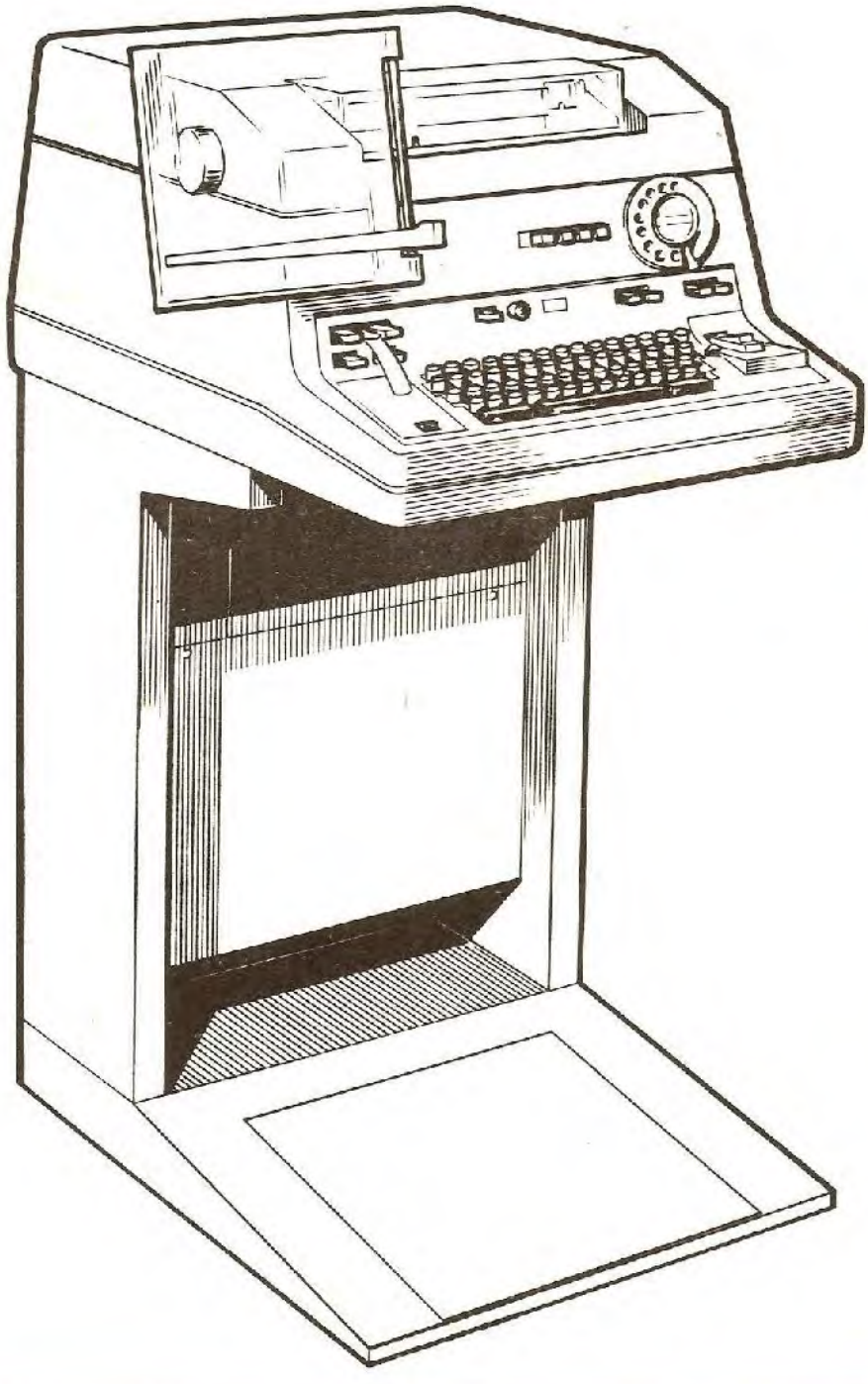
Post Office
Telecommunications

Educational Pamphlet

EP Telegraphy 4/3
Draft Series

Teleprinter 15



Issue 1 4/75

CONTENTS

This Educational Pamphlet is issued with an associated pamphlet, EP Telegraphy 4/4 Teleprinter 15 (FIMS). The diagrams contained in that EP should be referred to as indicated in the text of this pamphlet.

Your attention is drawn to the note on the FIMS (Functionally Identified Maintenance System) concept of information presentation on page 2 of EP Telegraphy 4/4.

Introduction

The BPO Standard Teleprinter No. 7 manufactured by Messrs. Creed and Co. (now ITT Creed Ltd) was first introduced in 1932. Whilst various modifications and improvements have been made over the years the machine is substantially the same. It was decided that a new machine was required for the rapidly expanding telex network and for the increasing number of data links operating at higher speeds. A particular requirement for the new machine was that the maintenance effort needed should be less than that required by the Teleprinter No. 7, because of increasing labour costs, and that interchangability of parts be simplified.

With these points in mind ITT Creed Ltd developed a new machine, Model 444 (four-forty four) which the BPO refer to as the Teleprinter No. 15.

Whilst following proven mechanical principles in teleprinter construction, the following principal improvements have been made.

(i) The machine is constructed on a unit principle, each unit being retained in position by up to four screws. The standard units are interchangeable and some units can be changed on site. On some units, such as the Selector Unit where the correct functioning of other units rely on the setting of the selector cam, a number of adjustments would have to be carried out.

(ii) Compared to earlier teleprinters, there is a reduction in the amount of mechanical adjustment required and a greater time interval between major overhauls.

(iii) The machine can work at either 50 or 75 bauds, the speed change being accomplished by changing the drive gears.

(iv) The type is held in a type basket, like a typewriter, so that a printed character is immediately visible. The type basket traverses the paper which remains stationary on its platen. There is therefore less weight to move and less energy to absorb than on earlier machines which had a moving paper platen containing a paper reel and the risk of overprinting when commencing a new line is reduced.

(v) Many mechanical parts are precision moulded from plastics, thus simplifying manufacturing operations and so reducing costs. The Answerback Unit has an interchangeable ward drum manufactured from plastic, with break off projections used for coding purposes, eliminating the need to supply a range of pre-cut metal coding wards.

(vi) The Paper Tape Reader and Punch are incorporated as integral parts of the machine (when required). This reduces the number of ancillary items and trailing leads, and enables the machine, if required, to be mounted on a purpose constructed plinth, reducing slightly the floor space required.

(vii) The machine cover is constructed to absorb most of the sound of the machine and is of modern appearance with a smooth enamel finish. Being quieter the machine is more acceptable in a general office obviating the need to provide a separate 'teleprinter room'.

Unit Construction

A feature of the Teleprinter No. 5, as mentioned in the introduction, is its unit type construction. This gives an ease of maintenance and accessibility, although some adjustments have to be made. Any unit that has been completely dismantled will need relatively few readjustments, when reassembled.

The number of fabricated parts is approximately 1250 for a basic transmitter/receiver version of the machine fitted with a synchronous motor. A further 160 parts are involved in the Tape Reader Unit, and 220 parts in the Tape Punch Unit.

EP Telegraphy 4/4, Fig. 1 gives a block schematic of the various units together with their functions and Fig. 2 shows the location of the units.

Outline of Operation

Before proceeding with a detailed description of the machine's operation an outline of the operation is given below. This should be read in conjunction with the schematic diagram of EP Telegraphy 4/4, Fig. 1.

It should be noted that throughout this EP the location of any item, left, right, front, or back, is with respect to an operator sitting at the keyboard of the machine. Similarly, any unit described in isolation from the machine's base is described with the unit held in the position it would occupy if it were on the base.

Transmission

The operation of a key for a particular character is converted by the teleprinter into a five-unit double level electrical signal known as MARKS (-80 volts) and SPACES (+80 volts).

Characters and machine control or function characters each have a unique code and can be received on a distant teleprinter and either printed or the function performed. The five unit code used for telex working is the CCITT Alphabet No. 2 and is shown as it appears on punched tape in Fig. 1. The holes represent MARKS, unpunched hole positions being SPACES.

The keyboard layout is shown in Fig. 2.

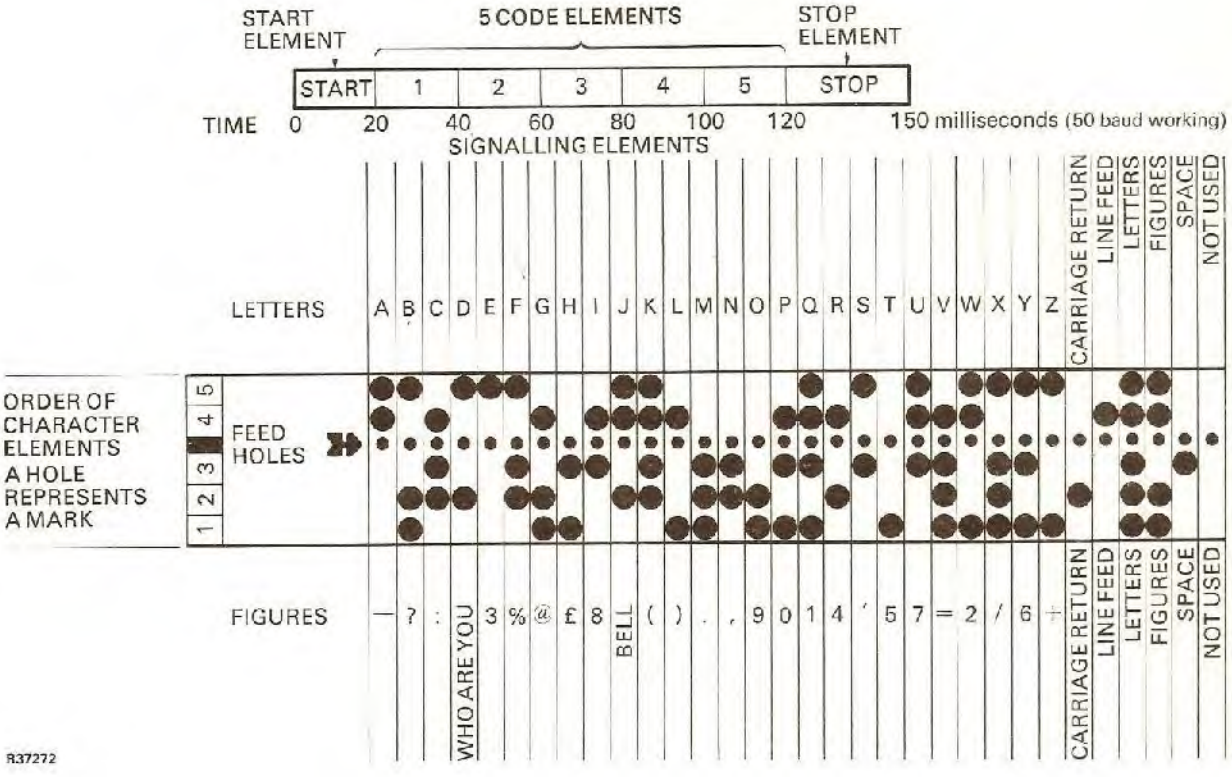


Fig. 1

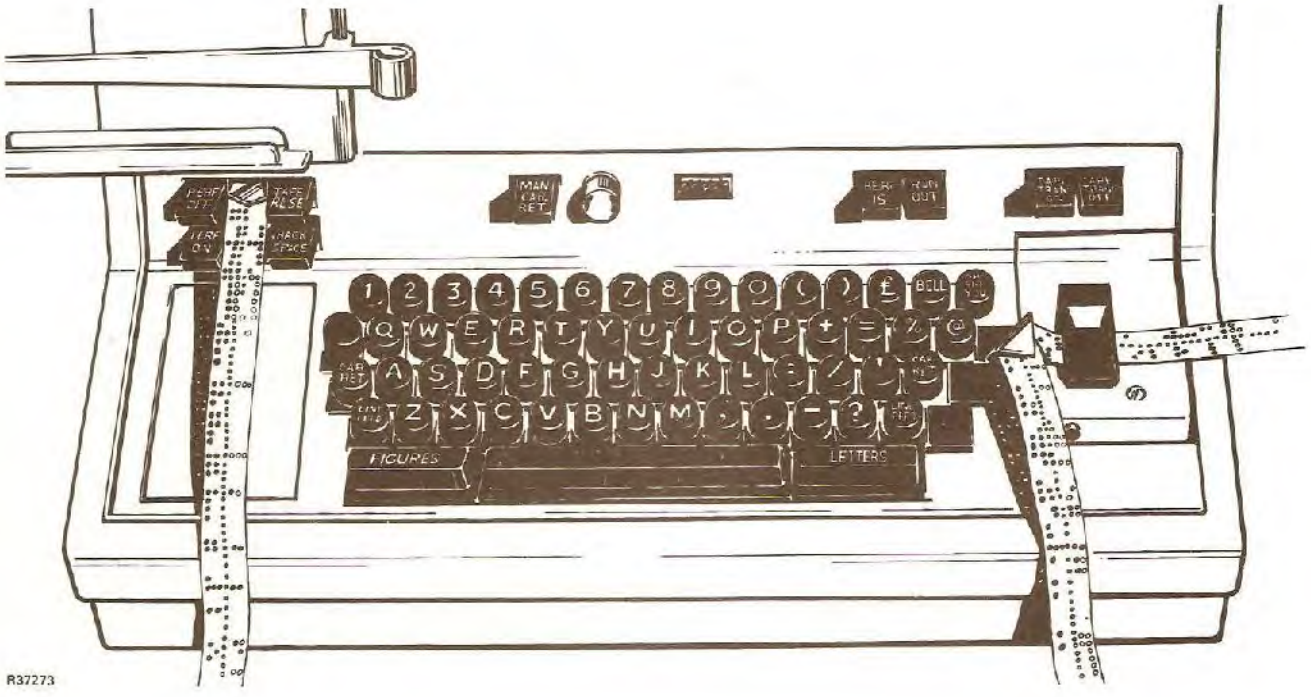


Fig. 2

With the machine's motor switched on, the operation of a key on the keyboard sets up the mark/space combination of the selected key on five groups of comb bars, and simultaneously activates a trip bar which is common to all keys and which releases the transmitter cam sleeve to make one revolution. During this revolution the transmitter mechanism inspects the code setting sequentially and converts it into a train of MARK/SPACE electrical signals that make up the 5-unit code for the depressed key. The transmitting mechanism, which electrically consists of a single, side-stable changeover contact, automatically inserts the START and STOP signals at the appropriate time. It also switches the send/receive switch to "send" before beginning a transmission, and returns it to "receive" when the transmission is concluded.

Reception

Signals from the distant teleprinter are received on a polarized electromagnet whose armature moves between MARK and SPACE positions in response to the reversals in line current that comprise the incoming code combination.

The START signal releases the selector unit cam sleeve which makes half a revolution during which it converts the subsequent movements of the electromagnet armature into a static code setting on five two-state latches. Towards the end of this revolution, the Selector Unit releases the main cam shaft and is itself brought to rest during the STOP signal. The main cam shaft then transfers the code established sequentially on the Selector Unit latches to the Link Unit and Code Control Unit where it is latched and stored in parallel. Once this has been done the Selector Unit is free to accept another code combination.

In the Code Control Unit the stored code is conveyed simultaneously to the print sectors that select the required type from the type basket, and to the Function Unit where it is inspected to determine whether it is a "printing" code or a "function" (non-printing) code such as "line-feed". If the code is found to be a printing code, the pull bars set the appropriate type bar which is activated by a print bail, and its character is impressed on the paper, the "carriage feed" operation following automatically. If the code is found to be a "non-printing" functional code, the print and feed operations are automatically inhibited, and the appropriate function is carried out.

Local Copy

As can be seen in the block schematic diagram (EP Telegraphy 4/4, Fig. 1), for the local copy of the transmitted message the outgoing signal from the transmitter is fed to the receiving electromagnet to be converted to type in the same manner as a received message, except that it is normally printed in red.

Drive

The layout of the drive to the machine is shown in EP Telegraphy 4/4 Fig. 3. The standard machine, connected to 240 V a.c. mains, is powered by a 300 r.p.m. synchronous motor. This drives, through a lay shaft, the main drive shaft which in turn drives directly.

(a) the Selector Unit through a friction clutch, and

(b) the carriage feed unit via gears.

The combined keyboard transmitter and Answerback Unit is driven directly from the lay shaft via gears.

The main drive shaft also has a cam sleeve which performs the 'translation' and printing operations, and provides power to operate the non-printing functions. The Tape Punch is driven by cam-riding levers from the main cam sleeve, the Tape Reader by a toothed rubber belt from the transmitter drive shaft.

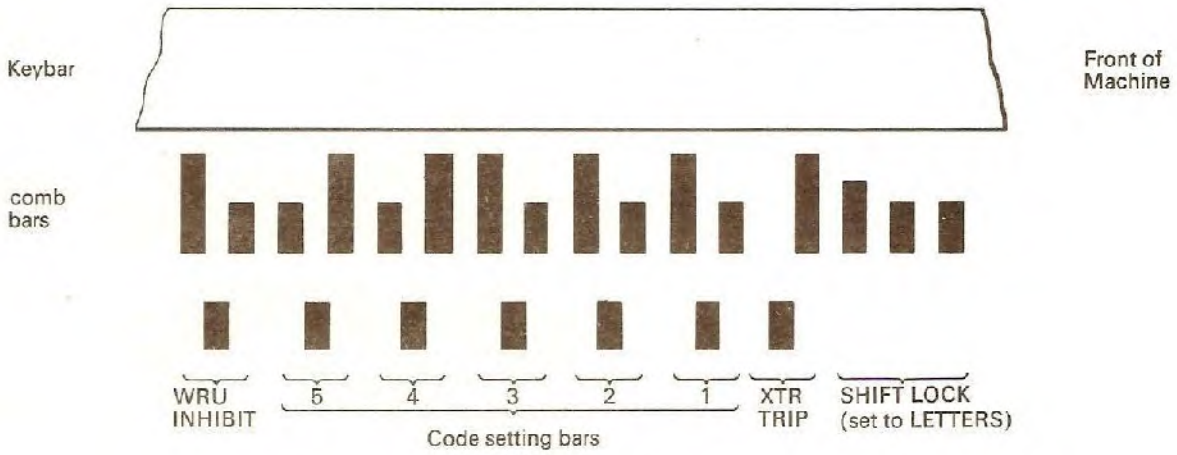
Keyboard Unit (Fig. 3 & EP Telegraphy 4/4 Fig. 4)

The operation of any key starts a trip action which activates the transmitter and also simultaneously five pairs of comb bars. These settings are interpreted by the transmitter into electrical signals to make up the five-unit code of the selected key.

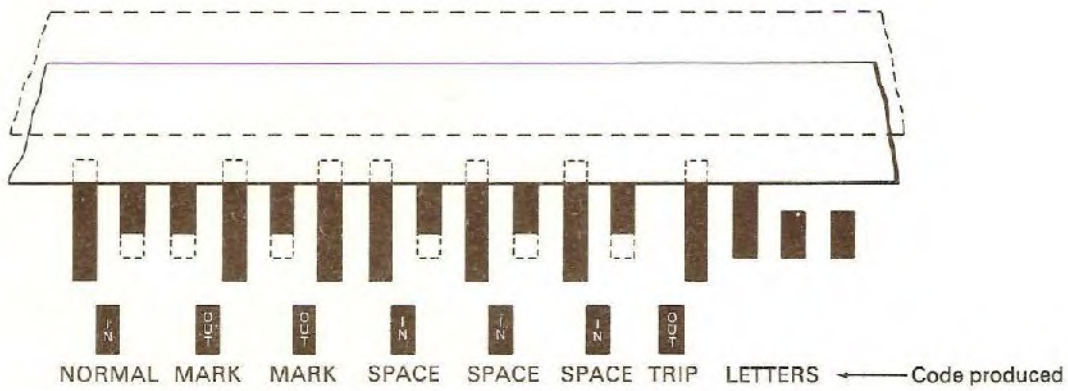
The main components of the keyboard are shown in EP Telegraphy 4/4 Fig. 4, but to avoid congestion on the illustration, only one of the five pairs of comb bars is shown. The key bars are held in a comb (not shown) and are pivoted at the rear end. At rest they are held above the comb bars by a leaf spring. A diagrammatic section of the comb bars is shown in Fig. 3(a).

Code Setting

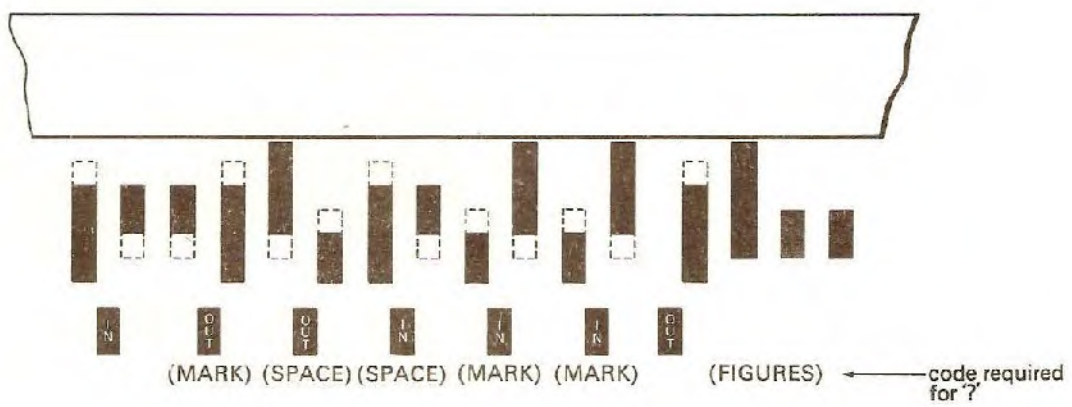
Operation of a keybar will press it down on the top edge of one of each of the five pairs of code setting bars. Each pair is linked together at its ends by T-shaped levers producing a parallelogram linkage. The second comb setting bar of each pair rises, having a gap corresponding to the projection in its partner. The code setting bar levers turn clockwise or anti-clockwise sliding the link bars to the left (for a MARK) or right (for a SPACE). A diagrammatic view of the operation of key A can be seen in Fig. 3(b). The underside of the depressed keybar also operates a trip bar which lies beneath all the keybars sliding the trip link to the left. This movement releases the Transmitter Unit cam sleeve.



(a) DIAGRAMATIC SECTION OF COMB BARS AT KEY 'A' – ALL KEYS NORMAL



(b) DIAGRAMATIC SECTION OF COMB BARS AT KEY 'A' – KEY 'A' DEPRESSED



(c) DIAGRAMATIC SECTION OF COMB BARS AT KEY '?' – KEY 'A' DEPRESSED

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Fig. 3

The particular combination of code setting bars depressed by one key (and therefore the particular combination of raised bars) is unique to that key. Since the projections and gaps on each pair of code setting bars are complementary the depression of a second key is prevented by the projections on one or more of the raised bars as shown in Fig. 3(c). (Note that the operation of the WHO ARE YOU? key is also prevented by the shift bar.)

Case Shift

The shift bar can be positioned to block either "letters" keys, or "figures" and symbols keys. It is moved to the left, to block letters keys when the figures keybar acts on the tooth of the letters blocking bar, and to the right, to block figures keys, when the letters keybar acts on the tooth of the figures blocking bar. A leaf spring retains the shift bar in the position to which it was last set.

Transmitter Unit (EP Telegraphy 4/4, Figs. 5 & 6)

Trip Action (Fig. 4)

As previously described, the operation of a keyboard key causes link bars to move to the left for MARK and to the right for SPACE. These movements bring the top ends of the associated selection levers to one side or the other of the lock frame.

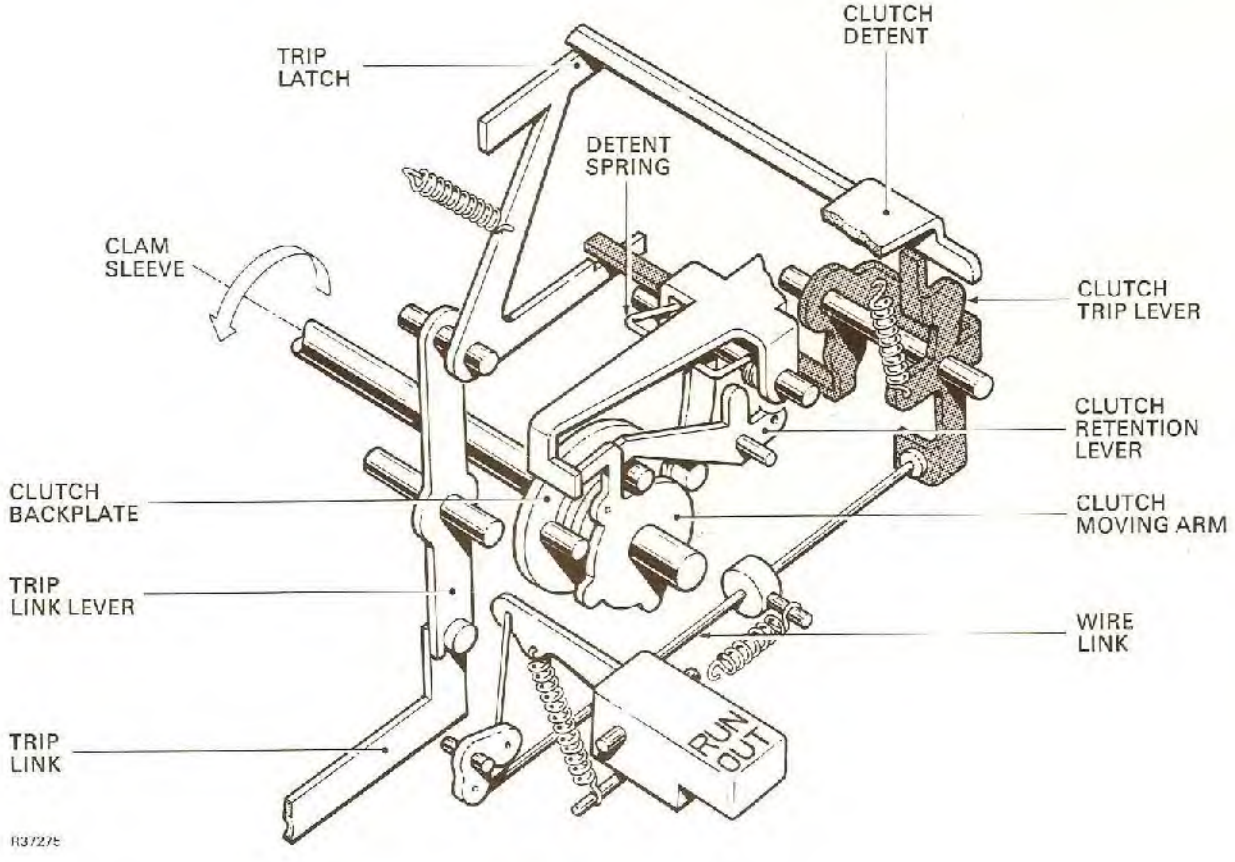


Fig. 4

A simultaneous movement to the left by the trip link turns the trip link/trip latch connecting lever clockwise, pushing the step in the lower arm of the trip latch against the clutch trip lever. The upper extension of the clutch trip lever is thus pulled away from underneath the right hand end of the clutch trip detent which is turned clockwise by a wire loop spring to release the clutch moving arm.

The clutch moving arm carries one end of a spring-steel band which is loosely wound around a continuously driven drum. The other end of this band is anchored to the clutch back plate, which is part of the transmitting cam sleeve. When the clutch moving arm is released, a spring draws the clutch band tight around the drum, and the cam sleeve starts to rotate anticlockwise.

Code Transmission (Fig. 5)

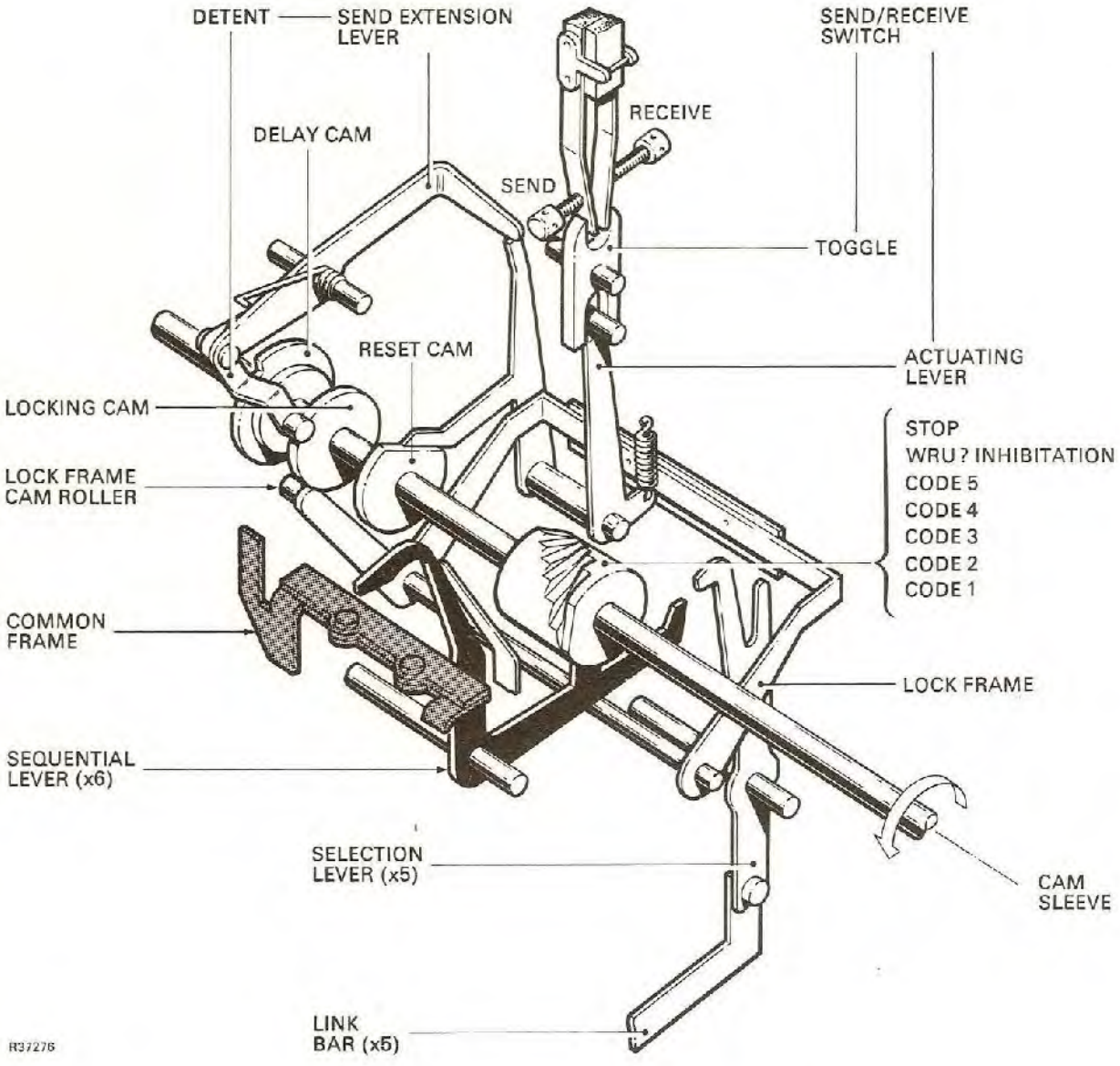


Fig. 5

When the transmitting cam sleeve is at rest, the transmitter tongue is at MARK and the send/receive switch tongue at RECEIVE. As soon as the sleeve starts to revolve the send/receive switch actuating lever is moved out and pivots the switch toggle to move its contacts to SEND. The locking cam then lowers the lock frame to lock the code set up on the selection levers and, in so doing, locks the keyboard.

Normally the common frame is urged clockwise by its spring to rest against the six sequential levers (for code characters 1-5 and WRU inhibition). An extension at the end of the common frame positions the carrier and hence the y-shaped striker as shown in Fig. 6.

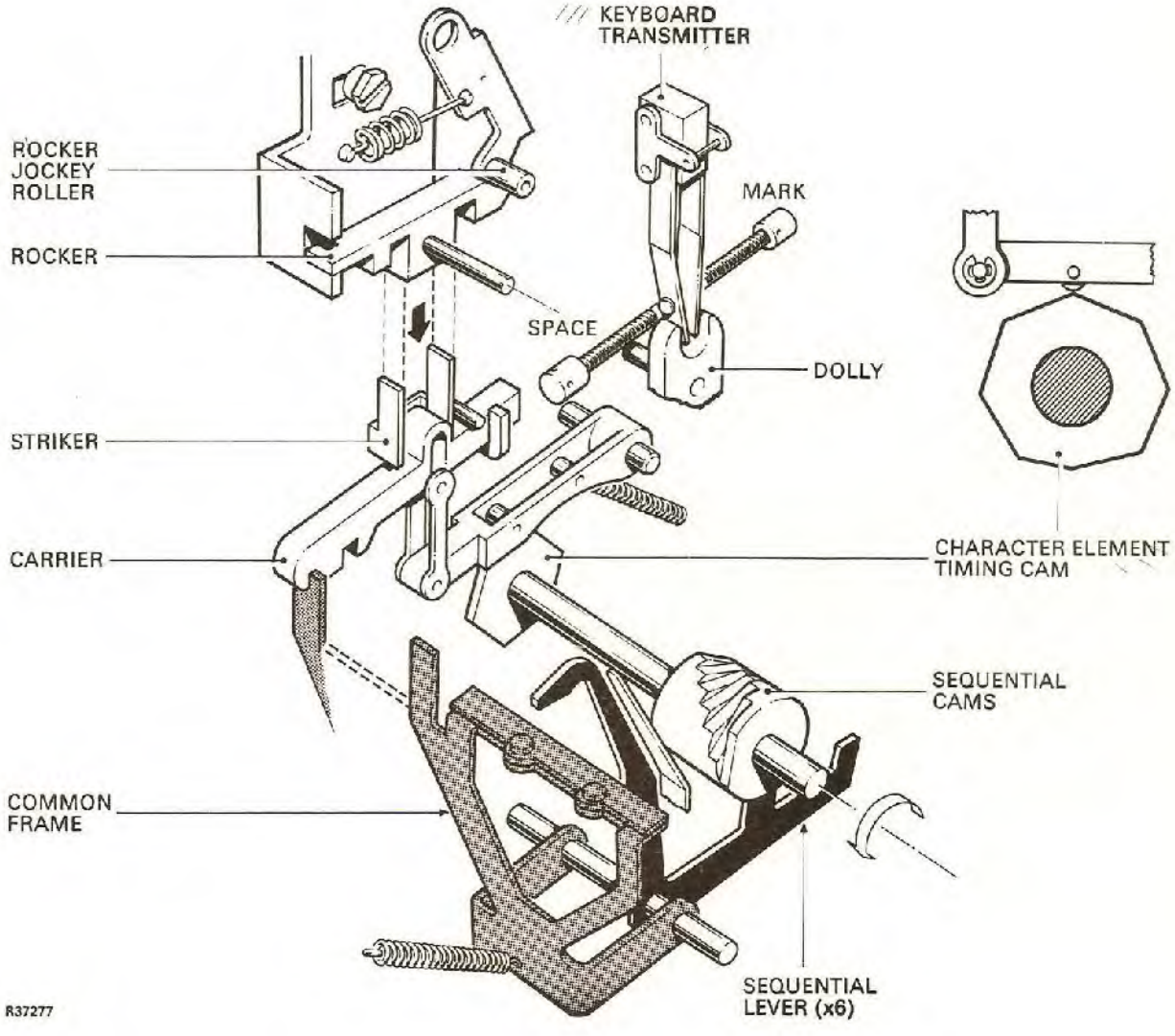


Fig. 6

As the cam sleeve rotates further, the first rise on the character element timing cam pushes the striker up against the right hand side of the rocker, which pivots the contact dolly anti-clockwise to move the contacts from MARK to SPACE, and so indicate the space START signal. The dolly is retained in this position by a spring jockey roller at the end of the rocker.

Twenty milliseconds later the character element timing cam lifts the striker again, and by this time the first of the sequential cams on the sequential cam pack will have presented a flat surface to its associated sequential lever. If the code selection lever is set to MARK (i.e. top of selection lever to the right) the sequential lever will be able to follow its cam, and so turn anti-clockwise to push down the common frame to the left. At the instant the striker operates, the common frame and the carrier will have moved the striker to the left, so that it will hit the rocker tilting it to the right. The contact dolly, being coupled by a shaft to the rocker, turns clockwise to operate the transmitter MARK contacts.

If the code selection lever is set to SPACE (i.e. top to left) the sequential lever is prevented from following the cam by the projection on the top of selection lever. The common frame is not therefore moved and a SPACE signal is transmitted in a similar manner to the START signal.

One or the other of these MARK/SPACE actions is repeated for each of the remaining operations of the striker, the movements of the transmitter tongue being dictated by the position of the common frame. A sixth sequantial lever, which has not an associated code selection lever, turns anti-clockwise at the end of each cycle to make the last operation of the striker produce the STOP mark signal.

Near the end of the revolution of the transmitter cam sleeve, the vertical arm of the clutch detent is pushed to the right by a reset cam built into the clutch back plate, so lowering the left hand end of the detent into the path of the clutch moving arm. As this arm engages the detent, the overshoot of the cam sleeve causes the clutch band to unwind and slacken its grip on the drum. The clutch retention lever then turns anti-clockwise to wedge the clutch intthe rest position.

Send/Receive Switch Delay (Fig. 5)

Since the first START strike occurs 10 milliseconds after the beginning of the transmitting cam sleeve revolution (which takes 150 milliseconds) and if the send/receive switch returned to RECEIVE at the end of the revolution, the STOP signal would be cut short on switched simplex circuits (e.g. telex). It is therefore necessary to hold the send/receive switch tongue on SEND for a short time after the transmitting sleeve has come to rest.

To provide for this time extension, during the transmission of the fourth code element the lock frame cam turns a send extension lever clockwise so lowering its right hand end into the path of the rear extension of the send/receive actuating lever to block its return to RECEIVE. The same movement of the send extension lever lifts the detent attached to it out of a cut out in the delay cam, which is driven anti-clockwise by a friction clutch, independently of the transmitting cam sleeve. The delay cam takes about 75 milliseconds to make a half-revolution during which time the transmitting cam sleeve has reached the end of its cycle and come to rest.

The detent attached to the send extension lever rides on the peripheral of the delay cam, however, and holds the send extension lever down in the path of the send/receive switch actuating lever's extension until the STOP signal has been extended to the required 30 millisecond duration, after which the detent falls into the cut-out in the delay cam so allowing the send/receive actuating lever to return the send/receive switch to RECEIVE.

Trip Reset (Fig. 4)

As the clutch detent privots clockwise to release the clutch, its rear extension depresses the arm of the trip latch, so moving the step on its lower arm away from the extension of the trip lever which then restores.

If the depressed keyboard key is released while the transmitting cam sleeve is revolving, the trip link lever will be restored by the spring on the trip link, allowing the trip latch and the trip lever to restore. If the key is held down longer than the transmitter revolution, the trip lever is able to restore and bring the cam sleeve to rest because the trip latch is displaced as above.

Run Out (Fig. 4)

To repeat continuously the last code set into the keyboard comb bars, the RUN OUT key is depressed. This action pushes the wire link to the right and simulates the action of the trip latch on the trip lever, turning it anti-clockwise to release the detent, and holding the detent out to produce continuous "run-away" transmission. The detent restores and transmission comes to an end when the RUN OUT key is released.

Selection Operations (EP Telegraphy 4/4 Fig. 7)

As incoming signals from the line are received on the side stable electromagnet, Fig. 7, its vertical armature moves to the right for SPACE and to the left for MARK. Fig. 7 shows the armature in the MARK position.

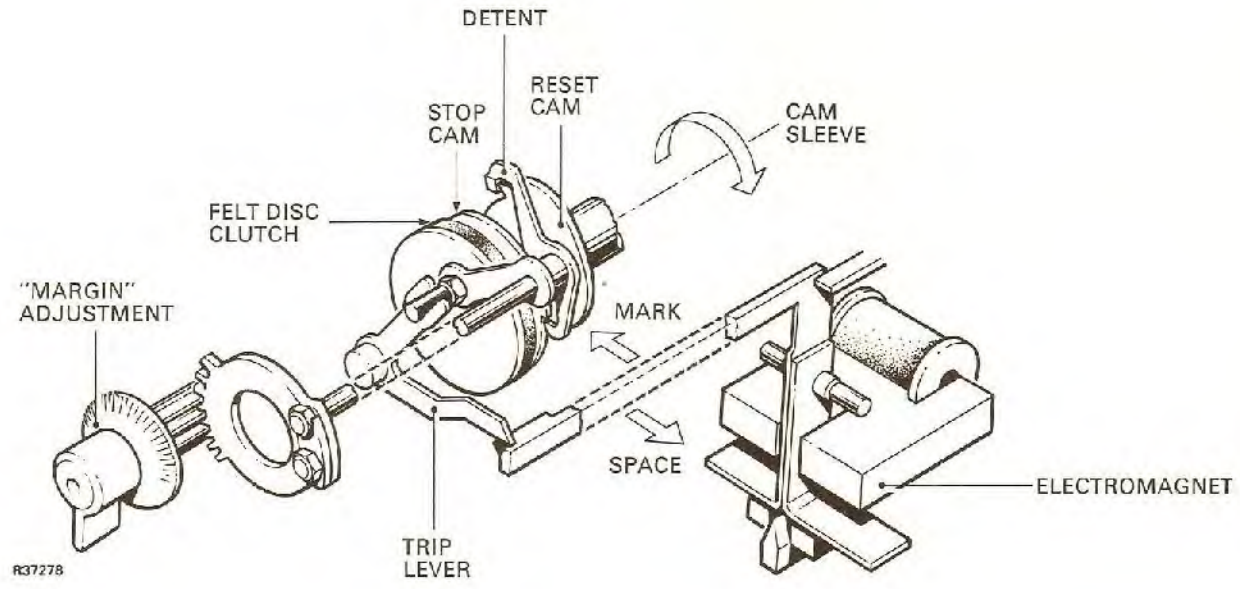


Fig. 7

The selector cam sleeve is urged in a clockwise direction by two felt discs driven continuously from the main shaft but normally held at rest by the lower arm of the detent engaging the stop cam. The pivot of the detent can be moved around the edge of the stop cam by rotating the graduated knob. This action advances or retards the sending operations of the selector unit with respect to the beginning of the START signal and so provides a means for estimating the timing distortion "margin" of the machine.

Selection (Fig. 8)

Receipt of the spacing START signal moves the electromagnet armature to the right, so withdrawing support for the trip lever. The trip lever allows the detent to move away from the stop cam, and the selector cam sleeve starts to revolve (clockwise).

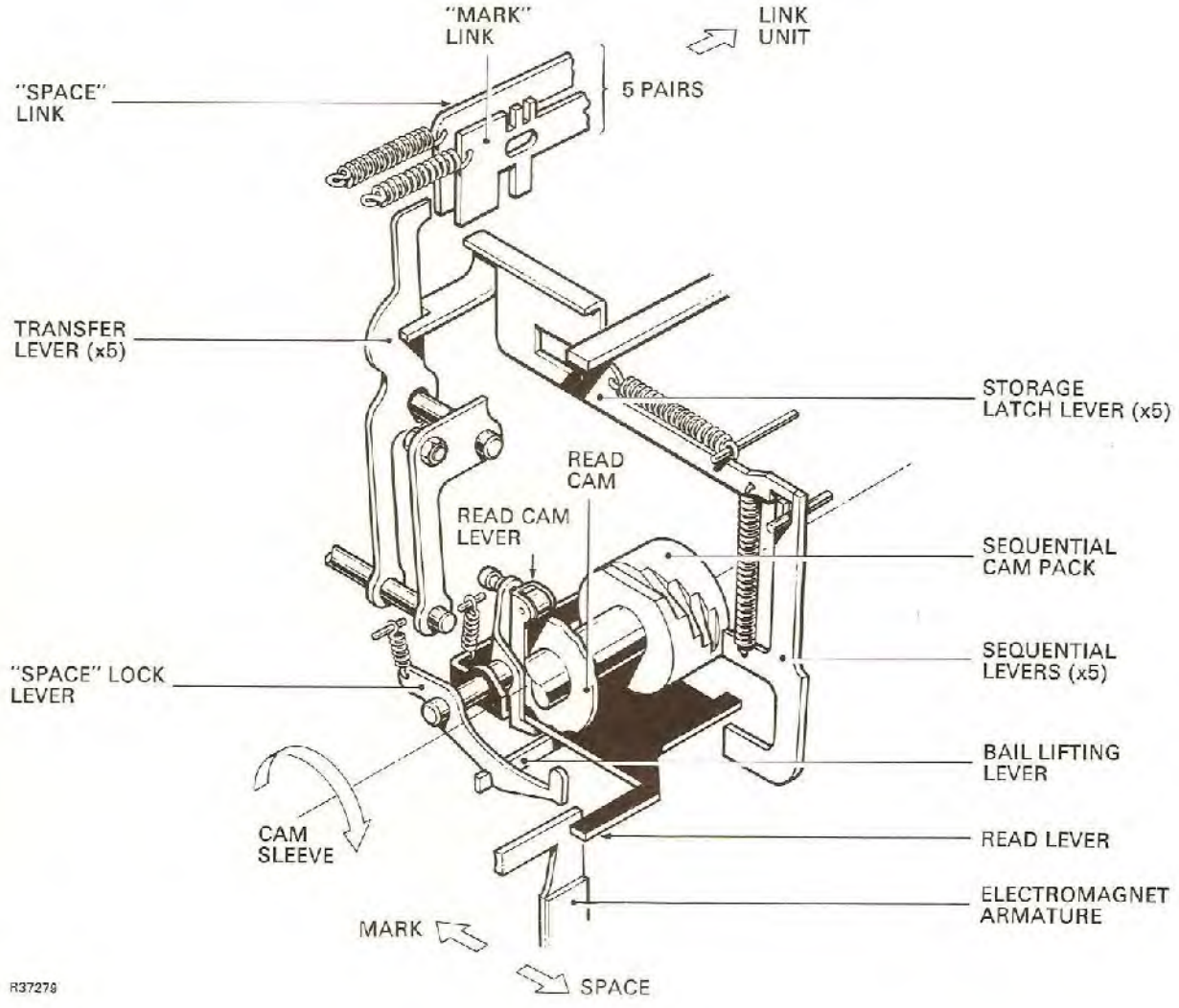


Fig. 8

As it revolves five flats on the sequential cam pack are presented in sequence to the five sequential levers which then pivot inwards. In the same time sequence, recesses in the read cam allow the read cam lever, in conjunction with the bail lifting lever, to lower the read lever if it is free. Whether the read lever is free to move or not depends on the position of the electromagnet armature. If the armature is at SPACE (i.e. to the right) the downward movement of the read lever is blocked. The bail lifting lever lowers the "space" lock lever down the left hand side of the armature to prevent it returning prematurely to MARK. In the SPACE position, the read lever does not effect the sequential levers, which pivot in and out in response to their cams.

Code Transfer and Selector Reset (Fig. 10)

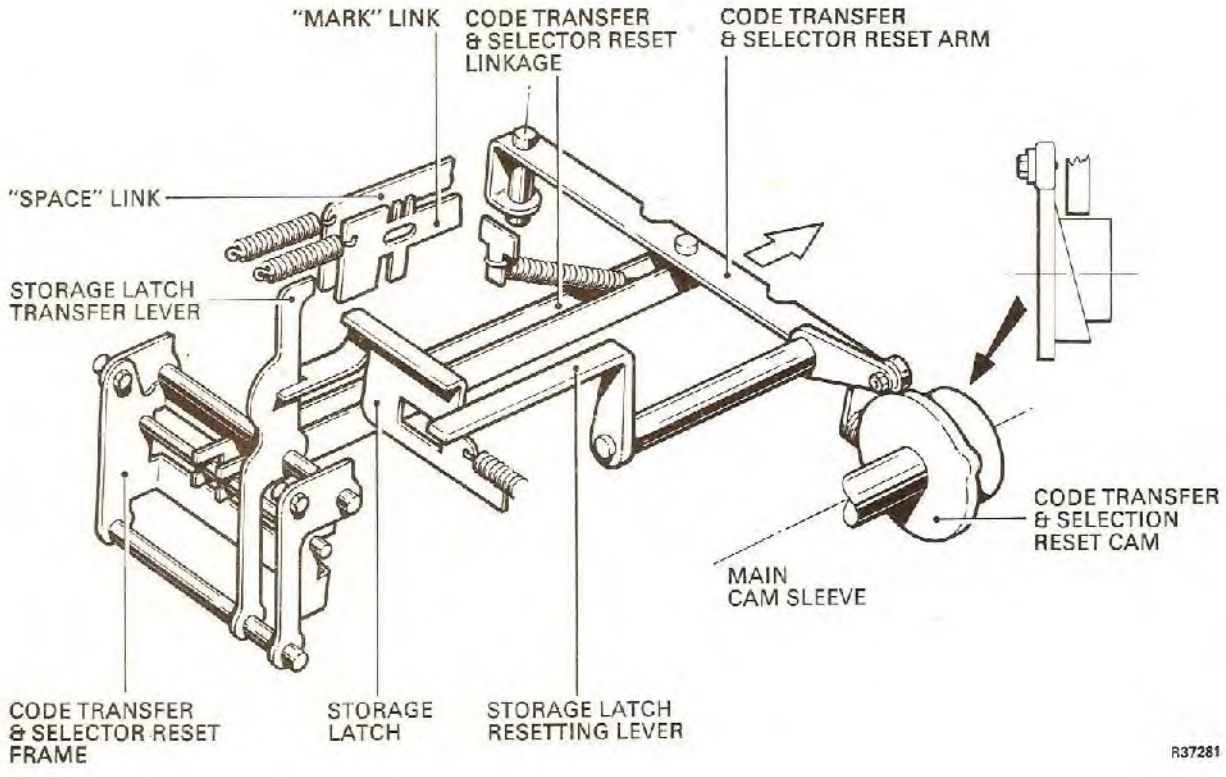


Fig. 10

A hump on the rear of the vertical face of the code transfer and selection reset cam now presses the reset arm and linkage to the right. This movement causes the reset frame, which is coupled via a spring to the left hand end of the linkage, to turn clockwise and press the transfer levers against the links. By this means, the code established on the transfer levers is passed to the Link Unit, where it is latched and stored.

The reset cam then rotates the storage latch resetting lever counter-clockwise to press all the storage latches to the left, so resetting the latches of any sequential levers that have been set to MARK.

The Selector Unit is now ready to respond to the next 5-unit code group, while the main cam sleeve is translating the code set up on the Link Unit.

Link Unit (EP Telegraphy 4/4 Fig. 8)

The Link Unit consists of five pairs of links and a shift link; one pair of links is shown in Fig. 11.

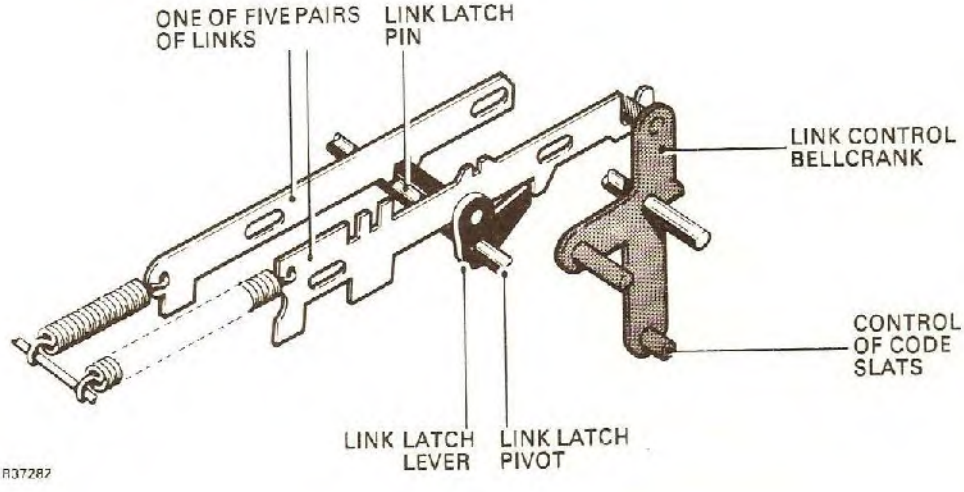


Fig. 11

In Fig. 11 the right hand link is shown held in the MARK position by the link latch. When a transfer lever takes up a SPACE position opposite the left hand link (as shown), and then moves forward, the subsequent inward movement of the link turns the link latch clockwise via a pin, so releasing the right hand link which is then restored to the left by its spring. The link latch lever is then urged against the bottom of the latching surface by the spring pulling on the link. A second SPACE strike on the left hand link will be ineffective.

When a transfer lever is set to MARK to bring it opposite the right hand link, its subsequent forward movement sets this link to the MARK position where it latches, as shown in Fig. 11. A subsequent MARK strike on this link will be ineffective.

Translating Code to Print (EP Telegraphy 4/4 Fig. 8)

Principle of Printing Code Translation

The right hand (MARK) link of each pair of links is connected to a bellcrank as shown in Figs. 11 and 12. This bellcrank, in conjunction with another at the far end of the code slots, control the *vertical* movement of the code slots, which select the required type, and the *horizontal* movement of the comb bars, which select the non-printing functions such as CARRIAGE RETURN.

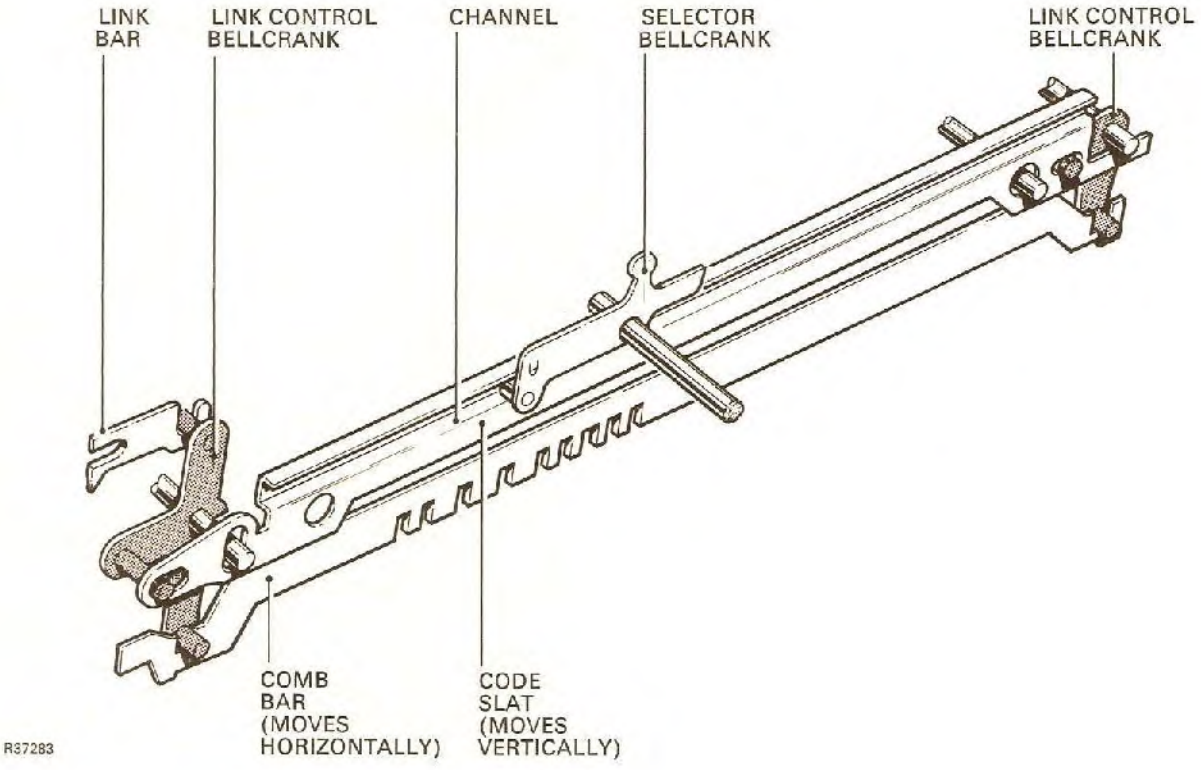


Fig. 12

The code slots have channels along their top edges in which run the rollers of the five selector bellcranks that control the type basket code sectors, Fig. 13. These sectors rotate slightly anticlockwise for a MARK and clockwise for a SPACE.

Arranged across the sectors are the code seeker bars, one for each two printing characters (i.e. a letter and its corresponding 'figure'). These bars are spring-loaded down onto the print bail which holds them clear of the sector teeth, Fig. 13.

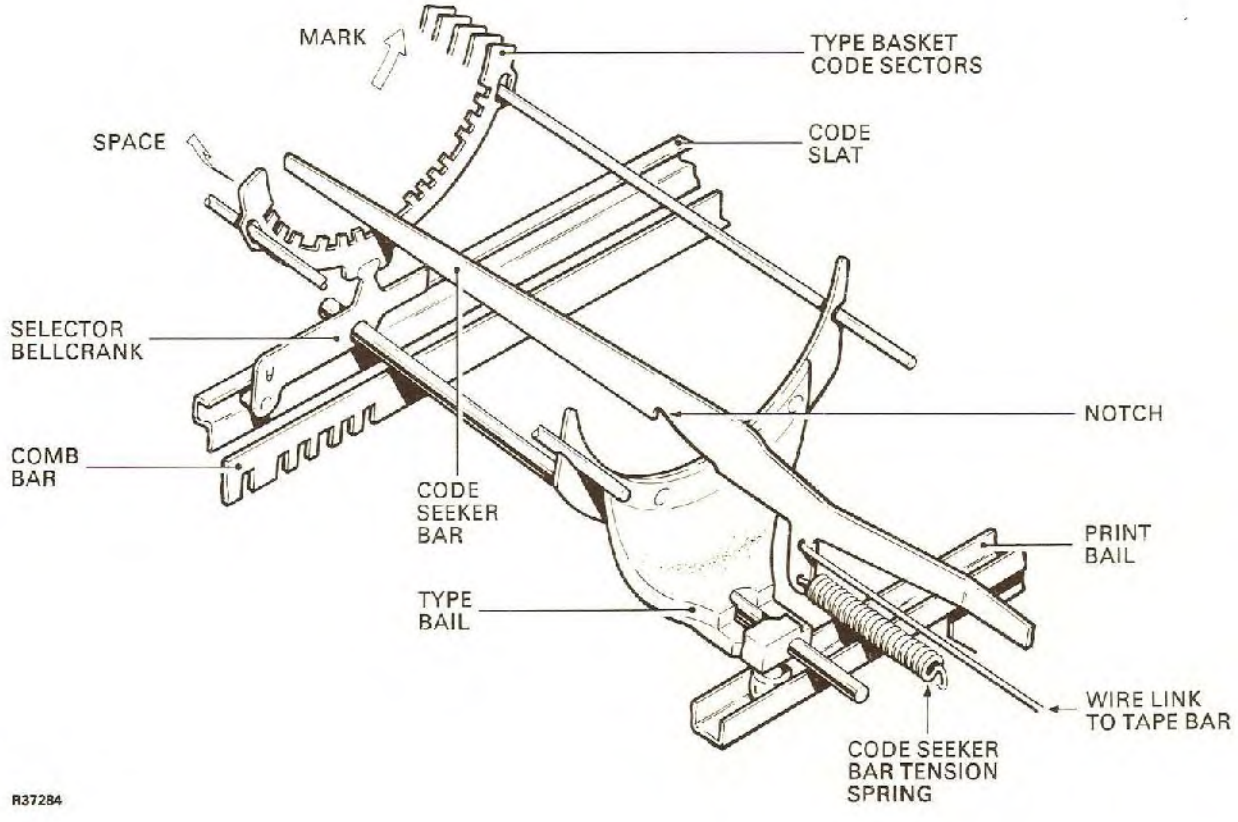


Fig. 13

All incoming codes are passed to the sectors, but only when it is a "printing" code will the type bail move to the rear (left) carrying with it the type bail. All of the code seeker bars are thus lowered on to the code sectors, but only one will find a path through the teeth and drop low enough for its notch to catch on the type bail. Further rearward movement of the type bail will swing the required type-bar, via the type-bar wire trip link, out of the type-basket and up on to the ribbon and paper. Fig. 14.

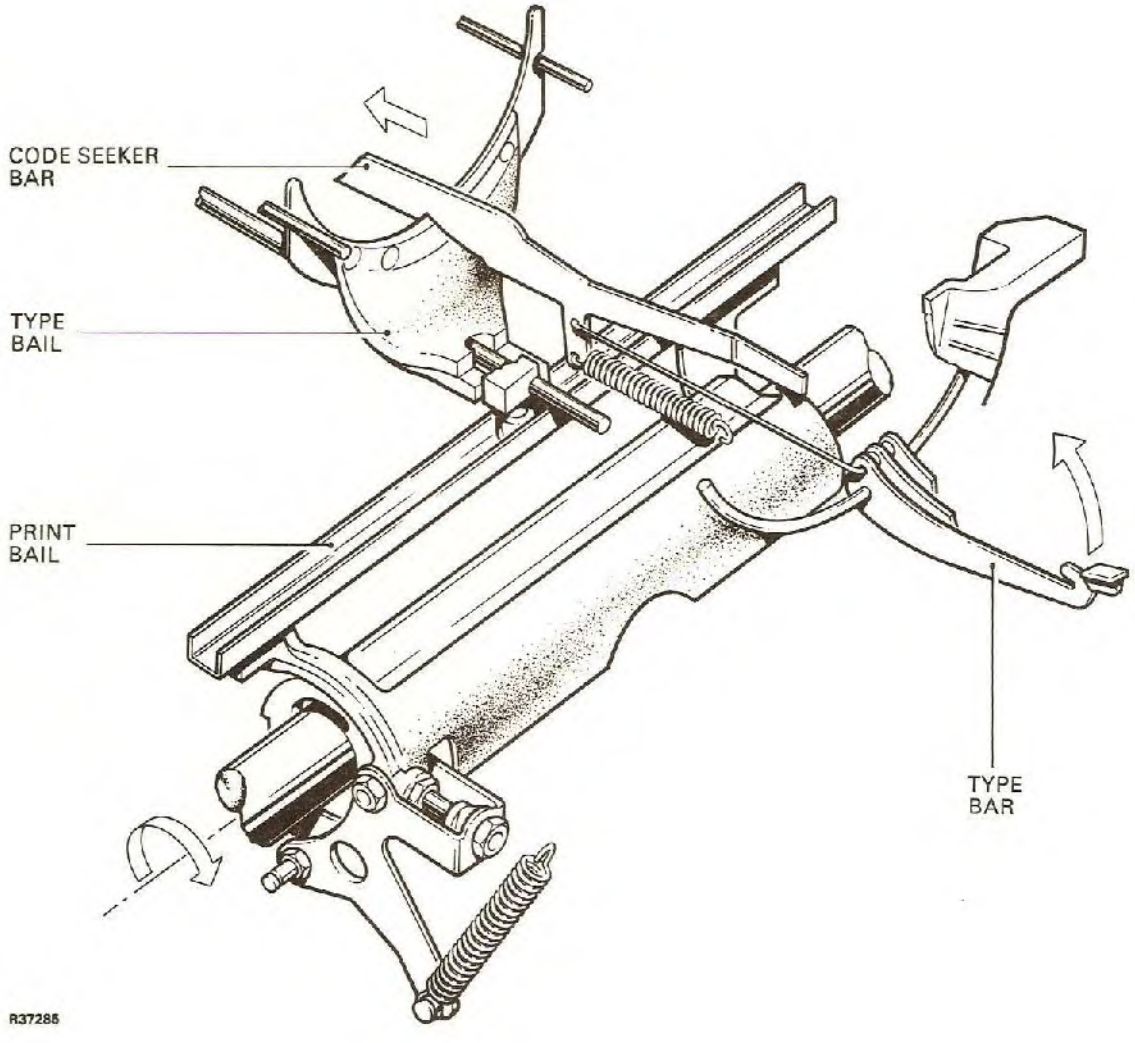


Fig. 14

Principle of Function Translation

Function control levers lie beneath the five comb bars which are moved to the left for MARK, and to the right for SPACE by the link control bellcrank Fig. 15.

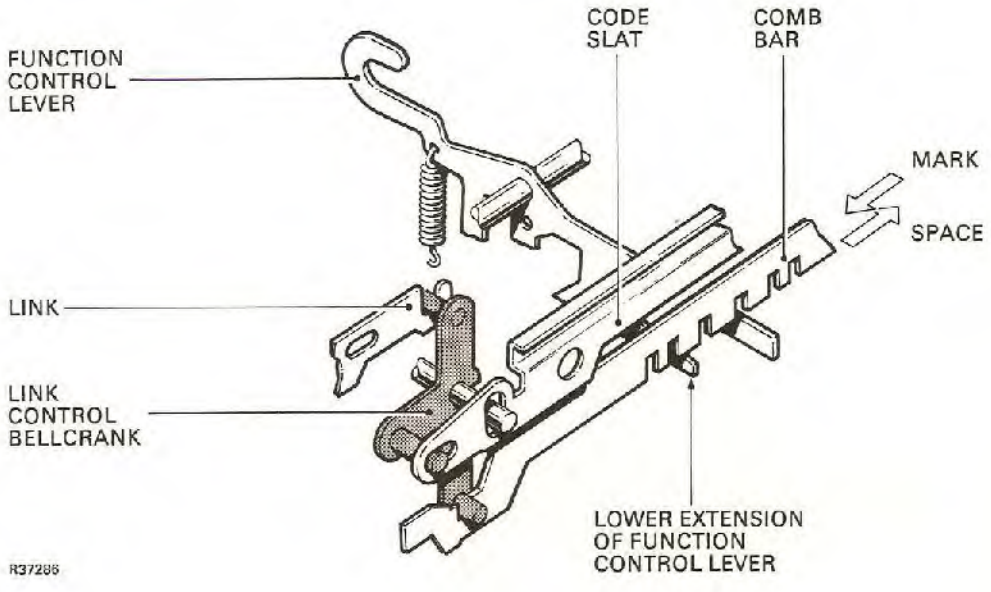


Fig. 15

When a code is set up on the teeth beneath the comb bars the function control levers are allowed to turn anti-clockwise by a bail (shown in Fig. 16) which is lifted off the lower extension of the control lever. The upper horizontal arm senses the pattern of the comb bar teeth.

If the setting on the comb bars is for a "printing" code, there will be no path across the teeth, and the function control levers will be lowered again. Carriage feed takes place automatically after the printing operation. If the code is that of a non-printing function, a path will open across the comb bar teeth, and the selected function control lever will move up into it. This extra anti-clockwise motion of the lever has three consequences:

1 Its lower vertical arm triggers (not shown) the appropriate machine function.

2 Carriage feed is suppressed.

3 Printing action is suppressed.

Print and Carriage Feed Control on Functions (EP Telegraphy 4/4 Fig. 9)

Print: The rear horizontal arm of the print suppression lever, is tensioned on the lower horizontal arms of the function control levers. In the unselected position of the function control levers, the front end of the suppression lever is positioned above the print bail arm as in Fig. 16.

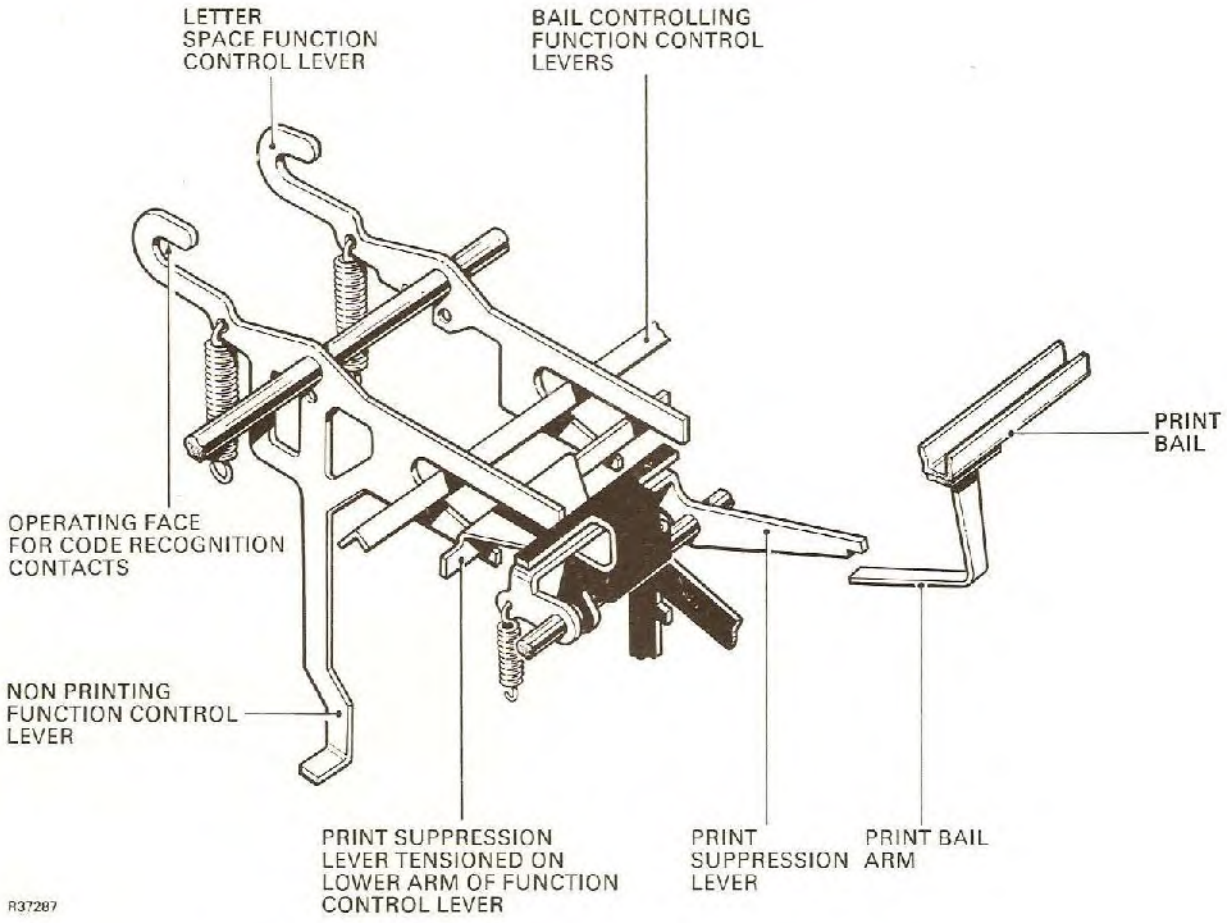


Fig. 16

The printing bail is therefore free to operate.

When any function control lever is selected, its lower arm in swinging upwards pivots the suppression lever clockwise to bring its front down into the path of the print bail arm, so blocking the print bail and preventing the printing action.

Carriage Feed: (Fig. 17) When a printing code is set up on the comb bars (i.e. non of the function control levers are selected) the carriage feed trip lever is free to turn anti-clockwise, the upper horizontal arm of this lever passing over the top of the upper horizontal arms of the function control levers. The lower vertical arm of the carriage feed trip lever then moves forward sliding the latch link to the right to displace the latch from beneath the arm of the carriage feed clutch detent. The clutch ratchet then engages its driving member, and rotates the feed shaft through half a revolution during which the type carriage is fed along $\frac{1}{10}$ inch (2.5 mm).

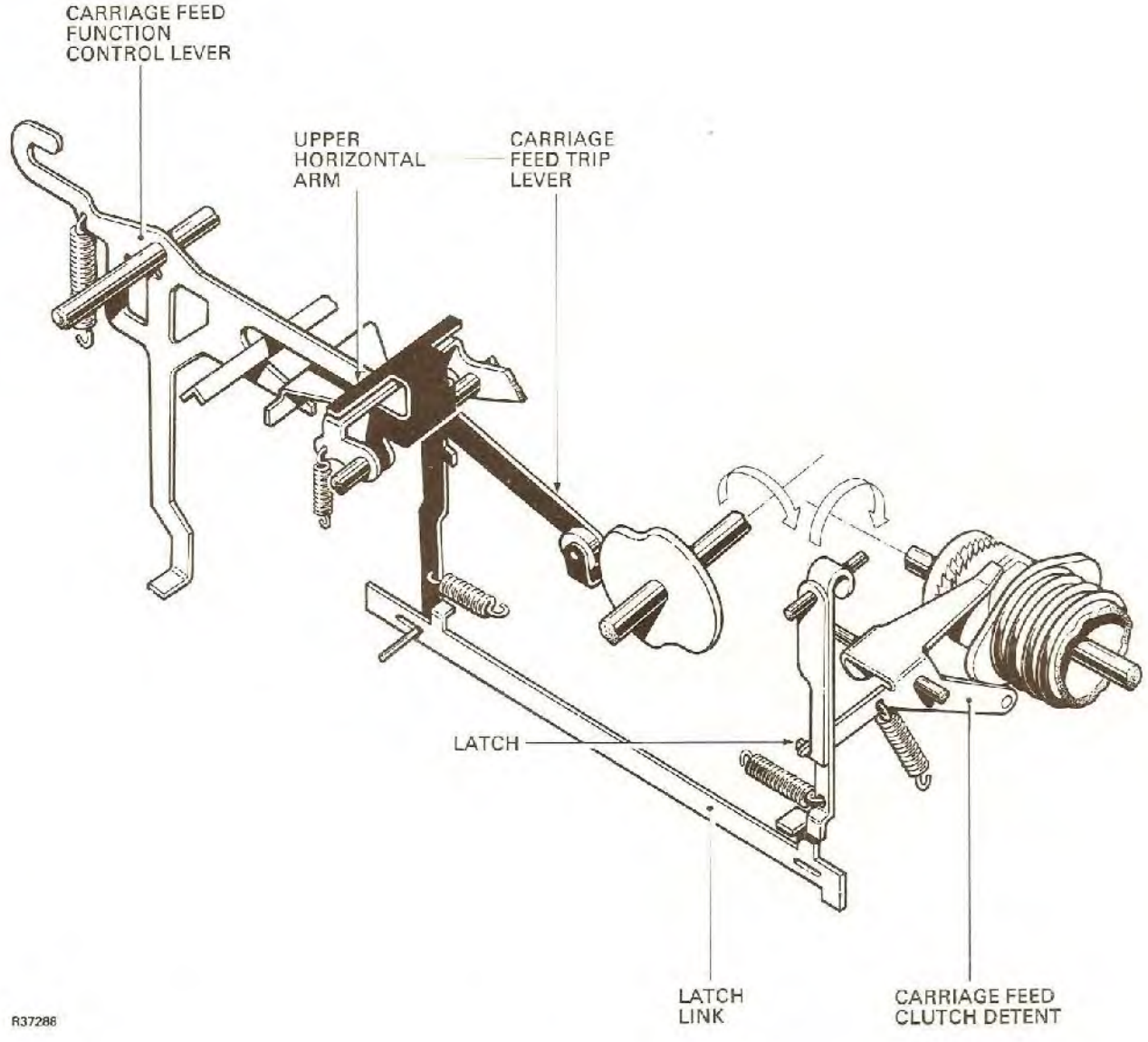


Fig. 17

When a non-printing functional code is set up on the comb bars, one of the functional control levers will be selected and will move anti-clockwise. The upper horizontal arm of the functional control lever will thus move up into the path of the upper horizontal arm of the carriage feed trip lever preventing the carriage trip lever from rotating, and thus inhibiting the carriage feed operation.

Letter Space: The LETTER SPACE operation on receipt of the SSMSS code is a special case of a "function" that requires "feed" but not "print". A special "letter space" function control lever is provided to produce this effect. When selected by the LETTER SPACE code, its lower horizontal arm engages the print suppression lever (Fig. 16), turning it to block the print bail and prevent printing, but it is located too far to the right for its horizontal arm to affect the carriage trip lever's lower arm. The carriage trip lever can therefore operate normally, and feed a trip action to the clutch detent to initiate a CARRIAGE FEED operation.

Carriage Movements (EP Telegraphy 4/4 Fig. 10)

Feed Action: As explained above, the carriage feed detent is released for any printing code (and for LETTER SPACE) so permitting the ratchet clutch to engage and drive the carriage feed cam sleeve for half a revolution during which it feeds the type carriage along one character space.

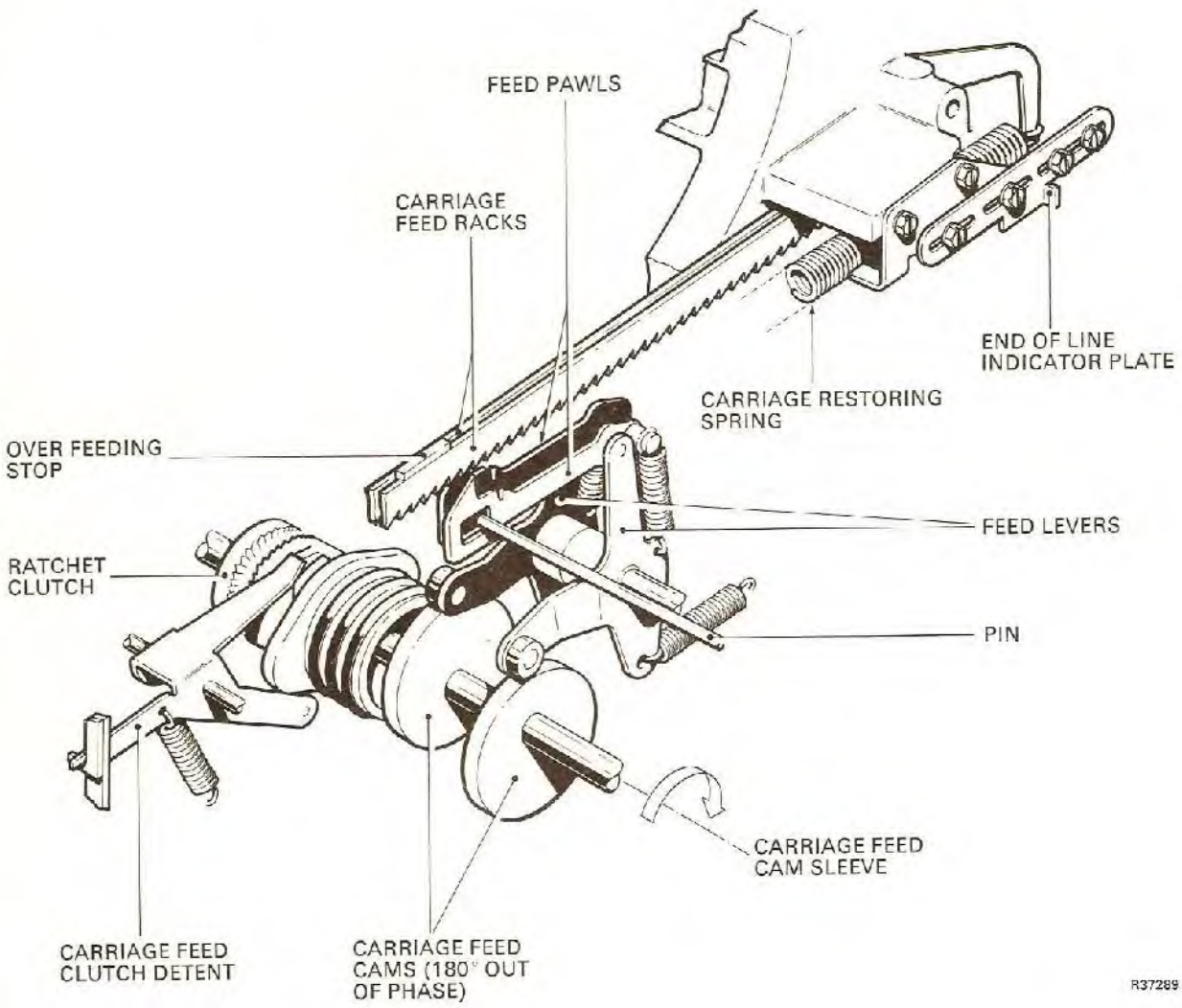


Fig. 18

The cam sleeve, shown again in Fig. 18, carries two cams whose high points are 180 degrees out of phase. These cams drive two feed levers, each carrying a feed pawl spring loaded against the twin feed racks that form part of the type carriage casting assembly. The teeth on each of the feed racks are spaced at $\frac{1}{5}$ inch (5.0 mm), the teeth on one being offset by $\frac{1}{10}$ inch (2.5 mm) in respect to the teeth on the other.

With the cams in the position shown in Fig. 15 the rear feed lever is operated and its associated feed pawl is fully engaged in the rear feed rack holding the carriage in position against the carriage restoring spring. As the cams start to revolve the front feed lever is rotated clockwise and its associated feed pawl moves to the right, drawing the carriage with it. The rear feed lever then restores (anti-clockwise) and its feed lever, which is no longer supporting the carriage, moves left until it engages in the next tooth of the rear feed rack. The cam sleeve is then stopped and the carriage held in position by the front feed pawl. During the next half revolution the carriage is moved right by the rear feed pawl and lever, the front pawl and lever returning to their original positions.

Overfeeding at the end of a line is prevented by an adjustable stop which masks the teeth at the end of the rack so that the pawls cannot continue their feed movement.

End of line indication is given by an adjustable roller on a plate, mounted on the type carriage casting. This roller depresses a plate mounted behind the Transmitter Unit, and so operates a microswitch to light a signal lamp for the operator.

Carriage Return: The type carriage can be returned to the left from any point along the line either on receipt of the CARRIAGE RETURN code, or by local operation of the MANUAL CARRIAGE RETURN key. Receipt of a CARRIAGE RETURN (code SSSMS) creates a common slot across all the comb bars into which the arm of the carriage return functional control lever pivots anti-clockwise, Fig. 19. Its lower hozizontal arm moves forward into the cranked end of the carriage return selection link, allowing the link to rise, (pushed up by the leaf-spring), so that this projection moves into the path of the selection drive lever as it is moved clockwise by its drive cam, Fig. 19.

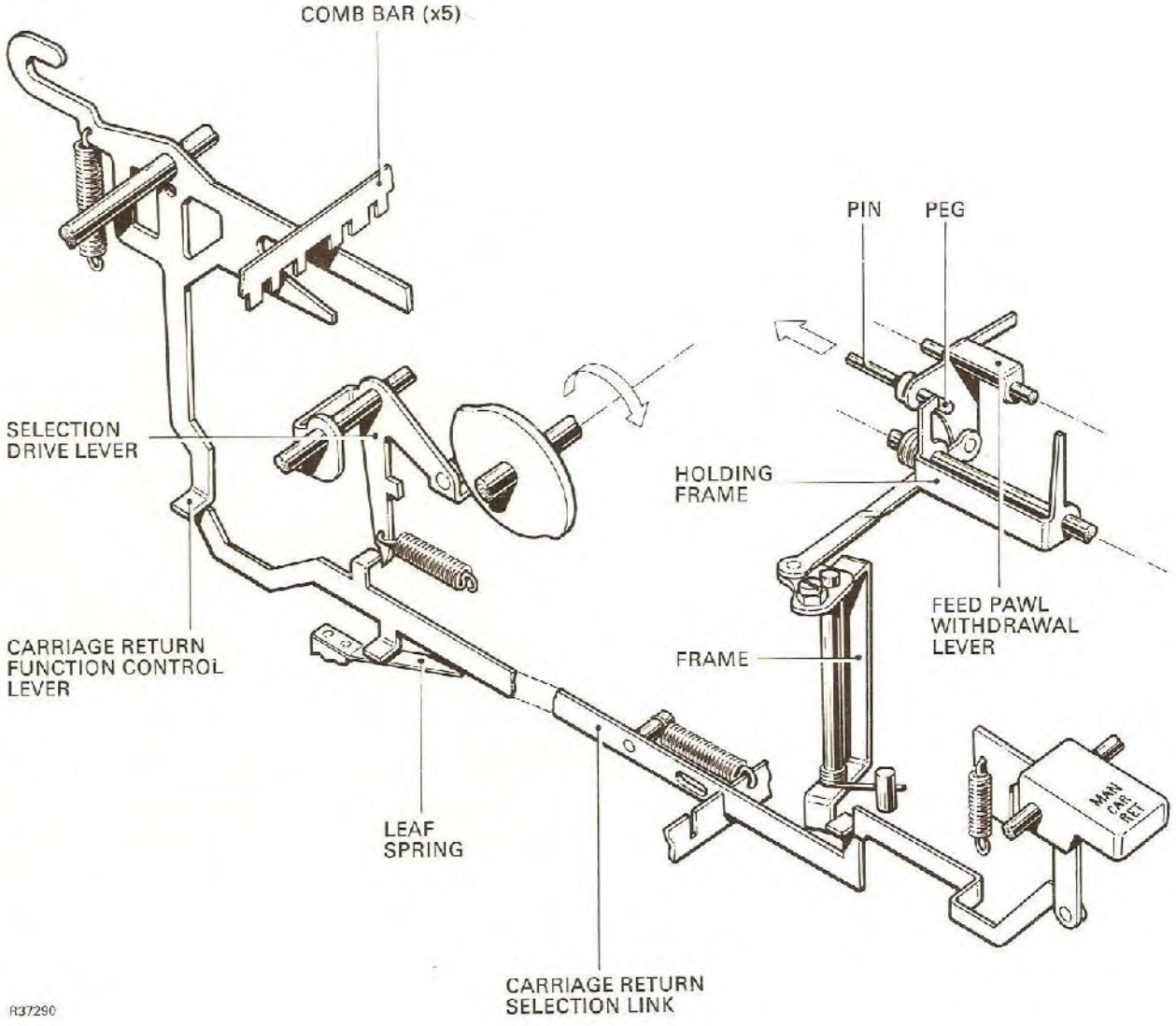


Fig. 19

The subsequent right-to-left movement of the selection link rotates a frame and turns a feed pawl withdrawal lever anti-clockwise. A pin carried on this lever (the other end of which can be seen in Fig. 18) depresses both pawls, so releasing the type carriage which is then returned to the beginning of the line by the carriage return spring.

The rotation of the withdrawal lever brings its peg, Fig. 19, under the latch on the inside of the holding frame, so ensuring that the carriage feed pawls cannot re-engage their racks while the carriage in transit. When the carriage reaches the beginning of the line, the "end of line" plate projection on the carriage (shown in Fig. 18) hits the extension of the holding frame (as shown in EP Telegraphy 4/4 Fig. 10). The frame turns anti-clockwise, releasing the peg, and so allowing the feed pawls to re-engage.

Depression of the MANUAL CARRIAGE RETURN key simulates the selection of the "carriage return" function control lever by pushing the link to the rear manually, so operating the frame and withdrawal lever as described above.

Case Shift Mechanism (EP Telegraphy 4/4 Fig. 11)

Since the majority of the type-bars carry both a "letters" and a "figures" character, the type-bar segment must be able to take up two positions; up to print "letters" and down to print "figures" (including symbols).

The vertical position of the type-bar segment is determined by the tubular segment runner (part of the shift beam assembly casting) along which the segment runs, maintaining contact by means of a roller above the runner, and a plate below it. At the left hand end of the shift beam assembly is fixed an inverted Y-shaped arm which runs on a shift cam fixed to a gear wheel that meshes with a quadrant. Fig. 20 shows the shift mechanism in the "letters" position.

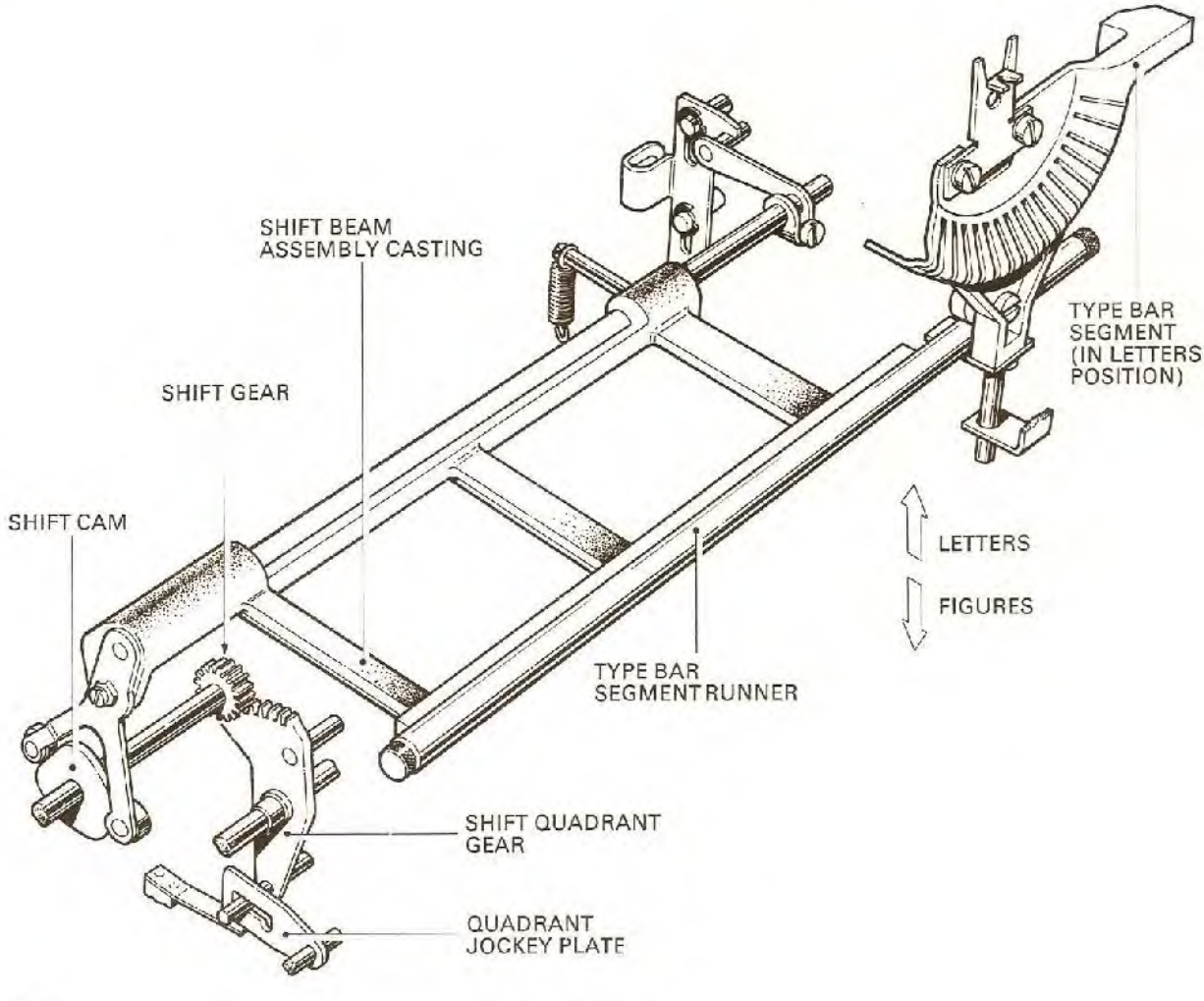


Fig. 20

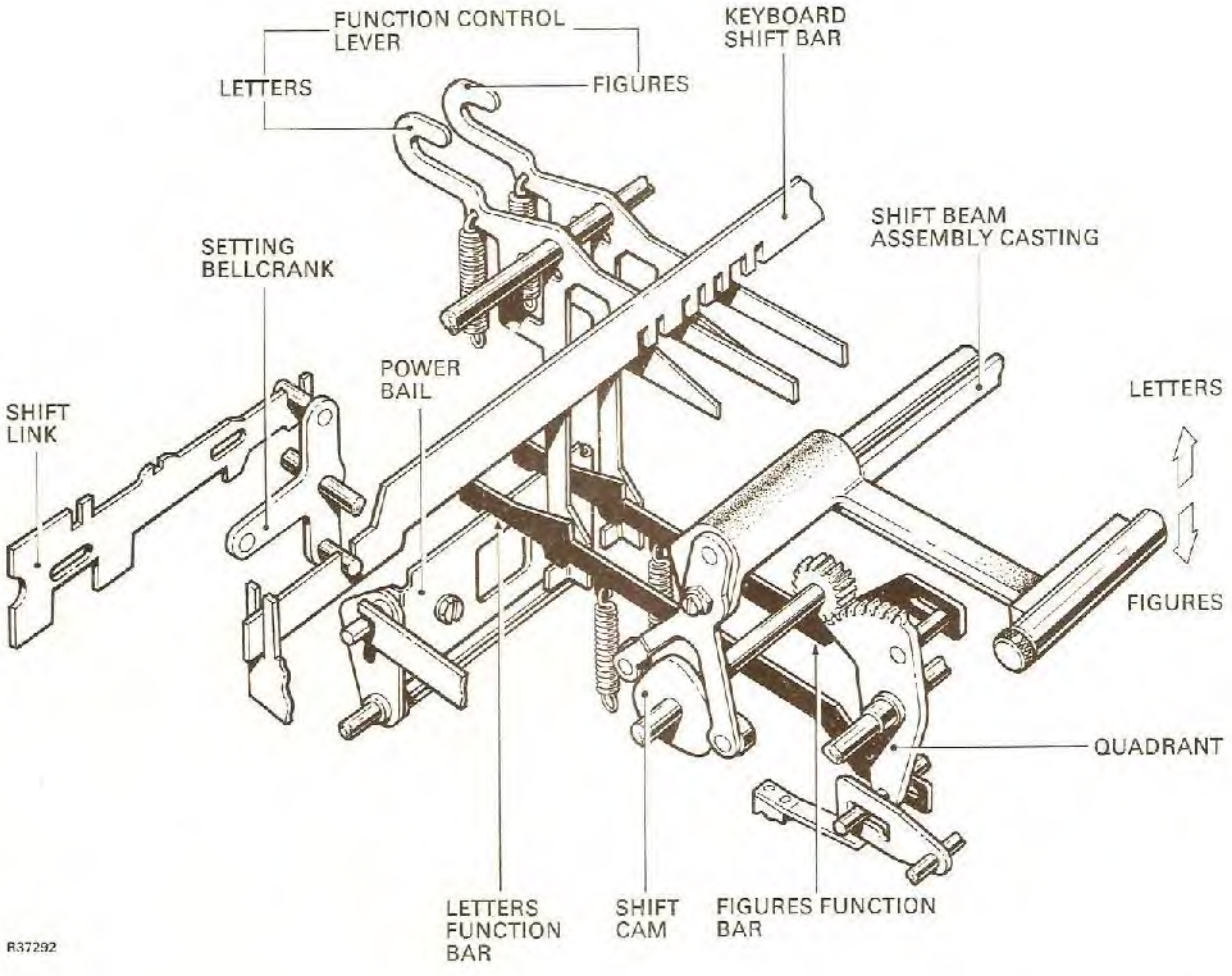


Fig. 21

Assuming the shift mechanism is in the letters position (i.e. the type segment is raised), on receiving a FIGURE SHIFT (code MMSMM) the "figures" function control bar, Fig. 21, is selected and rotates anti-clockwise, so moving the step on its lower vertical arm away from the projection on the "figures" function bar which then moves down into the path of the power bail. The subsequent movement of the bail draws the function bar to the rear and so turns the quadrant anti-clockwise, rotating the gear wheel and the shift cam to lower the type bar segment runner and consequently the type bar segment. At the end of the cycle the function control lever resets and the segment is maintained in its new position by a jockey plate.

Selection of the "letters" function control lever, lowers the letters function bar onto the power bail. Subsequent movement of the bail turns the quadrant clockwise so raising the type bar segment runner and the type bar segment to the "letters" position.

Code combinations which have a printing character in one case, and a machine function in the other (WHO ARE YOU?) have their function control levers blocked so that they do not select in "letters". This is done by the shift bar, which is moved to the left for "letters", and to the right for "figures" by the case shift

cam, (shown in EP Telegraphy 4/4 Fig. 11), operated through associated linkage by a spindle that rotates with the shift beam assembly. This shift bar lies at the rear of the five comb bars. A setting bellcrank conveys this MARK/SPACE setting on the shift bar to a link in the link unit for the benefit of the Tape Punch Unit.

Line Feed Action (Fig. 22 (appended) and EP Telegraphy 4/4 Fig. 12)

The selection of the line feed function control lever, in response to an incoming line feed code, allows the function bar to be lowered into the path of the power bail, which is driven to the rear by a cam.

The subsequent anti-clockwise motion of the link bar draws an attached link downwards. A pin at the top end of this link pivots a frame to feed the platen ratchet wheel which moves the platen anti-clockwise by one line feed.

The extent of the rotary movement conveyed to the platen by the feed pawl is determined by the manual setting on the line feed change lever, which can align the pin at the top of the link with one of the three notches in the frame; these notches (reading high to low) correspond to line feeds of $\frac{1}{6}$, $\frac{1}{4}$ and $\frac{1}{3}$ of an inch respectively (approximately 4, 6 and 8 millimetres).

The change lever also determines the position of the masking lever against which the feed pawl rests when not operating (this feature enables the platen to be turned both clockwise and anti-clockwise without difficulty) and consequently the point at which the feed pawl engages the ratchet when it makes its downward movement.

Paper is normally held against the platen by a pressure roller. Depression of the manual release lever swings the spindle of the pressure roller away from the platen which enables the paper to be threaded easily.

Two Colour Printing Facility (EP Telegraphy 4/4 Fig. 13)

The machine has a mechanism for varying the height to which the ribbon jumper rises when the machine is transmitting, and when receiving. This mechanism, with a two colour ribbon, makes it possible to distiguish between messages originating from the local keyboard (generally printed in red), and messages received from the distant station (generally printed in black).

When the machine is at rest, the ribbon jumper is held down below the printing line by a pin that links the two arms of the ribbon jumper, and lies beneath a projection of the jumper arm bail.

As the type bail moves forward to print, the ribbon jumper bail follows, its upper angled projection lifting the ribbon jumper carried on the twin arms and the stop arm. These are all tied together by the pivot of the roller and the ribbon jumper arms link pin. When the machine is RECEIVING, the colour bail is positioned as shown in Fig. 23, permitting maximum lift before the lower level of the stop arm touches the bail, so arresting the ribbon jumper with the lower, black part of the ribbon on the printing line.

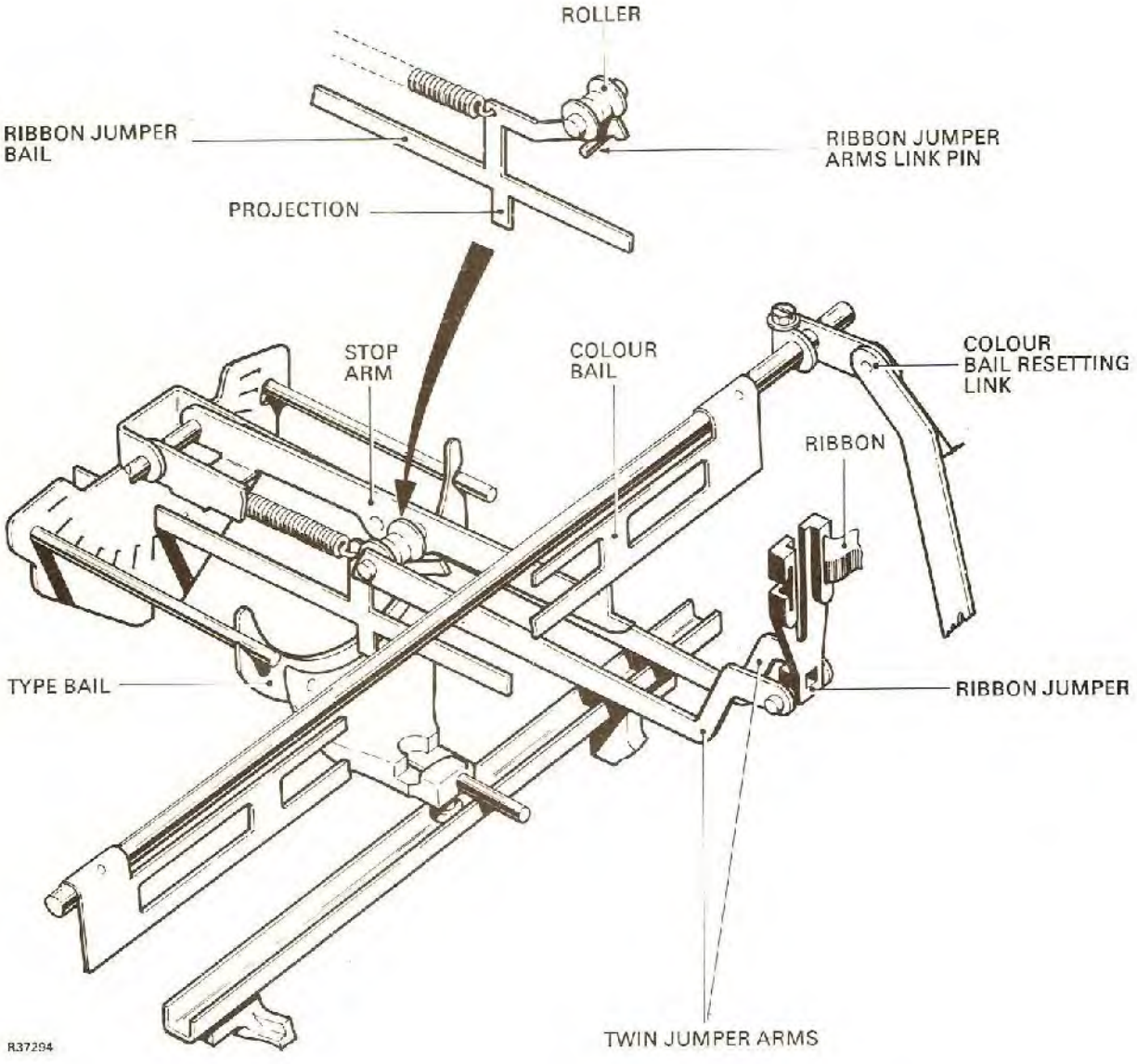


Fig. 23

The mechanism is reset to black at the end of every printing cycle by the ribbon resetting cam on the main cam sleeve (Fig. 24). The cam rotates a lever which turns the answerback trip shaft anti-clockwise. This lever has another lever fixed to the shaft spring loaded against the back of it. The consequent anti-clockwise rotation of the shaft rotates a lever at the right hand end of the shaft so that the resetting trip lever can fall into its step again to set up the "black print" condition.

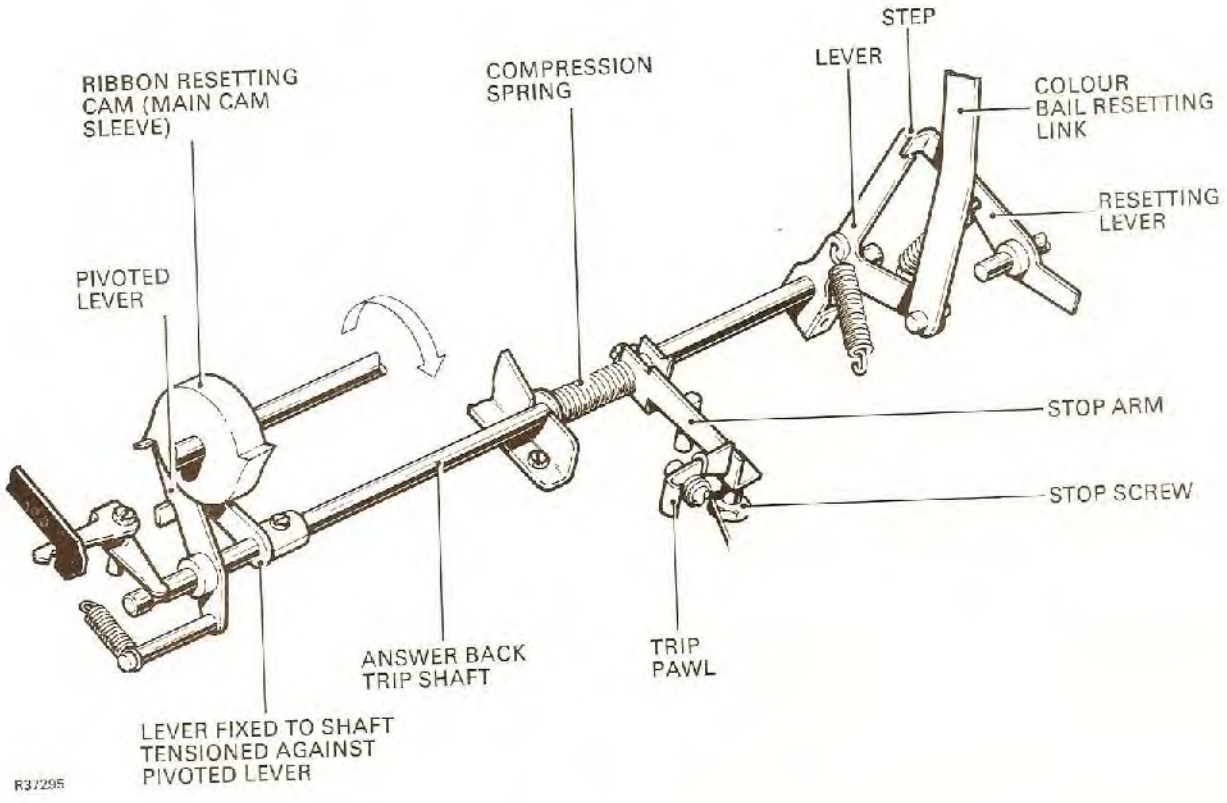


Fig. 24

The answerback trip shaft is also capable of a lateral movement which is used to convey the answerback trip action to the transmitter. When the "Who Are You?" function control lever (Fig. 25 appended) is selected, the function bar is lowered into the path of the power bail, which then moves towards the rear. The subsequent clockwise movement of the bell-crank riding in a groove on the trip shaft, draws the shaft to the left against the pressure of the compression spring. The stop arm then slides the trip pawl (which is part of the transmitter) to the left to initiate an answerback cycle.

Ribbon Unit (EP Telegraphy 4/4 Fig. 14)

Fig. 26 (appended) shows the two way ribbon drive and feed changeover mechanism. The ribbon spools are connected to their respective drive plates by a peg which passes through an off-centre hole in the spool. Ribbon tension is maintained by arms which are spring loaded away from the jumper, their lower ends are anchored to one end of a clutch band. These bands pass round the drum part of the feed ratchets and are anchored at the other end to the retention pawl pivots. Springs

joining these two anchor points urge them together, but when the ribbon tightens the light pull on either tension arm slackens the grip of its associated band and allows the spindle and spool to rotate. The purpose of these band clutches is to prevent over-running of the spool from which ribbon is being unwound; this would otherwise cause a slack loop that may become entangled with the type bars.

Feed Action

In Fig. 26, the left-hand spool and its vertical shaft are free to unwind since the associated feed pawl and retention pawl are held away from the ratchet wheel by projections on the left hand of the drive transfer link. Similar projections on the right hand end of the link are displaced so far to the left that the right hand spool's feed and retention pawls can engage the teeth of the other ratchet wheel.

During the printing action, the type bail moves to the rear, rotating the left and right ribbon feed levers and moving their associated links towards the front of the machine. Bellcranks pivoting round the spool spindles cause whichever of the feed pawls is in contact with its ratchet (the right hand one in this case) to move round to take up another tooth. When the type bail restores after printing, the rearward movement of feed lever links causes the engaged feed pawl (the right hand one) to rotate its ratchet one tooth; the movement being retained by its associated retention pawl. The movement of the left hand feed pawl is ineffective.

When all the ribbon has been transferred from one spool to the other, the full spool is continuing to feed, will draw the ribbon tighter and tighter, turning the right hand tension arm clockwise; a pin on its lower arm rotates the changeover lever, moving its lower arm to the left and extending the attached spring. The other end of the spring is attached to the right hand ribbon feed lever link which it draws to the left so that a cutout in its left-hand edge, which normally misses the ratchet beneath the star wheel, is now in line with the ratchet. The next rearward movement of the link will cause the cutout to engage the ratchet (shown in inset on Fig. 26) and turn it $\frac{1}{8}$ th of a revolution; the left-hand projection on the right hand ribbon feed lever link acting as an overshoot stop for the ratchet. This movement of the ratchet and star wheel causes the drive transfer link to move to its alternative position, and transfer the drive from the full spool to the empty one.

Answerback Facility (EP Telegraphy 4/4 Figs. 15 & 16)

The drum of the Transmitter Unit Answerback mechanism can be coded to carry up to 20 pre-set characters or functions, usually the machine's station identification. Receipt of the WHO ARE YOU? (WRU?) enquiry (MSSMS) triggers this mechanism, which then rotates a coded drum in front of the sequential levers, simulating the action of the keyboard comb bar selecting levers to generate the required sequence of 5-unit code signals, and send it to line.

The answerback mechanism can also be triggered locally be operating the HERE IS key. Measures are taken to prevent the operation of the local WRU? key from releasing the local answerback mechanism via the "local record".

The following points regarding the construction of the latch assembly Fig. 27, which is at the rear of the Transmitter Unit should be noted before reading the sequence of operation that follows.

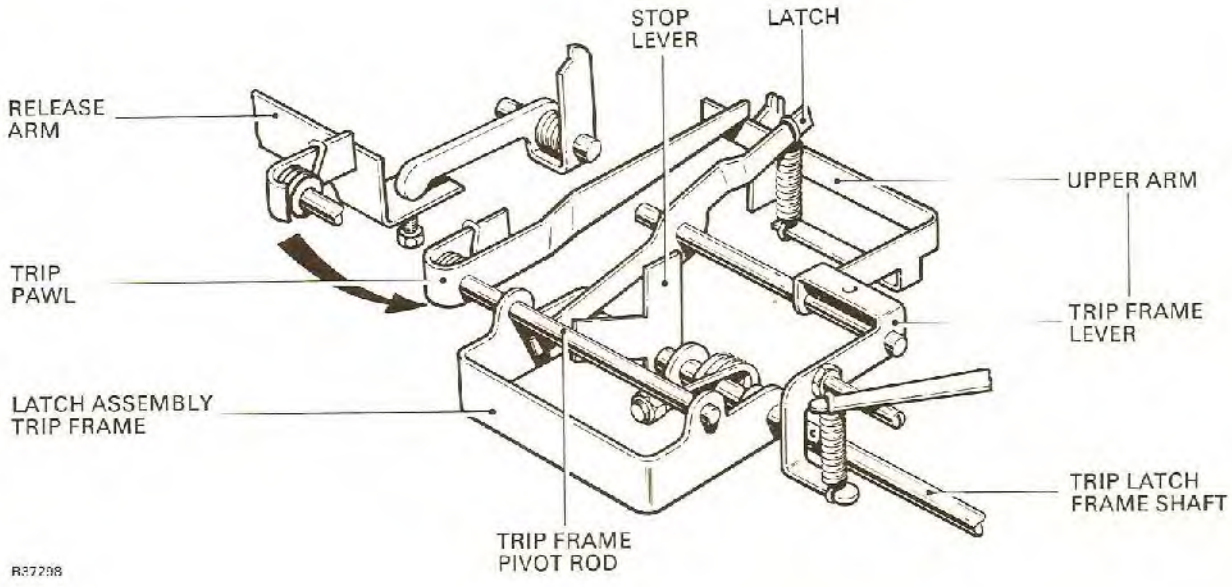


Fig. 27

The trip pawl is spring loaded clockwise around the pivot rod carrying the trip frame, and upper arm of the trip frame lever. The trip frame is free to turn around the pivot rod, but is sprung against the stop lever, which is itself clamped to the pivot rod. The pivot of the trip frame lever and the latch is fixed. The latch is tensioned clockwise; its left hand end normally rests against the underside of the trip frame pivot rod.

Release of Answerback Mechanism by Incoming WRU? Signal

Trip Action: As described earlier, the receipt of a WRU? signal causes the release arm, Fig. 27, to be drawn to the left. The consequent pressure on the trip pawl causes the trip frame, the stop level and the trip frame shaft to rotate together in an anti-clockwise direction until the vertical arm of the stop lever touches the casting; any further movement of the release arm then extends the torsion spring linking the trip frame to the stop lever.

A lever, Fig. 28, clamped to the front end of the shaft, rotates the drum detent lever clockwise, so lifting a projecting arm on the detent lever out of the cutout of the answerback stop/start cam, and at the same time causing the roller on the end of the detent lever to tread on the lock lever, moving it down far enough to engage the lock lever latch.

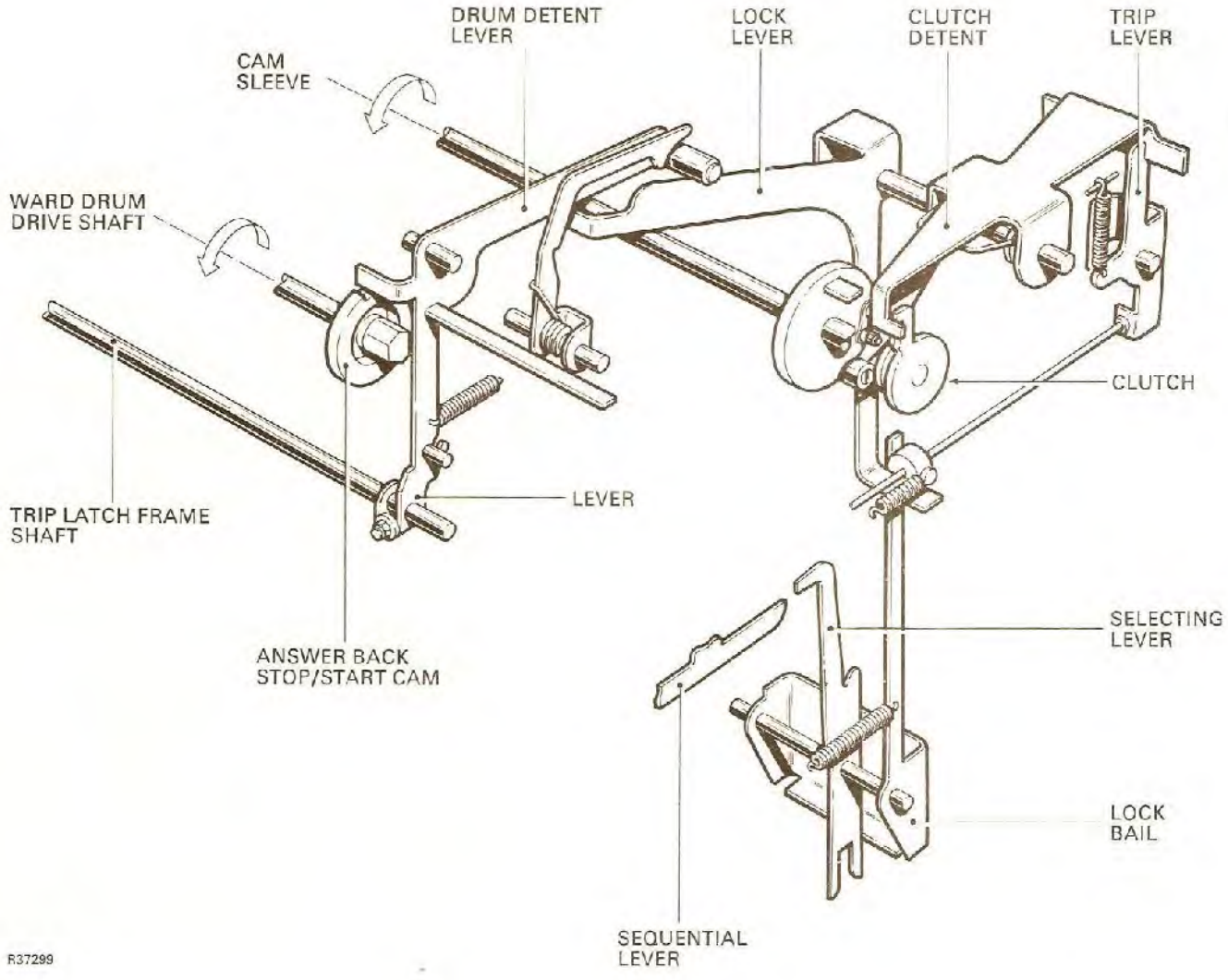


Fig. 28

The vertical arm of the lock lever is thus moved to the right, simultaneously displacing the trip lever to release the clutch detent, and rotating the lock bail clockwise. The lower surface of the lock bail thus moves all the selecting levers clear of the ends of their sequential levers, and in so doing prevents any keyboard operations from interfacing with the Answerback transmission.

Maintenance of Trip Condition: Until the end of the first cycle of the cam sleeve, this "trip" condition is maintained (after the release arm, Fig. 27, has restored) by the latch in the latch assembly. As the latch assembly trip frame moved down, it was able to turn clockwise to wedge its left hand end against the inside edge of the pivot rod, so holding the trip frame in the "operated" position. As the cam sleeve starts to revolve, the feed cam turns the feed ratchet lever anti-clockwise so feeding the ratchet one tooth anti-clockwise. Fig. 29.

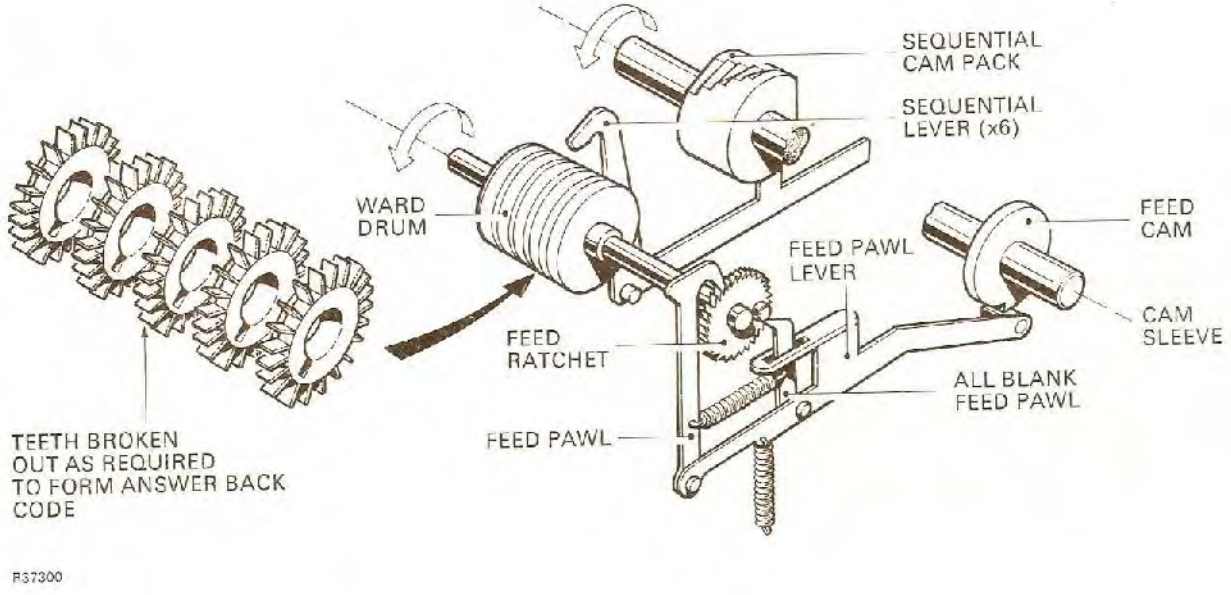


Fig. 29

This movement simultaneously presents the first line of teeth on the ward drum (entire teeth for SPACE, broken off for MARK) to the top ends of the five sequential levers and rotates the answerback Stop/Start cam so that its cutaway moves away from the projection of the drum detent lever.

Read Action

Further rotation of the cam sleeve causes the sequential levers to move forward in turn to sense the pattern of teeth across the ward drum; the "blocked" and "free" conditions they encounter controlling the common frame and striker (shown in Fig. 5) to produce the required MARK/SPACE electrical conditions and convey them to line.

Transfer of Trip Holdout

During the STOP signal of the first Answerback character, the WRU? inhibitation lever turns anti-clockwise, the selector lever being withdrawn by the lock bail, its left hand extension treading on the pin of the trip frame lever to turn this lever momentarily anti-clockwise. This movement of the lever lifts its arm so that the trip frame latch can pass beneath it, and, simultaneously, urge the trip maintaining latch anti-clockwise to restore its left hand end to the rest position beneath the latch assembly trip frame pivot rod. The latch assembly trip frame can now restore clockwise, so transferring the maintenance of the trip condition from the trip maintaining latch to the arm of the drum detent lever which moves down to run on the edge of the answerbacksStop/Start cam, Fig. 30.

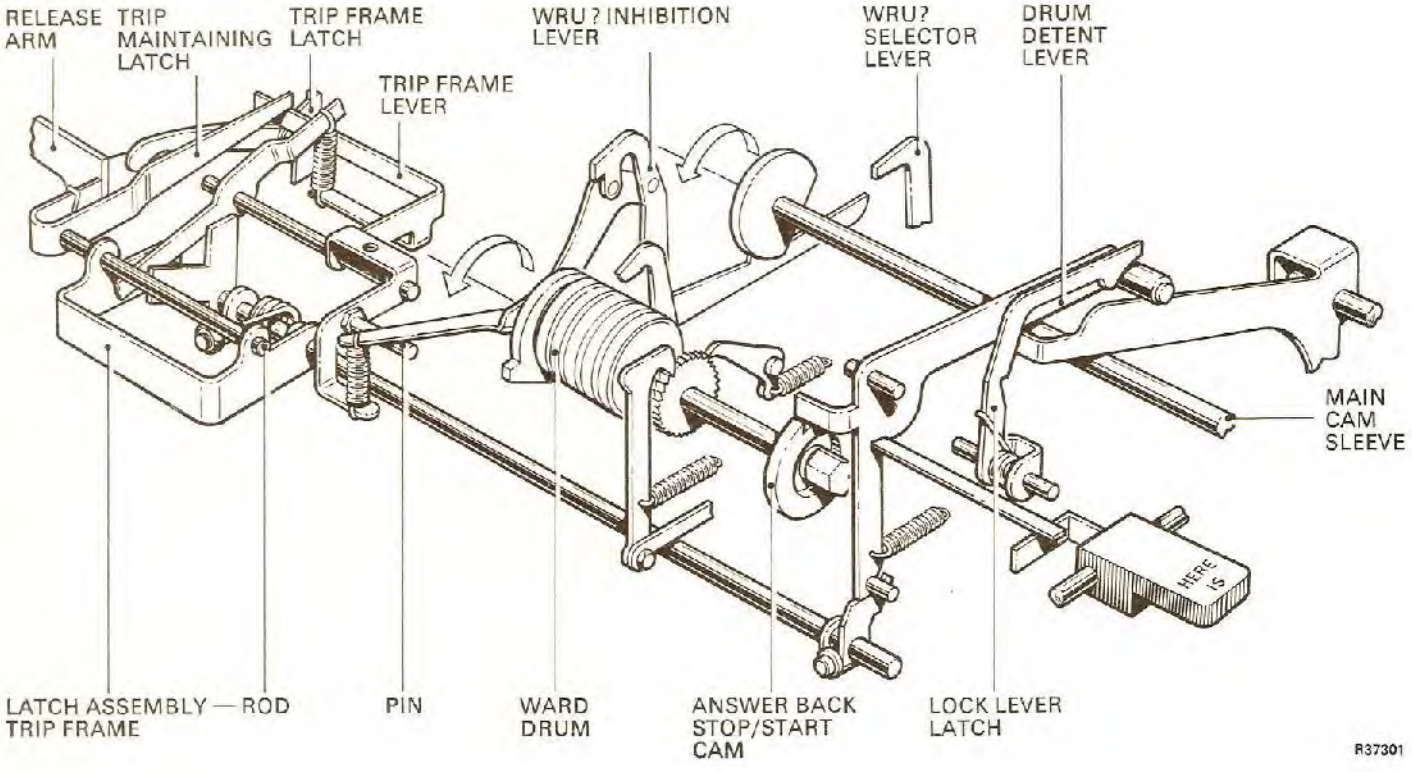


Fig. 30

The subsequent upward motion of the release arm (this is due to the "reset to black" action of the answerback trip shaft to which the release arm is clamped, shown in Figs. 27 and 30) at the end of the main cam sleeve half revolution, pivots the trip frame latch clockwise, so allowing the trip frame lever to restore the rest position.

The movement of the WRU? inhibitation lever which raises the trip frame lever on to the trip frame latch at the end of each reading cycle, and the subsequent disengagement of the trip frame latch by the release arm, is repeated for the remaining 19 characters, but is ineffective.

Conclusion of Transmission

The "feed and read" operation is repeated for the remaining characters coded on the ward drum until the cutout on the Stop/Start cam is presented to the extension of the drum detent lever on the 20th character. The lock lever then restores to normal (the roller on the right hand end of the horizontal arm of the drum detent lever displacing the lock lever latch as its rises) allowing the clutch detent to arrest the cam sleeve, and the lock bail to move anti-clockwise away from the selector levers.

Twenty-First Feed

On conclusion of the Answerback transmission it is necessary to rotate the ward drum one more position to bring an "all blank" position opposite the reading ends of the sequential levers, so enabling control of these levers to pass back to the keyboard.

This additional feed action is produced by the All Blank feed pawl (Figs. 29). This pawl is spring loaded and during the 20th reading cycle, is displaced by a stud on the side of the feed ratchet wheel, and then moves back beneath it. As the feed ratchet lever moves clockwise to restore after the 20th anti-clockwise feed operation, the all blank feed pawl pushes up on this stud, and so moves the ward drum round to the "all blank" position. This same movement of the feed ratchet lever also raises the feed pawl into the next tooth of the ratchet wheel ready for another Answerback operation.

Suppression of Local Answerback Response when WRU? Code is Transmitted

It is necessary to prevent the local answerback mechanism being activated via the "local record" when the local WRU? key is depressed to enquire the identity of a distant station, otherwise both local and distant Answerbacks would be released simultaneously. This double operation is prevented by breaking into the trip linkage from the release arm to the trip frame shaft, so making the right-to-left movement of the release arm ineffective.

The mechanism that produces this effect is controlled initially by the WRU? key on the keyboard. The WRU? comb bar at the rear of the comb bar assembly (shown earlier with the keyboard assembly, Fig. 3) is normally depressed by the operation of any key other than the WRU? key so maintaining the WRU? slide link to the right; depression of the WRU? key however, engages the single tooth on the other of the pair of WRU? comb bars and depresses it to slide the link to the left.

Suppression Action

The right hand end of the WRU? link on the keyboard (Fig. 3) controls a special lever which appears as the selector lever shown in Fig. 30. This lever is normally hooked over the rail of the inhibitation lever, except when the WRU? key is operated; the selector lever then moves away to permit the inhibition lever to follow its cam.

When the STOP signal of the WRU? enquiry is being transmitted to line, the inhibition lever turns anti-clockwise. Its left hand extension treads on a projecting pin of the trip frame lever raising the arm of that lever on to the

trip latch frame. In doing so the arm pivots the trip pawl anti-clockwise so that the subsequent movement of the release arm to the left (in response to "local record" interpretation of the transmitted WRU? signal), is ineffective, as the arm passes into a cutout on the underside of the trip pawl.

At the end of the main cam sleeve cycle, the "reset to black" movement of the release arm pivots the trip frame latch clockwise to restore the trip pawl to its normal position.

Here is Action

The local Answerback can be brought into operation without transmitting a signal to line, by a manually operated HERE IS key located above the teleprinter keyboard. Operation of this key simulates the movement of the lever on the end of the trip frame shaft by turning the drum detent clockwise via a direct mechanical link to the rear of the key assembly; thereafter the mechanism operates as described above.

Tape Punch Unit (EP Telegraphy 4/4 Figs. 17 and 18)

The Tape Punch Unit and its associated drive arm is mounted on the left hand side of the machine, within the cover. The unit produces fully-punched five-unit code paper tape with a punched smaller feed sprocket hole at the maximum speed of the associated teleprinter, and feeds this tape out from the front of the machine beneath a V-shaped tear-off face.

The unit is controlled from the Link Unit described on page 16. It therefore records received messages directly and transmitted messages indirectly via the electrical "local record" path. Code combinations are punched in the same cycle as they are printed.

Provision is made for automatic suppression of the punch and tape feeds actions on up to four codes, which can be in either or both shifts. Two of these codes are usually J BELL and WRU?; the other two can be used for mechanical control of the PERF ON and PERF OFF keys. These two keys can also be controlled remotely via electromagnets. When required, the "suppression" mechanism can be inhibited, and all 32 code combinations punched.

Drive for Punch and Feed Actions (Fig. 31)

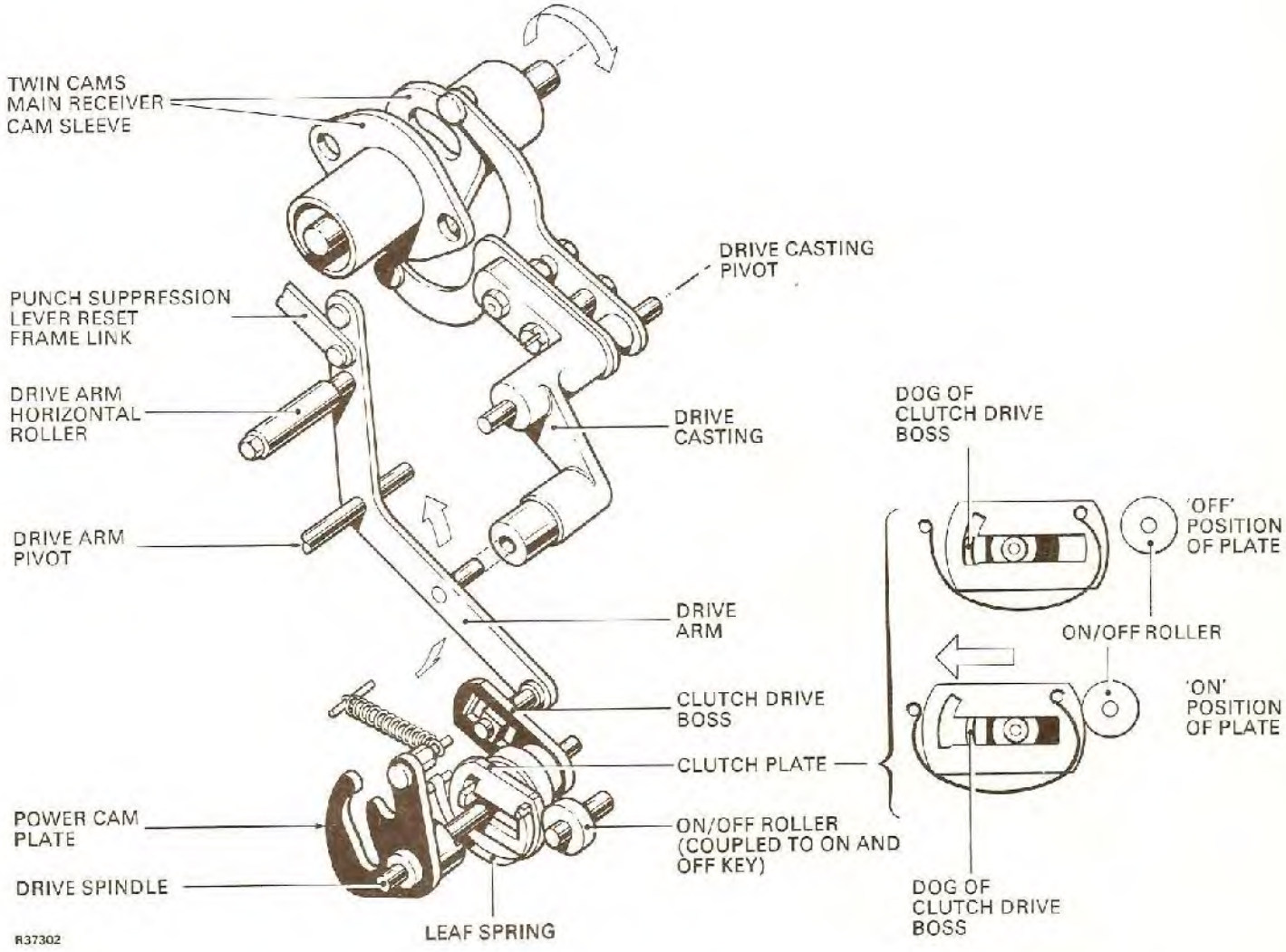


Fig. 31

Through the drive casting, the twin cams on the receiver main cam sleeve impart a continuous rocking motion to the drive arm. The top rear end of the arm carries, a horizontal roller that controls the code reading levers, and a link that operates the punch suppression level reset frame. The front end of the arm carries a trunnion block which converts the rocking motion into rotary motion of the clutch drive boss around the drive spindle.

The clutch drive boss has a dog which fits into a L-shaped slot in the clutch plate. In the OFF position the plate is urged towards the front of the machine by a leaf spring so that the dog simply moves up and down in the vertical part of the slot without conveying its motion to the clutch plate of the power cam plate, whose dogs lie in the horizontal part of the slot.

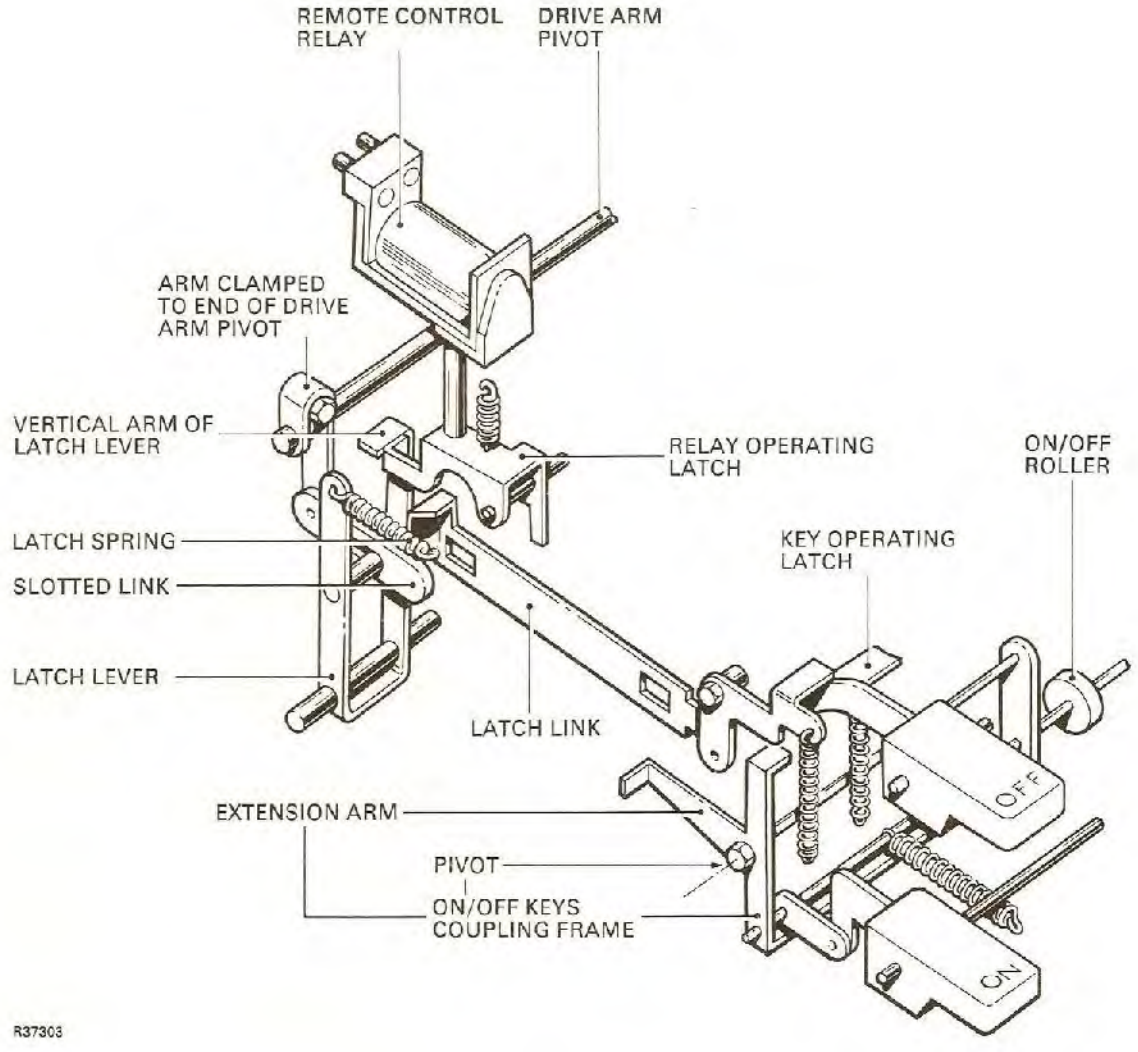


Fig. 32

Depression of the ON key, Fig. 32, turns the ON/OFF keys coupling frame clockwise around a pivot so causing a roller to push the drive clutch plate towards the rear, where it is held by the action of the operating latch on the top arm of the frame. This movement of the clutch plate brings the dog of the drive boss into the horizontal part of the slot in the clutch plate where it joins the two dogs of the power cam plate. The cam plate is thus temporarily linked to the drive boss, and so takes up its rocking motion.

The roller at the top of the drive cam plate provides power for the punching action; the vertical slot generates the tape feed action.

OFF Action

Manual: Operation of the OFF key lifts the operating latch to release the ON/OFF coupling frame and allow the roller to withdraw from the drive clutch plate. At the end of the cycle, the plate is moved towards the front of the machine.

by the leaf spring, so bringing its vertical slot into line with the dog on the drive boss, where the subsequent up and down movement of the dog is ineffective. The drive clutch plate is thus brought to rest.

Remote: The unit can be switched off remotely by energising the relay; this relay is shown in Fig. 32 and at RM in the signals circuit diagram, Fig. 21 of EP Telegraphy 4/4.

ON Action

Operation of the ON key results in the operating latch turning clockwise to retain the ON/OFF key coupling frame. The latch link is thus moved to the rear to bring it close to the vertical arm of the latch level, normally held against the relay latch by the spring attached to the latch lever frame. Because of the horizontal slot in the link between the arms of the latch lever frame, the frame is not disturbed by the to and fro movement of the link arising from the rocking motion being transmitted by the drive arm shaft and the arm clamped to its end.

When the relay is energised the latch coupled by a vertical rod to its armature is depressed below the bent end of the right hand arm of latch lever frame so allowing the frame to follow the next forward movement of the link between its arms. The right-hand arm of the frame drawn by the spring attached to it, engages the rear vertical face of the latch link, and moves the link towards the front of the machine, so upsetting the key operating latch. The consequent anti-clockwise movement of the coupling frame withdraws the ON/OFF roller, so breaking the drive link between the drive boss and the power cam plate to bringing the punch to rest.

Punch Selections Actions

Code Hole Punches: The pattern of holes that will be punched through the tape for a particular code combination is dictated by the lateral positioning of the five "active" links (one is shown in Fig. 33) of the Link Unit, whose lower projections are sensed by the five code reading levers, Fig. 33, which control the punch anvils. The projections along the top edges of the links are similarly sensed by up to four punching suppression levers, one being shown typically in Fig. 33.

At the point in the reception cycle when the code is about to be passed from the Selector Unit to the Link Unit, the front end of the drive arm moves down. The sleeve carried on the drive arm, urges the code reading lever away from a projection on the Link Unit link, a frame at the top of the drive arm is turned by a link anti-clockwise to lift a roller and hence the suppression lever away from the top projections of the links. The links are now free to accept the new code setting.

Once the new code is established on the links, the drive arm turns anti-clockwise withdrawing its attached sleeve to allow the code reading bars to rise and sense the under projections of the links. Links that have been set to the right for MARK, allow the code reading bars to pass up the left hand side of the under projections of the links. The punch anvil bars which form a lower bellcrank lever arm with the code reading bars, are tensioned by a spring against the retreating lower end of the code reading bars which thus move to the rear to bring the projection of the punch anvil beneath the associated punch.

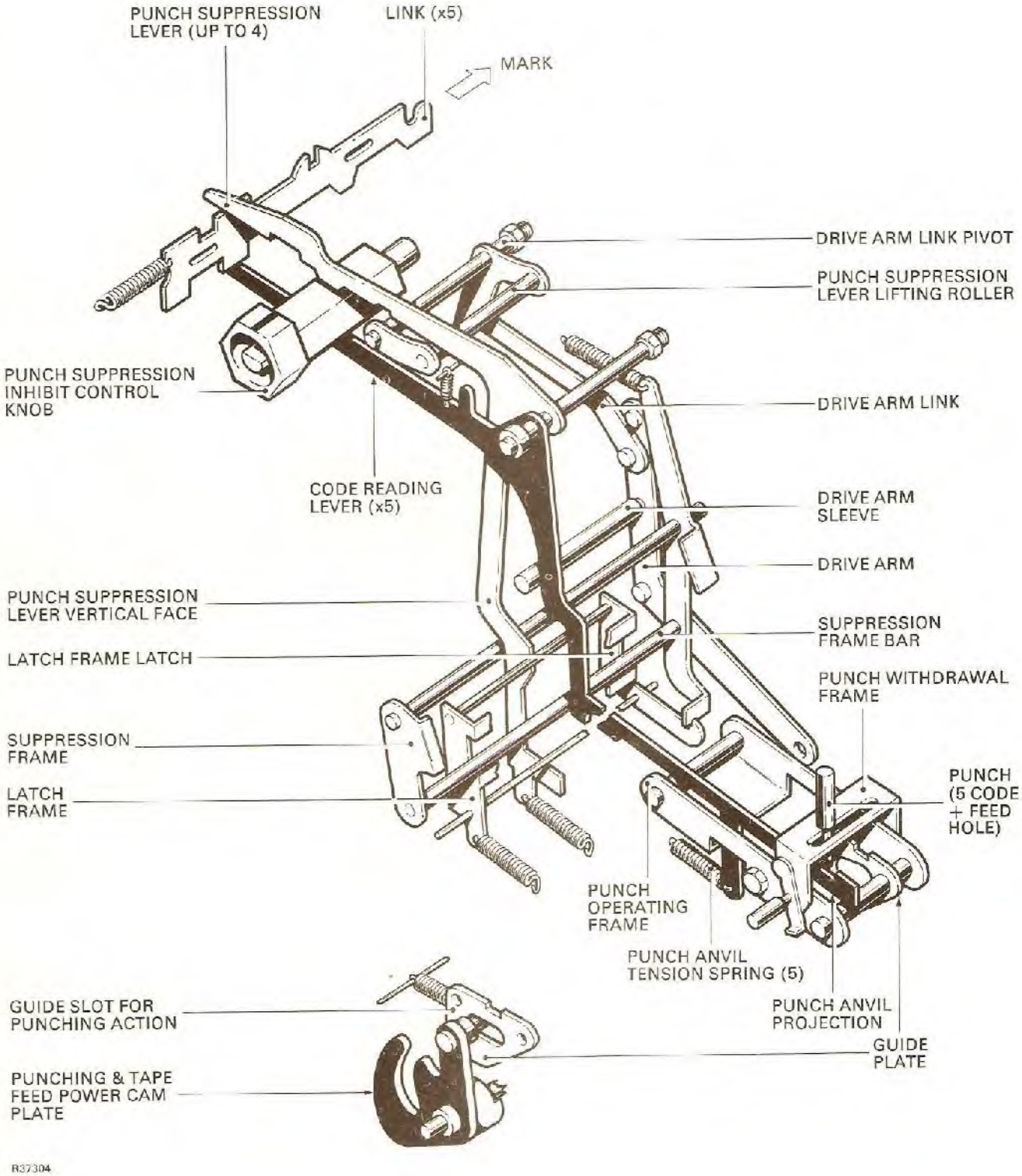

PUNCH SUPPRESSION LEVER (UP TO 4)
LINK (x5)
MARK
DRIVE ARM LINK PIVOT
PUNCH SUPPRESSION LEVER LIFTING ROLLER
PUNCH SUPPRESSION INHIBIT CONTROL KNOB
DRIVE ARM LINK
CODE READING LEVER (x5)
DRIVE ARM SLEEVE
DRIVE ARM
PUNCH SUPPRESSION LEVER VERTICAL FACE
SUPPRESSION FRAME BAR
LATCH FRAME LATCH
PUNCH WITHDRAWAL FRAME
SUPPRESSION FRAME
LATCH FRAME
PUNCH (5 CODE + FEED HOLE)
PUNCH OPERATING FRAME
PUNCH ANVIL TENSION SPRING (5)
PUNCH ANVIL PROJECTION
GUIDE SLOT FOR PUNCHING ACTION
GUIDE PLATE
PUNCHING & TAPE FEED POWER CAM PLATE
R37304

Fig. 33

A subsequent upward movement of the punch operating frame, which carries the five code and the feed hole punches, produced by the action of the roller of the cam plate in a guide plate (part of the punch operating frame and shown in inset to the left of Fig. 33) causes a hole to be punched in the tape for this particular code element. When the punch operating frame is lowered again, the withdrawal frame pulls any "marking" punches out of the paper.

Any links that remain at rest in the SPACE position leave their under projections in the path of the rising reading levers, and so prevent the associated anvil bars from moving to the rear. The cutout to the rear of the projections of the anvil bars thus remain beneath the punches, which are not therefore affected when the punch operating frame is raised.

Tape Feed Action

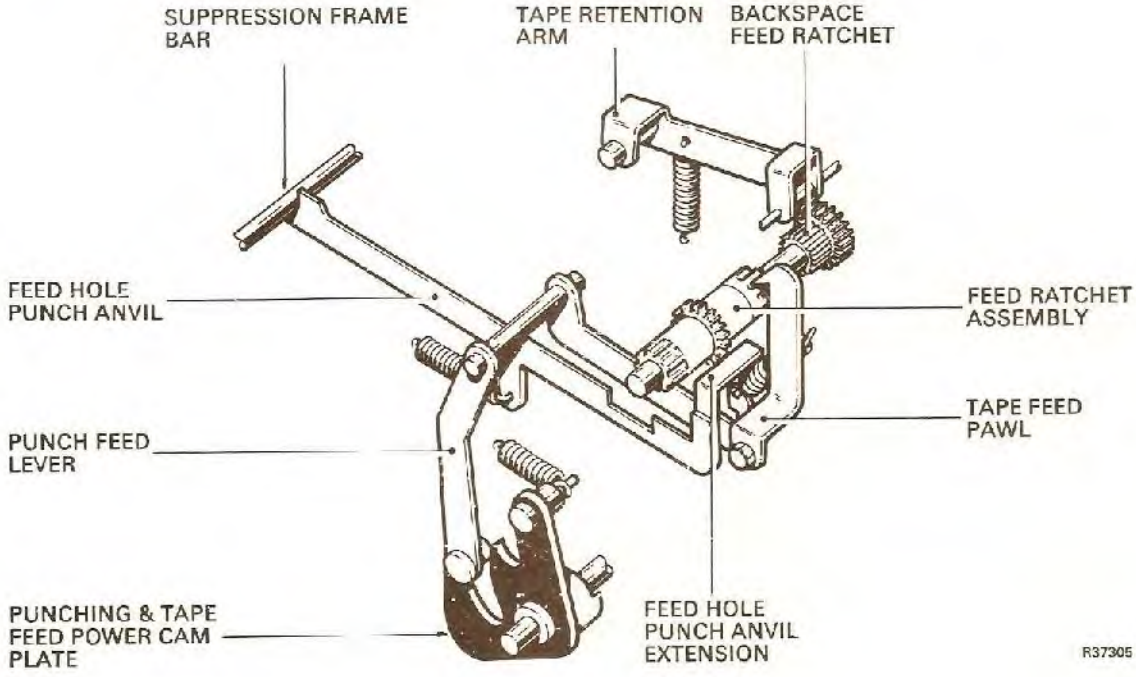


Fig. 34

The feed hole punch anvil bar, which is carried in the punch operating frame along with the five code hole punch anvil bars, is normally tensioned to the rear against a bar in the suppression frame (shown in Fig. 33). In this position the entire part of the anvil bar lies beneath the feed hold punch, so that when the punch operating frame is raised, a feed hole is produced in the tape.

As the cam plate turns clockwise to lift the punch operating frame, its internal cam track turns the feed lever anti-clockwise so lifting the feed pawl into the next tooth of the ratchet wheel assembly, which also carries the tape feed pin wheel. The downward movement of the pawl produced when the cam plate restores, rotates the ratchet wheel one tooth, so drawing a further $\frac{1}{10}$ inch (2.5 mm) of tape through the die assembly.

Punch and Feed Suppression (Fig. 33 and 34)

For some applications it is a requirement that the codes for WRU? and J BELL should not appear in the perforated tape. To provide for this requirement, up to four punch suppression levers can be fitted. These levers operate in the following manner.

As the front end of the drive arm rises, the front roller of the pair of the drive arm frame lowers the suppression levers to sense the top projections of the links. If the code is a "normal" one, the suppression levers will each be blocked by at least one projection. When a code that is required to be suppressed is set up on the links, however, a gap will open across all five links, and the selected suppression lever will move down into it. (A sixth link, operated from the case shift control mechanism, enables the suppression levers to discriminate between codes such as D/WRU? which are "normal" in the "letters" shift but require to be suppressed in the "figures" shift.)

The subsequent anti-clockwise of the selected suppression lever causes the mid-face of its lever arm to pivot the latch frame clockwise, so disengaging its latch from the lower arm of the suppression frame. Urged by a spring, the suppression frame now turns anti-clockwise, and a bar attached to this frame pushes the lower ends of any "marking" code reading levers forward to the space position. This rod also moves the feed hole anvil bar forward so that its cut out lies beneath the feed hole punch; an extension of the anvil displaces the tape feed pawl. The next upward movement of the punch operating the punch operating frame will therefore be ineffective as the code and feed hole punch anvils have all been set to SPACE, and the feed pawl has been displaced, so effectively suppressing the code established on the links.

When the drive arm subsequently turns clockwise to lower the punch operating frame, a roller attached to it rotates the suppression frame so that it can re-engage the latchframe and so restore control of the anvil bars to the code reading bars.

Punch ON/OFF on Receipt of Selected Code

A special suppression lever similar to those described above can be fitted which, when selected, causes the operating face on its lever arm to push the latchlink forward, releasing the key latch and the coupling frame to bring the punch unit to rest. The face on the suppression lever arm suppresses the OFF code by acting on the suppression frame bar that pushes the lower ends of any "marking" code reading levers forward as described above. Another suppression lever can be used to operate linkages that act on the extension piece of the key coupling frame to simulate operation of the ON key.

Tape Loading

Depression of the TAPE RELEASE key raises the tape retention arm and the pressure roller that holds the tape down on to the feed ratchet assembly. This enables the tape to be threaded easily over the pin wheel.

Back Space

The first part of the "back space" key movement disenages the tape feed pawl from the ratchet wheel assembly, and engages a "backfeed" pawl with a reverse ratchet. Further movement causes this backfeed pawl to turn the ratchet feed assembly anti-clockwise by one tooth. A retention arm maintains the pin wheel and the tape in its new position.

Suppression Control Knob

The punch suppression action of the punch suppression levers is inhibited in one position of the control knob. This knob has two other positions; one which permits all received codes to be punched, the other is used when the suppression mechanism is being adjusted. These three settings are indicated by one, two and three stripes respectively on three adjacent faces of the hexagonal knob, and correspond to the following conditions:-

One stripe to top; this is the normal position. All code reading levers and suppression levers are free to operate; WRU? and BELL are suppressed and do not appear on the tape.

Two stripes on to'; this setting blocks the movement of all the code reading levers and the suppression levers. It is only used when the suppression mechanism is being adjusted. If the Punch is switched on with the control knob in this position, only feed holes will be punched in the tape.

Three stripes on top; in this setting, the suppression levers are blocked, but the code reading levers are allowed to operate normally. All received code combinations, including BELL and WRU? are therefore recorded on the tape.

Tape Reader Unit (EP Telegraphy 4/4 Figs. 19 and 20)

The Tape Reader Unit which is located at the right hand side of the keyboard panel, will read 5-track $\frac{11}{16}$ inch (17.5 mm) tape at the same speed as the associated teleprinter. The Unit has its own striker transmitter of identical design to the one employed in the Keyboard Transmitter and Answer Back Unit but uses the send/receive switch of the keyboard transmitter.

Two manually-operated keys, labelled TAPE TRANS ON, and TAPE TRANS OFF, control the Reader mechanism. The "tape out" and "tape gate open" conditions bring this mechanism to rest automatically, and signal the condition to the controlling equipment by an "alarm" microswitch. Another microswitch indicates when the Reader is ON. The reader can be brought to rest remotely by energising a "Reader Off" electromagnet.

Fig. 35 shows the Reader mechanism in the rest condition, with both control keys at "normal". The arm of the clutch detent is holding the clutch assembly open, being maintained in this position by a cranked arm of the start trip lever interposing on an arm of the clutch detent. The TAPE IN control lever is raised to block any anti-clockwise motion of the trip lever, so holding the ON key inoperative. A spring connected underneath the TAPE IN control lever controls this lever and as the lever is clamped to the detent shaft, the spring controls the TAPE OUT arm as this is also clamped to the shaft (for convenience, the spring is shown attached to the TAPE OUT arm). The left hand clutch member is being driven continuously by the belt drive which is connected to the transmitter drive shaft.

When tape is loaded and the tape gate latched down, the TAPE OUT lever is depressed so rotating the detent shaft anti-clockwise. This movement urges the tape latch down onto a face of the stop lever and moves the TAPE IN control lever down clear of the start trip lever.

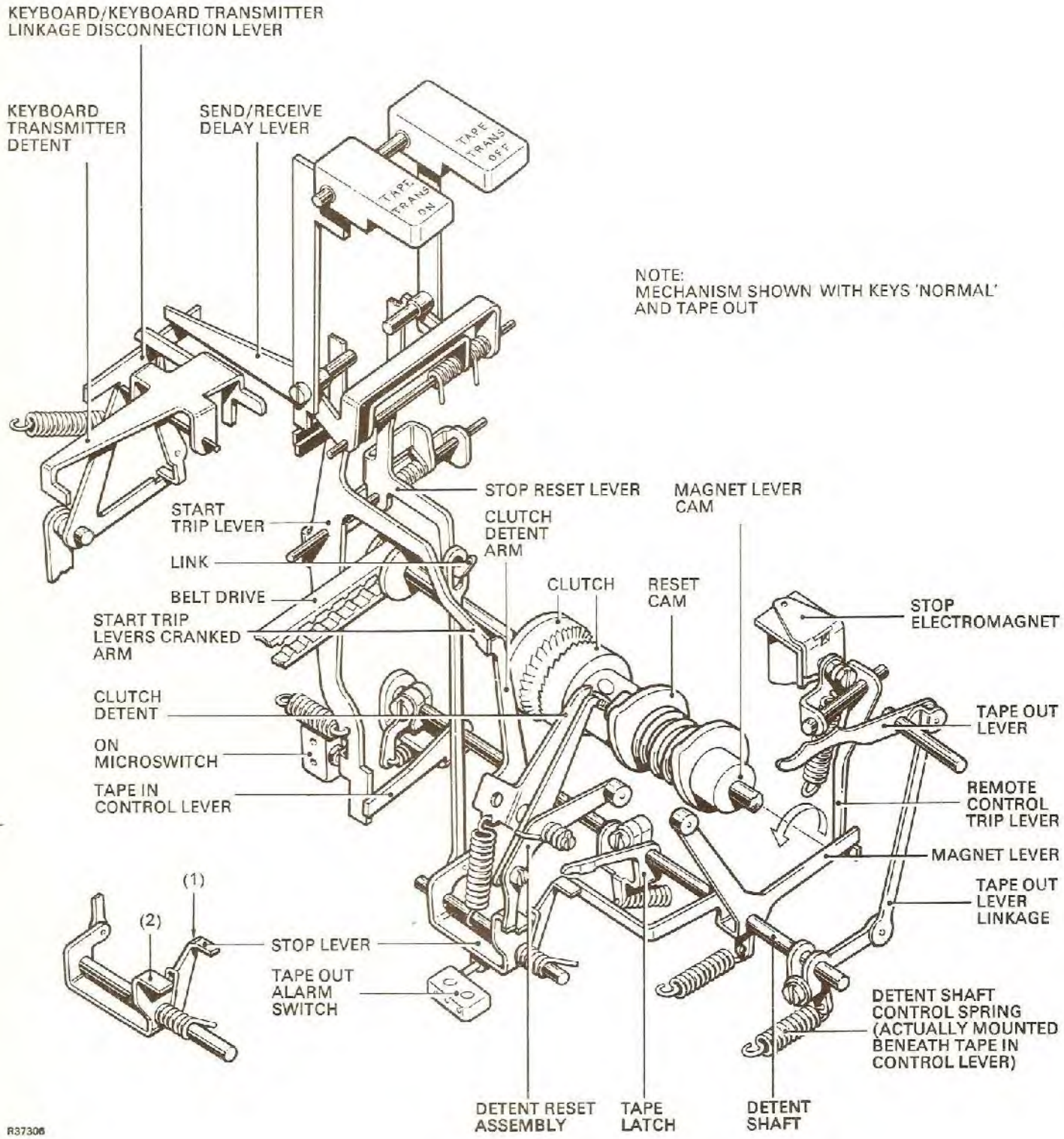

KEYBOARD/KEYBOARD TRANSMITTER LINKAGE DISCONNECTION LEVER
KEYBOARD TRANSMITTER DETENT
SEND/RECEIVE DELAY LEVER
TAPE TRANS OFF
TAPE TRANS ON
NOTE:
MECHANISM SHOWN WITH KEYS 'NORMAL' AND TAPE OUT
STOP RESET LEVER
MAGNET LEVER CAM
START TRIP LEVER
CLUTCH DETENT ARM
LINK
CLUTCH
RESET CAM
BELT DRIVE
STOP ELECTROMAGNET
START TRIP LEVERS CRANKED ARM
CLUTCH DETENT
TAPE OUT LEVER
ON MICROSWITCH
TAPE IN CONTROL LEVER
REMOTE CONTROL TRIP LEVER
MAGNET LEVER
TAPE OUT LEVER LINKAGE
(1)
(2)
STOP LEVER
TAPE OUT ALARM SWITCH
DETENT SHAFT CONTROL SPRING (ACTUALLY MOUNTED BENEATH TAPE IN CONTROL LEVER)
DETENT RESET ASSEMBLY
TAPE LATCH
DETENT SHAFT
R37306

Fig. 35

Starting Procedure

To start the mechanism to read the loaded tape, first the OFF key is depressed followed by the ON key.

A horizontal pin on the OFF key lever turns the stop reset lever anti-clockwise, a hook on its end, lifting a link to rotate the stop lever anti-clockwise. An arm (1) on the stop lever engages the tape latch and a second arm (2) (shown in inset in Fig. 35) is thus held down clear of the lower end of the detent reset lever. The detent reset lever now turns anti-clockwise; the detent still being held by an extension of the start trip lever.

When the ON key is depressed, a similar horizontal pin depresses the send/receive delay lever to tread on the Z shaped keyboard/keyboard transmitter linkage disconnection lever, so upsetting the keyboard/keyboard transmitter trip linkage at the keyboard transmitter detent. The same pin turns the start trip lever anti-clockwise; its lower end operates the ON microswitch, whilst its upper cranked arm releases the clutch detent which lifts to allow the two halves of the clutch to come together.

Transmission (Fig. 36 appended)

The cam sleeve now begins to turn anti-clockwise.

The switch cam rotates the switch frame and draws the switch link to the right, and so sets the keyboard transmitter's send/receive switch toggle to the send position.

Further rotation of the cam sleeve causes a start lever which is similar to a sequential lever but has no associated pecker, to turn anti-clockwise. A projection on the lever moves a space setting plate lever clockwise against a spring and cause the carrier arm to slide the carrier to the right. A subsequent upward movement of the signal timing arm causes the striker to turn the dolly anti-clockwise and so connect positive polarity to the line for the spacing START signal.

During the transmission of the START signal, the reset rack turns clockwise, allowing the five tape sensing peckers to rise (tensioned by leaf springs) and sense the pattern of holes in the tape. A pecker that can move up through the tape (MARK condition) moves its lower vertical arm into the path of the associated sequential lever; a pecker held down by entire paper (SPACE condition) does not move far enough clockwise to block a sequential lever, which can therefore follow its cam.

Towards the end of the START signal, a flat on code element No. 1 cam is presented to a sequential lever, which attempts to turn anti-clockwise. If its movement is blocked by a MARKING pecker the space setting plate lever will be free to turn anti-clockwise under the action of its tension spring, and the carrier arm will slide the carrier to the left. The next upward movement of the timing lever and the striker, which occurs 20 milliseconds after the first START strike, will then turn the dolly clockwise to connect negative MARK battery to line.

If the second code element is a SPACE, the associated sequential lever will be free to follow its cam, and, having a stronger spring that the space setting lever will tilt that lever clockwise, sliding the carrier to the right to align the striker in the SPACE position. The next upward movement of the striker will turn the dolly to connect positive SPACE battery to line.

The actions are repeated for the 3rd, 4th and 5th code elements; the position of the tape feeling peckers dictating whether a MARK or SPACE will be transmitted. When the 5th element sequential lever has restored, the cam sleeve holds all the sequential levers, including the start lever, down, allowing the space setting lever to turn anti-clockwise and move the carrier to the left. The last upward movement of the timing lever and striker then sets the dolly to connect negative MARK polarity to line for the STOP signal.

Tape Feed Action

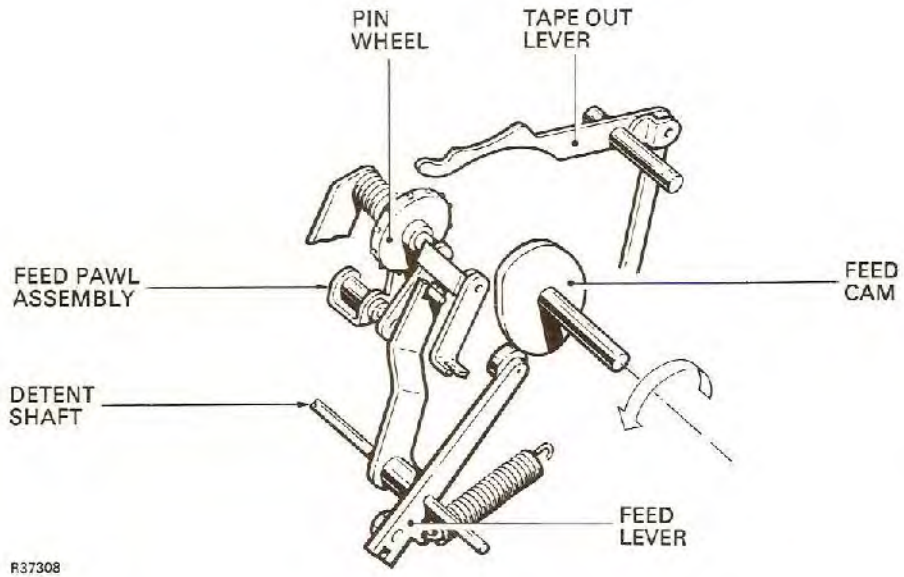


Fig. 37

The feed lever is mounted on the near end of the detent shaft shown in Fig. 36, shown above in Fig. 37. This lever enfolds a pin carried on the feed pawl assembly which pivots freely around the pin wheel spindle. During the STOP signal, the feed cam lever is turned clockwise by its cam, so urging the feed pawl assembly to the right. The nose of the feed pawl works directly into the pins of the pin wheel, which acts as a ratchet, and feeds the wheel round $\frac{1}{10}$ inch (2.5 mm) each cycle. The pin wheel is retained by a friction clutch around its pivot, when the pawl moves back (during the START signal of the next cycle) to take up the next pin.

Continuous Transmission

During the 5th code element, a detent reset cam acts on the horizontal arm of the detent reset lever turning it clockwise. This action causes its upper arm to press the clutch detent momentarily down into the path of the stop surface of the clutch. The reset cam, however, falls away and allows the cam riding face of the clutch detent to rise again before the stop surface of the clutch reaches it, Fig. 38.

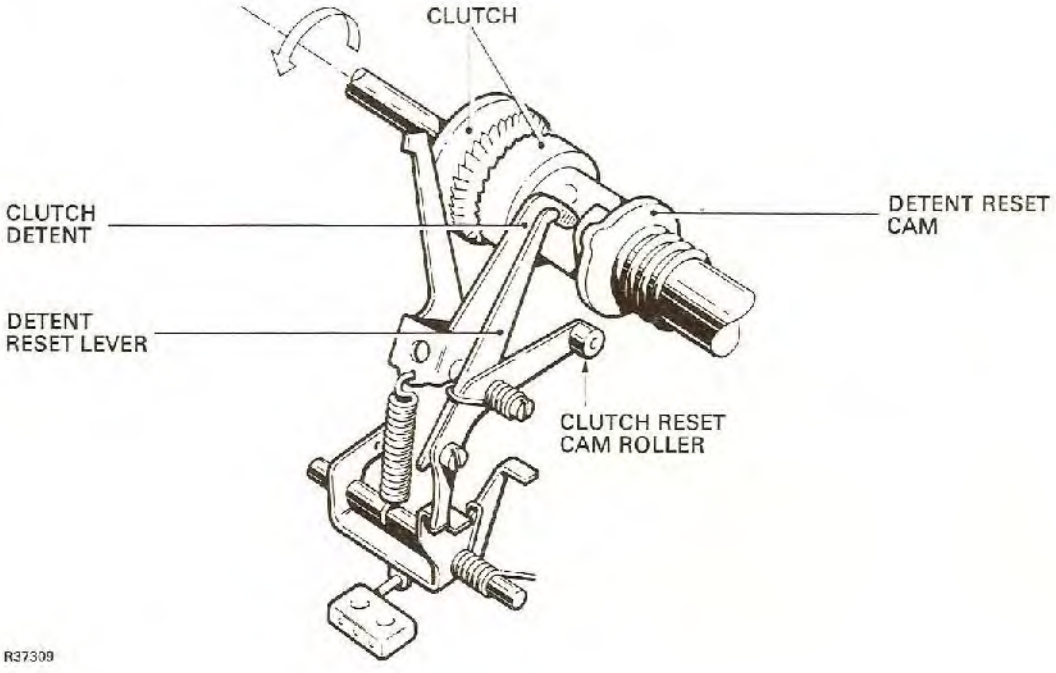


Fig. 38

The clutch therefore runs through, the transmission continues until one of three circumstances arise:-

1 The Reader senses TAPE OUT, or the tape gate is opened.

2 The TAPE TRANS OFF key is depressed.

3 The external equipment energises the STOP magnet.

Stop action on "Tape Out"

Under "continuous transmission" conditions, the stop lever is latched against the tape latch arm, and thus this face of the stop lever is held down clear of the detent lever. When a "tape out" or "gate open" condition occurs, the tape out lever and consequently the detent shaft are turned clockwise by the tape out lever tensioning spring. This same movement lifts the tape out latch to release the stop lever, which is then turned clockwise by its tension spring to bring a second face of the stop lever up against the tail of the detent lever (if this condition occurs later in the cycle, the second face of the stop lever may pass up the inside face of the detent lever, shown in inset on Fig. 36).

When the detent reset lever is subsequently turned clockwise by its cam (against the tension of the spring on the clutch detent) the second face of the stop lever moves up to block the anti-clockwise motion that would otherwise occur as the detent reset cam falls away. The detent thus remains in the path of the free side clutch member, which is then pressed back out of engagement with the driving half of the clutch to bring the mechanism to rest in the "alarm" condition. The OFF key is then depressed to restore the mechanism to normal.

Stop Action when OFF Key Operated

Assume that the Reader is running continuously with the tape gate down, so that the stop lever is latched by the tape latch; the ON key is held depressed by the OFF key latch lever, and the cranked arm of the start trip lever is held up clear of the clutch detent arm. Once each cycle the detent reset lever pushes the clutch detent down into the path of the clutch, but allows it to rise again before the clutch stop surface can reach it.

If the OFF key is now depressed, its latch lever is lowered to release the ON key and consequently the start trip lever, which then tries to turn clockwise under the action of the spring on its lower vertical arm. Depending on the instant in the cycle at which the OFF key is operated, the start trip lever cranked arm will now rest on the top of the clutch detent arm, or pass down into the path of the clutch by the detent reset lever; it will not be allowed to rise again because the cranked arm of the start trip lever will have blocked the clutch detent arm. The mechanism is thus brought to rest again.

Remote Control Stop Action

When the STOP electromagnet (Fig. 35) is energised from some external source, the remote control trip lever withdraws support for the arm of magnet lever allowing the lever to follow its cam which ultimately turns it clockwise. A cranked arm lifts the tape latch so freeing the stop lever which then turns clockwise to bring the mechanism to rest as described above. In common with the TAPE OUT stop action, this is an "alarm" condition which is reset to normal by the OFF key being depressed.

Extension of the Stop Signal

Although the reader cam sleeve has a revolution time of 150 milliseconds, some 10 milliseconds elapse before the first START strike. This leaves only the 20 milliseconds period from 130 milliseconds to the end of the cycle for the STOP signal, less the time taken by the switchcam, Fig. 36, to reset the send/receive switch to "receive". On switched simplex circuits this would cause an unacceptable shortening of the STOP signal, so arrangements are made to hold the send/receive switch on "send" until a STOP signal of the required 30 milliseconds duration has been transmitted. The mechanism used for this purpose is shown in Fig. 36.

During the 4th code element the stop extension cam rotates its cam lever anti-clockwise to tread on an arm fixed to the pivot of the send/receive delay lever. The arm is thus turned clockwise; its right hand end moves down into the path of an extension of the send/receive switch operating lever, so preventing it returning to "receive" when the switch link restores; the left hand end of the send/receive delay lever is lifted out of a cutout in the friction driven send/receive delay cam where it runs on the cam's periphery for approximately 75 milliseconds, after which it passes into another cutout.

The delay cam maintains the block on the send/receive switch operating lever for this period, this being sufficient if it is the last cycle of the mechanism, to extend the STOP signal to at least 30 milliseconds.

If the mechanism is cycling continuously, the delay mechanism holds the send/receive switch on "send" continuously; the 20 millisecond STOP signal at the end of the cycle then runs on to the 10 millisecond delay before the first START strike without a break, so producing the required continuous 30 millisecond STOP signal.

End of Cycle

When the cam sleeve comes to rest on the clutch detent (Fig. 35), at the end of a transmission, the OFF key is depressed. This action lifts the send/receive delay lever to free the keyboard transmitter, and allows the start trip lever to turn clockwise. The cranked arm of the start trip lever blocks the clutch detent arm: the bottom most part of the lever is blocked by the tape in control lever when the tape is removed; the rest of the mechanism then returns to the state shown in the diagrams ie keys "normal" and tape out.

Timing Sequence

Fig. 21 of EP Telegraphy 4/4 gives a diagram of the timing sequence of various items with the machine set to work at 50 bauds. From this the relationship of the timing of various items can be ascertained.

END

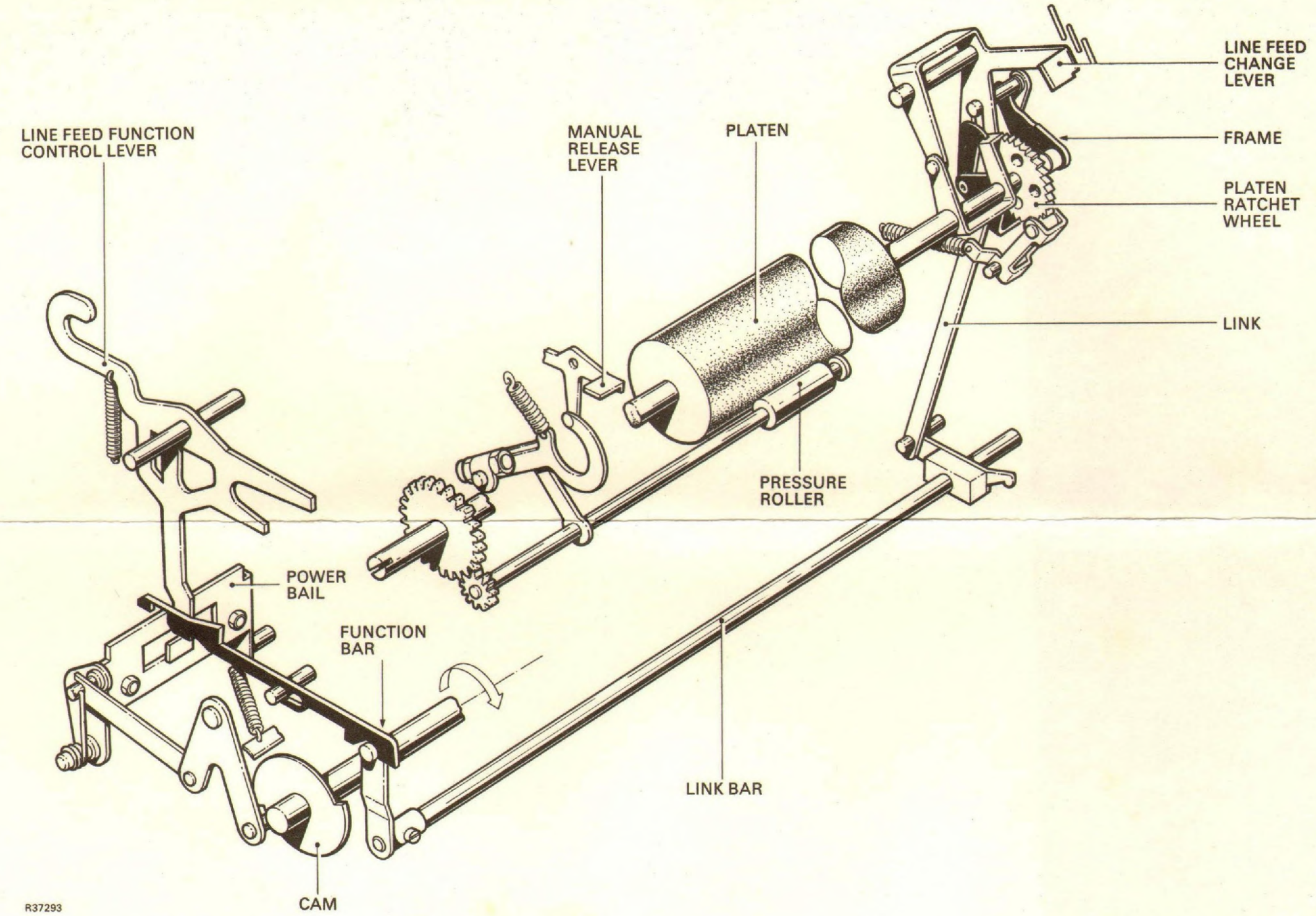

LINE FEED CHANGE LEVER
FRAME
PLATEN RATCHET WHEEL
LINK
LINE FEED FUNCTION CONTROL LEVER
MANUAL RELEASE LEVER
PLATEN
PRESSURE ROLLER
POWER BAIL
FUNCTION BAR
LINK BAR
CAM
R37293

Fig. 22

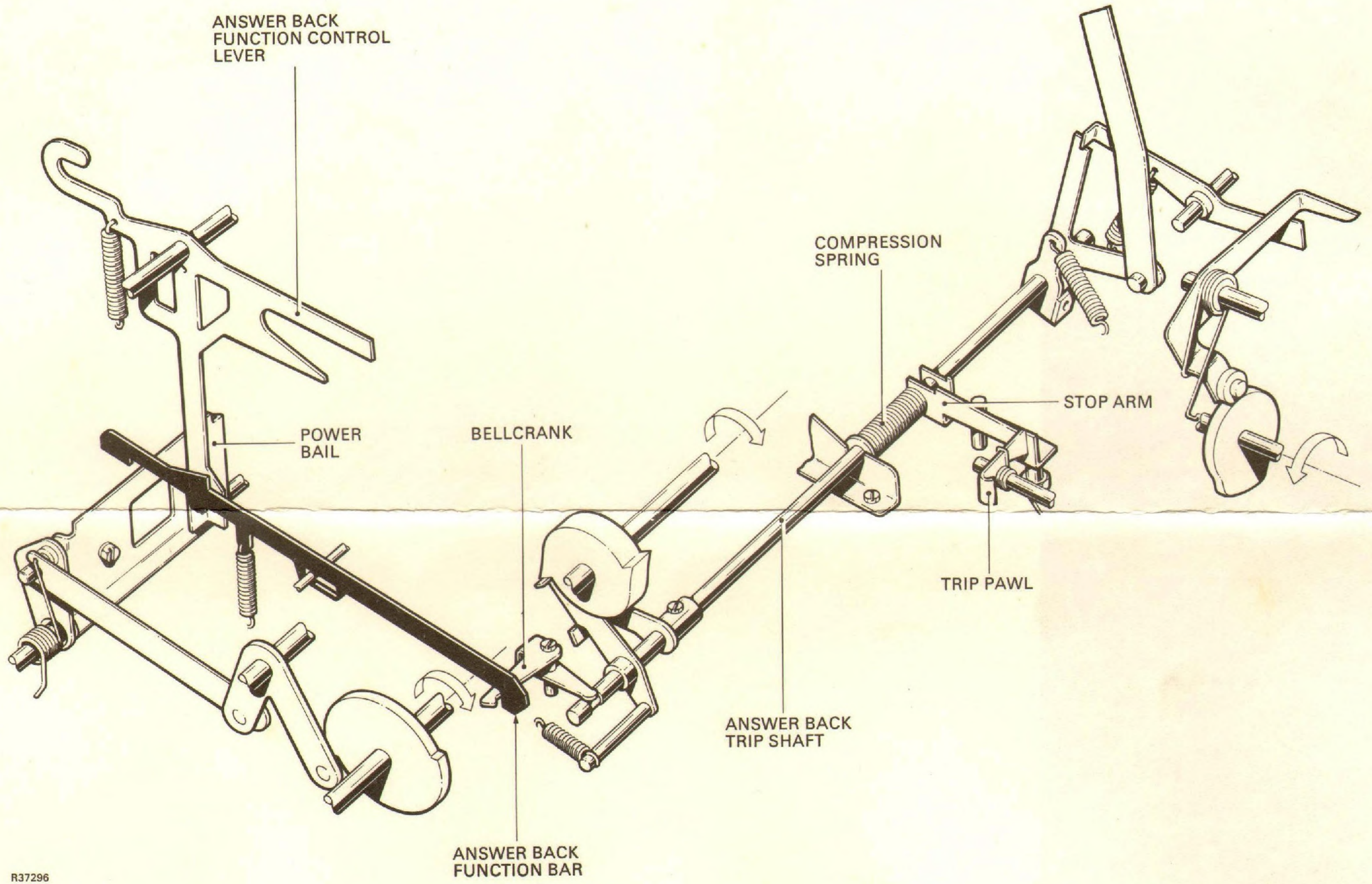

ANSWER BACK
FUNCTION CONTROL
LEVER
POWER
BAIL
BELLCRANK
COMPRESSION
SPRING
STOP ARM
TRIP PAWL
ANSWER BACK
TRIP SHAFT
ANSWER BACK
FUNCTION BAR
R37296

Fig. 25

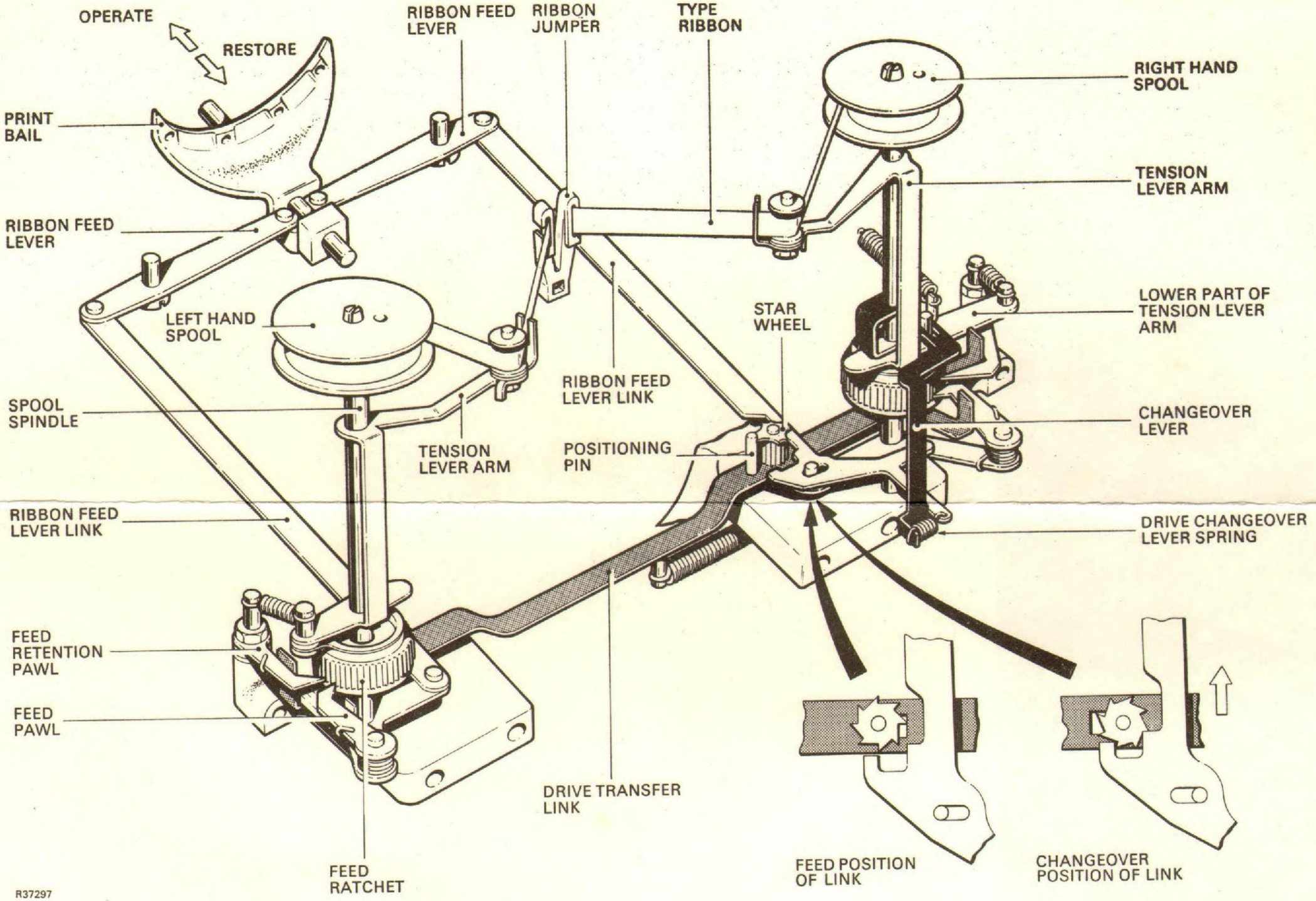
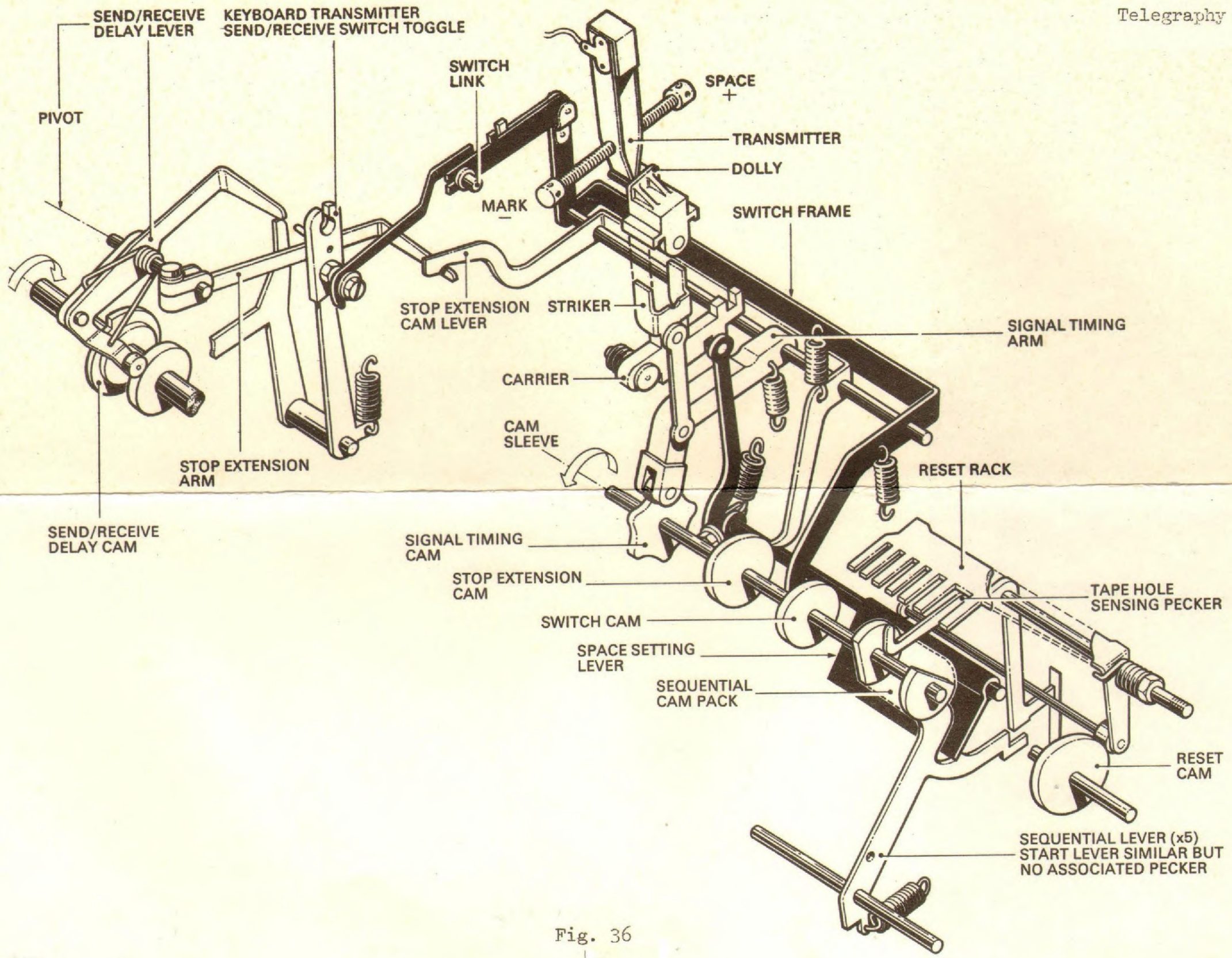

OPERATE
RESTORE
PRINT BAIL
RIBBON FEED LEVER
RIBBON FEED LEVER
RIBBON JUMPER
TYPE RIBBON
RIGHT HAND SPOOL
TENSION LEVER ARM
LOWER PART OF TENSION LEVER ARM
LEFT HAND SPOOL
STAR WHEEL
SPOOL SPINDLE
RIBBON FEED LEVER LINK
CHANGEOVER LEVER
TENSION LEVER ARM
POSITIONING PIN
RIBBON FEED LEVER LINK
DRIVE CHANGEOVER LEVER SPRING
FEED RETENTION PAWL
FEED PAWL
DRIVE TRANSFER LINK
FEED RATCHET
FEED POSITION OF LINK
CHANGEOVER POSITION OF LINK
R37297

Fig. 26



R37307

Fig. 36