

## AN INTRODUCTION TO TELEGRAPH MACHINES

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N.B. Figs. 4 and 11(a) are appended at the end of this pamphlet. ]

INTRODUCTION

The bulk of this pamphlet contains a description of the mechanical operations which take place in a teleprinter No. 7B when

- (1) a key on the teleprinter keyboard is depressed and
- (2) a signal is received at a receiving teleprinter.

The descriptions are confined only to the essential functions involved, no reference being made to such operations as the answer back, speed control etc. etc.

A brief reference is then made to the other types of teleprinters used by the G.P.O. and to the use of perforators and reperforators.

MECHANICAL OPERATION OF A TELEPRINTERGENERAL

The teleprinter is rather like a large typewriter in appearance. It is powered by a  $\frac{1}{25}$ th horse power motor which enables it to transmit and receive messages automatically by means of the five unit code.

The teleprinter consists essentially of two main parts, namely,

- (1) the transmitter
- (2) the receiver.

which are mounted on the same base plate. Both the transmit and receive mechanisms are at rest except when a signal is being sent or received.

A removable protective metal cover is attached to the baseplate of the machine enclosing all parts except the printing platen and the keyboard. The cover is hinged in such a manner that it can be either laid back, or entirely removed, as required. Thick felt is used to line the cover in order to reduce the noise from the working parts of the mechanism.

### OPERATION

For the sake of simplicity two teleprinters connected by a pair of wires and sending messages one to the other will be considered. The message to be sent is typed on the keyboard of one teleprinter and received and printed automatically at the other teleprinter. To facilitate typing the keyboard is similar in layout to that of a typewriter and facilities also exist for a 'local' copy of the message to be simultaneously printed at the sending teleprinter.

### THE TRANSMITTER

The transmitter is simply an automatic signalling device driven by the teleprinter motor and controlled by the keyboard. When a key is depressed, its position across five metal bars known as combination bars determines the code transmitted and a combination of pulses of negative (marking) and positive (spacing) potential are applied to the line:

The five unit code is used on all teleprinters in the B.P.O. i.e. when any key is depressed a combination of five pulses of positive and negative potential are applied to the line, each combination being preceded by a spacing pulse and followed by a marking pulse as illustrated in Fig. 1 where the code for letter Y is shown.

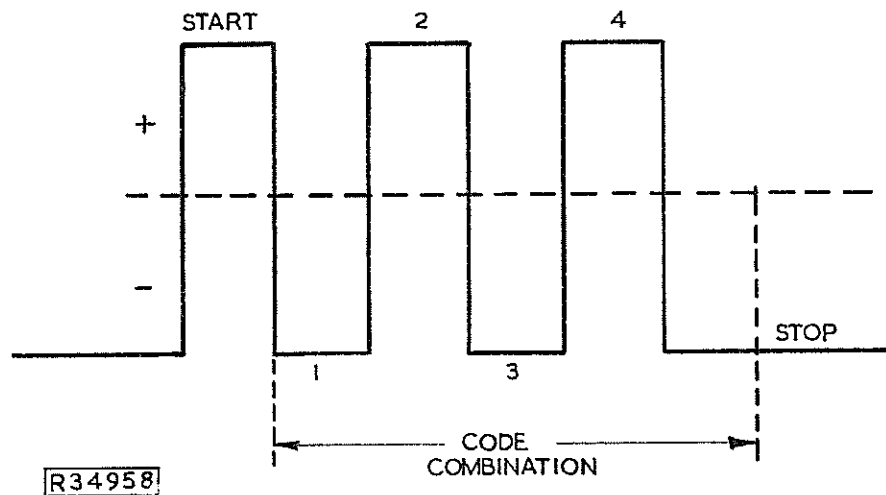


Fig. 1

In order to be able to send signals in this form, the transmitter consists essentially of a tongue which can be moved between two contacts one of which is connected to an 80V -ve potential and the other to an 80V +ve potential. The standard symbol used on diagrams to represent a transmitter is given in Fig. 2.

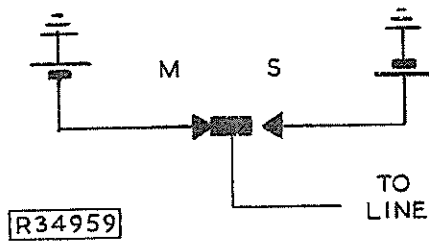


Fig. 2

A picture of the keyboard and transmitting unit is shown in Fig. 3, and Fig. 4 (appended) shows a schematic diagram of the transmitting mechanism.

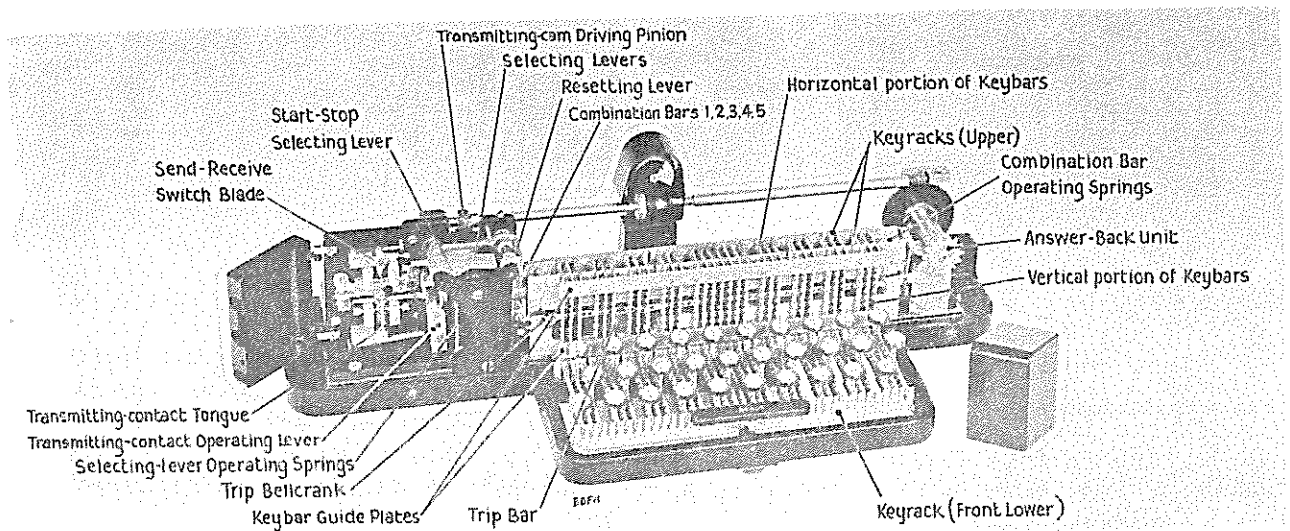


Fig. 3



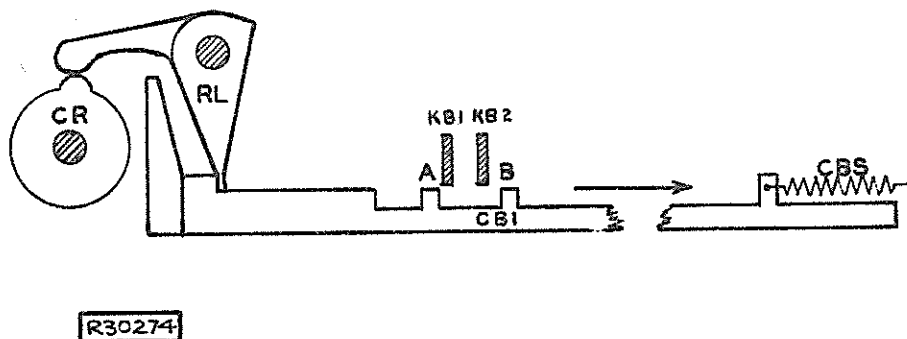


Fig. 6

In this diagram a front elevation is drawn showing the projections of two key-bars KB1 and KB2. If key KB1 is depressed then the combination bar will be prevented from moving to the right. On the other hand, should key KB2 be depressed then the combination bar will be allowed to move to the right.

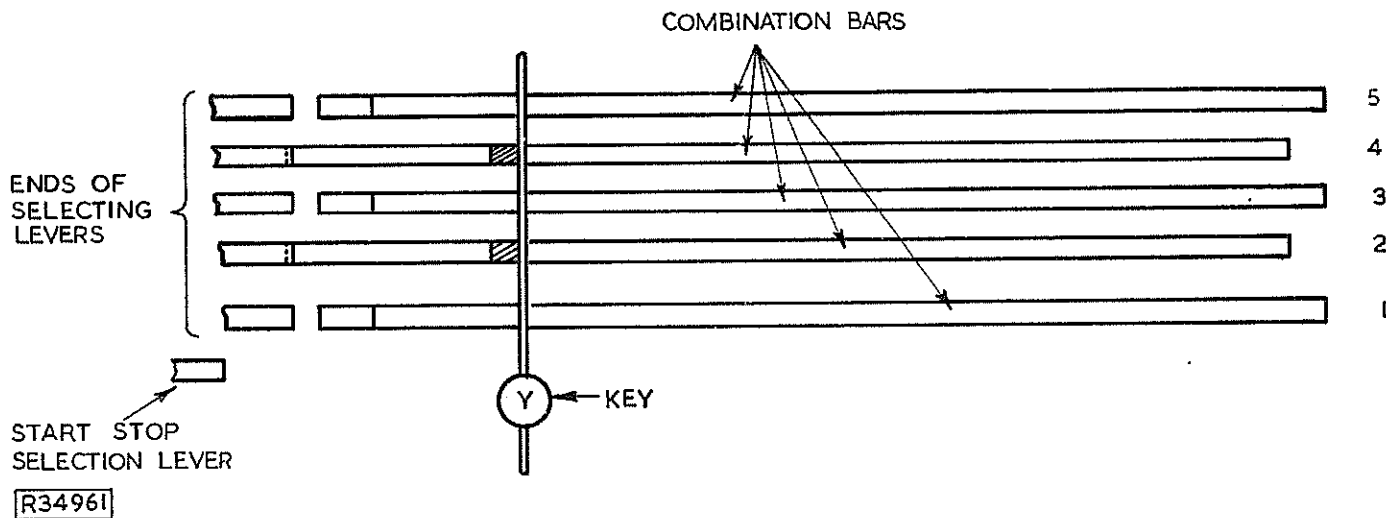
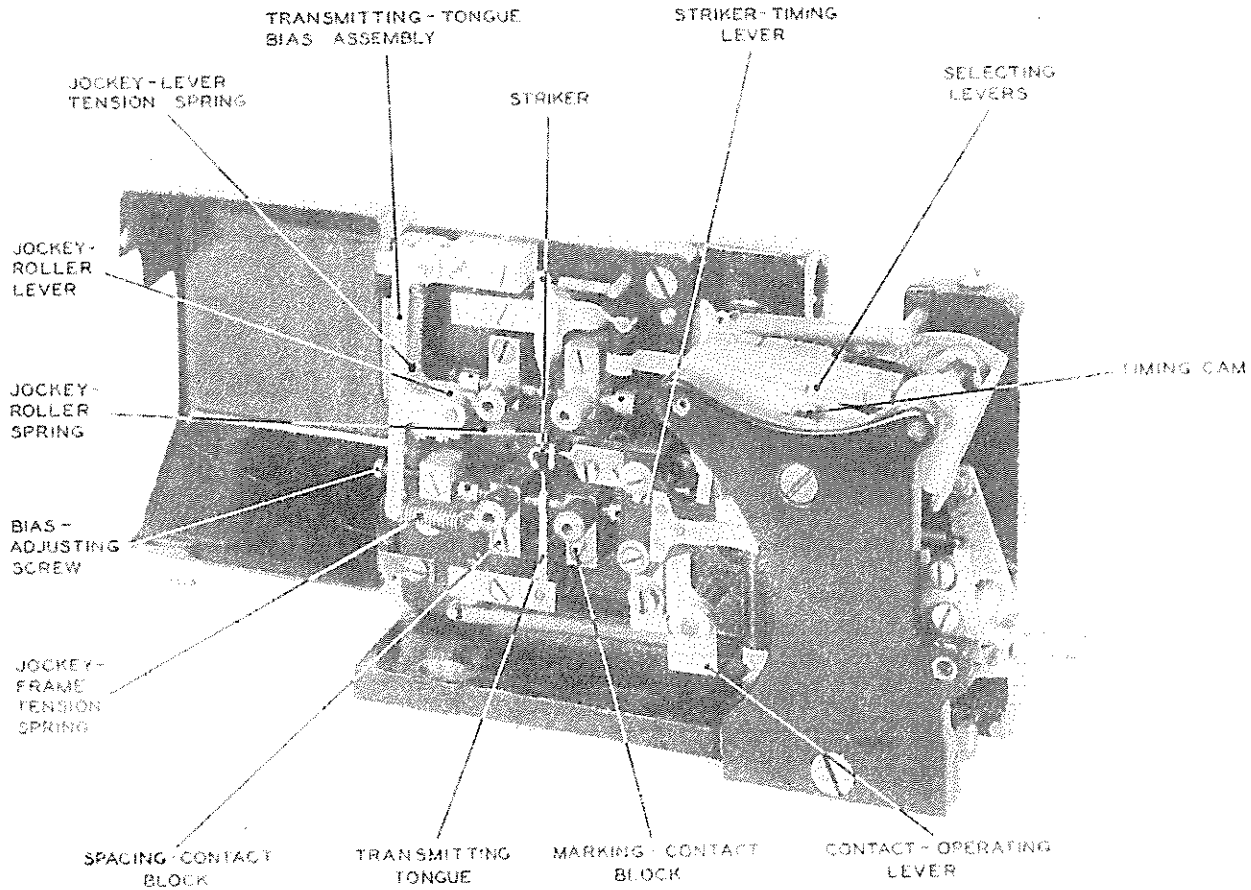


Fig. 7

Fig. 7 shows a plan of the combination bars, and the ends of the selecting fingers with a depressed 'Y' key. It will be seen that combination bars 1, 3 and 5 are allowed to move to the right while combination bars 2 and 4 are prevented from moving to the right by the projections on the combination bars immediately to the left of the keybar.

Inspection of Fig. 4 shows that the transmitting cam is made up of several cams and that each cam has a slot cut in its periphery in which the selecting lever may ride. As the cam shaft rotates each selecting lever is, in turn, permitted to ride over the cut away portion of the cam providing the corresponding combination bar has moved to the right to allow the top end of the selecting lever to move down. Such a downward movement constitutes a mark signal element. The cut away portions of the transmitting cams are so arranged that they pass any fixed point in the order 1, 2, 3, 4 and 5, thus in our example the mark signal elements will occur as 1st, 3rd, and 5th elements in the signal as shown in Fig. 1.



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Fig. 8

A picture of a teleprinter transmitter and the associated selecting levers is shown in Fig. 8. This type of transmitter is known as the striker type by virtue of its action. The transmitter is situated immediately to the left of the selecting levers when viewing from the front.

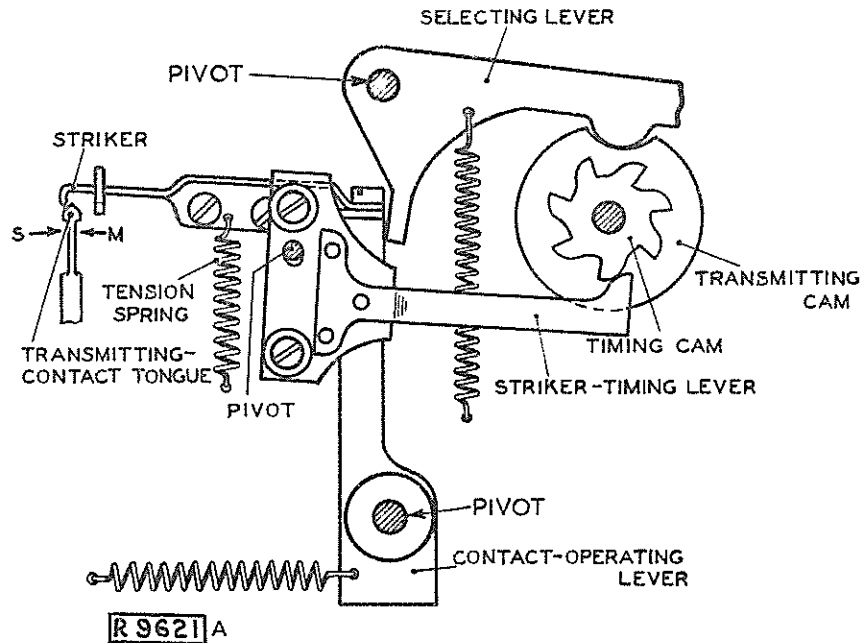


Fig. 9

Fig. 9 is a diagram showing the action of the transmitter. A timing cam is fitted on the end of the cam shaft and it moves the striker up and down at regular intervals during the revolution of the cam. The left hand end of the striker is bent downwards and shaped with a knife edge. This knife edge is caused to operate on a similar knife edge on the upper end of the transmitting tongue. When a marking signal is to be transmitted, the appropriate selecting lever enters the out away portion of the cam track and moves the contact operating lever and striker to the left, i.e. to the position shown in Fig. 9. When the striker timing lever next falls into a notch in the timing cam the striker moves downward and pushes the tongue sharply over to the marking contact. The tongue is so arranged that it remains on the marking contact until moved over to the spacing contact by another downward movement of the striker when the appropriate selecting lever is not allowed to follow the indent in its associated cam. Thus as the transmitting cam rotates, the striker moves up and down and, when appropriate moves the tongue from one contact to the other.

#### THE RECEIVING AND SELECTING MECHANISM

So far we have considered a signal consisting of pulses of positive and negative electricity which are being sent to line. This signal is usually received by a relay connected in the line terminating circuit. The relay repeats the signals to a polarized electromagnet and the consequent movements of the magnet armature produce the following effects:

- (a) Set in motion the character selecting and printing mechanism.
- (b) Select the character required to be printed.
- (c) Bring mechanism to rest at the end of a signal.

The Electromagnet

The electromagnet is shown in Fig. 10. It consists essentially of a U shaped permanent magnet with laminated pole pieces and a laminated armature. The movement of the laminated armature and its extension is limited by two stops. The two coils of the electromagnet almost completely enclose the armature which passes through them as shown. A spring clip is provided on the end of the armature extension for coupling to the electromagnet link (this will be described later).

The magnetic circuit of the electromagnet is such that a marking signal causes the armature to move over to the marking "stop" M while a spacing signal causes the armature to move over to the spacing "stop" S.

Mechanism Operation

A brief outline of the selection of a character will be given before the detailed description.

The selection of a particular character is effected by the I/C signal operating the appropriate combination of the five comb setting fingers, thereby allowing certain of the receiving combs to move and open up a way for the operation of one bellcrank. Operation of the bellcrank provides a stop for the rotating type head such that the appropriate character is opposite the typehead hammer.

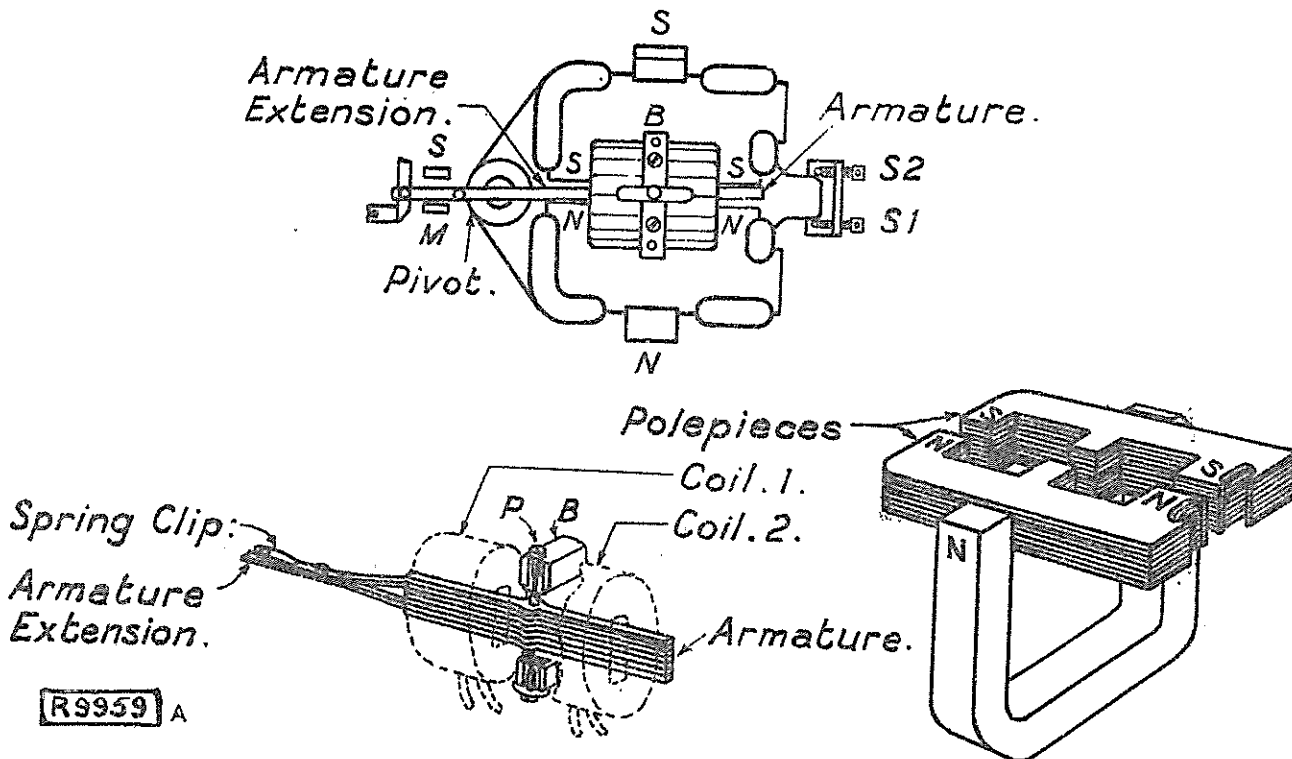


Fig. 10

A detailed labelled drawing of the receiving mechanism is shown in Fig. 11(a) appended, and a simplified drawing showing the essential elements concerned with the operation of the comb setting fingers is shown in Fig. 11(b).

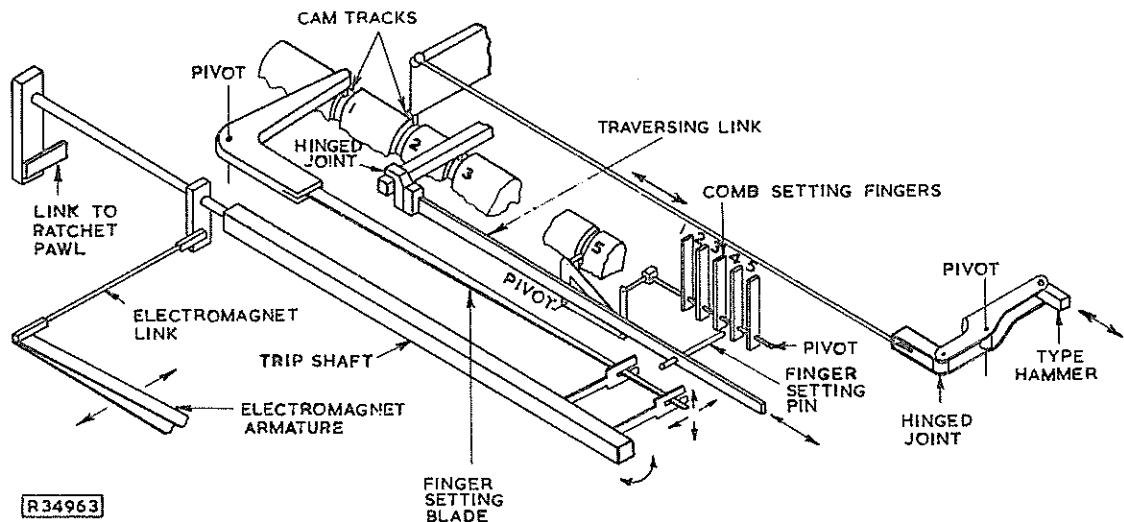


Fig. 11(b)

As the electromagnet armature (bottom left hand corner of Fig. 11(b)) moves in response to the incoming signals, the trip shaft takes up one of two positions depending upon whether the received signal is marking or spacing. The electromagnet armature is connected to the trip shaft by means of the electromagnet link.

The trip shaft performs two functions

- (a) it controls the starting and stopping of the receiving cam sleeve by engagement and disengagement of the pawls through the action of the pawl abutment (this is similar to the transmitting cam arrangement), and
- (b) it controls the deflexion of the finger setting blade in accordance with the incoming signals and thus translates the signal code combination into a corresponding setting of the five comb setting fingers.

The whole of the setting up and printing operation is controlled by 5 cam tracks in the receiving cam sleeve denoted by  $T_1$ ,  $T_2$ ,  $T_3$ ,  $T_4$  and  $T_5$  in Fig. 11(a). If the circumference of the cam sleeve is opened out into a horizontal plane, then the cam shapes and their respective phase positions are shown in Fig. 12.

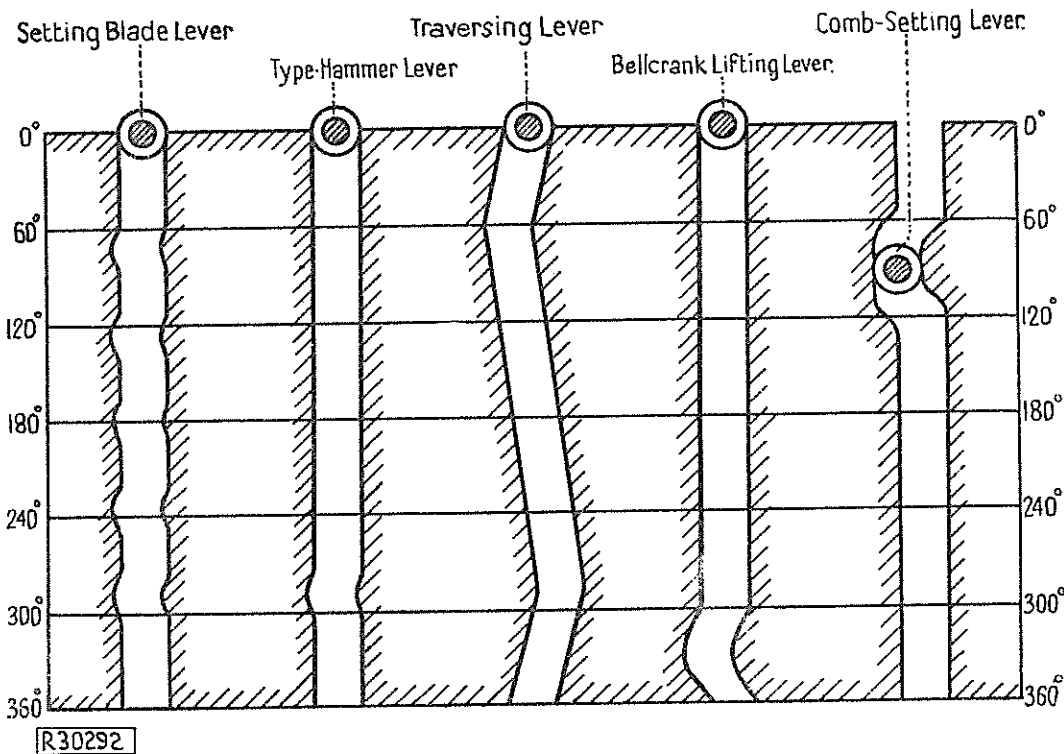


Fig. 12

The receiving cam sleeve is driven by means of a clutch consisting of a ratchet and pawls similar to those employed on the transmitting cam sleeve. A pawl abutment pivoted vertically on the base of the teleprinter, and coupled by a link to the trip shaft, normally holds the pawls from engagement with the ratchet whilst the electromagnet is in the rest or marking position. Fig. 13 shows a rear elevation and a plan view of motor spindle, type wheel shaft with the associated trip shaft coupling and pawl abutment.

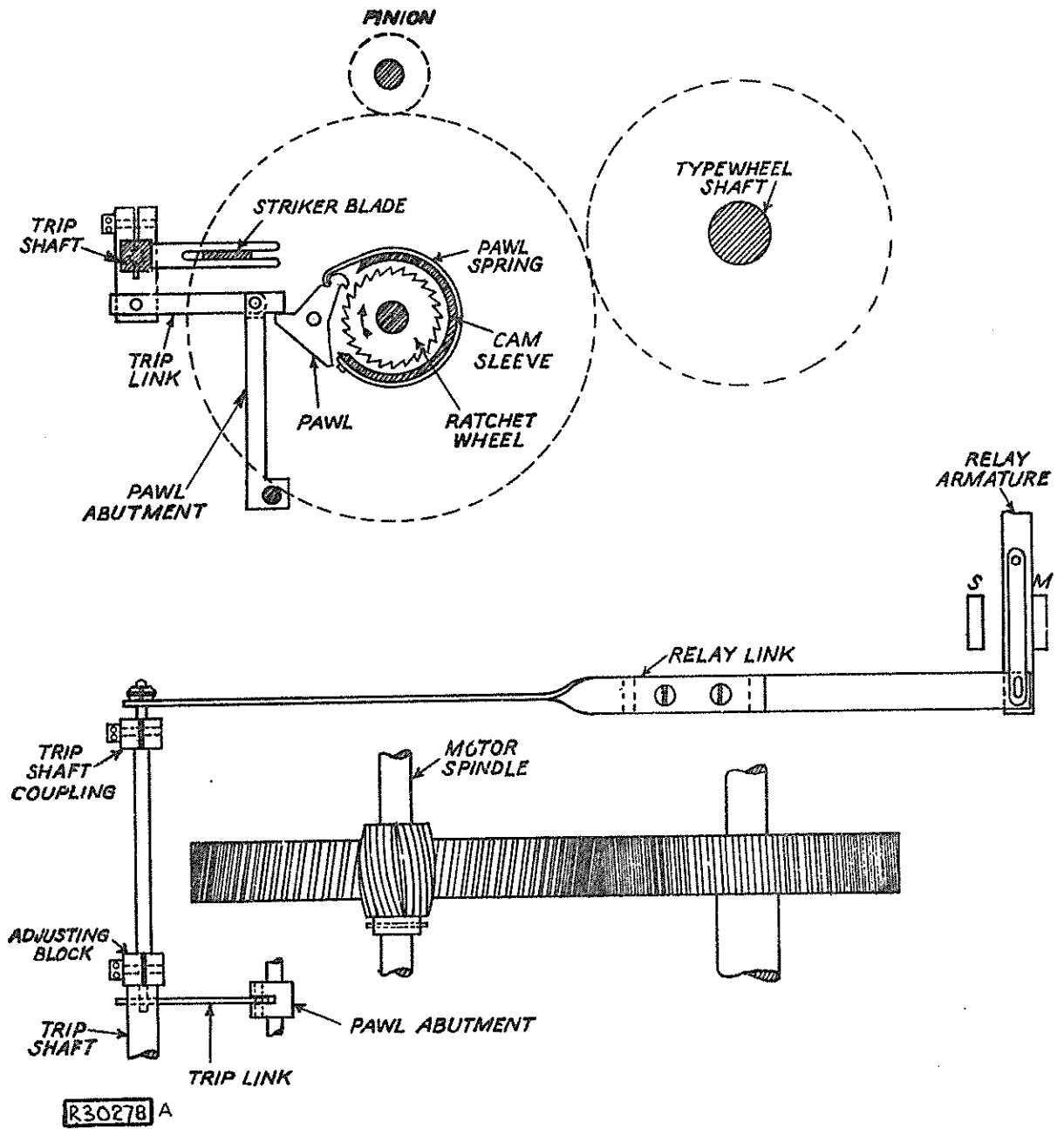


Fig. 13

Normally only the ratchet wheel is rotating and on receipt of an incoming signal, the first spacing pulse (start signal) causes the trip shaft (see Fig. 11a) to turn in such a direction that the end of the pawl abutment is withdrawn from the pawls and the pawl spring forces the pawl into engagement with the rotating ratchet causing the cam sleeve to commence to rotate. In a similar manner to the transmitting cam, the receiving cam sleeve is required to make one complete revolution

for the reception of each signal combination. This is made possible by the stop signal (marking pulse) which causes the pawl abutment to be reset in the path of the ratchet and pawls so disengaging them from the ratchet at the end of one revolution. This brings the cam sleeve to rest until the start signal of the next combination is received.

Reception of a signal combination causes the appropriate character to be set up by positioning a combination of the 5 receiving combs. Receiving combs are thin stampings of soft iron circular in shape and with a toothed circumference.

Fig. 14 shows a diagram of one of these combs (there are five of this type). Each comb is capable of slight rotary movement. To the right of each comb extension is a finger known as a comb setting finger which is pivoted at its base so that it can be moved under the receiving comb extension. To the right of the fingers is the traversing link, Fig. 11(b), this carries a pin which can be moved along in front of the five fingers, this movement being controlled by cam track  $T_3$  of the revolving cam sleeve.

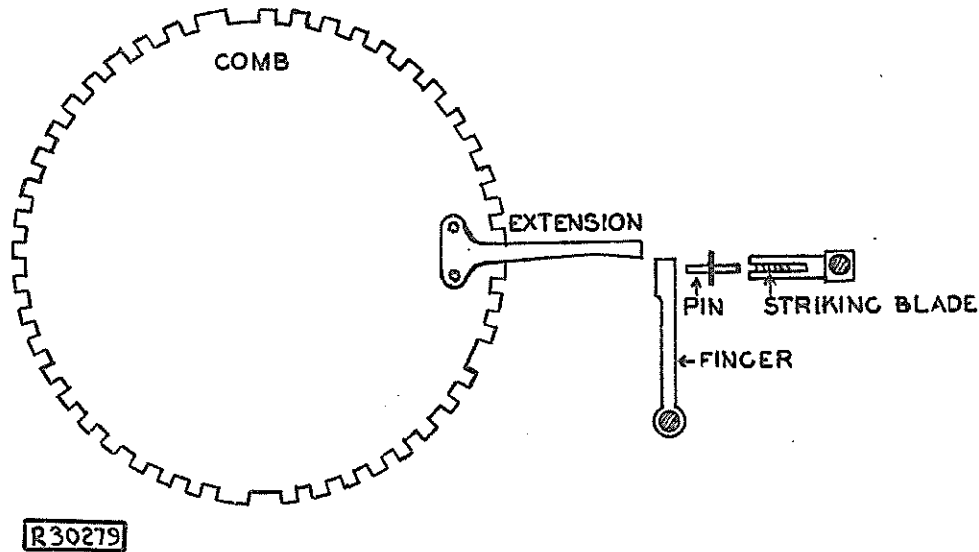


Fig. 14

A finger setting blade is mounted by the side of the traversing link. The finger setting blade is capable of two independently controlled movements. By means of cam track  $T_1$  the blade can be moved towards the traversing link. At the same time the finger setting blade is capable of being tilted by the armature of the electromagnet so that it will either hit or miss the pin in the link during its motion towards it. Receipt of a marking signal causes the blade to strike the pin and receipt of a spacing signal causes the blade to miss the pin. If the pin is hit it is forced forward and moves the finger under the comb extension.

Let us now consider the sequence of operations of the various parts when a signal combination is received from the line.

The start signal moves the armature of the electromagnet to spacing thereby operating a clutch causing the receiving cam sleeve to rotate. Cam track 3 causes the traversing link to move the finger setting pin from its normal position (opposite the 3rd finger) down towards the 1st finger. In this position cam track 1 causes the blade to move forward. At the same moment the first pulse of the combination is received from the line, and it does one of two things.

(1) If the pulse is marking, the blade strikes the finger setting pin.

(2) If the pulse is spacing the trip shaft is twisted so that the blade misses the finger setting pin. The traversing link (under the control of cam track 3) then moves the pin on to a position opposite the second finger where the blade is again moved forward and, at the same moment, the signal is received from line with the same effect as in the previous case. In the same manner the traversing link moves the pin opposite the remaining fingers in turn to record the incoming signal and then moves back to its normal position. Fig. 15 shows a plan of the combination head, comb setting fingers, traversing link and finger setting blade.

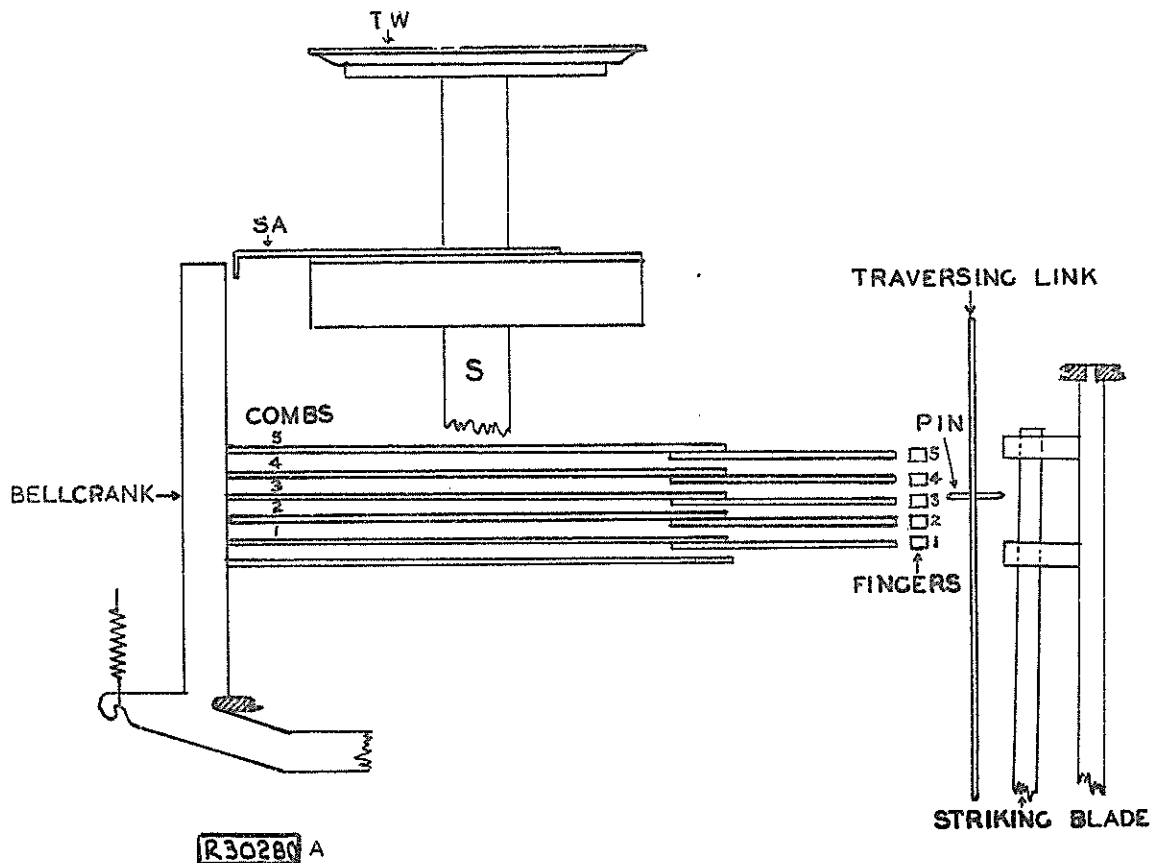


Fig. 15

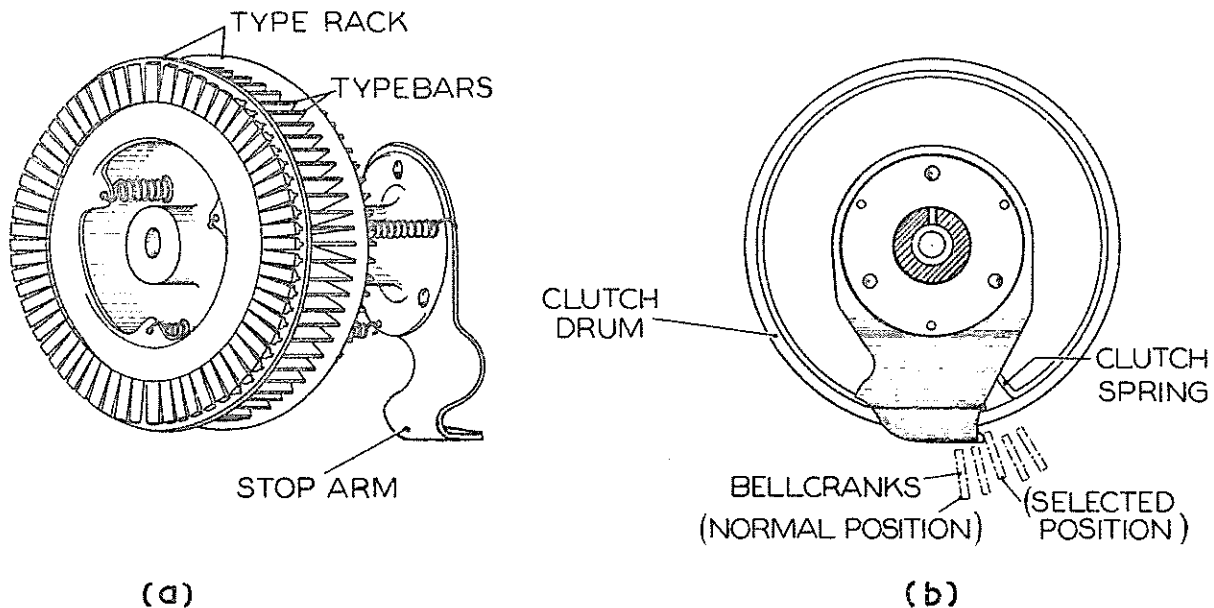
We now have the combination of the incoming signal stored in the comb setting fingers. The fingers which are moved forward correspond to the marking signals and those which are normal, correspond to the spacing signals.

At this point, under the control of a cam riding in cam track 5 each comb setting finger is made to rise (Fig. 11(b)). In their upward movement, according to the code combination set up, certain fingers will engage with the extensions of the receiving combs which are thereby lifted, causing these combs to rotate through a few degrees (Fig. 11(a)).

Inspection of Fig. 11(a) shows bellcranks mounted longitudinally along the combination head and these are mounted all the way around the combination head although only a few are shown in the diagram. Each bellcrank corresponds to a character which can be printed by the teleprinter.

As explained earlier, the receiving combs are mounted side by side, each comb having a toothed periphery. The periphery of each comb is cut in such a manner that for every signal combination there is only one set of slots in alignment. Hence when the fingers cause the combs to rotate, corresponding to the combination received from line, one of the bellcranks will fall into the set of slots which are now in alignment.

Referring again to Fig. 15 a continuously rotating shaft S, carrying the type wheel TW, passes through the centre of the combs. A friction clutch is interposed between the shaft and the type wheel so that the rotation of the type wheel may be stopped in any position. An arm SA is attached as shown and rotates with its end just clear of the ends of the bellcranks when these are normal. When one of the bellcranks falls into a set of slots (upon the receipt of a signal combination) and stops the arm SA from rotating, the type wheel is also arrested. The type is so arranged so that the character corresponding to the combination received is in line with the type hammer (see Fig. 11a & b). Fig. 16(a) shows a view of the type head while Fig. 16(b) shows an end-on elevation of the rear of the type-head indicating how a selected bellcrank has arrested the rotation of the type-head by means of the stop arm.



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Fig. 16

The printing of the character takes place during the next revolution of the receiving cam sleeve and this action is controlled by cam track 2 (Fig. 11(b)). Towards the end of the revolution of the camsleeve this cam track will cause the operation of the type hammer which will print the character set up during the previous revolution of the cam sleeve.

No further description of the mechanical operation of the teleprinter will be given in this pamphlet, the reader will appreciate that much detail has been omitted, a more detailed description will be given in later pamphlets.

TELEPRINTERS USED BY THE POST OFFICE

TELEPRINTER NO. 3

This machine was used for the first time in 1928 when teleprinter working was introduced into the inland public telegraph network. It is a tape printing machine, that is the received message is printed on a gum-backed paper tape. When printed the tape is removed and stuck on to a telegraph message form by the receiving teleprinter operator.

The teleprinter No. 3 is no longer used on the public telegraph network, having been superseded by the teleprinter No. 11. There are however a considerable number used for service purposes.

A picture of a teleprinter No. 3 is given in Fig. 17.

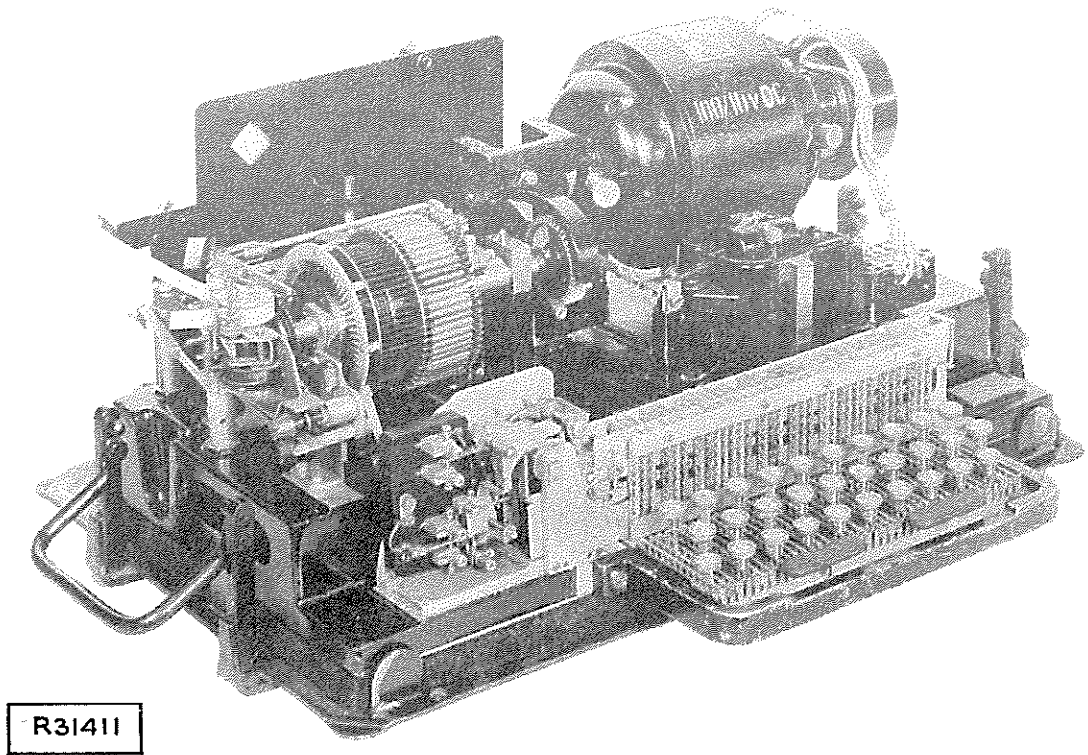


Fig. 17

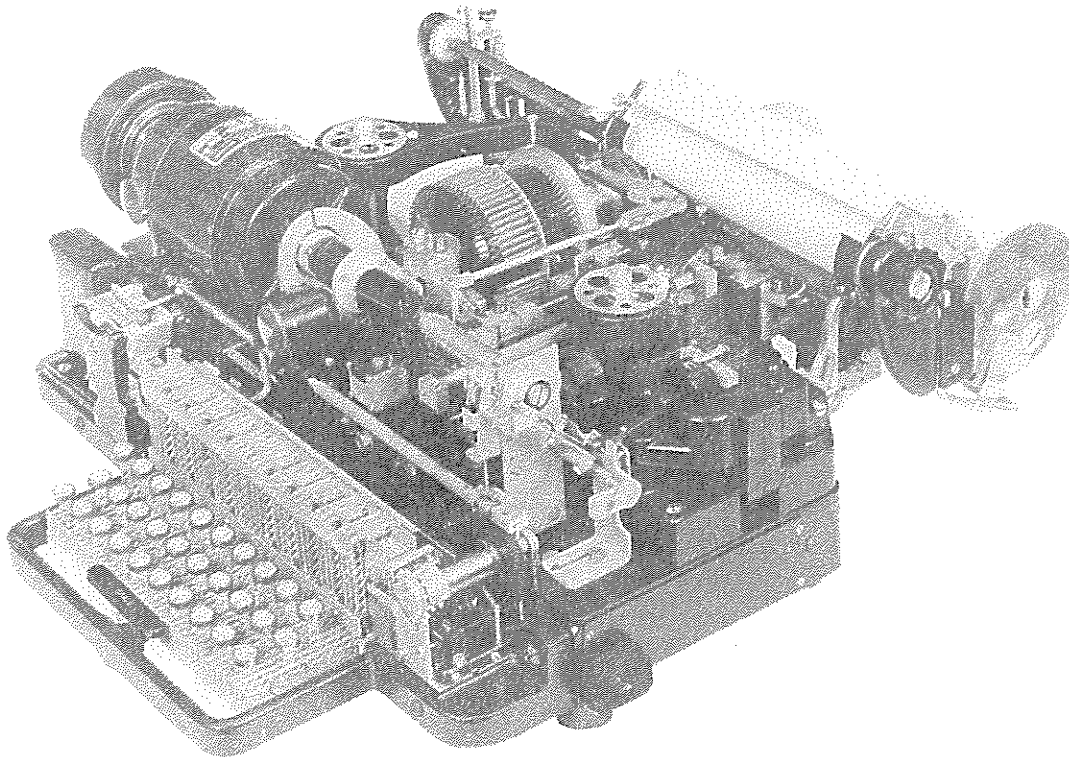
TELEPRINTER No. 7

The teleprinter No. 7, which is similar in operation to the No. 3, was introduced in 1932 for use on telex working and private wires. It is a page printing machine but can be adapted to print on a gummed tape. A local record of the transmitted message is provided.

The machine is similar in operation to the teleprinter No. 3 except for modifications which were necessary to make it page printing.

The teleprinter No. 7 is still the standard machine supplied to private renters and telex subscribers although a number of modifications have been made over the past years to improve its performance.

A picture of a teleprinter No. 7 is shown in Fig. 18.



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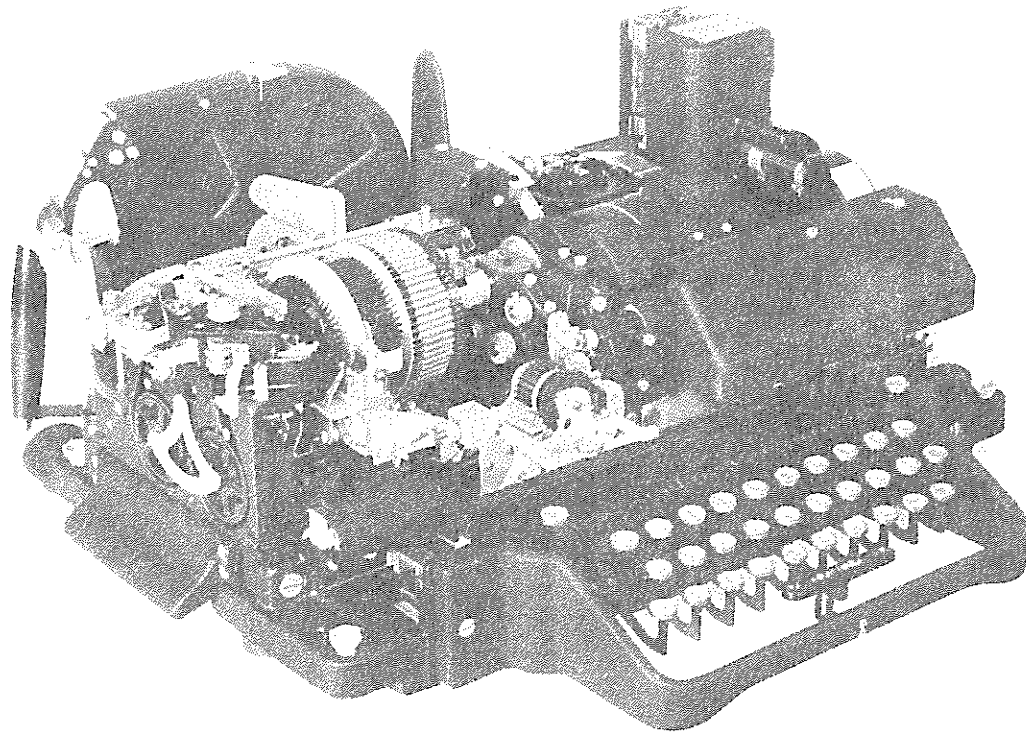
Fig. 18

TELEPRINTER NO. 11

The teleprinter No. 11, a picture of which is shown in Fig. 19, was first used in October 1950 when the first automatic switching centres for telegraph circuits were opened.

The teleprinter No. 11 is largely of orthodox design and makes use of many of the mechanisms and principles of operation employed in the teleprinter No. 7 and No. 3, in fact a large proportion of the parts are common to the three machines. It is a tape printing machine like the teleprinter No. 3 but by the addition of an "end of line" mechanism and warning lamp it can work direct to a teleprinter No. 7.

Of general interest is the widespread use of new materials and manufacturing techniques. Great use has been made of zinc alloy (Mazdak) die castings for smaller parts, this process permits the manufacture of large numbers of parts to extremely close dimensional tolerances.



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Fig. 19

AUTOMATIC MACHINES

Telegraph messages can be transmitted automatically by the use of a paper tape which is perforated according to the characters of the Five Unit Code. Perforators and Reperforators are machines used for this purpose.

The teleprinter perforator has a keyboard similar to that of the teleprinter. This keyboard instead of controlling a teleprinter transmitter, controls a perforating mechanism which punches holes in a paper tape in accordance with the five unit code combination corresponding to the key depressed.

The teleprinter reperforator is a machine very similar to a teleprinter but, on reception of signals in the teleprinter code it translates them into the equivalent five unit code perforations in a paper tape and, in addition causes a printed record to be made on the same tape.

In general, the advantage of automatic working is that messages can be transmitted, or retransmitted, by the use of perforated tape at maximum speed and without the possibility of operating errors which may occur with manual retransmission. There is also a great saving in operating staff - one operator being able to keep several sets of automatic equipment fully occupied.

END



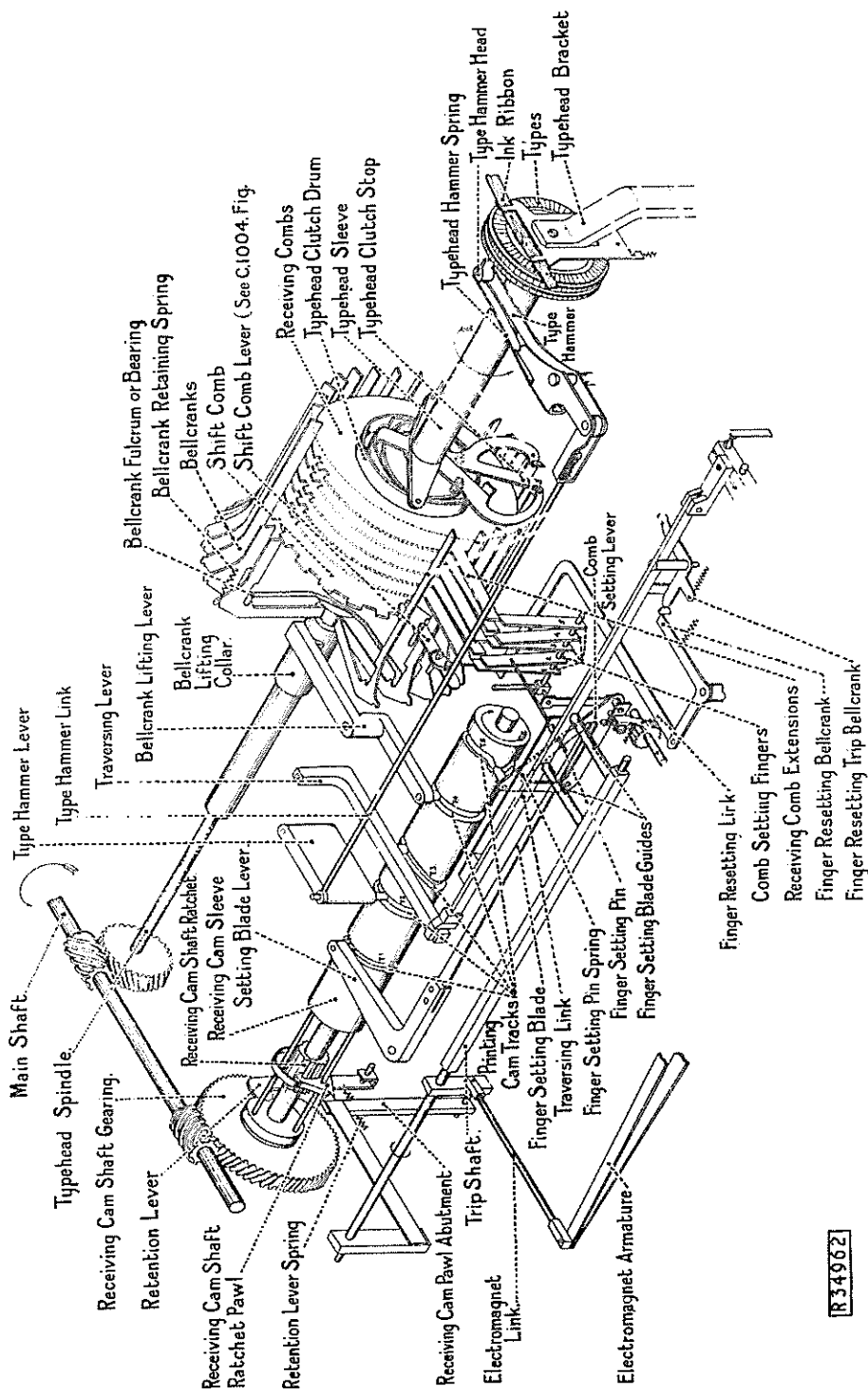


Fig. 11(a)

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