TELETYPE CORPORATION
SCHOOL OF MAINTENANCE TRAINING
201 NORTH WELLS STREET
Chicago 6, Illinois

M-28 ASR TAPE LINE EQUIPMENT

TRAINING COURSE

STUDENT'S GUIDE

FOR INSTRUCTION PURPOSES ONLY

SCHOOL INFORMATION

The Customer Service School provides, tuition-free, training for the maintenance personnel of Teletype's customers. As the School of Training is maintained for the customer, it is under the supervision of the Sales department.

Because there is no charge for the training provided, the Teletype Corporation will not assume the responsibility for making student's hotel reservations. For military personnel the School will, upon request, issue a form indicating time of arrival and departure. No certificate of non-availability of aircraft, rations or quarters will be issued.

Classes begin at eight o'clock and are in session until four forty-five in the afternoon. Breaks are scheduled for both morning and afternoon and a one hour lunch period is provided. Students may bring their lunch or eat at any of the numerous restaurants in the area. There are no classes on Saturdays.

Students are requested to observe the hours of the class and to be on time following each break. No extra training will be given students who come in late. Students who are repeatedly late will be asked to leave.

All text materials such as bulletins, charts and rulers may be retained by the student. Students are required to have a pen and/or pencil.

Although the classes are scheduled to run through four forty-five of the final Friday, some students complete the course earlier than others. Those who finish early may leave but no student may leave without completing the course unless he has special permission. Teletype personnel may not leave the School at any time unless they have the permission of their supervisor, lunch and break periods excepted.

The school's telephone may be used ONLY by instructors and Teletype personnel on company business.

The address and telephone number of the school is:

ADDRESS   201 N. Wells Street

PHONE   Financial 6-0586

Your instructors will be:

MODEL 28 AUTOMATIC SENDING AND
RECEIVING SET COURSE OF INSTRUCTION

Description of the Course

The purpose of this course is to train personnel in
the maintenance of the Model 28 Automatic Sending and Receiving
Set.

The course is scheduled for a 3 week period and will
cover theory, disassembly, adjustments of principle components,
also testing and operation of complete set.

The student is urged to take notes for future reference
and to ask questions so that he may derive the maximum benefit
from the course.

Literature

Literature in the form of Teletype bulletins, specifications and wiring diagrams will be furnished each student.

List of Literature

	Bulletins		Teletype Code
235B	Adj.	Single Contact Transmitter Distributor	LXD
1161B	Parts	Single Contact Transmitter Distributor	LXD
242B	Theory	Two Shaft Transmitter Distributor	LBXD
243B	Adj.	Two Shaft Transmitter Distributor	LBXD
1165B	Parts	Two Shaft Transmitter Distributor	LBXD
246B	Theory	Typing Reperforator	LPR
247B	Adj.	Typing Reperforator	LPR
1167B	Parts	Typing Reperforator	LPR
248B	Adj.	Tape Handling Stand (RT Set)	RT
1168B	Parts	Tape Handling Stand (RT Set)	RT
249B	Theory	Perforator Transmitter	LAK
250B	Adj.	Perforator Transmitter	LAK
1169B	Parts	Perforator Transmitter	LAK
251B	Theory	Pivoted Head Transmitter Distributor	LAXD
252B	Adj.	Pivoted Head Transmitter Distributor	LAXD
1170B	Parts	Pivoted Head Transmitter Distributor	LAXD
253B	Theory	Fixed & Pivoted Head Trans. Dist.	LCXD
254B	Adj.	Fixed & Pivoted Head Trans. Dist.	LCXD
1171B	Parts	Fixed & Pivoted Head Trans. Dist.	LCXD
255B	Theory	Non-Typing Reperforator	LRPE
256B	Adj.	Non-Typing Reperforator	LRPE
1172B	Parts	Non-Typing Reperforator	LRPE

1124B Tool Bulletin

In addition to the above, Western Union trainees receive:

244B	Theory	Multimagnet Reperforator	LARP
245B	Adj.	Multimagnet Reperforator	LARP
1166B	Parts	Multimagnet Reperforator	LARP

A. T. & T. Co. and all Telephone Co. trainees will also receive:

234B	Theory, Adj. & Lub.	Multiple Wire Distributor	LD
1159B	Parts	Multiple Wire Distributor	LD

In ordinary telegraph transmission, intelligence is relayed from one point to another by the making and breaking of the signal line. An operator at one end would open or close a telegraph key and cause a sounder at the receiving end to emit pulses of sound which could then be translated into characters by the other operator, trained to recognize the various code combinations. During the latter part of the nineteenth century, telegraphy took a step forward by substituting a mechanical sending mechanism for the old telegraph key, and a printer for the receiving station.

The new method of printing telegraphy, however, required modification of the old signaling method. The primary change has been in time control of the transmitted pulses. Specified time intervals or pulse lengths have replaced the, somewhat arbitrary, dot-dash system.

As devised by Jean Baudot, a French Signal Officer, the newer code requires that each character have a certain number of current and no-current time intervals (MARK or SPACE pulses) to indicate a particular code combination. It was decided that the intelligence portion of each complete character should have five of these time intervals. It may be seen that with two possibilities (MARK or SPACE) for five pulses:

$$2^5 = 32 \text{ possible code combinations}$$

Therefore, with the addition of an upper case, (figures) the Teletype Printer is capable of performing twice as many operations (printing or performing a function) as the number of available code combinations.
In the lower case, or letters, we have the 26 letters of the alphabet plus 6, so-called, "functions". These functions are mechanical operations of the printer as opposed to the actual printing of a character.
They include:

Letters (LTRS) = Either shifting the typebox to the letters segment or, as in the M15, shifting the platen down.

Figures (FIGS) = Just the opposite of letters

Space   = Moving the printing mechanism to leave a blank between words.

Carriage Return (C.R.) = Returning the printing mechanism to the left margin.

Line Feed (L.F.) = Feeding the paper out of the printer.

Blank   = All pulses spacing -- used for various operations

The length or time duration of the individual pulses is determined by the operating period of the various cams and levers that cause the signal line contacts to open and close. It may be seen, then, that as the operating speed increases, the pulse length decreases.

At this time three basic speeds are in popular usage. They are: 368rpm; 460rpm; and 600rpm. An expression, of these speeds, in "words-per-minute" has been roughly approximated by dividing each figure by 6. (This assumes that a "word" is composed of five characters and a space). Thus, 368 becomes 60 words-per-minute, 460 becomes 75 words-per-minute and 600 becomes 100 words-per-minute. For maintenance or other technical purposes, however, it is far more accurate to deal only with actual shaft speeds.

If, for every revolution of the transmitting shaft, a complete character is transmitted, we may refer to 368 characters or 368 operations-per-minute (opm). This breaks down:

(a)

$$\frac{368}{60} = \text{operations-per-second} = 6.13$$

(b)

$$\frac{1 \text{ second}}{6.13} = \text{length of one operation} = .163$$

(c) At 368opm, then, one operation take .163 seconds or: 163 milliseconds (ms.)

To maintain synchronism between the sender and the receiver, it is necessary to establish a starting point and a stoping point. Consequently, to our character combination of five pulses there has been added a START pulse and a STOP pulse. These pulses are not considered information pulses. In the systems used by most companies, the START pulse is the same length as an information pulse while the STOP pulse is somewhat longer. The STOP pulse is longer to insure that the receiving machine has time to complete detection of the last information pulse before the transmitter begins a new character. The STOP pulse, in most cases, is 1.42 (or 142%) times as long as the START or information pulse. If we designate the START (or standard pulse length) as 1 unit, we have:

(d)

```
START              =  1 Unit
Information pulse=  5 Units
STOP               =  1.42 Units
```

7.42

(e) 7.42 is known as the UNIT CODE

Western Union, as an alternate example, has a STOP pulse the same length as the START or information pulse. With all seven pulses the same duration, Western Union would be operating with a 7.00 Unit Code.

To determine the time duration of any pulse:

(f)

$$\frac{.163 \text{ sec (time for one complete operation)}}{7.42 \text{ (units)}} = 21.96 \text{ or } 22\text{ms.}= 1 \text{ Unit}$$

(g)

21.96 X 1.42 = 31.18ms or 31ms.

(h) The START or information pulse (1 Unit) = 22ms.
(i) The STOP pulse (1.42 Units) = 31ms.

The normal, or "rest" condition of the signal line is closed, that is, with current on the line. If the normal condition is closed, the beginning or START pulse must alter that condition. Obviously, then, the START pulse must be no-current or SPACING. The end of the transmission must return the signal line to its normal condition so the STOP pulse must be current or MARKING. As seen on an oscilloscope and assuming no distortion, the character 'Y' would look like this:
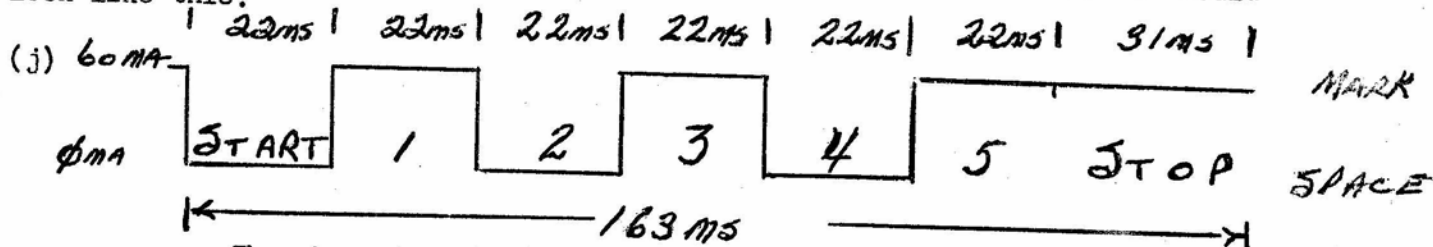
The character 'Y' is most often used for illustration and test purposes because every other pulse is different. As indicated on the rulers, however, the information pulses (between the START and STOP pulses) may vary according to the character selected. It has been noted that the STOP pulse is 1.42 times as long as the START or information pulse. This, of course, assumes continuous operation. Otherwise the STOP pulse might be 31ms, 31 minutes or ten days -- depending upon when the next character was transmitted.

POLAR OPERATION: Up until now, only NEUTRAL operation has been considered. In Neutral operation, a SPACE is when there is no-current on the line and a MARK is when there is current on the line (60ma or 70ma). In Polar op-eration, there is current on the line at all times and it is the difference between the current polarity that determines whether a MARK (+) or a SPACE (-) is being transmitted. Oviously the printer could not be hooked, directly, to a polar signal because current, no matter what polarity, would energize the selector magnets.

BAUD (from Baudot): An expression which combines shaft speed (operations-per-second) and unit code into one usable term or figure. It also indicates the maximum number of pulses-per-second. It is derived by multiplying the operations-per-second by the unit code:

(k)

$$\frac{368 \text{ opm}}{60} = 6.13 \text{ ops/sec} \times 7.42 \text{ (Unit Code)} = \underline{45.5} = \text{Baud}$$

In the case of Western Union, both the operations-per-second and shaft speed differ:

(1) $\frac{390 \text{ opm}}{60} = 6.5 \text{ ops/sec} \times 7.00 \text{ (Unit Code)} = \underline{45.5} = \text{Baud}$

It may be seen, in the above illustrations, that although both shaft speed and unit code differ, and Western Union machine may operate with any Teletype product because their BAUD is the same.

DOT CYCLE FREQUENCY: Each MARK-to-SPACE transition comprises a rectangular wave. Any rectangular wave is made-up of a fundamental sine wave plus a number of sub harmonic frequencies. This fundamental, or Dot Cycle Frequency of any character may be determined by dividing the length of one MARK-to-SPACE transition into one. Inasmuch as the character 'Y' changes from MARK to SPACE every other pulse, one MARK-to-SPACE transition would be equal to the length of two pulses or .044sec.

(m) $\dfrac{1}{.044}$ = approx. 23cps = Dot Cycle Frequency of character 'Y'

The character 'M' (3,4 & 5 MARK) does not have as many transitions as 'Y'. For 'M', the START, first and second pulse would be one part, while the third, fourth and fifth pulses would be the other part of its rectangular wave form.

(m) START + First + Second = 66ms.
Third + Fourth + Fifth = 66ms.

132ms.

$\dfrac{1}{.132}$ = approx. 8cps = Dot Cycle Frequency of character 'M'

The Dot Cycle Frequency is important in determining the necessary bandpass for Teletype transmission. If the highest frequency can get through, all others may. Consequently, the character 'Y', with the maximum number of transitions, provides this maximum or reference frequency. It has been found that the fundamental frequency plus the next ten or eleven harmonics provides a good signal. The BELL system, however uses only the third or fourth (around 89cycles) for their bandpass.

For purposes of illustration Teletype pulses are shown as perfect rectangular waveshapes with sharp transitions and precise timing. This optimum condition is seldom, if ever, found in actual practice.

The modification of the original, rectangular waveshape is called Distortion. The Total Distortion to any signal is broken-down into three catagories for purposes of classification but it is important to note that any signal may contain all three components of distortion. The three components of distortion are:

        Bias Distortion
        Characteristic Distortion

        Fortuitous Distortion

Bias and Characteristic Distortion are combined in the term Systematic Distortion because both occur in response to natural law and, consequently, either is roughly predictable. With the third element, Fortuitous Distortion, every possible modification is accounted for -- and labeled Total Distortion.

Bias Distortion

Bias Distortion effects all pulses uniformly and its effect upon a MARK is opposite to its effect upon a SPACE. Bias may effect either the beginning or the end of an impulse but inasmuch as the selector always begins with the MARK-to-SPACE transition of the Start pulse, the total effect of bias is to advance or retard the leading edge of any impulse with respect to the Start pulse.

Before illustrating Bias, it will be necessary to indicate the effect, upon a signal pulse, by the resistive, inductive and capacitive elements in the signal line.


1. Perfect MARK impulse
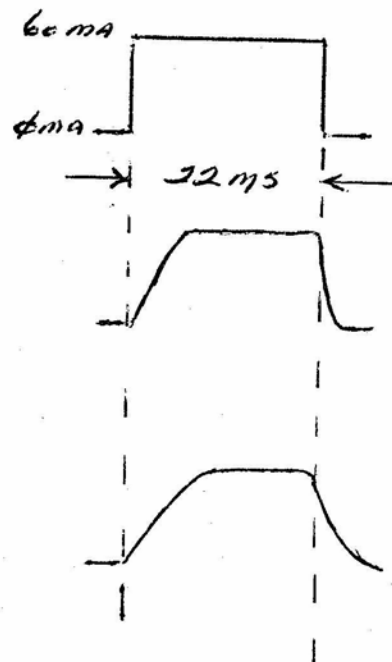
2. Line INDUCTANCE opposes sudden transitions of current. Inductance from Line Relays and/or selector magnet coils.

3. Line CAPACITANCE shunts the signal line preventing rapid current build-up and, thus, further sloping the edges of the wave.

  9.

The impulse in figure 3 is more likely to be found at the receiving printer than the one (figure 1) impressed at the transmitter. The impulse seen in figure 3, as applied to the selector magnets of the printer, will be used to illustrate Bias Distortion. It will be noted that this waveshape builds up to its 60ma level gradually -- due to the reactive elements of the signal line.

Instead of picking-up at the leading edge of the pulse (T1), the selector magnet will energize at a somewhat later time -- say, for example, at T2 -- or whenever the current has reached a level where it generates sufficient magnetic attraction. This point, T2, would be the beginning of the MARK impulse as far as the selector was concerned.
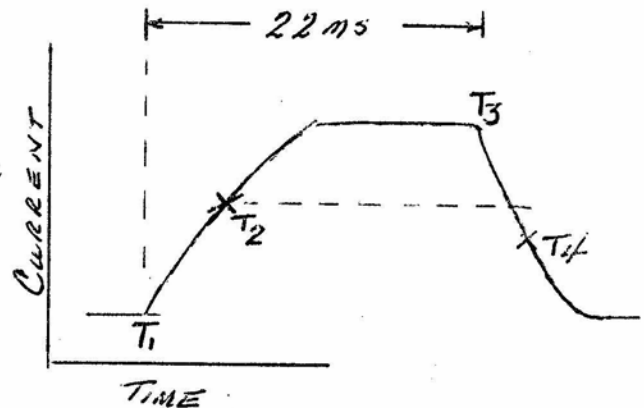
When, at the end of the transmitted pulse, the current again starts towards 0ma., the selector armature should, theoretically, fall away at T3. The trailing edge of the impulse, however, also slopes and, consequently, a definite time will have elapsed before the armature will drop away (T4). Notice that T2 and T4 are not identical current values. The de-energization point will be a lower value due to residual magnetism in the coils and, conceivably, to weak spring tension.

The time between when the armature should attract (T1) and when it does attract (T2) is known as SPACE-to-MARK TRANSITION DELAY. (abbreviated S-MTD)
The time between when the armature should drop away (T3) and when it does drop away (T4) is known as MARK-to-SPACE TRANSITION DELAY (M-STD).
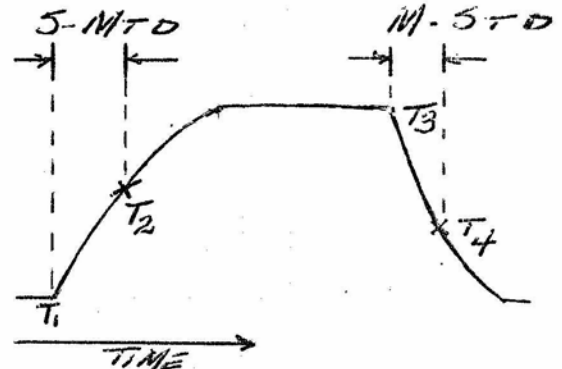
If the S-MTD is equal to the M-STD, the pulse as seen by the selector would be undistorted

If the S-MTD is greater than the M-STD the pulse has been shortened and the condition is known as SPACING BIAS

If the M-STD is greater than the S-MTD the pulse has been lengthened and the condition is known as MARKING BIAS

The BELL System uses the following formula to determine the actual Bias condition in milliseconds (ms.). The sign of the result indicates whether the Bias is MARKING (+) or SPACING (-).

$$M\text{-STD} - S\text{-MTD} = ms. \text{ Bias}$$

This example of Bias Distortion illustrates that although the M-STD may not equal the S-MTD, the two will be consistent for any given circuit and/or adjustment. It will be noted, also, that the effect of Bias will:

a) Be the opposite to a SPACE from its effect upon a MARK.
b) Be consistent for any character combination.

Characteristic Distortion

Characteristic Distortion, as the name implies, is determined by the signal line characteristics. That is, the resistance, capacitance and inductance. This type of distortion will effect different characters in different ways but it will always be consistent for the same character. In neutral operation, Characteristic Distortion will effect Bias.

Characteristic Distortion has varying effects upon different characters because the circuit's reactance will have less chance to become stabilized when characters with many current transitions are applied ('Y', for example) than when characters with few transitions are applied ('M', for example). It may be said that the effect of Characteristic Distortion is inversely proportional to the Dot Cycle Frequency of the character transmitted.

The contrasts between Characteristic Distortion and Bias may be summarized as follows:

1. The effect of Characteristic Distortion depends upon the length of the impulse transmitted. The effect of Bias is independent of the length of the impulses.

2. For a given length of impulse, the effect of Characteristic Distortion is independent of whether it is a marking or spacing impulse. The effect of Bias is always opposite on a mark to what it is on a space.

3. Characteristic Distortion is related to the amount and arrangement of the capacitance, inductance and resistance of a circuit. Except in neutral operation, these factors do not effect Bias.

4. Bias is caused by unequal marking and spacing line current, biased relays etc., conditions which do not effect Characteristic Distortion.

5. Characteristic Distortion, because it is due to the capacitance, inductance and resistance of a circuit, which, except for the resistance, are unchanging in value, varies only a small amount from day to day. Bias, because it is caused by uneven potentials, relays losing adjustment etc., may vary from hour to hour.

Fortuitous Distortion

This form of distortion covers such unpredictable occurances as sudden battery fluctuations or loose ground connections. This distortion may effect any portion of any character and little or no compensation may be made for it.
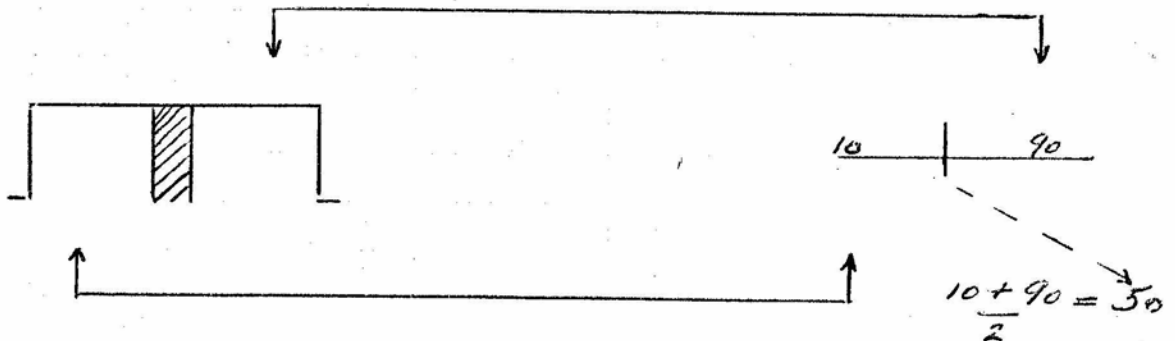
RANGE

All Teletype receivers (i.e. printers, perforators etc.) are equipped with a range scale. In every case, the function of the range scale is to orient the mechanical selector to the electrical signal to obtain maximum selecting margins.

The selecting interval of the impulse (i.e. when the actual selection is made) is only 20% of the pulse width or 4.4ms. Consequently a perfect selector should be able to tolerate 40% distortion of both leading and trailing portions of an impulse.

In a perfect impulse of 22ms duration, the necessary 20% selecting interval would be in the center with a range reading of 10 to 110:

SELECT INTERVAL

RANGE SCALE   10   SET RANGE   110

$$\frac{10+110}{2} = 60$$
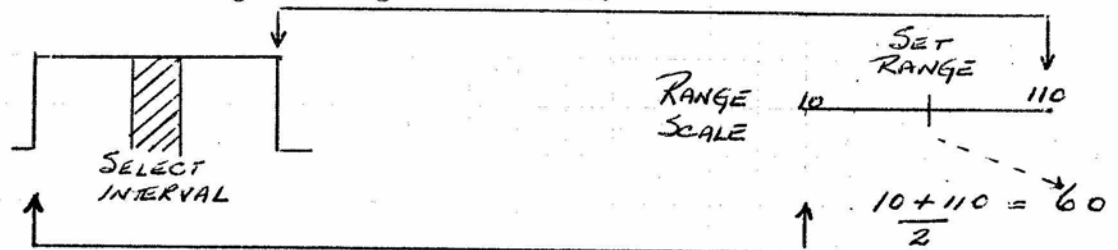
If 20% MARKING END DISTORTION (an artificially produced characteristic distortion used to test acceptance -- in this case it would extend the leading edge of the pulse) were introduced, the range would shift in order to maintain the selecting interval in the middle of the pulse:

10   90

$$\frac{10+90}{2} = 50$$

If 20% SPACING END DISTORTION were introduced the range would shift in an opposite direction:

$$\frac{30 + 110}{2} = 70$$

30 | 110
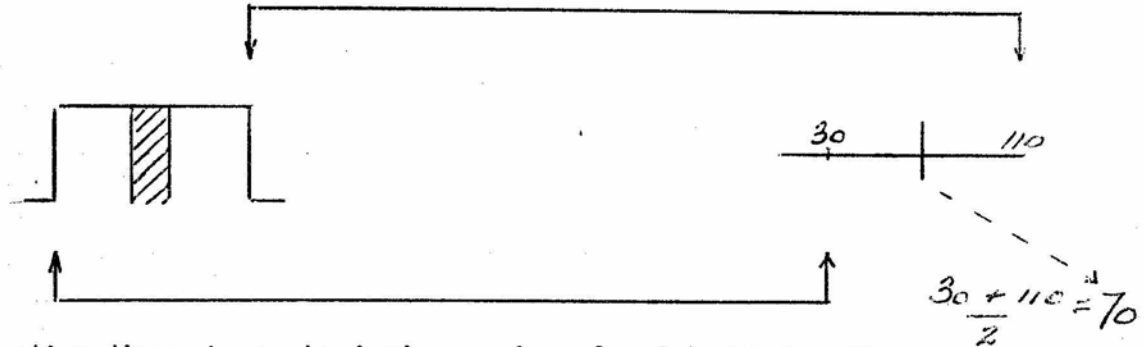
In any situation there is a standard procedure for determining the proper setting for the range scale:

a) Determine the high and low points on the range scale by observing errors in copy.
b) Add the high point to the low point and divide by two. (See examples in range illustrations)

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Most of the information on Signal Distortion and Range was taken from:

PRINCIPLES OF ELECTRICITY APPLIED TO TELEPHONE & TELEGRAPH WORK - A.T.&T Long Lines Div.
(1953)

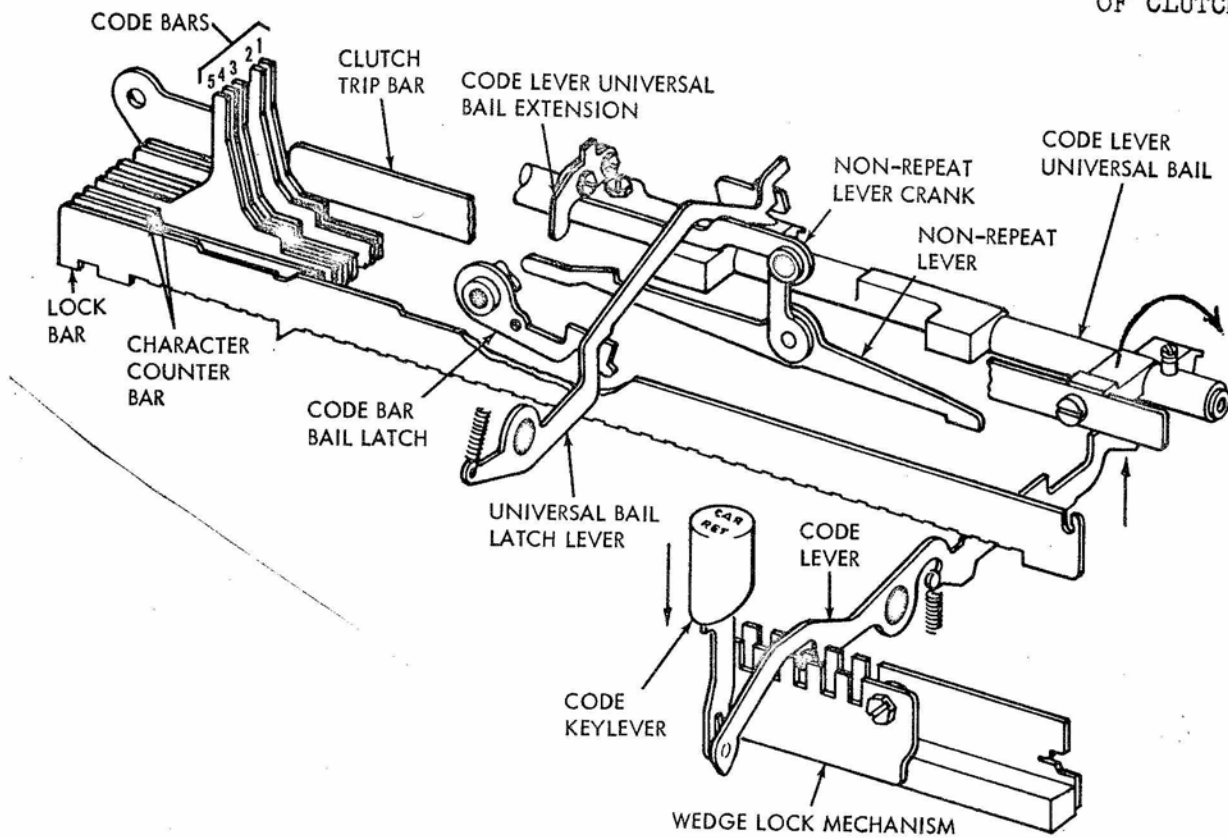MEASUREMENT OF SELECTING MARGINS - W.J. Zenner (1937)
FEDERAL AIRWAYS MANUAL OF OPERATIONS, Vol. IV Civil Areonautics Adminis. (1944)
TELETYPEWRITER TRAINING MATERIAL - A.T.&T. Co. (1947)

ASR SET OF TOOLS

1.   8 oz. scale
2.   32 oz. scale
3.   64 oz. scale
4.   set of gauges (#117781)
5.   (2) off set screwdrivers (90°) (30°)
6.   screwdriver (large)
7.   screwdriver (small)
8.   #8 crochet hook
9.   #12 crochet hook
10.   spring hook (push)
11.   spring hook (pull)
12.   screw holder with blades
13.   armature clip
14.   hand wheel
15.   wrench - 3/16" - 1/4"
16.   wrench - 5/16" - 3/8"
17.   wrench - 9/16" - 3/4"
18.   tommy wrench
19.   contact adjusting tool (#156170)
20.   tape lid gauge (#156743)
21.   top plate adjusting gauge (#159133)
22.   punch bail arm gauge w/pin (#159926)
23.   tape gauge w/pins (#156011)
24.   hexagon key wrench (#104457)
25.   "   "   "   (#159841)
26.   "   "   "   (#124682)
27.   key lever remover
28.   tweezers
29.   wrench #129534 - 3/16" - 1/4"

ASR KEYBOARD

CODE BARS
5 4 3 2 1
CLUTCH TRIP BAR
CODE LEVER UNIVERSAL BAIL EXTENSION
NON-REPEAT LEVER CRANK
CODE LEVER UNIVERSAL BAIL
NON-REPEAT LEVER
LOCK BAR
CHARACTER COUNTER BAR
CODE BAR BAIL LATCH
UNIVERSAL BAIL LATCH LEVER
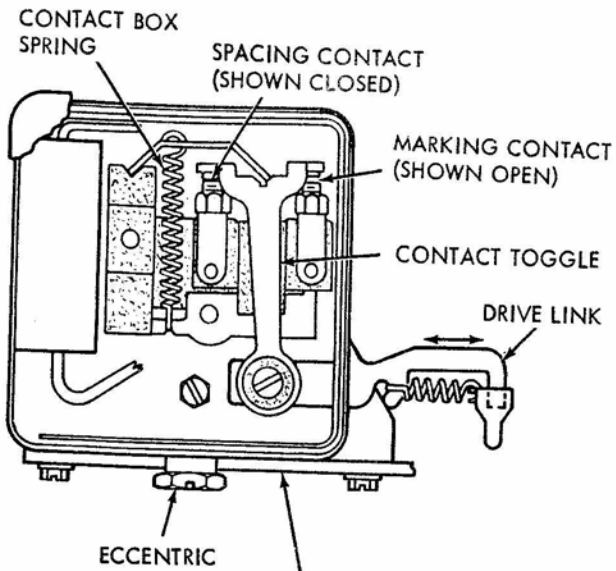CAR RET
CODE LEVER
CODE KEYLEVER
WEDGE LOCK MECHANISM

Depressing KEYLEVER operates

CODE LEVER rotates

UNIVERSAL BAIL rotates and allows

UNIVERSAL BAIL LATCH LEVER to move down

and release CODE BAR BAIL LATCH allows

CODE BAR BAIL to move to right

CLUTCH TRIP BAR and all selected

CODE BARS move to right

CLUTCH STOP LEVER trips

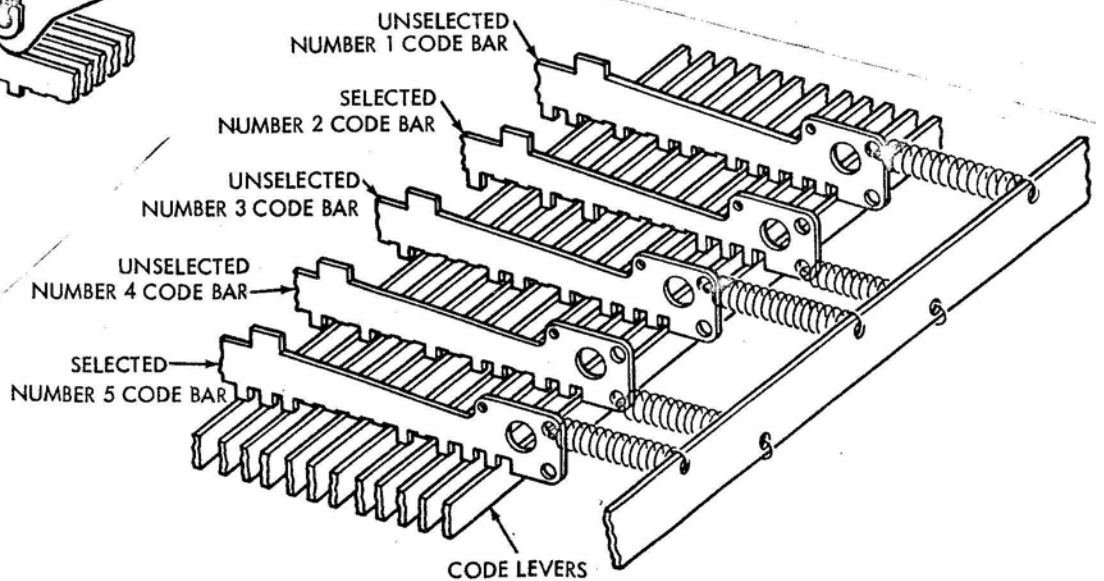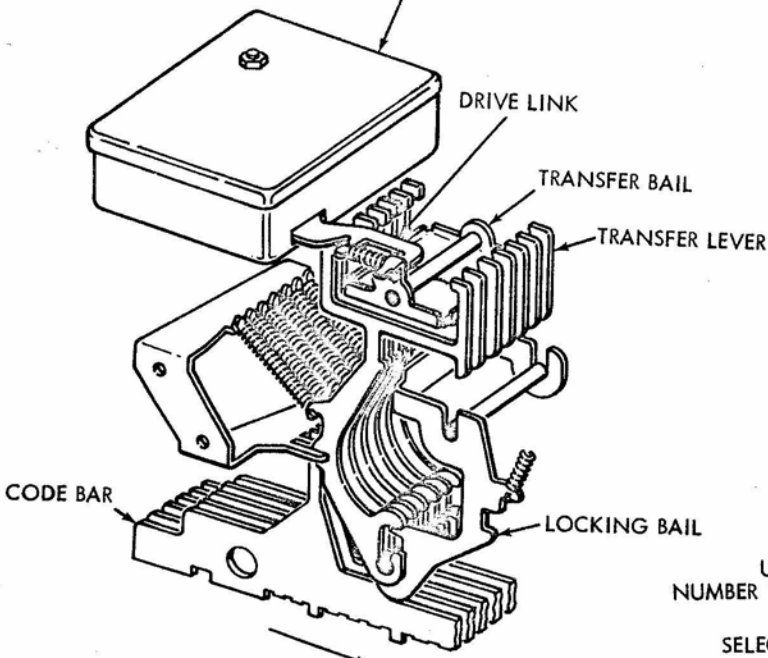CLUTCH and CAM SLEEVE rotates.

CODE BARS

(unselected code bars are
 blocked by the operated
 code lever)

FROM TRIPPING OF CLUTCH
TO OPERATION OF CONTACTS

CONTACT BOX SPRING

SPACING CONTACT (SHOWN CLOSED)

MARKING CONTACT (SHOWN OPEN)

CONTACT TOGGLE

DRIVE LINK

ECCENTRIC

CONTACT BOX

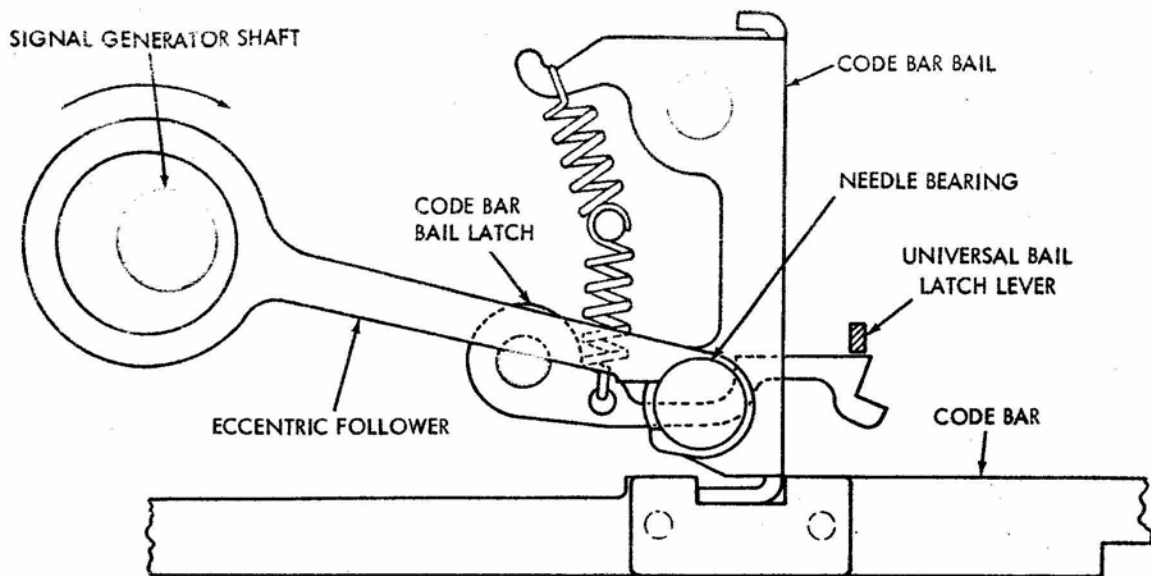DRIVE LINK

TRANSFER BAIL

TRANSFER LEVER

CODE BAR

LOCKING BAIL

selected CODE BARS move

code bar VERTICAL EXTENSION

engage TRANSFER LEVER

rotate TRANSFER BAIL

operates DRIVE LINK

operates CONTACT TOGGLE

actuates CONTACTS

UNSELECTED NUMBER 1 CODE BAR

SELECTED NUMBER 2 CODE BAR

UNSELECTED NUMBER 3 CODE BAR

UNSELECTED NUMBER 4 CODE BAR

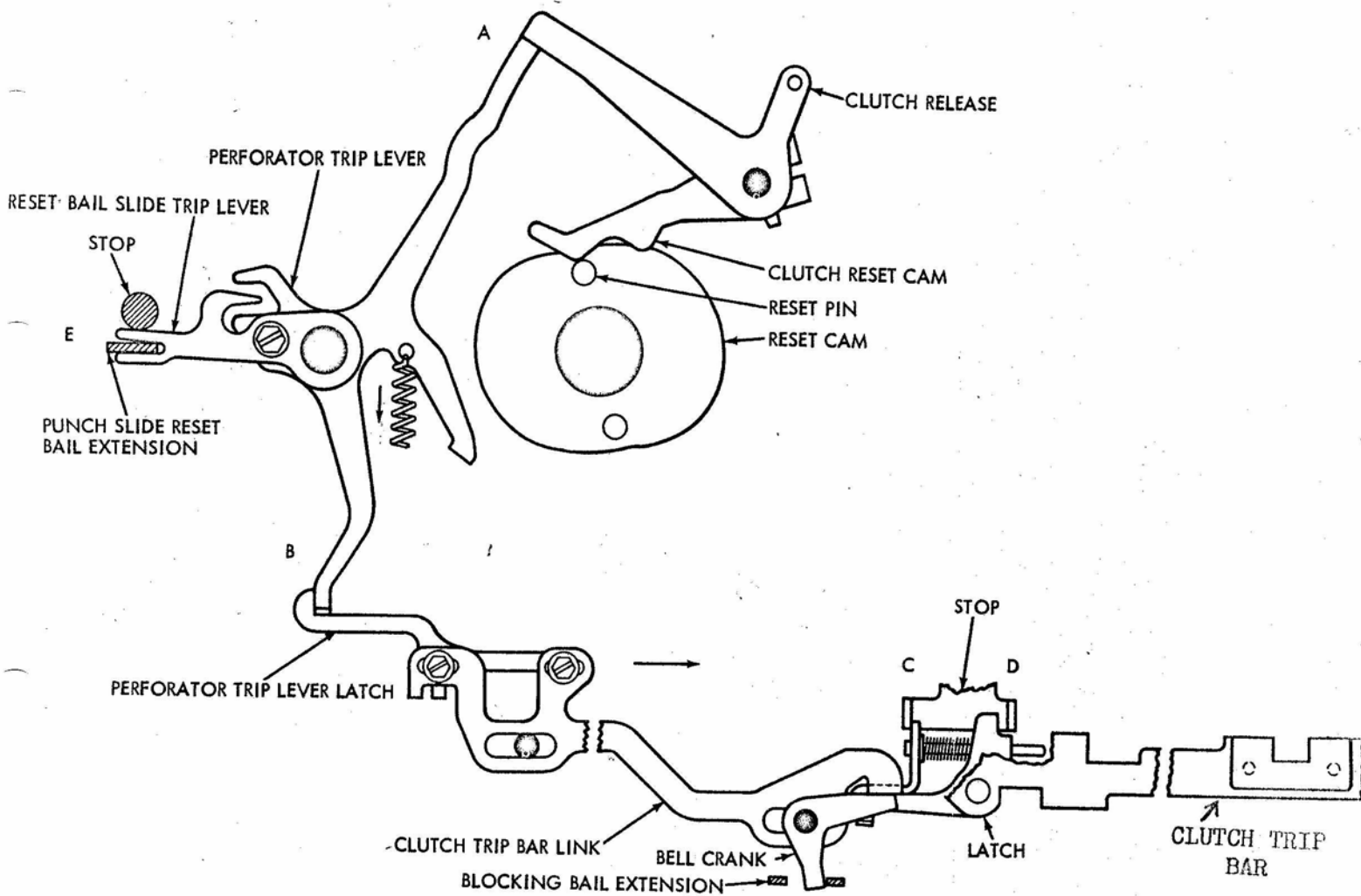SELECTED NUMBER 5 CODE BAR

CODE LEVERS

SIGNAL GENERATOR SHAFT rotates

ECCENTRIC FOLLOWER and

CODE BAR BAIL moves to left, allowing

CODE BAR BAIL LATCH to move up, latching

NEEDLE BEARING STUD.

    CODE BAR BAIL moving left engages

permutated   CODE BARS

        CLUTCH TRIP BAR

        NON-REPEAT LEVER

A

CLUTCH RELEASE

PERFORATOR TRIP LEVER

RESET BAIL SLIDE TRIP LEVER

STOP

E

CLUTCH RESET CAM

RESET PIN

RESET CAM

PUNCH SLIDE RESET
BAIL EXTENSION

B

STOP

C   D

PERFORATOR TRIP LEVER LATCH

CLUTCH TRIP BAR LINK

BELL CRANK

BLOCKING BAIL EXTENSION

LATCH

CLUTCH TRIP
BAR

IN K-T POSITION
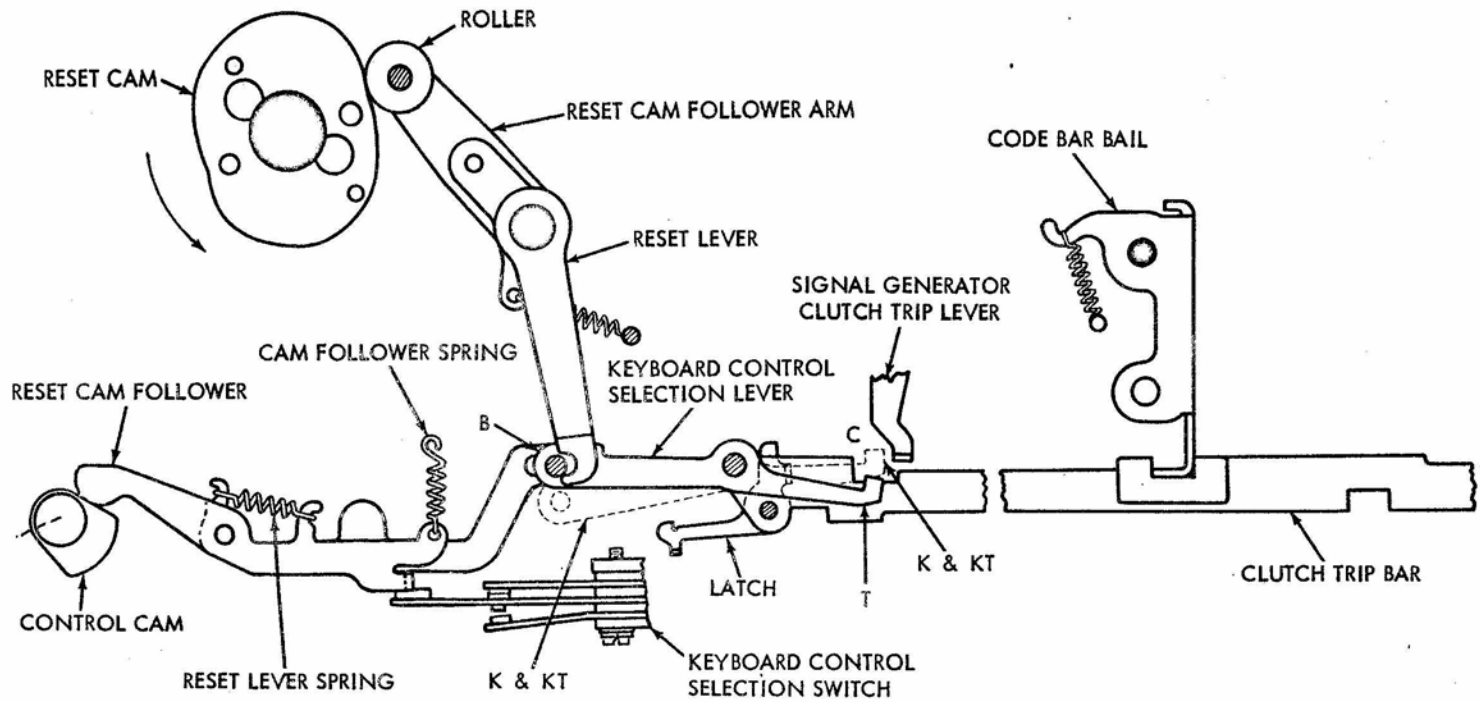   CLUTCH TRIP BAR moves to right
     LATCH engages
     CLUTCH TRIP BAR LINK
     PERFORATOR TRIP LEVER LATCH operates
     PERFORATOR TRIP LEVER releases
     CLUTCH RELEASE and
     FUNCTION CLUTCH TRIP LEVER (not shown)

CLUTCH IS DISENGAGED
WHEN CLUTCH RESET CAM
RIDES HIGH PART OF RESET
PIN.

GUIDE
PUNCH SLIDE LATCH
PUNCH SLIDE
PUNCH SLIDE BIAS SPRING
PUNCH SLIDE RESET BAIL
A   B   C
CONTROL CAM
CODE BAR EXTENSION
E
K K·T T
KEYBOARD CONTROL KNOB
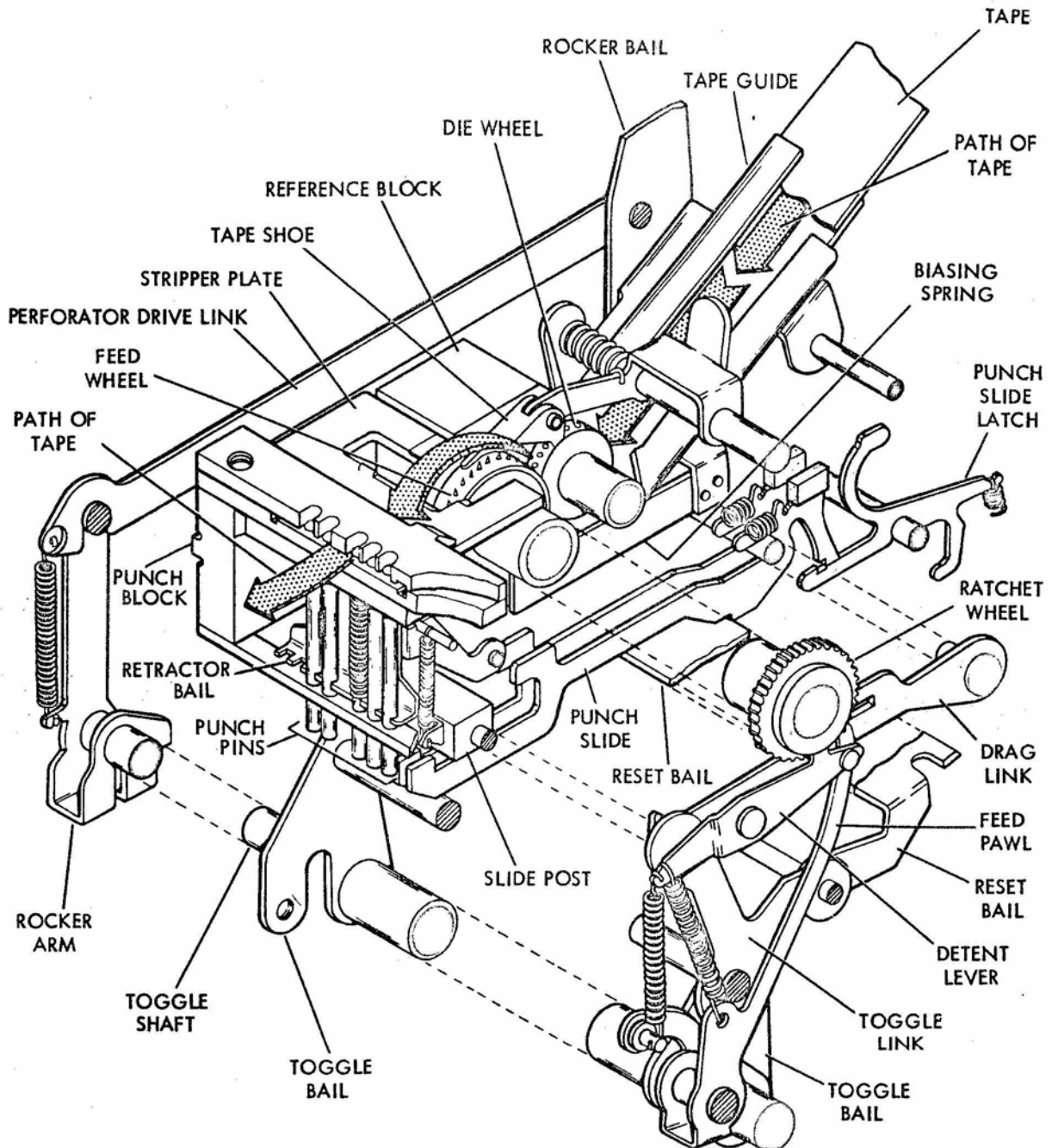BLOCKING BAIL   D   CODE BAR
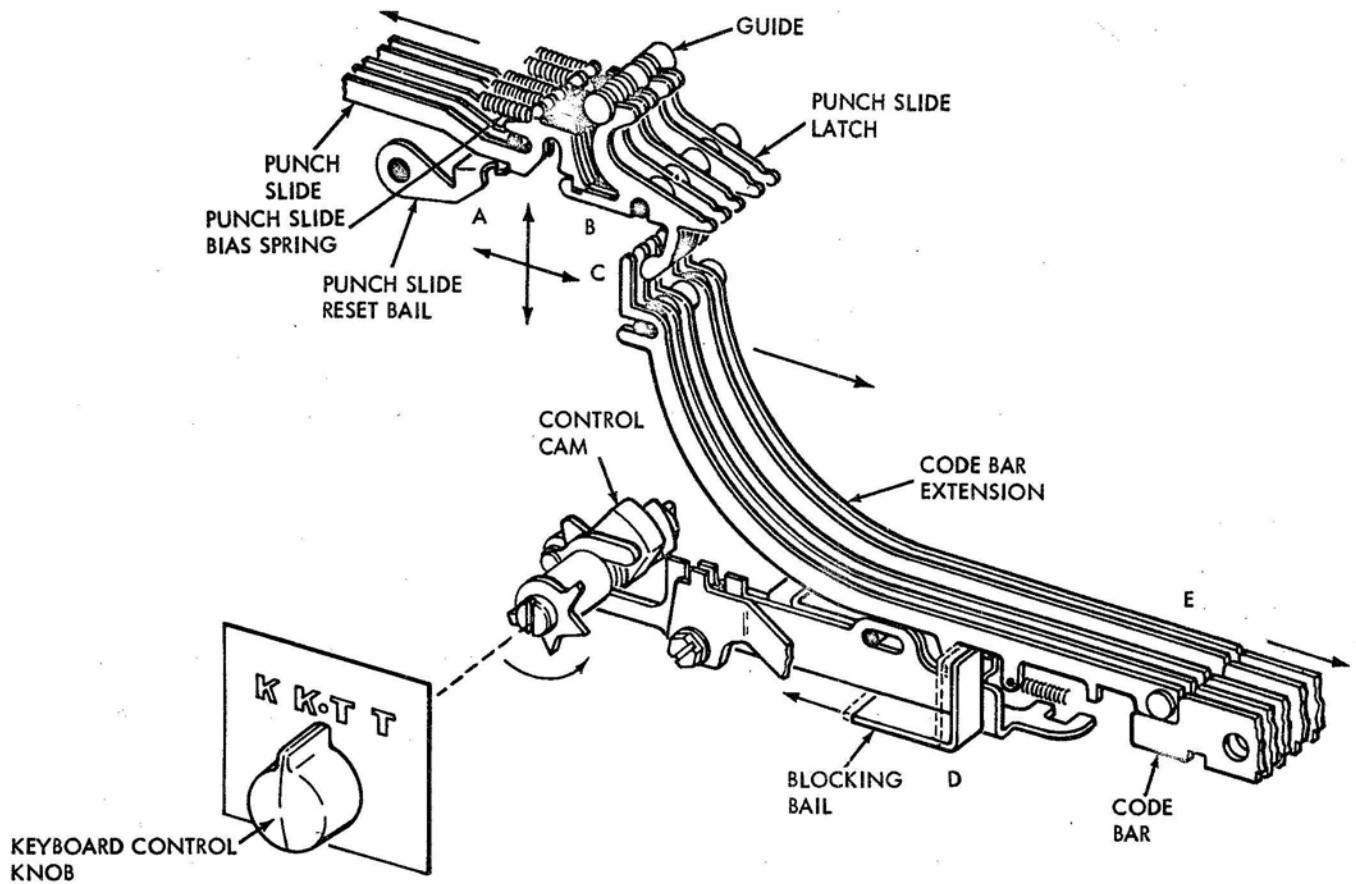
selected CODE BARS operate allowing
CODE BAR EXTENSIONS to move to right
rotating PUNCH SLIDE LATCH freeing selected
PUNCH SLIDES
(PUNCH SLIDE BIAS SPRING operates PUNCH SLIDES)

BLOCKING BAIL to right freeing CODE BAR EXTENSIONS
in K-T and T position, to left, blocking CODE BAR
EXTENSIONS in K position

Labels in diagram: RESET CAM, ROLLER, RESET CAM FOLLOWER ARM, RESET LEVER, SIGNAL GENERATOR CLUTCH TRIP LEVER, CODE BAR BAIL, CAM FOLLOWER SPRING, KEYBOARD CONTROL SELECTION LEVER, RESET CAM FOLLOWER, B, C, CONTROL CAM, RESET LEVER SPRING, K & KT, LATCH, KEYBOARD CONTROL SELECTION SWITCH, T, K & KT, CLUTCH TRIP BAR

RESET CAM revolves
RESET CAM FOLLOWER ARM operates
RESET LEVER actuates
KEYBOARD CONTROL SELECTION LEVER moves left operating
CLUTCH TRIP BAR resetting
CODE BAR BAIL
CODE BARS
NON-REPEAT LEVER

ROCKER BAIL

TAPE GUIDE

TAPE

DIE WHEEL

PATH OF TAPE

REFERENCE BLOCK

TAPE SHOE

BIASING SPRING

STRIPPER PLATE

PERFORATOR DRIVE LINK

PUNCH SLIDE LATCH

FEED WHEEL

PATH OF TAPE

PUNCH BLOCK

RATCHET WHEEL

RETRACTOR BAIL

PUNCH PINS

PUNCH SLIDE

DRAG LINK

RESET BAIL

FEED PAWL

ROCKER ARM

SLIDE POST

RESET BAIL

DETENT LEVER

TOGGLE SHAFT

TOGGLE LINK

TOGGLE BAIL

TOGGLE BAIL

ROCKER BAIL operates (after function clutch trips)
PERFORATOR DRIVE LINK actuates
ROCKER ARM rotates
TOGGLE SHAFT operates
TOGGLE BAIL counterclockwise
SLIDE POST moves up driving the selected
PUNCH SLIDES up striking
PUNCH PINS driving PINS through the tape

CAM SLEEVE

CLUTCH CAM DISK

CLUTCH SHOE LEVER

UPPER TRIP LEVER

CLUTCH LATCH LEVER

TRIP LEVER
RESET EXTENSION

CLUTCH TRIP
MAGNET

CLUTCH
TRIP LEVER
LOWER EXTENSION

ARMATURE BAIL
EXTENSION
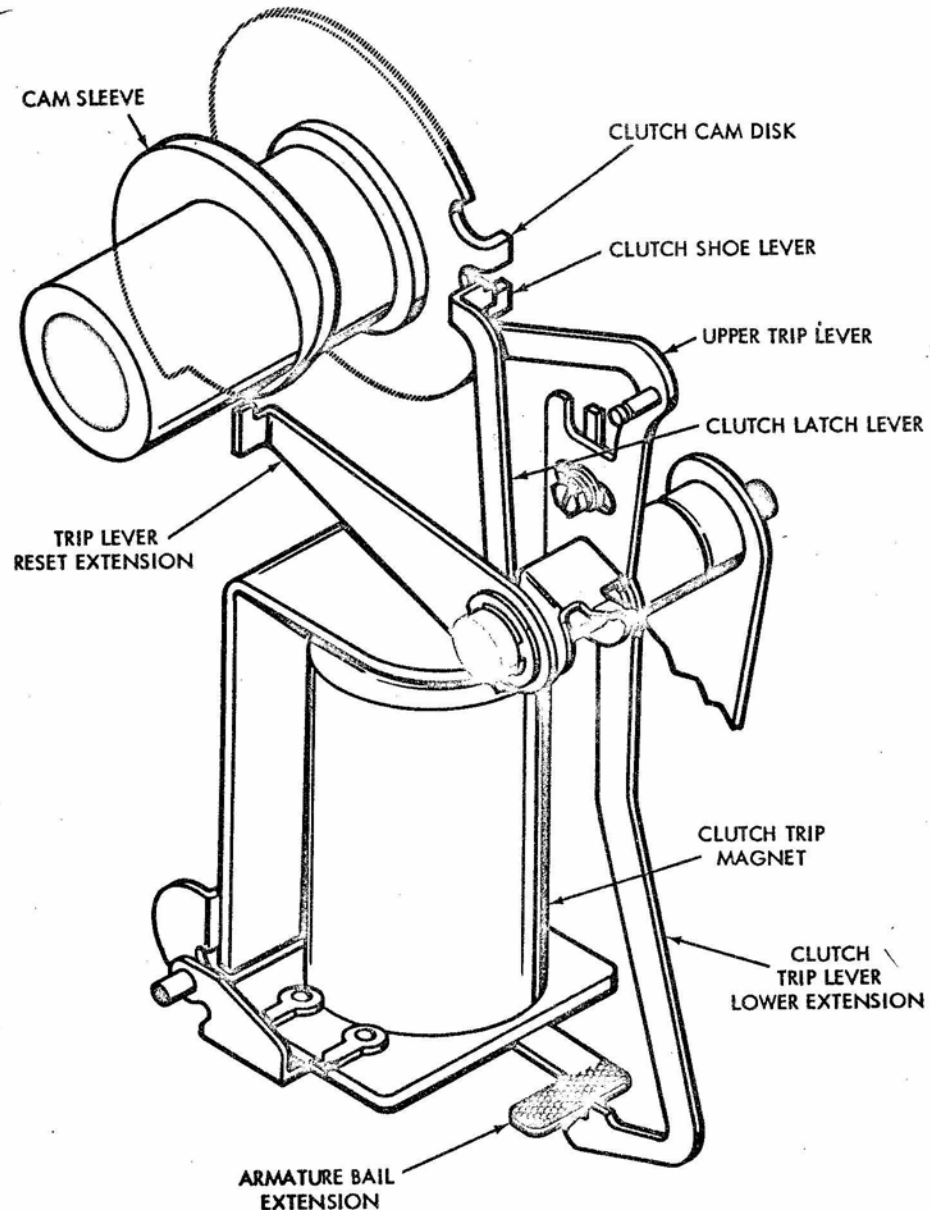
current applied to the CLUTCH MAGNET causes the
ARMATURE BAIL EXTENSION to rise and free
CLUTCH TRIP LEVER LOWER EXTENSION which rotates
UPPER TRIP LEVER moves away from
CLUTCH SHOE LEVER allowing the
CLUTCH to become engaged and the
CAM SLEEVE comences to rotate

resetting occurs as the
RESET CAM rotates
TRIP LEVER RESET EXTENSION which rotates shaft and presents
UPPER TRIP LEVER in path of
CLUTCH SHOE LEVER thus disengaging
CLUTCH

FEED WHEEL

FEED PAWL

FEED LEVER

DETENT LEVER

SENSING
CAM SLEEVE

FEED
PAWL
BAIL
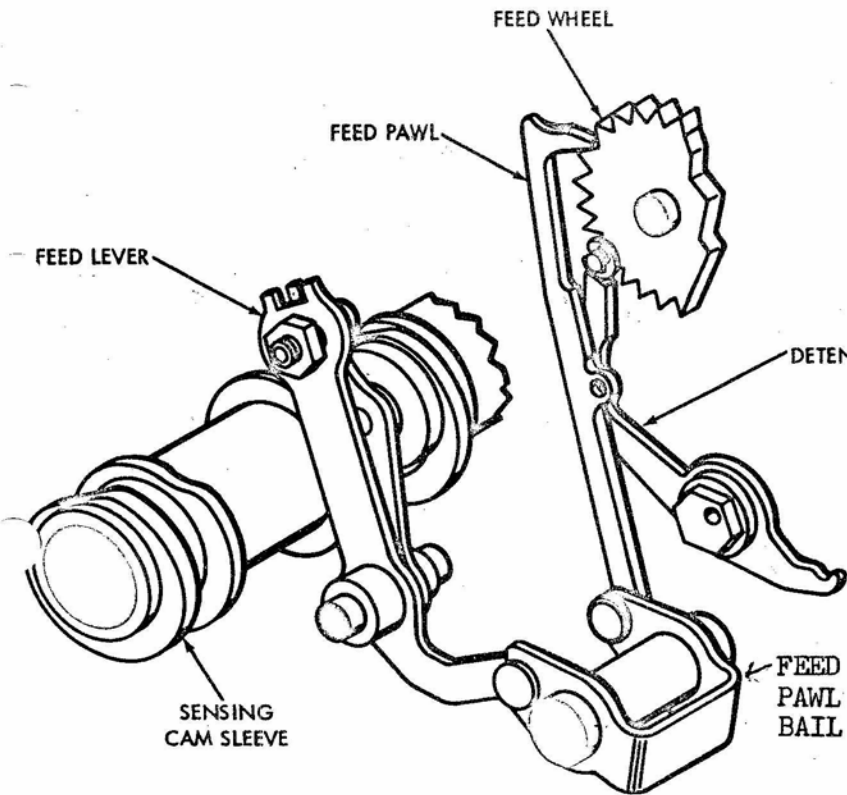
FIXED READER

SENSING CAM SLEEVE rotates
FEED LEVER operates
FEED PAWL BAIL moves
FEED PAWL down rotating
FEED WHEEL one space

* CAM FED SPRING RETURNED

FEED RATCHET

FEED WHEEL

CHECK PAWL

FEED LEVER

FEED PAWL

SENSING
CAM SLEEVE
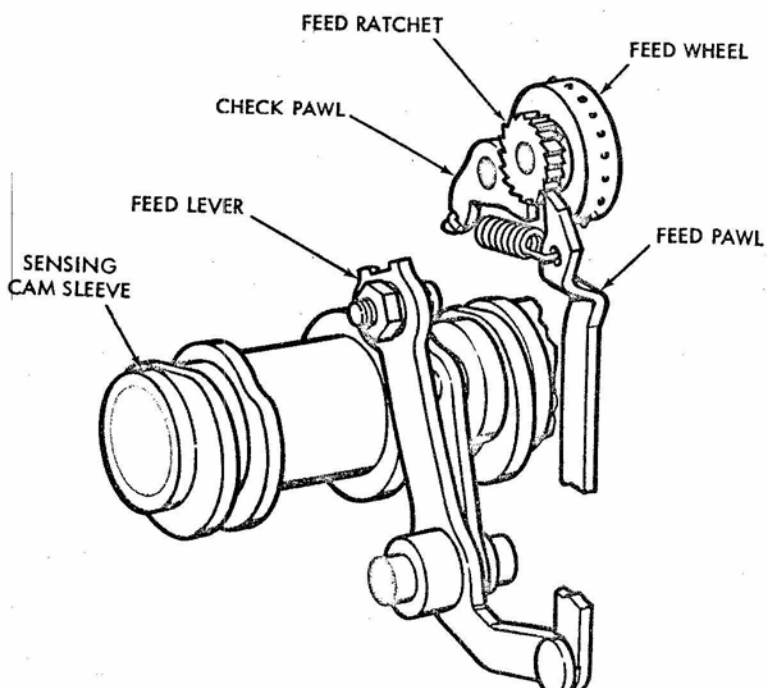
PIVOTED READER

SENSING CAM SLEEVE rotates allowing
FEED LEVER SPRING (not shown) to
operate
FEED LEVER moves
FEED PAWL up rotating
FEED WHEEL one space

* SPRING FED CAM RETURNED

LATCH BAIL
ROLLER

SENSING
BAIL

SENSING PIN

SENSING
BAIL

SENSING BAIL
ROLLER

PUSH LEVER BAIL

PUSH LEVER

LATCH LEVER

LATCH
BAIL

CONTACT LEVER SLIDE

STRIPPING

SENSING CLUTCH trips
permitting SENSING CAM
SLEEVE to rotate PUSH
LEVER BAIL strips PUSH
LEVERS from SENSING
PINS
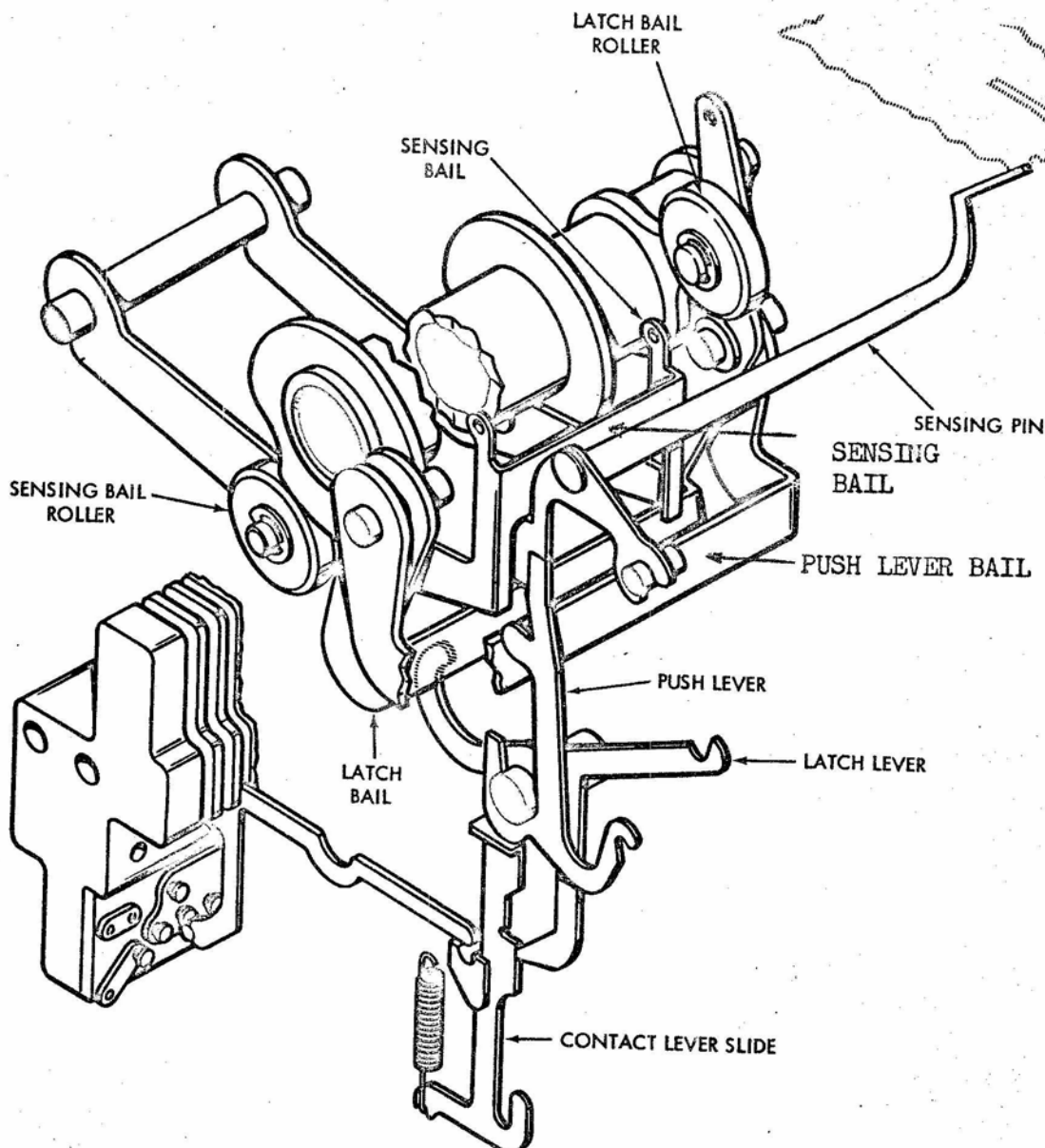
SENSING

SENSING BAIL CAMS (2) allow
SENSING BAIL and
SENSING PINS to rise & sense tape.

PUSH LEVERS fall under selected sensing pins
LATCH BAIL strips off
LATCH LEVERS from
CONTACT LEVER SLIDE allowing
CONTACTS to open, erasing last character in
STORING BLOCK

CONTACTS OPERATING

SENSING BAIL operates
SENSING PINS moving selected
PUSH LEVERS moving
CONTACT LEVER SLIDES down allowing
CONTACT to close

SENSING CAM SLEEVE

AUXILIARY LEVER

STORING
SWITCH

PUSH LEVER

CONTACT
EXTENSION

CONTACT LEVER
SLIDE
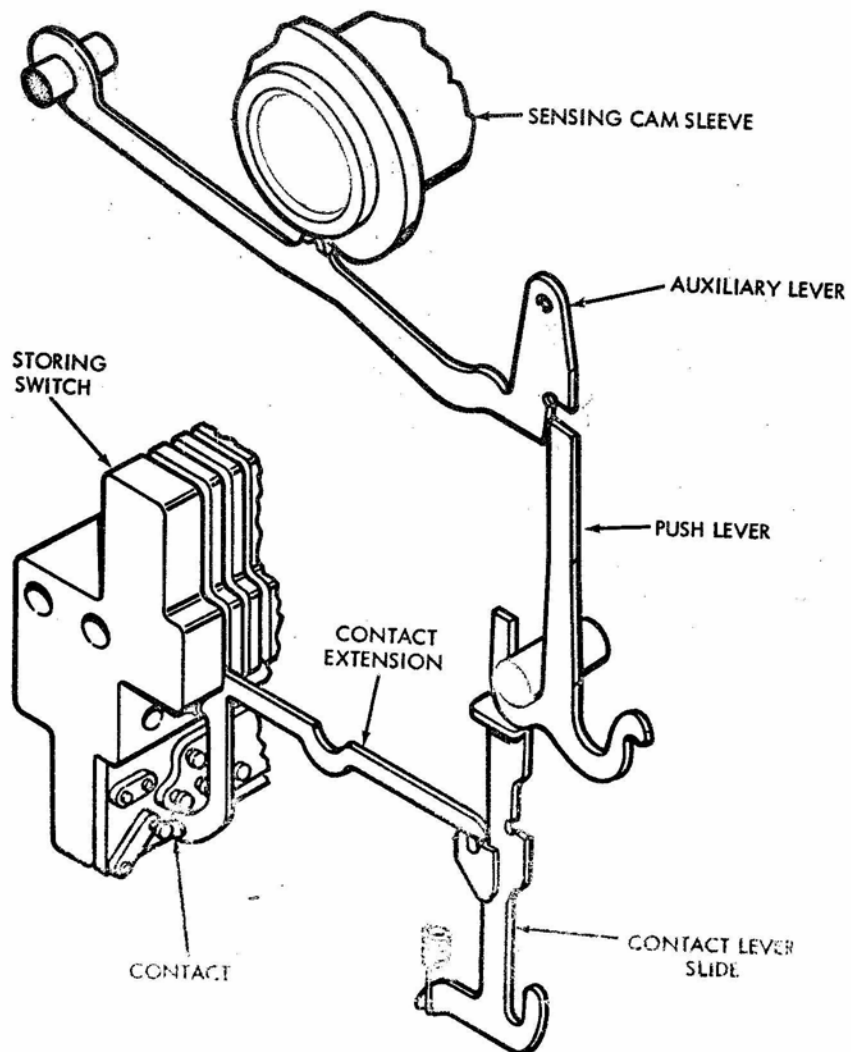
CONTACT

SENSING CAM SLEEVE rotating causes
AUXILIARY LEVER to move down against
PUSH LEVER moving
CONTACT LEVER SLIDE down permitting
CONTACT LEVER EXTENSION to drop allowing
CONTACT to close
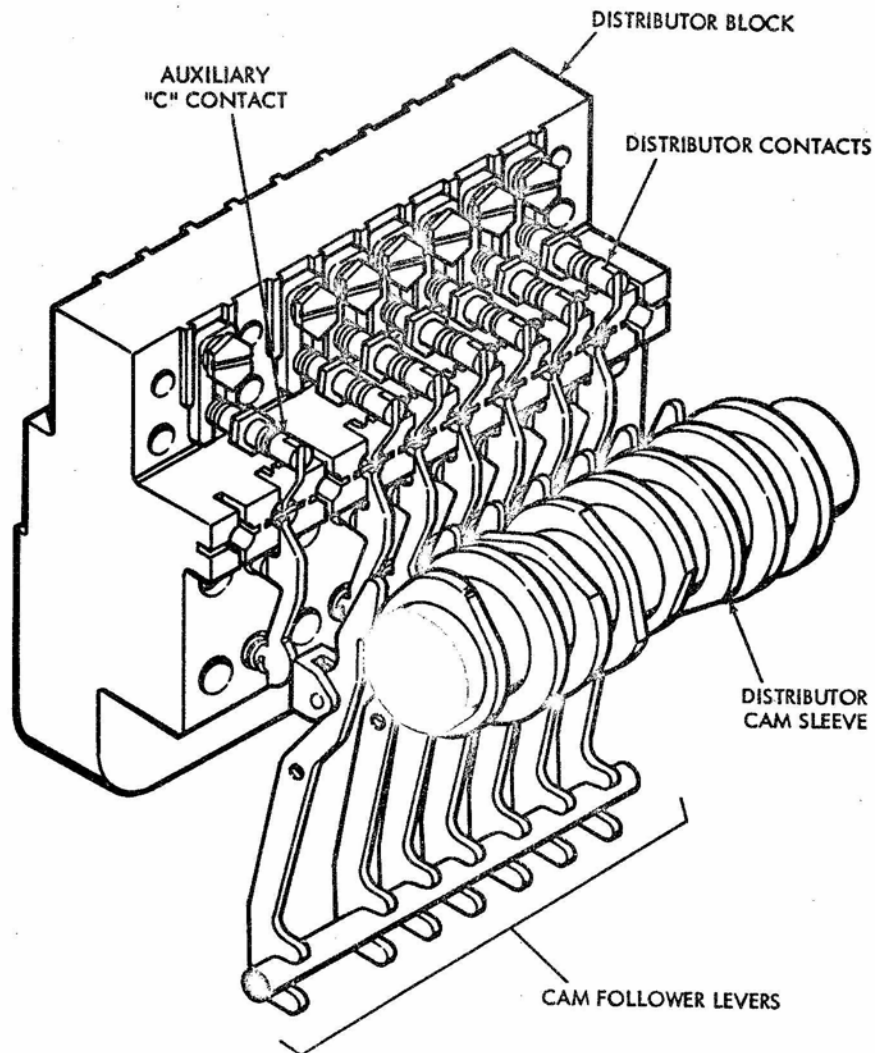
closing auxiliary contact on pivoted or fixed sensing mechanism causes
DISTRIBUTOR CLUTCH to become energized allowing
DISTRIBUTOR CAM SLEEVE to rotate permitting
CAM FOLLOWER LEVERS to fall into low part of cam (sequentially) permitting
DISTRIBUTOR CONTACTS to close generating a TELETYPE signal.

SELECTION

SELECTOR MAGNET POLE PIECES

SELECTOR MAGNET COILS

SELECTOR ARMATURE

SELECTOR CLUTCH DRUM

START LEVER

STOP ARM BAIL CAM

CLUTCH SHOE LEVER

STOP ARM

STOP ARM BAIL

SELECTOR ARMATURE

SPACING LOCK LEVER

MARKING LOCK LEVER

EXTENSIONS ON MARKING LOCK LEVER

PUSH LEVER RESET BAIL

PUSH LEVER

SELECTING LEVER

←—— FRONT   REAR ——→
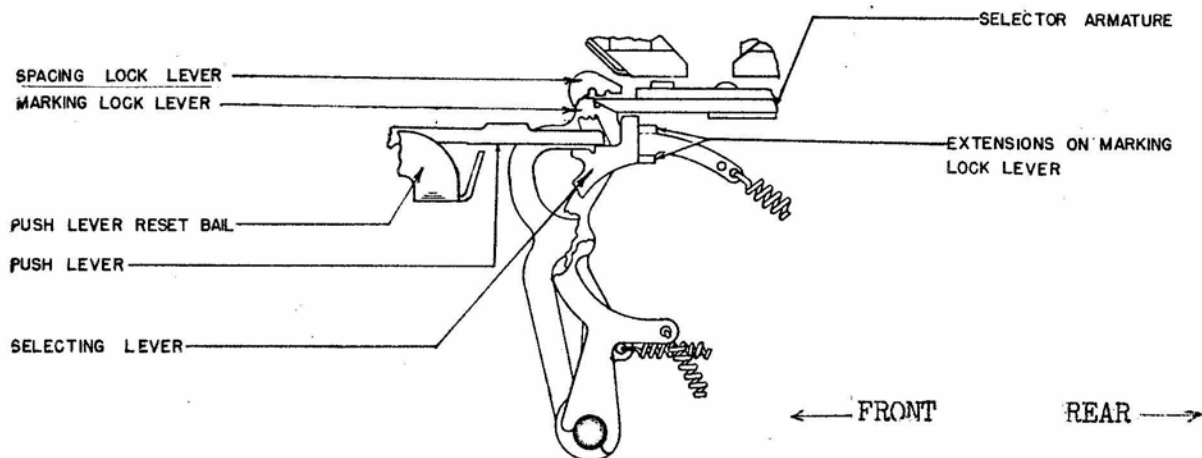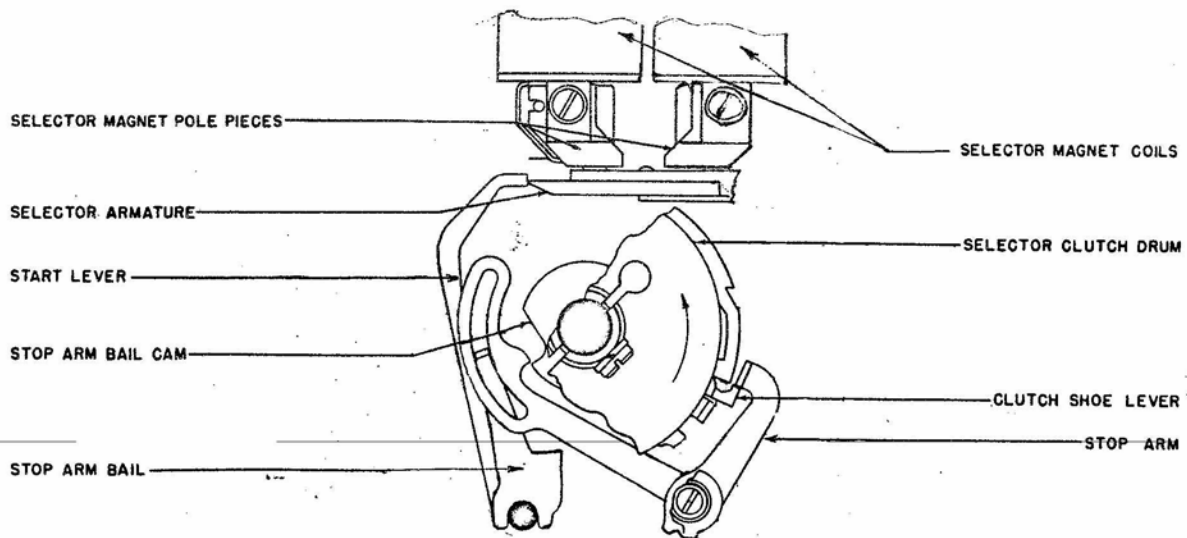
Start pulse received in SELECTOR MAGNET COILS releases

ARMATURE unblocks

START LEVER releases

STOP ARM BAIL and STOP ARM

CLUTCH trips and SELECTOR CAM SLEEVE rotates

PUSH LEVER RESET BAIL resets

PUSH LEVERS to the rear (spacing) position

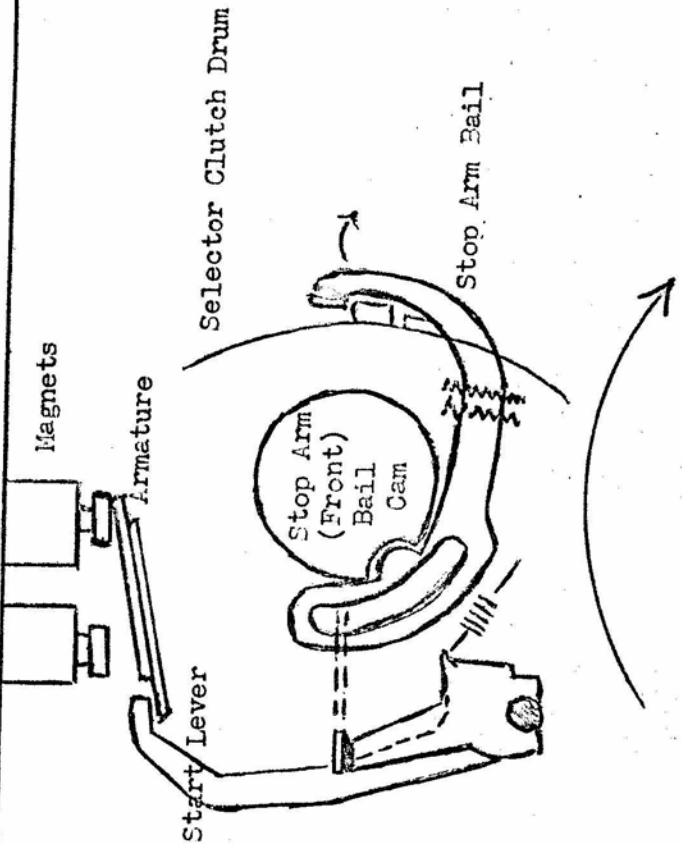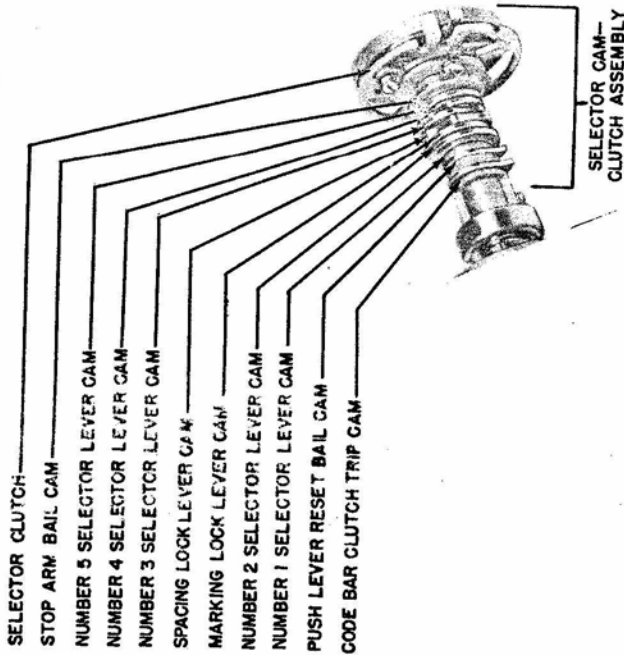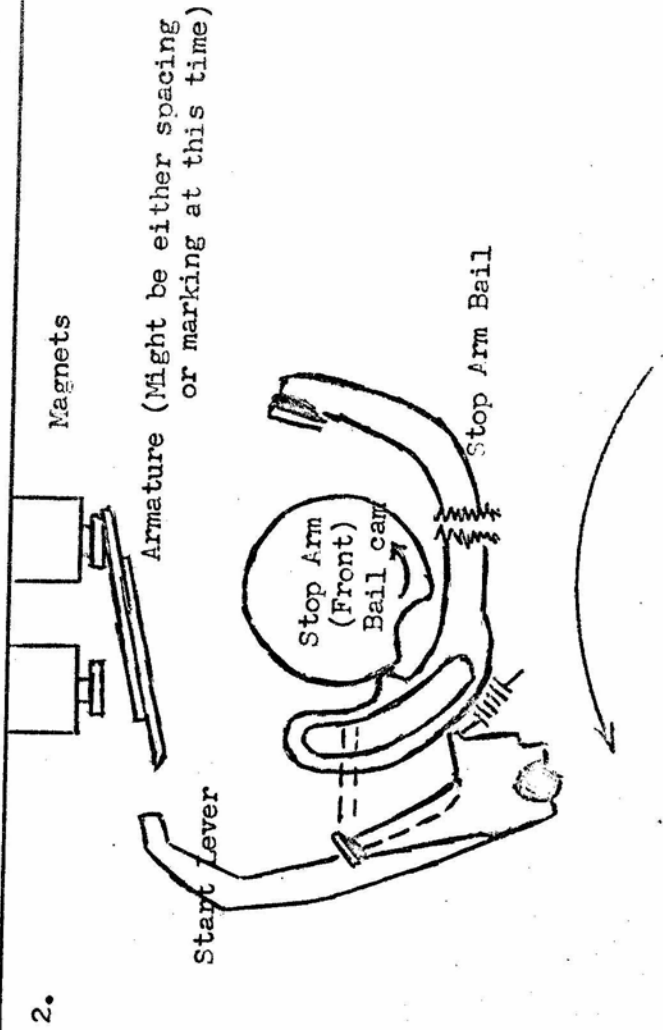| ARMATURE attracted (marking) permits	ARMATURE unattracted (spacing) blocks
SELECTING LEVER to move behind	MARKING LOCK LEVER
PUSH LEVER drops down	MARKING LOCK LEVER EXTENSIONS block
SELECTING LEVER moves	SELECTING LEVER causing PUSH LEVER to remain on top of SELECTING LEVER and to the rear in its spacing position
PUSH LEVER forward to its marking position	

MOVEMENT OF THE START LEVER

1. The armature drops down for the first pulse, the START pulse, which is always SPACING. The Start lever drops over the armature extension, holding the armature spacing. The Start lever is connected to the Stop Arm Bail -- as the Start Lever moves over the armature extension, the Stop Arm Bail is forced into the indent of its cam -- causing the Selector Clutch Stop Arm (shown as one piece with the Bail, for illustration purposes) to fall away and allow the clutch to engage and begin rotating.

2. As the Selector cam begins rotating, the reverse action takes place. The Stop Arm Bail extension rides to the high part of the front cam, forcing the Start Lever clear of the armature extension and pulling the Selector Clutch Stop Arm back against the clutch drum where it will be in position to stop the Selector clutch after one revolution.

NOTE: Because the Stop Arm Bail Cam (Front Cam) has only one indent, the Start Lever may not fall over the armature again during the cycle.

SELECTOR CLUTCH
STOP ARM BAIL CAM
NUMBER 5 SELECTOR LEVER CAM
NUMBER 4 SELECTOR LEVER CAM
NUMBER 3 SELECTOR LEVER CAM
SPACING LOCK LEVER CAM
MARKING LOCK LEVER CAM
NUMBER 2 SELECTOR LEVER CAM
NUMBER 1 SELECTOR LEVER CAM
PUSH LEVER RESET BAIL CAM
CODE BAR CLUTCH TRIP CAM

SELECTOR CAM—CLUTCH ASSEMBLY

2.

Magnets

Armature (Might be either spacing or marking at this time)

Stop Arm (Front) Bail cam

Stop Arm Bail

Start Lever

1.

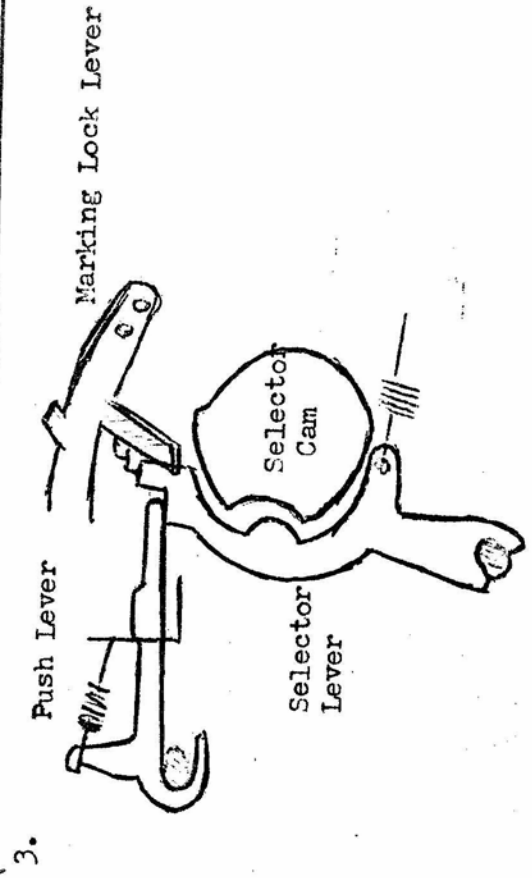Magnets

Armature

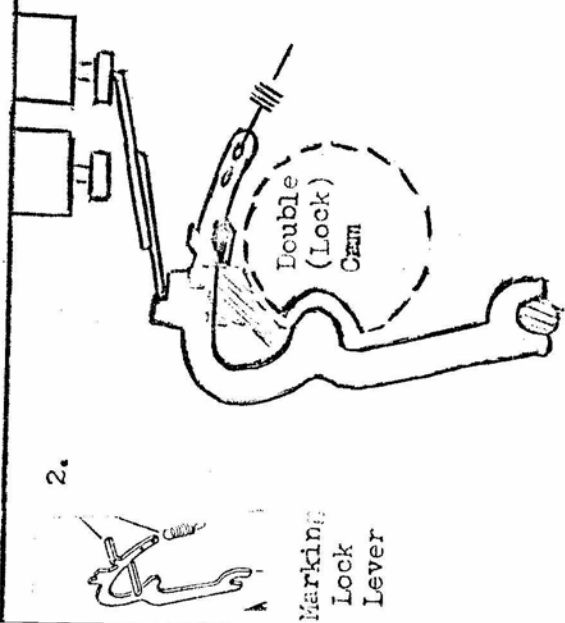Stop Arm (Front) Bail Cam
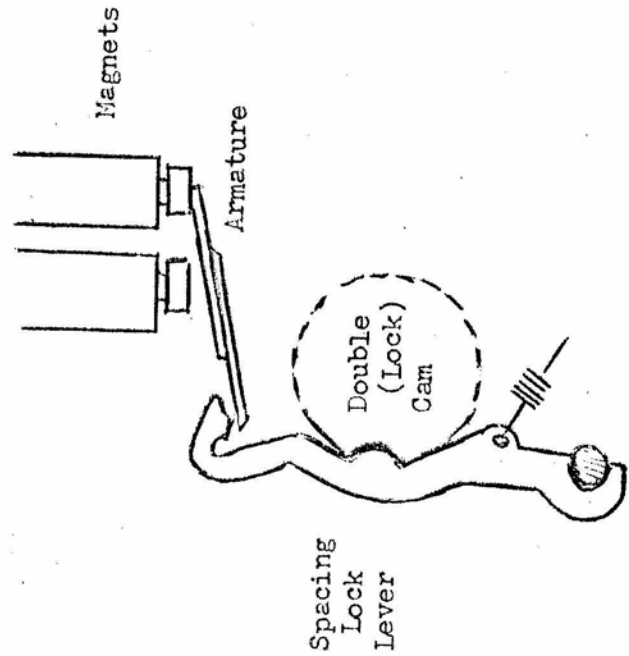
Selector Clutch Drum

Stop Arm Bail

Start Lever

SELECTOR MECHANISM DURING SPACING IMPULSE

1. Magnets are de-energized and armature drops down. Spacing Lock Lever falls over top of armature, holding it spacing. Spacing Lock Lever rides into indent of double (LOCK) cam.

2. With the armature down (Spacing), the Marking Lock Lever is blocked. The projection on the Marking Lock Lever rides in the air over the indent in the double cam.

3. As the Selector cam indent comes into line, the Selector Lever attempts to move back into the indent. Because the Marking Lock Lever is being blocked by the armature extension (2), the Selector Lever is blocked by the arm on the Marking Lock Lever. The Push Lever moves forward, slightly, but not far enough to drop off onto the Selector Lever Guide.

Note: BETWEEN EACH PULSE, THE MARKING AND SPACING LOCK LEVERS RIDE TO A HIGH PART OF THE DOUBLE CAM AND MOVE CLEAR OF THE ARMATURE.

Magnets

Armature

Double (Lock) Cam

Spacing Lock Lever

1.

Double (Lock) Cam

Marking Lock Lever

2.

Marking Lock Lever

Push Lever

Selector Cam

Selector Lever

3.

SELECTOR MECHANISM DURING <u>MARKING</u> IMPULSE
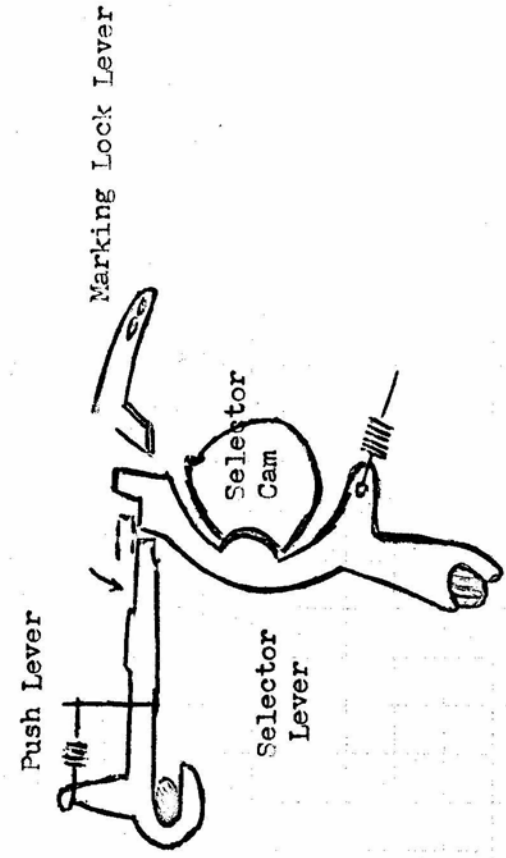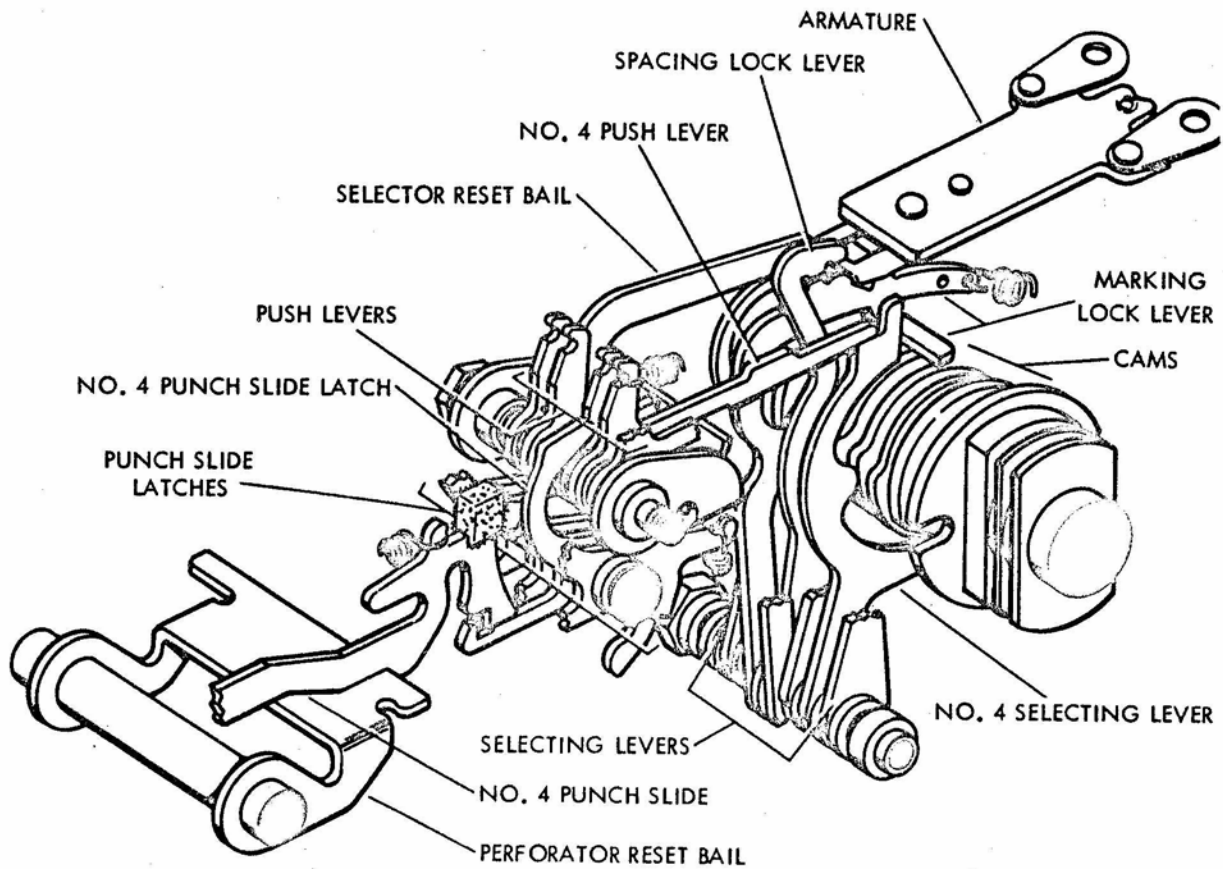
1. Magnets are energized and armature is pulled up. The Spacing Lock Lever attempts to move to the rear but is now blocked by the armature extension.

2. With the armature up (Marking), the Marking Lock Lever is free to be pulled to the rear by its spring. As it moves to the rear, it braces the armature against the pole pieces and rides into the indent of the double (Lock) cam. (The Spacing Lock Lever is, at this period, riding in the air above that same cam indent.)

3. The Marking Lock Lever is now out of the way so the Selector Lever, which has the indent of its cam available, may fall in. The indents of the other Selector cams have either passed or not yet arrived, consequently only one Selector may fall in during any given pulse. Moving to the rear, the Selector Lever can no longer support the Push Lever and, consequently, the Push Lever drops down onto the Selector Lever Guide. As the Selector rides out of its indent it will move forward which, in turn, will cause the Push Lever to be moved forward.

Note: BETWEEN EACH PULSE, THE MARKING AND SPACING LOCK LEVERS RIDE TO A HIGH PART OF THE DOUBLE CAM AND MOVE CLEAR OF THE ARMATURE EXTENSION.

1.

Magnets

Armature

Spacing
Lock
Lever

Double
(Lock)
Cam

2.

Magnets

Armature

Marking
Lock
Lever

Double
(Lock)
Cam

3.

Push Lever

Marking Lock Lever

Selector
Cam

Selector
Lever

ARMATURE

SPACING LOCK LEVER

NO. 4 PUSH LEVER

SELECTOR RESET BAIL

MARKING
LOCK LEVER

PUSH LEVERS

CAMS

NO. 4 PUNCH SLIDE LATCH

PUNCH SLIDE
LATCHES

NO. 4 SELECTING LEVER

SELECTING LEVERS

NO. 4 PUNCH SLIDE

PERFORATOR RESET BAIL
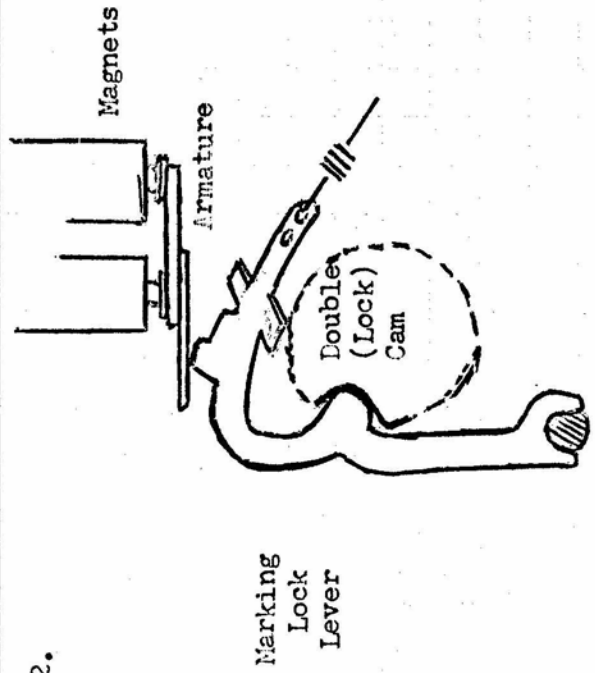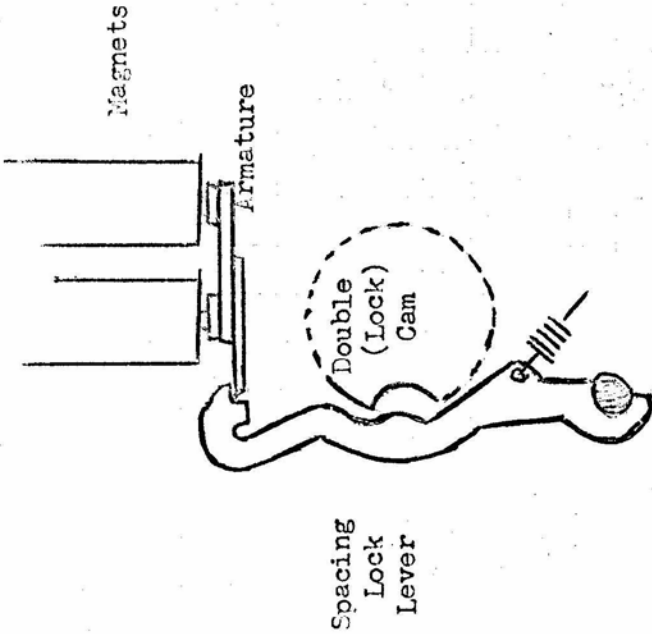
MARKING SELECTOR LEVER moves to left operating
PUNCH SLIDE LATCH counterclockwise permitting
PUNCH SLIDE BIAS SPRING to operate the
PUNCH SLIDE to a marking position

(SPACING SELECTOR LEVER causes PUNCH SLIDE LATCH
and PUNCH SLIDE to remain stationary)

NO. 4 PUSH
BAR

NO. 4 BELL
CRANK

BELL
CRANKS

NO. 4 PULSE BEAM

NO. 4 PUNCH
SLIDE
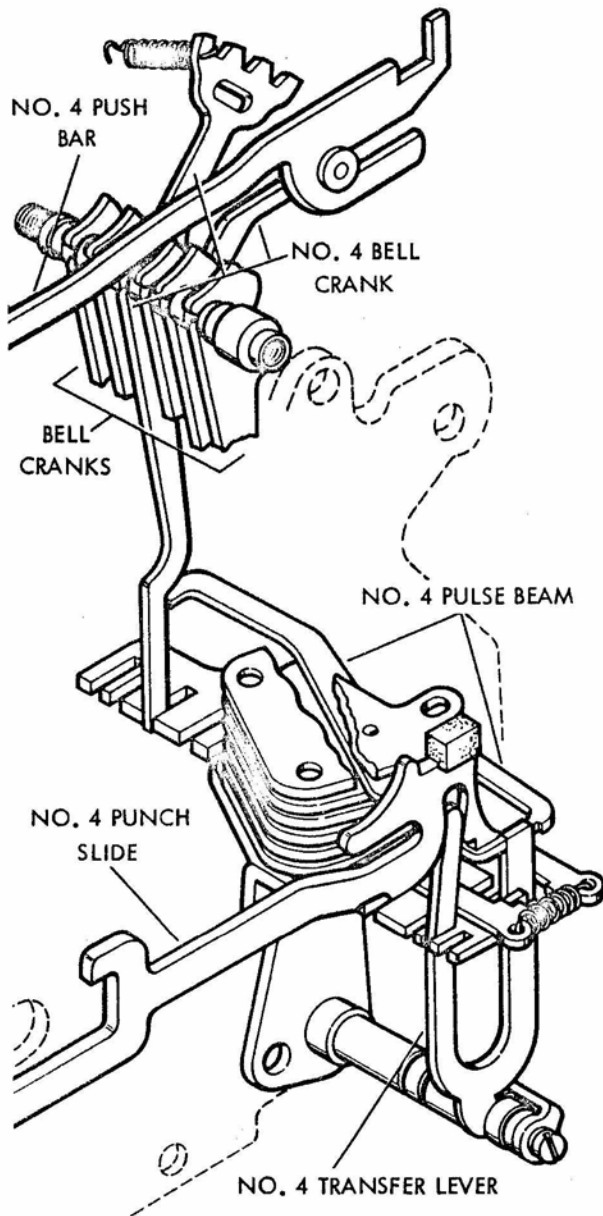
NO. 4 TRANSFER LEVER

PUNCH SLIDE marking (to left) moves
TRANSFER LEVER left rotating rear of
PULSE BEAM to right allowing
BELL CRANK to rotate counterclockwise
positioning PUSH BAR up MARKING

PUNCH SLIDE spacing
all parts would remain stationary
PUSH BAR would remain down
SPACING

FORWARD FUNCTION CAM

ECCENTRIC PIN

RESET ARM

FUNCTION CLUTCH

FUNCTION
CAM-CLUTCH
ASSEMBLY

PUNCH SLIDE

CLUTCH RELEASE

DOWNSTOP

FUNCTION TRIP CAM

TRIP SHAFT

RESET BAIL
TRIP LEVER

FUNCTION
CAM

MAIN TRIP LEVER

CLUTCH
LATCH LEVER

RESET BAIL

CAM DISK
STOP LUG

CLUTCH SHOE
LEVER

CLUTCH
TRIP LEVER

FOLLOWER
LEVER
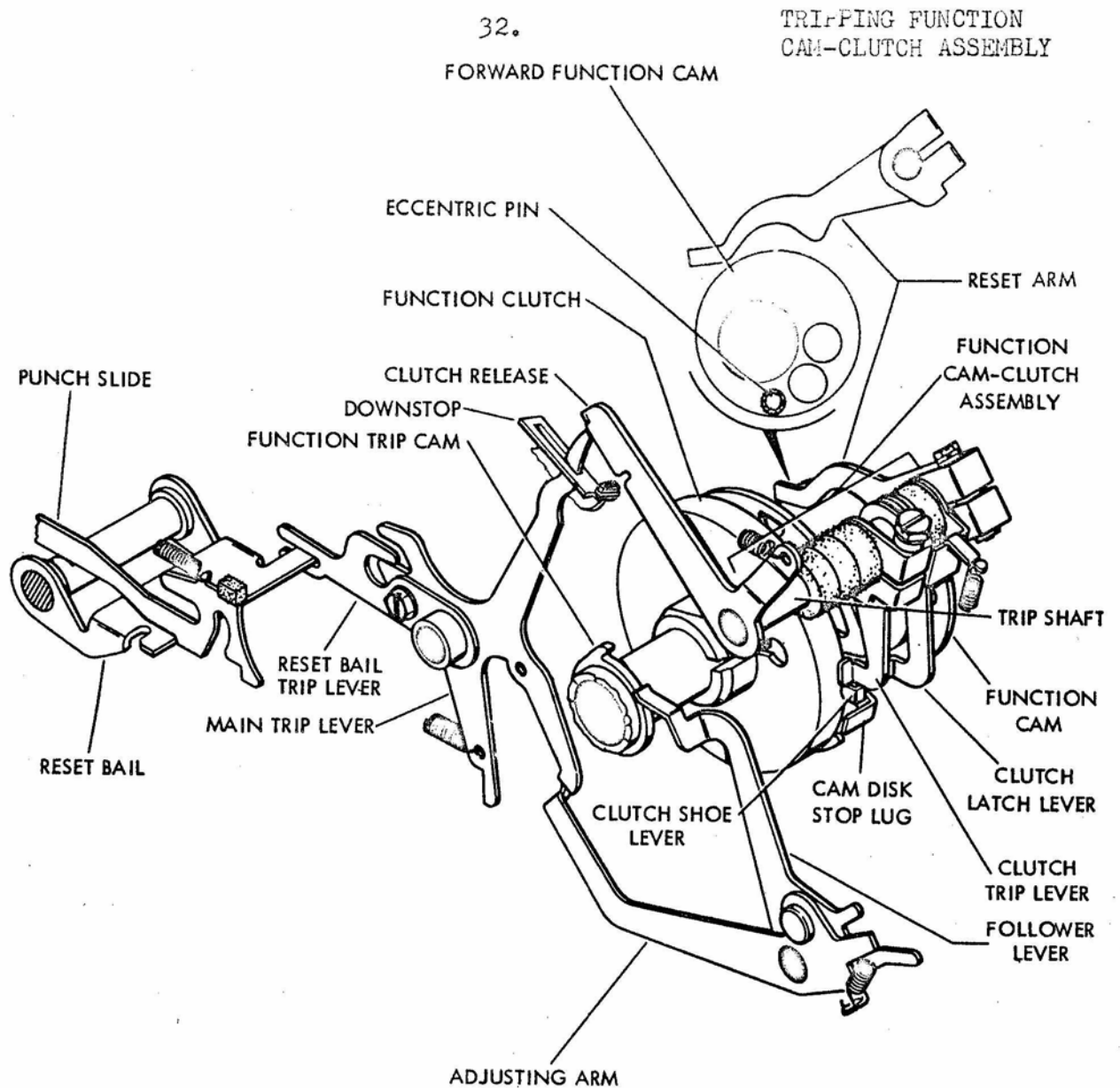
ADJUSTING ARM

SELECTOR CAM SLEEVE rotating causes
FUNCTION TRIP CAM to operate
FOLLOWER LEVER moving
ADJUSTING ARM up rotating
MAIN TRIP LEVER counterclockwise permitting
CLUTCH RELEASE to drop rotating
TRIP SHAFT moving
CLUTCH TRIP LEVER free of
CLUTCH SHOE LEVER permitting
CLUTCH ENGAGEMENT and rotation of
FUNCTION CAMS.

resetting occurs as
ECCENTRIC PIN moves
RESET ARM rotates
TRIP SHAFT presenting
CLUTCH TRIP LEVER into path of
CLUTCH SHOE LEVER disengaging
FUNCTION CLUTCH

RIBBON DRIVE ARM

PERFORATOR DRIVE LINK

LIFTER ROLLER
(ON FUNCTION BOX)

RIBBON FEED ROLLER

PUSH BAR

OPERATING BLADE

CORRECTING
DRIVE LINK

MOUNTING BAIL

UPPER ROLLER

OSCILLATING
DRIVE LINK

MAIN SHAFT

FUNCTION CAMS

PRINTING
DRIVE LINK

ROCKER BAIL
SHAFT

LOWER ROLLER

(REAR VIEW)
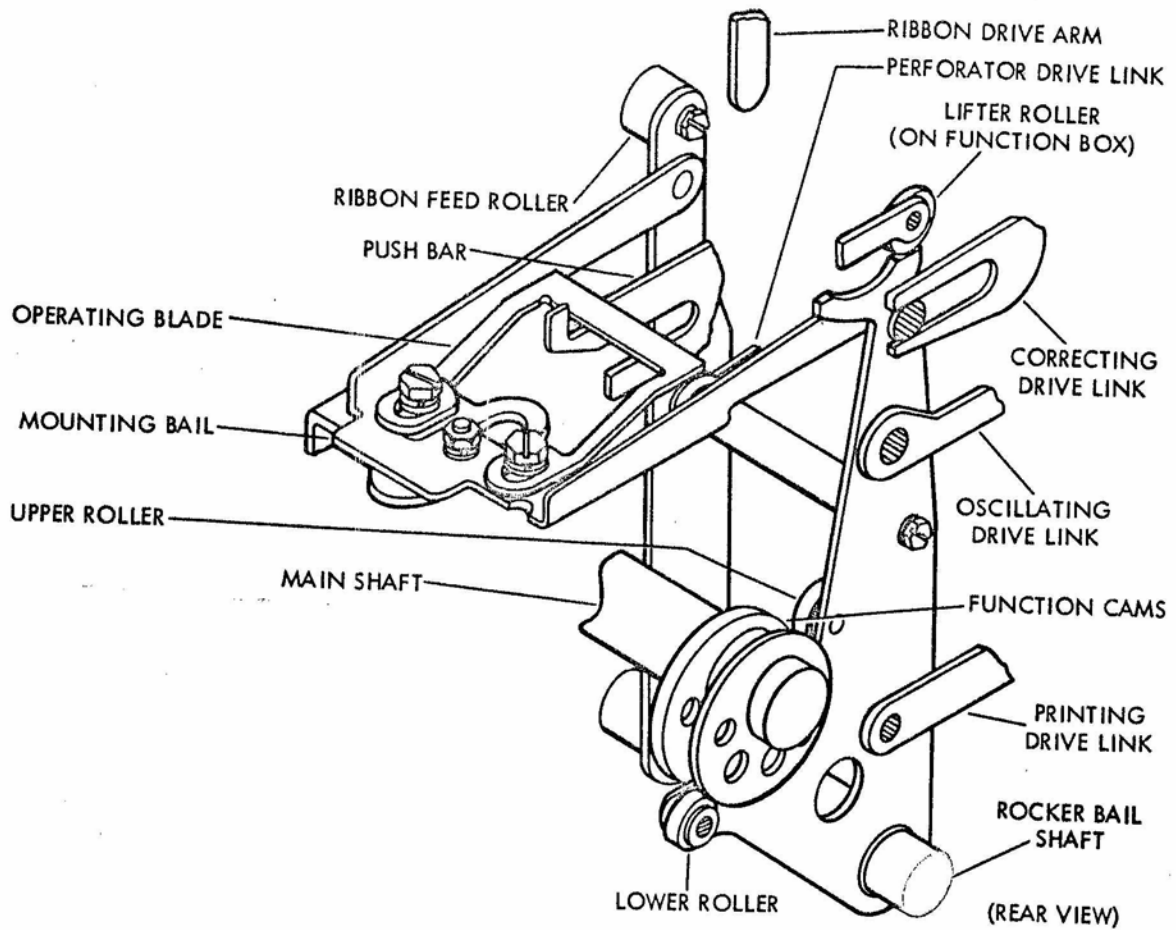
FUNCTION CLUTCH engaged causes
FUNCTION CAMS to rotate operating
UPPER and LOWER ROCKER BAIL ROLLERS moving
ROCKER BAIL operating
MOUNTING BAIL and moving
OPERATING BLADE left and right which will operate
the various PUSH BARS

OPERATING BLADE ───────── NO. 2 PUSH BAR

ROCKER BAIL ───────── NO. 1 PUSH BAR

NO. 4 PUSH BAR

NO. 5 PUSH BAR

LOWER PINION ───────── LETTERS PUSH BAR

AXIAL CRANK PIN ───────── NO. 3 PUSH BAR

OPERATING BLADE

AXIAL PRIMARY SHAFT

BELL CRANK

AXIAL SECONDARY SHAFT

CRANK PIN

PRIMARY SHAFT   SECONDARY SHAFT

FIGURES PUSH BAR

ROCKER BAIL

(EXPLODED VIEW)

Push Bars and Eccentric Assemblies
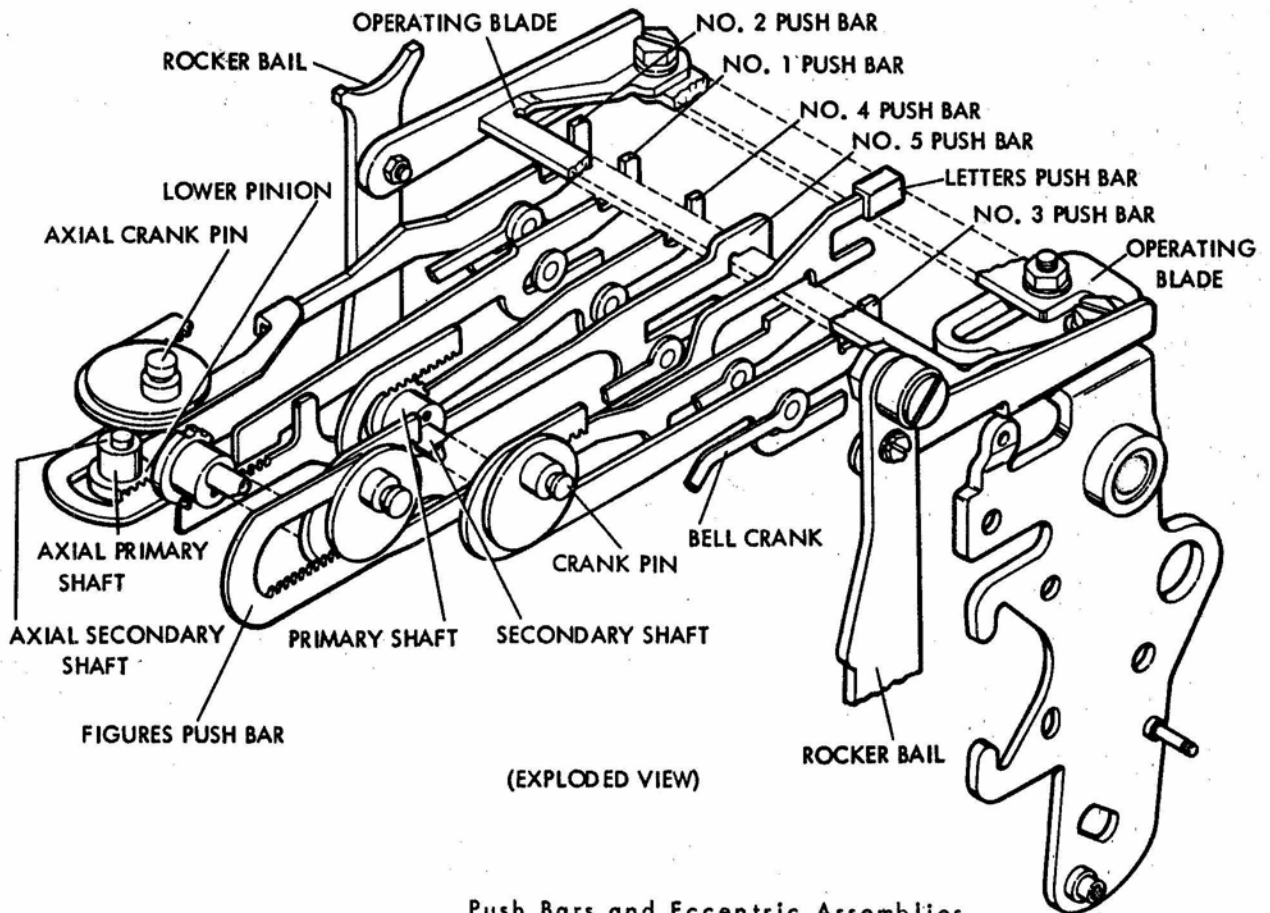
OPERATING BLADE moving to left will operate selected*
PUSH BARS which, through rack & gear arrangement, will
operate ECCENTRIC ASSEMBLIES (3)
        PUSH BARS #3,4,& 5 control ECCENTRIC ASSEMBLIES
        on front of unit and provide rotary positioning
        of TYPE WHEEL
        PUSH BARS #1 & 2 control rear ECCENTRIC ASSEMBLY
        and provide axial positioning of TYPE WHEEL.

* Selected PUSH BARS - 1,2,3 & 4 on mark (up)
                       5 on space (down) note construction #5

NO. 2 PUSH BAR

NO. 1 PUSH BAR

CORRECTING DRIVE LINK

CRANK PIN

CORRECTING CLAMP

TYPEWHEEL

STUD

ROCKER BAIL

ECCENTRIC ASSEMBLY

OUTPUT RACK

AXIAL SECTOR

OSCILLATING BAIL

AXIAL CORRECTING PLATE

CYLINDRICAL RACK ON SHAFT

OSCILLATING DRIVE BAIL

TYPEWHEEL SHAFT

TOGGLE LINK

(REAR VIEW)
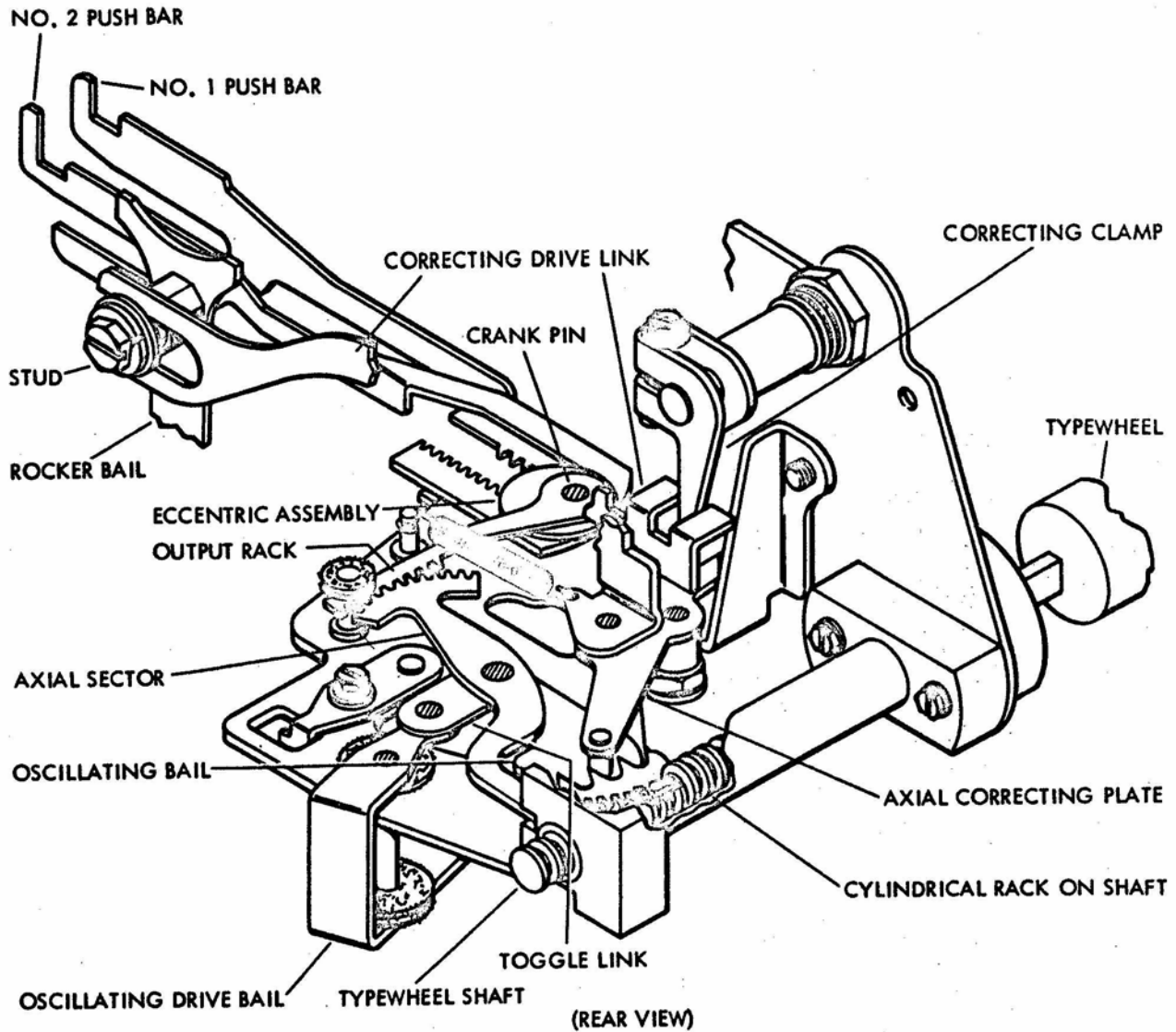
movement of #1 and/or 2
PUSH BAR causes
ECCENTRIC ASSEMBLY to rotate causing
CRANK PIN to move
OUTPUT RACK rotating
AXIAL SECTOR moving
CYLINDRICAL RACK and
TYPEWHEEL forward into one of 3 stops

ROTARY CORRECTING LEVER

FIGURES PUSH BAR

LEFT ECCENTRIC ASSEMBLY

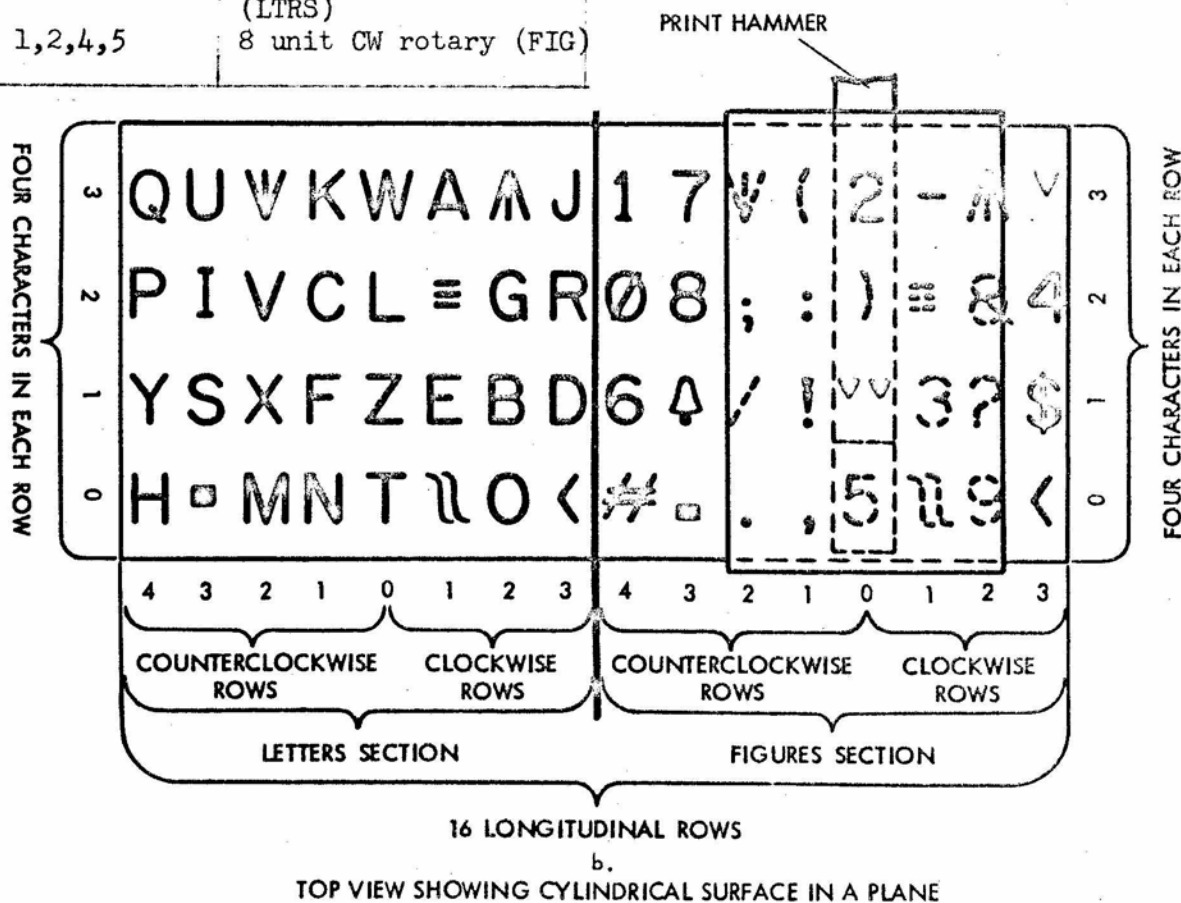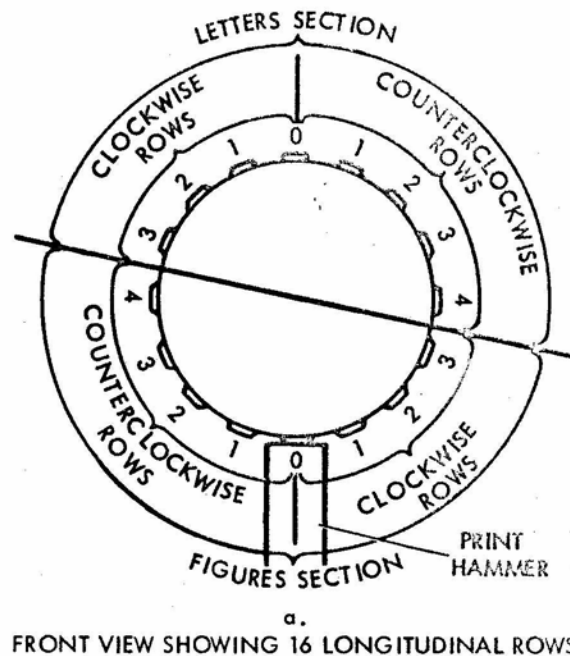LETTERS PUSH BAR

GEAR BEARING HOUSING

NO. 4 PUSH BAR

RIGHT ECCENTRIC ASSEMBLY

DETENT ASSEMBLIES

TYPEWHEEL SHAFT SPUR GEAR

NO. 5 PUSH BAR

REAR PINION

CRANK PIN (FORMS FRONT ECCENTRIC)

PRIMARY ECCENTRIC SHAFT

TYPEWHEEL RACK

TYPEWHEEL

SECONDARY ECCENTRIC SHAFT (FORMS REAR ECCENTRIC)

LEFT OUTPUT CONNECTING ROD

TYPEWHEEL DRIVE ASSEMBLY

FRONT PINION
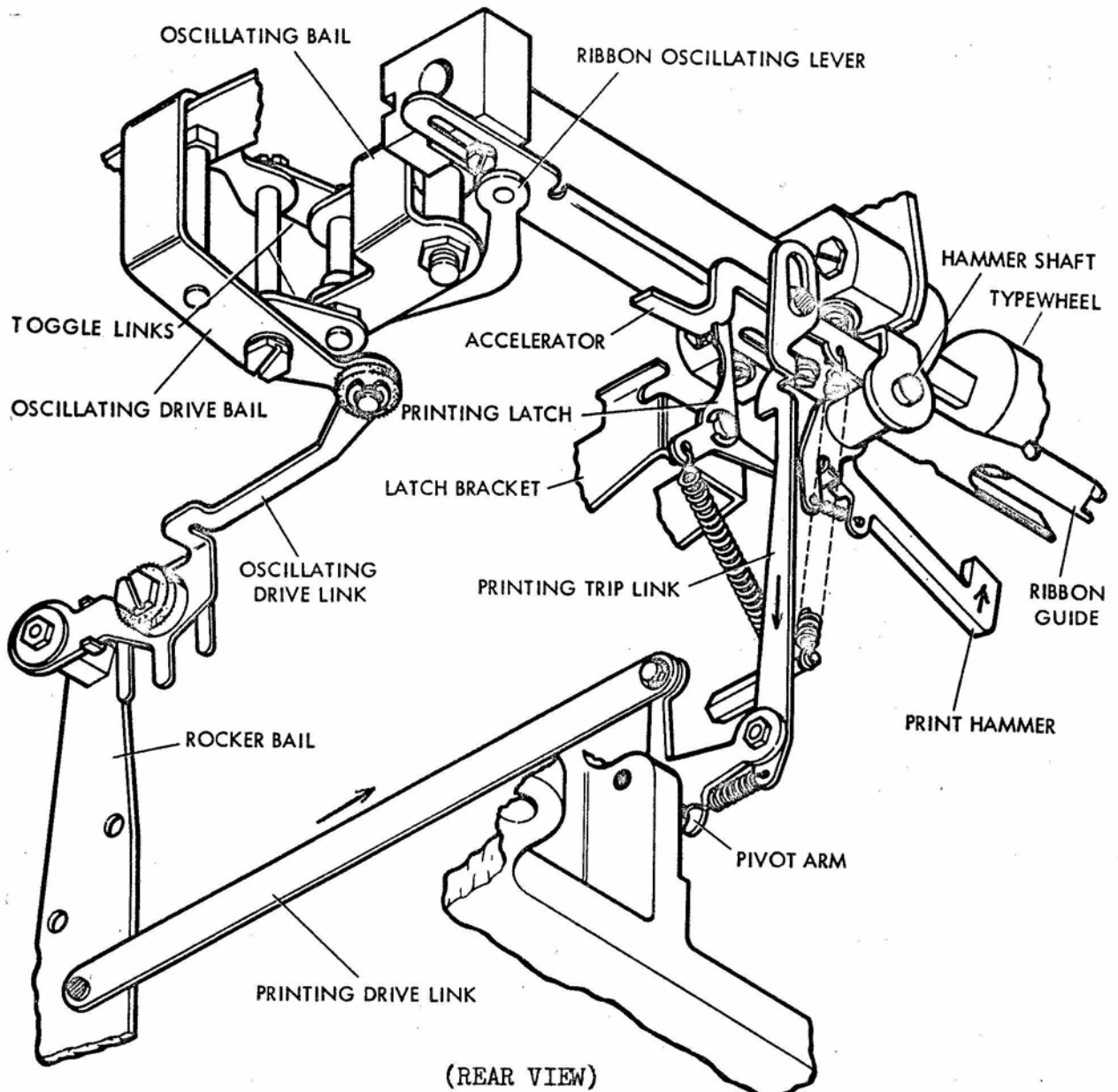
NO. 3 PUSH BAR

CROSS LINK

RIGHT OUTPUT CONNECTING ROD

The various selection of #3,4,& 5
PUSH BARS to operate the right and/or left
ECCENTRIC ASSEMBLIES operating the
OUTPUT CONNECTING RODS moving the
CROSS LINK operating
TYPEWHEEL RACK rotating
TYPEWHEEL SHAFT SPUR GEAR rotating the
TYPEWHEEL into one of eight stops

LETTERS-FIGURES shift gives eight additional stops
for a total of sixteen.

CODE		Displacement Produced
Spacing	Marking	
1,2	- -	0 units axial
2	1	1 unit axial
1	2	2 unit axial
- -	1,2	3 unit axial
3,5	4	3 unit CW rotary
3	4,5	2 unit CW rotary
3,4,5	- -	1 unit CW rotary
3,4	5	0 units rotary
5	3,4	1 unit CCW rotary
- -	3,4,5	2 unit CCW rotary
4,5	3	3 unit CCW rotary
4	3,5	4 unit CCW rotary
- -	1,2,3,4,5	8 unit CCW rotary (LTRS)
3	1,2,4,5	8 unit CW rotary (FIG)

a.
FRONT VIEW SHOWING 16 LONGITUDINAL ROWS

b.
TOP VIEW SHOWING CYLINDRICAL SURFACE IN A PLANE

OSCILLATING BAIL

RIBBON OSCILLATING LEVER

HAMMER SHAFT

TYPEWHEEL

TOGGLE LINKS

ACCELERATOR

OSCILLATING DRIVE BAIL

PRINTING LATCH

LATCH BRACKET

OSCILLATING DRIVE LINK

PRINTING TRIP LINK

RIBBON GUIDE

ROCKER BAIL

PRINT HAMMER
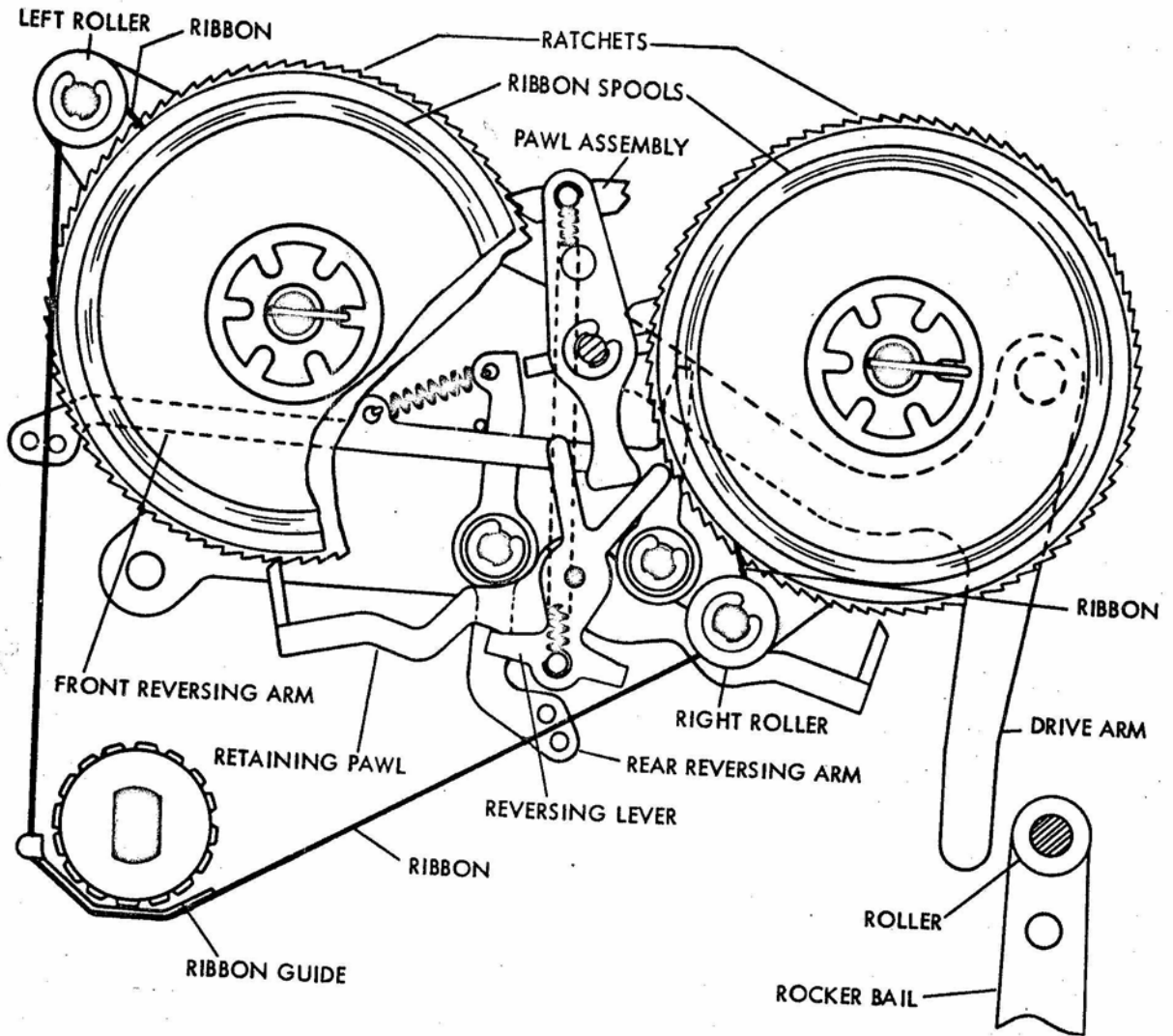
PIVOT ARM

PRINTING DRIVE LINK

(REAR VIEW)

PRINT
   ROCKER BAIL operates
   PRINTING DRIVE LINK rotating
   PIVOT ARM pulling down
   PRINTING TRIP LINK rotating
   PRINTING LATCH permitting
   ACCELERATOR SPRING to pull down
   ACCELERATOR driving
   PRINT HAMMER up against
   RIBBON

RESET
   ROCKER BAIL, PRINTING DRIVE LINK, PIVOT ARM & PRINTING
   TRIP LINK reverse their previous movements operating
   ACCELERATOR, PRINT HAMMER down allowing PRINTING LATCH
   to relatch

LEFT ROLLER   RIBBON   RATCHETS
                                        RIBBON SPOOLS
                                        PAWL ASSEMBLY

FRONT REVERSING ARM
RETAINING PAWL   REAR REVERSING ARM
                                        REVERSING LEVER
                        RIGHT ROLLER
                        RIBBON
                        DRIVE ARM
                        ROLLER
RIBBON
RIBBON GUIDE   ROCKER BAIL

ROCKER BAIL ROLLER moves to left striking
DRIVE ARM moving
PAWL ASSEMBLY up rotating one of the
RATCHETS and its
RIBBON SPOOL advancing
RIBBON

RIBBON REVERSE occurs as
PAWL ASSEMBLY comes down striking
FRONT or REAR REVERSING ARM rotating
PAWL ASSEMBLY to opposite ratchet also
REVERSING LEVER is rotated allowing
RETAINING PAWL to engage opposite
RATCHET

RIBBON will now be fed in reverse