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 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 shoot-
ing 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.

<table>
<thead>
<tr>
<th>Bulletins</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>216B</td>
<td>Desc. &amp; Theory</td>
</tr>
<tr>
<td>217B</td>
<td>Adj. &amp; Lubrication</td>
</tr>
<tr>
<td>1149B</td>
<td>Parts</td>
</tr>
<tr>
<td>1124B</td>
<td>Maintenance Tools</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teletype Code</th>
<th>Keyboard &amp; Printer</th>
<th>Kybrd.,Base,Ptr.,Cabinet</th>
</tr>
</thead>
<tbody>
<tr>
<td>LK, LP</td>
<td>LK, LB, LP, LAC</td>
<td></td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>DAY</th>
<th>SUBJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st.</td>
<td>Keyboard theory - Disassembly &amp; assembly</td>
</tr>
<tr>
<td>2nd.</td>
<td>Keyboard adjustments</td>
</tr>
<tr>
<td>½ 3rd.</td>
<td>Keyboard adjustments</td>
</tr>
<tr>
<td>½ 3rd.</td>
<td>Printer theory</td>
</tr>
<tr>
<td>4th.</td>
<td>Printer theory</td>
</tr>
<tr>
<td>5th.</td>
<td>Printer theory - Disassembly &amp; assembly</td>
</tr>
<tr>
<td>6th.</td>
<td>Printer adjustments</td>
</tr>
<tr>
<td>7th.</td>
<td>Printer adjustments</td>
</tr>
<tr>
<td>8th.</td>
<td>Printer adjustments - Adjustments under power</td>
</tr>
<tr>
<td>9th.</td>
<td>Trouble Shooting</td>
</tr>
<tr>
<td>10th.</td>
<td>Trouble Shooting</td>
</tr>
</tbody>
</table>

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 troubleshoot 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.

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

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: 360 rpm, 460 rpm, and 600 rpm. 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, 360 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 360 characters or 360 operations-per-minute (rpm). This breaks down:

\[
\frac{360}{60} = \text{operations-per-second} = 6.13 \quad \text{1 second = length of one operation = .163 sec.}
\]

(a) At 360 rpm, 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 stopping 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 ensure 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) \[
\begin{align*}
\text{START} & = 1 \text{ Unit} \\
\text{Information pulse} & = 5 \text{ Units} \\
\text{STOP} & = 1.42 \text{ Units}
\end{align*}
\]

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) .163 sec (time for one complete operation) = 21.96 or 22 ms. = 1 Unit

\[
7.42 \text{ (units)}
\]

(g) \[
21.96 \times 1.42 = 31.18 \text{ms or 31 ms.}
\]

(h) The START or information pulse (1 Unit) = 22 ms.

(i) The STOP pulse (1.42 Units) = 31 ms.
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:

\[
\begin{array}{c|c|c|c|c|c|c}
|   | 22ms | 22ms | 22ms | 22ms | 22ms | 31ms |  \\
\hline
\text{MARK} &   &   &   &   &   & \\
\hline
\text{SPACE} & 60ma & 60ma & 60ma & 60ma & 60ma &  \\
\hline
\text{START} & 1 & 2 & 3 & 4 & 5 &  \\
\hline
\end{array}
\]

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, assumed continuous operation. Otherwise the STOP pulse might be 3ms, 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. Obviously 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:

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

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

\[
\text{l) } \frac{390 \text{ opm}}{60} = 6.5 \text{ ops/sec} \times 7.00 \text{ (Unit Code)} = \frac{45.5}{60} \text{ = Baud}
\]
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 .044 sec.

\[
\frac{1}{.044} = \text{approx. } 23\text{cps} = \text{Dot Cycle Frequency of character 'Y'}
\]

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.

\[
\begin{align*}
\text{START + First + Second} & = 66\text{ms}. \\
\text{Third + Fourth + Fifth} & = 66\text{ms}. \\
& = 132\text{ms}.
\end{align*}
\]

\[
\frac{1}{.132} = \text{approx. } 8\text{cps} = \text{Dot Cycle Frequency of character 'M'}
\]

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 89 cycles) 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 categories 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 0Om 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 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 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 (-).

$$M-STD - S-MTD = ms. \text{ Bias}$$
This example of Bias Distortion illustrates that although the M-STD may not equal the S-STD, 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 affect 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 occurrences as sudden battery fluctuations or loose ground connections. This distortion may affect 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 4.4 ms. 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 22 ms duration, the necessary 20% selecting interval would be in the center with a range reading of 10 to 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:

\[
\frac{10 + 90}{2} = 50
\]
If 20% SPACING END DISTORTION were introduced the range would shift in an opposite direction:

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. Zaner (1937)

FEDERAL AIRWAYS MANUAL OF OPERATIONS, Vol. IV Civil Aeronautics Admin. (1944)

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
M28 KEYBOARD
FROM TRIPPING OF CLUTCH TO OPERATION OF CONTACT

ROCKER BAIL
ROCKER EXTENSION
SELECTOR LEVER
TRANSFER 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

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
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)
selected CODE BARS move
code bar VERTICAL EXTENSION
engage TRANSFER LEVER
rotate TRANSFER BAIL
operates DRIVE LINK
operates CONTACT TOGGLE
actuates CONTACTS
RESET OF CODE BARS IN K POSITION

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
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
**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 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.

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.

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

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)
### Vertical Positioning of the Type Box

#### Letters

<table>
<thead>
<tr>
<th>LETTERS</th>
<th>LEFT</th>
<th>RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOTTOM ROW</td>
<td>4TH</td>
<td>3RD</td>
</tr>
<tr>
<td>SUPP</td>
<td>MARKING</td>
<td>SPACING</td>
</tr>
<tr>
<td>0</td>
<td>485</td>
<td>1-345</td>
</tr>
<tr>
<td>1</td>
<td>K</td>
<td>Q</td>
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#### Code Bar

<table>
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<tr>
<th>CODE BAR</th>
<th>LEFT</th>
<th>RIGHT</th>
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<tr>
<td>COMM</td>
<td>MARKING</td>
<td>SPACING</td>
</tr>
<tr>
<td>0</td>
<td>M</td>
<td>N</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
<td>F</td>
</tr>
<tr>
<td>2</td>
<td>V</td>
<td>O</td>
</tr>
</tbody>
</table>

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.

**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 Top** buckle 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.
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.

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 strikes 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.

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.

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 TELETYPING CODE BY USING THE VERTICAL AND HORIZONTAL PICTURES INDICATED BELOW

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
As the TYPE BOX CLUTCH rotates, the ROCKERSHAFT 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.
As the TYPE BOX CLUTCH rotates, the ROCKERSHIFT and the ROCKERSHIFT 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.
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
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
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.

**NOTE:**
Fig. 14 - Sequential Selection of a Function
STUNT BOX AND STRIPPER BLADE DISASSEMBLY
SEQUENTIALLY AS FOLLOWS
(Bu. 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.
(All numbers preceded by 15-)  

**AN (Bell) STUNT BOX ARRANGEMENT**

<table>
<thead>
<tr>
<th>SLOT #</th>
<th>FUNCTION BAR</th>
<th>#</th>
<th>LEVER</th>
<th>LATCH</th>
<th>SW.</th>
<th>SHIFT FORK</th>
<th>PURPOSE</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Space</td>
<td>5129</td>
<td>2642</td>
<td>2660</td>
<td></td>
<td>yes</td>
<td>Unshift on Space</td>
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<td>2</td>
<td>Figs.</td>
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<tr>
<td>5</td>
<td>'U' (SEL.)</td>
<td>5120</td>
<td>2298</td>
<td>2089</td>
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<td>Shift Supp. Spacing = PRINT</td>
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<td>&quot;</td>
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<td>4613</td>
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<td>2673</td>
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<td>Busy lamp - off on PCM</td>
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<td>SLOT #</td>
<td>FUNCTION</td>
<td>BAR</td>
<td>LEVER</td>
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<td>SHIFT FORK</td>
<td>PURPOSE</td>
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<td>Space</td>
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All use:

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<tr>
<td>Print - Select</td>
<td>S</td>
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<tr>
<td>Non-Print - Select</td>
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</tr>
<tr>
<td>Print - Non-Select</td>
<td>S</td>
</tr>
<tr>
<td>Non-Print - Non-Select</td>
<td>M</td>
</tr>
</tbody>
</table>
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
Code bar latch adj.
None

Code bar bounce bracket support screw adj.
None

Generator contact adj.
None

Intermediate gear bracket
Time delay mechanism position

TYPING UNIT

Selector armature adj.
Selector magnet bracket adj.
Selector clutch stop arm adj.

Selector magnet bracket adj.
Selector clutch stop arm adj.

Selector clutch drum adj.
None

Transfer lever eccentric adj.
Intermediate arm backstop bracket adj.
Shift lever link guide adj.

Intermediate arm backstop bracket adj.
None

Shift lever drive arm adj.
Shift lever link guide adj.

Shift lever link guide adj.
None

Selector clutch stop arm adj.
None

Code bar clutch trip lever adj.
None

Function clutch trip lever adj.
None

Clutch trip shaft set collars adj.
None

Spacing clutch trip lever adj.
None

Line feed clutch trip lever eccentric post adj.
Line feed clutch trip lever adjusting screw adj.

Line feed clutch trip lever adjusting screw adj.
Line feed clutch trip lever eccentric post adj.
Type box clutch trip lever eccentric post adj.
None

Type box clutch trip lever adj.
None

Clutch shoe lever adj.
None

Clutch drum position adj.
None

Spacing gear clearance adj.
None

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

Line feed clutch phasing adj.
Line feed spur gear detent eccentric adj.

Rocker shaft left bracket adj.
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.

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.

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

Spacing trip lever bail cam plate adj.
None

Shift code bar operating mechanism adj.
None

Function reset bail blade adj.
Carriage return lever adj.

Reversing slide adjusting stud adj.
Shift slide drive linkage adj.

Reversing slide extension adj.
Shift slide drive linkage adj.

Shift slide drive linkage
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.

Vertical positioning lock lever adj.
None

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

Carriage wire rope adj.
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.

Type box carriage roller adj.
Printing hammer stop bracket adj.
Printing arm adj.
Printing carriage lower roller adj.
   Printing track adj.
   Printing hammer stop bracket adj.
   Printing arm adj.

Carriage return spring adj.
   Dashpot vent screw adj.

Carriage return latch bail adj.
   None

Carriage return lever adj.
   None

Dashpot vent screw adj.
   None

Printing carriage position adj.
   Shift linkage adj.

Shift linkage adj.
   None

Printing hammer bearing stud adj.
   None

Printing track adj.
   Printing arm adj.

Printing hammer stop bracket adj.
   Printing arm adj.

Printing arm adj.
   None

Printing hammer operating bail spring adj.
   Printing arm adj.

Left hand margin adj.
   Right margin adj.
   Automatic carriage return arm adj.
   Margin indicating lamp adj.

Right margin adj.
   None

Ribbon reverse spur gear adj.
   Ribbon reverse detent adj.

Ribbon reverse detent adj.
   None

Ribbon feed lever stop bracket adj.
   None
Line feed spur gear detent eccentric adj.
None

Function stripper blade arms adj.
None

Single-double line feed lever adj.
None

Automatic carriage return arm adj.
None

Paper straightener collar adj.
None

Paper finger adj.
None

Bell or motor stop function contacts adj.
None

Unshift on space function pawl adj.
None

Code bar detent adj.
None

Margin indicating lamp adj.
None
MODEL 28 PRINTER
CLUTCH SEQUENCE CHART

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

SELECTOR CLUTCH ENGAGES
SELECTOR LEVERS OPERATED
SELECTOR CLUTCH DISENGAGES

ENGAGES
CODE BARS START TO MOVE

ENGAGES
CODE BAR CLUTCH DISENGAGES

ENGAGES
TWO STOP FUNCTION CLUTCH DISENGAGES

ENGAGES
ONE STOP FUNCTION CLUTCH DISENGAGES

ENGAGES
PRINT HAMMER STRIKES "R" TYPE PALLET

ENGAGES
TYPEBOX CLUTCH DISENGAGES

ENGAGES
SPACING CLUTCH DISENGAGES

SINGLE LINE FEED ENGAGES
LINE FEED CLUTCH DISENGAGES

DOUBLE LINE FEED ENGAGES
LINE FEED CLUTCH DISENGAGES

FOR TRAINING PURPOSES ONLY
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.
Motor Type - A. C. Synchronous 1/20 H.P.  
Speed - 3600 R. P. M.  
Power Required: 115VAC, 60 Cycle (± .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 ± 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)  
2. Two ½ wave selenium rectifiers  
3. One 220 microfarad filter capacitor
116VAC - 60 cycle - single phase

R. F. Noise suppressor
(Floor of console)

30 Console Terminal Board 29

Convenience Receptacle
(on LSSU)

Power Switch
(side of LSSU to front of console)

Rectifier
Transformer
Primary

Line Shunt Relay

Bell
Contact in Stunt Box

Time Delay (Kybd)

Stop Magnet of Motor Control Relay

Motor Contact (Motor Control Relay)

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

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

6.3VAC
Copy Lamps - Top of Console

Model 28 - A.C. Power Distribution
Model 28 Wiring Diagram (Simplified)

Power Switch "Off"

Signal Line is shunted to other Printers in Loop
LINE RELAY
( Teletype - RY-30
Western Electric - 255A )

Line Shunt Relay

Keyboard + To - Line Battery Source

Local DC from Rectifier on LESU

Line

Bias

Space

Mark

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 contact #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
Model 28 Wiring Diagram
(Simplified)

Line Test Key
in "Test" Position
Model 28 Wiring Diagram
(Simplified)

Normal "On Line"
Operation
* Copy light switch located in Console Dome in newer units.
1. **To Check Selector** - Observe intermediate arms from the front of the typing unit. If they are positioned correctly the selector and the keyboard are functioning properly.

2. **To Check Keyboard** - Depress "Y" key lever, observe contact box and make sure the "Y" combination is being transmitted. Then repeat this procedure for the "R" combination.

3. **To Check Code Bar Positioning** - 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 **Printing & Spacing** - Make sure hammer strikes selected pallet and there is equal spacing between characters.

6 & 7 **Function Bars etc., and Functional Operation** - Select all functions and check operation.

8. **Space Suppression** - Operate all functions on which space suppression is to occur and check.