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 certicifate of non-availability of aircraft, rations or quarters will be issued.

Classes begin a eight o'clock and are in session until four fourty-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 fourty-five of the final day, 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 KEYBOARD SENDING AND
PRINTER 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 Keyboard (Sending) and Printer (Receiving) Set.

The course is scheduled for a 2 week period and will cover theory, disassembly, adjustments of principle components, trouble shooting 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

The following Teletype Bulletins will be furnished each student.

Bulletins			Teletype Code
216B	Desc. & Theory	Keyboard & Printer	LK, LP
217B	Adj. & Lubrication	Kybrd.,Base,Ptr.,Cabinet	LK, LB, LP, LAC
1149B	Parts	" " " "	LK, LB, LP, LAC
1124B	Maintenance Tools		

The Model 28 Keyboard and Printer will be disassembled in the order indicated below. DO NOT REMOVE ANY PARTS UNTIL THE INSTRUCTOR DEMONSTRATES THE CORRECT PROCEDURE. This procedure, if followed correctly, will throw-off a minimum number of adjustments.

Parts will be replaced in the reverse order.

KEYBOARD

1. Contact Box
2. Signal Generator
3. Keylevers
4. Space Bar Link*
5. Lockball Channel
6. Code Bar Assembly
7. Local Line Feed, Carriage Return, Blank Lock Mechanism, Break Mechanism.

(*Note: When replacing the Space Bar Link, connect the link to its code lever BEFORE replacing the Lock Ball Channel)

PRINTER

1. Front Plate
2. Stunt Box
3. Code Bar Shift Bars
4. Code Bar Positioning mechanism
5. Selector Cam
6. Magnet Bracket
7. Main Shaft
8. Platen

The course of instruction covering the Model 28 Keyboard and Printer is two weeks long. Normally, the material will be covered according to the schedule below. However, certain conditions such as holidays, tend to alter the schedule slightly.

DAY	SUBJECT
1st.	Keyboard theory - Disassembly & assembly
2nd.	Keyboard adjustments
½ 3rd.	Keyboard adjustments
½ 3rd.	Printer theory
4th.	Printer theory
5th.	Printer theory - Disassembly & assembly
6th.	Printer adjustments
7th.	Printer adjustments
8th.	Printer adjustments - Adjustments under power
9th.	Trouble Shooting
10th.	Trouble Shooting

The keyboard and printer theory is presented to the class as a whole or to separate groups. All adjustments are given, a few pages at a time, to separate groups.

With the exception of a few basic mechanisms, the school places no particular emphasis upon the retention of part names. However, the student must have an understanding of theory in order to trouble-shoot effectively.

Each student will have a keyboard and printer, the adjustments for which are his responsibility. After the adjustment has been demonstrated by the instructor the student will make the adjustment. It is felt that only by actually making the adjustment will the student understand how it is properly made and the difficulties that might be encountered.

Many students who have had previous experience with other models of Teletype equipment will be familiar with the types of adjustments that will be called for. They are:

1. Clearance: A measurement, USING THE GAUGES PROVIDED, will be required. Unless otherwise specified, the measurement will be taken at the point of minimum clearance. Should the requirement, for example, read: "Min: .002" Max: .020" ", any point between the two limits will be satisfactory.

2. Spring Tensions: Ordinarily we do not change springs in the school's equipment unless it is broken or badly distorted. For this type of check, it is usually satisfactory for the student to know where and how the tension should be measured.

3. End Play: Although the adjustment manual will give the point at which the required end play may be measured, it is usually satisfactory to check the particular part for freedom from bind without excessive slop.

4. Double Requirements: Some adjustments have two requirements. Both are to be met with the same adjustment.

Below are listed the tools issued to each student. It will be the student's responsibility to return all tools at the end of the course.

QTY	NAME	USE OR DESCRIPTION
1	Wrench	3/16" x 1/4"
1	Wrench	3/8" x 5/16"
1	Handwheel	Turn the printer mainshaft manually
1	Armature clip	To hold the armature in a MARKING position for off-line checks.
2	Spring Hook	(1) Push hook (1) Pull hook
1	Crochet Hook	Small springs
1	Tweezers	
2	Screwdrivers	(1) Large (1) Small
2	Offset Screwdrivers	(1) 90 degree (1) 45 degree
3	Spring Scales	(1) 8 oz. (1) 32 oz. (1) 64 oz.
1	Tommy Wrench	For "Transfer Lever Eccentric" adjustment
1	Screw Starter	
1	Keylever remover	Remove keylevers from keyboard
1	Box of gauges	.002" through .008"; .010"; .012"; .018"; .020"; .025"; .030"; .035"; .037"; .040" through .080" in steps of .005"

At the end of the course, the instructor is required to fill-out a report on each student. The report is submitted to the customer who sponsored the student. The report indicates starting and completion dates and a grade covering attitude and performance in theory, adjustments and trouble shooting.

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

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

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	= <u>1.42 Units</u>

7.42

(e) <u>7.42 is known as the UNIT CODE</u>

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) <u>The **START** or information pulse (1 Unit) = 22ms.</u>
(i) <u>The **STOP** pulse (1.42 Units) = **31**ms.</u>

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:

(j)
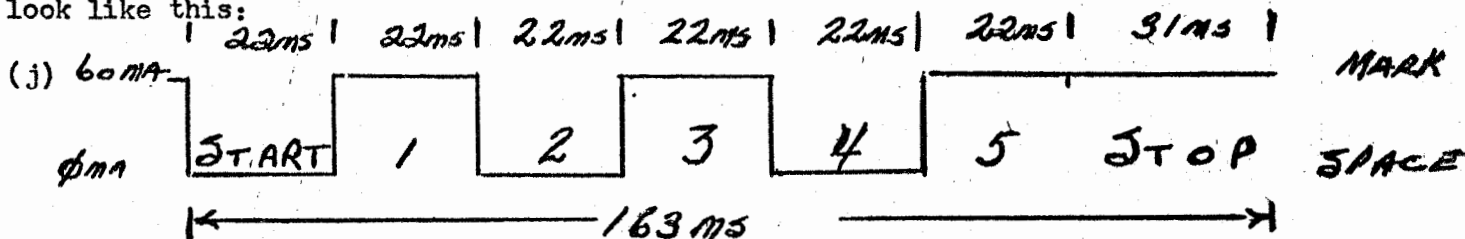
The character 'Y' is most often used for illustration and test purposes because every other pulse is different. As indicated on the rulers, however, the information pulses (between the START and STOP pulses) may vary according to the character selected. It has been noted that the STOP pulse is 1.42 times 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 operation, 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.
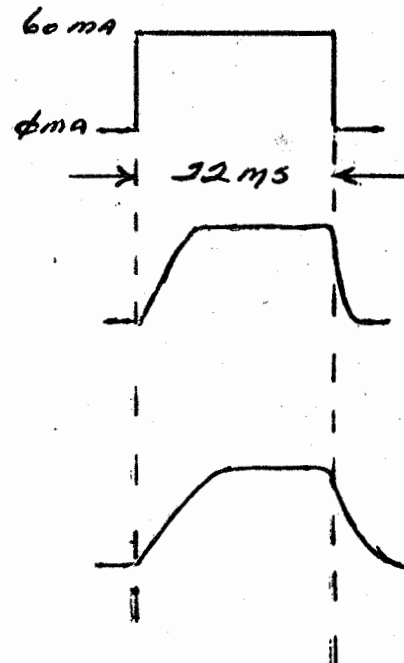
The impulse in figure 3 is more likely to be found at the receiving printer than the one (figure 1) impressed at the transmitter. The impulse seen in figure 3, as applied to the selector magnets of the printer, will be used to illustrate Bias Distortion. It will be noted that this waveshape builds up 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 suff- icient magnetic attraction. This point, T2, would be the beginning of the MARK impulse as far as the selector was concerned.
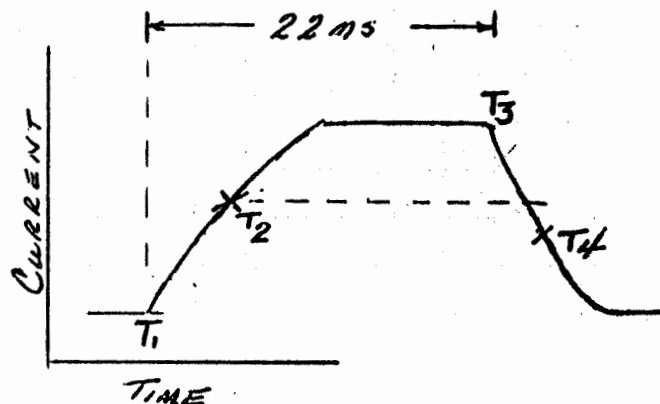
When, at the end of the transmitted pulse, the current again starts towards Oma., the selector armature should, theoretically, fall away at T3. The trailing edge of the impulse, however, also slopes and, consequently, a definite time will have elapsed before the armature will drop away (T4). Notice that 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 TRANS- ITION DELAY (M-STD).
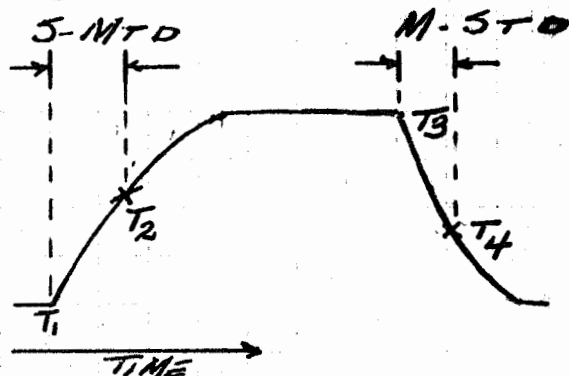
If the S-MTD is equal to the M-STD, the pulse as seen by the selector would be undistorted.

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-STD - S-MTD = ms. 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 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.
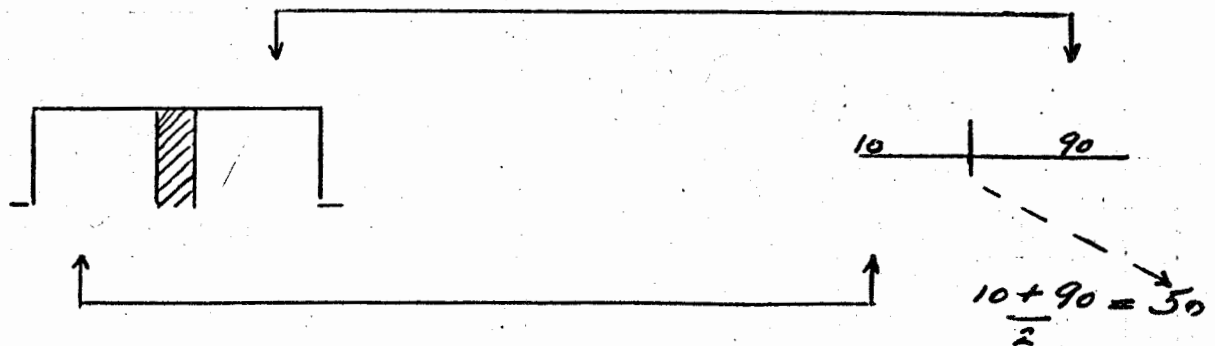
RANGE

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:
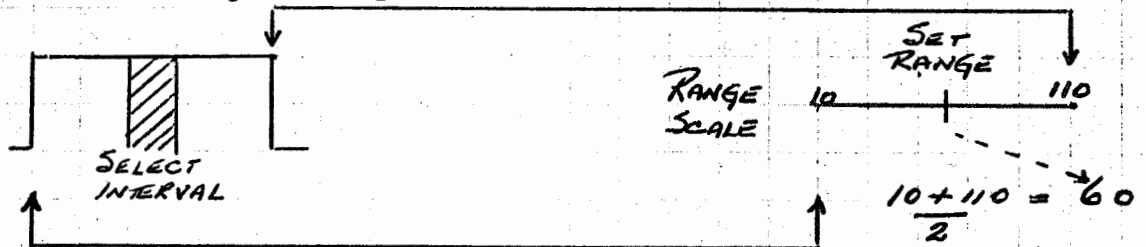
If 20% MARKING END DISTORTION (an artificially produced characteristic distortion used to test acceptance -- in this case it would extend the leading edge of the pulse) were introduced, the range would shift in order to maintain the selecting interval in the middle of the pulse:

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

$$\frac{30 + 110}{2} = 70$$
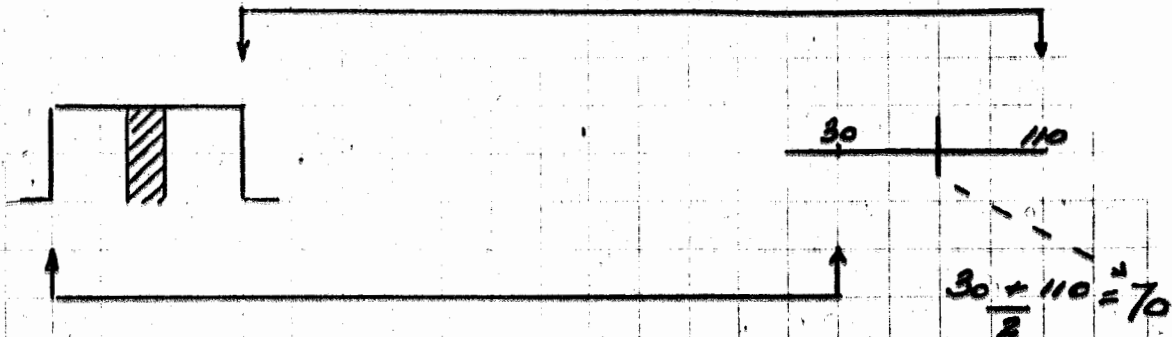
In any situation there is a standard procedure for determining the proper setting for the range scale:

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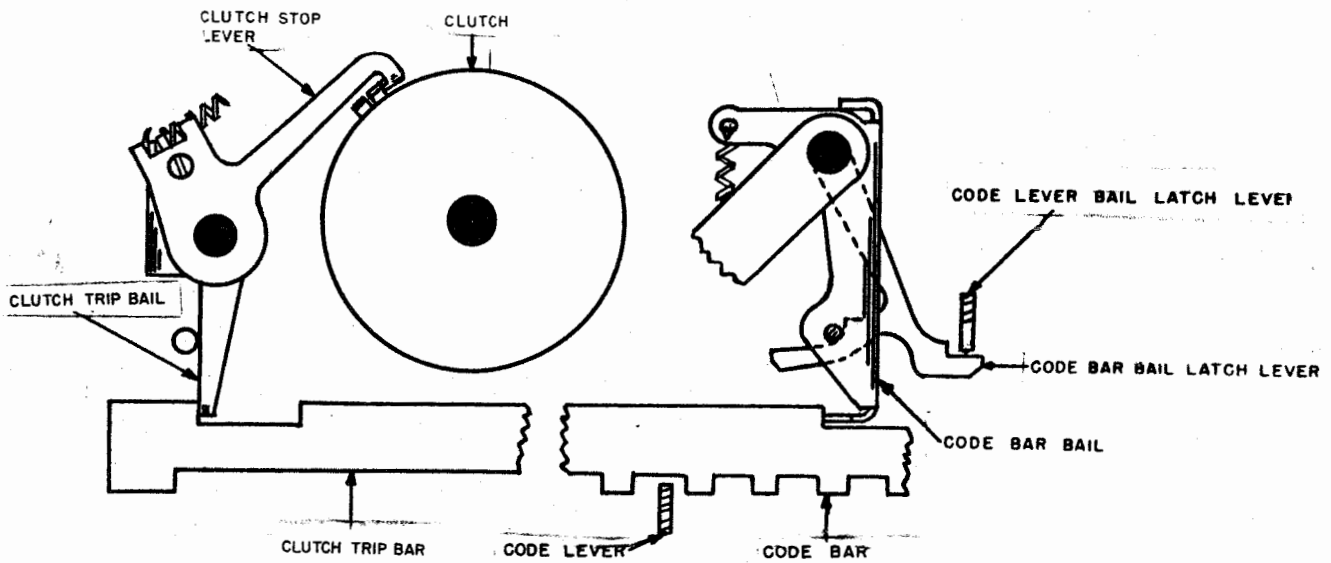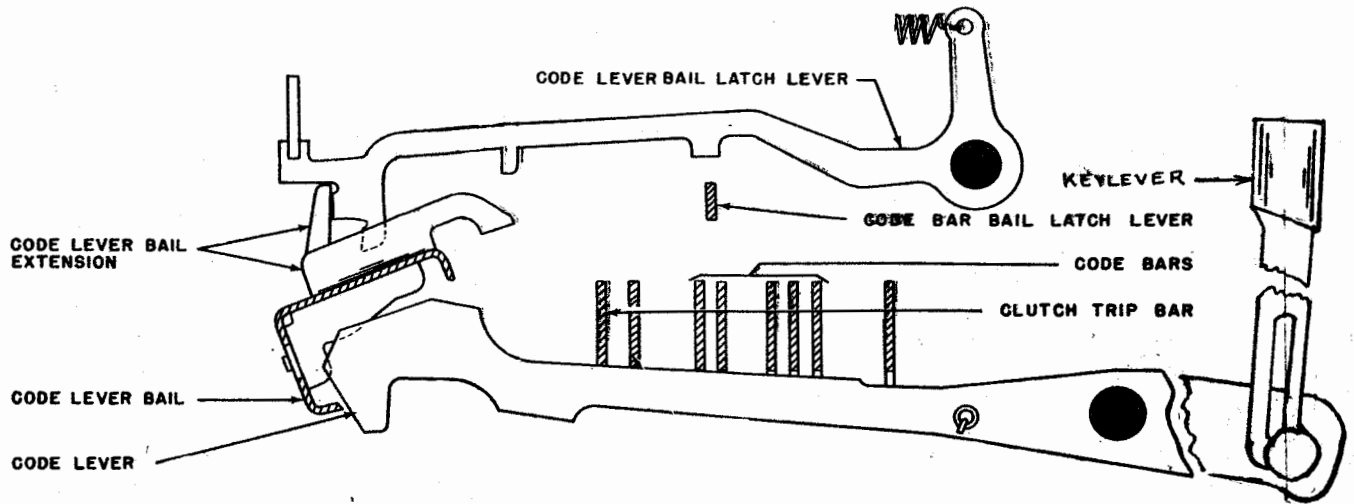
Most of the information on Signal Distortion and Range was taken from:

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)

Depressing KEYLEVER moves

CODE LEVER rotates

CODE LEVER BAIL releases

CODE LEVER BAIL LATCH LEVER depresses

CODE BAR BAIL LATCH LEVER unlatches

CODE BAR BAIL releases

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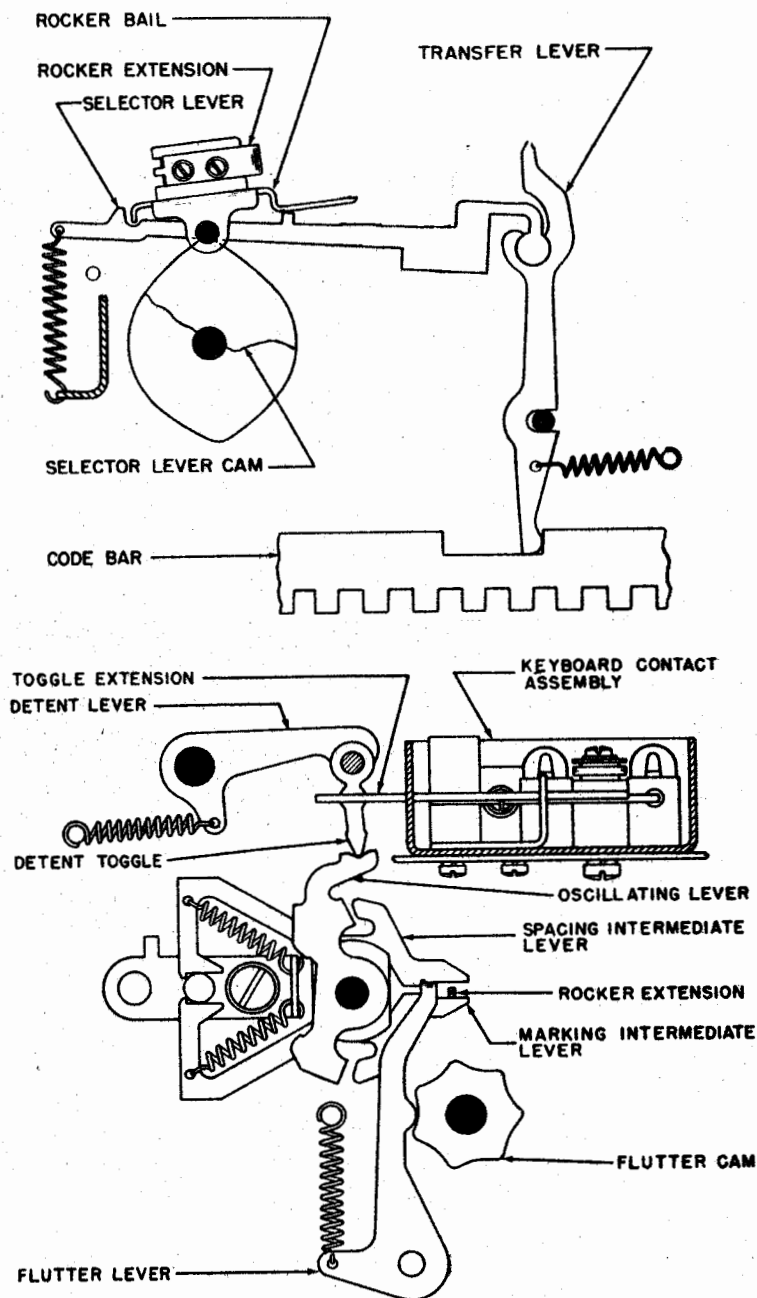   code lever)

CLUTCH TRIP BAR operates

CLUTCH TRIP BAIL and
CLUTCH STOP LEVER trips

CLUTCH and CAM SLEEVE rotates

ROCKER BAIL

TRANSFER LEVER

ROCKER EXTENSION

SELECTOR LEVER

SELECTOR LEVER CAM

CODE BAR

TOGGLE EXTENSION

DETENT LEVER

KEYBOARD CONTACT ASSEMBLY

DETENT TOGGLE

OSCILLATING LEVER

SPACING INTERMEDIATE LEVER

ROCKER EXTENSION

MARKING INTERMEDIATE LEVER

FLUTTER CAM

FLUTTER LEVER

CODE BARS move

TRANSFER LEVERS move   CLUTCH trips and CAM SLEEVE rotates, raising

SELECTOR LEVERS actuate

ROCKER BAIL and ROCKER BAIL EXTENSION moves

unselected INTERMEDIATE LEVER out of the path of

FLUTTER LEVER drives

selected INTERMEDIATE LEVER rotates

OSCILLATOR LEVER moves

DETENT TOGGLE and TOGGLE EXTENSION to open
         or close the signalling contact

CODE BARS

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
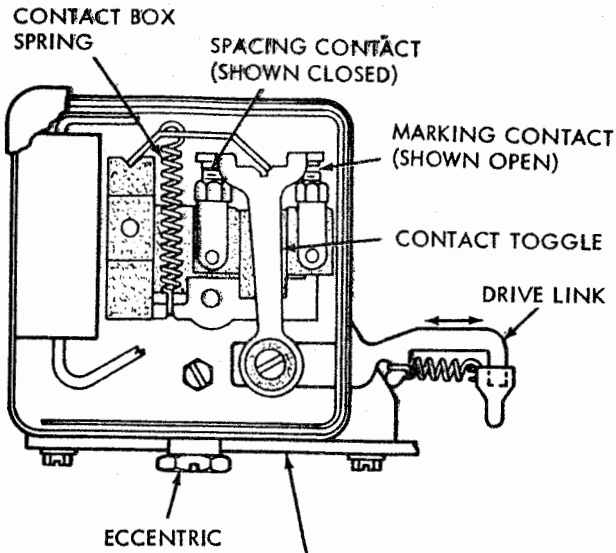
CODE LEVER

CODE KEYLEVER

WEDGE LOCK MECHANISM
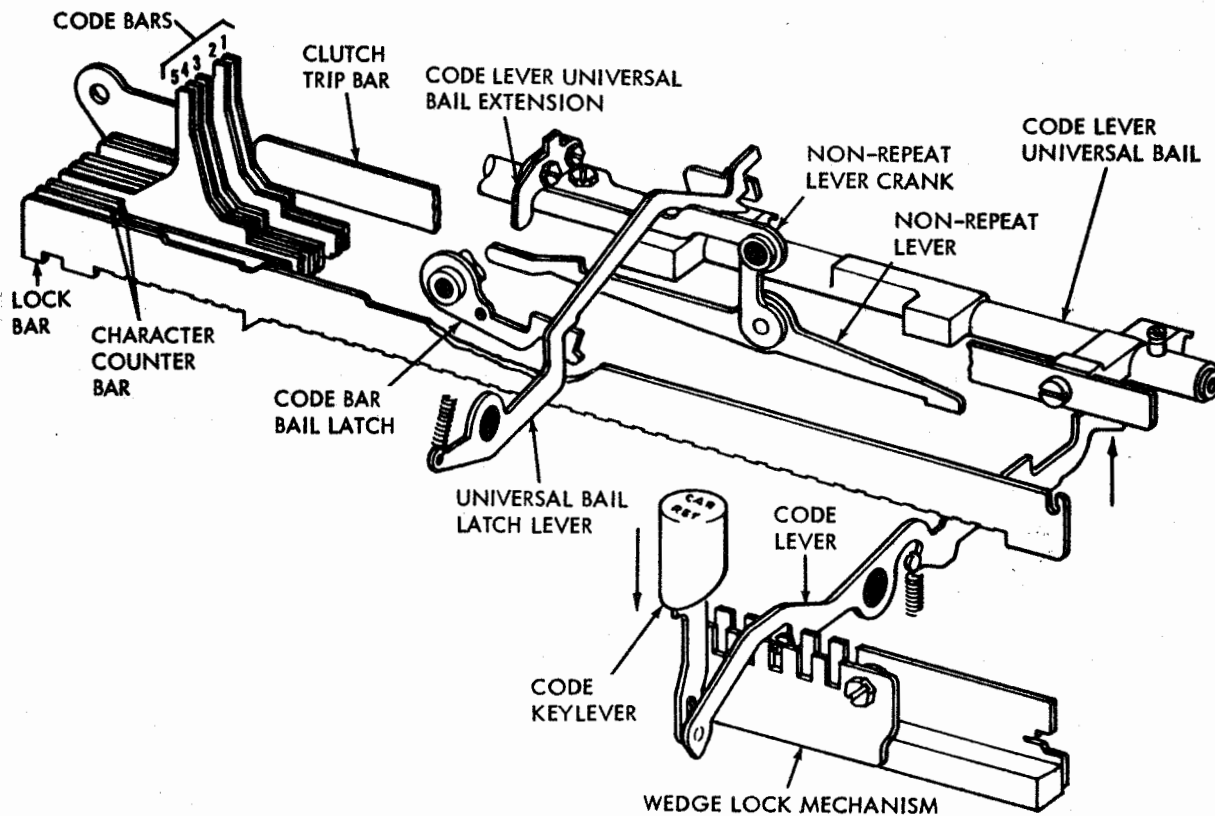
Depressing KEYLEVER operates

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

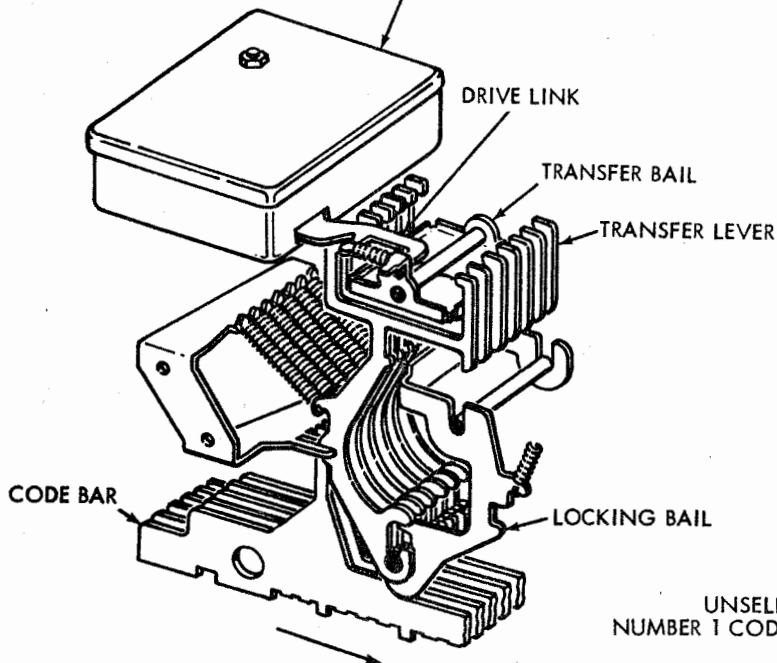CLUTCH STOP LEVER trips

CLUTCH and CAM SLEEVE rotates.

CODE BARS

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

CONTACT BOX SPRING

SPACING CONTACT (SHOWN CLOSED)

MARKING CONTACT (SHOWN OPEN)

CONTACT TOGGLE

DRIVE LINK

ECCENTRIC

CONTACT BOX

FROM TRIPPING OF CLUTCH
TO OPERATION OF CONTACTS

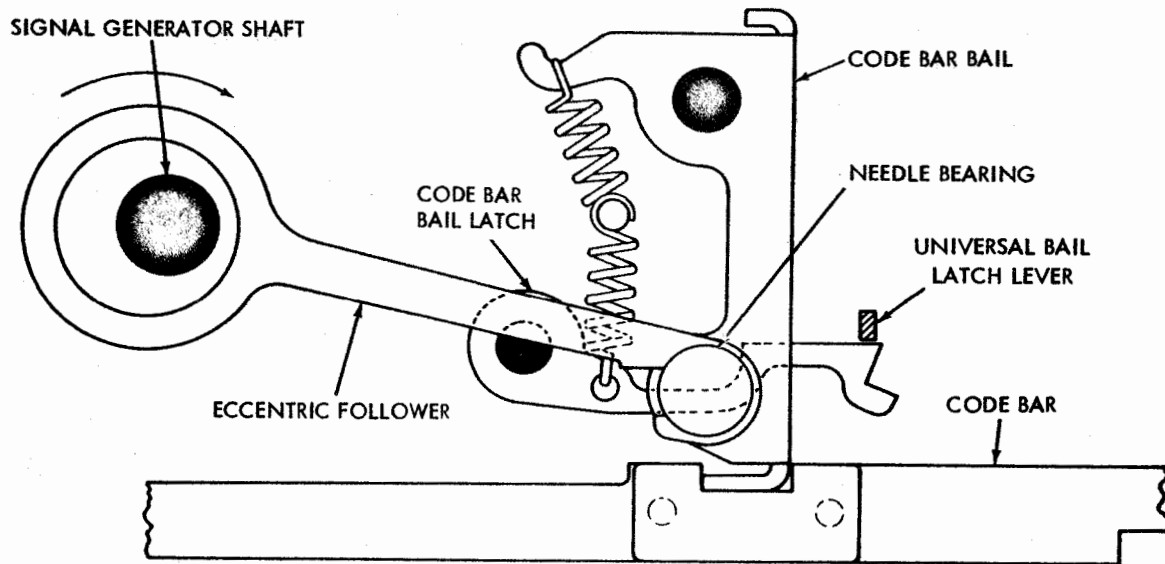DRIVE LINK

TRANSFER BAIL
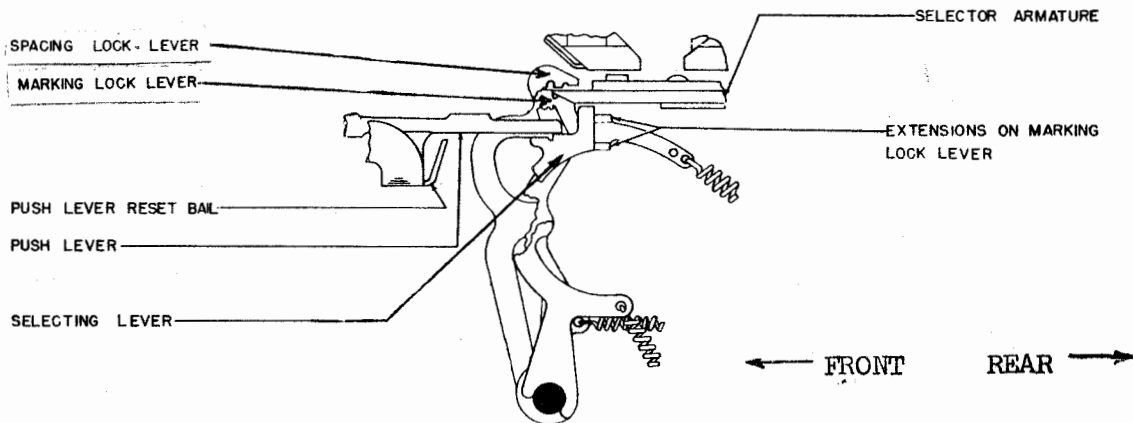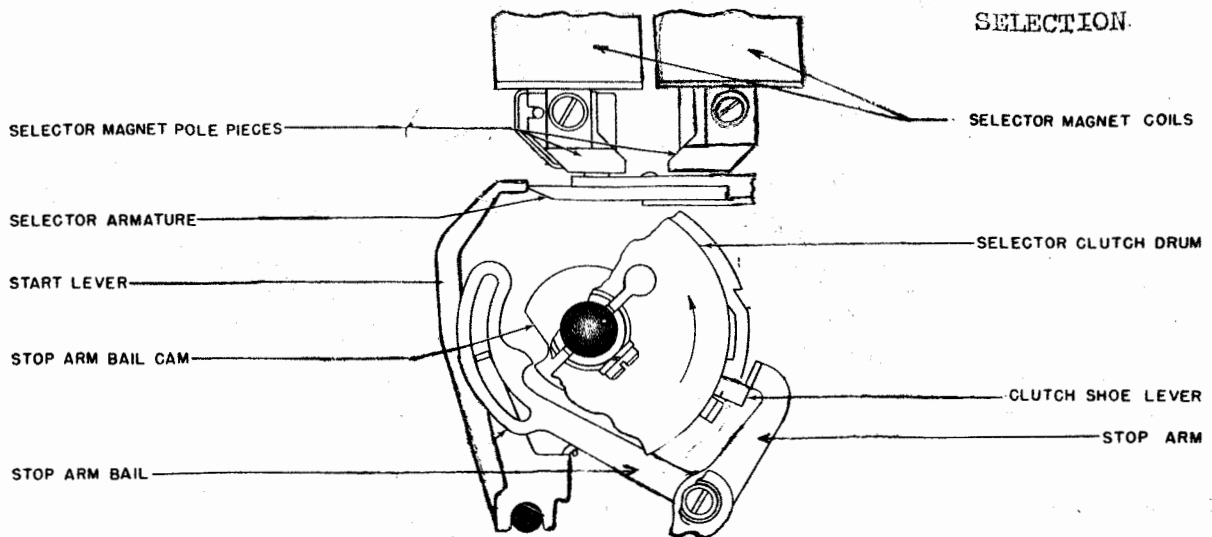
TRANSFER LEVER

LOCKING BAIL
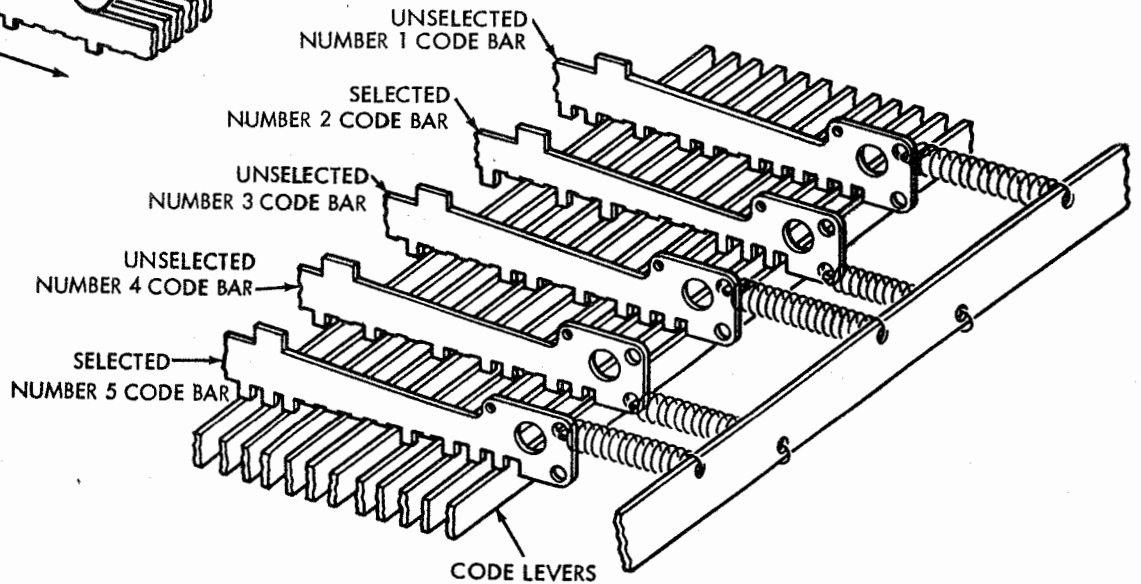
CODE BAR

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

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

SPACING LOCK LEVER

MARKING LOCK LEVER

SELECTOR ARMATURE

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

SELECTING LEVER to move behind

PUSH LEVER drops down

SELECTING LEVER moves

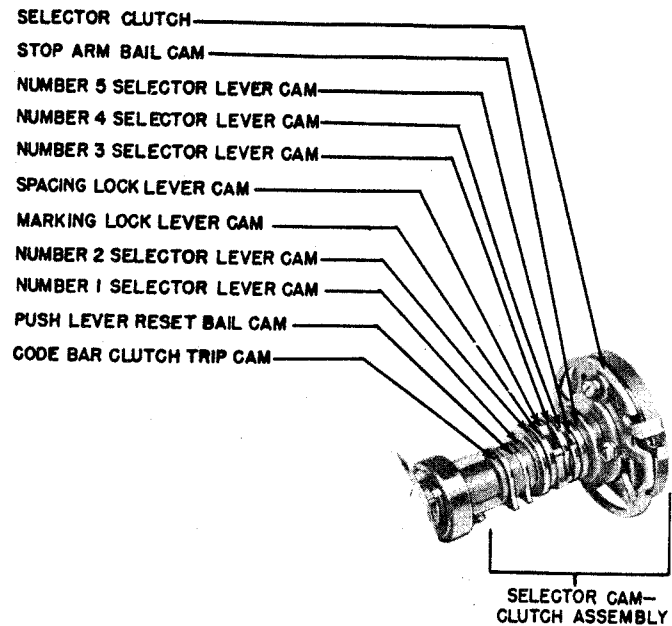PUSH LEVER forward to its marking position

ARMATURE unattracted (spacing) blocks

MARKING LOCK LEVER

MARKING LOCK LEVER EXTENSIONS block

SELECTING LEVER causing PUSH LEVER to remain on top of SELECTING LEVER and to the rear in its spacing position

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 I SELECTOR LEVER CAM
PUSH LEVER RESET BAIL CAM
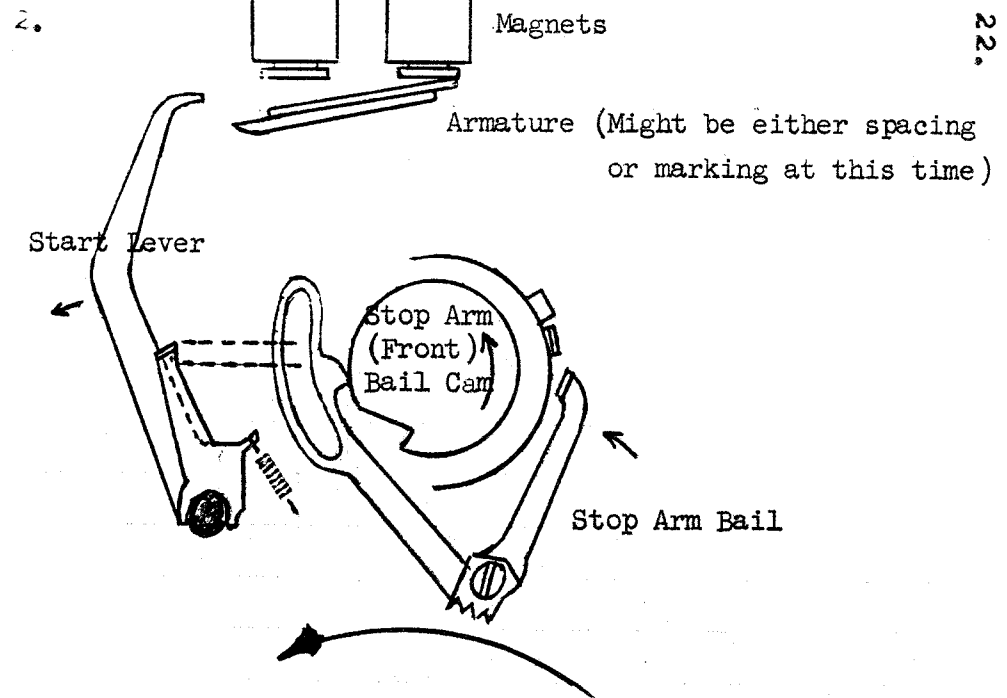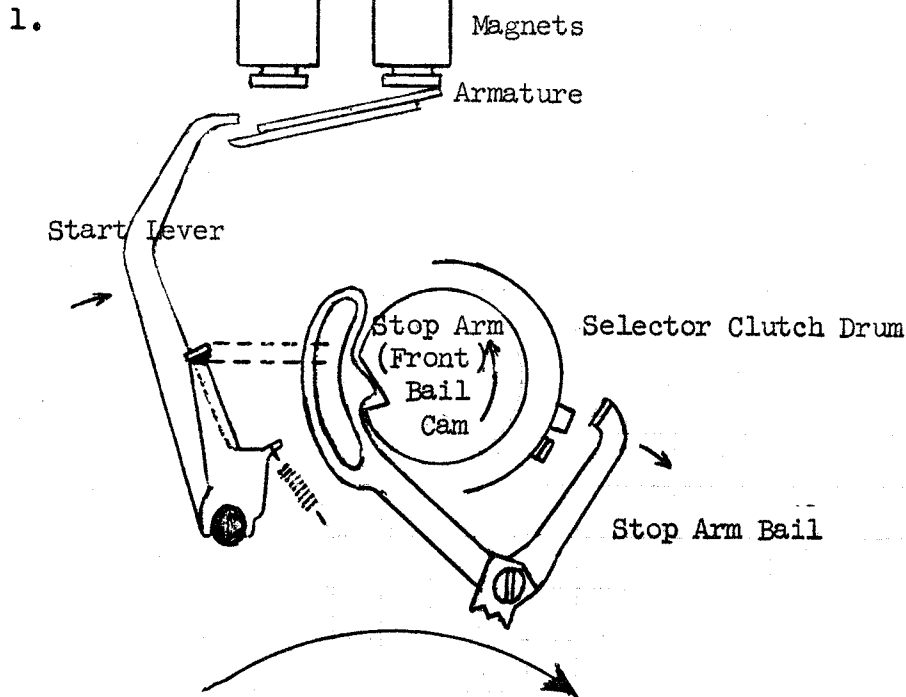CODE BAR CLUTCH TRIP CAM

SELECTOR CAM—
CLUTCH ASSEMBLY

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.
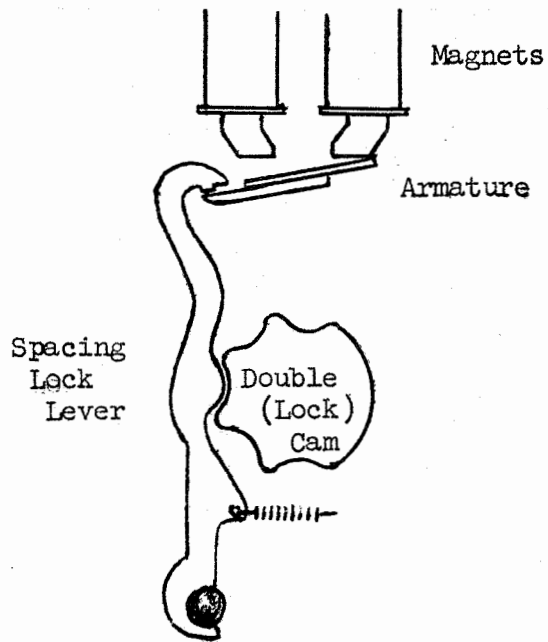
NOTE: Because of the Stop Arm Bail Cam (Front Cam) has only one indent, the Start lever may not fall over the armature again during the cycle.
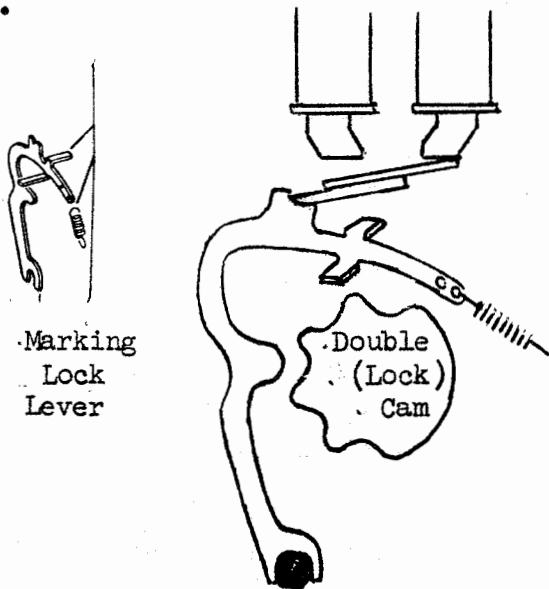
1.

Magnets
Armature
Start Lever
Stop Arm (Front) Bail Cam
Selector Clutch Drum
Stop Arm Bail

2.

Magnets
Armature (Might be either spacing or marking at this time)
Start Lever
Stop Arm (Front) Bail Cam
Stop Arm Bail

22.

Magnets

Armature

Spacing
Lock
Lever

Double
(Lock)
Cam

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 Selector Lever moves to the rear slightly, but not far enough to allow the Push Lever to drop down on to the Selector Lever Guide.
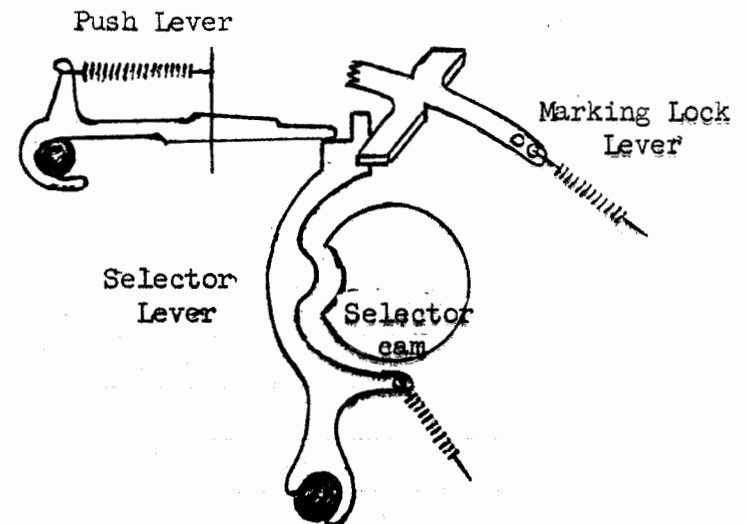
NOTE: BETWEEN EACH PULSE, THE MARKING AND SPACING LOCK LEVERS RIDE TO A HIGH PART OF THE DOUBLE CAM AND MOVE CLEAR OF THE ARMATURE.
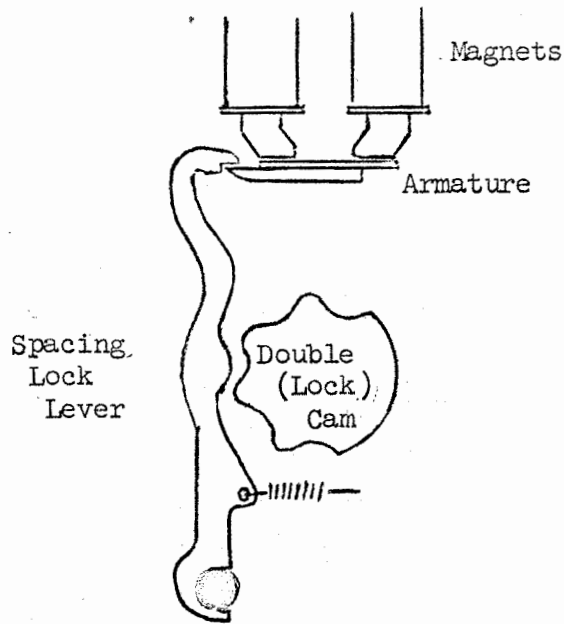
2.

Marking
Lock
Lever

Double
(Lock)
Cam

3.

Push Lever

Marking Lock
Lever

Selector
Lever

Selector
cam

Magnets

Armature

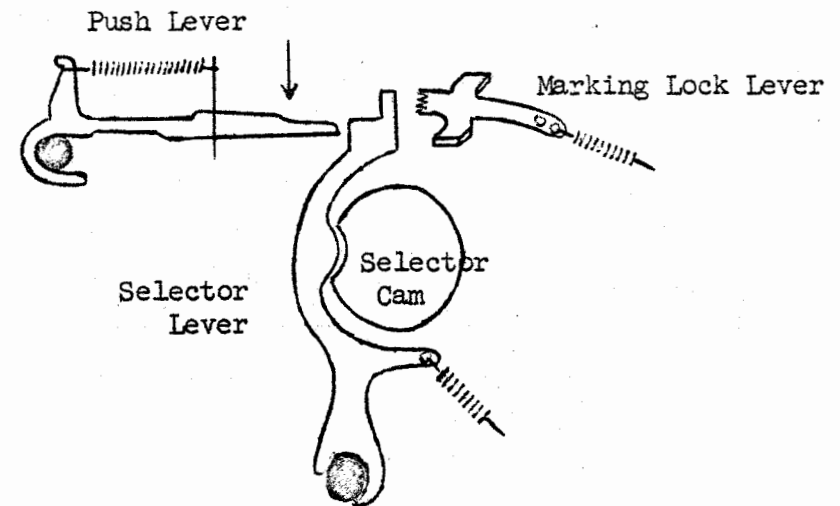Spacing
Lock
Lever

Double
(Lock)
Cam

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
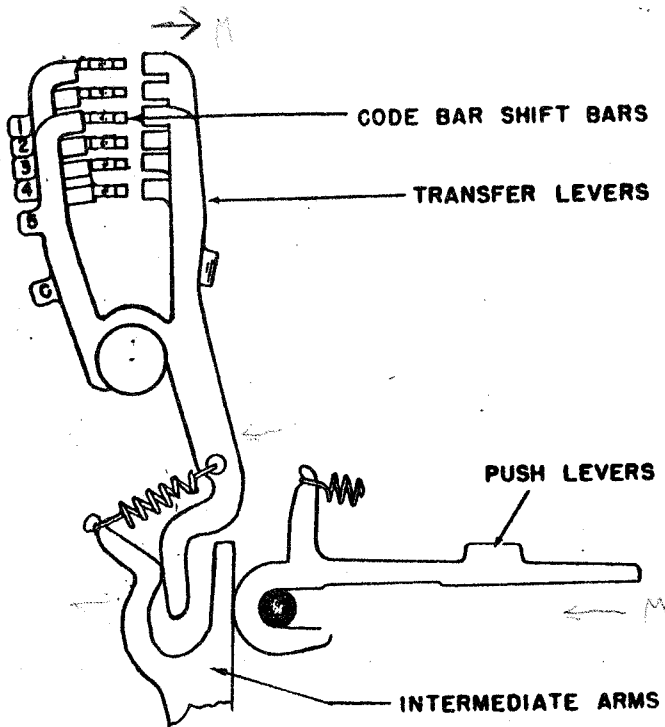RIDE TO A HIGH PART OF THE DOUBLE CAM AND MOVE CLEAR OF THE
ARMATURE EXTENSION.

2.

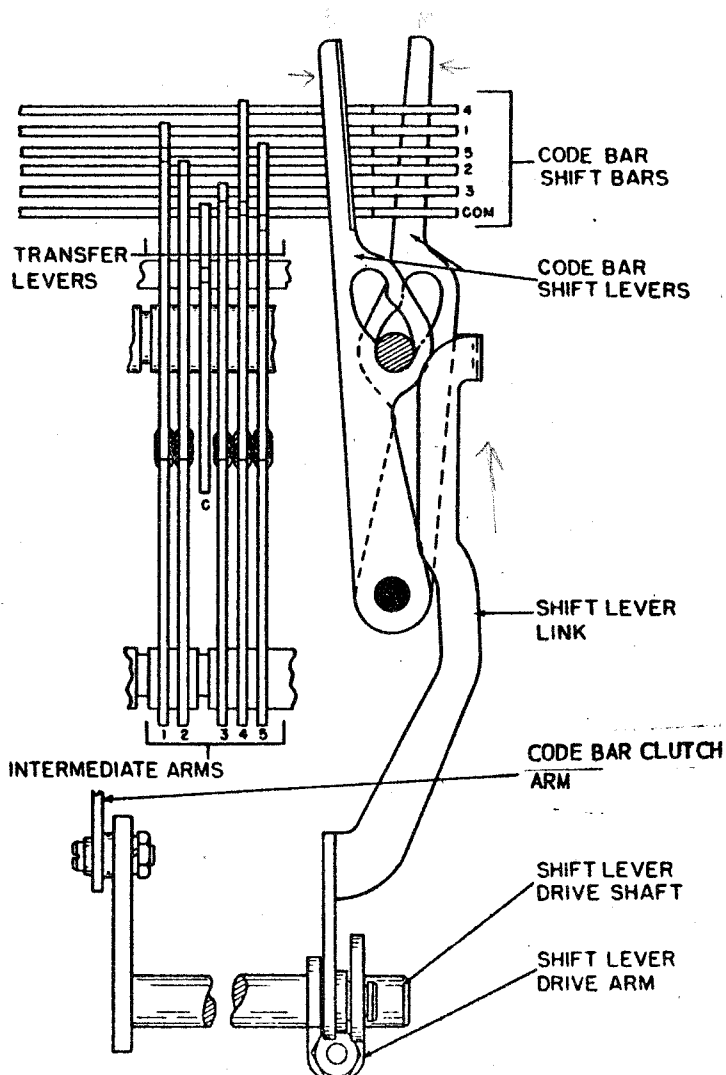Magnets

Armature

Marking
Lock
Lever

Double
(Lock)
Cam

3.

Push Lever

Marking Lock Lever

Selector
Lever
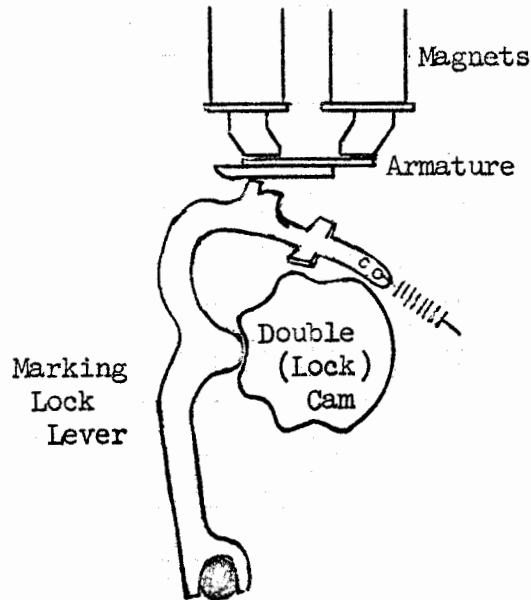
Selector
Cam

24.

M28 PRINTER

CODE BAR POSITIONING MECHANISM

CODE BAR SHIFT BARS

TRANSFER LEVERS

PUSH LEVERS

INTERMEDIATE ARMS

PUSH LEVERS operate

INTERMEDIATE ARMS operate

TRANSFER LEVER SPRINGS and
TRANSFER LEVERS to hold

CODE BAR SHIFT BARS against
  marking (rear) or
  spacing (front)
  CODE BAR SHIFT LEVERS

CODE BAR
SHIFT BARS

TRANSFER
LEVERS

CODE BAR
SHIFT LEVERS

SHIFT LEVER
LINK

INTERMEDIATE ARMS

CODE BAR CLUTCH
ARM

SHIFT LEVER
DRIVE SHAFT

SHIFT LEVER
DRIVE ARM

then,

SELECTOR CAM SLEEVE operates

CODE BAR CLUTCH TRIP LEVER ARM
  which trips

CODE BAR CLUTCH drives

SHIFT LEVER DRIVE SHAFT,
SHIFT LEVER DRIVE ARM, and
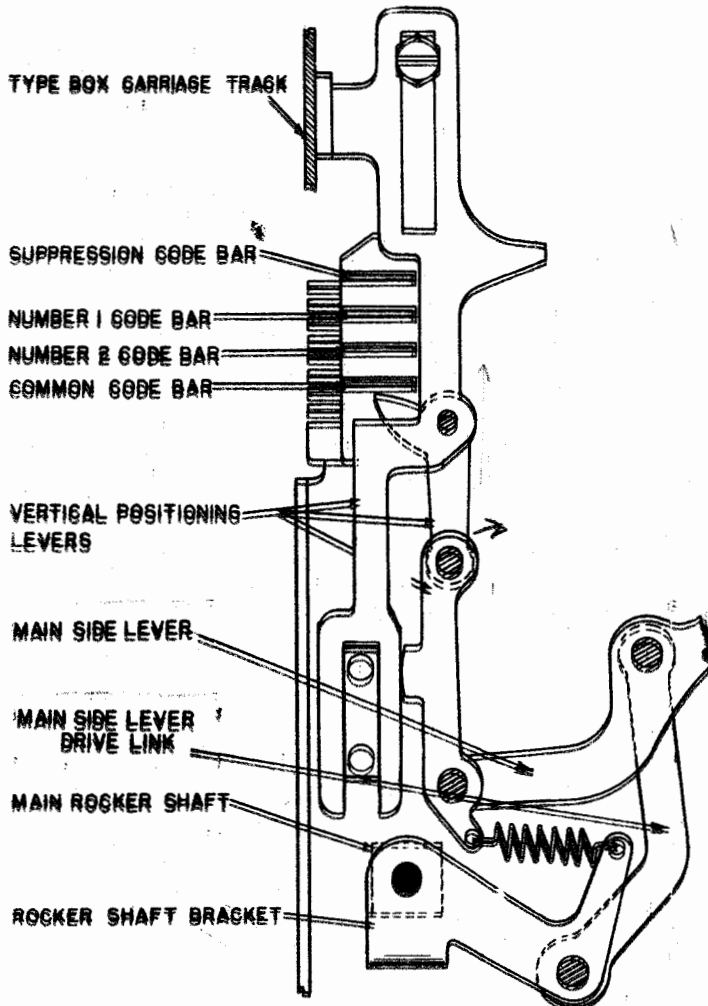SHIFT LEVER DRIVE LINK cams

CODE BAR SHIFT LEVERS position

CODE BAR SHIFT BARS and
CODE BARS to the left (marking
  or to the right (spacing)

LETTERS

LOWERMOST CODE BAR		LEFT				RIGHT			
		4 & 5 MARKING	4 MARKING 5 SPACING	4 SPACING 5 MARKING	4 & 5 SPACING	4 & 5 SPACING	4 SPACING 5 MARKING	4 MARKING 5 SPACING	4 & 5 MARKING
COMM	TOP ROW	M --345	N --34-	H --3-5	SPACE --3--	BLANK -----	T ----5	C.R. ---4-	O ---45
2	2ND ROW	X 1-345	F 1-34-	Y 1-3-5	S 1-3--	E 1----	Z 1---5	D 1--4-	B 1--45
1	3RD ROW	V -2345	C -234-	P -23-5	I -23--	L.F. -2---	L -2--5	R -2-4-	G -2-45
SUPP	BOTTOM ROW	LETTERS 12345	K 1234-	Q 123-5	U 123--	A 12---	W 12--5	J 12-4-	FIGURES 12-45
		3 MARKING				3 SPACING			
		4TH ROW	3RD ROW	2ND ROW	1ST ROW	1ST ROW	2ND ROW	3RD ROW	4TH ROW

TYPE BOX CARRIAGE TRACK

SUPPRESSION CODE BAR

NUMBER I CODE BAR

NUMBER 2 CODE BAR

COMMON CODE BAR

VERTICAL POSITIONING LEVERS

MAIN SIDE LEVER

MAIN SIDE LEVER DRIVE LINK

MAIN ROCKER SHAFT

ROCKER SHAFT BRACKET

Right Side Mechanism

As the code bar clutch rotates, a cam follower actuates the clutch trip lever shaft which trips off both the function clutch and the type box clutch.

Function 1st, Type Box 2nd

TYPE BOX CLUTCH, through a drive link and the left rocker shaft bracket, rotates the

ROCKER SHAFT and the right rocker shaft bracket

ROCKER SHAFT BRACKETS drive

MAIN SIDE LEVER DRIVE LINKS move

MAIN SIDE LEVERS move

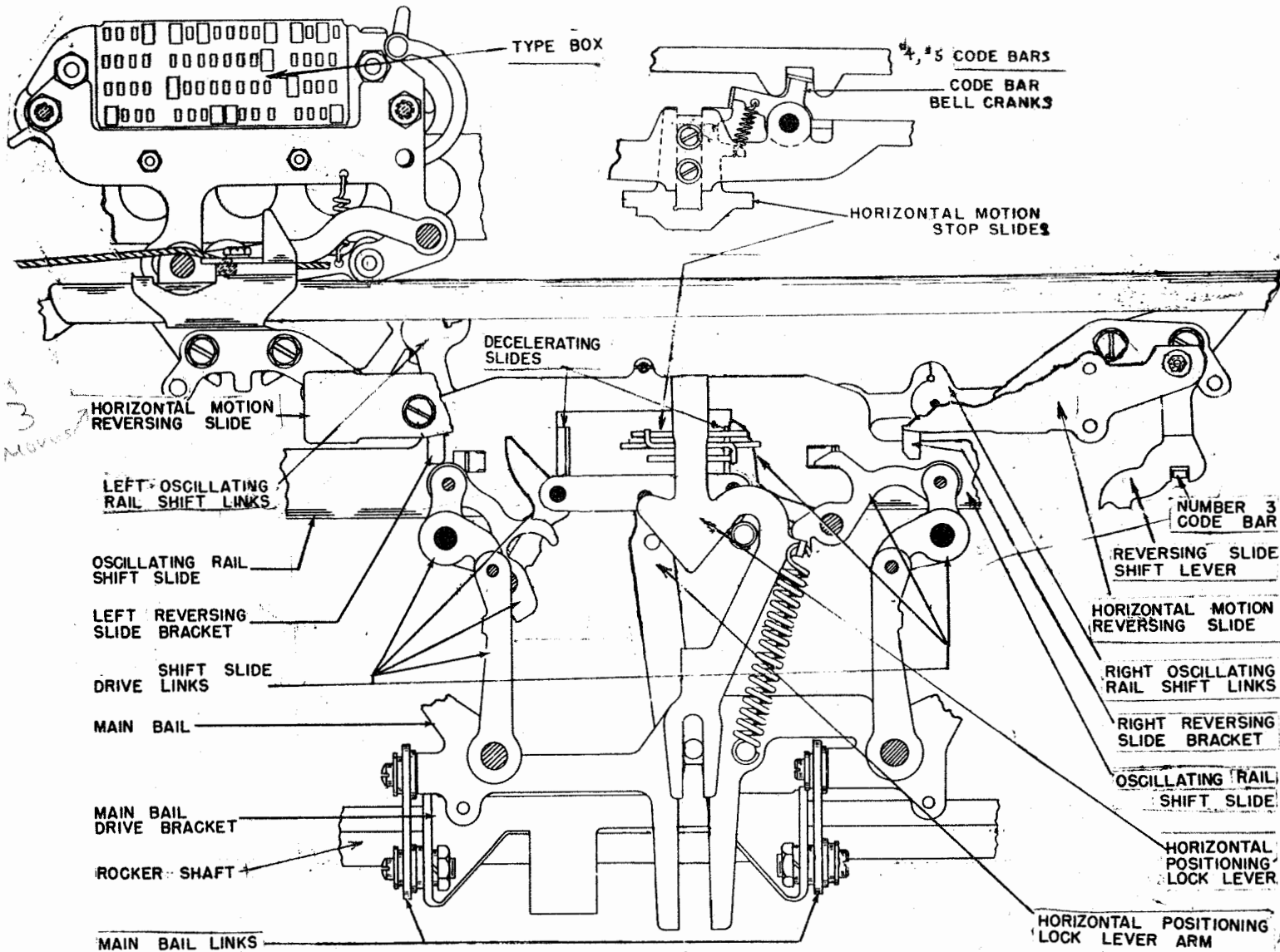VERTICAL POSITIONING LEVERS raise

TYPE BOX CARRIAGE TRACK and TYPE BOX

VERTICAL POSITIONING LEVER TOE buckles against lowermost CODE BAR in its path to select printing level of type box.

The #4 and #5 CODE BARS through the CODE BAR BELL CRANKS control the HORIZONTAL STOP SLIDES

The #3 CODE BAR, through the REVERSING SLIDE SHIFT LEVER, the REVERSING SLIDE and the REVERSING SLIDE BRACKETS will disable the LEFT SHIFT SLIDE DRIVE LINK when the #3 code bar is spacing, and will disable the RIGHT SHIFT SLIDE DRIVE LINK when the #3 code bar is marking.

As the TYPE BOX CLUTCH rotates, the ROCKER SHAFT moves the MAIN BAIL DRIVE BRACKET and the MAIN BAIL LINKS to pull the MAIN BAIL down. The undisabled SHIFT SLIDE DRIVE LINK, through its DECELERATING SLIDE, initiates the motion of the OSCILLATING RAIL SHIFT SLIDE. This motion is completed by the HORIZONTAL POSITIONING LOCK LEVER which through its LOCK LEVER ARM moves the OSCILLATING RAIL SHIFT SLIDE against the longest of the HORIZONTAL STOP SLIDES in its path. The OSCILLATING RAIL SHIFT SLIDE drives the OSCILLATING RAIL SHIFT LINKS and the OSCILLATING RAIL to move the TYPE BOX horizontally to its selected printing row.
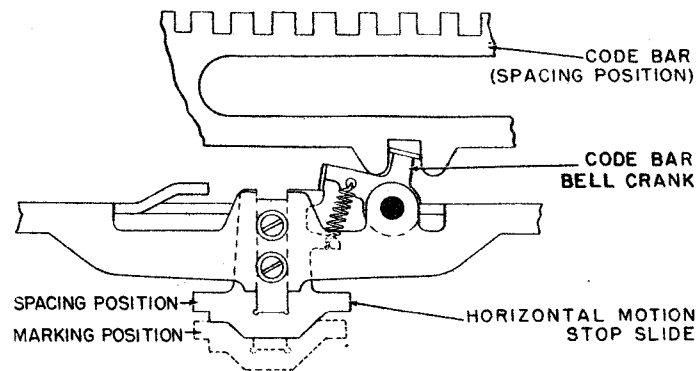
28.

FIGURE 2-48. STOP SLIDE POSITIONING

View, looking down, of the relationship between the horizontal stop slides and the code bars which position them.. The middle, or Common stop slide, DOES NOT HAVE A CODE BAR ASSOCIATED WITH IT. It is merely spring loaded to the rear (SPACING) Movement of the code bar to the left (MARKING) causes the bell crank to push the associated slide to the front. Either the upper or lower slide will carry the middle (Common) slide forward.
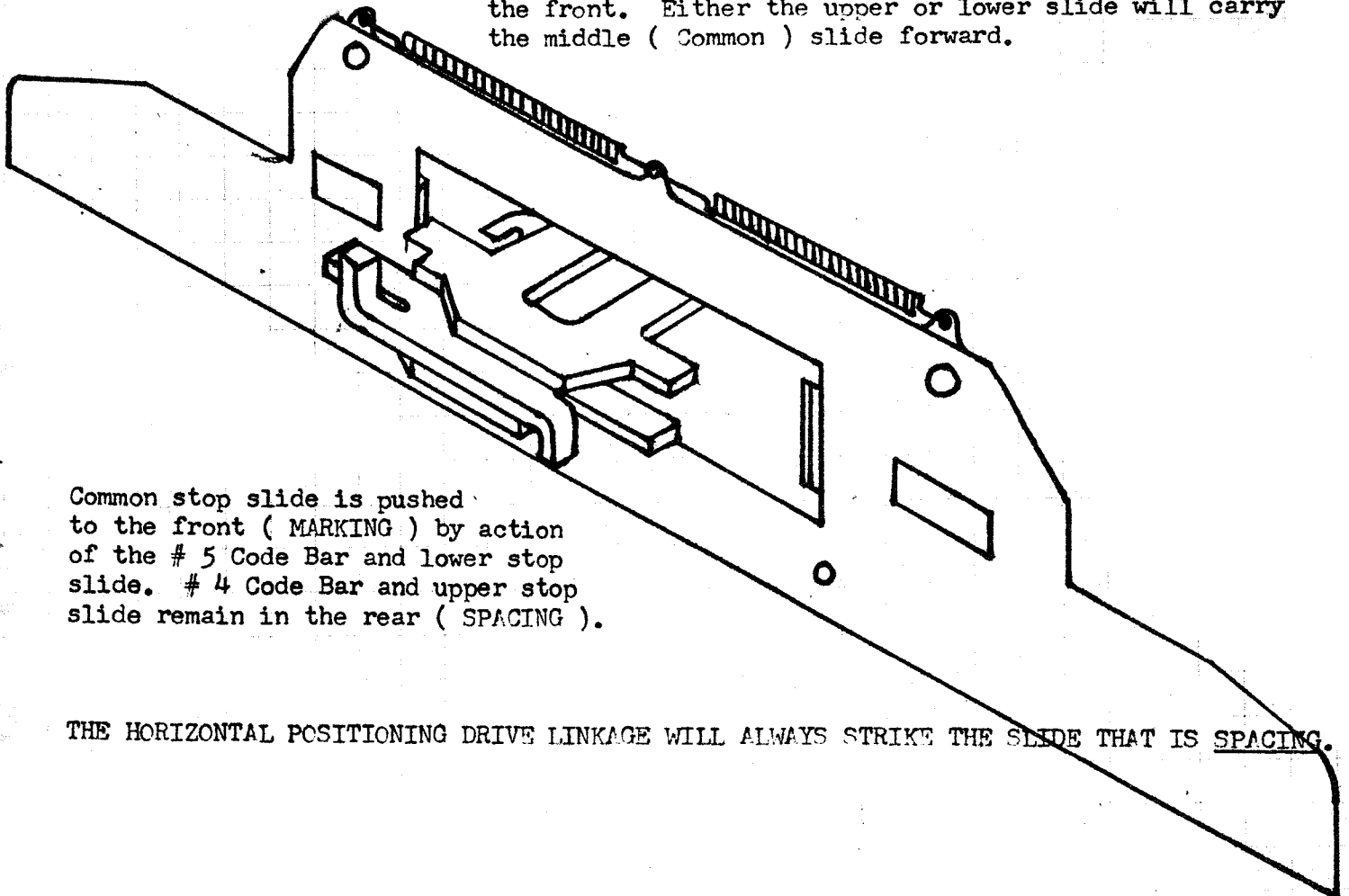

Common stop slide is pushed to the front (MARKING) by action of the # 5 Code Bar and lower stop slide. # 4 Code Bar and upper stop slide remain in the rear (SPACING).

THE HORIZONTAL POSITIONING DRIVE LINKAGE WILL ALWAYS STRIKE THE SLIDE THAT IS SPACING.

1.) #3 Code Bar SPACING, Left linkage partially buckled.
#4 & #5 Code bar, upper & lower horizontal stop slides
and common stop slide SPACING.

The horizontal linkage drives to the LEFT, moving
the typebox to the left. Linkage strikes the SHOULDER
of the common horizontal stop slide. The linkage
has traveled the LEAST distance and, consequently
the hammer will strike   in the first row to the
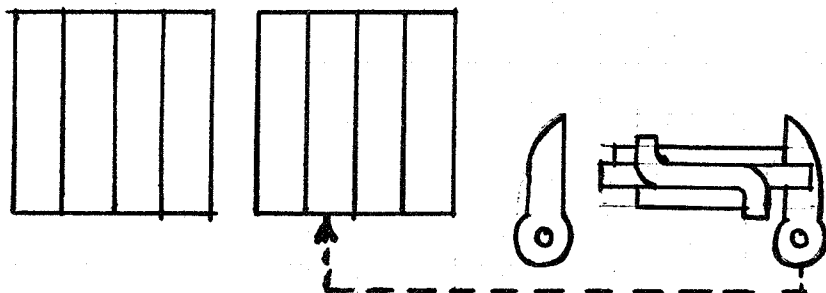right of center.
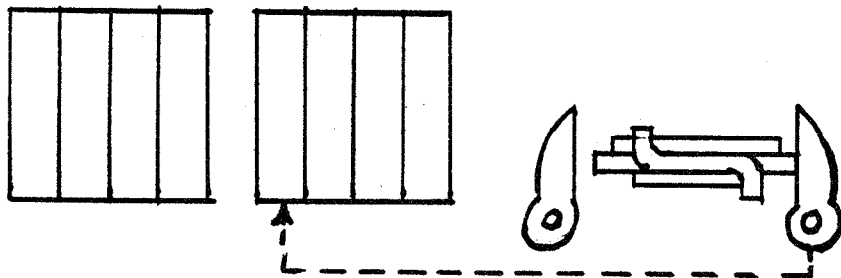
3.) #3 Code Bar MARKING, Right linkage partially buckled.
#4 "   "   "   , Upper & middle slides to front
#5 "   "   SPACING, Lower slide to rear

The horizontal linkage drives to the RIGHT, moving
the typebox to the right. Linkage strikes the SHOULDER
of the Lower stop slide. The linkage has traveled
to its third stop and, consequently, the hammer
will strike three rows to the left of center.
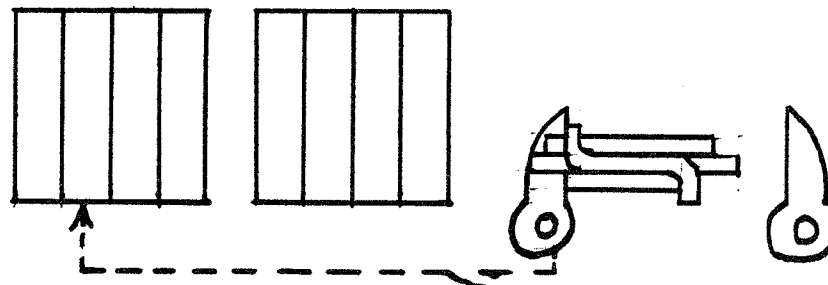
2.) #3 Code Bar SPACING, Left linkage partially buckled.
#4 "   "   "   , Upper stop slide in rear
#5 "   "   MARKING, Lower & common slides to front.

The horizontal linkage drives to the LEFT, moving
the typebox to the left. Linkage stikes the SHOULDER
of the Upper slide. The linkage has traveled to its
second stop and, consequently, the hammer will strike
in the second row to the right of center.

4.) #3 Code Bar MARKING, Right linkage partially buckled.
#4 "   "   "   , Upper slide to front
#5 "   "   "   , Lower & common slide to front.

The horizontal linkage drives to the RIGHT, moving
the typebox to the right. Linkage strikes the SHANK
of the common stop slide. The linkage has traveled
to its fourth stop and, consequently, the hammer
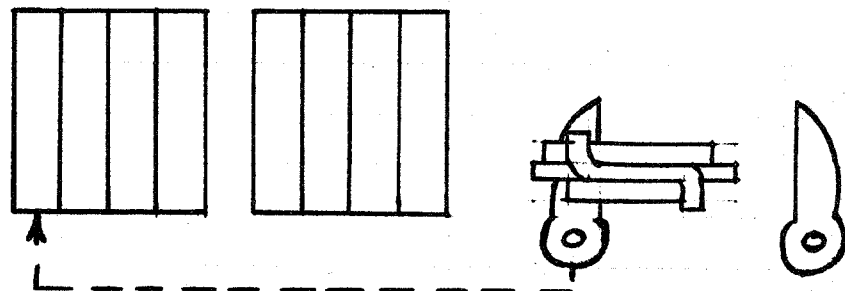will strike four rows to the left of center.

FILL IN THE SQUARES WITH THE TELETYPE CODE BY USING THE VERTICAL AND HORIZONTAL

PICTURES INDICATED BELOW

HAMMER

3 M

3 S

HORIZONTAL SLIDE TO REAR - S
HORIZONTAL SLIDE FORWARD - M

M   S

SUP

*1

*2

COM

*4

--- COM

*5

SHANK
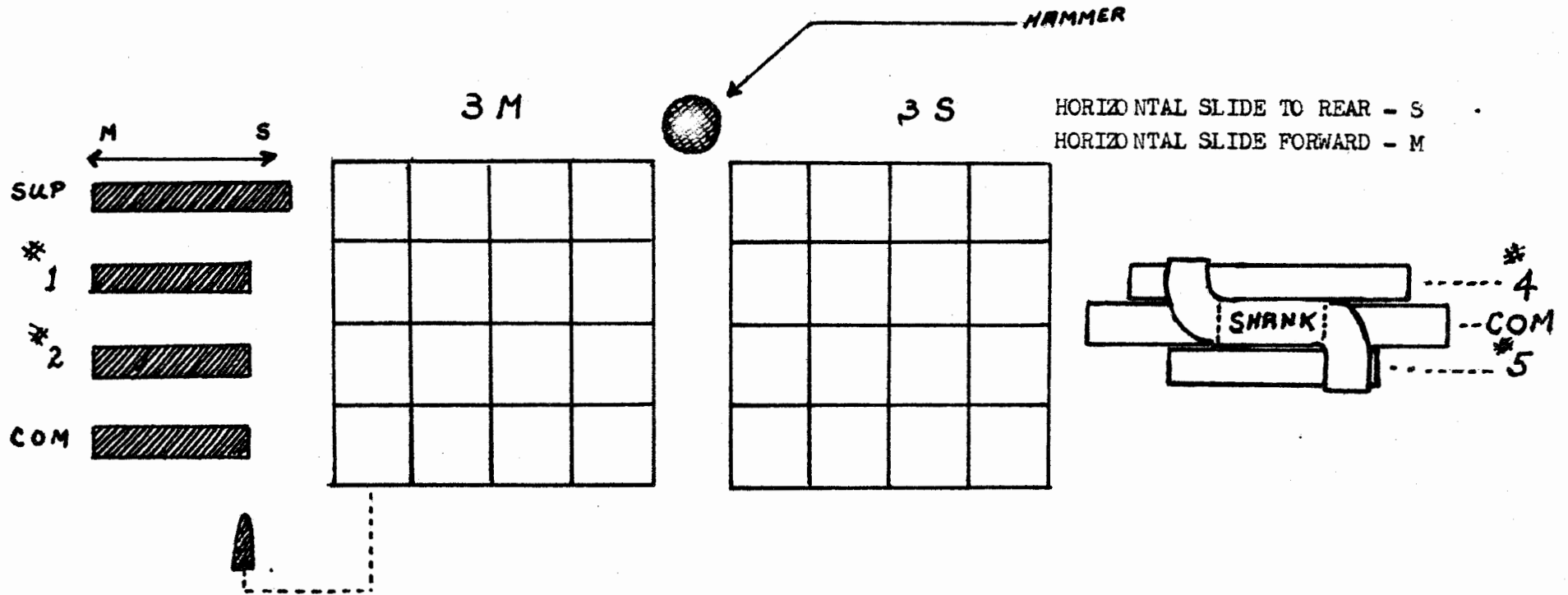
VERTICAL POSITIONING

Rule:

    If #1 marks common marks

    If #2 marks common marks

    If #1 & #2 mark common marks

    If #1 & #2 space common spaces

HORIZONTAL POSITIONING

Rule:

    If #4 marks common marks

    If #5 marks common marks

    If #4 & #5 mark common marks

    If #4 & #5 space common spaces

M28 PRINTER   PRINTING MECHANISM
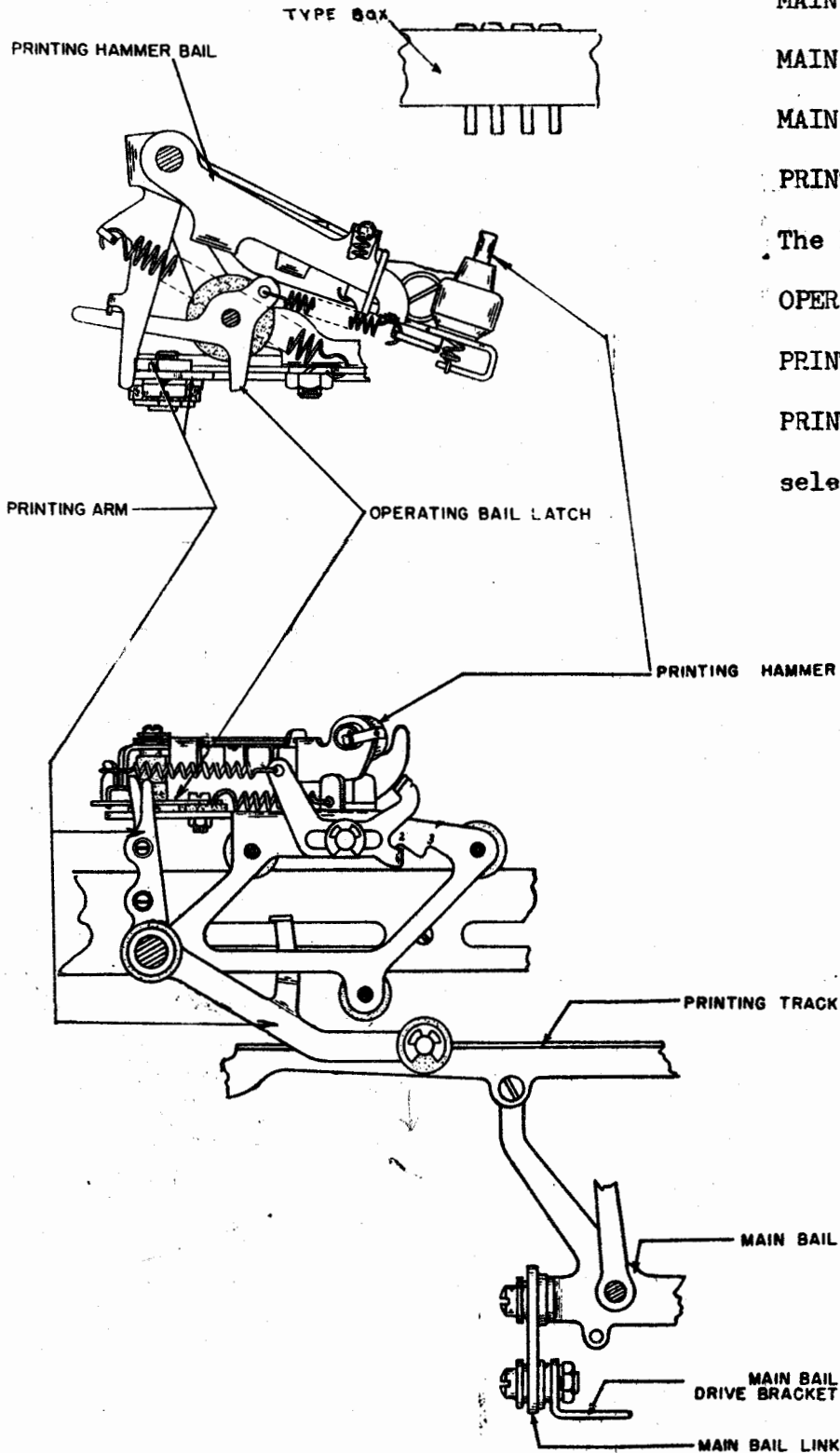
TYPE BOX

PRINTING HAMMER BAIL

PRINTING ARM

OPERATING BAIL LATCH

PRINTING HAMMER

PRINTING TRACK

MAIN BAIL

MAIN BAIL DRIVE BRACKET

MAIN BAIL LINK

As the TYPE BOX CLUTCH rotates, the

ROCKER SHAFT moves the

MAIN BAIL DRIVE BRACKET,

MAIN BAIL LINKS,

MAIN BAIL, and the

PRINTING TRACK downward.

The PRINTING ARM actuates the

OPERATING BAIL LATCH to unlatch the

PRINTING HAMMER BAIL and

PRINTING HAMMER which strikes the

selected TYPE PALLET.

M28 PRINTER

SPACING MECHANISM

SPACING CLUTCH TRIP LEVER ARM

ROCKER SHAFT
CAM PLATE

ROCKER SHAFT

SPACING CLUTCH
TRIP LEVER

SPACING TRIP LEVER BAIL
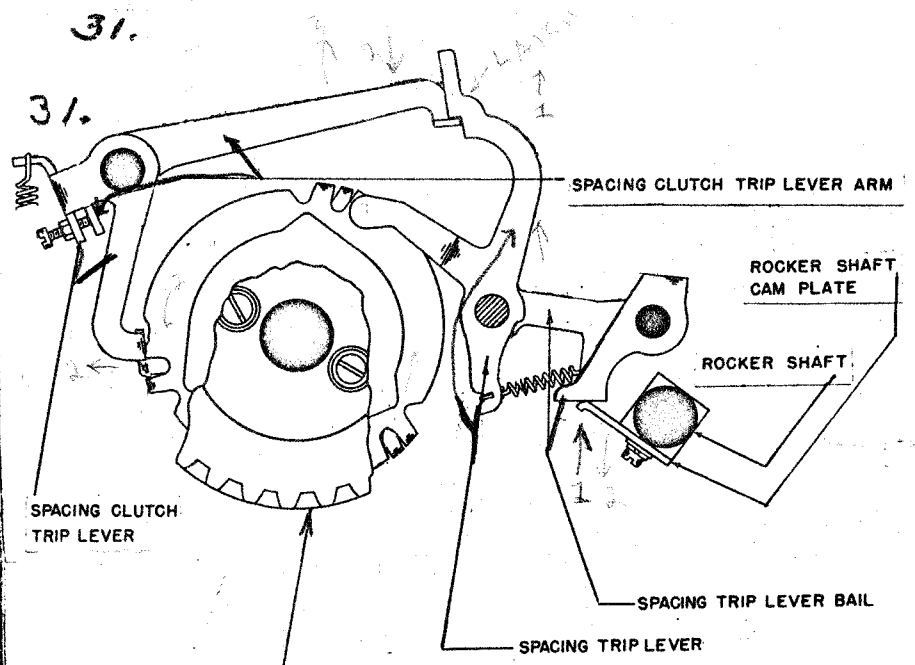
SPACING TRIP LEVER

As the TYPE BOX CLUTCH rotates, the

ROCKER SHAFT and the

ROCKER SHAFT CAM PLATE actuate the

SPACING TRIP LEVER BAIL moves the

SPACING TRIP LEVER past the

SPACING CLUTCH TRIP LEVER ARM.

SPACING TRIP LEVER BAIL SPRING moves

SPACING TRIP LEVER moves

SPACING CLUTCH TRIP LEVER ARM moves

SPACING CLUTCH TRIP LEVER trips

SPACING CLUTCH rotates

SPACING SHAFT DRIVING GEAR drives

SPACING SHAFT DRIVEN GEAR rotates

SPACING ECCENTRICS drive

SPACING DRUM FEED PAWLS advance

SPACING DRUM rotates
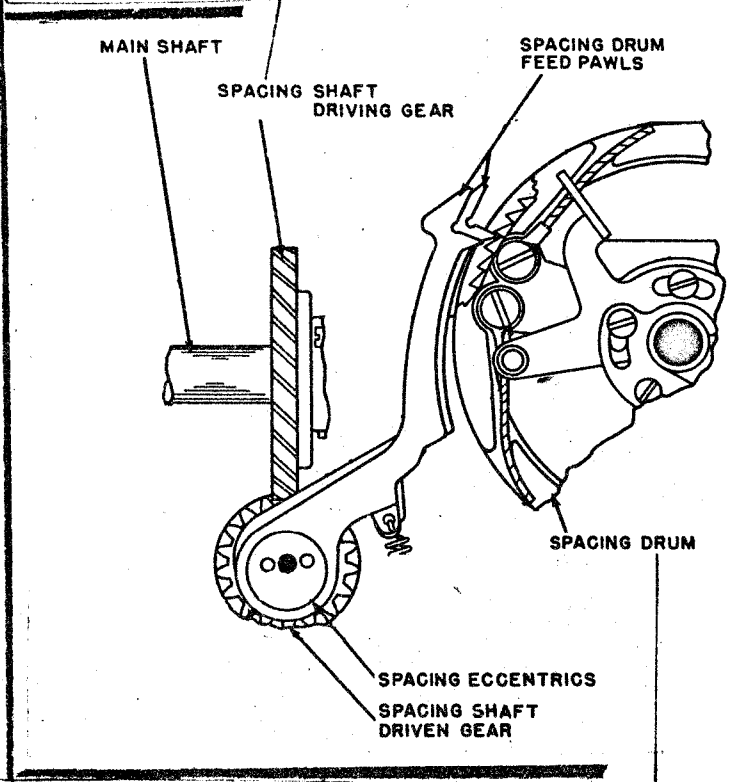
DRAW WIRE ROPE MECHANISM to space
the PRINTING CARRIAGE and the
TYPE BOX CARRIAGE.

MAIN SHAFT

SPACING SHAFT
DRIVING GEAR

SPACING DRUM
FEED PAWLS

SPACING DRUM

SPACING ECCENTRICS

SPACING SHAFT
DRIVEN GEAR

PRINTING CARRIAGE
TYPE BOX CARRIAGE LINK

OSCILLATING RAIL SLIDE
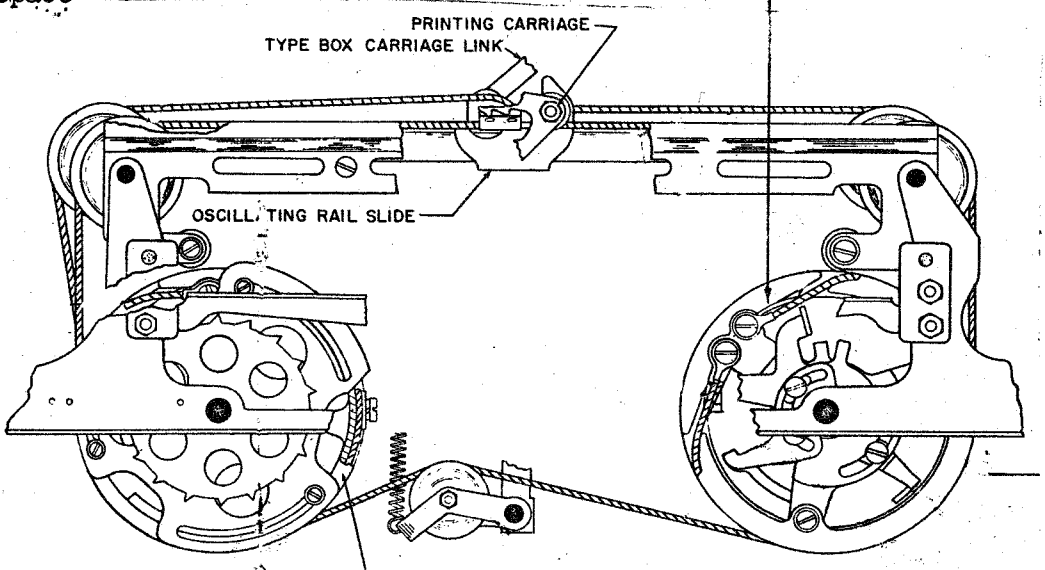
M28 PRINTER

FUNCTION MECHANISM

← front   rear →

FUNCTION LEVER

FUNCTION PAWL
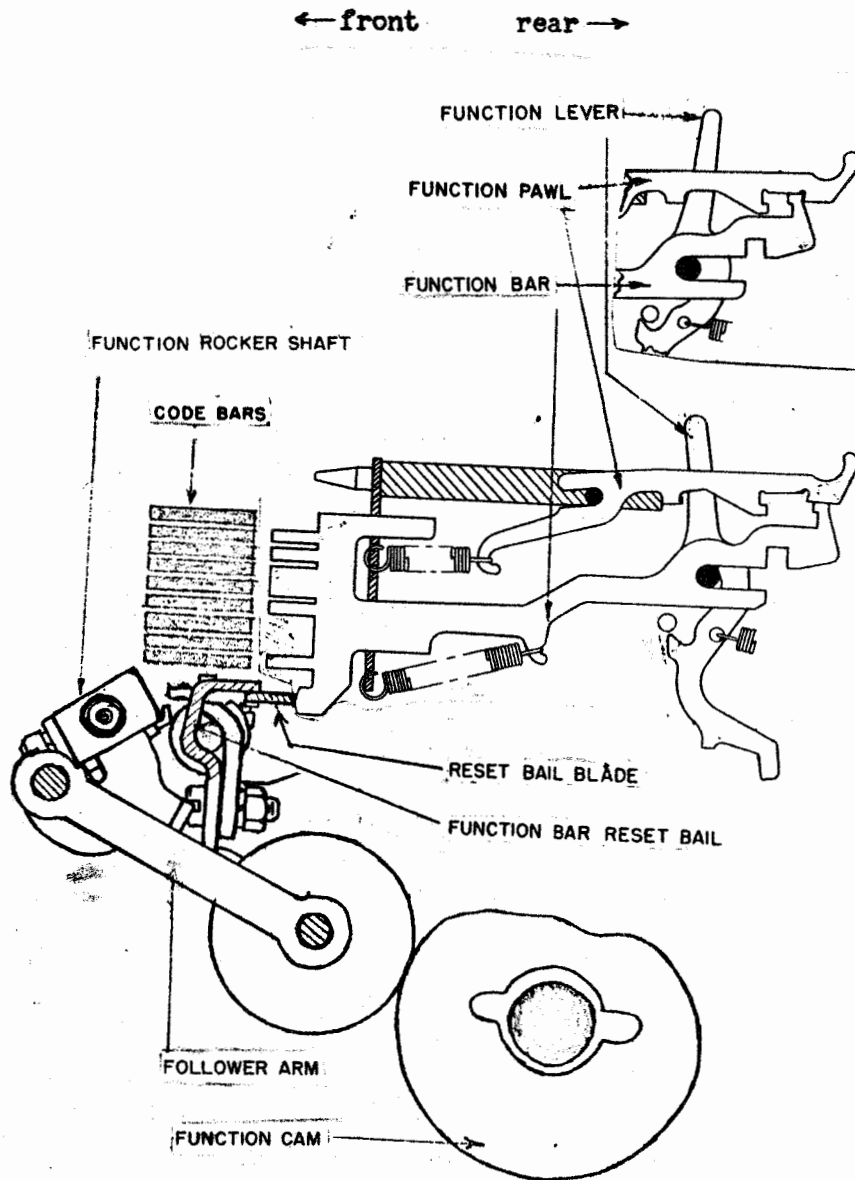
FUNCTION BAR

function bar selected

FUNCTION ROCKER SHAFT

CODE BARS

function bar unselected

RESET BAIL BLADE

FUNCTION BAR RESET BAIL

FOLLOWER ARM

FUNCTION CAM

CODE BARS

SELECTED FUNCTION BAR

UNSELECTED FUNCTION BAR

As the code bar clutch rotates, through its cam follower and the clutch trip shaft, the function clutch and the type box clutch are tripped off.

FUNCTION CLUTCH AND FUNCTION CAM operate

FUNCTION ROCKER SHAFT cams

FUNCTION BAR RESET BAIL and RESET BAIL BLADE withdraw to let

FUNCTION BARS sense

CODE BARS block UNSELECTED FUNCTION BARS but unblock

SELECTED FUNCTION BAR moves forward to let

FUNCTION PAWL drop over rear of SELECTED FUNCTION BAR

RESET BAIL BLADE moves to the rear to operate

SELECTED FUNCTION BAR moves

FUNCTION PAWL moves

FUNCTION LEVER actuates associated

FUNCTION MECHANISM or CONTACT

FRONT OF
MACHINE

SPACING TINE

TOP VIEW

SPACING

MARKING TINE

MARKING

TINES

CODE BARS

FUNCTION
BAR

SUP — PRINT

4

1

5

2

3

} 5 UNIT CODE

COMMON

0 — SELECT

S — LTRS—FIGS CASE

END VIEW
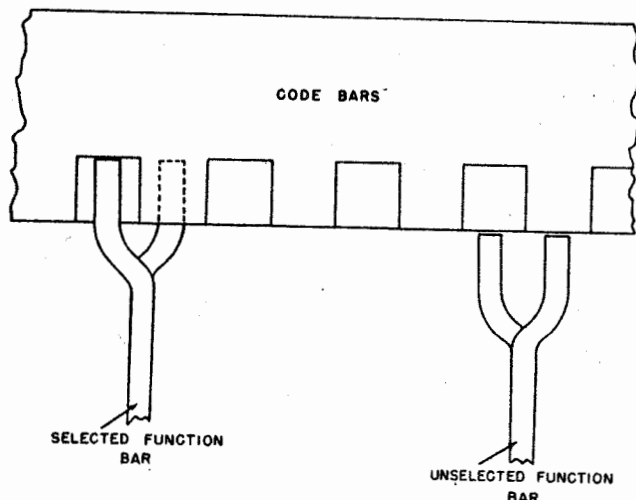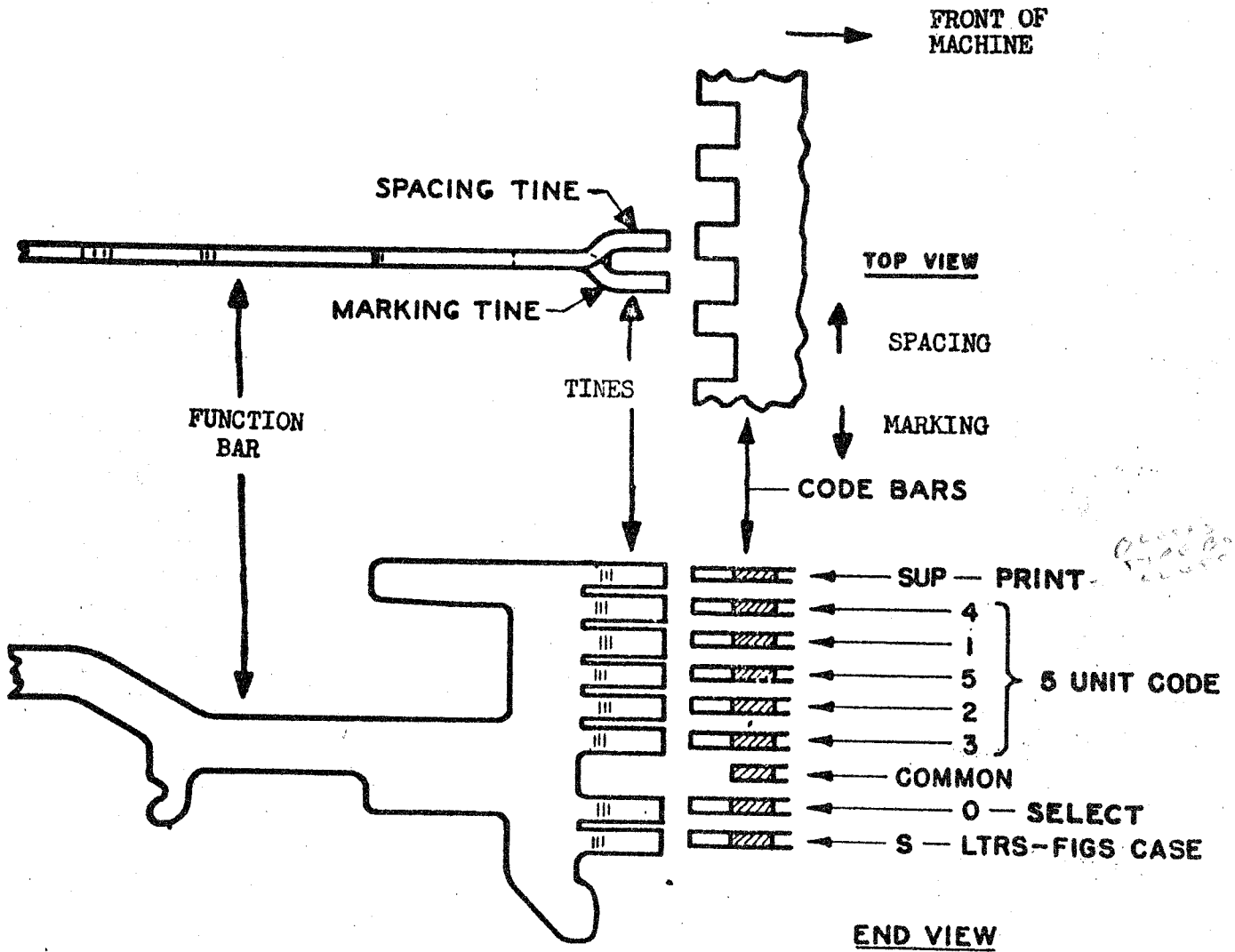
**EACH TINE MAY BE FORMED TO PERMIT OPTIONAL SELECTION WHEN
THE ASSOCIATED CODE BAR IS TOWARD THE LEFT (MARKING) OR
RIGHT (SPACING).   SELECTION IS PERMITTED IN EITHER CASE
IF THE TINE IS OMITTED.**

Fig. 3 — Function Bar

FUNCTION PAWL
NOT ENGAGED

FUNCTION LEVER

FUNCTION BAR

FUNCTION BAR BLOCKED
BY CODE BARS

FIG. 1 - Operation of a Printer Function

FUNCTION LEVER

PAWL ENGAGED

FUNCTION BAR HAS
ENTERED CODE BARS 9

FIG. 2 - Operation of a Printer Function

PAWL ACTUATES FUNCTION LEVER

LEVER OPERATES SLIDE

CLUTCH FREE TO ROTATE

FUNCTION BAR
RESET BAIL

FIG. 3 - Operation of a Printer Function

PAWL DISENGAGED

STRIPPER BLADE

FIG. 4 - Operation of a Printer Function
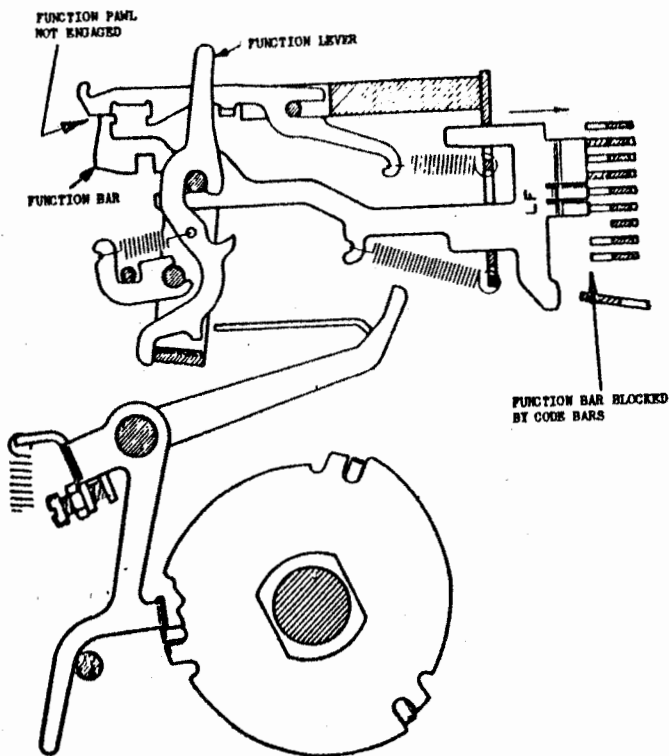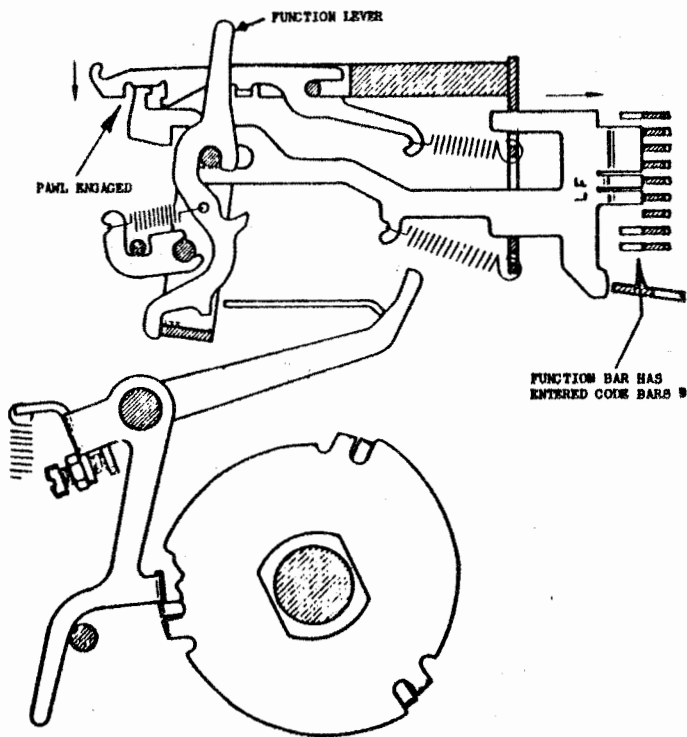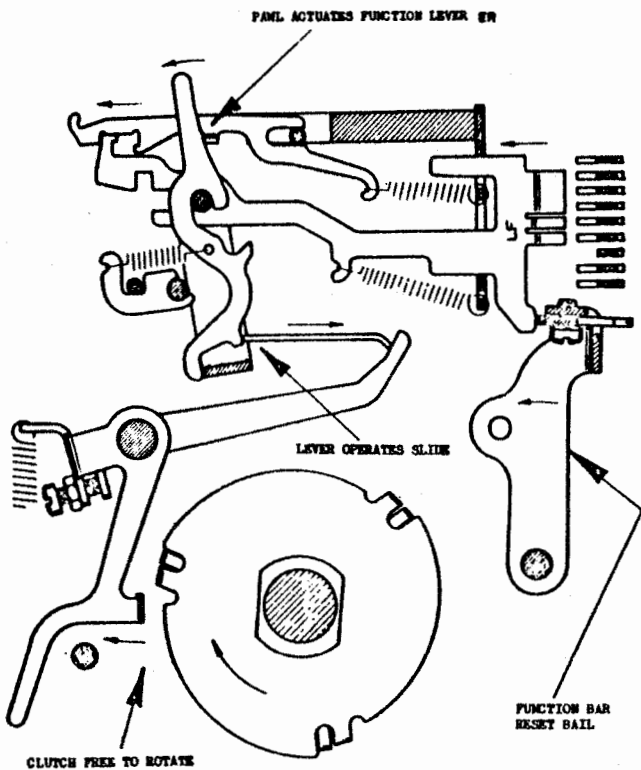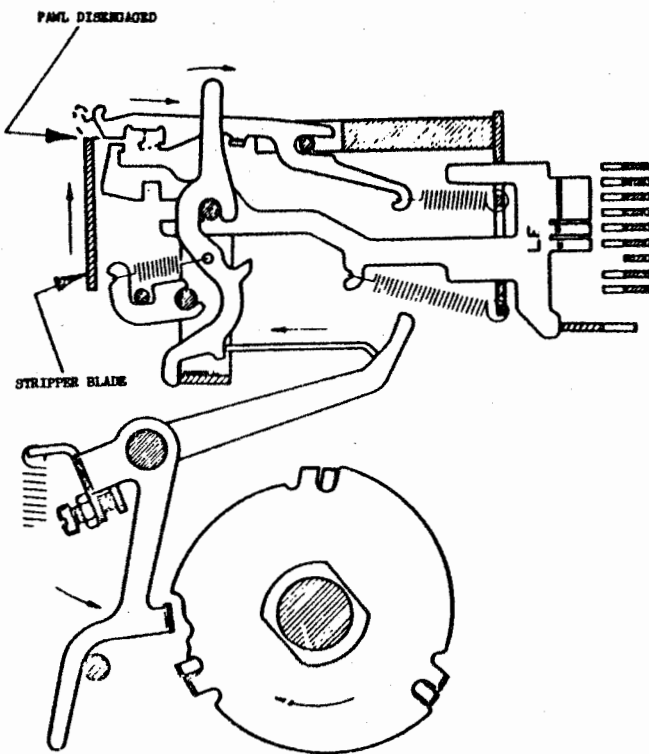
UNIVERSAL FUNCTION BAR 153440

SIDE VIEW · FRONT VIEW

MARKING TINES — SPACING TINES

SUPPRESSION
4TH PULSE
1ST PULSE
5TH PULSE
2ND PULSE
3RD PULSE
ZERO
FIGS.–LTRS

A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z FIGS. LTRS. CR. LF.

SPACE · BLANK · UNIVERSAL OR (COMMON) · PRINT CASE · NON PRINT CASE OR (STUNT CASE) · SELECT CASE · NON SELECT CASE

FIGS. CASE · LETTERS CASE

NOTE: A function bar coded for a particular character can be coded in addition for print or non print case, Select or non-select case, Figs. or Ltrs. Case, or any combination thereof.

KEY
□ BREAK OUT TINE
■ LEAVE IN TINE

LATCHING PROJECTION

((IN NON OPERATED POSITION FUNCTION
BAR BLOCKED BY PROJECTION AT "X")

BLOCKING PROJECTION

"FIGS" FUNCTION BAR

"H" FUNCTION BAR

STRIPPER
BLADE

SUBSEQUENT
UPWARD
MOTION

NORMAL
POSITION

INITIAL
DOWNWARD
MOTION

FUNCTION LEVER LATCH

Fig. 14 - Sequential Selection of a Function

STUNT BOX AND STRIPPER BLADE DISASSEMBLY
SEQUENTIALLY AS FOLLOWS
(Bul. 1149, P. - 2-104, Fig. 2-55)

1. Remove 151637 screw 110743 lock washer from 153291 arm.
   Remove two screws 151692 lock washer 2191 from left bracket 153299
   and right bracket 153298 located in lower rear corners of Stunt Box
   that secure Stunt Box to Printer frame.

   The removal of screws listed above will enable one to remove
   the Stunt Box from Printer by first pushing 153291 arm out of
   engagement with the function clutch operating arm, and then pulling
   Stunt Box out of Printer frame. CAUTION: If contact switches are
   affixed to top of Stunt Box, remove them before removing Stunt Box
   by removing their mounting screws. This will allow for complete
   freedom of movement in handling the Stunt Box.

2. Remove the 151637 screws and 110743 lock washers from both ends of
   153295 shaft.
   Slide shaft through function box frame after removing a 119653
   retaining ring from each end of the 153295 shaft.
   Remove the two 153301 arms by removing their 155099 mounting screws.
   Stripper blade 155061 can then be removed by sliding blade through
   function box.

3. Remove the 151657 screws from the faces of the left bracket 153299
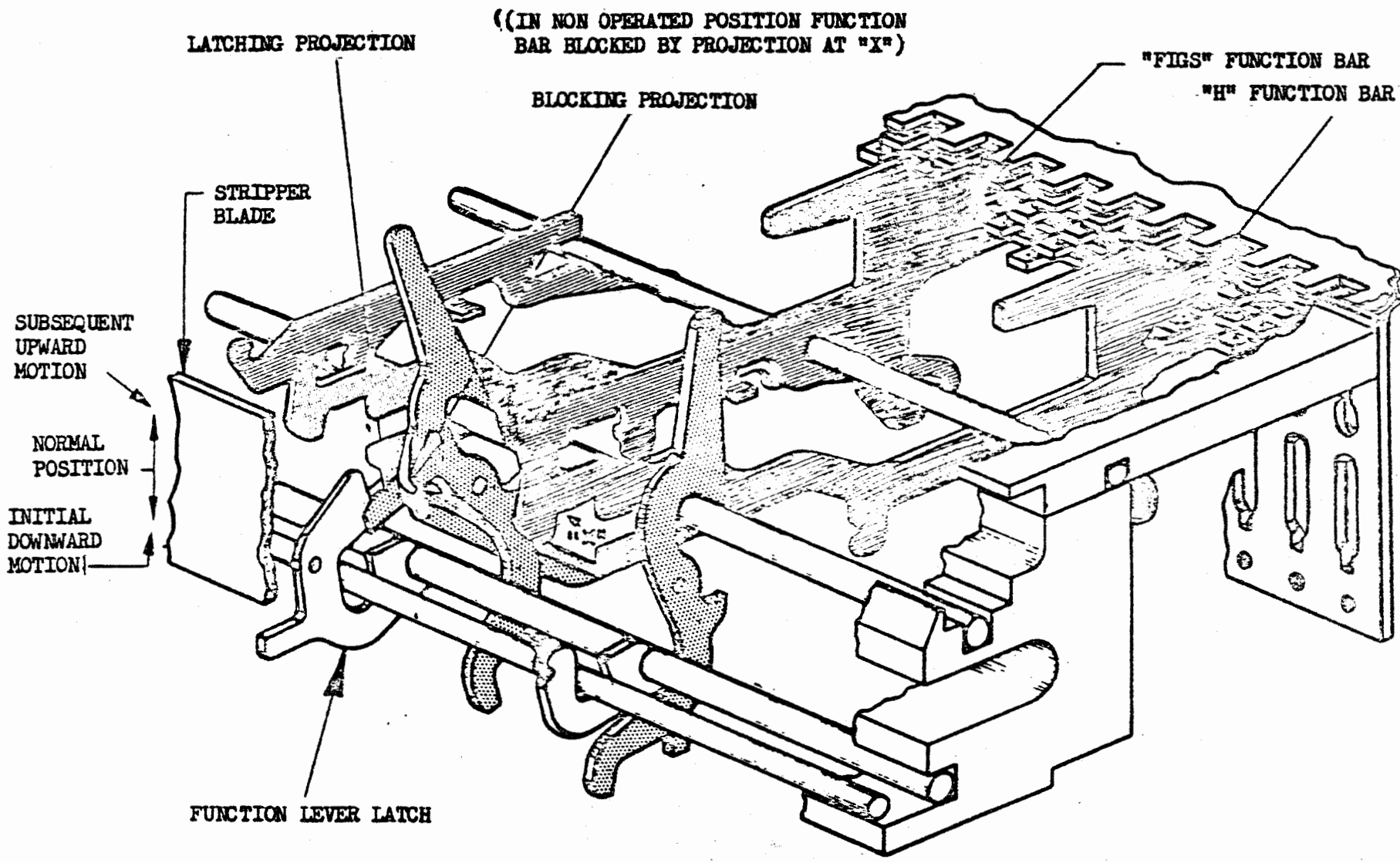   or the right bracket 153298. NOTE: If one intends to load the Stunt
   Box from the right to left, viewing the Box from the front, it will
   be necessary to remove both 151657 screws. However, if the Box is
   to be loaded from the left only, the 151657 screw holding the 153299
   left bracket need only be removed.

4. Pry 152889 plate retainer mounted on 153299 left bracket away from
   the 150547 shafts of which there are two.

5. In order to remove or add function levers or function latches, it
   will be necessary to push the 150547 shafts beyond the function lever
   or latch to be changed or beyond slot to be utilized in loading a
   previously unused slot.

        NOTE - Refer to Fig. 2-55 Page 2-104
               Bulletin 1149B for location of parts

   SPRINGS FUNCTION

            Function Bar   -   #4703
            Function Lever   -   #157240 with wick 72522
            Function Latch   -   #90517

With the exception of a few specialized applications, the Bell System arrangement (AN) is becoming the standard for Model 28 Selective Calling. It must be remembered, however, that the AN Stunt Box arrangement is merely one of the, virtually limitless, ways in which the Stunt Box may provide Selective Calling.

In the AN arrangement there is a four step procedure bringing printers in and, later, taking them out of selection. The steps are:

1. Condition   =   FIGS - H - LTRS
2. CDC (Call Directing Code) =   U - LTRS
3. End of Address   =   C.R. - L.F. - LTRS
4. End of Message   =   FIGS - H - LTRS

A LTRS combination follows the selecting combination in each of the four steps indicated above. Except in the case of the busy light (explained below), this LTRS combination serves only to introduce a time lag because there are no LTRS function bars associated with the condition, CDC, EOA or EOM sequences. If, by accident, the printer were left in figures, this LTRS combination, after step 2, would return the typebox to its normal position. In step 2, only one CDC was indicated ('U'). This character is in every Stunt Box and is used for a universal call. The three slots adjacent to this character are left open for the insertion of the desired CDC's. Normally, for 1 to 20 printers, one CDC should be sufficient; from 20 to 400: 2; and from 400 on up: 3. In any event, the characters 'M', 'O', 'T', 'V' should be avoided as CDC's.

OPERATION

1. Condition - FIGS-H-LTRS

FIGS unlatches H and allows it to operate, if selected. H strips off the zero and suppression code bars, returning them to their marking position. The printer is now in the SELECT - NON-PRINT condition.

2. CDC

The CDC shifts the suppression code bar spacing thus unblocking the typebox clutch. The printer is now in the SELECT- PRINT condition.

3. End of Address - C.R. - L.F. - LTRS

    (After step # 2 it is possible to begin transmitting. However, if the character, which had been assigned as a CDC of another printer, were hit, it too would start copying because, at this stage, all printers in the circuit are in the SELECT condition. Consequently, an EOA must be transmitted to block unselected printers.)

    C.R. unlatches L.F. and allows it to operate, if selected. L.F. shifts the zero code bar to a spacing position. The selected machine is now in NON-SELECT - PRINT condition while all others are in Non-Select - Non-Print.

    (Because the zero code bar is in the non-select, spacing position while traffic is being received, AN printers are not equipped with automatic C.R./L.F. which operates off the zero code bar in a spacing position.)

4. End of Message - FIGS - H - LTRS

    Same as condition code. If the End of Message combination had previously been transmitted, the first step, condition, serves only as insurance.

SWITCHES (Slots 25 through 28)

Slot # 25: Standard U.C. 'S' which will operate the signal bell. (N/O)

Slot # 26: A N/C switch that will shut-off the printer's Busy Lamp upon receipt of either the condition or EOM sequence. Inasmuch as the operator will always send a LTRS combination, this slot requires a LTRS function bar. If there were no function bar, the light would go back on when the stripper blade went down.

Slot # 27: A N/C switch associated with a SPACE function bar and in series with slot # 26 and the Busy Lamp. Upon transmission of a SPACE (approx. every five characters), this contact causes the Busy Lamp to flash.

Slot # 28: A N/C switch connected to the Copy Lamp. Operates when the printer goes in to the SELECT - PRINT condition.

AN (Bell) STUNT BOX ARRANGEMENT

SLOT #	FUNCTION BAR	#	LEVER	LATCH	SW.	SHIFT FORK	PURPOSE
1	Space	5129	2642	2660		yes	Unshift on Space
2	Figs.	2666	2641	"		yes	Figs. Shift
3	Ltrs.	2665	"	"		yes	Ltrs. Shift
4							
5	C.R.	2667	2641	2660			C.R.
6	'U' (SEL.)	5120	2298	2089		yes	Shift Supp. Spacing = PRINT
7							
8	Opt. CDC (SEL.)		"	"		"	"
9							
10	Figs.	2666	2121	4613			Unlatch U.C. 'H'
11	U.C. 'H'	2673	4647	2660			Oper. 154669 Rod w/31=Cond.&TOM
12							
13	C.R.	2667	2121	4613			Unlatch 14
14	L.F.	2668	2298	2089		yes	Shift zero spacing=non-select
15	Blank	2669	2641	2660			Space suppression on BLANK
16	L.F.	2668	"	"			" " " single L.F.
17							
18							
19							
20							
21							
22							
23							
24							
25	U.C. 'S' (PRINT)	3437	2641	2660	N/O		Bell
26	Ltrs.	2665	4646	4613	N/C		Busy lamp - off on TOM

SLOT #	FUNCTION BAR	#	LEVER	LATCH	SW.	SHIFT FORK	PURPOSE
27	Space	5129	2642	2660	N/C		Busy light interrupt on SPACE
28	Univ. (PRINT-SEL)	5126	2298	2089	N/O		Copy Light after CDC
29							
30	Figs.	2666	2121	4613			Unlatch 31
31	U.C. 'H'	2673	4647	2660			See 11
32							
33							
34							
35	Blank	2669	2121	4613			Double Blank Lock w/36
36	"	"	2642	2660			"
37	L.F. (non-PRINT)	5130	"	"			Kybd. Lock in non-PRINT
38							
39							
40	L.F. (PRINT)	3435	2642	2660			L.F.
41							
42							

- -

All use:
152653 - Pawl
4703 - Func. Bar Spring
154690 - Pawl   "
90517 - Lever   "

	SUPP.	ZERO
Print - Select	S	M
Non-Print - Select	M	M
Print - Non-Select	S	S
Non-Print - Non-Select	M	S

41.

RELATED ADJUSTMENTS
MODEL 28 PRINTER

KEYBOARD UNIT

Selector lever guide adj.
: None

Rocker bail detent adj.
: Rocker extension adj.
: Flutter lever adj.

Rocker extension adj.
: Flutter lever adj.

Detent toggle stop bracket adj.
: Intermediate lever stop plate adj.
: Flutter lever adj.

Intermediate lever stop plate adj.
: Detent toggle stop bracket adj.
: Flutter lever adj.

Flutter lever adj.
: None

Clutch stop lever adj.
: None

Clutch shoe lever adj.
: None

Code bar bail adjusting screw adj.
: None

Code lever bail adj.
: None

Non-repeat lever adj.
: None

Keylever lock ball channel and lock ball end play adj.
: Code lever bail latch lever eccentric adj.
: Code lever bail non-repeat extension adj.
: Code lever spring tension

Code lever bail latch lever eccentric adj.
: Code lever bail non-repeat extension adj.
: Keylever lock ball channel and ball end play adj.

Code lever bail non-repeat extension adj.
: None

Code lever guide adj.
: None

Code bar bail bumper adj.
: None

<u>Code bar latch adj.</u>
    None

<u>Code bar bounce bracket support screw adj.</u>
    None

<u>Generator contact adj.</u>
    None

<u>Intermediate gear bracket</u>
    Time delay mechanism position

TYPING UNIT

<u>Selector armature adj.</u>
    Selector magnet bracket adj.
    Selector clutch stop arm adj.

<u>Selector magnet bracket adj.</u>
    Selector clutch stop arm adj.

<u>Selector clutch drum adj.</u>
    None

<u>Transfer lever eccentric adj.</u>
    Intermediate arm backstop bracket adj.
    Shift lever link guide adj.

<u>Intermediate arm backstop bracket adj.</u>
    None

<u>Shift lever drive arm adj.</u>
    Shift lever link guide adj.

<u>Shift lever link guide adj.</u>
    None

<u>Selector clutch stop arm adj.</u>
    None

<u>Code bar clutch trip lever adj.</u>
    None

<u>Function clutch trip lever adj.</u>
    None

<u>Clutch trip shaft set collars adj.</u>
    None

<u>Spacing clutch trip lever adj.</u>
    None

<u>Line feed clutch trip lever eccentric post adj.</u>
    Line feed clutch trip lever adjusting screw adj.

<u>Line feed clutch trip lever adjusting screw adj.</u>
    Line feed clutch trip lever eccentric post adj.

<u>Type box clutch trip lever eccentric post adj.</u>
        None

<u>Type box clutch trip lever adj.</u>
        None

<u>Clutch shoe lever adj.</u>
        None

<u>Clutch drum position adj.</u>
        None

<u>Spacing gear clearance adj.</u>
        None

<u>Spacing gear phasing adj.</u>
        Left hand margin
        Right margin
        Automatic carriage return arm adj.
        Margin indicating lamp adj.

<u>Line feed clutch phasing adj.</u>
        Line feed spur gear detent eccentric adj.

<u>Rocker shaft left bracket adj.</u>
        Rocker shaft bracket eccentric stud adj.
        Right vertical positioning lever eccentric stud adj.
        Left vertical positioning lever eccentric stud adj.
        Spacing trip lever bail cam plate adj.
        Reversing slide extensions adj.
        Shift slide drive linkage adj.
        Vertical positioning lock lever adj.
        Printing track adj.
        Printing arm adj.
        Ribbon feed lever stop bracket adj.
        Function stripper blade arms adj.

<u>Rocker shaft bracket eccentric stud adj.</u>
        Right vertical positioning lever eccentric stud adj.
        Left vertical positioning lever eccentric stud adj.
        Spacing trip lever bail cam plate adj.
        Reversing slide extensions adj.
        Shift slide drive linkage adj.
        Vertical positioning lock lever adj.
        Printing track adj.
        Printing arm adj.
        Ribbon feed lever stop bracket adj.
        Function stripper blade arms adj.

<u>Right vertical positioning lever eccentric stud adj.</u>
        Left vertical positioning lever eccentric stud adj.
        Vertical positioning lock lever adj.
        Ribbon feed lever stop bracket adj.
        Function stripper blade arms adj.

<u>Left vertical positioning lever eccentric stud adj.</u>
    Vertical positioning lock lever adj.
    Ribbon feed lever stop bracket adj.
    Function stripper blade arms adj.

<u>Spacing trip lever bail cam plate adj.</u>
    None

<u>Shift code bar operating mechanism adj.</u>
    None

<u>Function reset bail blade adj.</u>
    Carriage return lever adj.

<u>Reversing slide adjusting stud adj.</u>
    Shift slide drive linkage adj.

<u>Reversing slide extension adj.</u>
    Shift slide drive linkage adj.

<u>Shift slide drive linkage</u>
    Rocker shaft bracket eccentric stud adj.
    Right vertical positioning lever eccentric stud adj.
    Left vertical positioning lever eccentric stud adj.
    Spacing trip lever bail cam plate adj.
    Reversing slide extensions adj.
    Vertical positioning lock lever adj.
    Printing track adj.
    Printing arm adj.
    Ribbon feed lever stop bracket adj.
    Function stripper blade arms adj.

<u>Vertical positioning lock lever adj.</u>
    None

<u>Oscillating rail clamp slide position adj.</u>
    Printing carriage position adj.
    Shift linkage adj.
    Left hand margin adj.
    Right margin adj.
    Automatic carriage return arm adj.
    Margin indicating lamp adj.

<u>Carriage wire rope adj.</u>
    Oscillating rail slide position adj.
    Printing carriage position adj.
    Left hand margin adj.
    Right margin adj.
    Automatic carriage return arm adj.
    Margin indicating lamp adj.

<u>Type box carriage roller adj.</u>
    Printing hammer stop bracket adj.
    Printing arm adj.

<u>Printing carriage lower roller adj.</u>
    Printing track adj.
    Printing hammer stop bracket adj.
    Printing arm adj.

<u>Carriage return spring adj.</u>
    Dashpot vent screw adj.

<u>Carriage return latch bail adj.</u>
    None

<u>Carriage return lever adj.</u>
    None

<u>Dashpot vent screw adj.</u>
    None

<u>Printing carriage position adj.</u>
    Shift linkage adj.

<u>Shift linkage adj.</u>
    None

<u>Printing hammer bearing stud adj.</u>
    None

<u>Printing track adj.</u>
    Printing arm adj.

<u>Printing hammer stop bracket adj.</u>
    Printing arm adj.

<u>Printing arm adj.</u>
    None

<u>Printing hammer operating bail spring adj.</u>
    Printing arm adj.

<u>Left hand margin adj.</u>
    Right margin adj.
    Automatic carriage return arm adj.
    Margin indicating lamp adj.

<u>Right margin adj.</u>
    None

<u>Ribbon reverse spur gear adj.</u>
    Ribbon reverse detent adj.

<u>Ribbon reverse detent adj.</u>
    None

<u>Ribbon feed lever stop bracket adj.</u>
    None

<u>Line feed spur gear detent eccentric adj.</u>
None

<u>Function stripper blade arms adj.</u>
None

<u>Single-double line feed lever adj.</u>
None

<u>Automatic carriage return arm adj.</u>
None

<u>Paper straightener collar adj.</u>
None

<u>Paper finger adj.</u>
None

<u>Bell or motor stop function contacts adj.</u>
None

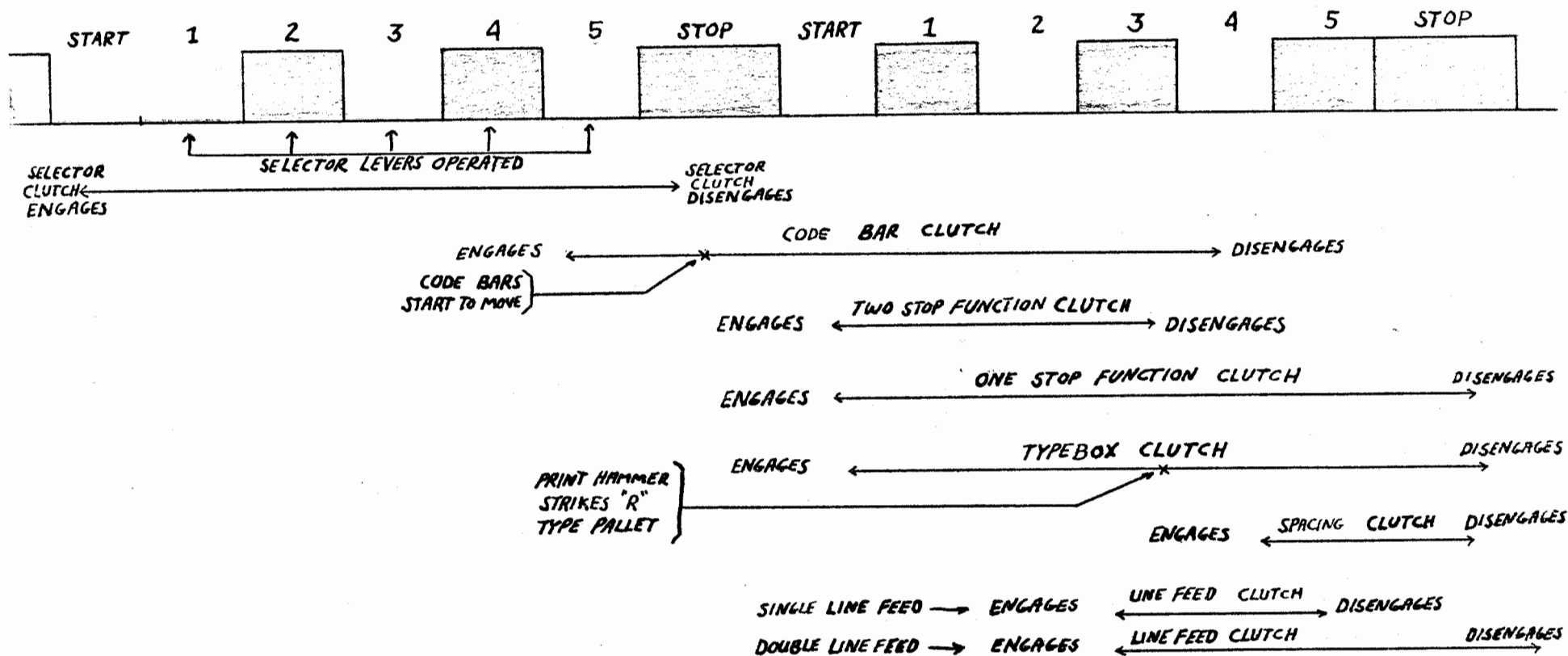<u>Unshift on space function pawl adj.</u>
None

<u>Code bar detent adj.</u>
None

<u>Margin indicating lamp adj.</u>
None

TELETYPE SCHOOL 1271

MODEL 28 PRINTER
CLUTCH SEQUENCE CHART

| START | 1 | 2 | 3 | 4 | 5 | STOP | START | 1 | 2 | 3 | 4 | 5 | STOP |

SELECTOR LEVERS OPERATED

SELECTOR
CLUTCH ← ———————————————————————————→
ENGAGES

SELECTOR
CLUTCH
DISENGAGES

CODE BAR CLUTCH

ENGAGES ← ———————————————————————————→ DISENGAGES

CODE BARS
START TO MOVE

TWO STOP FUNCTION CLUTCH

ENGAGES ← ———————————————————————————→ DISENGAGES

ONE STOP FUNCTION CLUTCH

ENGAGES ← ———————————————————————————→ DISENGAGES

TYPEBOX CLUTCH

ENGAGES ← ———————————————————————————→ DISENGAGES

PRINT HAMMER
STRIKES "R"
TYPE PALLET

ENGAGES ← SPACING CLUTCH → DISENGAGES

SINGLE LINE FEED → ENGAGES ← LINE FEED CLUTCH → DISENGAGES

DOUBLE LINE FEED → ENGAGES ← LINE FEED CLUTCH → DISENGAGES

48.

1-140

MODIFYING MODEL 28 EQUIPMENT FOR 20 MA OPERATION

(Schematic references are from NAVSHIPS Manual 99MA)

I.   Modification for 20ma LINE Current

        NOTE: The following procedure assumes that the electrical service
unit is equipped with the RY30 (WECO 255A). Customers such as
Western Union need to follow slightly different procedures
depending upon the arrangement of their line relays.

GENERAL

In order to allow the line relay (RY30) to operate at 20 ma it is
necessary to increase the resistance of the relay's bias winding. The
Motor Control Relay's coils must be re-wired to a series connection
and resistance added to this circuit.

PROCEDURE

1.   To increase resistance of the RY30's bias winding:

        On the line relay mounting assembly, move A-86-BR from its present
position on the 8Kohm resistor to the open terminal on the same
resistor.

        NOTE: This resistor (Part # 81775 = R1203) is physically located
beneath the RY30 base plate, in the LESU, electrical service unit.
For 60 ma operation, this resistor will have two wires connected to
the same terminal.

2.   To modify the Motor Control Relay wiring:

        On the Motor Control Terminal Block (part # 151411 = TB 1104)
remove BK strap between terminals 7 & 9. (The Start Magnets are
now in series). Remove the end of the strap from terminal 6
and connect to terminal 9. (This adds a 200ohm resistor R1101
Part # 151439 = Line balancing resistor).

II.   To modify the equipment so that the selector magnets operate with
20 ma line current, the selector magnet wiring must be changed from
parallel to series.

III.   To operate with 60 ma LINE current and 20 ma local (selector
magnet) current, it would be necessary to add resistance to the selector
magnet circuit.

SYNCHRONOUS MOTOR UNIT,
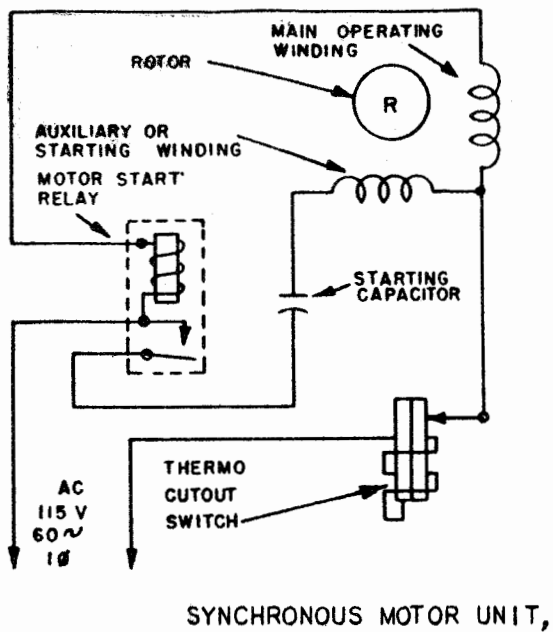
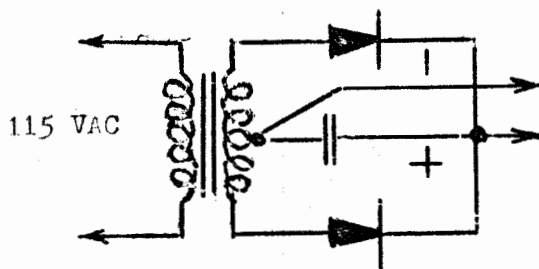Motor Type - A. C. Synchronous 1/20 H.P.

Speed - 3600 R. P. M.

Power Required: 115VAC, 60 Cycle ($\pm$ .5 Cycle)

Single Phase

Starting Current: Approx. 9 Amps

Thermal Cutout Level: Approx. 11 Amps

Rectifier Assembly

Input- 105-125 VAC, 60 Cycle, Single Phase

Output Voltage- 115VDC $\overset{+}{-}$ 5 at .012 Amp

Output Current- 150 MA Intermittant

120 MA Continuous

A. C. Component - Not more than 2% R. M. S.
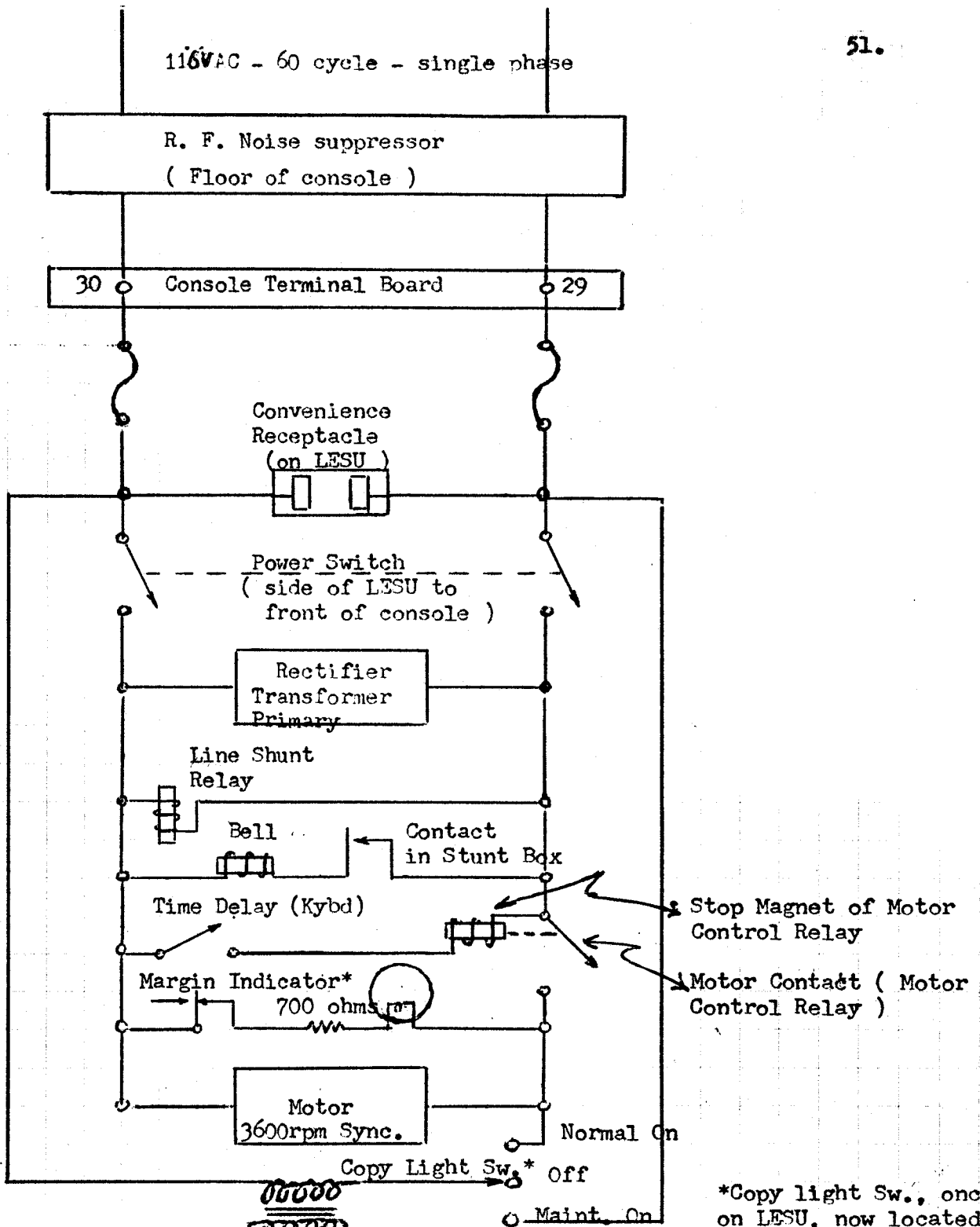
Purpose- Supplies 90MA to Line Relay

(See Line Relay diagram)

Composition- 1. Transformer (Primary = 260 OHMS)
(Secondary = 565 OHMS)

2. Two $\frac{1}{2}$ wave selenium rectifiers

3. One 220 microfarad filter capacito
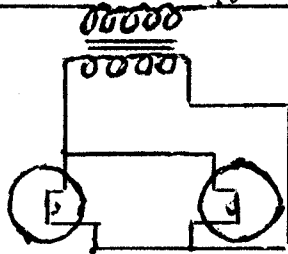capacitor

116VAC - 60 cycle - single phase

R. F. Noise suppressor
(Floor of console)

30 ○ Console Terminal Board ○ 29

Convenience
Receptacle
(on LESU)

Power Switch
(side of LESU to
front of console)

Rectifier
Transformer
Primary

Line Shunt
Relay

Bell

Contact
in Stunt Box

Time Delay (Kybd)

Stop Magnet of Motor
Control Relay

Margin Indicator
Contact on Kybd.
Lamp in upper
R/H corner of
Console.

Margin Indicator*
700 ohms

Motor Contact (Motor
Control Relay)

Motor
3600rpm Sync.

Normal On

Copy Light Sw.* off

Maint. On

*Copy light Sw., once
on LESU, now located
in upper left corner
of console.

6.3VAC
Copy Lamps -
Top of Console

Model 28 - A.C. Power Distribution

LBM 4/57

115
VAC

Rectifier

+   —

Space

Mark

Selector
Magnets

0   3

1   4

Line
3   Relay   6

Line Shunt
Relay   C/3

C/4

KEYBOARD

S   M

Contact
Box

Electrical
Noise
Suppressor

Motor
Control
Relay

Line
Break
Sw.

9   4

9   2

Line Test
key

7

5   15

R. F.
Filter
(Floor of
Cabinet)

Signal
Line

+   —
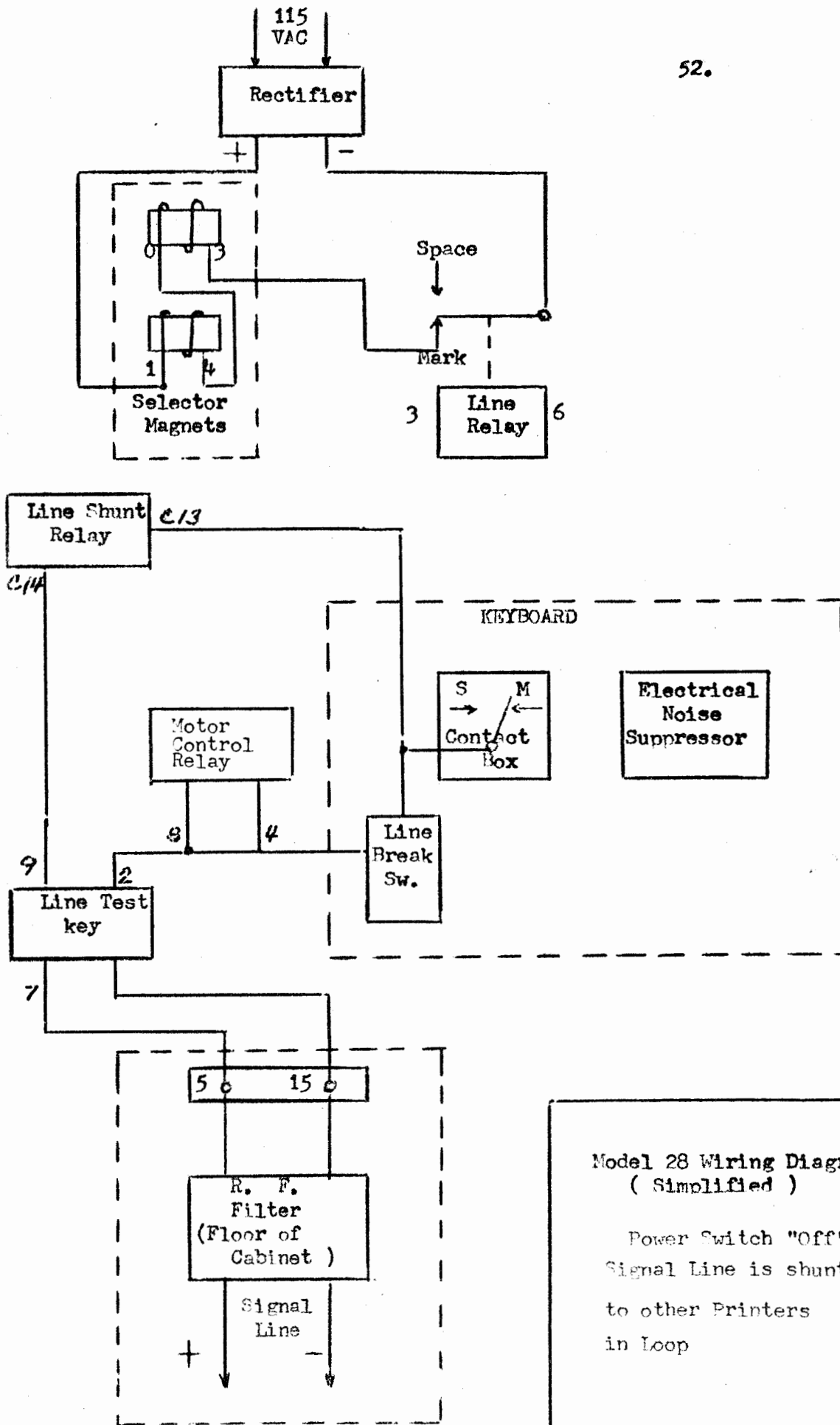
Model 28 Wiring Diagram
(Simplified)

Power Switch "Off"
Signal Line is shunted
to other Printers
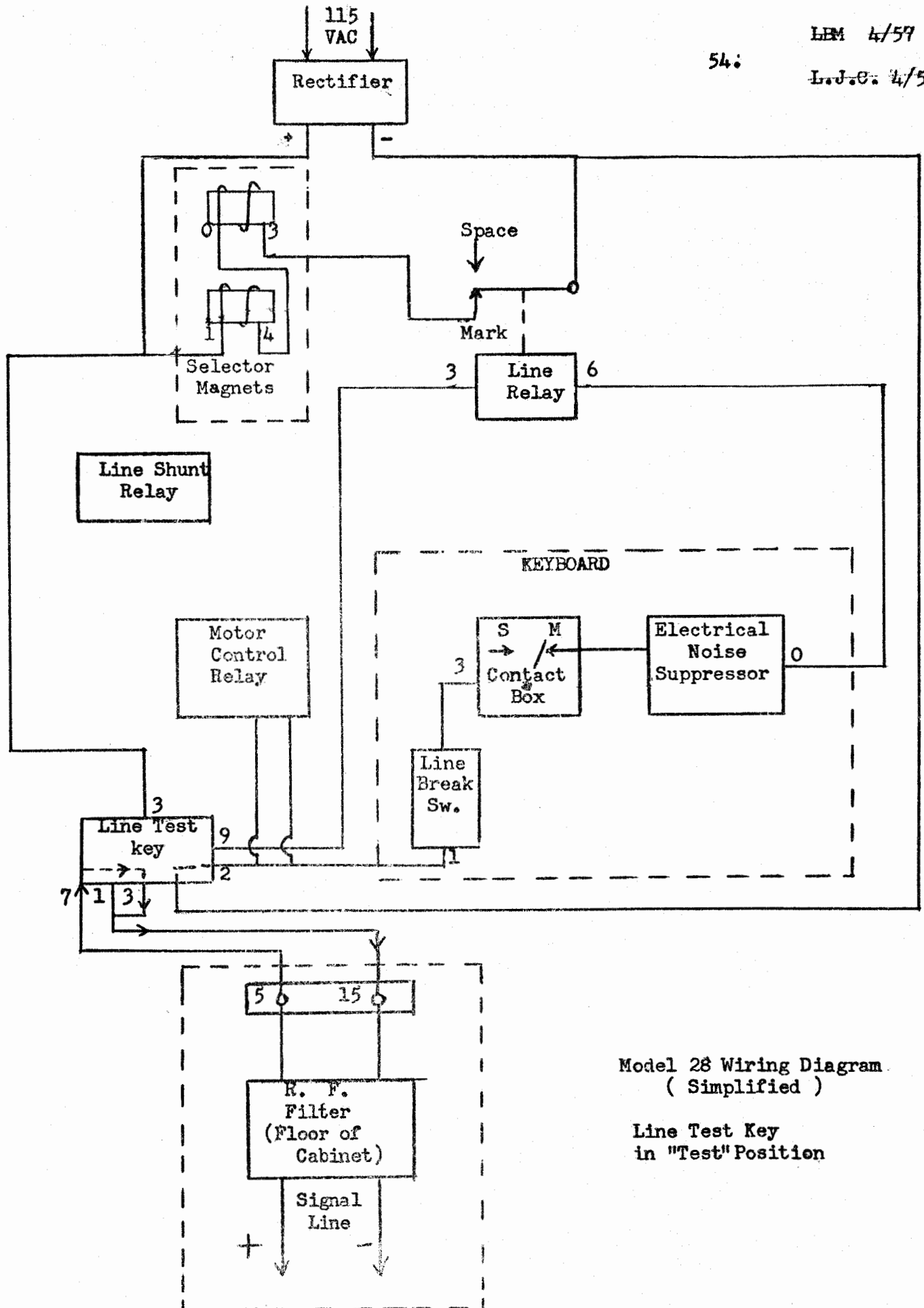in Loop

Selector Magnets
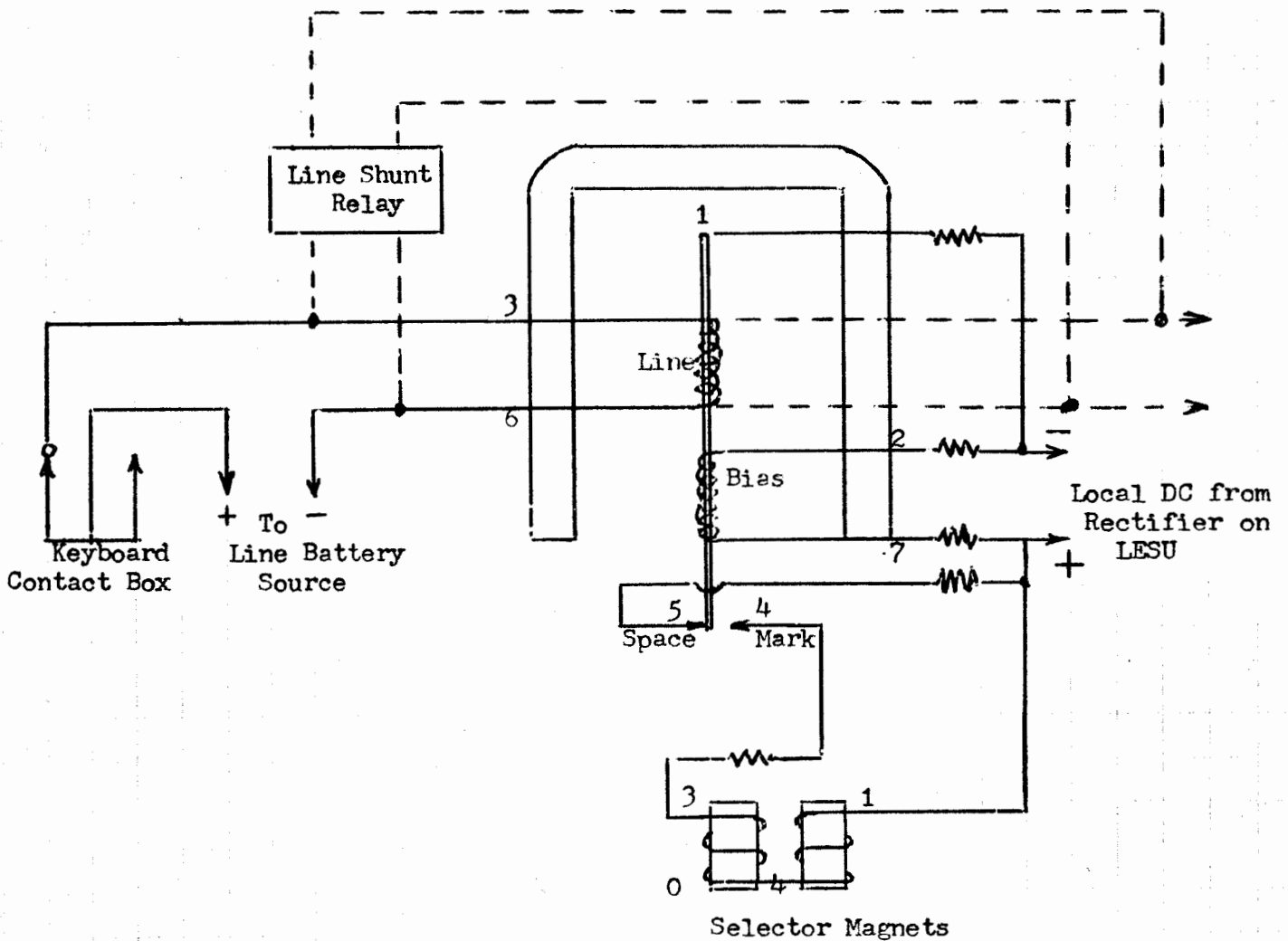
SPACE ON SIGNAL LINE:
   During a spacing (no current) pulse, 30ma flows from the rectifier through
   the 2 - 7 winding of the relay and creates a polarity in the armature that will
   cause the armature to be attracted to the SPACE contact. No current may flow
   through the selector magnets.

   At the same time, 60ma is supplied from the rectifier, through contact # 5,
   out at contact # 1 and back to negative battery. The purpose of this "dummy"
   circuit is to maintain a steady 90ma drain on the rectifier.
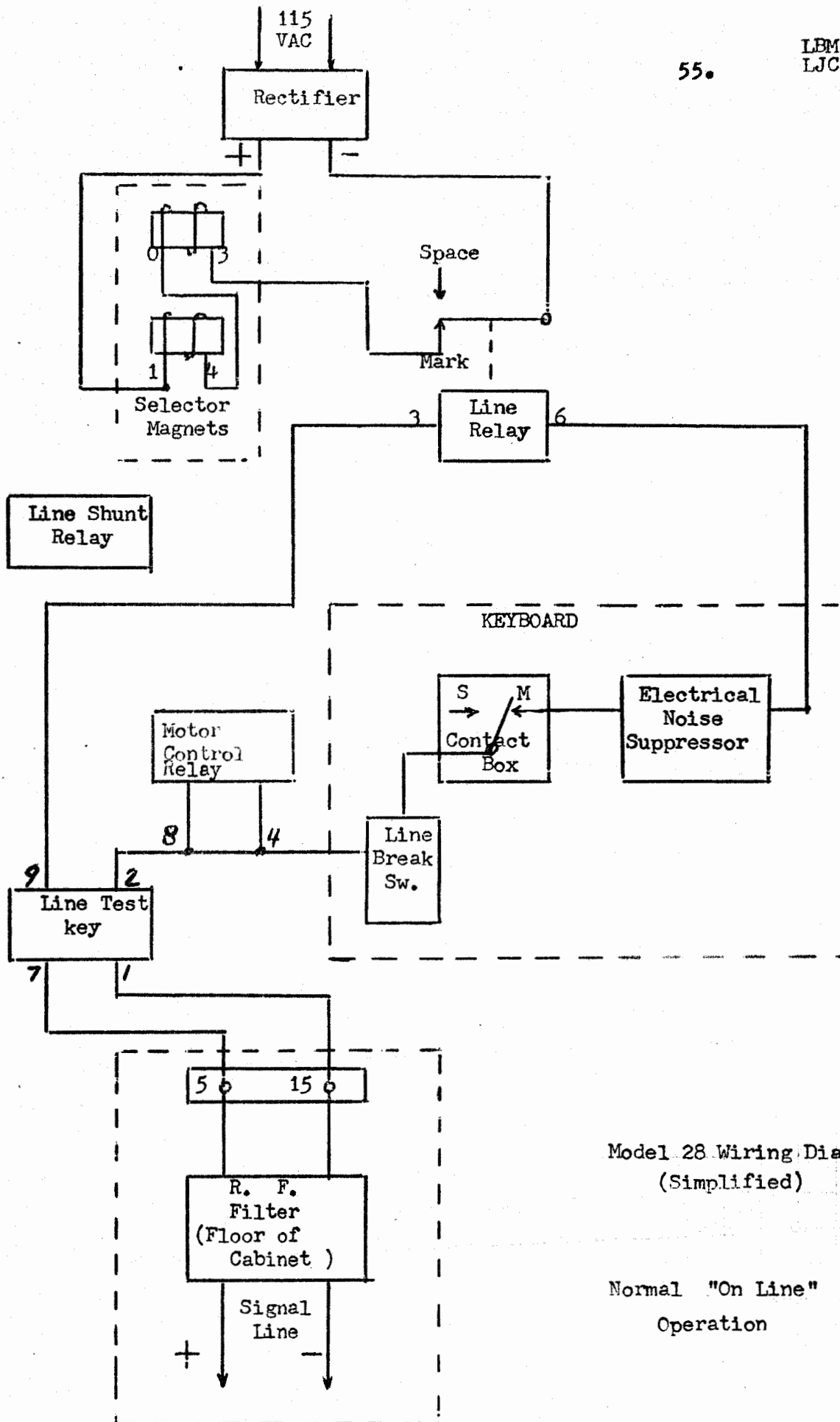
MARK ON SIGNAL LINE:
   During a marking (current) pulse, the 60ma from the signal line, through the
   3 - 6 winding, creates a polarity in the armature that will cause the armature
   to be attracted to the MARK contact. (The 60ma from the line overcomes the
   30ma in the 2 - 7, bias, winding.) At this time, 60ma flows from the rectifier,
   through the selector magnets, through conact # 4, out at contact # 1 and back
   to negative battery.

Note: All numbers, except those on the selector magnets, indicate contacts on
the bottom of the Line Relay in the LESU.

                                                              LBM 4/57

115 VAC

Rectifier

Space

Mark

Selector Magnets

Line Relay

3 — 6

Line Shunt Relay

KEYBOARD

Motor Control Relay

S   M

Contact Box

3

Electrical Noise Suppressor

0

Line Break Sw.

Line Test key

3

9

2

7 1 3

5   15

R. F. Filter (Floor of Cabinet)

Signal Line

Model 28 Wiring Diagram
(Simplified)

Line Test Key
in "Test" Position

Model 28 Wiring Diagram
(Simplified)

Normal "On Line"
Operation

ELECTRICAL MOTOR CONTROL MECHANISM

PLUG IN LINE RELAY

LINE SHUNT RELAY

LINE TEST KEY ASSEMBLY

SIGNAL LINE RELAY
MOUNTING ASSEMBLY

KEYBOARD PLUG

STOP MAGNET

0.100 AMPERE RECTIFIER ASSEMBLY

POWER FUSES

COPY LIGHT SWITCH

CONVENIENCE RECEPTACLE

POWER SWITCH
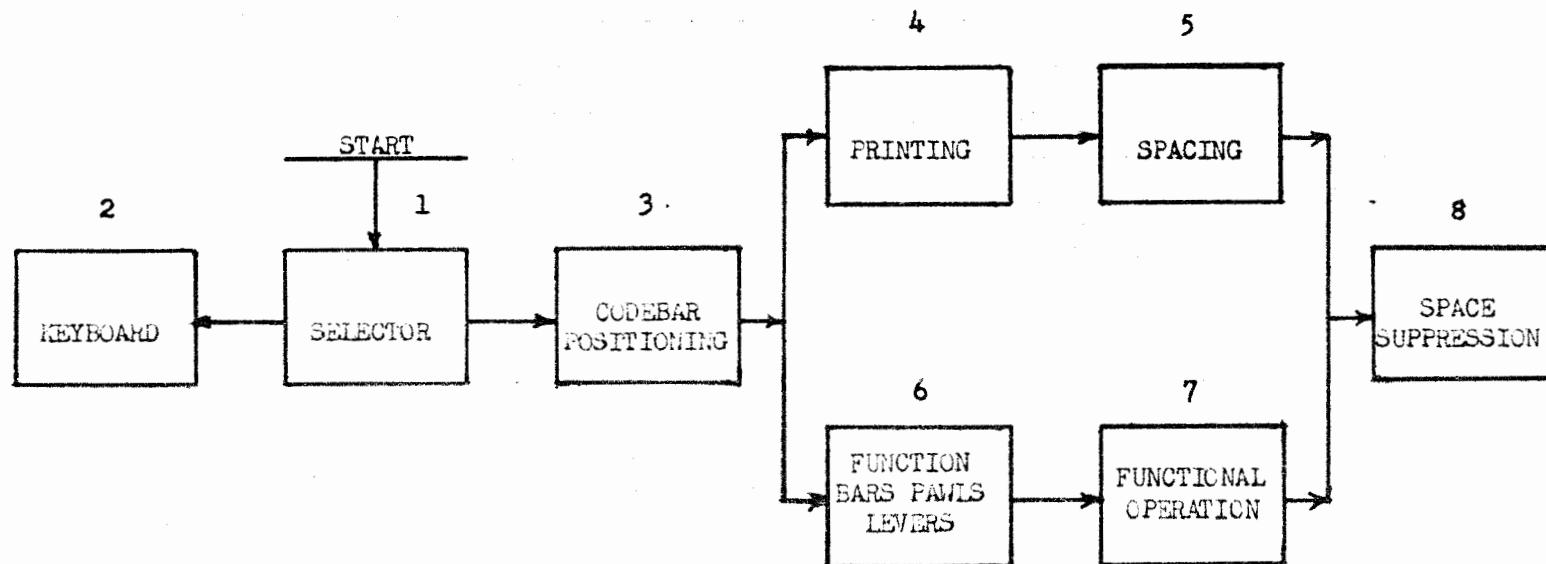
TYPING UNIT PLUG

START MAGNETS

* Copy light switch located
in Console Dome in
newer units

ELECTRICAL SERVICE UNIT

56.

```
                    ┌─────────────────────┐
                    │  TROUBLE SHOOTING   │
                    │   BLOCK DIAGRAM     │
                    │   MODEL 28 KSR      │
                    └─────────────────────┘
```


1. <u>To Check Selector</u> – Observe intermediate arms from the front of the typing unit. If they are positioned correctly the selector and the keyboard are functioning properly.

2. <u>To Check Keyboard</u> – Depress "Y" keylever, observe contact box and make sure the "Y" combination is being transmitted. Then repeat this procedure for the "R" combination.

3. <u>To Check Code Bar Positioning</u> – Check code bars on left side of printer. If the transmitted combination is not set up, the trouble is in the code bar positioning mechanism.

4 &5 <u>Printing & Spacing</u> – Make sure hammer strikes selected pallet and there is equal spacing between characters.

6 & 7 <u>Function Bars etc., and Functional Operation</u> – Select <u>all</u> functions and check operation.

8. <u>Space Suppression</u> – Operate all functions on which space suppression is to occur and check.