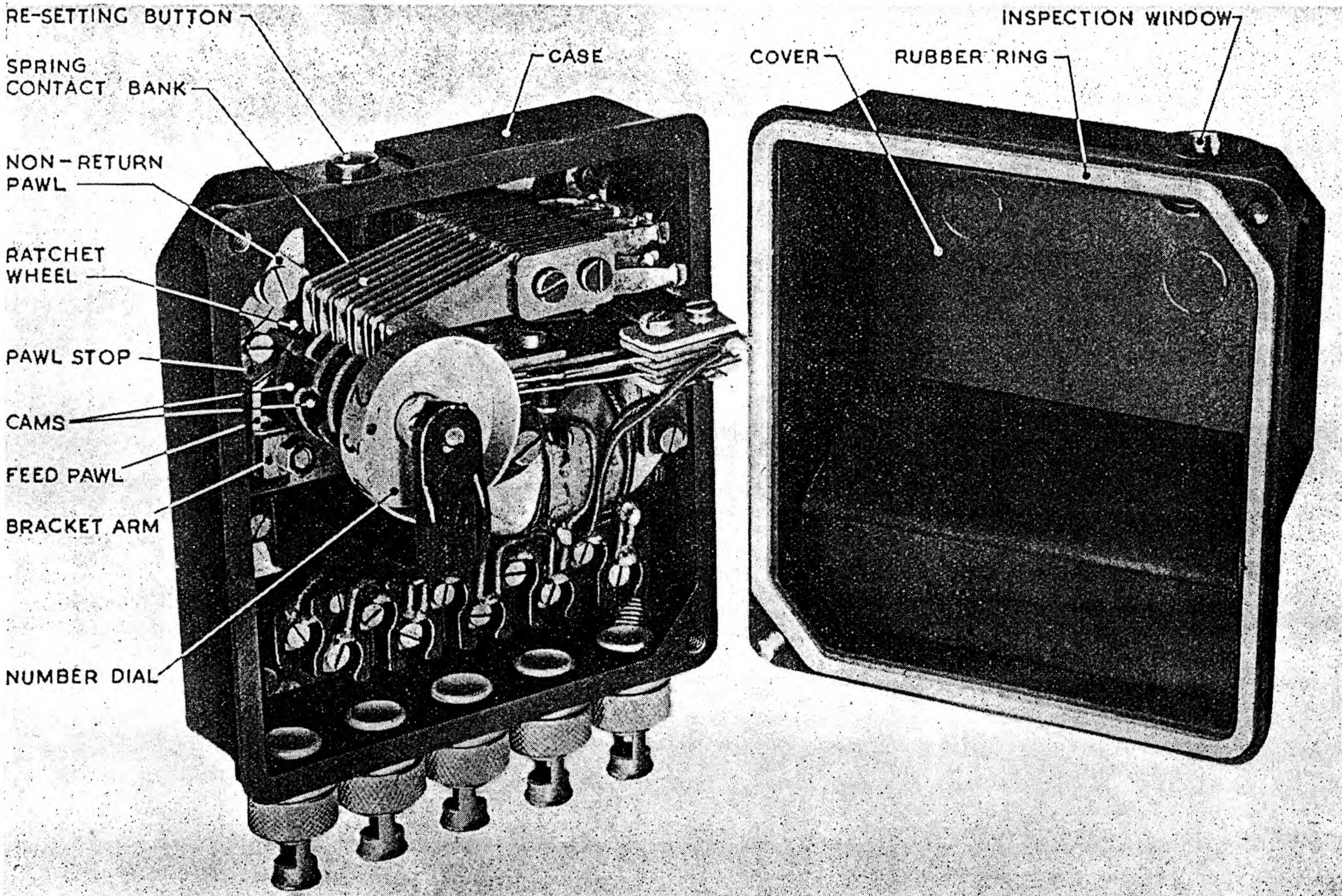

Fig 1.—4-way auto-selector switch, Type B or C and cover