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Colin Hinson
In the village of Blunham, Bedfordshire.

Creed

THE 3-GANG MULTIPLE TRANSMITTER

(Models 71D, 72D and 74D)

TECHNICAL DESCRIPTION

Creed & Company Limited

TELEGRAPH HOUSE

CROYDON

Telegrams: "CREDO, TELEX, CROYDON" *Cables:* "CREDO, CROYDON"

Telephone: CROYDON 2121 (10 lines)

Telex: CROYDON, TELEX 1082

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TECHNICAL DESCRIPTION

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THE 3-GANG MULTIPLE TRANSMITTER

CONTENTS

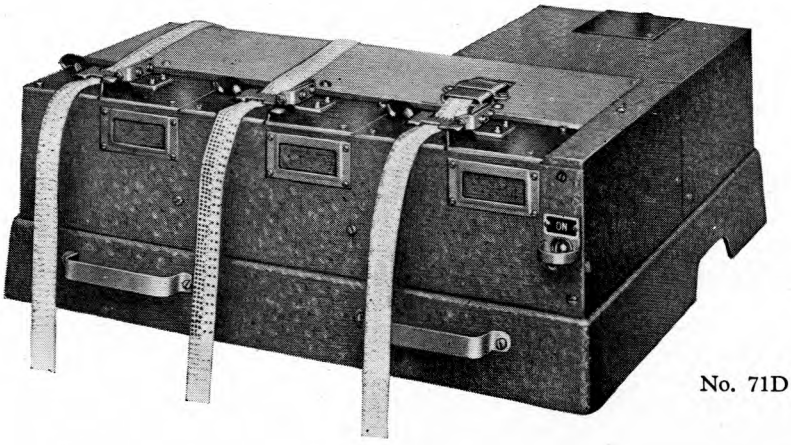
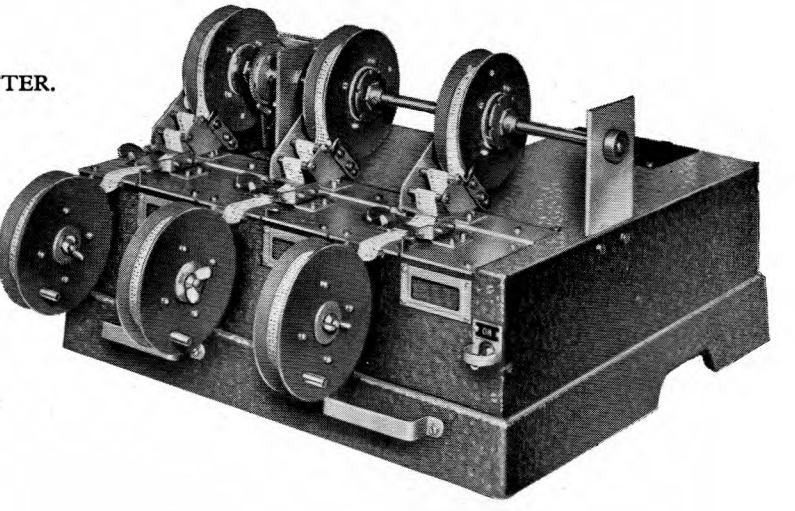


FIGURE 1
No. 71D MULTIPLE MESSAGE TRANSMITTER

FIGURE 2
No. 72D MULTIPLE NUMBER TRANSMITTER.



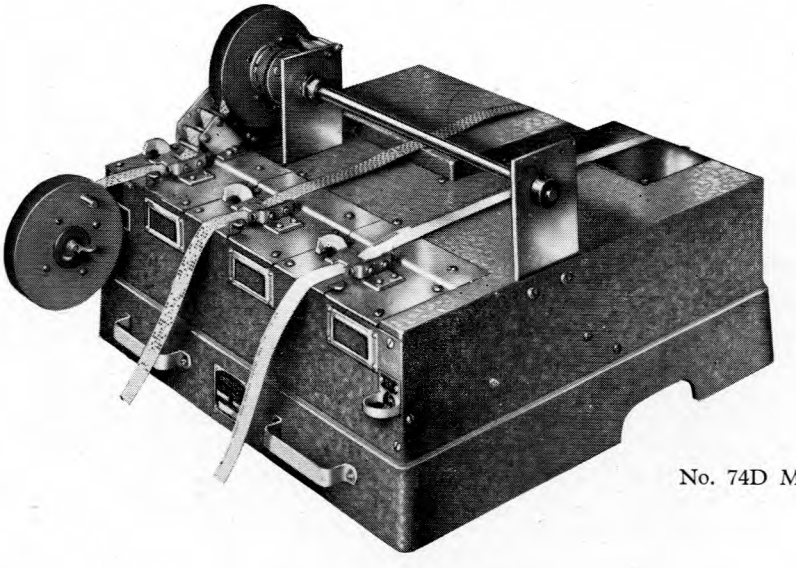


FIGURE 2A
No. 74D MULTIPLE MESSAGE AND NUMBER TRANSMITTER

INTRODUCTION

In recent years, the use of 5-unit perforated tape for the automatic transmission of intelligence has greatly increased, both inside and outside the field of telegraphy. Tape relay systems, for example, are now a commonplace in many countries, and there is a growing interest in the applications of 5-unit tape transmission to punched card techniques and to digital computors.

A basic piece of equipment in all such applications is the automatic tape transmitter which, in view of the wide range of special operating facilities it is required to provide, must be readily adaptable and, therefore, flexible in construction.

The Creed Multiple Transmitter, which is a multi-purpose, 5-unit, automatic tape transmitter has been designed to meet these requirements and is intended for use both in manual transfer tape relay systems and in a wide variety of non-telegraphic applications.

It consists, essentially, of three automatic tape transmitter units and a relay unit all mounted together on the same base, the transmitter units being driven by a common motor. Flexibility is obtained by the provision of alternative transmitter and relay units, and by connecting complete transmitters together. To permit this to be done, the transmitter and relay units have been designed as self-contained assemblies, all electrical wiring between them and the main base being made through plug and socket connections. Similar plug and socket connections are used to connect together complete transmitters.

For tape relay applications, there are two basic kinds of transmitter unit, which are used for transmitting messages and message serial numbers respectively. Three models comprising different combinations of these units, are in current production :—

71D : comprising three message transmitting units.

72D : comprising three number transmitting units.

74D : comprising two message and one number transmitting units.

These three models, in conjunction with a range of different relay units, provide a large number of operating facilities, a selection of which is given later in this bulletin.

Other facilities can be easily obtained by slight modifications to the transmitter units and by the use of appropriate external relay equipment. For example, the transmitter unit may be modified to register the presence of a particular combination in the tape, whenever it occurs, by the closure of a pair of electrical contacts.

One application of this provides for the automatic registration of printed forms used in teleprinter receivers. In this case, the presence of the 'line feed' combination in the tape is detected by the transmitter unit, and this is made to operate an external counting circuit. The latter, in co-operation with another of the transmitter units, is arranged to insert the correct number of 'line feed' combinations and thus bring the form into proper registration.

This bulletin contains a general description of the multiple transmitter, followed by a more detailed description of the message and number transmitting units and the common motor circuit. To illustrate the interoperation of these units in an actual circuit, the bulletin concludes with the description of a specimen circuit arrangement employing a No. 74D (two message and one numbering) transmitter.

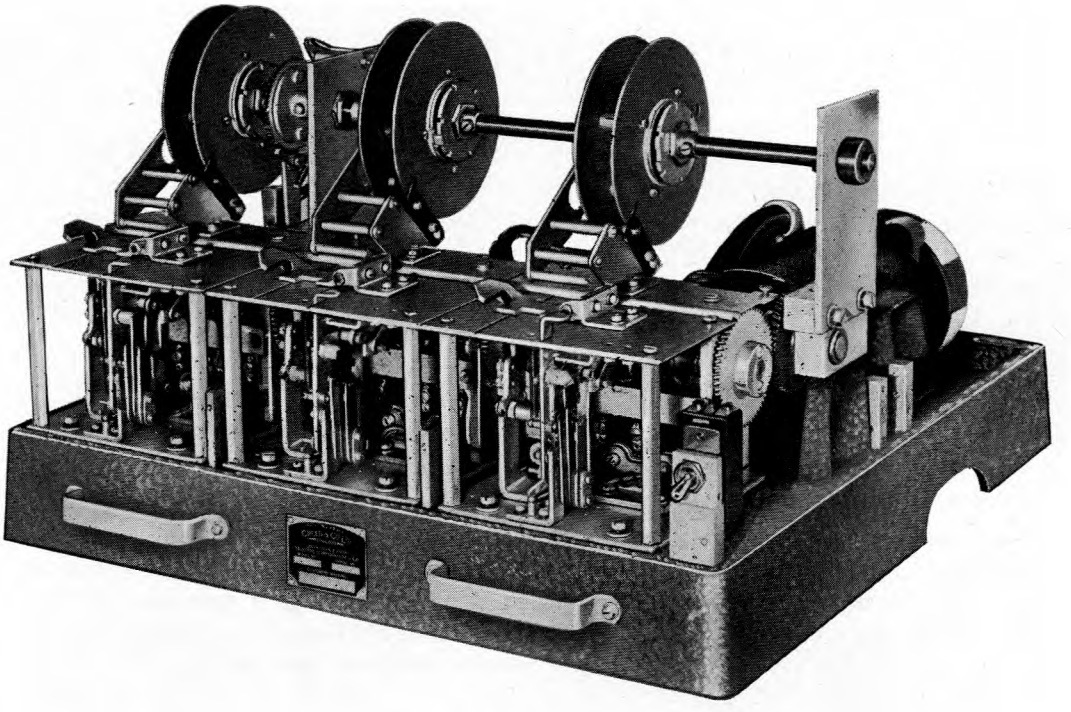


FIGURE 3
MULTIPLE NUMBER TRANSMITTER
(front view with covers removed)

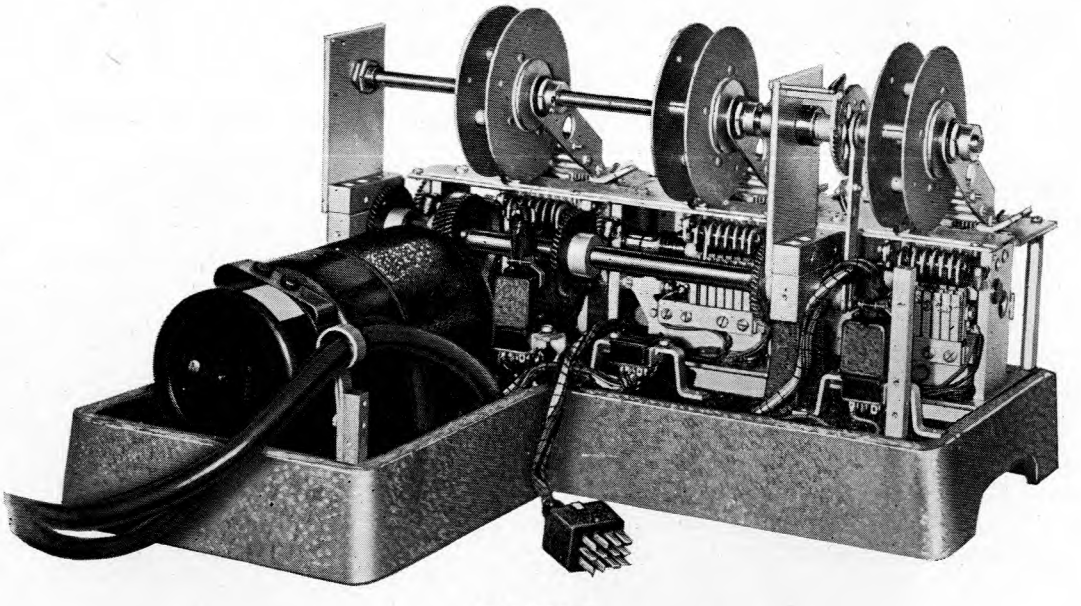


FIGURE 4
MULTIPLE NUMBER TRANSMITTER
(rear view with covers removed)

GENERAL DESCRIPTION

The main types of unit employed in the different models of the Creed Multiple Transmitter are :—

(a) Message Transmitting Units.
(b) Number Transmitting Units.
(c) Relay Units.
(d) Main Base.
(e) Motor Unit.

the last two units being common to all models.

A. MESSAGE TRANSMITTING UNITS

The message transmitting units are designed for 50 baud, 7.42 unit transmission, and are suitable for either fully-perforated or 'chadless' tape, and either 'centre' or 'advanced' feed hole operation. They provide a single-current output, but this may be converted to double-current, if desired, by including a polarised relay in the relay unit.

Start Key.

Each unit is fitted with a start key, which is manually operated to prepare the unit for transmission. To do this, the start key is first depressed. This frees the tape wheel so that the tape may be placed in position without raising the tape retaining plate and, simultaneously, breaks a pair of start contacts. The key is then released again, thereby closing the start contacts which, according to the state of the circuit, either initiates the transmission or presets the unit for subsequent transmission.

Tape-Out Contacts.

Each unit is also fitted with tape-out contacts controlled by a tape-out pecker. These are provided to detect the end of a message, the contacts being arranged to open when the tape runs out. They are closed mechanically when the start key is depressed and remain closed when the key is raised again.

Clutch Magnet.

A clutch magnet is included in each unit to permit the starting and stopping of the message transmission to be controlled electrically by a relay.

Cams and Cam Levers.

Each unit contains a camshaft which is driven continuously through a helical gear by the main driving shaft. About this is an assembly of cams mounted together on a common sleeve which is permitted to engage or disengage with the cam shaft by means of the electromagnectically controlled ratchet clutch.

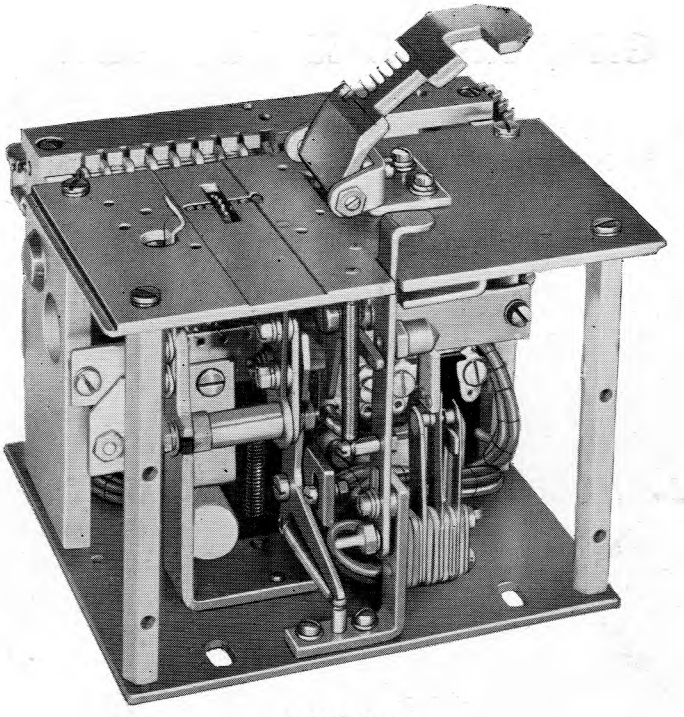


FIGURE 5
TRANSMITTING UNIT
(front view)

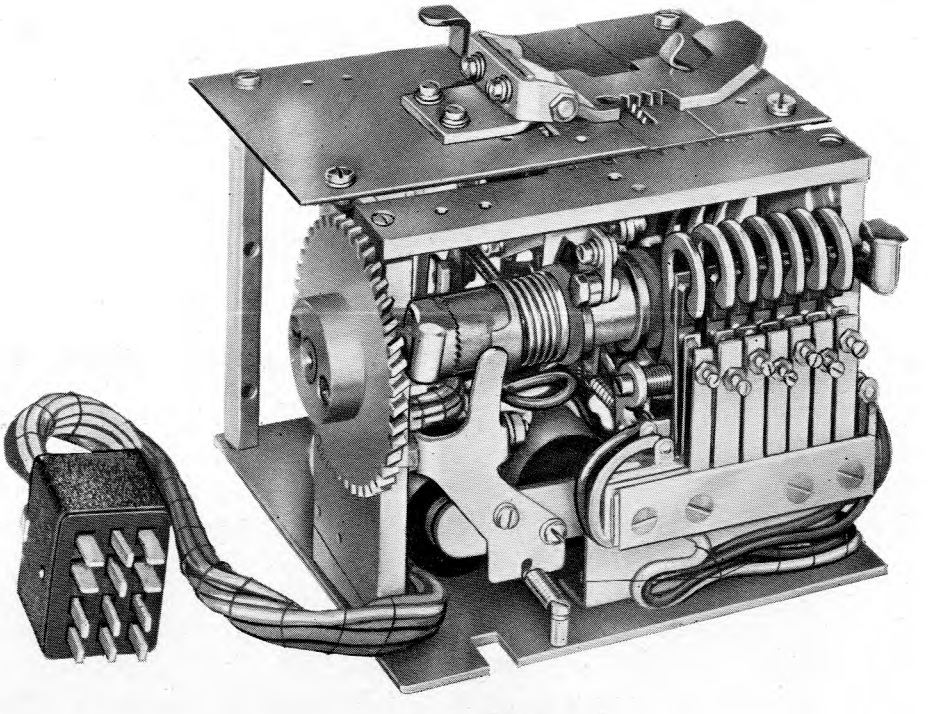


FIGURE 6
TRANSMITTING UNIT
(rear view)

The cams operate a number of levers whose functions are :—

(1) to operate a bank of contacts consisting of the start-stop contact, the five element contacts and the tape-out contact, all in the correct timing sequence.

(2) to raise the tape sensing peckers before the code elements are transmitted, and to lower these again afterwards.

(3) to feed the tape on to the next combination at the end of the operating cycle.

Electrical Components.

In order to facilitate the removal of the transmitter units from the main base without disturbing the wiring, the internal electrical connections of the units are terminated on separate 12-way plugs, which are plugged into corresponding sockets on the main base.

These connections are from the start-stop and transmitting contacts, which are wired in parallel and fitted with Radio Interference Suppression consisting of one inductor and two capacitors.

B. NUMBER TRANSMITTING UNITS

The number transmitting unit is closely similar in construction and principle of operation to the message transmitting unit, the principal differences being as follows :—

'Letters' Sensing Contacts.

The contacts which are used on the message transmitting unit as tape-out contacts have the function, on number transmitting units, of registering the 'letters' combination which is perforated in the numbering tape immediately after each serial number. These contacts, when fitted to number transmitting units, are, therefore, referred to as 'Letters' sensing contacts and have the function of registering the end of a serial number transmission.

The tape sensing mechanism which controls these contacts may be modified to make the contacts register the presence of any combination in the tape. This is of special use in certain non-telegraphic applications of the multiple transmitter (see next section).

Serial Number Suppression.

The start key on number transmitting units is slightly modified in order to provide for the facility of suppressing the transmission of serial numbers by depressing and latching the start key.

Numbering Tape.

The number transmitter is equipped externally with a tape storage reel to carry the numbering tape, and a take-up reel to store used tape in readiness for re-winding.

This tape may be either a normal tape or a special hard wearing tape which is suitable for repeated use.

C. RELAY UNITS

The sequential operation of the message and number/transmitting units, i.e. their alternate connection to the line ('flip-flop') and the release of their clutch magnets to start transmission, is normally controlled by a relay unit mounted at the back of the main base.

This relay unit may include, apart from a number of such control relays, a polarised relay to convert the single-current output of the transmitter to double-current, and other relays and components to provide special operating facilities.

A complete multiple transmitter installation may consist of one or more 3-gang transmitters (i.e. Models 71D, 72D or 74D), together with one or more relay units (maximum one per transmitter) selected from the range of units available.

The following list contains a selection of the facilities that may be obtained in this way. Customers with special requirements not mentioned in this list should write to Creed & Company for further information.

Transmitters	Relay Units	Facilities
71D	—	Message Transmitter with three S.C. outputs.
71D	S.3771	Message Transmitter with three D.C. outputs.
71D (CL.125A)	S.3773 (CL.125A)	Message Transmitter with either :— (a) One S.C. output with flip-flop between the three heads, priority on head No. 3 ; or (b) Two S.C. outputs :— (1) Flip-flop heads 1 and 2. (2) Straight circuit head 3. (See Note 1).
71D (ESK.1158)	S.3772 (ESK.1158)	Tape Comparator (see Note 2).
71D (CL.139)	S.3812	One D.C. output with flip-flop between heads 1-2, 1-3, 2-3 as required and count of line feed signals transmitted (see Note 3).
71D 72D	S.3772	Three S.C. message outputs with sequential numbering.
71D 72D	S.3771 S.3772	Three D.C. message outputs with sequential numbering.
74D	S.3773A	One S.C. output with flip-flop of two message and one number heads (see Note 4).
74D	S.3774A	One D.C. output with flip-flop of two message and one number heads (see Note 4).
71D (CL.138) 74D	S.3774 (CL.138)	Either :— (a) One D.C. output with flip-flop between the three message heads, priority on head No. 3 of Model 71D ; or, (b) One D.C. output with flip-flop of two message and one number heads of Model 74D (see Note 5).

Notes : (1) Switching from one to the other of these modes of operation is accomplished by means of a U-link connection.

(2) The Tape Comparator is a device for comparing the combinations perforated in two tapes. Any discrepancy is detected by the transmitter stopping and bringing up an alarm.

(3) This transmitter provides the facility of automatic form registration referred to in the introduction.

(4) This circuit arrangement is fully described in this bulletin (see page 22).

(5) The alternative facilities are obtained by plugging either Model 71D or Model 74D into the relay unit.

D. MAIN BASE

This unit is common to all models of the multiple transmitter, and mounts the other units, which may be easily removed from it for maintenance and repair. It mounts, in addition, all the electrical components for the motor circuit and those of the signal circuit components that are not contained in the relay unit.

E. MOTOR UNIT

The motor is a series-wound motor of the K.B.B. type. This is available for any nominal voltage between 90 and 270 volts in steps of 5 volts when the A.C. supply is 50 cycles per second. Further details are given later under the section dealing with the motor.

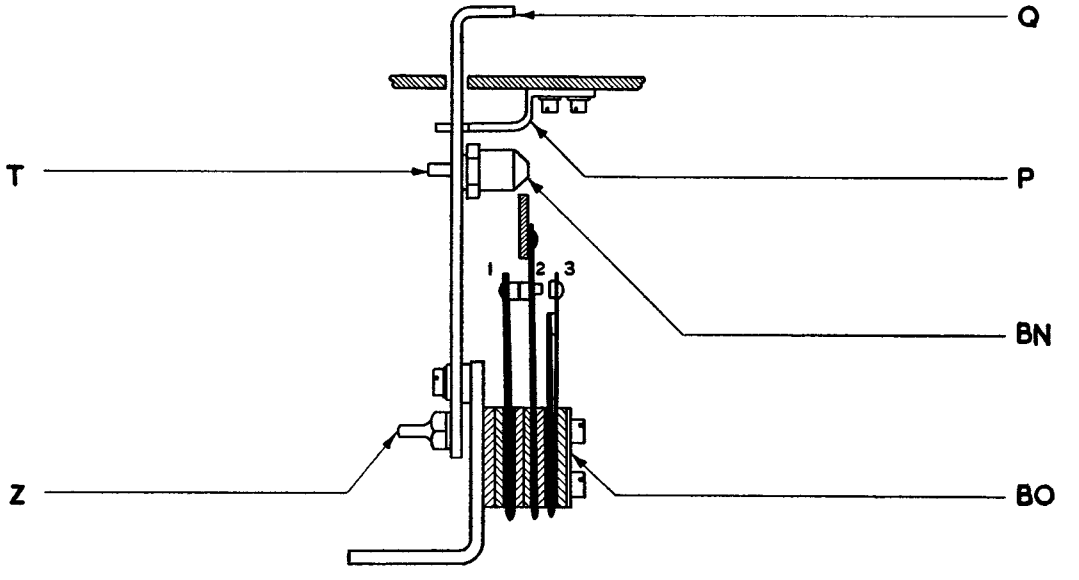


FIGURE 7
START KEY

METHOD OF OPERATION

A. MESSAGE TRANSMITTING UNIT

Each message transmitting unit features in the operating sequence of the whole transmitter twice :—

(1) when the transmitter is prepared for transmission by operating the start key and loading it with tape ;

(2) when the clutch magnet is released, and the message perforated in the tape is transmitted.

PREPARATION FOR TRANSMISSION

The transmitter is prepared for transmission by depressing the start key, latching it down, threading the tape under the tape retaining plate (or lifting up the plate, putting in the tape and lowering the plate again) and then releasing the key.

The details of this sequence of operations are as follows :—

(1) The operator depresses the start key Q, Fig. 12 (see Pullout), against the tension of a spring S which is anchored to the underside of the top plate. The movement of the lower end of the key, as it goes down, is guided by a pin Y engaging in a slot in the key ; that of the upper end is free in the plane of the lever but is restrained in the plane at right angles to it by a slot cut in the unit top plate.

As key Q moves downwards, a stud BN, Fig. 7, screwed into the side of the key, bears down on the insulated extension to contact 2, thereby breaking the key contacts 1 and 2 and making the unused contacts 2 and 3. (Contacts 1 and 2 are the start contacts. For a description of the function of these and other electrical components referred to in this section, see the description of a specimen circuit arrangement given at the end of this bulletin).

At the same time as this occurs, an unthreaded part T of the screw on stud BN, Fig. 7, which projects through the other side of the key, presses down on the horizontal arm of the tape feed detent lever O, Fig. 12. This is, therefore, caused to rotate clockwise about its pivot against the tension of spring R, which is anchored to the underside of the

top plate. The upper arm of lever O moves away from the tape feed ratchet L, disengaging the retention roller N. The lower arm of O presses against the bottom end of the tape feed pawl V. This is rotated about its pivot M on the end of the feed pawl operating lever K against the tension of spring W and, therefore, swings the feeding end of the pawl V away from the ratchet L. Thus, the tape feed ratchet L, and hence the tape feed wheel AC, are completely freed so that the tape may be loaded into the head without having to lift the tape retaining plate.

When key Q is about half-way down in its downward movement, a pin Z at the lower extremity of the key presses down on the tail of the latch lever AB. This rotates about its pivot in a clockwise direction against the tension of spring AD. Its vertical arm thereby moves to the right, withdrawing the latch from the tail end of the tape-out contact operating lever BG. Lever BG, which is being urged anti-clockwise by the moving contact of contact assembly AZ, is thus allowed to move, permitting the tape-out contacts 1 and 2 to close.

(2) The operator now pushes the key Q inwards towards the latch P and releases it. The key rises slightly under the pull of spring S, i.e. insufficiently to affect the freedom of the tape feed wheel, and then stops, a step cut on the edge of key Q latching under latch P.

(3) The operator next threads the tape under the tape retaining plate or, if he prefers, raises the plate, places a tape in position and lowers it again, a latch automatically retaining it in this position.

(4) The operator finally pulls the key forward away from the latch P, and allows it to rise under the pull of spring S. This produces the following effects :—

(a) The key contacts 1 and 2, Fig. 7, are permitted to make again.

(b) The tape feed detent O, Fig. 12, is allowed to rotate anti-clockwise under the pull of spring R, re-engaging the retention roller N with ratchet L, and releasing the detent V, which is, therefore, pulled around by spring W into engagement with ratchet L. Thus, the tape feed wheel AC is once more placed under the control of the tape feed mechanism.

(c) The tail of latch lever AB is released and the vertical arm of the lever is allowed to move to the left until it comes into contact with the tail end of tape-out operating lever BG. Lever BG is not, therefore, operated again.

The transmitter is now ready to transmit the message perforated in the tape.

MESSAGE TRANSMISSION

The transmission of the message perforated in the tape is initiated by the energisation of clutch magnet BC, Fig. 12. This consists of two 140-ohm coils connected in series, with a long horizontal iron armature BB, to which is riveted a thin brass residual strip.

The armature is secured by two screws to the lower end of the pivoted clutch detent BF, the upper end of which abuts against the camming-out face of the clutch B, disengaging this from the dog A in the rest position.

When the clutch magnet is energised, the armature, together with the lower end of the detent BF, are drawn inwards, the detent is swung about its pivot, and its upper end, therefore, is moved away from the clutch camming-out face. This permits the clutch to move to the left under the endwise thrust of the helical spring C, and results in the engagement of the clutch ratchets. Since dog A is positively driven by the gear BK, the cam sleeve AM also starts to rotate and makes one complete revolution in approximately 148 m.s.

When the clutch magnet is de-energised, i.e. when the message has been transmitted, spring AY rotates the upper end of detent BF into the path of the clutch. At the end of the revolution during which the magnet is de-energised, the clutch sleeve is arrested, the clutch itself being driven to the right as the detent slides up the sloping cam face of the clutch, and the ratchets are, therefore, disengaged.

The sequence of the operations that take place during the revolution of the clutch sleeve is indicated graphically in Fig. 8. This will now be described in the 20 millisecond stages into which the diagram has, for convenience, been divided.

0—20 Milliseconds.

As soon as the cam sleeve starts to rotate, the five code peckers AA, Fig. 12, and the tape-out pecker X, begin to rise (see also Fig. 8).

This action is intiated by cam roller F, which is pivoted on an arm of lever H, riding up out of a hollow in cam E. This results in lever H turning in an anti-clockwise direction about pivot AG. The pecker lever bail AH to which lever H is secured is thereby also rotated about pivot AG in the same direction. The bail AH moves away from the knees of the code and tape-out pecker levers, and these are thus free to move under the action of springs AJ and AE provided that, in the case of the code peckers, there is a combination hole in the tape permitting them to rise, and in the case of the tape-out pecker the tape has run out.

A further action that takes place as soon as the cam starts to revolve is the lowering of ratchet pawl V to pick up another tooth on ratchet wheel L. The tape is not, however, fed on until the end of the cam revolution (see Fig. 8). This is effected by cam roller BH, Fig. 12, riding up out

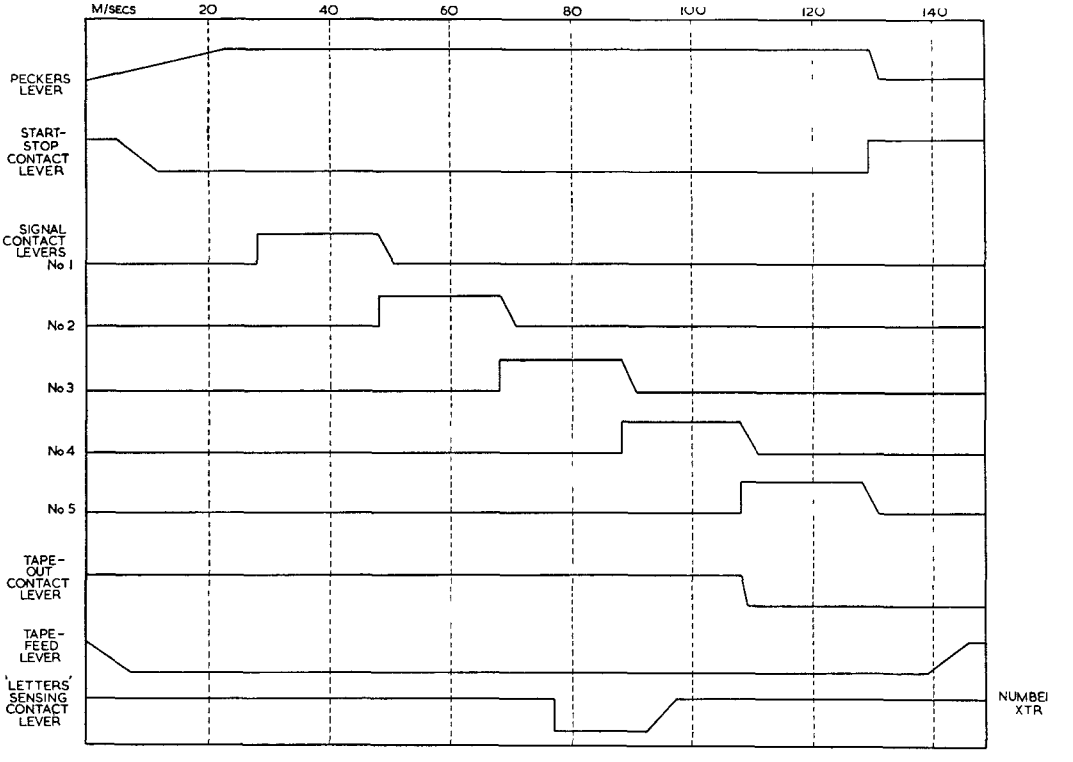


FIGURE 8
LEVER SEQUENCE DIAGRAM

of the cam hollow in cam D. The feed pawl lever K, which the cam roller controls, is rotated in a clockwise direction about pivot AG and against the tension of spring L. This lowers feed pawl V, which is pivoted on the end of lever K, and the pawl picks up the next tooth on the ratchet.

After the cam has revolved for about five milliseconds (see Fig. 8), the start-stop contacts are opened. This is accomplished by cam AN, which depresses the tail of contact operating lever AP, thereby rotating this lever about its pivot AQ and causing it to break the start contacts AR.

20—40 Milliseconds.

If the first code combination to be sent is a mark, the pecker AA will have already risen, and the lower end of the vertical arm of lever AK will be clear of the tail of contact operating lever AV. Thus, when the fall in cam AU is opposite the projection AS on lever AV, this lever will be free to rotate anti-clockwise about pivot AQ, thereby allowing the transmitting contacts AT to make, and causing a mark to be transmitted.

If the first code combination to be sent is a space, the pecker AA will be held down by the tape, and lever AV will be prevented from rotating by the tail of lever AK abutting against the tail of lever AV. The contacts AT will, therefore, remain open and a space will be transmitted.

40—120 Milliseconds.

After approximately 50 milliseconds, the second code operating lever either operates or remains unoperated in the same manner as has already been described for the first lever. (On Fig. 12, for simplicity, only one set of code transmitting contacts, one contact operating lever and one code pecker have been shown. The others are, however, identical to the ones illustrated).

Immediately after this, the contact operating lever for the first code element breaks contacts AT as projection AS rides up the other side of the cam hollow. (It has been assumed here that a marking combination has been sent).

The actions described in the last two paragraphs are now repeated at twenty millisecond intervals (see Fig. 8) for all five code operating levers.

Finally, at about 110 milliseconds after the start of the cam revolution, the tape-out contacts AZ, which were allowed to make when the start key was manually operated, attempt to open but are prevented from doing so by the presence of the tape in the transmitter. If the tape had run out, then contacts AZ would have opened.

The mechanism controlling this action consists of the square-section tape-out pecker X, pecker lever AF with associated spring AE, operating lever AW, operating lever BG and contacts AZ. If there is tape in the transmitter, pecker X is held down and lever AF, in consequence, prevents the tail of lever AW from moving downwards under the pull of spring AO, when it is permitted to do so by cam BD. Hence, lever BG does not operate. If there is no tape in the transmitter, however, the pecker X rises and the tail of lever AF is withdrawn from under the tail of lever AW. When cam BD permits lever AW to rotate in a clockwise direction about pivot AQ under the pull of spring AO, a pin BA, which is pivoted to lever AW, presses down on the horizontal arm of BG, which is, therefore, caused to rotate about pivot AQ. (The right-hand extremity of lever BG is unlatched from lever AB). Contacts AZ are, therefore, permitted to break. The tail of lever BG drops into the latching slot of latch lever AB and hence the contacts AZ remain open when AW is restored.

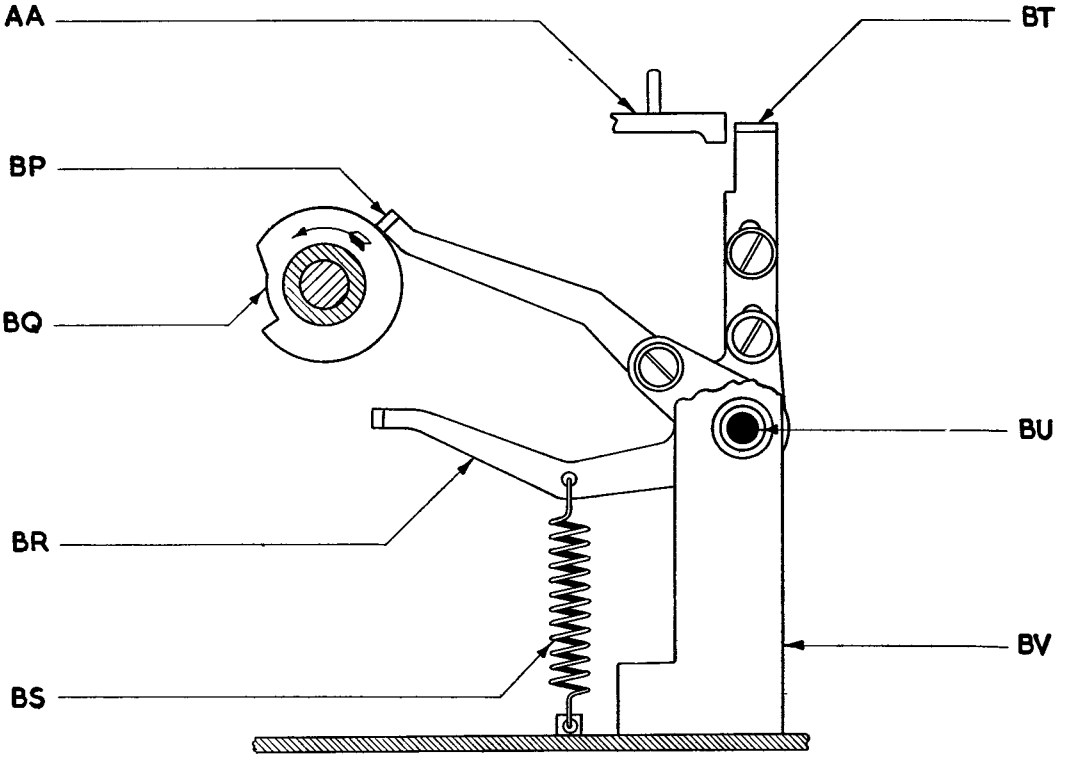


FIGURE 9
'LETTERS' SENSING MECHANISM

120—148.4 Milliseconds.

After approximately 130 milliseconds, the start-stop contacts are closed to send the stop signal (see Fig. 8), the fifth code operating contacts are broken (if they had been previously closed), and the peckers are lowered by the bail AH pressing against the knees of the pecker levers and rotating these against the tension of springs AE and AJ.

At about 140 milliseconds, the tape is fed forward to the next combination. Cam D rotates lever K about pivot AG, in a clockwise direction against the tension of spring I. The tape feed pawl V, which is pivoted on the right-hand end of lever K, feeds on the ratchet L one tooth, and the ratchet is retained in this position by retention roller N.

At the end of the cam sleeve revolution, the cam sleeve is arrested by the clutch detent BF in the manner already described.

B. NUMBER TRANSMITTING UNIT

The number transmitting unit is closely similar both in construction and principle of operation to the message transmitting unit. It differs from it only in the following respects :—

(a) The tape-out contacts are used on the number transmitting unit to register the presence of a 'letters' combination in the tape. (They will, for this reason, be referred to in this section as the 'letters' sensing contacts). As the letters sensing contacts are required to open at a different time in the sequence of operations from the tape-out contacts, a different mechanism is used in this case to control the contacts. (The function of the letters sensing contacts is described on page 9 and in the specimen circuit description at the end of this bulletin). The tape-out pecker X, lever AF, Fig. 12, and latch lever AB are left on the unit, however, to permit the number transmitting unit to be converted into a message transmitting unit with the minimum number of changes. Lever AB is permanently held down in a clockwise direction by a screw (not illustrated in Fig. 12) to prevent this from latching the letters sensing contact operating lever BG.

(b) The manual start key assembly is modified slightly in order to provide for the facility of suppressing the transmission of serial numbers by depressing and latching the start key.

(c) The unit is equipped externally with a tape storage reel to carry the numbering tape, and a take-up reel to store tape in readiness for rewinding.

'Letters' Sensing.

The letters sensing mechanism is illustrated in Fig. 9. This consists of a cam follower BP, which rests on the same track that controls the transmitting contacts for the first code element, but on the upper side of the cam. The other end of BP is pivoted on a long pin BU, which is secured by a nut and washers to a bracket BV standing on the unit bottom plate.

A lever BR, which is screwed to cam follower BP and pivoted on the same pin, engages its left-hand end over the long horizontal arm of the letters sensing operating lever BG, Fig. 12. Cam follower BP has a second vertical arm, to which an extension BT, is secured by two screws. The top end of BT is bent over at right angles to form a sensing arm that is positioned in front of the ends of all five code peckers AA.

When a serial number is sent, the last combination to be read is a 'letters' combination, for which all five peckers AA, Fig. 12, rise. After approximately 75 milliseconds from the start of the cam sleeve revolution, the cam follower BP, Fig. 9, rides up the hollow of the cam BQ and lever BR permits lever BG, Fig. 12, to close the letters sensing contacts.

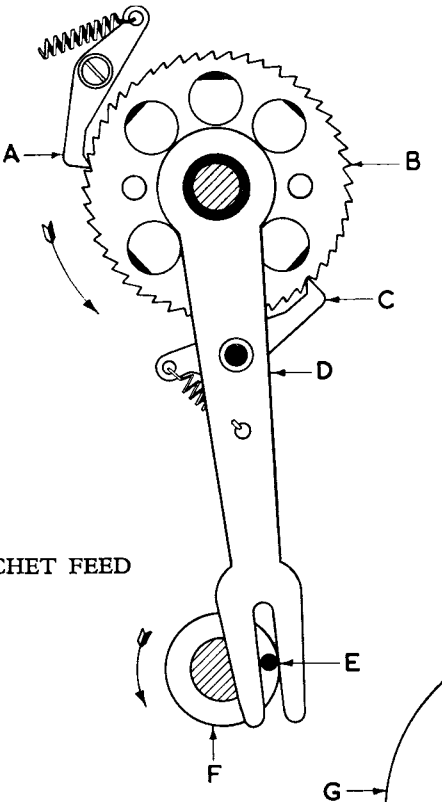


FIGURE 10
TAKE-UP REEL RATCHET FEED

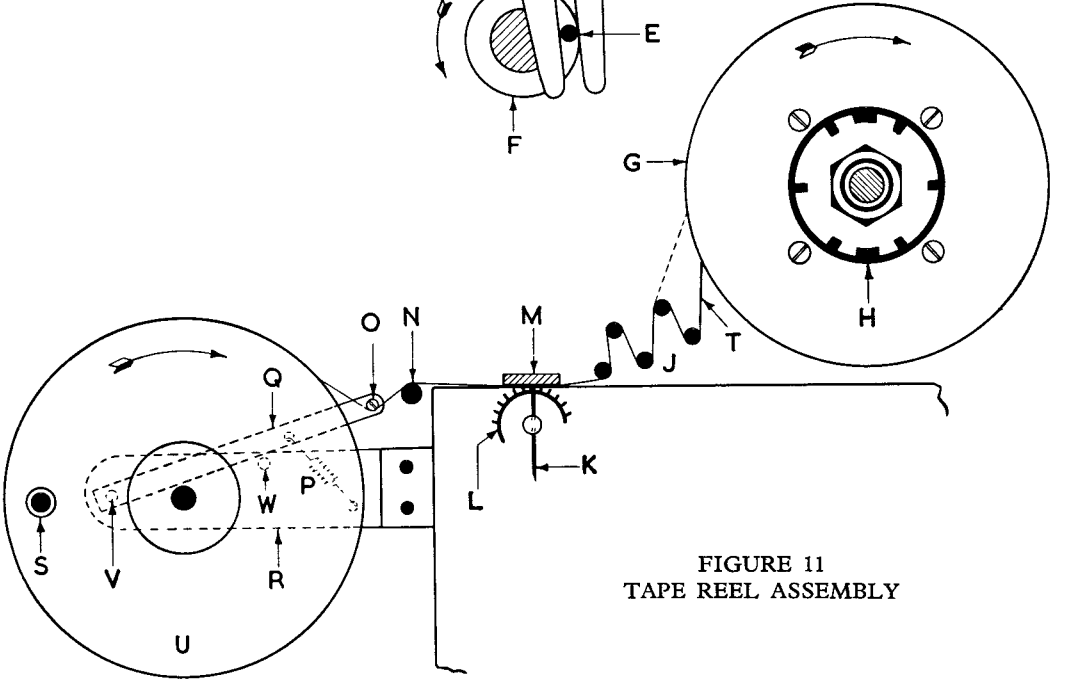


FIGURE 11
TAPE REEL ASSEMBLY

Serial Number Suppression.

Serial number transmission may be suppressed by depressing the start key on the number transmitting unit and latching it down.

The effect of this is to break the start contacts. (For an explanation of the electrical effects of this action see the description of a specimen circuit arrangement at the end of this bulletin). The other function possessed by the start key when fitted to message transmitting units, viz. that of freeing the tape wheel, is suppressed on number transmitting units by the removal of the stud T, Fig. 12. This is to prevent the take-up reel, which is continuously driven off the main shaft through a friction clutch, even when the cam sleeve is stationary, from feeding the numbering tape.

Tape Feed Arrangements.

The tape is drawn off a storage reel U, Fig. 11, mounted on the front of the unit, by the tape feed wheel L. To minimise the drag on the tape holes caused by this feeding action, and to prevent the reel U from overrunning, a feed control mechanism is fitted, consisting of a pin O screwed into the end of a spring-loaded arm Q. This is pivoted at V and is normally held down against a stop pin W, thereby drawing the tape down into a loop round pin O. When the tape feed wheel L feeds on the tape, the initial impulse is taken by spring P, which afterwards contracts again, turning reel U round slowly but in time for the next feed impulse from the tape feed wheel.

The tape that has been fed on by the feed wheel L is wound on to a take-up reel G, mounted on the top of the transmitter unit. This is rotated by a ratchet mechanism illustrated in Fig. 10, via a friction clutch H, Fig. 11. The drive for the take-up reel is derived from a pin E, Fig. 10, on the end of the main driving shaft. This engages in a slot of the tape winder feed lever D, which is pivoted at its upper end on the tape winder shaft. The main driving shaft F rotates continuously, and hence lever D moves from side to side about its pivot. A spring-loaded ratchet feed pawl C, pivoted on the lever, is thereby caused to rotate the feed ratchet B continuously, the ratchet being prevented from returning by a retention pawl A.

Ratchet B is coupled via a friction clutch H, Fig. 11, to the take-up reel G. Hence, if there is any slack tape between the wheel L and reel G, the reel is drawn round by the ratchet B until it is wound on fully. To minimise the drag on the tape feed holes in the numbering tape, a system of snubbing pins is interposed between wheel L and reel G. The method of threading the tape through the snubbing pins is illustrated in Fig. 11. The normal method, which is used for thin numbering tapes, is shown by the full line. Thick numbering tapes should be threaded so as to by-pass the last pin, i.e. it should be threaded in the manner indicated in the diagram by the dotted line. The reason for this is that the snubbing action on thicker tapes is more severe than on thin.

C. MOTOR CIRCUIT

Schematic and component identification diagrams for the motor circuit, which is common to all models of the 3-gang multiple transmitter, are given in Fig. 13. (see Pullout.)

In the interests of safety, it is important that the motor supply socket should be so wired that the switch N intercepts the live main. The black pin should be connected to the neutral main, and the large uncoloured pin, which is wired to the transmitter base, should be earthed.

Motor

The standard motor that is fitted to the multiple transmitter is a Creed Type KBB, single-voltage, AC/DC, series-wound motor, which is available for any nominal voltage between 90 volts and 270 volts in steps of 5 volts when the frequency is 50 cycles per second. For frequencies above and below 50 cycles per second, this range is modified according to frequency since the same set of coils is used as for the 50 c/s range. The motor may be used where the variations from the nominal voltage for which it is supplied do not exceed ± 10 per cent.

Two strapping blocks W and F, which are mounted on the motor body and main base respectively, are provided for changing the circuit connections so that the motor may work to AC or DC supplies. The strapping arrangements for these blocks are as follows :—

For AC supply : Strap F1—F2, F3—F4
W1—W2, W3—W4

For DC supply : Strap F2—F3, W2—W3

Governor

The nominal speed of the standard motor is 3,000 r.p.m. The standard Creed series governor used with this motor controls its speed within ± 0.5 per cent of this figure for the voltage variations mentioned above.

The governor casing is painted with five white stripes for use in adjusting the motor speed with a 125 d.v.s. tuning fork stroboscope. The stripes may be viewed by swinging aside a small metal cover plate in the top of the main base cover. The governor adjustment screw may be reached through this same aperture.

Governor Resistor.

The value of the resistor G shunting the governor contacts varies according to the supply voltage in the following manner :—

Supply Voltage	Resistance of G
130 V.—270 V.	1,000 ohms
90 V.—125 V.	270 ohms

Radio Interference Suppression.

The following parts of the circuit are fitted with radio interference suppression :—

(a) The motor brush/commutator contacts are shunted by a single-can twin 0.01 μF capacitor, the centre point being earthed at 03 via the can fixing lug.

(b) Interfence originating from the governor contacts is eliminated by inductor B, in conjunction with resistors U and P, and capacitors A, D, H and S.

(c) The mains supply leads are filtered by inductors K and L.

D. SIGNALS CIRCUIT (Specimen Arrangement)

A description is given in this section of a complete multiple transmitter installation, in order to provide an illustration of the functioning of the message and number transmitting units in a typical circuit.

The circuit that has been chosen for this purpose consists of a 74D (two message and one number) transmitter with relay unit S.3773A. These together provide a single-current output fed by the two message transmitting units working in tandem (i.e. flip-flop) and by the number transmitting unit which is arranged to insert a message serial number before each message transmission.

A brief description is also given of relay unit S.3774A, which may be used in place of S.3773A in order to obtain the additional facility of a double-current output. The method of single / double-current conversion employed in relay unit S.3774A is employed throughout the range of relay units.

Diagrams of these circuit arrangements are given in Figs. 14, 15 and 16. Fig. 14 is a simplified circuit schematic, Fig. 15 a diagram showing the layout of the components, and Fig. 16 a schematic giving details of the plug and socket connections.

Operating Procedure.

The normal operating procedure, assuming that neither message transmitter is loaded at the start, is as follows :—

(a) The operator depresses the manual start key on one of the message transmitters, latches it down, inserts a message tape and releases the start key again.

(b) The number transmitting unit automatically sends the next serial number.

(c) When it senses the 'letters' combination in the numbering tape, the number transmitting unit is stopped. The message transmitting unit is started and transmits its message.

(d) While the message is being sent, the other transmitting unit may be loaded as described in paragraph (a).

(e) When the tape runs out of the first transmitting unit, this transmission is stopped. The number transmitting unit is then once more started, and sends the next serial number.

(f) As in paragraph (c), when the 'letters' combination in the numbering tape is sensed, the number transmitting unit is stopped and the second message transmitting unit is started, thereby sending its message to line.

(g) This sequence continues indefinitely so long as the message transmitters are kept loaded, and the start keys are depressed and released.

Sequence of Operations.

The transmitter is prepared for operation by :—

(a) switching on the motor switch N, Fig. 13.

(b) switching on the 110 V. DC supply to the relay and signal circuit. (The switch for this is not mounted on the machine and so is not illustrated in Fig. 15.)

In the normal 'rest' condition, with the power applied to the transmitter, relay D /3 is operated, causing contact D1 to be normally closed and contacts D2 and D3 to be normally open.

The detailed operating sequence of the signal circuit is as follows :—

1. The operator depresses the manual start key MK(A) on message transmitting unit A (see Fig. 14) and latches it down. This opens the contacts of MK(A) and mechanically closes the tape-out contacts T /O(A). (The manner in which this occurs is described on pages 13 and 14).

2. The operator now inserts the message tape into the message transmitting unit and releases the start key again. The release of the start key closes contacts MK(A) and completes a circuit for the operation of relay A /3, viz. Earth, MK(A), T /O(A), M(A), A /3, B2, D1, RF, -110 V. DC Supply. As contact D3 is normally open, this circuit includes the 5,000 ohm high resistance winding of relay A /3. This is to limit the current flowing to an amount sufficient to operate relay A /3 but insufficient to operate the clutch magnet M(A). Hence, relay A /3 operates.

A1— closes and completes a circuit to operate the numbering unit clutch magnet N. (Earth, C1, L/S, N/K, N, C2, A1, RD, -ve supply).

A2— disconnects -ve supply from relay B/3 so that this will not be operated when tape is loaded into message transmitting unit B.

A3— not connected.

Thus the number transmitting unit transmits the next serial number. A typical transmission might consist of a group of letters giving the station code, followed by the 'figures' shift signal, followed by the numeral or numerals comprising the serial number itself, and ending with the 'letters' shift combination.

3. When the 'letters' shift combination is sensed by the number transmitting unit, contacts L/S open for 16—18 m/s, thereby removing the short circuit from across relay C/3. Relay C/3, therefore, operates (Earth, C/3, N, C2, A1, RD, -ve supply).

C1— opens so that C/3 will remain operated when the letters sensing contacts close again.

C2— operates, first providing an alternative holding circuit for C/3 round the clutch magnet N, and then disconnects N from the power supply to ensure a rapid collapse of its field. N therefore de-operates.

C3— opens and breaks the circuit for relay D/3.

4. Relay D/3 is slow to release, de-operating after a delay of 100 m/s. This delay is required to allow time for the transmission of the final 'letters' shift signal by the number transmitting unit before message transmitting unit A is permitted to operate.

D1 — opens to prevent the operation of message transmitting unit B at the end of A's transmission and before the number transmitting unit operates.

D2 — closes but has no function at this stage.

D3 — closes, shorting out the 5,000-ohm high resistance winding of relay A/3, thus increasing the current through the clutch magnet M(A) and permitting this to operate.

5. Message transmitting unit A now transmits its message. While this is happening, transmitter B, we shall assume, is loaded with tape in the manner described in paragraphs 1 and 2.

It is convenient to note at this stage that, when tapes are prepared, the last combination perforated in them should be a 'letters' shift combination. The object of this practice is to ensure that the group of letters at the beginning of each serial number transmission are translated by the distant receiver in the letters case. This cannot be done by including a 'letters' shift combination in the numbering tape itself immediately before the station code because the 'letters' shift combination is used to operate the letters sensing contacts and thereby *stop* the number transmitting unit.

6. At the end of the message transmitted by transmitting unit A, after the final 'letters' combination has been transmitted in the manner described above, the tape runs out and the tape-out contacts T/O(A) open. This breaks the circuit for the clutch magnet M(A) and relay A/3, and these both de-operate.

A1 — opens and breaks the circuit for relay C/3 (Earth, C/3, C2, A1, RD, -ve supply.)

A2 — drops back to prepare for the operation of the B transmitting unit.

7. Relay C/3 therefore de-operates.

C1 — closes and shorts out relay C/3.

C2 — restores, preparing for power to be applied to N by B1 (see paragraph 9).

C3 — closes, completing the circuit for relay D/3.

8. Relay D/3 therefore operates.
   D1 — closes, operating relay B/3.
   D2 — opens, putting the 5,000-ohm winding of B/3 in series with M(B), preventing this from operating.
   D3 — opens (no function in this case).

9. Thus, relay B/3 operates.
   B1 — closes, completing the circuit for clutch magnet N.
   B2 — changes over, disconnecting power from message transmitting unit A's circuit and providing an alternative connection to the -ve supply for message transmitting unit B's circuit, which will hold later when D1 opens.
   B3 — not used.

10. Hence, the clutch magnet N operates and the next serial number is transmitted. At the end of this transmission, the letters sensing contacts sense the 'letters' shift combination in the numbering tape and open. This removes the short circuit across C/3, which operates.
   C1 — breaks to maintain C/3 operated when contacts L/S close again.
   C2 — operates disconnecting power from N without de-operating C/3.
   C3 — opens, breaking the circuit for relay D/3.

11. Relay D/3, after a time delay of 100 m/s, as before, de-operates.
   D1 — opens.
   D2 — closes, shorting out the 5,000-ohm winding of relay B/3, thus permitting M(B) to operate.
   D3 — closes, but has no function at this stage.

12. Message transmitting unit B now transmits its message. We shall assume, for convenience, that no tape is loaded into transmitter A during this period. At the end of this message transmission, the tape runs out and tape-out contacts T/O(B) open, thereby de-operating both relay B/3 and the clutch magnet M(B).
   B1 — opens, breaking the circuit for relay C/3.
   B2 — drops back.

13. Relay C/3 therefore de-operates.
   C1 — closes and shorts out relay C/3.
   C2 — restores.
   C3 — closes, completing the circuit for relay D/3.

14. Relay D/3 therefore again operates.
   D1 — closes but does not operate relay A/3 because transmitting unit A, by assumption, contains no tape and contacts T/O(A) are, therefore, open.
   D2 — opens.
   D3 — opens.

15. The transmitter is thus again in the rest condition.

The sequence of operations described above has, for convenience, been limited to a single message transmission from each of the transmitting units A and B, the transmitter being assumed to start and finish in the rest condition. The principles given are, however, applicable to the more general case in which the transmitting units are alternately loaded several times before the transmitter is allowed to return to the rest condition.

Suppression of Serial Numbering.

In the preceding description, it has been assumed that the contacts of the numbering key N/K are left permanently closed, i.e. that the numbering key is not touched. This is the normal practice, but if, for any reason, the serial numbering facility is not required, it may be suppressed by depressing the key N/K and latching it down.

The effect of this on the sequence of operations is as follows :—

(a) Contacts N/K are permanently broken and hence the direct low resistance path to N from earth which is, at the same time, the short circuit across C/3, is permanently broken.

(b) Thus, when either of the contacts A1 or B1 operates, the clutch magnet does not operate, as before, to send the next serial number. (The resistance of relay C/3 is such that the current through N and C/3 in series with RD is too low to operate the clutch magnet). Instead of this, relay C/3, which formerly did not operate until the letters sensing contacts removed the short circuit across C/3, is operated immediately by contacts A1 and B1.

(c) Once relay C/3 is operated, the normal sequence is resumed and the next message transmitting unit sends its message.

Thus, the effect of depressing the key N/K and latching it down is merely to suppress the transmission of serial numbers.

Double-Current Operation.

The transmitter units are designed for single-current operation with separate make contacts for each code element. It is, therefore, necessary to use a polarised relay as a single/double current converter if the transmitter is to be used in a double-current circuit.

The converter circuit is obtained, in the present case, by connecting the three transmitting units in series with one another, with the 110 volt supply, two 11-ohm windings of the relay and an 8,400-ohm current-limiting resistance. The direction of current flow through the relay windings is so arranged that when all the transmitting units are marking, i.e. have closed contacts, marking current flows through the relay, and the relay tongue moves to mark. When one of the transmitting units is spacing, however, i.e. interrupting the transmitter loop, the relay contacts are moved to space by the permanent current through a 160-ohm winding.

The marking and spacing contacts of the relay are connected to a separate 80+80 volt centre-tapped signalling supply. One leg of the line is connected to this centre tap and the other to the relay tongue. On Fig. 14 the convention of negative to mark has been adopted, but the opposite convention may be used by reversing the leads from the 80+80 volt supply.

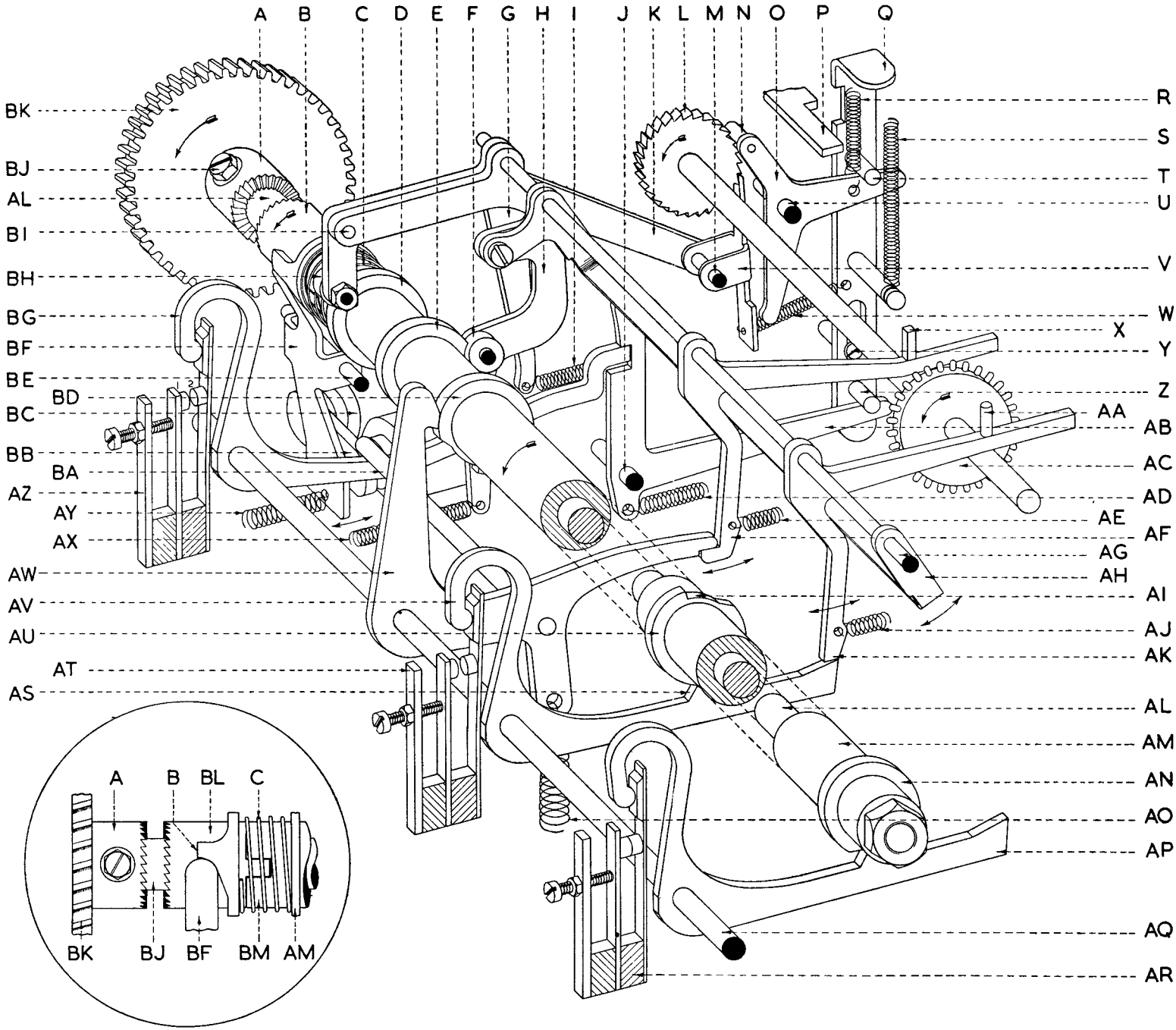
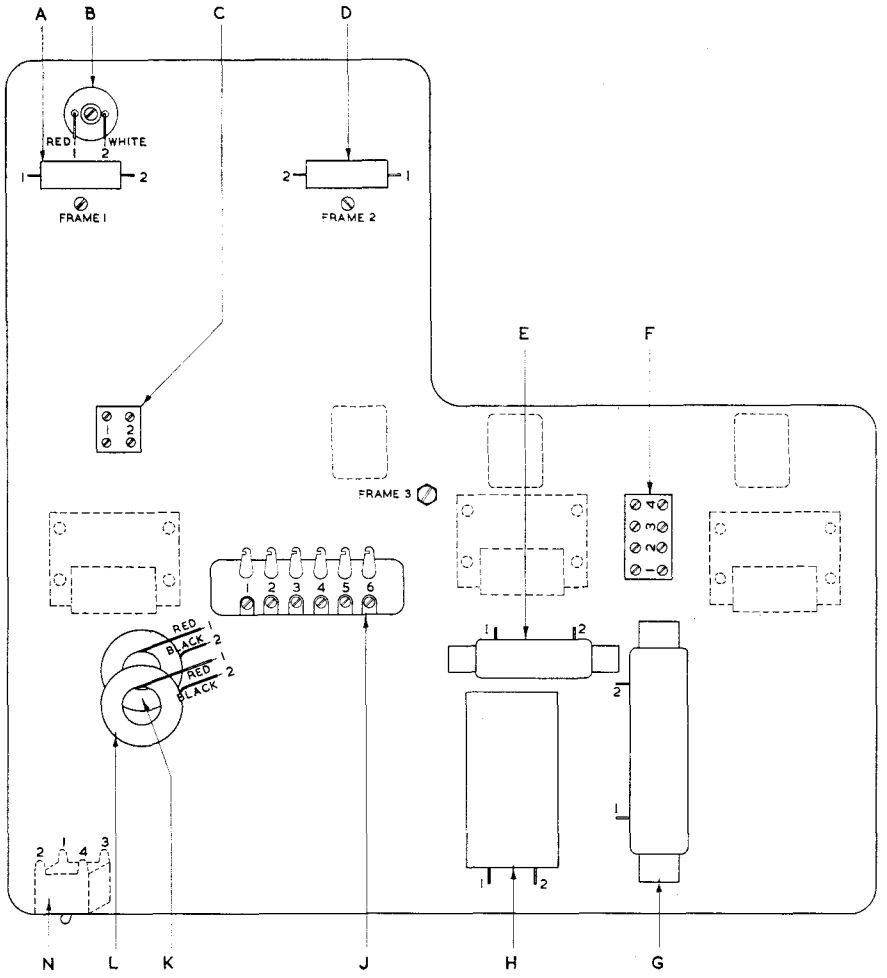
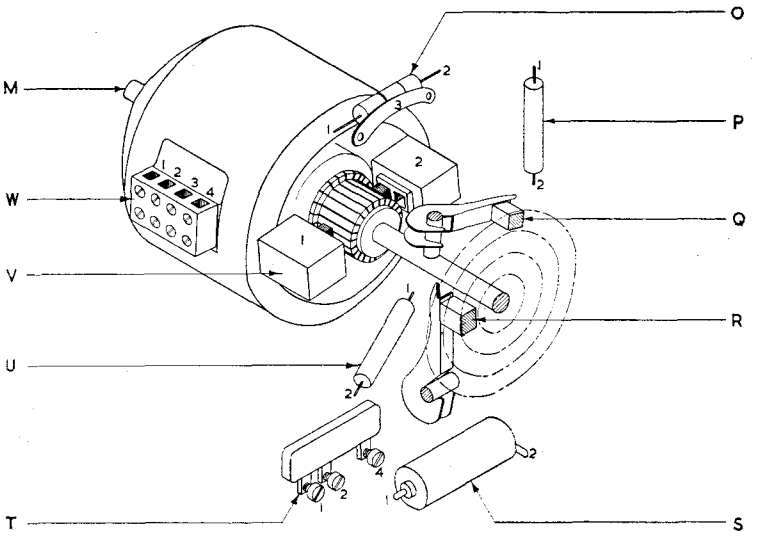


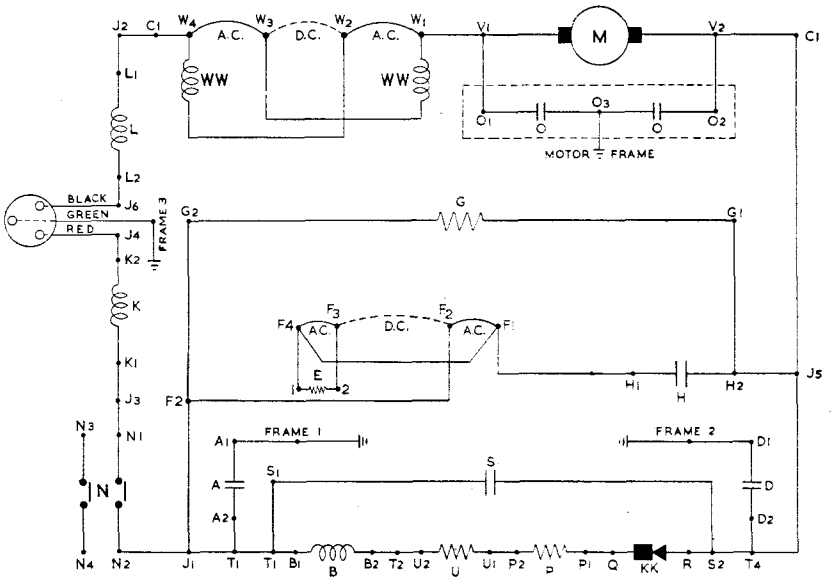
FIGURE 12
TRANSMITTER UNIT MECHANISM



MAIN BASE COMPONENTS



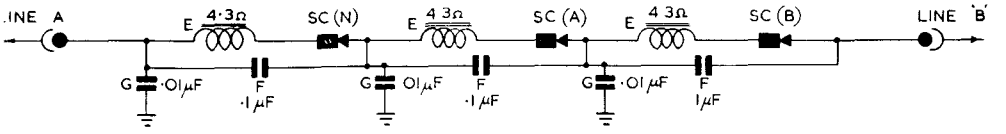
MOTOR COMPONENTS



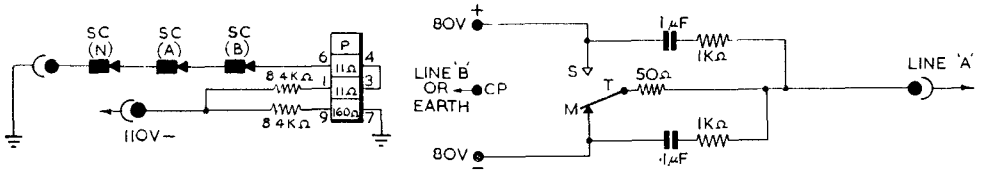
MOTOR SCHEMATIC CIRCUIT

A	R.I.S. CAPACITOR, ·01 μF	L	R.I.S. INDUCTOR, 1000 μH AT 1000 C.P.S.
B	R.I.S. COIL, 1·1 Ω	M	MOTOR ARMATURE
C	CONNECTION BLOCK	N	MOTOR SWITCH
D	R.I.S. CAPACITOR, ·01 μF	O	MOTOR R.I.S. CAPACITORS, ·01 μF + ·01 μF SINGLY, OR TWO IN CONTAINER AS SHOWN
E	RESISTOR, 270 Ω	P	SURGE LIMITING RESISTOR, 5 Ω
F	STRAPPING BLOCK	Q	GOVERNOR BRUSH
G	GOVERNING RESISTOR: 1000 Ω FOR 130 – 270 VOLT SUPPLIES, 270 Ω FOR 90 – 125 VOLT SUPPLIES	R	GOVERNOR BRUSH
		S	R.I.S. CAPACITOR, 0·1 μF
H	CAPACITOR, 0·5 μF	T	CONTACT STRIPS
J	6-WAY TERMINAL BLOCK	U	SURGE LIMITING RESISTOR, 5 Ω
K	R.I.S. INDUCTOR, 1000 μH AT 1000 C.P.S. (NEAREST CASTING)	V	MOTOR BRUSHES
		W	MOTOR FIELD STRAPPING BLOCK
KK	GOVERNOR CONTACTS	WW	MOTOR FIELD WINDINGS

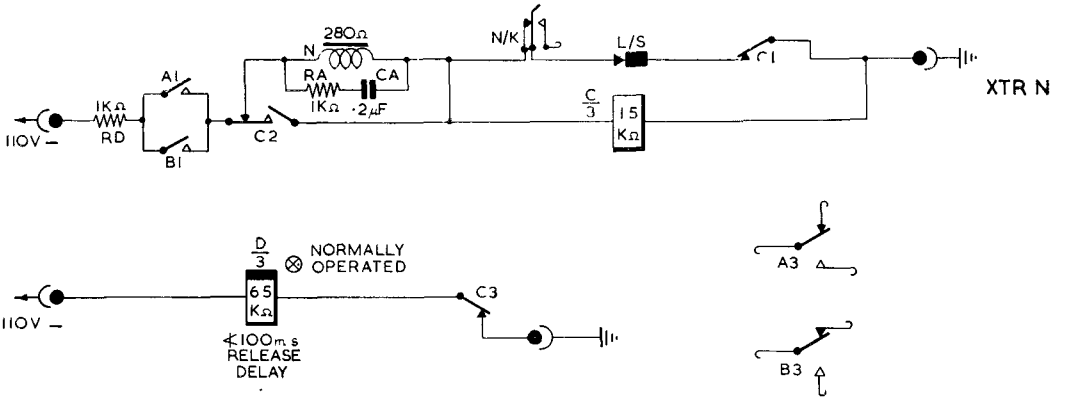
FIGURE 13
MOTOR CIRCUIT



SIGNALLING CIRCUIT S/C



SIGNALLING CIRCUIT D/C



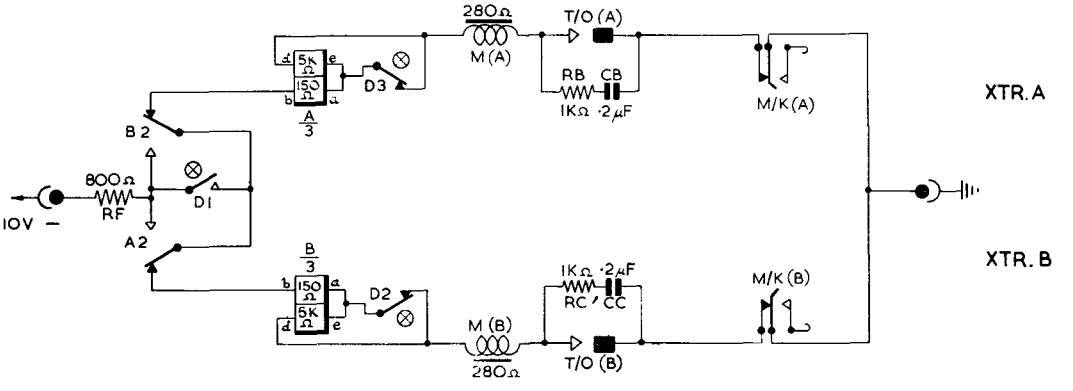
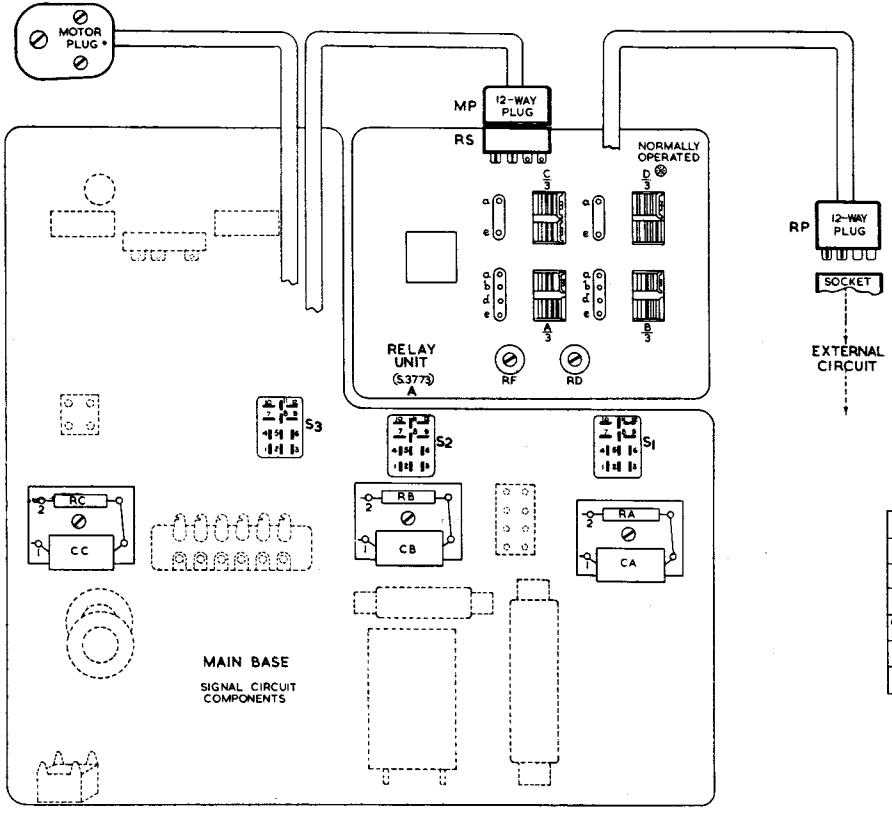
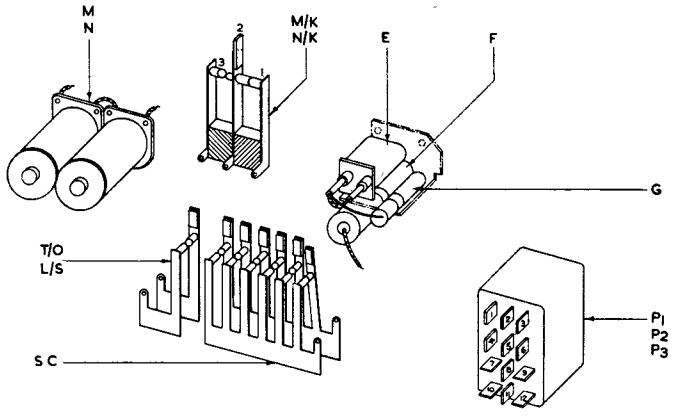


FIGURE 14
SIMPLIFIED CIRCUIT SCHEMATIC





TRANSMITTER UNIT COMPONENTS

A/3	RELAY 150+5000 Ω	G	CAPACITOR 0·01 μF	RD	RESISTOR 1000 Ω
B/3	RELAY 150+5000 Ω	L/S	LETTER SENSING CONTACTS	RF	RESISTOR 800 Ω
C/3	RELAY 1500 Ω	M/N	CLUTCH MAGNETS	RP	RELAY UNIT PLUG
D/3	RELAY 6500 Ω	M/K N/K	KEY CONTACTS	RS	RELAY UNIT SOCKETS
CA,CB CC	CAPACITORS 0·2 μF EACH	MP	MACHINE PLUG	S1,S2, S3	TRANSMITTER UNIT SOCKETS
E	RETARD COIL 4·3 Ω	P1, P2, P3	TRANSMITTER UNIT PLUGS	S C	SIGNAL CONTACTS
F	CAPACITOR 0·1 μF	RA,RB, RC	RESISTORS 1000 Ω EACH	T/O	TAPE-OUT CONTACTS

FIGURE 15
COMPONENTS IDENTIFICATION DIAGRAM

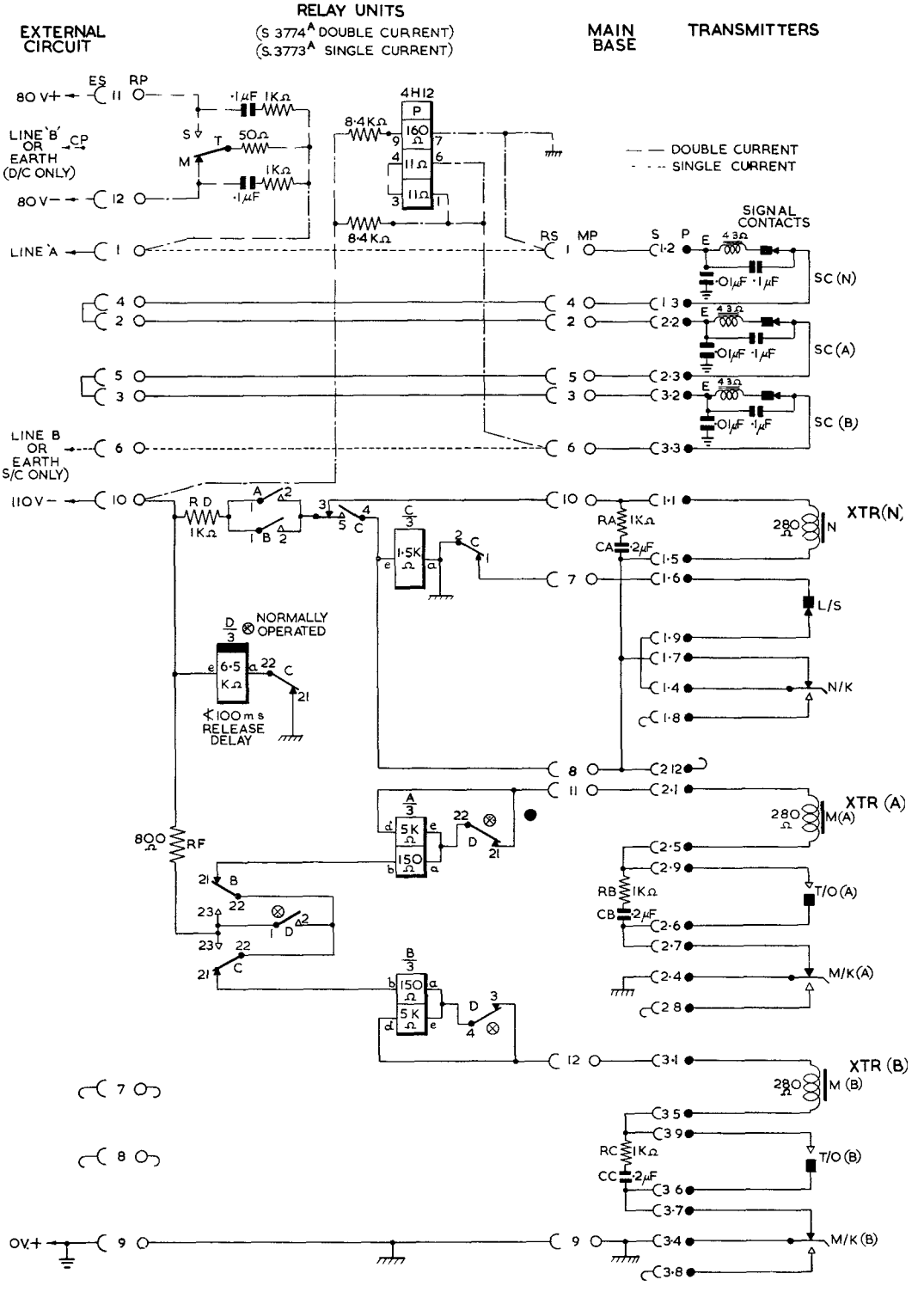


FIGURE 16
CIRCUIT SCHEMATIC