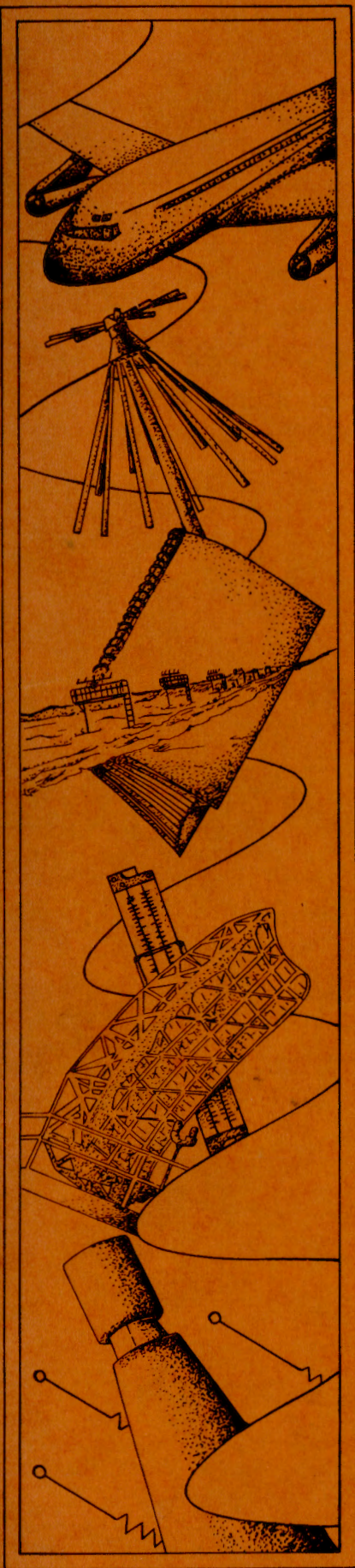


AERONAUTICAL CENTER TRAINING SERIES  
AIR NAVIGATION FACILITIES BRANCH  
MANUAL 151



MODEL 28 R/O EQUIPMENT

FEDERAL AVIATION AGENCY  
AERONAUTICAL CENTER  
OKLAHOMA CITY, OKLAHOMA

1911  
1912  
1913

1914  
1915  
1916

1917  
1918  
1919

MODEL 28 PRINTER  
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MODEL 28 PRINTER  
COURSE OUTLINE

FIRST DAY

- I. INTRODUCTION
  - A. History of Printing Telegraph Equipment
  - B. Start - Stop Code
  - C. Printing Telegraph Lines

Reading Assignment: Chapter 1 of Model 28 Printer Course Material

SECOND DAY

- I. PRINTING UNIT
  - A. Electrical System
  - B. Line Relay
  - C. AC Circuitry
  - D. DC Circuitry
  - E. Main Shaft

Reading Assignment: Chapter 2, paragraphs 1.0 through 2.0

THIRD DAY

- I. PRINTING UNIT
  - A. Clutch Action
  - B. Selecting Mechanism
  - C. Code Bar Mechanism - General
  - D. Code Bar Shift Bar Positioning

Reading Assignment: Chapter 2, paragraphs 2.1 through 4.2



FOURTH DAY

- I. PRINTING UNIT
  - A. Code Bar Positioning
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  - C. Type Box and Type Box Carriage - General
  - D. Vertical Positioning
  - E. Function and Type Box Clutch Engagement
  - F. Left and Right Side Mechanism
  - G. Horizontal Positioning - General

Reading Assignment: Chapter 2, paragraphs 4.3 through 5.3.1

FIFTH DAY

- I. PRINTING UNIT
  - A. Left or Right Half Positioning
  - B. 1st, 2nd, 3rd and 4th Row Positioning
  - C. Spacing
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Reading Assignment: Chapter 2, paragraphs 5.3.2 through 6.1

SIXTH DAY

- I. PRINTING UNIT
  - A. Functions - General
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  - C. Carriage Return Function
  - D. Line Feed Function

Reading Assignment: Chapter 2, paragraphs 7.0 through 7.4





SEVENTH DAY

I. PRINTING UNIT

- A. Single Line Feed
- B. Double Line Feed
- C. Spacing Suppression on Single Line Feed
- D. Advancing the Platen
- E. Local Line Feed
- F. Automatic Carriage Return - Line Feed Function
- G. Signal Bell Function

Reading Assignment: Chapter 2, paragraphs 7.4.1 through 7.6

EIGHTH DAY

I. SIGNAL DISTORTION

- A. General
- B. Types of Distortion
- C. Bias Distortion
- D. Characteristic Distortion
- E. Fortuitous Distortion
- F. Total Distortion

Reading Assignment: Chapter 3,



## NINTH DAY

- I. SIGNAL DISTORTION
  - A. Effects of Distortion on the Signal
  - B. Effects of Bias
  - C. Fortuitout Effects
  - D. Effects of Total Distortion
  
- II. MODEL 14 TRANSMITTER DISTRIBUTOR
  - A. General
  - B. Commutator Distributor
  - C. Contact Assembly
  - D. Transmitter Assembly
  - E. Tape Feed Mechanism
  - F. Setting Up the Code Combinations
  - G. Main Shaft
  - H. Operating Cam
  - I. Operating Lever
  - J. Clutch
  - K. Control Circuit
  - L. Automatic Control of Transmitter Distributor
  - M. Maintenance Notes
  - N. Summary

Reading Assignment: Chapter 4,

## TENTH DAY

- I. REVIEW
- II. FINAL EXAMINATION

Reading Assignment: Review entire course



MODEL 28 PRINTER  
MODEL 19 EQUIPMENT  
INTRODUCTION

1.0 HISTORY OF PRINTING TELEGRAPH EQUIPMENT

Morse invented the telegraph in 1833. It was the first means of wire communications. The teletypewriter system, which we are now studying, gives more speed with only typists for operators and also provides record copies for both sending and receiving stations.

In 1851, the Hause Printer, the first character printer was invented. It was a typewriter adapted to Morse Code. Many different codes for printer wire communications were developed and in 1874, a French postal employee developed the Baudot five unit code.

An engineer by the name of Howard Crum became interested in printed wire communications. He interested the Morton Salt Company in his scheme, secured their financial backing and formed Morkrum Company in 1906. He built a teletypewriter which was a typewriter adaptation. In 1918, Howard Crum devised the Start-Stop system to keep the sending and receiving stations in synchronization. The Start-Stop system will be discussed later.

In 1921, the Model 11 Printer which was a Tape Wheel Page Printer was developed. In 1921, a man by the name of Kleinschmidt came into the teletypewriter design picture and the Morkrum-Kleinschmidt Company was formed.

In 1922, the Model 12 Printer, which was a motor driven L. C. Smith typewriter, was built.

In 1925, the Model 14 Printer, which is a Type Bar Tape Printer, was made. The Model 14 was used for many years by the FAA, is still used by Western Union, and one is available in the laboratory for inspection.

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MODEL 19 EQUIPMENT

This was the first printer to have a selector mechanism and was designed by Kleinschmidt.

In 1930, the Morton Salt Company withdrew their financial support and the Morkrum-Kleinschmidt Company was sold to the Teletype Corporation. The work "Teletype" is copywrited and can only be used by the Teletype Corporation. However, the work "Teletypewriter" can be used by others.

Shortly after 1930, the Model 15 Printer was developed. It is a Type Bar Page Printer and an adaptation of the Model 14. By January 1953, 180,000 had been produced. The Model 15 is the older of the two types of printers now in use by the FAA. In 1936, the Bell System bought the Teletype Corporation.

In 1940, the Model 28 Printer was developed. It is a Type Box Page Printer and was invented by a man of Polish extraction, who is now a Vice President of the company. This printer met the need for higher speeds, more functions and longer intervals between maintenance visits. About 1,4000 LP3 models were produced. Later, the PL6 model was produced, and is used by the FAA in the field and here in the laboratory. LP3 models may be in use in Alaska.

## 2.0 BAUDOT CODE AND THE START-STOP SYSTEM (Figure I-1 and I-2)

Our printers, either the Model 15 or 28, are designed to recognize two conditions; mark, which is a condition of current flowing, or space, which is a condition of no current flowing. Thus we have two conditions. The teletypewriter code we use has five pulses or five units. Then with two conditions and five units we have two to the fifth power or 32 possible combinations. But that isn't enough; we need more combinations. So, first a letters character is transmitted. All characters transmitted thereafter will be in the letters category. Or a figures character may be transmitted. All characters transmitted thereafter will be in the figures category.

By the use of figures and letters, we have doubled the possible combinations. The total possible character combinations, using the five unit code and figures and letters is 64. In THE PRINTER chapter, if you will examine the Type Box, Figure I-1B, you will find 64 places where type could be placed.

Refer to Figure I-2. This tape is 11/16" wide and comes out of a perforator and is continuous until torn off. When the Perforator keys are pushed, holes are punched in the tape. The punched tape is inserted in a Transmitter Distributor (TD). The switch is turned on and the message is sent out on the teletypewriter circuit. Referring to Figure I-2, the tape moves through the TD in a leftward direction and the tape sensing mechanism of the TD will sense from left to right on the tape. The small holes in the tape are tape feed holes and may be disregarded. Each character uses the space in a vertical line above and below each feed hole. On the drawing, a black dot indicates a hole. The top of the tape corresponds to impulse No. 1 and so on down to the No. 5 impulse at the bottom. In each one of the horizontal rows, there can be either a hole which corresponds to a current or marking impulse, or there can be no hole which corresponds to no current or spacing impulse.

This is our first reference to marking and spacing. Referring to Figure I-1, the start impulse and the Nos. 2 and 4 pulses are space conditions. The number 1, 3, 5 and stop pulses are mark.

Each character transmitted consists of one start (ST) impulse, which is always space, five code impulses which may be either mark or space, and one stop (SP) impulse which is always mark. When the circuit is idle, the condition is mark. When a character is transmitted, a start impulse first appears on the line, all printers on the line go space at the same time, thus synchronizing all machines. Actually, a lever moves and allows the selector cam sleeve to start rotating. During the remainder of the character, the receiving machines keep in step with the sending machines, because both are driven by synchronous motors.

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Refer to Figure I-1, as each printer reaches the point in time corresponding to the center of the No. 1 impulse, its selector mechanism will be set up either mark or space corresponding to the impulse being received. The same is true for impulses two through five. When the stop (SP) impulse is received, the lever moves to mark and blocks the rotation of the selector cam sleeve. The character is finished, all printers are mark and ready for the next character.

The start and the five code impulses are of equal length of time. The stop impulse is 1.42 times as long. Each character takes the same length of time to transmit. Refer to Figure I-3.

In using Figure I-3, one operation means one character, such as A. Six characters or spaces equal one word.

In using the Start-Stop system, the frequency of the electric power must be close to 60 cycles; otherwise, the synchronous motors will get out of step and the receiving printer will garble. The stop impulse is longer than the others, so that if the receiving printer gets behind during reception of one character, it will have time to get back to mark before the start of the next character.

### 3.0 PRINTING TELEGRAPH LINES

Two general types of teletypewriter connecting lines are used in connection with FAA teletypewriter equipment, polar and neutral.

#### 3.1 Polar Operation (Figure I-4)

Polar operation is shown in its simplest form in Figure I-4.

The 130 V battery at the sending station is adjusted for 35 ma line current. When the line goes from mark to space, or space to mark, the line is connected to a battery of opposite polarity. Thus, the current in the coil of the receiving station relay flows in one direction



for mark and in the opposite direction for space; and the armature of this relay moves from mark to space in a like manner. Since the mark circuit is identical to the space circuit except for direction of current flow, changing line conditions will affect mark and space pulses alike, and no bias distortion will result. Distortion will be discussed later. Many things can happen to a long line to cause bias distortion. Therefore, the Telephone Company, which furnishes the connecting lines for FAA, uses polar operation on their long lines. These long polar lines are in turn connected to short neutral lines, which are in turn connected to the FAA teletypewriters.

### 3.2 Neutral Operation (Figure I-5)

The FAA teletypewriters are connected to neutral circuits or lines. Neutral circuits vary in length from a few feet to a few miles long. A neutral circuit is shown in Figure I-5.

The Telephone Company is responsible for the maintenance of all equipment on their side of the demarcation strip and the FAA is responsible for the maintenance of all equipment on the FAA side of the demarcation strip. In Figure I-5, all equipment below the demarcation strip would be the responsibility of the FAA. 30 ma of current is furnished continuously to the bias winding of the line relay by the FAA printer rectifier. 60 ma of current is furnished during mark impulses only to the line winding of the line relay by the Telephone Company. In neutral circuits, it is important that the line current be maintained at 60 ma and the bias current at 30 ma to avoid distortion. If this is not possible the bias current should equal half the line current. Neutral circuits are very susceptible to failure caused by incorrect line and bias currents and other line troubles and are therefore used on short local lines adjacent to FAA printers. Every piece of equipment of a teletypewriter line is connected in series.



# MODEL 82 PRINTER

## CHAPTER ONE

### LINE RELAY

#### 1.0 ELECTRICAL SYSTEM

#### 1.1 Electrical Theory (Figure I-1)

To fully understand the function of the line relay and the part it plays in the operation of the teletypewriter circuit, one must have a knowledge of the electrical circuits involved. There are three paths of current flow, often referred to as battery.

##### 1.1.1 Line Current

This current flows in the signal line. Both line and current are furnished by the telephone company. Line current is rated at 60 ma DC and flows thru the primary or line winding of the relay.

##### 1.1.2 Selector Magnet Current (Mark)

This current is furnished by the DC power supply in the printer cabinet. This current flows from negative side of battery through the armature of the relay, mark contact of the relay, through the selector magnet coils of the receiver to the positive side of battery. This current keeps the selector magnet energized during the mark condition of the line.

##### 1.1.3 Shunt Circuit (Space)

During the space impulse, this current flows from negative side of battery, through the armature of the relay, space contact of the relay, through a load balancing resistor to the positive side of battery. In this way the resistor replaces the selector magnet coils in the circuit maintaining a constant load on the power supply and prevents fluctuation of the bias current.

#### 1.1.4 Bias Current

This current is furnished by the same power supply that furnishes the armature current. Bias current flows through the secondary or bias winding of the line relay any time the AC power is on. Bias current is rated at approximately one-half the line current or usually 30 ma DC.

### 2.0 APPLICATION

A line Relay is installed in each FAA printer. This line relay is an electrically biased relay used to repeat the signal on the line to the selector magnet coils. By the use of such a system, very sensitive and positive response of the selector magnet to the line signal is obtained. One reason for this is that the line relay has a mark to space or space to mark current differential of 6 ma or less. Also, if the incoming pulses on the signal line should have sloping leading and trailing edges, the line relay will repeat this signal to the selector magnet as essentially square sided pulses for positive action.

### 3.0 TYPES OF RELAYS

At the present time, two types of relays are in use by the FAA, 215-H and 255A. Originally, a third type, a 215-A was in use. The stationary contacts on this type (215-A) were changed to tungsten (stamped "T"), which makes it the 215-H type. At this time we are concerned with the 255-A Relay only since the 215 Relay is not in any great use today.

#### 3.1 Component Parts - Type 255-A (Figure 1-2 and 1-4)

The line relay consists of a permanent magnet, two pole piece screws, two pole piece screw lock nuts, two pole pieces, an armature, a coil with two identical windings and two stationary contacts, spacing and marking, a terminal block with eight terminals for connections and four posts for mounting, mounting frame and dust cover.

#### 4.0 THEORY OF OPERATION (Figure 1-4 and 1-5)

##### 4.1 Space Condition (Figure 1-4)

When bias current only flows, (through the bias winding of the line relay coil) its effect on the armature is to polarize the armature south. Under this condition, the south pole of the permanent magnet through the pole piece and pole piece screw will repel the armature. The north pole of the permanent magnet will attract the armature through the pole piece screw to the space side of the relay.

##### 4.2 Mark Condition (Figure 1-5)

Bias current flows through the bias winding of the line relay all the time that DC is applied. The line current must overcome the magnetizing effect on the armature set up by this bias current, to allow the armature to be attracted by the south pole of the permanent magnet during a mark condition of the line. By having the line current at two times the value of the bias current, the polarizing effect of the bias current on the armature can be overcome with twice the magnetic power set up by the bias current. Since bias current and line current flow in opposite directions, magnetic polarity of the armature will also be changed by the keying of the greater or line current.

#### 5.0 MAINTENANCE NOTES (Figure 1-6)

The 215-H and 255-A relays use tungsten (stamped "T") spacing and marking contacts. The 215-H uses one type of armature and the 255-A uses another (Information only). The upper end of the 215-H armature should be scored with diagonal pliers as shown in Figure 1-6 and the portion marked with an "X", broken off. This allows installation of the armature without disassembly of the relay.



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CHAPTER TWO  
SIGNAL DISTORTION

1.0 GENERAL

The ideal printing teletypewriter circuit will reproduce signals at the receiving end which are the same as those impressed at the sending end. In most circuits this condition is impossible to attain due to inherent characteristics in the connecting line, receiving equipment and the transmitting equipment involved. These characteristics may cause the receiving mechanism to be advanced or retarded and progressively displace succeeding transitions of characters. These irregularities are known as distortion. There are several types of distortion that go to make up, what is usually referred to as total distortion. Each type will be discussed before their total effects (total distortion), can be considered. Distortion is by definition, the time displacement of transitions between conditions, such as marking (current flowing) and spacing (no current flowing), with respect to their proper relative positions in perfectly timed signals. This displacement is expressed in percentage of the undistorted signal element.

2.0 TYPES OF DISTORTION

The types of distortion that make up the effect known as total distortion are bias distortion, characteristic distortion and fortuitous distortion. Each will be discussed below, with consideration of its effects on the impulses of the teletypewriter signal. Since systematic distortion is the algebraic sum of the systematic components of bias and characteristic distortion it will be referred to as a result rather than a type of distortion.

2-1 Bias Distortion

Transmission of intelligence over a teletype circuit is accomplished by sending various combinations of mark and space impulses through the circuit. Each marking impulse must start with a transition from a spacing to a marking condition, which is referred to as a S-M transition. Conversely, each spacing impulse starts with a marking to a spacing condition or as abbreviated, M-S transition. Bias distortion is a uniform displacement of these transitions, resulting in a uniform lengthening or shortening of all marking or spacing impulses.

A lengthened marking impulse is referred to as positive or marking bias, while a lengthened spacing impulse is called negative or spacing bias. In determining whether the bias present in a circuit is marking or spacing, their values must be added algebraically, with marking taking the positive sign and spacing taking the negative sign, as shown by the formula below.

$$\text{Bias Distortion} = + \frac{M - S}{2}$$

Where: M = % length of marking impulse

S = % length of spacing impulse

Bias percentage is based on the length of a single impulse, its full length denoting 100%.

The direct cause of bias distortion, whether marking or spacing is the delay in transitions, the mark to space transition delay (M-STD) and the space to mark transition delay (S-MTD). Figure 2-1 (a) shows a perfect signal as might be transmitted from a correctly adjusted transmitter distributor. Diagram (b) of Figure 2-1 brings out the effect, on the signal, when M-STD is equal to S-MTD. By projecting this distorted signal down to diagram (c), relative to the 30 ma. line of diagram (b) we again have a perfect signal containing no bias and comparable to the one originally transmitted, with the only difference being a delay in the receiving selectors start time denoted by (t) in diagram (c) of Figure 2-1.



Figure 2-2 (b) brings out the departure from the ideal transmitted signal when the M-STD is greater than the S-MTD. Here it will be noted in the resultant diagram (c) Figure 2-2, that the marking impulses have been lengthened causing a condition of marking bias. The signal presented to the receiving selector would be that of the diagram (c) and delayed the amount (t) as noted.

The effects of S-MTD being greater than M-STD, with spacing bias resulting, is brought out in Figure 2-3. Diagram (c) of the figure shows that the S-MTD has lengthened the spacing impulses without affecting the M-S transition at the beginning of the sequence. This time, the resultant wave shape, will be as shown in (c) of Figure 2-3 with spacing bias and no delay in start time.

Another condition known as end distortion, which does not usually occur due to line conditions, has an effect on the signal opposite that of bias distortion, since it adds to or subtracts from the rear of the marking impulses, but not to the M-ST of the start pulse. A test set is used to produce this type of distortion in order to determine the condition of the selector mechanism of the teletypewriter.

Diagrams (a) through (f) of Figure 2-4 indicate on what portion of the impulse the various forms of bias distortion and end distortion will occur during the reception of a character. Notice that bias distortion always affects the front end of the marking impulse and end distortion always affects the rear end of the marking impulse. Although displacement of the start time may be to the right, as was previously shown, when comparing the received signal with the transmitted signal, our receiver will only see the effects of bias and end distortion as shown in Figure 2-4.

## 2.2 Characteristic Distortion

This type of distortion is the result of changing current conditions as it affects the signal impulse. These transients may be electrical, where the characteristic distortion arises from transmission through wires, or mechanical where the distortion comes from the action of a relay. In other words a line containing capacitance or inductance, a definite amount of time is required for the current at the receiving end to change from its steady marking value to its steady spacing value and vice versa. This is due to the fact that the inductance and capacitance of the line store energy and their demands must be met before the receiving line current can reach a steady value. Characteristic distortion may be low at slow operating speeds of the teletypewriter circuit but will increase rapidly as the speed increases. At higher speeds the transitions from mark to space and space to mark are more frequent, and the line current may fail to reach a steady state before the next transition occurs. Figure 3-5 depicts two conditions, the effects of distortion when the impulses are long and the affect on a shorter impulse. In the teletypewriter circuit the shorter pulse would indicate the machine was operating at a higher rate of speed. Now, consider a pulse that is four units long, as shown in (a) of Figure 2-5.

Although this pulse was perfect when transmitted, it may take on the shape as shown in Figure 2-5 (b) at the receiving end of the teletypewriter circuit. The time relationship brings out the point that approximately 90% of the impulse time was utilized before the receiving end pulse had reached the steady state condition (mark). Even though this marking pulse is highly distorted its effective operation of the receivers selector magnet would be of an undistorted character. The squaring up of the received impulse is brought about by the relay action at the midpoint between steady state space and steady state mark

which results in an undistorted impulse from the relay. The shaded area in Figure 2-5 (b) represents a single received impulse, distorted about 20% with respect to a perfect transmitted pulse, denoted in the shaded area of (a). Considering the line characteristic to be equal in both cases and only the mark to space and space to mark transitions occurring more frequently, then it may be seen that for the shortened impulse the line current never reaches the steady state condition. In the figure, the mark to space transition is taking place at about the time the marking current on the receiving end reaches 40 ma. It then drops, as indicated by the dotted line, toward steady state space. As the rate of transitions increase it becomes apparent that during the time of a single impulse our line current will never assume steady state condition, resulting in a distorted received impulse.

Line characteristics may allow the current of the received impulse to rise above its steady state value. In the neutral circuit this would exist only when our signal was going from space to mark. A condition of this kind would tend to lengthen the marking impulse. In summary characteristic distortion results from the following:

1. Characteristics of the line
  - a. Inductance
  - b. Capacitance
  - c. Resistance
2. Frequency of the space to mark and the mark to space transitions. (Speed of transmission-words per minute)
3. Low or high line current. (Failure to reach steady state)

### 2.3 Fortuitous Distortion

Fortuitous distortion may be defined as random hits caused by lightning, crossfire, power induction or such as that commonly produced by interference. In explanation, let us assume that a given character is being repeated over the teletypewriter circuit and each repetition is perfect

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at the transmitting end. If the distortion content of each unit mark were measured at the receiving end, it would be found that each element differed. Assume that the average of a large number of distortions for a particular element is obtained and consider each individual distortion as being made up of two components, one the average and the other the departure from the average. These averages were previously referred to as systematic distortion. An individual departure from the average is called the fortuitous distortion.

#### 2.4 Total Distortion

Since total distortion is composed of the previously mentioned types of distortion, it may now be defined as the algebraic sum of the bias, characteristic and fortuitous distortions. Figure 2-6 shows in block diagram form the components and the various causes that go to make up the effect of total distortion.

MODEL 28 PRINTER  
CHAPTER THREE  
PRINTING UNIT

1.0 GENERAL CIRCUITRY

1.1 AC Circuitry (Figure 3-2)

Referring to Figure 3-2, the convenience receptacle, fuse and power switch are located at the right end of the Electrical Service Unit. This unit is mounted close to the rear wall, inside the cabinet and behind the typing unit. The AC power comes in at (A) and (B) at approximately 115 volts. The convenience receptacle is wired ahead of the fuse to allow closer fusing of the printing unit. Only one fuse is used and it is a Slow Blow or time delay type. The power switch is controlled, through linkage, from the front of the cabinet. When it is turned on, power is applied at (C) and (D).

1.1.1 Copy Lights (Figure 3-2)

The copy lights are located under the cabinet lid to illuminate the printed copy. When the light switch is turned to "Maint. On", the copy lights will light even though the power switch is off. In the "Off" position, the lights are off. In the "Normal On" position, the lights are on only when the power switch is on. The two lamps are in parallel and are double contact, bayonet base type, rated at 6.3 volts.

1.1.2 Motor Circuit (Figure 3-2)

The motor provides the motive power for all the mechanical operations of the printing unit. The motor is a two pole, single phase, capacitor start, 3600 RPM, synchronous unit. To avoid loss of receiving margin, the frequency of the power source feeding this motor must be maintained within plus or minus .45 cycles. In Figure 3-2, the current path is from (C), through the coil of the motor start relay, through the operate winding of the motor, through the contacts of the thermal cutout, through the heating element of the thermal cutout to (D). On starting, the current will be large, causing the motor start relay contacts to close. This connects

the starting capacitor and start winding into the circuit. After the motor comes up to speed, the current in the coil of the motor start relay decreases, the armature releases and disconnects the starting circuit. In case of a motor overload, the contacts of the thermal cutout will open, disconnecting the motor. The thermal cutout must then be manually reset by pressing the red button located behind, and under the curve, of the motor bell housing. The motor start relay, the starting capacitor and the thermal cutout are located in a compartment mounted beneath the motor.

#### 1.1.3 Margin Lamp (Figure 3-2)

The margin switch is located on the left front of the base. The 600 ohm resistor, R-1, is mounted under the right mounting plate of the electrical service unit. Designations such as R-1, R-2, etc., given to the resistors in Figure 3-2 are not official and only used to simplify the explanation. The margin lamp is located under the hinged cabinet cover, and uses the same type of lamp as the copy lights.

#### 1.1.4 Line Shunt Relay (Figure 3-2)

The line shunt relay is located at the left end of the electrical service unit under a black cover. In Figure 3-2, the line shunt contacts are shown at the lower left. With the power switch on, the contacts are open, and the signal line is connected to the line winding of the line relay. With the power switch off, the contacts are closed, shorting out the line winding of the line relay. This eliminates wear of the line relay contacts during long idle periods and allows the line relay to be removed without causing the line to run open as long as the power switch is off.

#### 1.1.5 Signal Bell (Figure 3-2)

The signal bell contacts are located over slot 41 in the stunt box. The signal bell itself is mounted underneath the cabinet compartment containing the printing unit.

### 1.1.6 Off-Line Solenoid (Figure 3-2)

The local-remote switch and the off-line solenoid are shown in the lower right hand corner of Figure 3-2. The local-remote switch is located on the front of the cabinet. The off-line solenoid is located on the left end of the typing unit. With the local-remote switch in the local position, the off-line solenoid is energized, allowing the typing clutch to be engaged and printing to occur. With the switch in the remote position, the off-line solenoid is connected to open terminals C23 and C24. With the solenoid de-energized, the typing clutch will not engage and no printing will occur unless the printer is "conditioned". Conditioning will not be included in this discussion.

## 1.2 DC Circuitry

### 1.2.1 Rectifier (Figure 3-2)

The rectifier which is located near the center of the electrical service unit, provides full wave rectification with an output of about 115 volts DC, rated at 120 ma. It supplies the required "mark", "space", and "bias" currents. These currents may be measured using the Printer Test Set. This rectifier, due to it's small capacity, cannot be used to supply dummy line current.

### 1.2.2 Selector Magnet Circuit (Figure 3-2)

The selector magnet is mounted on the right end of the typing unit. All resistors R-2 through R-11 and all the capacitors are mounted under the line relay mounting plate in the electrical service unit. The four capacitors in the selector magnet circuit, the .01 ufd capacitor attached to the line relay winding and resistors, R-3 and R-5 are physically located inside the No. 152109 Filter shown on Page 15 of Teletype Bulletin 1157B. The other eight resistors associated with the selector magnet and line relay circuits are actually four tapped resistors shown on the same page.

Referring to Figure 3-2, the electron flow path of the selector magnet circuit is from (F), through the 2750 ohm resistor R-2 to the line relay armature. In a mark condition, the electrons flow through the M (mark) contact, the 400 ohm resistor R-3, the 600 ohm resistor R-4 and the two selector magnet coils to (E). In a space condition, the electrons flow from DC-, through the 2750 ohm resistor R-2, the S (space) contact, the 400 ohm resistor R-5, the 810 ohm resistor R-6 to DC+. With the selector magnet coils in series, as shown in the figure, the current is approximately 30 ma. The purpose of the capacitor arrangement is to reduce radio interference caused by arcing at the line relay contacts.

### 1.2.3 Bias Current Circuit (Figure 3-2)

The electron flow path of the bias current is from (F), through the 1800 ohm resistor R-11, the bias winding of the line relay, the 2000 ohm resistor R-8 to (E). The bias current, for our use, will be approximately 30 ma, and cannot be adjusted.

### 1.3 Reperforator Control Assembly (Figure 3-2)

The reperforator control assembly is mounted on top of and near the center of the stunt box. It consists of a bakelite block with either one or two switches. The switches, normally closed, are used to start reperforators at service B relay stations. On the printers at relay stations, there are two switches which correspond to adjacent push buttons on the Switching Cabinet. Only one switch is used at a time. By moving the bakelite block or by using the appropriate switch, reperforator control can be positioned to operate over any available slot. In Figure 2-2, the reperforator control contacts are shown near the bottom of the drawing.

## 2.0 MAIN SHAFT (Figure 3-3)

The main shaft is situated in the lower rear portion of the typing unit, and is shown in Figure 3-3. It extends across the rear of the typing



unit and is supported by ball bearings mounted in each side frame. When the typing unit is placed on the base, the main shaft helical driven gear meshes with the intermediate helical driving gear. Through this gear train, mechanical power is transferred from the motor to the typing unit.

Six all-steel internal expansion clutches are mounted on the main shaft which rotates continuously when the motor is energized. Two of these, the line feed and spacing clutches, have three sets of trip lever lugs equally spaced about the clutch circumference. Upon engagement, the spacing clutch will rotate one-third of a revolution and the line feed clutch will rotate either one-third or two-thirds of a revolution depending upon whether the single-double line feed lever is set for single or double line feed. The four remaining clutches each have one set of trip lever lugs. Upon engagement, they will rotate one complete revolution.

#### 2.1 Clutch Action (Figure 3-4 and 3-5)

Referring to Figure 3-4, each clutch has two shoes, primary and secondary, which bear against the inside surface of a serrated drum at four points. The drum is fastened to the main shaft by a set screw. Consequently, the drum rotates continuously when the motor is running. The clutches operate as follows:

Figure 3-4 shows a typical single stop clutch in the disengaged position.

Disengagement occurs when the lug on the lower end of the clutch shoe lever B, and lug A on the lower end of the clutch cam disk are brought close together. The clutch shoe lever pivots clockwise about clutch shoe lever ear C which is pivoted in a notch at the upper end of the secondary shoe. Clutch shoe lever ear D is moved to the right. The upper spring pulls the primary and secondary shoes together and away from the serrated drum surface, disengaging the clutch. The drum continues to rotate but all of the other parts, which are attached to the clutch cam disk remain stationary. The drum is serrated around its entire inner surface.

Figure 3-5 shows the same clutch in the engaged condition.

Engagement occurs when lug A on the lower end of the clutch cam disk and the lug on the lower end of the clutch shoe lever B are released. The lower spring, being anchored to the disk on the right, pulls the lower end of the clutch shoe lever B to the right. The clutch shoe lever pivots counterclockwise about clutch shoe lever ear C, overcoming the upper spring, moving the clutch shoe lever ear D to the left, and forcing the primary shoe against the serrated drum surface at E. The counterclockwise rotation of the drum drives the primary shoe downward and so makes further contact with the drum at F. The drum forces F to the right, which causes G and then H to move to the right. The drum forces H and I upward. Point I is also being forced to the right by the clutch shoe lever ear C, caused by the counterclockwise rotation of the clutch shoe lever B. The whole action is cumulative, causing the four shoe faces to expand and engage the serrated drum surface. The disk quickly assumes the speed of the drum and its rotation performs the operation designated for that clutch. The transfer of power is from the drum, to the secondary shoe, to the lug on the clutch disk, to the disk. The action of this clutch is quick and positive which is imperative in high speed operation. Another advantage over friction type clutches is that there are not felt washers which heat and glaze and must be replaced and oiled at frequent intervals.

### 3.0 SELECTING MECHANISM (Figures 3-3, 3-6,3-7 and 3-7a)

The selecting mechanism consists of the selector electromagnet and armature, a selector cam-clutch, and the associated levers, arms, bails, and slides necessary to convert the electrical code signals into the mechanical motions which determine the characters printed and the functions performed.

The selector magnet performs the actual transition from electrical code signals to equivalent mechanical motions in the typing unit. The magnet

consists essentially of two 132 ohm coils which are wired to a cable connector mounted on the typing unit right side frame. A cable from the electrical service unit, when plugged into this connector, connects the selector magnet coils to the selector magnet terminal board in the electrical service unit. The selector magnet coils are wired in series at the factory for approximately 30 ma operation.

As shown in Figure 3-3, the selector cam-clutch comprises, from right to left, the clutch, the stop arm bail cam, the fifth, fourth, and third selector lever cams, one cam for the spacing and marking lock levers, the second and first selector lever cams, the push lever reset bail cam, and the code bar clutch trip cam.

Referring to Figure 3-6, during the time in which a closed line circuit (marking) condition exists, the selector magnet coils are energized and hold the selector armature against the selector magnet pole pieces. In this stop position, the selector armature (35) blocks the start lever (34). At the start of a signal for any character or function, the start (spacing) interval releases the selector armature which, under the tension of its spring, moves down and away from the magnet cores and thus unlatches the start lever. The start lever turns clockwise, with the top end moving to the right, under the tension of its spring to move the stop arm bail (31) into the indent of the stop arm bail cam (33). In this position, the selector armature is physically locked in space (down) position for the duration of the start pulse. As the stop arm bail rotates about its pivot point, the attached stop arm (19) is moved to the right and down, releasing the clutch shoe lever (18), which moves up. The clutch is engaged as shown in Figure 3-5 and begins to rotate counterclockwise. The stop arm bail immediately rides to the high point of its cam where it remains to hold the start lever to the left and away from the selector armature during the signaling time. When the stop impulse at the end of the signal is received, the selector armature is pulled up to block the start lever.

Thus, the stop arm bail is prevented from dropping into the low part of its cam (stop position of cam-clutch), and the attached stop arm is held so as to stop the clutch shoe lever. The selector cam-clutch disk (17), upon which the latch lever (20) rides, has an indent at its stop position. When the clutch shoe lever strikes the stop arm, the inertia of the cam disk assembly causes it to continue to turn until the lug on the disk, shown to the left of the latch lever (upper arrow), makes contact with the clutch shoe lever. At this point, the disk has turned far enough to allow the latch lever to drop into the notch in the disk as shown in Figure 3-6. The clutch is held disengaged as shown in Figure 3-4 until the next start impulse is received.

In Figure 3-7, a series of five selecting levers (only one of which is shown), the marking lock lever and the spacing lock lever ride their respective cams on the selector cam-clutch.

All of these levers are spring loaded to the right. As the marking and spacing signals are applied to the selector magnet, the selector cam-clutch rotates and actuates the selector levers.

When a spacing pulse is received, the selector armature moves down and its left end blocks the rightward travel of the marking lock lever. The extensions on the marking lock lever block the rightward travel of the selecting lever that happens to be opposite its cam indent and holds it in the space (left) position. With the selecting lever in the space (left) position, the associated push lever rests upon the upper right portion of the selecting lever. When the selector armature moves down, it allows the spacing lock lever to move to the right and over and above the armature, thus physically locking the armature in the space (down) position for the duration of one pulse.

Between each pulse, the marking lock lever and the spacing lock lever are cammed to the left and clear of the selector armature to allow it to move either mark or space in following the incoming electrical pulses.

When a marking pulse is received, the selector armature moves up, its left end blocks the rightward travel of the spacing lock lever. The marking lock lever moves to the right and under the selector armature, thus physically locking the selector armature in the mark position. The extensions on the marking lock lever, being part of the marking lock lever, move to the right. The selecting lever (spring loaded to the right), which happens to be opposite its cam indent, is allowed to move to the right momentarily, allowing its associated push lever to drop down onto the lower left hand step of the selecting lever.

Each of the five selecting levers has only one chance to move to the right and is afterward cammed to the left. For those selecting levers which are selected space, the push levers will be on the upper step of the selecting levers as shown in Figure 3-7 and the push levers will remain to the right by spring action. For those selecting levers which are selected mark, the push levers will be on the lower step of the selecting levers and as the selecting levers are cammed left, they will push their associated push levers to the left and hold them there. Shortly after the beginning of the start pulse of the next character, the push lever reset bail, in following its cam, pushes all five push levers upward to the space position, where they will remain unless selected mark.

#### 4.0 CODE BAR MECHANISM

The character which is to be printed is determined basically by the combination set up on the six code bars which are operated by the code bar positioning mechanism. In order to position the code bars, their associated shift bars must first be individually positioned toward the front or rear of the typing unit by transfer levers which respond to action of the selecting mechanism. While held in these positions, the code bar shift bars are moved either to the left or the right by code bar shift levers which are activated when the code bar clutch engages. Detailed functioning of the coordinated mechanism is as follows.

#### 4.1 Code Bar Shift Bar Positioning (Figures 3-8 and 3-9)

Referring to Figure 3-8, each push lever (15), of which there are five, has an associated intermediate arm (17), transfer lever (13), and code bar shift bar (12). In addition, there is a "common" transfer lever with its code bar shift bar. In Figure 3-8, the ear marked "C" and the extension (14) are part of the common transfer lever.

When a push lever is moved toward the right (space) its associated intermediate arm, being pivoted at the lower end (pivot not shown), turns clockwise due to the spring on its upper end. The lower end of the transfer lever is pushed to the right and the upper end moves to the left, pushing the associated code bar shift bar to the left (space) position.

When a push lever is moved toward the left (mark) its associated intermediate arm is pushed counterclockwise, pulling the lower end of the transfer lever to the left by spring action. The upper end of the transfer lever moves to the right, pushing the associated code bar shift bar to the right (mark) position.

Referring to Figure 3-9, the common transfer lever (36) has an extension (39) which passes behind the number one and number two transfer levers.

When either or both of these transfer levers (38) are moved to the rear (into the paper-mark) position, they move the common transfer lever to the rear. This, in turn, moves the common code bar shift bar (11) toward the rear (mark) position. The rule is, if both number one and number two transfer levers are space, the common transfer lever will be space.

#### 4.2 Code Bar Positioning (Figures 3-3, 3-9 and 3-10)

As the selector cam-clutch completes its revolution, the trip shaft operating lever (fastened to the code bar clutch trip shaft) rides to the peak of the code bar clutch trip cam shown in Figure 3-3. The code bar clutch is the next clutch to the left of the selector clutch. The trip shaft operating lever causes the shaft to turn slightly and its attached code bar clutch trip lever releases the code bar clutch which immediately engages. Referring to Figure 3-9, rotation of the clutch actuates the code bar shift levers (12)

through the intervening shift lever drive shaft (19), the shift lever drive arm (20) and the shift lever link (16). The initial position of the shift lever link is down. The shift lever link moves upward and the extension (13) which is attached to the link moves upward, causing the upper end of the code bar shift levers to move towards each other. In Figure 3-10, as the code bar shift levers move towards each other, the code bar shift bars which have been moved toward the rear position by their transfer levers are engaged by the rear code bar shift lever and are shifted to the left (mark). The code bar shift bars which have been moved toward the front position are engaged by the front code bar shift lever and are shifted toward the right (space). Thus, the six code bar shift bars shift their respective code bars toward the right or left where they are retained by a detenting mechanism. The one-stop code bar clutch rotates 360 degrees and is disengaged in the same manner as the selector clutch previously described.

#### 4.3 Arrangement of Code Bars (Figure 3-11)

Three additional code bars bring the total number of code bars to nine as shown in Figure 3-11. They are arranged from top to bottom as follows: suppression, number 4, 1, 5, 2 and 3, common, automatic carriage return and line feed or "0" for "OT O matic", and "S" for shift-unshift or figures-letters. The automatic carriage return and line feed code bar and the shift-unshift code bar are actuated by mechanisms which will be discussed under FUNCTIONS.

#### 5.0 TYPE BOX AND TYPE BOX CARRIAGE (Figures 3-12, 3-13 and 3-14)

The various characters and symbols printed by the typing unit are embossed on type pallets arranged in a compact, lightweight type box which may be readily detached for cleaning or replacement by a type box having a different set of characters or symbols. Figure 3-12 shows the type box. In operation, the type box, mounted on a type box carriage, is positioned

both vertically and horizontally by the printing mechanism so that the character to be printed is positioned in back of the printing hammer which moves from left to right one space per character except for functions. The five selecting elements of the start-stop code are used to accomplish this positioning.

Looking at Figure 3-13, the type box carriage, which is attached to the type box carriage link (4), has rollers which ride on a track which positions the type box vertically. The carriage is positioned horizontally on its track by the oscillating rail slide (3) and the type box carriage link. The oscillating rail slide rides the oscillating rail (7) and is clamped to the rear section of the upper draw wire rope (2). The type box carriage link provides a flexible connection to permit the type box carriage to follow both the vertical movement of the type box carriage track and the horizontal movement of the oscillating rail slide. The lower right rear end of the upper draw wire rope is fastened to the spacing drum (21). From this point, it passes part way around the spacing drum, upward and around the right oscillating rail pulley (8), over to the left oscillating rail pulley (30), and downward to the spring drum (28). After passing part way around the spring drum, the upper draw wire rope is doubled backward around the spring drum in a clockwise direction and upward and over the left printing carriage track pulley (1), over to the right printing carriage track pulley (10), and downward to the spacing drum to which it is again fastened. The lower draw wire rope (27) is fastened at its left end to the spring drum and, at its right end, to the spacing drum. It acts in opposition to the upper draw wire rope and holds the two drums in phase. The draw wire rope tensioning pulley (24) rides the under side of the lower draw wire rope, to take up any slack which may occur due to stretching of the upper and lower draw wire ropes. The oscillating rail is supported by pivoted arms at each end. These arms which extend downward are pivoted on the typing unit frame at their lower ends. Thus, the oscillating rail and the draw wire rope that it carries may be shifted to the left or right with no change in position relative to each other.



Generally speaking, the selection of the various characters in the type box from the four horizontal rows and the eight vertical rows in either the Letters or the Figures side of the type box and the printing of these characters takes place as follows. Referring to Figure 3-14, the letters side of the type box, containing the alphabet, is brought into the printing position by the letters code combination, and the figures side of the type box, containing the figures and special symbols, is brought into the printing position by the figures code combination. Essentially, the mark or space condition of the No. 1 and the No. 2 pulses in the selecting code determine which of the four horizontal rows will be positioned for printing; the No. 3 impulse determines which way the type box will be moved from the letters or figures centerline, left or right; the No. 4 and No. 5 impulses determine which of four vertical rows on either side of the centerline is selected for printing.

#### 5.1 Vertical Positioning (Figure 3-11)

In Figure 3-11, when the No. 1, No. 2, or Common code bar is in the spacing (right) position, it projects slightly beyond the edge of the right code bar bracket into the path of the right side vertical positioning lever, thus limiting the total rise of the lever. If none of the code bars are in the spacing (right) position, the lever will be blocked in the topmost position by the Suppression code bar. Notches in the left end of each code bar are arranged so that the left side vertical positioning levers are in each case blocked by the same code bar that blocks the right side vertical positioning lever.

#### 5.1.1 Function and Type Box Clutch Engagement (Figure 3-15)

After all the code bars have been shifted to the marking or spacing position corresponding to the line signal variations, (see Figure 3-15) the follower arm roller (33) in traversing the indent on the code bar clutch cam (31) causes the clutch trip lever shaft (20) to rotate part of a revolution. As the shaft turns, the function clutch trip lever (38) releases the stop lug on the function clutch (36), causing its engagement.

Then, the type box clutch trip arm actuates its type box clutch trip lever (18), releasing the stop lug on the type box clutch (19) which also engages. Both clutches commence rotating. By the time each clutch has completed one revolution, the follower arm roller has moved to the high portion of the code bar clutch cam, rotating the clutch trip lever shaft in the opposite direction and back to its original position, returning the clutch trip levers to the stop position. Thus, the function and type box clutches, complete 360 degrees of rotation, and are disengaged in the same manner as the selector clutch previously described.

#### 5.1.2 Left and Right Side Mechanism (Figures 3-14 and 3-16)

As the type box clutch engages, motion is extended to a drive link and a bracket located on the left side of the typing unit. The bracket is attached to the main rocker shaft and causes it to oscillate. The main rocker shaft extends from left to right in the lower front part of the typing unit. Figure 3-16 shows the right side mechanism which is actuated by the main rocker shaft. However, a similar left side mechanism is actuated by the other end of the main rocker shaft. In Figure 3-16, the main rocker shaft (32) transmits motion, through the rocker shaft bracket (31), the main side lever drive link (20), the main side lever (19) and vertical positioning levers (34). These levers are driven upward until they strike a projecting code bar, (35), (36), (37) or (38), which causes them to buckle at the arrow. The type box carriage track (39) is mounted between the left and right vertical positioning levers and its vertical motion is controlled by them. When the number 1 code bar and the number 2 code bar toward the right (spacing-out of the paper), the common code bar is also toward the right where it blocks the vertical positioning levers. The type box will move upwards a minimum distance and the top row of characters shown in Figure 3-14 are then in line for printing. When the number 1 code bar

is left (mark), and the number 2 code bar is right (space), the common code bar will be left (mark). The number 2 code bar blocks the vertical positioning levers, and the second row of characters in Figure 3-14 are in line for printing. When the number 1 code bar is right (space), and the number 2 code bar is left (mark), the common code bar is also left (mark). The number 1 code bar blocks the vertical positioning levers and the third row of characters in Figure 3-14 are then in line for printing. When the number 1 and the number 2 code bar are left (mark), the common code bar is also left (mark). In this case, the suppression code bar blocks the vertical positioning levers, and the bottom row of characters in Figure 3-14 are then in line for printing. The rule is, if both number 1 and number 2 code bars are space, the common code bar will be space. At each of the four levels at which the vertical positioning levers may be stopped, they are locked momentarily by the vertical positioning lock levers (13) which are controlled by the main side lever follower arms (14), and the main side levers (19).

## 5.2 Horizontal Positioning (Figure 3-17)

Referring to Figure 3-17, the main bail bracket (33) attached to the main rocker shaft (19) applies vertical motion to the main bail (34) by means of two main bail links (28). Attached to each end of the oscillating rail shift slide (36) are pivoted "buckling" type shift slide drive links (35) and (17). These links extend downward to each end of the main bail. As the main bail moves downward from its initial upward position, the left shift slide drive links, if not buckled, will try to shift the oscillating rail shift slide toward the right while the right shift slide drive links, if not buckled, will try to shift the oscillating rail shift slide toward the left.

### 5.2.1 Left or Right Half Positioning (Figures 3-17 and 3-18)

When the number 3 code bar (16) is shifted toward the right (space), the horizontal motion reversing slide (13) or (37) is shifted toward the right

by the reversing slide shift lever (18), and is held there by the detent levers (16.5). Figure 3-18 shows the initial motion of the reversing slide. The reversing slide moves to the right (space), the left reversing slide bracket makes contact with the ear on the left horizontal positioning drive linkage causing the left linkage to break as shown. Going back to Figure 3-17, the left shift slide drive links (35) are now broken. As the main bail (34) is driven downward, the unbuckled right shift slide drive links (17) will start to shift the oscillating rail shift slide (36) toward the left. And since the type box follows the oscillating rail shift slide, printing will occur in the right half of the letters or figures side.

In a similar manner, when the number 3 code bar is shifted toward the left (mark), the horizontal motion reversing slide is shifted toward the left by the reversing slide shift lever and is held there by the detent levers. The right reversing slide bracket (12) makes contact with the right shift slide drive links and causes them to buckle. As the main bail is driven downward, the unbuckled left shift slide drive links will start to shift the oscillating rail shift slide toward the right. This positions the type box so that the character to be printed will be found in the left half of the letters or figures side.

The above explanation covers only the initial motion of the oscillating rail shift slide. This initial motion is necessary to determine on which side of the heart shaped horizontal positioning lock lever (27), the horizontal positioning lock lever arm (20) will remain. As the upper end of the horizontal positioning lock lever arm is connected to (5), which is connected to the oscillating rail shift slide, this initial motion determines on which side of the typing unit the oscillating rail shift slide will remain. Later, both the left and right shift slide drive links will break.

5.2.2 First, Second, Third and Fourth Row Positioning  
(Figures 3-14, 3-17 and 3-19)

After it has been thus determined whether printing will occur in the "left" or "right" half of Figure 3-14, the number 4 and number 5 code bars operate three horizontal motion stop slides to determine the "row" in that group in which the character is to be found. First, second, third and fourth rows are shown in Figure 3-14 under "3 marking" and "3 spacing". Referring again to Figure 3-17, a heart shaped horizontal positioning lock lever (27), which is pulled downward by the main bail (34) through a yield spring, bears against the round post on the upper end of the horizontal positioning lock lever arm (20). This arm drives the oscillating rail shift slide (36) in the direction in which it was started (by the number 3 code bar selection) until one of the two decelerating slides (31), which are mounted on the oscillating rail shift slide, strikes a horizontal motion stop slide (6), (7), or (8). The camming surface marked B, near the right end of (5), on the unbuckled right shift slide drive links (17), makes contact with and rolls down the face of the right decelerating slide (turns clockwise about its lower pivot) and causes the right shift slide drive links to buckle. The oscillating rail shift slide finally comes to rest when it strikes the blocked right decelerating slide. At this point, both the left shift slide drive links and the right shift slide drive links are buckled. Thus, the downward movement of the horizontal positioning lock lever is ended, and the yield spring is extended until the main bail reaches the lowest point of its oscillation.

Referring to Figure 3-19, the number 4 and number 5 code bars each operate a code bar bell crank (one above the other). Each, in turn, moves a horizontal motion slide toward the front (mark) or toward the rear (space). Figure 3-17, shows the upper horizontal motion stop slide (7) (operated by the number 4 code bar) and the lower horizontal motion stop slide (8) (operated by the number 5 code bar). A third slide, the common horizontal motion stop slide (6), spring tensioned toward the rear, is located between

the upper and lower stop slides and has projections which pass in front of these slides. Each slide is of a different length. The common stop slide, which is the longest stop, has an additional step on its rear portion so that it serves also as the shortest stop when all the slides are moved forward. The upper slide is the second longest stop, and the lower slide is the third longest.

When both the number 4 and the number 5 code bars are toward the right (space), their respective horizontal motion stop slides (7) and (8) and the common stop slide (6) are toward the rear. The oscillating rail shift slide is moved to the right or left of its central position (determined by the number 3 code bar) until it is stopped by one end of the long front portion of the common horizontal motion stop slide. This positions the 1st vertical row (right or left of the letters center or the figures center) in line for printing as shown in Figure 3-14. Referring to Figure 3-17, when the number 4 code bar is toward the right (space) and the number 5 code bar is toward the left (mark), the lower stop slide and the common stop slide are toward the front and the upper stop slide is toward the rear. The oscillating rail shift slide is moved to the right or left of its central position until it is stopped by one end of the upper stop slide. This positions the 2nd vertical row (right or left of letters center of figures center) in line for printing as shown in Figure 3-14.

Referring again to Figure 3-17, when the number 4 code bar is toward the left (mark) and the number 5 code bar is toward the right (space), the upper and the common stop slides are toward the front and the lower stop slide is toward the rear. The oscillating rail shift slide is moved toward the right or left of its central position until it is stopped by one end of the lower stop slide. This positions the 3rd vertical row (right or left of letters center of figures center) in line for printing as shown in Figure 3-14. Referring to Figure 3-17, when both the number 4 and number 5 code bars are toward the left (mark), all three stop slides are toward the front. The oscillating rail shift slide is moved toward the right or left of

its central position until it is stopped by one side of the rear portion of the common stop slide, at which point it has moved a greater distance than at any other time. This positions the 4th vertical row (right or left of letters center or figures center) as shown in Figure 3-14.

The first rule is, if the number 4 and 5 code bars are space, the common stop slide will be space. The second rule is, the space position of the stop slides is to the rear of the typing unit.

#### 6.0 SPACING (Figures 3-13 3-20 and 3-21)

To properly space the printed characters, the type box and printing carriages must be advanced with each character printed. As was shown previously and in Figure 3-13, the carriages are connected to a draw wire rope, which in turn, is fastened to the spring drum and the spacing drum. The purpose of the spring drum, which contains a torsion spring, is to tension the draw rope and thus move the carriages to the left. Referring to Figure 3-20, the spacing drum has ratchet teeth about its circumference which are engaged by the eccentric driven spacing drum feed pawls. The spacing shaft, on which the spacing eccentrics are mounted, is driven through its spacing shaft helical driven gear attached to the three-stop spacing clutch on the main shaft. The gear ratio of 1-1/2 to 1 causes the spacing shaft to turn one-half of a revolution each time the spacing clutch is engaged. This allows the feed pawls to advance the spacing drum by the amount of one ratchet tooth. Referring to Figure 3-21, as shown previously, each time the type box clutch is engaged, the main rocker shaft (17) is made to oscillate about its center. The rocker shaft cam plate (18) is in its lowest position during the rest time. During the time that printing is to take place, the cam plate is moved upward by the main rocker shaft and turns the spacing trip lever bail (19) (right arrow) clockwise about its black pivot point. This causes the spacing trip lever bail (left arrow) to move upward, causing the spacing trip lever (20) to move upward. The upper end of the spacing trip lever is spring loaded to the left. As the spacing trip lever moves upward, it latches over the projection (37) on the spacing clutch trip lever arm (40).

As the rocker shaft reverses its direction of rotation, the spacing trip lever bail turns counterclockwise, the spacing trip lever (left arrow) moves downward, causing the latched-up spacing clutch trip lever arm to turn clockwise about its black pivot point. The lower end of the spacing clutch trip lever (34) moves to the left and releases the spacing clutch, causing its engagement.

Before the spacing clutch completes one-third of a revolution, its spacing clutch restoring cam (31) turns the spacing trip lever clockwise, the upper end of the spacing trip lever (left arrow) moves to the right, clearing the projection on the spacing clutch trip lever arm, allowing the arm to turn counterclockwise. The lower end of the spacing clutch trip lever moves to the right in time to stop the spacing clutch after one-third of a revolution, and the spacing clutch is disengaged in the same manner as the selector clutch previously described.

#### 6.1 Spacing Suppression (Figure 3-21)

When certain functions are selected, or when the carriage reaches its extreme right position, it is necessary to suppress spacing. Referring to Figure 3-21, this is accomplished by moving the spacing suppression slide (12) to the right. In this position, the projection (11) on the spacing suppression slide contacts the upper end of the spacing trip lever (20) (left arrow) and holds it to the right. In this position, although the spacing trip lever (left arrow) moves up and down, it is not allowed to latch on the projection (37) on the spacing clutch trip lever arm (40), and the spacing clutch remains disengaged and does not turn.

In the case of spacing suppression on functions, the spacing suppression slide is shifted to the right by means of the spacing suppression bail (39). The manner in which this bail is operated will be discussed under FUNCTIONS.



When the carriages are near their extreme right positions, an adjustable spacing cut-out lever (16) (on spacing drum) moves upward, causing the spacing cut-out transfer bail (14) to turn counterclockwise. A projection on the left end of this spacing cut-out transfer bail, as it moves down, contacts and causes the spacing cut-out bail (13) to turn clockwise. A projection on the upper end of the spacing cut-out bail moves to the right, makes contact with a projection on the upper side of the spacing suppression slide, moving it to the right. After which, spacing is suppressed as described before. Spacing is thus suppressed until the carriages are returned. The maximum number of characters which the typing unit may print in one line is eighty-five. In order to prevent spacing beyond this point several teeth are omitted from the spacing drum ratchet wheel.

#### 7.0 FUNCTIONS (Figures 3-22,3-23, 3-24, 3-25 and 3-26)

Essentially, the operations performed within the typing unit can be divided into two distinct classifications; those which are directly concerned with the actual printing of a character and those which result in line feed, carriage return, space, figures - letters shift, etc. The latter operations are known as functions.

As in printing, the reception of a function code combination positions the code bars in accordance with the marking and spacing intervals of the signal. A series of square notches extends across the rear edge of each code bar. Referring to Figure 3-22, the stunt box containing the function bars is positioned directly behind the code bars. The front edge of each function bar has a series of tines which are offset to one side or the other. After the code bars have been positioned, the function bars are allowed to bear against the code bars. Only the function bar with the correct arrangement of tines will enter the notches in the code bars. All other function bars will be blocked by one or more code bars.

Referring to Figure 3-23, when the function clutch is engaged, it rotates and imparts motion to the function cam, the follower arm, the rocker shaft, the function bar reset bail and the reset bail blade. The reset bail blade moves to the right. As the reset bail blade moves to the right (front), the spring tensioned function bars which are pushing against the left edge of the reset bail blade, are released and move forward to bear against the code bars as shown in Figure 3-24. Referring to Figure 3-24, if the code bars are positioned for a particular function, each tine on the function bar for that function will be opposite a notch in the code bar. This will permit the selected function bar to enter the code bars while the others are blocked by one or more code bars. Selected function bars move farther towards the front of the typing unit than do unselected function bars. A function pawl and function lever is associated with each function bar.

Referring to Figure 3-25, in the unselected position, the function pawl (40) notch is not engaged by the top right ear of the function bar (18) as shown in Figure 3-25. In Figure 3-26, when the function bar reset bail (20) moves to the left and releases the function bars (18), the selected function bar moves to the left, the top right ear of the function bar moves under the notch on the lower side of the function pawl (40), and the function pawl by spring action drops down over the top right ear of the function bar as shown in Figure 3-26.

In the second half of the cycle, the function bar reset bail moves to the right, moving the function bar to the right. The function bar, being engaged in the notch of the function pawl, moves the function pawl to the right (rear). The projection (35) on the function pawl causes the function lever (39) to turn clockwise on its pivot. A projection (17), on the lower end of most function levers, moves the spacing suppression bail (33) to the left to suppress spacing. This extension (17) of the function lever is omitted when spacing on a function is desired.

Near the end of the function cycle, the stripper blade (11), operated by a cam on the function clutch assembly, rises beneath the rear edge of any selected function pawl and strips it from its function bar. Springs return the released function pawl and the function lever to their original positions. It should be noted here that, to prevent printing during a function cycle, whenever a function selection occurs, the type box is positioned such that the printing hammer will strike the type box where there is no type pallet. The function clutch is disengaged upon the completion of one revolution in the same manner as the selector clutch previously described.

It should be noted here, that either the upper, lower or both ends of the function lever may be used to perform the desired work.

#### 7.1 Letters and Figures Shift Function (Figures 3-27 and 3-28)

The letters and figures function bars, pawls and levers which are located near the right end of the Stunt box operate on letters and figures codes respectively. Referring to Figure 3-27, the upper ends of the function levers engage the letters and figures function slides and pull them to the rear. The front ends of these function slides have camming surfaces which, when a slide is shifted to the rear by its function lever, move the letters-figures code bar fork to the right (letters position) or to the left (figures position). Referring to Figure 3-28, the letters-figures code bar fork (14) engages a pin (13) on the bracket (15) which is fastened to the letters-figures shift code bar (36), and positions the code bar toward the right for letters function as shown in Figure 3-28 or toward the left for figures function. A slotted code bar extension (16) engages the letters-figures shift slide (17) and causes it to follow the movements of the code bar. In Figure 3-28, the letters-figures shift slide has moved right (letters). Pins (19) and (34) at the end of the shift slide serve as lower guides for the right and left shift link breaker slides (20). The black pins above (34) and (19) which project from the front plate serve as upper guides and pivot points. Mounted

on the ends of the main bail (33) are the left breaker slide bail (35) and the right breaker slide bail (18). When the letters function code is received, the shift slide is shifted to the right as shown. This places the left shift link breaker slide in a vertical position with its lower end over the left breaker slide bail. The right breaker slide is positioned such that its lower end is to the right of the right breaker slide bail. As the main bail moves upward, the right breaker slide bail clears the right breaker slide while the left breaker slide bail engages the left breaker slide and moves it upward. This action causes the left oscillating rail shift links (40) to break and shift the oscillating rail (39) to the right for the printing of letters characters. In a similar manner, when the figures function code is received, the right oscillating rail shift links (11) are broken and the oscillating rail is shifted to the left for the printing of figures characters.

#### 7.2 Carriage Return Function (Figures 3-29 and 3-30)

The carriage return function mechanism is located in the right end of the typing unit. Referring to Figure 3-29, reception of the carriage return code causes the carriage return function bar (39), pawl (40) and lever (38) to operate. The lower end of the function lever pushes the carriage return slide arm (15) to the left. The slide arm, in turn, pivots the carriage return bail (18) counterclockwise, causing the left end of the carriage return lever (20) to move downward. Referring to Figure 3-30, as the carriage return lever (35) moves downward, it takes with it the lower section of the spacing drum feed pawl release link (37) (lower arrow). This causes the upper portion of the spacing drum feed pawl release link (upper arrow) to turn counterclockwise about its black pivot to push the upper end of the spacing drum feed pawls (39) to the left, clearing the spacing drum (36). When the carriage return lever reaches its lowest point, the carriage return latch bail (31) locks it there as shown. The disengagement of the spacing drum feed pawls from the spacing drum permits

the spring drum (not shown) to return the printing and type box carriages toward the left side of the typing unit. As the spacing drum nears the end of its counterclockwise rotation, the stop arm roller (17) contacts the transfer slide (20) which, in turn, drives the dashpot piston (19) into the dashpot cylinder (16). A small passageway with an inlet from the inside of the cylinder and two outlets to the outside is incorporated in the end of the cylinder. One of the openings to the outside is closed by a steel ball which is held in its seat by means of a compression spring. A set screw, on the ball valve assembly (15), which may be locked in place with a nut, is used to regulate the spring pressure on the ball.

The rate of deceleration provided by the cushioning effect of the trapped air is automatically regulated for various lengths of lines by means of the ball valve. This, together with the direct opening to the outside, determines the rate at which the air may escape from the cylinder. When the spacing drum reaches its extreme counterclockwise position, the extension (40) on the stop arm trips the carriage return latch bail plate (32) which is fastened to the carriage return latch bail. The latch bail disengages the carriage return lever and the feed pawls are again permitted to engage the spacing drum.

Local (off line) operation of the carriage return mechanism may be obtained by pressing the CAR RET keylever on the front of the cabinet. Referring to Figure 3-29, through linkage, the local carriage return trip arm (31) is moved to the right, causing the carriage return lever (20) to turn counterclockwise, after which the carriage return will occur in the manner previously described.

### 7.3 Line Feed Function (Figure 3-31)

The line feed function mechanism is located in the left end of the typing unit. Referring to Figure 3-31, the reception of the line feed code causes the line feed function bar (38), pawl (40), and lever (39) to operate. The lower end of the line feed function lever engages the line feed slide arm (37) and pushes

it to the left. The slide arm, in turn, moves the line feed clutch trip arm (36) counterclockwise about its pivot, causing the line feed clutch trip lever (17), lower end, to move to the right and release the three-stop line feed clutch (35) which immediately engages. The line feed gearing is such that each one-third revolution of the clutch will advance the platen by one line. Therefore, the length of time that the line feed clutch trip lever is held away from the clutch will determine the number of line feeds that occur. The timing relationship between the stripper blade (14) cycle and the main shaft rotation is such that the function pawl is not stripped from the function bar by the stripper blade until after more than one-third of a revolution of the clutch has occurred. Thus, the line feed clutch trip lever will stop the clutch after two-thirds of a revolution, or when double line feed has occurred.

#### 7.3.1 Single Line Feed (Figures 3-31 and 3-32)

When single line feed is desired, it is necessary to strip the function pawl from the line feed function bar before the line feed clutch completes one-third of a revolution. This is accomplished by the use of the line feed function pawl stripper which is actuated by the stripper bail. Referring to Figure 3-32, when the single-double line feed lever (15) is in the single position, its lower end moves to the left, the operating arm (18) lower end moves to the right, the operating arm (11) moves toward the top of the page, the lower end of the stripper bail arm (39) moves to the right by spring action, and is also shown as (31). The cam disk, on the three stop line feed clutch, pushes the stripper bail (40) up and out of the paper, once each one-third revolution of the line feed clutch. As the stripper bail moves up, it pushes the stripper bail arm (39) or (31) up. The stripper bail arm pushes the line feed stripper (32) up and strips the line feed function pawls (36) before they would have been normally stripped by the stripper blade (33). Referring to Figure 3-31, when the line feed function pawl (40) is stripped prematurely, the line feed clutch trip lever (17) is released in time to stop the three stop line

feed clutch (35) and cause disengagement after one-third revolution and one line feed occurs.

### 7.3.2 Double Line Feed (Figure 3-32)

Referring again to Figure 3-32, when the single-double line feed lever (15) is in the double position, its lower end moves to the right, the operating arm (18) lower end moves to the left, the operating arm (11) moves toward the bottom of the page, turning the stripper bail arm (39) clockwise, and the stripper bail arm (31) to the left. The cam disk, on the three stop line feed clutch, pushes the stripper bail (40) up and out of the paper, once each one-third revolution of the line feed clutch. As the stripper bail moves up, it pushes the stripper bail arm (39) or (31) up. Since the stripper bail arm (31) has been moved to the left and out of its slot, when it moves upward, it does not push the line feed stripper (32) up. The pawls (36) will be stripped in a normal manner when the stripper blade (33) moves up. Thus the line feed clutch will rotate two thirds of a revolution in a normal manner before stopping, and double line feed will occur.

### 7.3.3 Spacing Suppression on Single Line Feed (Figures 3-22 and 3-32)

When single line feed is being used, the line feed function lever is released too soon (by the line feed function pawl stripper) to prevent spacing. Referring to Figure 3-22, an additional line feed function bar (space suppression on line feed), pawl, and lever are installed in the extreme left end of the Stunt box for the sole purpose of suppressing spacing on single line feed function. This mechanism, which always operates on the line feed function code, is released only by the stripper blade (33) in Figure 3-32, and therefore holds the spacing suppression bail operated until the spacing cycle is completed. After the line feed clutch is stopped by its trip lever, it is disengaged in the same manner as the selector clutch previously described.

#### 7.3.4 Advancing the Platen (Figure 3-33)

For each one-third revolution of the line feed clutch, the platen is advanced one line. In Figure 3-33, each one-third revolution of the line feed clutch (32) causes its attached line feed clutch spur gear (17) to rotate the line feed eccentric spur gear (33) and its attached line feed eccentrics (34) one-half of a revolution. The eccentrics, which are offset in opposite directions, each carry a line feed bar (14). These bars, guided by the line feed bar bell crank (35), alternately engage the line feed spur gear (38) on the platen (37) and advance the platen one line for each one-half turn of the eccentrics. The platen detent bail (39) engages the line feed spur gear to retain the platen setting.

When it is desired to manually position the platen, this may be accomplished by bearing down on and turning the platen hand wheel (40). This causes the platen hand wheel spur gear (39.5) to engage the platen idler spur gear (13) which, in turn, is engaged with the platen spur gear (13.5) on the platen shaft. At the same time, the line feed bar release lever (36) bears on the line feed bar bell crank and causes it to disengage the line feed bars from the line feed spur gear.

#### 7.3.5 Local Line Feed (Figure 3-31)

Local (off-line) operation of the line feed mechanism may be obtained from the base. Pushing the Line Feed keylever on the front of the cabinet will cause the trip link (20) in Figure 3-31 to move to the right, tripping the line feed clutch (35), after which continuous line feeds will occur until the line feed keylever is released.

#### 7.4 Automatic Carriage Return - Line Feed Function (Figure 3-30)

Referring to Figure 3-30, if the operator fails to send the carriage return and line feed function before the type box and the printing carriages are within one character space from the right end of the line, the automatic



carriage return arm (13) on the spacing drum (36) trips the automatic carriage return bell crank (12). As the bell crank turns clockwise, it shifts the automatic carriage return line feed code bar (11) ("0" bar) to the right. In Figure 3-22, adjacent to the carriage return and line feed function bars in the stunt box are the automatic carriage return and the automatic line feed function bars. These two function bars are identical. When the "0" code bar moves towards the right of the typing unit, the automatic carriage return function bar and the automatic line feed function bar are selected. After selection, carriage return and line feed are accomplished as shown in Figures 3-29, 3-30, 3-31 and 3-33 simultaneously in the same manner as the regular carriage return and line feed.

While the carriages are returning, the character being received during that cycle of operation will be printed and will overwrite other printing at some random point.

#### 7.5 Signal Bell Function (Figure 3-34)

The circuit to the signal bell magnet is controlled by a set of normally open electrical contacts shown in Figure 3-34, mounted on the left end of the stunt box. The signal bell function bar has six code lugs - five for the signal code which is "S" and one for the letters-figures shift code bar. In order to select the signal bell function, the letters-figures shift code bar must first be shifted to figures position. Then, each time the signal code for the letter S is received, the upper end of the signal bell function lever will move to the right, allowing the contact arm to move down, close the contacts in the electrical switch and ring the signal bell once. If the signal code for the letter S is received when the letters-figures shift code bar is in the letters position, the signal bell function bar will be blocked by the letters-figures shift code bar, and the bell will not ring.

## 8.0 STUNT BOX (Figure 3-35)

In addition to normal functions, carriage return, line feed, bell, etc., which occur during normal printing operation, it is very desirable that FAA printers at individual stations print only messages intended for that station. The Function Assembly contains the apparatus necessary to perform this trick. This is called a stunt, therefore we refer to the Function Assembly as the "Stunt Box" occasionally. It can also be used by a single controlling station to turn the transmitter distributor on and off at a definite time, or to control other "stunts" at the desire of the controlling station.

### 8.1 Local Operation

When the "Local-Remote" switch on the front of the cabinet is in the local position, the off-line solenoid, located on the left end of the typing unit, is energized and the printer will print everything transmitted to the line. The "SUP" (Suppression) Code Bar is positioned to the right in this condition.

### 8.2 Remote Operation

When the "Local Remote" switch is in the remote position, the off-line solenoid is de-energized and the spring loaded Suppression (SUP) Code Bar moves to the left. This prevents the type box clutch from engaging, and no printing will occur. The Selector, Code Bar, and Function Clutches operate normally in the Non-Print (Suppressed) Condition, and all of the mechanical operations associated with these clutches occur. The Type Box, Line Feed, and Spacing Clutches do not operate in Non-Print.

#### 8.2.1 Conditioning For Print

When it is desired for the printer to print, the "Condition Code" and the designated call letters of the station must be received by the printers selector. The condition code is the same for all printers, being CR

(Carriage Return) CR LTRS (Letters). At each station, its printers will have a minimum of two designated calls. One, the station call "LOL" for example, and the other, the Area call "XOA" for example. This means that this printer will print upon receiving "CR CR LTRS L O L" or "CR CR LTRS X O A". But all six characters must be received in sequence without a break in continuity.

The condition code, CR CR LTRS is located in slots 12, 13 and 14 of the Stunt (or Function) Box, as numbered left to right viewed from the rear of the printer. Referring to Figure 3-35, the first character of the condition code, CR, allows the function bar in slot 12 to be selected. Slot 13 cannot be selected at this time, due to a projection on the function lever in slot 12 holding the 13 function bar to the rear. When slot 12 is selected, the upper end of the 12 function lever moves to the rear, and its projection holding the slot 13 function bar on the right of slot 12, moves down and clear of the 13 function bar. This allows 13 to be selected next. However, the slot 12 function lever must be held in the selected position until the slot 13 function bar can be selected. This is accomplished by the upper end of the 12 latch lever, latching over an extension on the 12 function lever.

The second CR is now received. The function lever in slot 13 moves in the same manner as the lever in slot 12 did, and unlocks the slot 14 function bar. After the slot 13 selection has occurred, the stripper blade, moving downward, strikes the 12 latch lever, turns it counter-clockwise, and allows the 12 function lever to return to the unselected position.

The LTRS character is now received and because the slot 14 function bar is unlocked, it is selected. The stripper blade moving downward unlatches slot 13. As the upper end of the LTRS function lever in slot

14 moves to the rear, it operates a slide which moves the "0" Bar (Automatic Carriage Return and Line Feed) to the right. However, it is not desired for an Automatic Line Feed and Carriage Return to occur at this time. In order to prevent this, the Condition Code Shift Fork moves the Function Bar Blocking Slide to the right along with the "0" bar, and prevents the Automatic Line Feed and Automatic Carriage Return Function bars from engaging the code bars.

The station call, LOL in our case, is located in slots 9, 10, and 11. The area call, XOA is located in slots 21, 22 and 23. Both calls operate in the same manner, so we will consider only LOL. At this point, the "0" Bar has moved to the right. This code bar is so arranged that it allows the "SC L" (Stunt Case "L") function bar to be selected if the proper baudot code for "L" is received. The printing code function bar in the first position of the station or area call must be stunt case. The second and third letters do not require coding for the "0" bar.

The third letter of the station call "L" in our example, cannot be selected at this time because its function bar is being blocked by the second station call letter "0" in our example. The SC L function bar in slot 9 is selected, the 9 function lever turns counterclockwise, its right extension unlocks 10 function bar and 9 latch lever latches the 9 function lever in the counterclockwise position. The stripper blade moves down, strikes the 14 latch lever which releases the 14 function lever and the "0" code bar.

The second letter "0" is now received. The slot 10 function bar is selected, the slot 10 function lever turns counterclockwise, its right hand extension unlocks the 11 function bar and the 10 latch lever latches the 10 function lever in the counterclockwise position. The stripper blade moves down, strikes the 9 latch lever which releases the 9 function lever.

The third letter "L" is now received. The slot 11 function bar is selected, the slot 11 function lever turns counterclockwise and the 11 latch lever latches the 11 function lever in the counterclockwise position. As the upper end of the 11 function lever moves to the rear, it pulls a shift slide

to the rear, which moves the "SUP" code bar to the right and printing will occur thereafter. The same thing would have happened in slots 21, 22 and 23 had XOA been received instead of LOL. The difference being that only one station was selected to print on "LOL" where "XOA" would have conditioned several stations in a particular area, or on a desired service.

The "SUP" bar stays to the right because the last area or station code selected, has its attached latch lever constructed so that the stripper blade, on moving downward, will not strike the latch lever, leaving the last latch lever operated until another sequence occurs to stop the printing operation.

#### 8.2.2 Conditioning For Non-Print

When it is desired to put the printer back into Non-Print or Printing suppression, the end-of-message conditioning code FIGS, CR, LTRS, must be received.

Reception of the End-of-Message code causes two sets of function bars, pawls, and levers to operate. One set is in slots 6, 7 and 8, while the other identical set is in slot 33, 34 and 35. These bars operate in the same manner of "Sequential Selection" as the "Print" and "Station" code previously described. Only three characters must be received without a break in sequence or continuity to perform the non-print stunt.

The third or last function lever of each set in the non-print group, has attached to the lower end, a long thin rod called a "Latch Lever Release Bail Shaft". As the last character of the end-of-message (Non-print) code is received, slots 8 and 35 function levers turn counterclockwise, moving the bail shaft down and towards the front. The latch levers in slots 11 and 23 (the last character of the station or area call) have extensions which, when the latch lever is latched, are positioned in the path of the bail shaft as it moves down, thus unlatching slots 11 and 23.

Slots 11 and 23 function levers and their associated shift slides return to their unselected positions. The SUP code bar is allowed to return to the left by spring action and printing will again be suppressed until something else happens.

By utilizing function bars coded for a particular character in the print or non-print (SUP Bar right or left), Select or Non-Select (O Bar right or left), Figures or Letters Case (S Bar right or left), any combination would make possible unlimited variety of selections.

### 8.3 Relay Stations

At service B relay stations, the stunt boxes are so arranged that printing will also occur when the condition code followed by any of the following calls are received. The relay call "XLOL" and the adjacent area call XSL. XLOL is necessary to provide a printed copy of the message being received or relay. XSL is necessary so that any of the three printers at the relay station can be used interchangeably. XLOL is located in slots 29, 30, 31 and 32, XSL is located in slots 24, 25 and 26.

#### 8.3.1 Reperforator Control

At relay stations it is necessary to start a re-perforator making a tape when the relay call is received. This is accomplished by opening the re-perforator control contacts in the stunt box which remove the short on the line relay terminals 1 and 4 of the reperforator. These contacts short the armature and marking contacts on the relay and give a continuous mark condition. No start pulse prevents the tape from being made.

The relay call XLOL is located in slots 15, 16, 17 and 18. When CR CR LTRS X L O L is received the L function lever in slot 18 turns CCW in the same manner as when printing occurs and the slot 18 latch lever locks it there. As the upper end of the 18 function lever moves rearward, it pushes upward on the reperforator control operating arm, opening its contacts. This removes the short on the line relay and the reperforator can now make a tape.

The reperforator is stopped in the same manner as the print operation. By receiving the non-print code or end-of-message code (FIGS CR LTRS). The tape will remain in the transmitter distributor portion of the reperforator until the TD portion is started automatically by the automatic scan control station. At this time it will sent the stored tape into the adjacent area B circuit.

### 8.3.2 Transmitter Distributor Control

The stunt box is designed so that slots 37 and 38 control the starting of the transmitter distributor. The Automatic Scan Control Station on the service B circuit, scans each station in its area at regular intervals. At non-relay stations, the regular TD is scanned. At service B relay stations the TD portion of the reperforator is scanned (Also the regular TD). When CR CR LTRS K and one additional letter is received, the last additional letter, turns the function lever in slot 38 CCW. This causes a switch located on top of the stunt box to momentarily close the "start" circuit of the TD, causing the TD clutch magnet to energize, allowing the transmission to occur in a normal manner. At the end of the tape the "end-of-tape switch on the TD will stop the transmitting operation, releasing the scan equipment for the next station call up. At relay stations there is only one slot left in the stunt box when everything is installed. This is not enough to set up scanning of the regular TD. So, transmission through the regular TD must be started by pushing the start button on the front of the modified TD.

## 9.0 PREVENTIVE MAINTENANCE

Preventive maintenance is maintenance performed at regular intervals to prevent equipment failure. The following discussion is of a general nature, especially as to lubrication schedules. Specific information as to what to do, how often and how much will depend on Washington Regional and local instructions.

It is important that all points requiring lubrication in the printer, be lubricated at regular intervals. It is something that cannot be neglected, because without regular lubrication, the printer will not operate continuously. Our business is to provide reliable and continuous communications service.

The instruction book recommends that the printer shall, at 75 words per minute, be lubricated every 100 days of continuous operation or 9 months, whichever occurs first; and at 100 words per minute, be lubricated every 62 days of continuous operation or 6 months, whichever occurs first. This schedule may be changed by the FAA.

A regular preventive maintenance operation consists of the following: cleaning, inspection and replacement of worn or broken parts, and lubrication.

#### 9.1 Cleaning

Before every lubrication, the printer should be cleaned. As a minimum, it should be wiped clean with lint free rags. In hard to reach spots, use a small stick inside a rag. Be careful not to deform or knock off small springs. A better system is to place the typing unit in a small flat pan and pour cleaning solvent over all parts except the magnets and wiring.

Cleaning solvent is sold by different companies under different names as follows: Standard Oil - Stansol, Magnolia - Savasol, Humble - Varsol, Shell and Sinclair - Stoddards Solvent. Cleaning solvent evaporates completely in time. It will burn, but the fumes are not supposed to be explosive. However, open flame should be kept away and some ventilation provided. Cleaning solvent may be used alone or with other agents. When mixed with ammonia, it cleans better. When mixed 10 to 1 with oil, the remaining oil will provide some lubrication and exclude the possibility of rust. After washing off with cleaning solvent, blow off the excess liquid by an available means. At places where such cleaners as "Gunk" is used, follow local instructions.



9.2 Inspection and Replacement of Worn or Broken Parts

After cleaning, the printer should be inspected. Be sure all springs are completely hooked at their ends. Replace any missing spring wicks. Look for machine screws and nuts that have worked loose. Look for worn parts. A worn part will usually have a notch worn in it or a corner worn off. In the parts bulletin, look up the part number and description of the missing or worn part, and if locally available, replace the part. If not locally available, requisition it from the Warehouse.

9.3 Lubrication

There are approximately 836 lubrication points in the printer, 438 of which are in the stunt box which must be removed from the typing unit for lubrication.

The instruction book recommends that only KS-7470 oil and KS-7471 grease be used in lubricating the printer. Here again, follow FAA instructions.

Illustrating symbols used in Section III, Lubrication of Teletype Bulletin 226B are as follows:

0	Apply 1 drop of oil
02	Apply 2 drops of oil
03	Apply 3 drops of oil
020	Apply 20 drops of oil, etc.
G	Apply thin film of grease
GF	Fill in (spaces between cams) with grease
SAT	Saturate (felt oilers, washers, wicks) with oil

Apply only the indicated amount of oil. If 0 (one drop of oil) is indicated, be sure that only one drop is applied. How to apply this one drop of oil is a difficult problem. Most force feed (pistol type) oilers will not meter out a drop at a time. The pencil type, push-to-dispense, one-drop oiler

is difficult to use in close quarters and will not operate except with the point down. A very small artists brush, dipped in oil and wiped on the oiling point, could possibly be used. In any event, do not overlubricate. The excess oil or grease will be thrown away from the desired spot, soil the cabinet and cause deterioration of the wiring. It is also very important not to let oil get between the selector armature and its magnet pole faces. This causes sluggish action of the selector and poor margin. The effect is similar to trying to pull two pieces of glass apart after oil has been placed between them. It is recommended that, after each lubrication, a piece of hard surface paper, such as bond, be placed between the selector armature and magnet pole faces and the armature closed on the paper until the paper comes away clean.

Page 3-6 of 226B shows two drops of oil in each motor shaft bearing. In addition, if the motor is disassembled at any time, repack the bearings with KS-7471 grease.

Specifications for the camming surfaces of the clutch disks call for 02 (2 drops of oil). This can best be applied by "painting" the oil on with a small artists brush.

Certain lubrication points are more critical than others. A sleeve bearing, continuously turning on a shaft, is such a point. On page 3-27, 226B, under "Clutch Sleeve", is listed five such points. One Region has reported failures in this section. Do not overlook these points. It might be well to remove the typing unit and lubricate these critical points midway between regular lubrication times.

The stunt box must be removed during each lubrication (see top of page 3-17, 226B). On the same page, under "Function Pawl Springs", it says to "SAT Each Felt Wick". This is difficult to reach without deforming the springs below the wick. It is best to use a small push bottom oiler for this purpose.

There are six clutch assemblies on the main shaft that require lubrication. The felt wick, on the open side of the drum near the edge of the clutch, requires saturation with oil. 04 (4 drops of oil) is specified for "Internal Mechanism". As the internal mechanism is not exposed in many cases, apply 4 drops of oil internally (with a small oiler), through any possible opening, from whence it will be distributed by "sling" action.

Certain points specify G (apply thin film of grease). This means that the total surface should be covered with grease, but with as thin a coat as possible. The easiest way to do this is to use a small stiff brush to apply the grease. A small, metal handle, acid brush sold in hardware stores works fine. Dip the brush in the KS-7471 grease and wipe it across the part to be greased, pressing hard and wiping fast. Be sure to cover all of the specified surface. By pressing hard when wiping, excess grease is carried away on the brush.

Page 3-1, 226B specifies a thin film of grease on the "spacing clutch reset cam plate". By this is meant the rocker shaft cam plate (18) in Figure 2-21 of this chapter.

Page 3-27, 226B, Selector Cam Assembly, shows "02 Each Camming Surface". These two drops of oil can be painted on with a small artists brush.

Lubrication of all points at regular intervals pays good dividends.

#### 9.4 Distortion Test

At regular intervals, a distortion test should be taken on all Model 28 Printers. Electronic Facility Instruction, Printing Telegraph Equipment - 1 recommends every six months. Present requirements are: at least 40% distortion tolerance and no more than  $\pm$  5% internal bias distortion. If a printer is found to be out of tolerance, it is suggested that a check be made of all the selector adjustments, including spring tensions, after checking the Line Relay in the Printer Test Set.



# MODEL 28 R/O EQUIPMENT

## CHAPTER FOUR

### MODEL 14 TRANSMITTER DISTRIBUTOR

#### 1.0 GENERAL

The Model 14 Transmitter Distributor is a motor driven combination tape transmitter and distributor. Its purpose is to translate the code combinations perforated in the tape into electrical impulses and to transmit these impulses to the signal line. The type of distributor in which we are interested is designed to accept the five unit code. The transmitter distributor is made up of two principal units: the transmitter and the commutator distributor. The tape transmitter, utilizing the perforated tape, sets up the code combinations to be transmitted. The commutator distributor sends the code combinations out over the line as marking and spacing impulses, in proper sequence and at predetermined speed. The two units are driven by either a synchronous motor or a governor controlled motor operating at a constant rate of speed. The synchronous motor is generally used by the Federal Aviation Agency.

#### 2.0 THEORY OF OPERATION

The various components that go to make up the transmitter distributor will be discussed separately. The connection between the various units will become apparent as each is explained.

##### 2.1 Commutator Distributor

The commutator is made up of two concentric conducting segment rings attached to an insulating disk. The outer commutator ring is composed of seven segments. Five of these segments correspond to the five intervals of the code. The "start" segment immediately precedes the number 1 segment, and the "stop" segment follows the number 5 segment. When the brushes pass over the start segment, a spacing impulse is always transmitted, whereas a marking impulse results when it passes over the

stop segment. These two invariable impulses cause the receiving mechanism to operate in unison with the distributor brush arm. The inner commutator ring is a solid ring which is connected to the line. As the distributor brush arm revolves, it connects the segments of the outer ring successively to the line.

## 2.2 Contact Assembly

As indicated by the wiring diagram (Figure 4-1) the five tongues on the tape transmitter move between upper and lower contacts, called the spacing and marking contacts respectively.

The coded perforations in the tape determine which contact tongues will be on the spacing contacts and which on the marking contacts. When the distributor brush is on the stop segment, no signals are transmitted and marking current is sent to the line. At such a time, the selector at the receiving end of the line will be at rest. To transmit a combination of impulses, the distributor brushes revolve in the direction indicated in Figure 4-1. It will pass over the start segment, sending a spacing impulse (no current flowing) over the line. This impulse starts the receiving mechanism.

Each of the five code segments of the distributor is connected by a contact tongue to either an upper (spacing) or lower (marking) contact, depending on the character of the signal to be sent. As the brush revolves, it will successively connect the five code segments to the line, each in turn sending out a marking or a spacing impulse. Finally the brushes reach the stop segment again and send out the stop (current flowing) impulse, which stops the receiving mechanism. This start-stop system keeps the receiver in synchronism with the distributor.

## 2.3 Transmitter Assembly

As previously stated, the five contact tongues on the tape transmitter move between two sets of contacts, the lower set being connected to one side of the signal line and the upper set presenting an open circuit to the teletype line.

These five contact tongues are mechanically connected to the ends of five irregularly shaped levers, known as contact levers, shown in Figure 4-2. Each contact lever has three extensions, labeled A, B, and C, and is pivoted on shaft S. When a contact lever is in its normal position, extensions A and C are approximately horizontal. Extension B is normally in a vertical position. The extension C is turned up at the end, and set into it is a small tape pin projecting vertically upward. As viewed from above, the distance between the upward projecting tape pins is the same as the distance between the holes in the perforated tape. Mounted just to the right of the B extensions of the five contact levers is a pivoted contact lever bail. When the contact lever bail is actuated by the operating lever, it moves the B extensions of the contact lever to the left. This movement draws the tape pins, in the ends of the C extensions of the levers, below the surface of the tape guide over which the perforated tape passes, and it also causes the left end of the A extensions to move upward. Being pivotally attached to these extensions, the contact tongues will also move upward, and will be pressed against the upper (spacing) contact screws. The contact tongues are so attached to the A extensions of the levers that after the tongues have touched the upper contacts, any further travel of the lever extensions is absorbed by the springs attached to the contact tongues. There is a feed wheel to the right of the tape pins. This feed wheel and the tape pins project through the tape guide. Besides the five code perforations in the tape, there is also a smaller hole which is engaged by one of the pins on the feed wheel. As the feed wheel rotates, its pins engage these smaller holes, one after another, moving the tape from right to left over the tape pins.

### 2.3.1 Tape Feed Mechanism

Pivoted on the shaft S, with and behind the five contact levers, is a sixth lever known as the feed lever (Figure 4-3). When the vertical

extension B of this lever is moved by the contact lever bail, the outer end C moves downward. A feed pawl attached to the end of the extension C engages a tooth in a ratchet attached to the shaft of the feed wheel.

The downward movement of this pawl causes the feed wheel to rotate a distance corresponding to that between two teeth on the feed wheel ratchet. To insure an even movement of the feed wheel, a detent is provided which bears upon the ratchet teeth. The position of the feed pawl is such that the downward movement of the feed levers does not cause it to engage with the ratchet until the five pins have been drawn below the surface of the tape guide. This action prevents the tearing of the tape, and makes certain that it does not move before the pins are withdrawn.

### 2.3.2 Setting Up the Code Combinations

When the contact lever bail is in its unoperated position (Figure 4-2), the contact lever springs attached to the contact tongues exert a downward pull on the A extensions of the contact levers. This causes the C extensions to move upward and the tape pins are pressed against the tape. If at this position on the tape, holes have been perforated in the tape, the pins corresponding to these holes will pass through. The additional upward movement of the contact lever, when its pin passes through a hole, moves the contact tongue attached to extension A of this lever from its upper (spacing) contact screw to its lower (marking) contact screw. Where there is no hole in the tape, the pin will be blocked and the corresponding contact tongue will remain against the upper (spacing) contact screw. Various combinations of mark and space may be set up depending on the perforations in the tape.

### 2.4 Main Shaft

The main shaft is driven by a motor through a medium of gears and a friction clutch. The distributor brush and the operating cam which controls the contact lever bail are mounted on the main shaft. The position



of the contact lever bail bears a certain fixed relation to the position of the distributor brush, which makes it necessary for the tape transmitter and the commutator distributor to operate in unison.

### 2.5 Operating Cam

The operating cam (Figure 4-4) actuates the operating lever which in turn moves the contact lever bail. The position of the cam with respect to the distributor brush is set so that the bail starts to move just as the brush comes in contact with the stop segment, causing the B extensions (Figure 4-2) on the contact levers to move the contact tongues away from their lower (marking) contact screws.

### 2.6 Operating Lever

The operating lever (Figure 4-5) transmits motion from the main shaft to the transmitter portion of the transmitter distributor. Its roller rides the operating cam, while its extension beyond the pivoted center moves against the contact lever bail, serving to position the contact tongues and to stop the tape that is being transmitted. When the transmitter distributor has been modified for use with the "Automatic Station Identification Device" (ASID), a solenoid (Tape Lock Out) is installed in its base to control the movement of the operating lever as indicated in Figure 4-5. When the solenoid is not energized, its plunger pin blocks the travel of the operating lever, preventing it from following the operating cam. When the Automatic Station Identification Device has completed its function, the Tape Lock Out (TLO) solenoid is energized and allows the operating lever to follow the operating cam. In this manner, the ASID controls the tape transmission allowing it to be transmitted only after station identification.

### 2.7 Clutch

A large number of transmitter distributors in use are equipped with a friction type clutch, consisting of two felt washers operating between

steel disks and the flat surfaces of the main shaft gear. Since the trend toward higher speeds of operation, in many cases this friction type clutch is being replaced by an all steel, internal expansion clutch similar to that of the Model 28 Printer. The constant drag presented by the friction type clutch will be eliminated by this new type of clutch action. The internal expansion clutch will engage and dis-engage more rapidly than the friction type and when it is disengaged, will remove all load from the transmitter distributor motor.

### 2.8 Control Circuit

The starting and stopping of the transmitter distributor is accomplished by means of a circuit operating the tape stop magnet (Figure 4-6). The magnet, when de-energized, allows the stop arm to latch up the stop cam. The stop cam and hence, the main shaft will then be held stationary, stopping both the distributor and the transmitter. The position of the distributor brush is fixed with respect to the stop cam lug, so that the distributor brush will always be stopped on the stop segment. The standard control circuits used in the past years are shown in Figure 4-7 with diagram (a) depicting the simplest form of transmitter distributor control while diagram (b) shows the distributor circuit used when the ASID is installed. It should be noted that terminals 5 and 6 of diagram (a) represent slip connector contacts located on the base of the transmitter distributor. The numbers in diagram (b), from 1 to 21, represent connections that are routed through the ASID. In general the control circuit includes the stop magnet (CT), tape stop switch (TGL), resistor (R), end of tape contacts (ET) and the tight tape switch. The tight tape switch is generally shorted in FAA equipment. Either direct or alternating current may be used in the control circuit. When used with alternating current the 350 ohm portion of resistor (R) should be shorted. The other consideration in using alternating current is to be sure that the heavily chrome-plated surface of the armature of the stop magnet, stamped "C", is away from the magnet core. In direct current operation the shorted section of the resistor should be included in the circuit and the side of the armature that is stamped "C" should be toward the magnet.

### 3.0 AUTOMATIC CONTROL OF THE TRANSMITTER DISTRIBUTOR

With modification, the transmitter distributor can be automatically controlled from a remote point. The modifications allow the transmitter distributor to be used as a unit of an "Automatic Scanning System." This section does not describe the operation of the complete system but only the wiring changes affecting the transmitter distributor control circuit. Figure 4-8 shows the control wiring changes that are required to convert a regular transmitter distributor of the non-ASID type to automatic operation. Figure 4-9 shows the same transmitter distributor modified for ASID and automatic control. Figures 4-8 and 4-9 both show that a relay, RY-1, has been added in addition to two push button switches of the start-stop type which replace the toggle switch. The starting of the motor is now accomplished by use of the end of tape contacts (ET) which were formerly used to complete the clutch magnet circuit when a tape was inserted in the transmitter distributor.

Since the control system is basically the same for either modification, this discussion will use Figure 4-8 for analysis. Starting and stopping of a modified transmitter distributor will now be considered.

#### 3.1 Start Control

With reference to Figure 4-8, placing a tape in the transmitter distributor tape guide completes the AC circuit through the (ET) contacts, thus starting the motor. With the motor in operation two possibilities exist for starting the transmitter distributor. One is to manually push the start button and the other is accomplished by closing a remote switch whose contacts are connected across the base slip connectors 1 and 4. Generally, connections 1 and 4 are tied to the "Stunt Box" of the Model 28 Printer, which in turn is controlled from some remote location. In either case, relay RY-1 is energized and remains energized through its holding contacts 1 and 2.

With RY-1 energized contacts 3 and 4 close the clutch throw-out magnet circuit thus allowing the transmitter distributor to start normally. Contacts 7 and 8 are generally wired into the Model 28 Printer in a manner that removes the printer from "printing suppression" so that it will print a monitor copy of the tape that is being transmitted by the TD.

### 3.2 Stop Control

When the tape transmission is completed, the end of tape contacts (ET) will open, de-energizing relay RY-1 and shutting down the motor. The transmitter distributor could be stopped by pushing the push button, thus releasing RY-1 but the motor would continue to run because of the closed ET contacts. In either case, relay RY-1 will open as will all of its associated contacts. The opening of contacts 7 and 8 of RY-1 returns the monitoring printer to a suppressed printing condition.

## 4.0 MAINTENANCE NOTES

With proper care the transmitter distributor will operate at maximum efficiency for many years. Proper lubrication, replacement of worn parts and careful adjustment is required, if trouble free operation is to be expected.

Maintenance of teletypewriter equipment is generally either preventive or corrective. Preventive maintenance consists of systematic periodic inspection, lubrication, and adjustment, while corrective maintenance is that effort required to return printing equipment to service after it fails to operate.

### 4.1 Preventive Maintenance

By thorough lubrication and by keeping the equipment clean and free from dust, it is possible to prevent a very large number of failures that might otherwise occur. This reduces the corrective maintenance to a minimum.

The cost of preventive maintenance is low in comparison to that of corrective maintenance. The frequency of preventive maintenance should be carried out in accordance with Regional and Washington directives. The Teletype Corporation recommends the equipment be lubricated as follows:

(Using Teletype Oil No. 7470 and Teletype Grease No. 7471)

- (1) Clutch washers - saturate with oil.
- (2) Main shaft bearings - pack with grease when doing major servicing - 2 drops of oil per month otherwise.
- (3) Operating lever - one drop of oil.
- (4) Contact lever bail bearings - use oil.
- (5) Contact lever bearings - use oil.
- (6) Feed pawl, feed lever, feed wheel bearings - use oil.
- (7) Detent lever, detent roller, retaining lid bearing - use oil.
- (8) Stop cam - apply oil - grease - oil.
- (9) Stop arm - apply oil - grease - oil.
- (10) Motor pinion - apply thin film of grease.
- (11) Main shaft gear - apply thin film of grease.
- (12) Operating cam - apply thin film of grease.
- (13) Springs - oil both loops of all helical springs that exert a normal tension of less than 2-1/2 pounds. Apply grease to all helical springs that exert a normal tension of more than 2-1/2 pounds.
- (14) Operating lever adjusting screw - apply thin film of grease to head of screw.

NOTE: The application of oil - grease - oil means that a film of oil should be applied, then a film of grease, and finally another film of oil.

#### 4.1.1 Commutator

Since perfect contact is desired between the segments of the commutator and the brushes, it is necessary to keep these segments free from dirt and oil, or any substance that might interfere with a good electrical connection. The segments should be cleaned occasionally with a solvent

that contains no oil. if necessary a light abrasive such as Crocus Cloth may be used to remove pits or scratches in the copper segments. It is not necessary that the segments have a bright copper color at all times. The dark copper color that the commutator takes on after operating for some time is really more desirable. Too much burnishing will shorten the life of the commutator. During routine maintenance, the carbon dust that may fall from the brushes should be cleaned from between the copper segments.

#### 4.1.2 Distributor Brushes

The distributor brushes used in FAA equipment are of the carbon type. Proper adjustment and care will prolong their life and result in better operation of the transmitter distributor. The distributor brush spring tension should be set in accordance with the instruction book requirements. When installing new brushes or making adjustments on the spring tension, that portion of the brush making contact with the distributor segment should be seated perfectly. With the brush spring adjusted to the approximate correct tension against the segment, the following process for proper seating of the brushes should be used. Between the brush and segment, weave a strip of very fine sandpaper (abrasive side up). With the back side of the sandpaper flat against the segment, move it from side to side until the brush has been worn away and its lower surface mates perfectly with the flat surface of the commutator segment. Carbon dust that may have fallen between the distributor segments should be removed. The main shaft of the distributor should never be rotated in the reverse direction, due to the possibility of breaking the brushes or bending the brush springs.

#### 4.1.3 Transmitter Contacts

The upper and lower contact screws as well as the contact tongues should be free of oil or dust at all times. Ordinarily, burnishing the contacts is sufficient, but in case of oil accumulation they should be cleaned with solvent before burnishing.

#### 4.1.4 Tape Lock Out Solenoid (A. S. I. D.)

The tape lock out solenoid plunger is spring loaded in such a way that when the solenoid is not energized the spring will push the plunger out of the solenoid. The solenoid coil is wound around a cylindrical non-magnetic form, in which the plunger moves. There is a small air hole in the upper end of the cylinder which allows air to escape as the plunger enters, thereby preventing dash pot action. If oil is allowed to accumulate inside the cylinder, action will be sluggish. The same is true if the air escape hole becomes clogged.

#### 4.2 Corrective Maintenance

Corrective maintenance is both costly in time and money. Due to emergencies that arise when corrective maintenance is necessary, there is a tendency to disrupt an otherwise smooth functioning organization. Every effort should be made to reduce the necessity of corrective maintenance to a minimum, but at the same time complete preparation must be made to cope with situations that may arise. Since most trouble that develops in the transmitter distributor may be found without connecting it to the receiving machine, it is well to make a complete visual inspection before trying the machine on the circuit. The ultimate check on its operation, however, is its ability to convert the code on the perforated tape into signals and transmit the signals to the line so that they may be correctly printed by a receiving machine. There are seven mechanical adjustments in the transmitter distributor that are all interrelated and must be made in a definite order. A change in any one will affect the other adjustments, therefore, if it becomes necessary to change one adjustment, all the others should be checked. The seven are as follows:

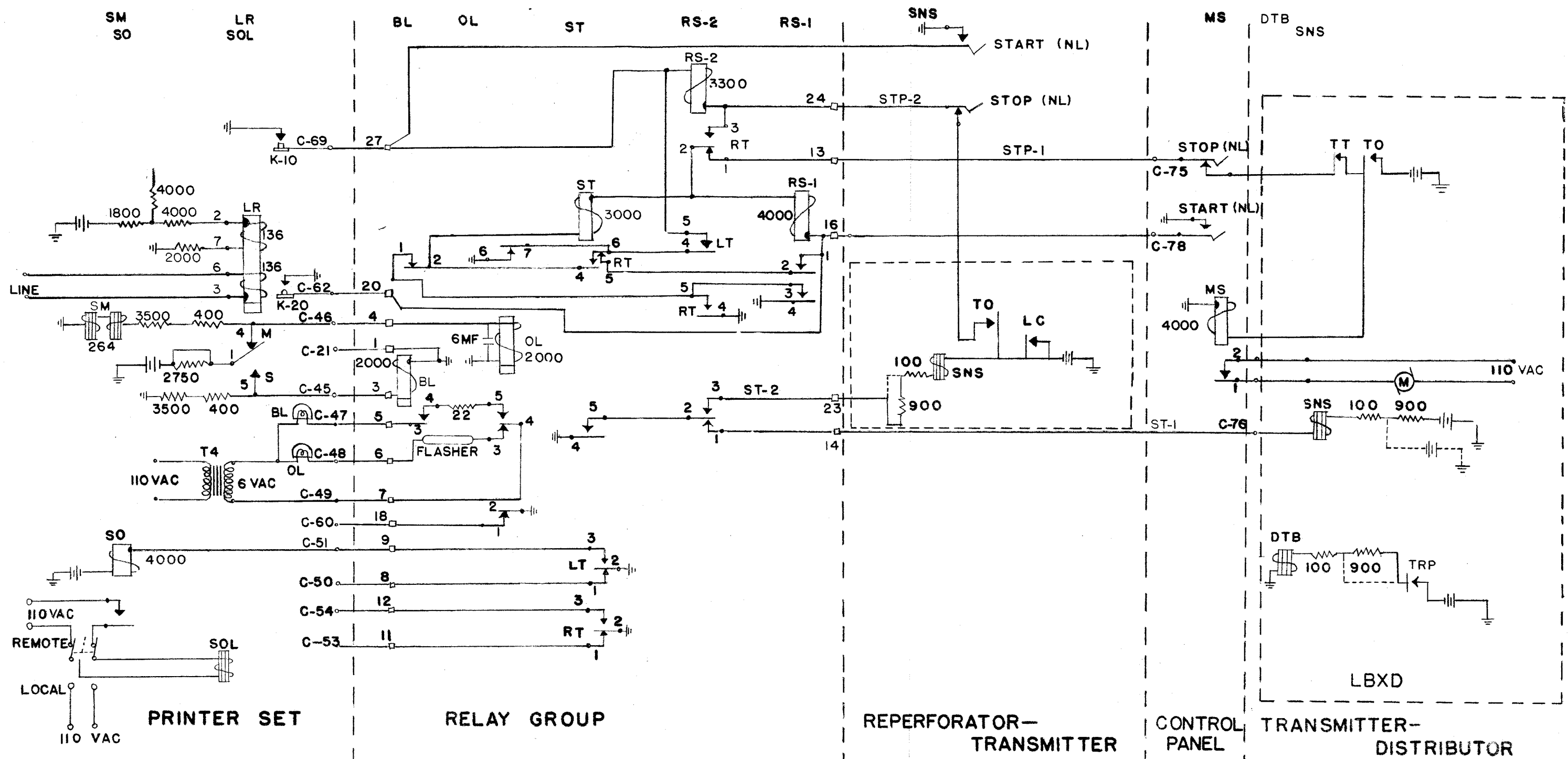
- (1) Tape transmitter contacts
- (2) Detent bracket position
- (3) Retaining lid plate

- (4) Feed pawl
- (5) Operating lever adjusting screw
- (6) Contact tongues alignment
- (7) Contact screw

#### 4.3 Tools

The proper tools for working on the transmitter distributor will be found at each FAA Facility where the maintenance technician is responsible for routine maintenance. The usual care in using the proper tool in its proper place should be exercised.





**NOTES**

- (1) GROUND RETURN ILLUSTRATED FOR OPERATIONAL SIMPLIFICATION & DOES NOT REPRESENT FRAME OR PANEL GROUND.
- (2) BATTERY IS 110 VDC.
- (3) RESISTANCE VALUES IN OHMS.
- (4) ALL RELAYS SHOWN DE-ENERGIZED. (EXCEPT LINE RELAY)

**LEGEND**

- (1) BL-BUSY LINE RELAY.
- (2) OL-OPEN LINE RELAY.
- (3) LR-LINE RELAY.
- (4) SO-DC CONTROL RELAY.
- (5) SOL-OFF-LINE STUNT-SHIFT SOLENOID.
- (6) ST-START RELAY.
- (7) RS-1-REQUEST START RELAY. (XD)
- (8) RS-2-REQUEST START RELAY, (RT)

- (9) SM-SELECTOR MAGNET.
- (10) DTB-DISTRIBUTOR CLUTCH MAGNET.
- (11) SNS-SENSING CLUTCH MAGNET.
- (12) MS-MOTOR START RELAY.
- (13) TO-TAPE OUT CONTACTS.
- (14) TT-TIGHT TAPE CONTACTS.
- (15) LC-LAST CHARACTER CONTACTS.
- (16) TRP-CLUTCH TRIP CONTACTS.

- (17) NL-NON LOCKING PUSH BUTTON.
- (18) RT-RIGHT HAND SIDE CONTACTS.
- (19) LT-LEFT HAND SIDE CONTACTS.

FIG. \_\_\_\_\_



MODEL 28 PRINTER  
MODEL 19 EQUIPMENT  
APPENDIX ONE

COPY

COPY

COPY

Department of Commerce  
CIVIL AERONAUTICS ADMINISTRATION  
Washington 25, D. C.

OFFICE OF FEDERAL AIRWAYS  
MAINTENANCE ENGINEERING DIVISION

MAINTENANCE ENGINEERING DIVISION INSTRUCTION NO. 23

February 21, 1951

TO : All Regional Administrators

FROM : Chief, Maintenance Engineering Division

SUBJECT: Minimum Teletypewriter Equipment Servicing Requirements

The following information supersedes MANOP IV-MT2 Parts 1, 2 and 3 insofar as the teletype servicing periods are concerned.

Effective March 1, 1951, the minimum teletype equipment service required will be as follows:

Model 15, 19 Teletypewriters, Model 14 Transmitter Distributors, Model 14 Reperforators and FRXD Reperforator Transmitter Distributors to be serviced as follows:

1. MAJOR SERVICE - To be performed once each year.
2. ROUTINE SERVICE - To be performed quarterly.
3. MINOR SERVICE - To be performed at 15 day intervals.

SECO units and Model 14 Perforators to be serviced as follows:

1. Major Service - to be performed once each year.
2. Routine Service - Quarterly.
3. Minor Service - Monthly.

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February 21, 1951

MEDIS Multiple Reperforator Units to be serviced as follows:

1. Major Service - Semi-annually
2. Routing Service - Monthly
3. Minor Service - to be performed at 10-day intervals.

The above schedule was developed as a result of a recent survey in which six regions reported in favor of the plan, some with minor differences largely incorporated in our final plan. Two regions opposed the change. One region indicated that minor service should be eliminated and that service should consist of monthly routines plus one major service each year.

The major changes in the new minimum schedules as compared to the old is the increased time between the routing and major services. This places a greater importance upon proper performance of minor servicing which is a lubrication task. KS-7470 oil and KS-7471 grease are the lubricants that have been authorized for purposes of teletype lubrication and should be utilized by all regions. The felt wicks used throughout the teletype equipment becomes hardened for two principle reasons:

- (1) filter action of the wicks which results in the collection of impurities from lubricants and dust particles in the air, and
- (2) high temperature, generally resulting from too infrequent lubrication but sometimes experienced in hot, dry climates

In view of these factors, inspection personnel should stress the importance and necessity for prompt attention and proper accomplishment of MINOR SERVICING.

It will be noted that the above schedule outlines the minimum Teletype servicing expected and is not to be considered as all servicing that may be required. As an example, while minor service of a piece of equipment is being performed, it may be noted that attitional work is required which is generally done at routine or major servicing periods. It is expected that this additional work will be performed as required, regardless of the type of service due on the particular item of equipment.

There is no objection to any region continuing the servicing schedules previously used provided that above minimum requirements are met and action is taken (additional training, etc.) to gradually reduce teletype servicing to that specified in the new schedule.

February 21, 1951

In connection with the additional training referred to above, it has been noted in inspection reports prepared by the Maintenance Inspection Branch, as well as in regional inspection reports, that the majority of teletype exceptions are in the "Adjustment" category. This indicates that the personnel servicing teletype equipments are either not adequately trained or sufficient time is not being spent to make correct adjustments. It is expected that vigorous action will be taken by all regions to materially reduce the "Adjustment" exceptions now being observed in teletype equipment. It is recommended that any time saved as a result of the above servicing schedules be utilized in study by technicians of Teletype adjustment requirements.

/s/ Joseph H. Tippetts  
Joseph H. Tippetts, W-360

Copied 9/6/57

Note: KS-7470 Oil is furnished by Teletype Corporation under catalog number 88970 (CAA catalog #04-88970)



MODEL 28 PRINTER  
MODEL 19 EQUIPMENT  
APPENDIX TWO

LIST OF FREQUENTLY USED TERMS AND NOMENCLATURE

- BAIL . . . . . A hoop or ring, a half-hoop or horse-shoe shaped piece for supporting something. An arched metal bow to which motive power is attached or through which motive power is delivered. Used to complete the transfer of power to other parts for a particular operation.
- BELL-CRANK . . . . . A lever whose two arms form an angle, and having its fulcrum at the apex of the angle.
- CENTRIFUGAL . . . . . Proceeding or flying from the center.
- CENTRIFUGAL FORCE . . . . . A force which impels something or parts of something outward from the center of rotation.
- BUSHING . . . . . A metallic sleeve, usually removable and replaceable, inserted in a body to resist wear. ELECTRICAL - A lining for a hole that insulates a through conductor.
- CAM . . . . . A projecting part of a wheel or other moving piece of machinery for imparting motion.
- CLUTCH . . . . . A device for mechanically coupling two working parts.
- DETENT . . . . . A stop or checking device, as a pin, lever, etc., on a ratchet wheel or the like.
- DIFFERENTIAL . . . . . Pertaining to, or involving, a difference; that is, a differential current device is one which operates upon the basis of a difference in two current values.
- DISTORTION . . . . . An alteration or deformity (of a wave form for example).
- ECCENTRIC SCREW . . . . . A screw whose shaft is off center.

MODEL 28 PRINTER  
MODEL 19 EQUIPMENT

A2-2

- ESCAPEMENT. . . . . A contrivance which controls the motion of a train of movements and through which the energy is delivered at regular intervals.
- FORTUITOUS. . . . . From the Latin Fortis meaning fortune or chance. Chance or random effects.
- FRICTION. . . . . Act of rubbing one body against another. The resistance to relative motion between two bodies in contact with each other.
- FRICTION CLUTCH. . . . . A clutch or coupling operating by friction for engaging or disengaging revolving parts.
- FUNCTION. . . . . The duty or job performed by a device. With regard to teletypewriters, the mechanical operation of line feed, carriage return, space, letters shift, figures shift or similar jobs other than actual printing of a character.
- GARBLE. . . . . A bad spot in teletypewriter transmission which is unreadable.
- GEAR. . . . . A toothed wheel, serving to transmit motion from one shaft to another, or change its rate, or direction of rotation.
- IMPEDANCE. . . . . The total opposition of the flow of current, consisting of resistance and reactance.
- INDUCTIVE REACTANCE. . . . . The opposition to the flow of alternating or pulsating current due to the inductance of the circuit.
- LOCK-WASHER. . . . . An open, spiral, spring tempered steel washer for preventing the loosening of nuts or machine screws.
- LEVER. . . . . A mechanical device, turning freely on a fixed point or fulcrum and serving to impart pressure or motion to exert effective power. Power is generally applied at one point and taken off at another.



MODEL 28 PRINTER  
MODEL 19 EQUIPMENT

A2-3

- LOWER CASE. . . . . On a teletypewriter, the position of the platen when letters are being printed. The platen is in its lowered position.
- MARKING BIAS. . . . . The tendency of mechanical or electrical equipment to produce results that favor marking impulses at the expense of the spacing impulses.
- MARKING CURRENT. . . . . That contact of a telegraph relay which is closed when marking current is controlling the relay operation.
- MARKING CURRENT. . . . . That magnitude and polarity of current in the line when the receiving mechanism is in the operated position.
- ECCENTRIC SCREW. . . . . A screw whose shaft is off center.
- LINE. . . . . (Electrical ) wire or wires stretched between two fixed points.
- CIRCUIT. . . . . (Electrical ) Closed: Flow of current through line.  
Open: Flow of current interrupted through line.



MODEL 28 PRINTER  
APPENDIX THREE

COPY

COPY

COPY

Department of Commerce  
CIVIL AERONAUTICS ADMINISTRATION  
Washington 25, D. C.

April 14, 1953

ELECTRONIC FACILITY INSTRUCTION:  
PRINTING TELEGRAPH EQUIPMENT - 1

TO : All Regional Administrators  
FROM : Chief, Electronics Maintenance Branch  
SUBJECT: Model 28 Teletypewriters

The following is the recommended servicing schedule for Model 28 Teletypewriters operated at 60 wpm:

1. Clean and lubricate every 45 days using KS-7470 oil and Beacon 325 or KS-7471 grease. All points to be lubricated are specified in the Model 28 instruction book. After cleaning and lubricating, ascertain that the printer will copy correctly, signals with bias distortion of 40% - both marking and spacing. (It is not necessary to determine the maximum distortion tolerance at this time.)
2. Make a complete distortion run every six months in accordance with Form ACA-1117 (11-51) as pertains to a holding magnet type selector. (Model 28 has pulling magnet selector; however, holding magnet type test should be made.) Minimum requirements are 40% distortion tolerance with a maximum of pulse or minus 5% internal bias. The Model 28 teletypewriter should not be used to determine loop or long line characteristics.
3. All adjustments should be checked annually.

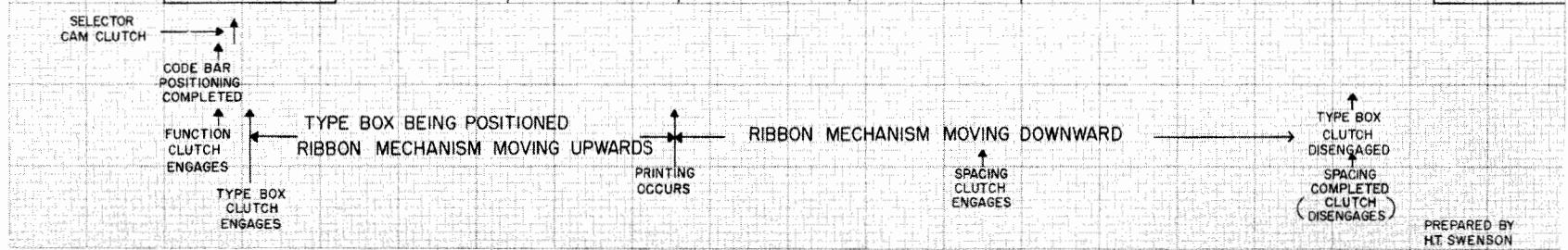
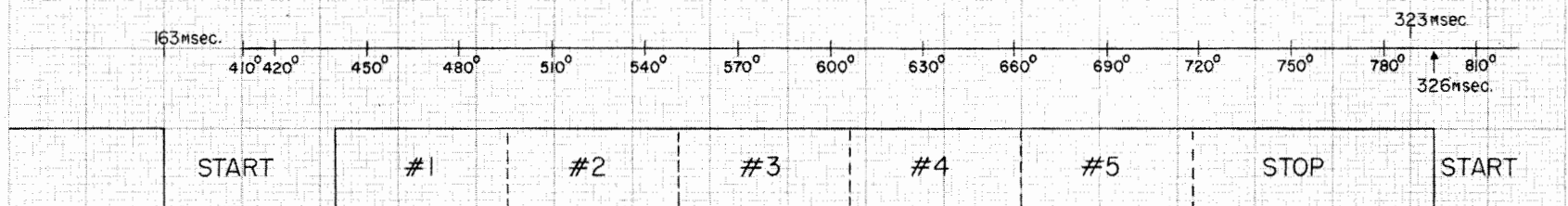
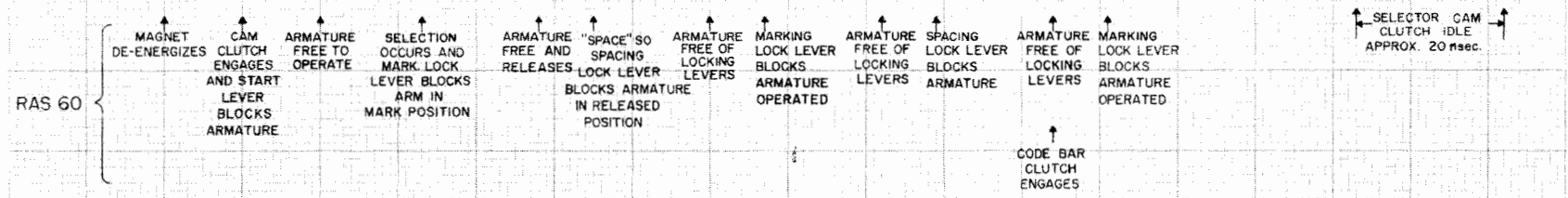
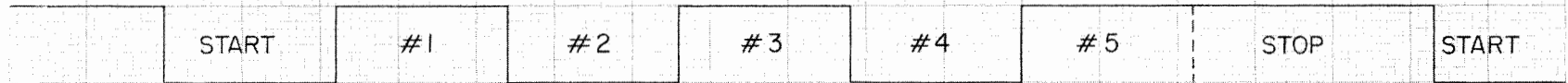
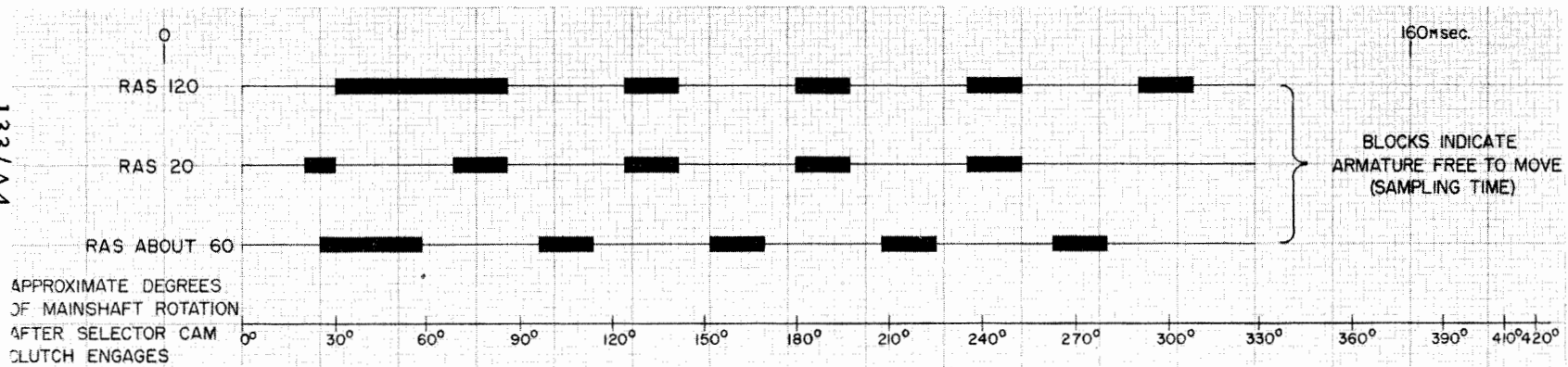
Until further notice, it is requested that Part 1 of Form ACA-419 (Communications Equipment Failure Report) be completed for each Model 28 part failure. One copy of each completed form should be forwarded to W-367.

/s/ W. M. King, W-365

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133/A4  
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PREPARED BY  
HT SWENSON

TIME RELATIONSHIPS - MODEL 28 PRINTER SELECTION AND PRINTING

MODEL 28 PRINTER  
APPENDIX FOUR



FAA AERONAUTICAL CENTER  
AIR NAVIGATION FACILITIES BRANCH  
COMMUNICATIONS EQUIPMENT UNIT

MODEL 28 PRINTER LABORATORY EXPERIMENT NO. 1

Name \_\_\_\_\_

Date \_\_\_\_\_ Class \_\_\_\_\_

LINE RELAY

PURPOSE OF EXPERIMENT

To familiarize the student with the Relay and Printer Test Sets, Model CA-405A and CA-1385A.

To demonstrate to the student the accepted methods of adjusting and servicing the type 215-H and / or 255-A Teletype Relays, and the checking of Printer currents.

EQUIPMENT REQUIRED

Model 28 Teletype Printer and associated dummy circuit  
Model CA-405A or Model CA-1385A Relay and Printer Test Set  
Set of Teletype tools  
Type 215-H or 255-A Teletype Relay

REFERENCES

Procedure Instructions  
Test Set Instruction Book  
Lecture Notes

PROCEDURE I (Familiarization)

- A. Raise the cabinet dome by depressing the button on the lower right side while using the front edge of the copy holder as a handle.
- B. Turn the switch under the Transmitter Distributor (TD) table on, and the switch on the front of the Model 28 Printer on. Insert a tape in the TD, turn the switch on the front of the TD on and observe the printer under actual operating conditions to gain an insight into the functional applications of the printing unit.

- C. Take an "Operational Check" as follows. While transmitting a tape, determine how high and low on the range finder scale the printer will print one full line of perfect copy. Enter the difference (high - low) on the performance sheet under "A".

PROCEDURE II (Familiarization)

	<u>215-H</u>	<u>255-A</u>
Number of windings . . . . .	2 . . . . .	2
Resistance per winding, ohms . . . . .	85 . . . . .	136
Signaling current, milliamperes . . . . .	60 . . . . .	60
Biasing current, milliamperes . . . . .	30 . . . . .	30
Contact metals:		
Armature contact . . . . .	W.E. No. 4	W.E. No. 4
Stationary contact . . . . .	Tungsten . . . . .	Tungsten
Armature type number . . . . .	78874 . . . . .	99857
Contact screw number . . . . .	94092 . . . . .	94092

The 255-A Relay is equipped with knurled tension knobs for increased convenience in adjusting the pole piece screws.

Efficient operation of the Line Relay in the Printer circuits depends upon a periodical routine of inspection, cleaning and adjustment. The adjustments are so interrelated that it is essential for each adjustment to be made in the given sequence. If any adjustment is changed, it will be necessary to check all subsequent adjustments.

Locate and identify the various parts of the relay by referring to Figures 1-2 of figures section of manual.

PROCEDURE III (Disassembly)

- A. Remove relay cover.
- B. Loosen the locking nuts on the pole piece adjusting screws and back off each adjusting screw as far as possible to provide maximum clearance between the armature and adjusting screw.
- C. Remove the stationary contact screws (94092), from their mounting brackets.



D. Remove armature. (Para. 1: 255-A)

1. For 255-A type

Refer to Figure 1-2. Loosen the two screws (99851) and the clamping plate (99867), and lift the armature out through the coil spool.

PROCEDURE IV (Cleaning and Servicing)

A. Relay Base and Connecting Pins.

1. Fold a piece of crocus cloth, 1-1/2" by 5" in half in the long direction with the abrasive material to the outside.
2. Weave the folded crocus cloth in and out of one row of connecting pins and draw it back and forth to clean one side of each pin in the row.
3. Repeat this operation with the crocus cloth woven through on the opposite side of each pin in the row.
4. Clean the second row of pins in the same manner, making sure that all pins are cleaned.
5. Check for bent pins and straighten as needed. Also, check for loose nuts securing the pins in the base. Tighten as needed.

B. Contacts.

1. Inspect the armature contacts with a magnifying glass to detect pits and build-ups. Remove the pits or build-ups which are present by gently buffing the contacts against a piece of crocus cloth or oil stone. If pit or build-up is excessive then a contact file may be used.

NOTE: Do Not Use a File on the Contact Screws Use on Armature Contact only when absolutely necessary. Be sure to hold armature in such a way as to keep the contact parallel to the abrasive material. To produce a highly polished contact, the contacts may be rubbed over coarse brown paper or the back side of the crocus cloth after all pits have been removed.

CAUTION: Apply only a light pressure to the armature to avoid the possibility of distorting the contact springs. In case the contact springs are distorted or not properly seating against each other, the armature should be replaced.

2. Clean between the tips of the flexible springs by pulling a piece of clean paper through and then pull the burnisher through two or three times.
3. The stationary contacts may be cleaned by rubbing them on a piece of crocus cloth, being careful to apply light pressure and keep the contact in a rolling or rotary motion in order to maintain a smooth rounded surface.

C. Pole Piece Screw.

1. Inspect the face of the pole piece screws by use of the magnifying glass to detect any foreign matter or particles of filings, etc. Clean as needed. To remove filings, gently press a small piece of friction tape against the pole adjusting screw face. DO NOT RUB as this will leave the adhesive substance of the tape on the screw.

D. Relay Cover.

1. Use a clean rag and wipe both the inside and outside of the cover.

PROCEDURE V (Adjustments)

A. Armature Alignment.

1. Replace the armature in the mounting bracket and secure.
2. With the bracket screw loosened, position the bracket (99866-255-A), and armature so that the upper or contact end of the armature is aligned to the center of the upper end of the frame. This may be done by using the 6" metal scale to find the center of the frame and with one of the reference lines on the scale aligned with this center point, position the armature to coincide with the reference line. Then tighten the front bracket screws.

B. Winding Positioning.

1. The coil spool winding may be centered by loosening the screws holding the spool heads to the relay frame and then position the spool to meet the requirement. The armature is now the reference and the spool is centered about it. This adjustment is made by eye.

C. Alignment of contacts.

1. Install the contact screws in their brackets.
2. Loosen the screws which hold the contact screw brackets to the frame, then position the brackets so that they are approximately equal distances from the armature.
3. With screws still loose, position the brackets so that each contact tip is pointing toward the other and the screws form a straight line. Tighten bracket screws.
4. Loosen the armature mounting or clamping screws and position the armature to where each screw contact tip is aligned, as close as possible, to the center of the armature contact surface.

D. Contact Adjustment.

1. Setting up the printer test set.

MODEL CA-405A

- a. Turn the "AC CURRENT ADJ." control to the off position (maximum counterclockwise)
- b. Place the key lever "MEASURE CURRENT-RELAY TEST" in the "RELAY TEST POSITION".
- c. Place the key lever "BIAS-CONTACT TEST" in the "BIAS" position.

MODEL CA-1385A

- a. Place the toggle switch "AC-ON-OFF" in the "OFF" position.
- b. Place the key lever "MEASURE CURRENT-RELAY BIAS" in the "RELAY BIAS" position.

2. After equipment has been set up proceed with relay adjustment.
3. Install the relay in the test set.
4. Place the magnetic shunt bar over the ends of the pole pieces to cancel the effect of the permanent magnet on the armature.
5. Insert a .004" gauge between the armature contact springs.
6. Observe Figure A, of experiment figures, showing relay contact circuit.

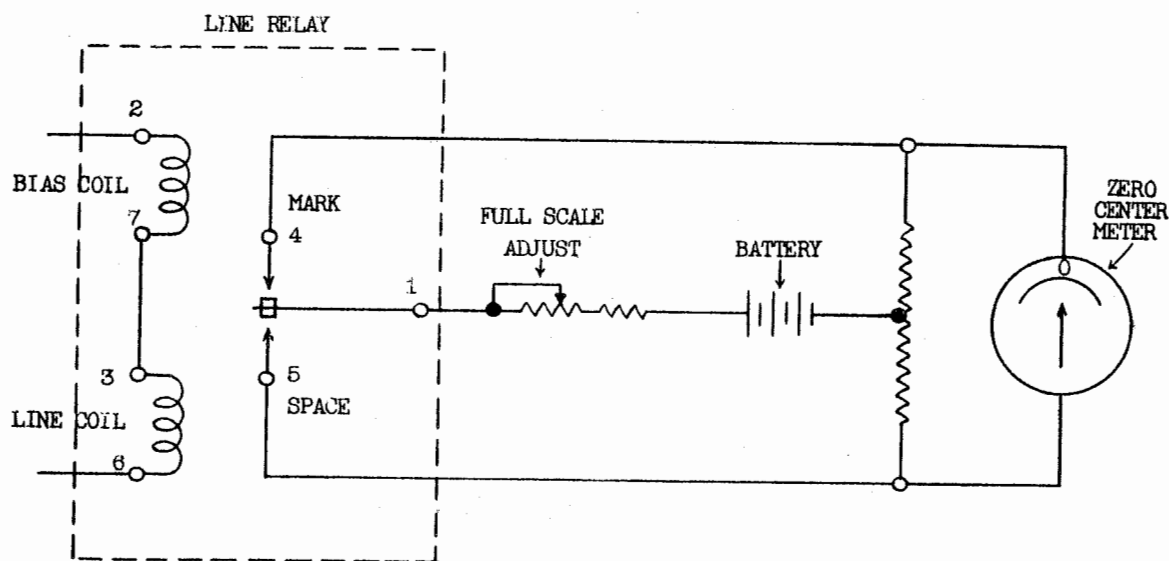


Figure A, Relay Contact Balancing Circuit

7. Advance the left hand contact screw until the zero center scale meter just deflects to the left. (Adjust the meter deflection control on the test set to cause the meter to read full scale. If this is not possible, the battery should be replaced). Now, back off on the relay contact screw until no meter reading is obtained.
8. Advance the right hand contact screw until the meter just deflects to the right. Back off the contact screw slightly until no meter reading is obtained.
9. THIS IS THE FINAL ADJUSTMENT OF THE CONTACT SCREWS AND SHOULD NOT BE CHANGED TO MEET ANY OTHER TEST.
10. Remove the magnetic shunt and the .004" gauge from the relay.

E. Pole Piece Screw Adjustment.

1. Advance the left hand pole piece screw against the armature, pushing the armature contact over until it just touches the opposite or right hand stationary contact. This will be indicated by a deflection of the meter needle to the right. Then back off the pole piece screw 1/4 turn and lock carefully in this position.
2. Apply reversal current to the relay.

CA-405A MODEL TEST SET

- a. Connect AC power cord to source.
- b. Apply AC current to the relay by turning the "AC CURRENT ADJUST" rheostat until the coil current meter reads 6MA. It may be necessary to readjust the rheostat occasionally during the adjustment to maintain 6 MA.

CA-1385A MODEL TEST SET

- a. Connect AC power cord to AC source.
- b. Apply AC current to the relay by operating the toggle switch to the "ON" position.

3. Advance the right hand pole piece screw toward the armature. As this pole piece screw is advanced the armature will begin to vibrate. Continue to advance the screw until the test set meter needle vibrates an equal amount in each direction, thus indicating a zero reading at center scale. (NOTE: In relays that have weak magnets, the final adjustment may be rather critical in that a light movement of the pole piece screw may cause considerable variation in the meter readings. Relays suspected of having weak magnets should be replaced).
4. If upon completion of the procedure under item 3 the armature was striking one or both of the pole piece screws, repeat items 1 and 3, but with the left hand pole piece screw mentioned in item 1 backed off slightly more than a 1/4 of a turn.

F. Bias Test.

1. With the relay properly adjusted the meter should read "0" as the vibration of the armature from left to right is faster than the meter movement.
2. If the meter needle indicates either to the right or left of "0", bias is indicated. Spacing bias is indicated by a left hand reading and marking bias is indicated by a right hand reading.
3. Final bias test should be made with the relay cover in place and should indicate "0" bias, + or - 1%.

Model CA-405A - 1% equals 1/2 scale division.

Model CA-1385A - 1% equals 1/4 scale division.

PROCEDURE VI (Operational Check)

- A. Install the line relay in the printer.
  1. Turn the power switches on for the Transmitter Distributor and Printer.
  2. Send a test tape through the Transmitter Distributor and check the upper and lower limits of the Printer range arm. Record on the performance sheet.
  3. Turn power switches off.

PROCEDURE VII (Measure Printer Currents with Test Set)

(PLEASE NOTE THIS PROCEDURE VII PERTAINS TO THE MODEL  
CA-405A SET)

(SEE PROCEDURE VIII FOR MODEL CA-1385A)

- A. Remove the Line Relay from the Printer and install it in the printer test set.
- B. Take the jumper cable located in the back of the printer test set and install the unconnected plug into the relay socket of the Printer.
- C. Turn on the power switches for the Printer and Transmitter Distributor.
  1. It is not necessary to feed the tape through the Transmitter Distributor during this operation.
- D. Operation of the Test Set. Refer to Figure B of experiment figures.
  1. AC power switch off.
  2. Place the key lever "MEASURE CURRENT-RELAY TEST" in the "MEASURE CURRENT" position.
  3. Place the key lever "BIAS-CONTACT TEST" in center off position.
  4. Press the "LINE" push key and read the line current indicated on the meter.
  5. Press the "BIAS" push key and read the bias current indicated on the meter.
  6. Press the "MARK" push key and read the loop marking or selector magnet current indicated on the meter.
  7. Press the "SPACE" push key and gently push the relay armature to the spacing contact (left with an orangewood stick, and read the loop spacing contact current (with the load balancing resistor replacing the selector magnets in the loop) as indicated on the meter.

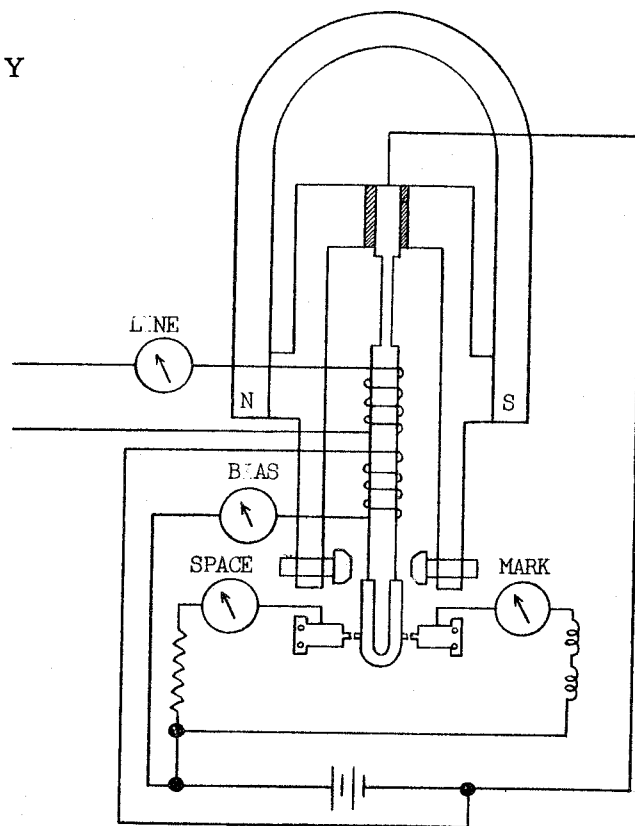


Figure B, Relay and Test Set Circuit for Checking Printer Currents - CA-405A Model

8. Disconnect the test set from the Printer and re-install the Line Relay in the Printer.

PROCEDURE VIII (Measure Printer Currents with Test Set)

MODEL CA-1385A PRINTER TEST SET

- A. Remove the Line Relay from the Printer and install in the printer test set.
- B. Take the jumper cable located in the back of the printer test set and connect between the test set and printer relay socket.
- C. Turn on the power switches for the Printer and Transmitter Distributor.
  1. It will not be necessary to feed tape through the Transmitter Distributor while reading the currents.
- D. Operation of test set. Refer to Figure C of experiment figures.
  1. AC power switch off. Leave AC power cord disconnected.



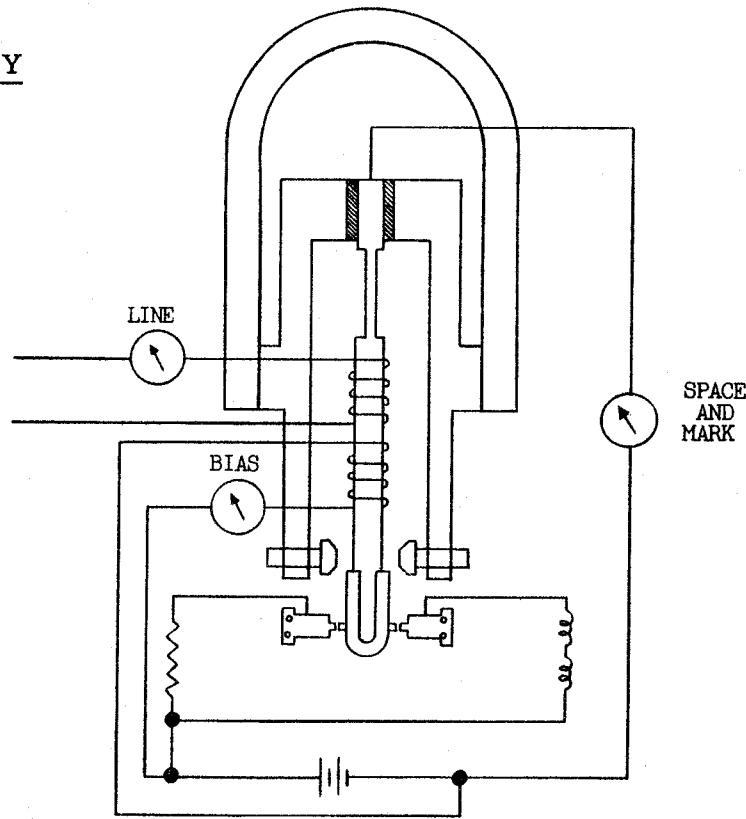


Figure C, Relay and Test Set Circuit for Checking Printer currents - CA-1385A Model

2. Place the key lever "MEASURE CURRENT-RELAY BIAS" in the "MEASURE CURRENT" position.
3. Press the "LINE" push key and read the line current indicated on the meter.
4. Press the "BIAS" push key and read the bias current indicated on the meter.
5. Press the "CONTACT" push key. Read the marking loop or selector magnet current indicated on the meter.
6. To read the space loop current, gently position the armature to the space or left contact by using an orangewood stick and NOTE METER READING. (This condition replaces the selector magnets with the load balancing resistor)
7. Disconnect the test set from the Printer and re-install the Line Relay in the Printer.



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COMMUNICATIONS EQUIPMENT SECTION

MODEL 28 PRINTER LABORATORY EXPERIMENT NO. 1

PERFORMANCE SHEET

Name \_\_\_\_\_ Date \_\_\_\_\_ Class No. \_\_\_\_\_

LINE RELAY

- A. Disassembly. . . . .
- B. Cleaning and servicing. . . . .
  - 1. Relay base and connecting pins. . . . .
  - 2. Contacts. . . . .
  - 3. Pole piece adjusting screw. . . . .
  - 4. Relay Cover. . . . .
- C. Adjustments
  - 1. Armature alignment. . . . .
  - 2. Winding positioning. . . . .
  - 3. Alignment of contacts. . . . .
  - 4. Contact adjustment. . . . .
  - 5. Pole piece screw adjustment. . . . .
  - 6. Bias Test. . . . .
- D. Operational Check
  - 1. High \_\_\_\_\_ Low \_\_\_\_\_ Optimum \_\_\_\_\_
- E. Measure printer currents with test set
  - 1. Line current \_\_\_\_\_ ma
  - 2. Bias current \_\_\_\_\_ ma
  - 3. Marking contact current \_\_\_\_\_ ma
  - 4. Spacing contact current \_\_\_\_\_ ma
- F. All tools and equipment back to normal. . . . .



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COMMUNICATIONS EQUIPMENT UNIT

MODEL 28 PRINTER LABORATORY EXPERIMENT NO. 2

Name \_\_\_\_\_

Date \_\_\_\_\_ Class \_\_\_\_\_

DISTORTION TEST

PURPOSE OF EXPERIMENT

To familiarize the student with the use of the Distortion Test Set and the approved methods of determining the following for a Model 28 Printer:

- A. Optimum range arm setting for bias distortion.
- B. Percent of bias distortion tolerance.
- C. Percent of end distortion tolerance
- D. Percent of internal bias distortion.

EQUIPMENT REQUIRED

CA-406 Distortion Test Set.  
Model 28 Printer

REFERENCES

None

PROCEDURE I (Preliminary)

- A. Lift the front end of the Model 14 Transmitter Distributor slightly, slide it forward, lift it out and place it on the masonite square on the work table.
- B. Obtain a CA-406 Distortion Test Set, bearing the same number as your Model 28 Printer, and place it on the work table. (Laboratory test sets are set for 75 wpm so this procedure will be performed by the instructor.) This procedure for information only.

- C. Lift the cover of the Distortion Test Set straight up and off the unit, being careful not to damage the carbon brushes on the top of the unit. Observe the pointer on the side of the collector ring. It should be set on "35", indicating that the value of applied distortion being transmitted is 35%. This value is always used in testing Model 28 Printers.
- D. Replace the cover, being careful not to damage the carbon brushes. Set the Distortion Test Set on the transmitter distributor base and slide rearward until the front end drops down behind the front stops.
- E. Obtain a test tape as follows:
- (LTRS CR LF) MARY 4679 MARY 4679 MARY 4679 MARY  
4679 MARY 4679 MARY 4679 MARY 4679 MARY 4679  
(BELL and repeat) and insert the tape in the tape guide.
- F. Turn the switch under the transmitter distributor table on and the switch on the front of the Model 28 Printer on. Raise the printer cabinet dome by depressing the button on the lower right side while using the front edge of the copy holder as a handle.

PROCEDURE II (Making the test)

- A. Turn the selector switch on the front of the Distortion Test Set to "M" under "Bias", indicating that 35% Marking Bias Distortion is being transmitted to the printer. Turn the switch on the front of the Distortion Test Set on and adjust the printer range finder knob (on the right end of the typing unit) to as high a number as possible and still print one full line of perfect copy. Record this number on line 1 of page E2-4 of this experiment.
- B. Turn the selector switch on the front of the Distortion Test Set to "S" under "Bias", indicating that 35% Spacing Bias Distortion is being transmitted to the printer. Turn the Distortion Test Set on and adjust the range finder knob to as low a number as possible and still print one full line of perfect copy. Record this number on line 2 of page E2-4.

- C. Turn the selector switch on the front of the Distortion Test Set to "S" under "ED", indicating that 35% Spacing End Distortion is being transmitted to the printer. Turn the Distortion Test Set on and adjust the range finder knob to as high a number as possible and still print one full line of perfect copy. Record this number on line 5 of page E2-4.
- D. Turn the selector switch on the front of the Distortion Test Set to "M" under "ED", indicating that 35% Marking End Distortion is being transmitted to the printer. Turn the Distortion Test Set on and adjust the range finder knob to as low a number as possible and still print one full line of perfect copy. Record this number on line 6 of page E2-4.

PROCEDURE III (Calculations)

- A. Do the necessary calculations as indicated on page E2-4. All calculations must be algebraic. The answer to 9 will be positive or negative. If positive, the Internal Bias Distortion will be Marking. If negative, the Internal Bias Distortion will be Spacing.

PROCEDURE IV (Tolerances)

- A. Model 28 Printers are required to have a Bias Distortion Tolerance of 40% or more.
- B. Model 28 Printers are not allowed to have more than plus or minus 5% Internal Bias Distortion.
- C. The Internal Bias Distortion as measured in this experiment is the algebraic sum of the internal bias distortion of the Line Relay and the internal Bias distortion of the Printer itself.
- D. Model 28 Printers usually have an End Distortion Tolerance of 40% or more and do not require corrective measures.

DISTORTION TEST

The following is the recommended test procedure for determining receiving characteristics of Model 28 Printer selectors.

Upper Limit for Marking Bias . . . . . 1. \_\_\_\_\_

Lower Limit for Spacing Bias . . . . . 2. \_\_\_\_\_

Optimum Range arm Setting for Bias =  $\frac{1 + 2}{2}$  . . . . . 3. \_\_\_\_\_

Bias Distortion Tolerance =  $\frac{1 - 2}{2} + 35$  . . . . . 4. \_\_\_\_\_ %

Upper Limit for Spacing End Distortion . . . . . 5. \_\_\_\_\_

Lower Limit for Marking End Distortion . . . . . 6. \_\_\_\_\_

Optimum Range Arm Setting for End Distortion =  $\frac{5 + 6}{2}$  . . . . . 7. \_\_\_\_\_

End Distortion Tolerance =  $\frac{5 - 6}{2} + 35$  . . . . . 8. \_\_\_\_\_ %

Internal Bias Distortion = + 7 - 3 . . . . . 9. \_\_\_\_\_ % (+)  
(Positive indicates Marking - Negative indicates Spacing)

Leave Range Arm set at Optimum Range Arm Setting for Bias.



SUPPLEMENTARY DATA

The following will not be accomplished in this experiment, but is furnished for your information.

A. At the field station, if the results of a Distortion Test indicate a condition of out of tolerance as stated in Procedure IV, A or B, it will be necessary to bring it into tolerance by:

1. First - check the Line Relay in the Printer Test Set and bring it within the tolerance of not more than plus or minus 1% bias distortion.
2. Second - if the internal bias distortion of the Line Relay and the Printer is still out of tolerance, as determined by a Distortion Test, all selector adjustments and selector spring tensions should be checked.

B. The distortion Test Set can be mechanically calibrated as follows. Hold the clutch magnet armature against the pole piece, turn the motor fan counterclockwise as viewed from the fan end until the carbon brush arm clears all three screws passing through the square bakelite washers on the collector ring assembly. Loosen these screws and turn the outer collector ring, being careful not to buckle the carbon brush, until the mark on the outer ring lines up with the mark on the inner ring. The pointer should now point to zero on the scale. If it does not, loosen the pointer mounting screws and set the pointer on zero and tighten the screws. Turn the outer ring until the pointer rests on 35 on the scale. Tighten the three screws. This completes the mechanical calibration.

The Distortion Test Set can also be calibrated, using the regular Transmitter Distributor as a standard, by the following method which is taken from Manop IV-C-1-1-1, first edition, page 33. Transmit signals from the regular transmitter distributor to a printer located on the local test or dummy circuit and determine the local margin by observing the upper and lower limits of the range arm. Next, substitute the distortion test set for the regular transmitter distributor and transmit signals to the printer with the selector switch on the distortion test set positioned to "zero" and again determine the margin received. If the two margins are practically identical for both transmitters, it can be assumed that the distortion test set is free of bias distortion when the selector switch is set for "zero".

To see if the magnitude of distortion being transmitted is actually 35%, the following procedure should be followed. Set the distortion test set selector switch to marking bias and transmit signals to the printer and determine the upper and lower limits of the range arm. If the local margin on unbiased signals is 10 to 90, the range limits for 35% marking bias should be close to 10-55 on the range finder scale. Conversely, 35% spacing bias should change the limits to 45-90. Comparison tests should be made with a great amount of care to be of any real value.

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MOEL 28 PRINTER LABORATORY EXPERIMENT NO. 3

Name \_\_\_\_\_

Date \_\_\_\_\_ Class \_\_\_\_\_

MODEL 28 PRINTING UNIT

PURPOSE OF EXPERIMENT

To train the student in the correct disassembly, reassembly and adjustment technique of the Model 28 Printing Unit, while familiarizing him with component parts, nomenclature and theory.

To familiarize the student with the Model 28 Printer Electrical Service Unit.

EQUIPMENT REQUIRED

Model 28 Printer  
Model 14 Transmitter Distributor  
Model 28 Printer Tools

REFERENCES

Teletype Bulletins 225B  
"Model 28 Adjustments" manual  
Disassembly and Reassembly Instructions in the Course Material  
Lecture notes and extracts of 1157B in Course Material

FAMILIARIZATION INSTRUCTIONS

These instructions along with Teletype instruction books are designed so that the student may disassemble and reassemble the Model 28 Printer with a minimum assistance from the instructor.

It is suggested that each item be read carefully and its interpretation clearly understood before proceeding with the removal of parts.

CAUTION: The typing unit may be laid in only three positions: (1) upright, (2) tilted back, or (3) upside down. Do not lay it on its front face or either end.

A glass container is included at each position for keeping the small parts, such as screws and springs, that you may remove from the machine. See that the container is empty at the beginning of the experiment, to avoid the confusion of extra parts.

In order that the printer operate normally as the main shaft is rotated, the printing suppression mechanism must be disabled. This is accomplished by placing a rubber band around the suppression solenoid, which is located on the left end of the printer. Under normal conditions the solenoid is energized, when printing. Rubber bands are included in the tool set--if none are found--ask your instructor.

A hand wheel is provided for rotating the main shaft. It is designed to slip over the end of the selector clutch drum hub and the screw holding the drum to the main shaft. Rotation of the shaft is counterclockwise as indicated by the arrow on the hand wheel.

Some of the adjustments require a clutch to be disengaged, latched, stop and/or stopped. All of the terms mean the same. If the printer main shaft was being turned by its motor - the clutches would be disengaged, latched or stopped due to the momentum attained by the main shaft. On the work bench, as you make adjustments, you will have to manually latch or disengage the clutches as necessary to perform the adjustments properly.

To hold the selector armature in marking position during certain procedure, an armature clip is provided. If its use is not readily seen call the instructor.

NOTE: All reference to direction are with the typing unit right side up and facing the observer.

Turn to "Related Adjustments" immediately following Experiment No. 3. These six pages are for use in the FIELD ONLY and will not be used here in the lab. In the field, if you have trouble with the printer and have to make an adjustment, immediately after making that adjustment you would have to look up that adjustment in the "Related Adjustments" pamphlet and find where it is underlined. Turn to page 5 at the top of the page. If it was the "Rocker Shaft Bracket Eccentric Stud Adj." that you made, it would be necessary that you CHECK the 10 adjustments listed under the Stud adjustment.

Refer to the "Performance Sheet". Students will work together down through part D. One student will remove one sub-assembly and his partner the next sub-assembly. Do the same on reassembly. Students will alternate on adjustments. Both students will sign in the left hand column for A through D.

Only one student will sign for the adjustments. When completing an item, the student will sign in the left hand column, call the instructor who will check the adjustment and sign in the right hand column and maladjust the next adjustment. **DO ONLY ONE ITEM OR ADJUSTMENT AT A TIME.**

It should not take you more than 1/2 day to disassemble, two 1/2 days to reassemble and bench check your unit. The remainder of the time will be spent on adjustments.

Read EACH and EVERY word of the adjustment instructions carefully and understand the requirements before you start making the adjustment and you will make fewer mistakes.

Disassemble the typing unit using "Disassembly Instructions - Model 28 Printer" in the course material. In locating the part numbers in Bulletin 1157B, always locate the main part number other than the screw or Tru-arc fastener number, because there is probably only one such part number, whereas there may be numerous screws or fasteners with the same part number.

It may be helpful to replace the screws after disassembly. Then in re-assembling the typing unit, the correct screw for a certain hole is easy to find. Also, the parts Bulletin will show a picture to tell whether it is a round or hex head. The description opposite the part number will give the length of the threads.

I. Operating Components

- A. Raise the cabinet dome by depressing the button on the lower right side while using the front edge of the copy holder as a handle.
- B. Turn the switch under or on the front of the Transmitter Distributor (TD) table on, and the switch on the front of the Model 28 Printer cabinet on. Insert a tape in the TD, push the start button (red) on the front of the TD on and observe the printer under actual operating conditions to gain an insight into the functional applications of the printing unit.
- C. Take an "Operational Check" as follows. While transmitting a tape, determine how high and low on the range finder scale the printer will print one full line of perfect copy. Enter the difference (high-low) on the performance sheet under "A".

- D. Remove the four 1/4" x 32 hex head screws, with captive lockwashers, holding the typing unit to the base. Remove the right hand connector from the typing unit. Lift the typing unit free of the base and place it on the work bench. Keep all the heavy parts on the masonite square to avoid defacing the work bench top.
- E. Refer to Figure 3-2, Model 28 Teletypewriter Electrical System drawing in the course material. Also, refer to Bulletin 225B and observe the following components in the printer cabinet:

Margin indicator switch, Bulletin 225B, Figure 1-2.

Local-remote switch, Figure 1-2.

Synchronous motor, Figure 1-2.

Synchronous motor unit, reset button, starting capacitor, starting relay and thermal cutout, Figure 1-7.

Line shunt relay, line relay, rectifier, fuse, convenience receptacle and power switch, Figure 1-8.

Copy light switch, margin indicator (lamp) and power switch extension in Figure 1-10. Locate two copy lamps not shown in Figure 1-10.

Look underneath the cabinet and observe the signal bell.

Observe the following components on the typing unit. (Bulletin 225B):

Selector magnet, front plate and platen (round rubber roller), Figure 1-3.

Stunt (function) box, the black signal bell switch on the left and the black reperforator control switch in the center of Figure 1-6.

Main shaft and selector cam-clutch assembly, Figure 2-8.

Selector mechanism, Figures 2-11 and 2-12.

Code bar positioning mechanism, Figures 2-13 and 2-14.

Code bars, Figures 2-15 and 2-16.

PROCEDURE I (Disassembly - Model 28 Printer LP-6 and LP-12)

## A. Front Plate Assembly: (Check off each item as completed)

1. Remove ribbon.
2. Position type box carriage.
  - a. Check to see if the type box is in the letters position.
  - b. Place the armature clip on the armature to hold it in the marking position. (If the type box is not in the letters position, rotate the main shaft until all clutches latch up. Initiate a start pulse by pushing down on the lower part of the armature clip, allowing the start lever to move over the armature. Rotate the main shaft until all clutches latch up again. This should return the type box to the letters position.)
  - c. Rotate the main shaft until the hammer strikes the letters pallet and stop right there.
  - d. Slide the type box to the extreme right.
3. Remove type box. (Reference Bulletin 1157B)
  - a. Flip lever at upper right side of 152502 type box carriage and remove type box. (Page 53)
4. Remove type box carriage. 1157B, Page 53
  - a. Remove Tru-arc fastener, 119649, from type box carriage 152503 link and free the link from the type box carriage. (The link is fastened to the lower right side of the type box carriage).

CAUTION: Place hand over your work when removing fastener with spring hook. Replace the fastener for safe keeping.

- b. Rotate main shaft as before so that type box carriage is at its lowest point to clear the ribbon lever.
- c. Slide type box carriage off to the right.

5. Disconnect main bail drive bracket 150245 from main Rocker Shaft. 1157B Page 55 and 39.
  - a. Remove two 153841 screws, from main rocker shaft 150365. (Only one screw shown)
6. Remove front plate assembly. 1157B Page 41.
  - a. Remove four 151606 screws holding front plate to side members of main frame. Remove front plate.
- B. Function Box Assembly: (Reference Bulletin 1157B Page 59 and 49)
  1. Remove hexagonal cross member 151627 (s) located behind function box.
    - a. Remove two screws, 6745, one on each side of frame. Remove hexagonal cross member.
  2. Remove stunt box mechanism as follows: 1157B Page 27.
    - a. Remove the two 151692 (lower) screws holding the left and right function box mounting brackets to the printer frame.
    - b. Remove 151637 screw from 153291 arm, move THE ARM TO THE LEFT. (LP-12 only, remove tru-arc 119652 located in the right extension of 153291 arm).
    - c. Disengage 153300 (stripper blade driving link). (Page 49)
    - d. Slide stunt box out about half way before removing screws from the switch assemblies. Use rubber bands to keep switch assemblies together. Tie cable and switches to frame of printer to prevent unnecessary bending of wires. CAUTION: Wires break easily from switch terminals.
    - e. Remove Function Box.
    - f. Note the function box is type "AK" for LP-6; "AEY" for LP-12.



C. Code Bar Positioning Mechanism: (Bulletin 1157B Page 21-37 and 35)

1. Remove trapezoidal 150301 shift bar retaining plate. (Note that beveled side of plate is toward the right.) Remove the six code bar shift bars. (Note the relative position of the code bar shift bars so that they may be replaced properly.) Page 21
2. With small spring hook (crochet hook), disengage 150563 (page 37) common transfer lever spring from bracket 152403 (page 35). To facilitate removal, first remove felt wick 152457, shown on page 37. Be careful not to deform the common transfer lever spring nor disturb the push lever springs.
3. Remove the three screws holding the code bar positioning mechanism. Locate screws 151630 and 151657. CAUTION: The latter is the lowest one on the 150525 shift lever guide bracket. Also remove 151658 which is located inside the wick holder above the selector levers. (Page 37)
4. Remove the Tru-arc fastener 119652 and free the 150451 shift lever link from the 150447 shift lever drive arm. The physical location of these parts is directly behind the dashpot at the lower right side of the machine. Trip push levers out of the selector lever notches so they may go rearward to space. Remove the code bar positioning mechanism. (Page 37)

D. Code Bar Assembly: (Bulletin 1157B Page 53, 55 and 21)

1. Rotate main shaft until 150396 and 150397 vertical positioning levers are straight.
2. Remove the four 151657 screws, two on each side frame member just behind the code bar guide brackets. Call an Instructor. CAUTION: These screws are pictured on page 21 and it must be remembered that they hold the code bar assembly to the side frames. It is important that you locate these four screws and remove them only.) Remove the code bar assembly. Do not perform, (for information only)

E. Selector Mechanism: (Bulletin 1157B)

1. Remove selector cam-clutch assembly, as follows: 1157B Page 35 and 49.

- a. Lift and push in on 152410 reset bail to latch push levers in spacing position. (Reset bail is located under the five push levers.) (Page 35)
  - b. Push marking lock lever 152405 forward until armature drops, locking selector levers 152409, away from their cams. (Page 35)
  - c. Remove locknut 3598 and screw 151642 on selector clutch drum. (Page 49)
  - d. With screwdriver tip, or spring hook hold spacing lock lever 152407 and start lever 152408 slightly forward and remove selector cam clutch assembly from main shaft with counterclockwise rotary motion. (CAUTION: Do not use force that might bend or break levers.) (Page 35-49)
  - e. Remove selector clutch drum by holding the clutch shoe lever against the cam disk projection. (Page 49)
2. Remove the selector mounting plate assembly, as follows: 1157B Page 31, 35 and 49.
- a. Remove both Micarta Terminal shields 152458 and disconnect the four wires to selector magnets, noting color coding. (Page 31)
  - b. Remove three 151630 screws, holding the 152400 "Selector Mounting Plate" to the side frame. The two 150479 mounting studs should be left attached to the frame. One of the 151630 screws (Page 49) also holds one side of the 152573 bearing retainer.
  - c. A fourth screw was previously removed. Its location was inside oil wick holder as described in Part I, Paragraph III-C. (Page 37)
  - d. Remove the Selector mounting plate assembly.
- F. Main Shaft: (Bulletin 1157B Page 51, 47 and 49)
1. Lay typing unit upside down facing rearward.

2. Remove 150244 rocker shaft drive link at left end of main shaft by removing screw and 150010 retainer plate from 150046 clutch sleeve bearing. CAUTION: Do not touch 150364 eccentric stud, ask the instructor to locate and explain.
3. Unhook the trip and latch lever springs 74701 of all clutches, plus the 74712 cam follower arm spring of the code bar clutch, also function clutch latch lever spring 135716. (Page 47)
4. Remove single remaining screw in right bearing retainer 152573. Only one 151630 screw shows (Page 49)
5. Remove two screws in left bearing retainer 152537. Only one 151630 screw shows (Page 51)
6. Twist main rocker shaft so left side linkage does not obstruct left bearing retainer.
7. Rotate main shaft until screw 151689 in collar clamp 153824 at the right of the right bearing, is toward you. Remove screw and slide 153824 clamp, felt washer 89096 and 153823 collar off the main shaft. (Page 49)
8. Slide main shaft about 1/2 inch to the left and remove it toward you. (Some difficulty may be experienced in passing stripper blade driver link 153300 (page 49) past bearing bracket 153317 (page 61). Gradually remove, turning mainshaft slightly, without using excessive force.

G. Platen Assembly: (Bulletin 1157B Page 63, 57 and 67)

1. Remove paper fingers.
  - a. Unhook paper finger spring 72468. (Page 63)
  - b. Remove upper screw 151637 of right platen retainer 150719. CAUTION: Note order of washers. (Page 57)
  - c. Slide paper finger shaft 150685 a little to right and with tweezers remove pin 151703 in end of shaft. Slide paper fingers off to the left, and shaft out to the right. (Page 63)

2. Remove platen retainers 150719 and 150720.
3. Operate the paper release lever to the rear. Pull platen up and out against the tension of the detent lever spring at left. (Page 67) (Spring-150969 - Lever 150900)
4. Remove the six rollers. (LP-6) 150269; two rollers (LP-12) (Page 63)
5. Have the instructor check the disassembly.

PROCEDURE II (Reassembly)

Foreward:

Reassembly is essentially the reverse of disassembly, therefore in most part only the outline of the steps in reassembly is given. For more detailed instructions consult Procedure I, Disassembly.

Precaution notes are included through-out the assembly procedure, which are purposely included to avoid damages to the equipment and to facilitate reassembly.

A. Platen Assembly:

1. Replace rollers.
2. Replace platen.
3. Replace paper finger shaft. Replace pin.
4. Replace platen retainers. CAUTION: Replace top screws first, friction tight. Press down on platen and snap bent end of retainer into notch of frame. Bottom screw holes will now be aligned. Replace bottom screws. (Arrangement of washers should be noted.)

B. Main Shaft:

1. Typing unit upside down, facing rearward.
2. Insert main shaft as follows:
  - a. Swing the five latch levers to the rear of typing unit. (Count them.)

- b. Swing shift lever drive shaft stud to front of typing unit. (Since the unit is upside down this will be away from you.)
  - c. Code bar clutch follower arm on its pivot with felt washer.
  - d. Turn main rocker shaft so that left side linkage does not obstruct the bearing retainer.
  - e. Rotate main shaft while inserting.
- 3. Replace collar, clamp and felt washer.
  - 4. Replace left bearing retainer.
  - 5. Replace right bearing retainer (single screw).
  - 6. Replace the trip lever latch springs and the cam follower spring.
  - 7. Replace rocker shaft drive link and felt washer with CAUTION.
  - 8. Have Instructor check main shaft installation.
- C. Selector Mechanism:
- 1. Replace selector mounting plate, as follows:
    - a. Three screws. CAUTION: Fourth screw that holds oil wick holder to be put in later.
    - b. Connect wires to selector magnet, note color code, and replace micarta strip.
  - 2. Replace selector cam clutch assembly, as follows:
    - a. Latch push levers to space.
    - b. Check to see if five push lever springs are in place.
    - c. See that selector clutch drum is installed properly.
    - d. Unlatch latch lever spring 41382 (Page 35-1157B) allowing latch lever to fall rearward. Push Marking lock lever forward.

- e. Hook rubber band around upper end of start lever and spacing lock lever. Pull levers forward, while stretching rubber band over the front plate mounting surface of the side frame. Continue with rubber band, stretching it in a counterclockwise direction around rear leg of side frame. Hook the rubber band over the extension of the code bar clutch trip lever 150444. All levers are now positioned so that cam assembly may be replaced.
- f. In replacing cam, rotate counterclockwise slowly. (NOTE: It is likely that the selector clutch drum hub is not in perfect alignment with the cam assembly when replacing the cam sleeve.)
- g. Replace screw and lock nut.
  - (1) Lockwasher on each side of drum.
  - (2) Tighten screw before tightening nut.

D. Code Bar Assembly:

1. Rotate main shaft until vertical positioning levers are straight.
2. Replace code bar assembly, with four screws.

E. Code Bar Positioning Mechanism:

1. Allow push levers on the selector mechanism to go space.
2. Replace code bar positioning mechanism and replace all screws except one inside of wick holder. (CAUTION: Be sure felt washer is on shift lever link.)
3. Replace Tru-arc fastener.
4. With small spring hook attach rear end of common transfer lever spring to transfer lever spring anchor bracket.
5. Replace wick holder and position wick against push lever guide bracket. CAUTION: Do not disturb push lever springs.
6. Replace code bar shift bars and retaining plate. CAUTION: There are nine code bars and all are notched. There are seven slots in the shift lever guide bracket, but there are only six code bar shift bars. The upper code bar, "suppression" is not actuated by the transfer levers. Only the six upper slots in the shift lever guide bracket are used.

7. Replace shift bar retaining plate, beveled side to the right.

F. Function Box Assembly: (Stunt Box)

1. Place function box about half way into positions.
2. Replace switch assemblies.
3. Insert function box assembly.
  - a. Be sure the guides on the function box mounting brackets enter the provided slots on the side frame.
  - b. Engage line feed stripper slide page 27, with the single-double line feed stripper bail, Page 61. Be sure shift lever forks engage properly with pins on code bars.
  - c. Replace hexagonal cross member.
  - d. Replace the two 151692 screws.

G. Front Plate Assembly:

1. Place typing unit right side up facing you.
2. Place the number 4 and the number 5 code bars in spacing position. (to the right)
3. Place front plate assembly about one inch in front of typing unit.
4. Raising main bail drive bracket above rocker shaft, slide front plate against typing unit.
5. Secure a few threads of the upper left hand front plate screw. CAUTION: Avoid cross threading.
6. Trip the carriage return and hold the spacing drum feed pawl release link (located outside the spacing drum) away from the drum against the spacing drum feed pawls.
7. Hold the automatic carriage return bell crank to the right.

8. Guide the front plate against the typing unit, checking to see that all projections fit into their respective slots. These include the number 3, 4 and 5 code bars, the Carriage Return lever, the automatic CR bell crank, the Letters-Figures shift code bar; see Figure 3-30 of your course book to check for correct positioning of the carriage return latch bail (part #35) and the automatic carriage return bell crank (part #12).
9. Holding the front plate firmly against the typing unit insert the front plate screws. (CAUTION: Avoid cross threading of screws.)
10. Have instructor check front plate replacement.
11. Replace the main bail drive bracket screws.
12. Replace the type box carriage, as follows:
  - a. Type box track at its lowest point. Insert carriage from the right.
  - b. Type box track at highest point. Oscillating rail in "Letters" position. Oscillating rail slide at extreme right. Insert and Tru-arc fastener.
  - c. Replace ribbon and type box.
13. While the typing unit is on the work bench, manually set up and turn through the following operations: MARY 4679", Bell, Carriage Return, and Line Feed. Remove armature clip, pull "S" code bar to the left, turn handwheel counterclockwise to put the printer in the figures printing position. Push printing carriage to the extreme right side, turn handwheel counterclockwise and an automatic carriage return and line feed should occur.
14. If the typing unit will do everything in "13", call the instructor for a reassembly check. If it will not, the unit is not properly assembled. Make sure the unit is properly assembled before calling for a check.

### PROCEDURE III (Adjustments)

- A. Due to the removal of the main shaft and front plate the Spacing Gear Phasing and Line Feed Clutch Phasing have been disturbed. These two adjustments, and their related adjustments, marked (R) on the performance sheet, must be done.



PROCEDURE IV (Initial Performance Check)

- A. After making the first ten adjustments, make a Performance Check, which is the same as the Operational Check made near the beginning of the experiment, and record on the performance sheet after adjustment number ten.

PROCEDURE V (Further Adjustments)

- A. Students will continue making the adjustments as listed on the performance sheet as time permits.



FAA AERONAUTICAL CENTER  
AIR NAVIGATION FACILITIES BRANCH  
COMMUNICATIONS EQUIPMENT SECTION

MODEL 28 PRINTER LABORATORY EXPERIMENT NO. 3

PERFORMANCE SHEET

Name \_\_\_\_\_ Name \_\_\_\_\_

Date \_\_\_\_\_ Class \_\_\_\_\_ Printer No. \_\_\_\_\_ TD \_\_\_\_\_ LR No. \_\_\_\_\_

PRINTING UNIT

- A. Operational check, Hi \_\_\_\_\_ -Lo \_\_\_\_\_ = \_\_\_\_\_
- B. Correct disassembly. . . . .

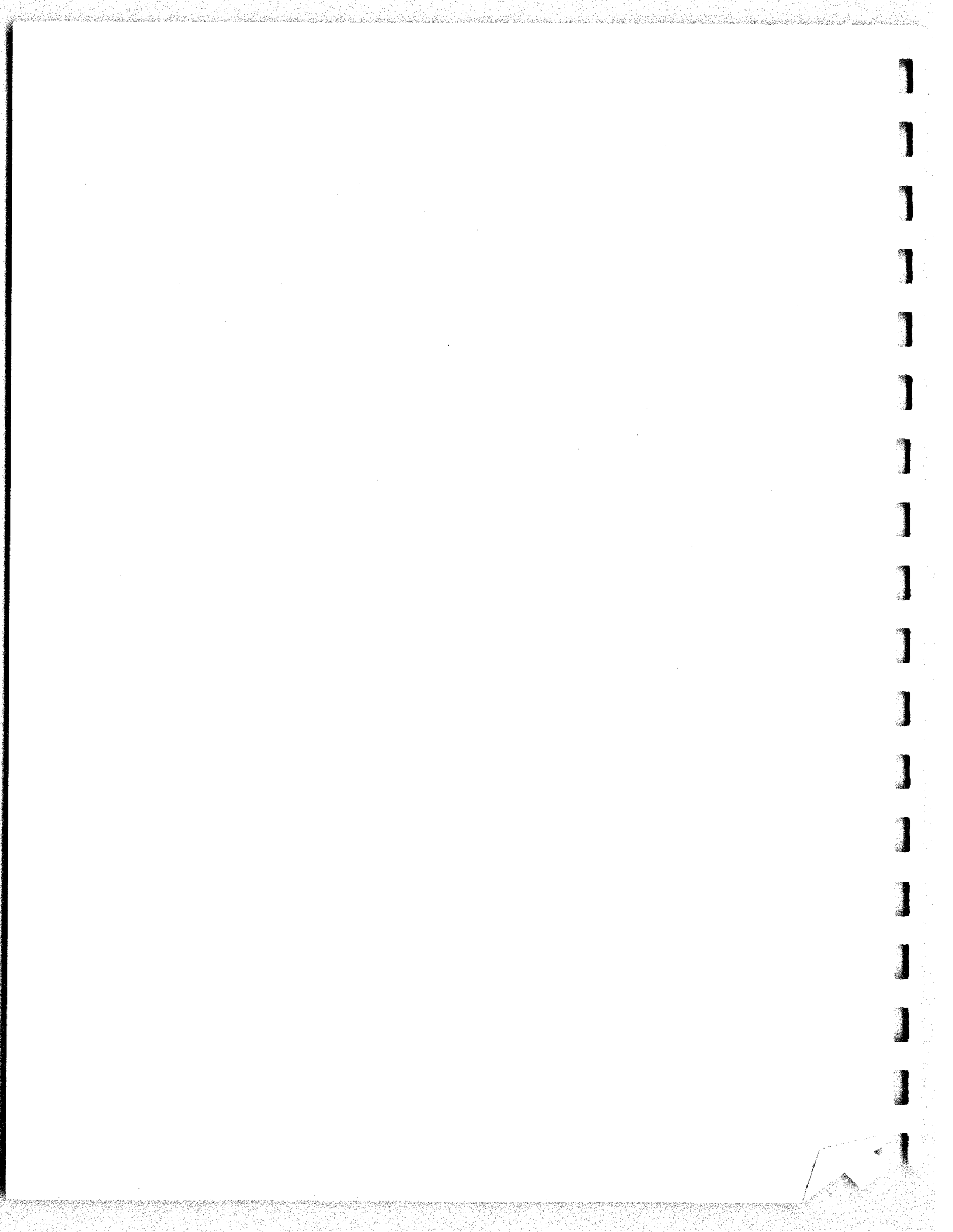
  - Type Box clutch disassembled. . . . .
  - Other. . . . .

- C. Mainshaft installation. . . . .

  - Stripper blade drive arm incorrect. . . . .
  - Code Bar clutch follower arm incorrect. . . . .
  - Other. . . . .

- D. Correct Assembly. . . . .

  - Line Feed Stripper Blade Incorrect. . . . .
  - No. 3 code bar incorrect. . . . .
  - No. 4 code bar incorrect. . . . .
  - No. 5 code bar incorrect. . . . .
  - "0" bar incorrect. . . . .
  - Carriage return latch bail incorrect. . . . .
  - Other. . . . .

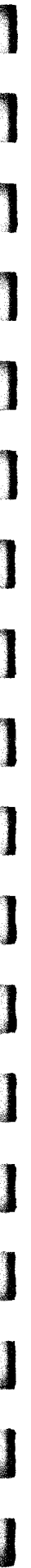


E. Adjustments: (Check for interrelated adjustments in information section at end of experiment) The following is to be used as a guide only.

Adjustment No.	"Model 28 Adjust- ments" Page No.
-------------------	--------------------------------------

- 1. Spacing gear phasing. . . . . 2-25
- 2. (R) Left Hang margin. . . . . (C1\_\_\_\_) . . . . . 2-41
- 3. (R) Automatic carriage Return Arm. . (1\_\_\_\_) . . . . . 2-60
- 4. Line Feed clutch phasing. . . . . 2-26
- 5. (R) Line feed spur gear detent eccentric. . . . . 2-57
- 6. Printing carriage position. . . . . 2-43
- 7. (R) Shift linkage. . . . . 2-44
- 8. Code bar clutch trip lever. . . . . (C1\_\_\_\_) . . . . . 2-17
- 9. Code bar shift lever drive arm. . . . (C1\_\_\_\_) . . . . . 2-15
- 10. (R) Code bar shift lever link guide. . . . . 2-16  
(C1\_\_\_\_)  
Performance check - Hi \_\_\_\_\_ -Lo \_\_\_\_\_ = \_\_\_\_\_
- 11. Selector armature. . . . . (C1\_\_\_\_) . . . . . 2-6
- 12. (R) Selector magnet bracket. . . . . 2-7  
(#1 C1\_\_\_\_) . . . . . (#2 C1\_\_\_\_)  
Performance Check - Hi \_\_\_\_\_ -Lo \_\_\_\_\_ = \_\_\_\_\_
- 13. (R) Selector Clutch stop arm. . . . . 2-11
- 14. Transfer lever eccentric . . . . . (C1\_\_\_\_) . . . . . 2-13
- 15. Off line shift bracket assembly (Req.D). . . . . 2-24
- 16. Intermediate Arm backstop bracket. . . . . 2-14
- 17. Printing track. . . . . (C1\_\_\_\_) . . . . . 2-45
- 18. (R) Printing arm (#1 C1\_\_\_\_) . . . . . (#2 C1\_\_\_\_) . . . . . 2-46

(R) = Related to previous adjustment.



- 19. Printing hammer stop bracket. . . . . 2-46  
(C1 \_\_\_\_\_)
- 20. (R) Recheck printing arm. . . . . 2-46  
(#1 C1 \_\_\_\_\_) . . . . . (#2 C1 \_\_\_\_\_)
- 21. Ribbon reverse spur gear. . . . . 2-47
- 22. (R) Ribbon reverse detent. (LP-12 2-47A). . . . . 2-47

THE FOLLOWING SERIES OF ADJUSTMENTS REQUIRE ABOUT FOUR HOURS

- 23. Rocker shaft bracket eccentric stud. . . . . 2-27  
(C1 \_\_\_\_\_)
- 24. (R) Right vertical positioning levwr eccentric stud. . . . . 2-28  
(C1 \_\_\_\_\_) . . . . .
- 25. (R) Left vertical positioning lever eccentric stud. . . . . 2-29  
(C1 \_\_\_\_\_)
- 26. (R) Spacing trip lever bail cam plate. . (C1 \_\_\_\_\_) . . . . . 2-31
- 27. (R) Reversing slide brackets. . . (C1 \_\_\_\_\_) . . . . . 2-32
- 28. (R) Horizontal positioning drive linkage. . . . . 2-33  
(C1 \_\_\_\_\_)
- 29. (R) Vertical positioning lock lever. . (C1 \_\_\_\_\_) . . . . . 2-35
- 30. (R) Printing Track. . . . . (C1 \_\_\_\_\_) . . . . . 2-45
- 31. (R) Printing Arm . . . . (#1 C1 \_\_\_\_\_) (#2 C1 \_\_\_\_\_) . . . . 2-46
- 32. (R) Ribbon feed lever bracket. . (C1 \_\_\_\_\_) . . . . . 2-48

Performance check - Hi \_\_\_\_\_ - Lo \_\_\_\_\_ = \_\_\_\_\_





FAA SCHOOLS  
AIR NAVIGATION FACILITIES BRANCH  
COMMUNICATIONS EQUIPMENT SECTION  
TELECOMMUNICATIONS UNIT

MODEL 28 R/O EQUIPMENT LABORATORY EXPERIMENT NO. 4

Name \_\_\_\_\_

Date \_\_\_\_\_

MODEL 14 TRANSMITTER DISTRIBUTOR

PURPOSE OF EXPERIMENT

To familiarize the student with the Model 14 Transmitter Distributor and the approved methods of disassembly, reassembly and adjustment.

REFERENCES

Attached adjustment sheets  
Performance Sheet  
Lecture Notes

EQUIPMENT REQUIRED

Model 14 Transmitter Distributor  
Model 28 Teletype  
Teletype Tools

PROCEDURE I (Familiarization)

A. Operational Check

1. Run an "RY" test tape through the TD and observe the Model 28 Teletype.
2. Turn the Range Finder Indicator to as high a number as possible and still receive one full line of perfect copy, and record on scratch paper.
3. Do the same for the lowest number.
4. Record "Local Range" (High - Low) at top of Performance Sheet.

B. Screw Removal

1. Whenever possible, after removing parts, replace screws to avoid confusion in selecting correct lengths in reassembly. In case of doubt, look up the part number of the screw in the parts bulletin and find the screw length in the back of the parts bulletin, opposite the number.

C. Partial Disassembly

1. Remove top cover.
2. Remove screw holding Brush Arm Assembly to main shaft and remove assembly.
3. Remove Transmitter Snap Panel.
4. Remove two screws and Transmitter Cover (left top).
5. Remove four screws and Base Plate.

D. Carefully inspect the unit for obvious faults and study the unit in order to retain general location of various components.

1. Tape Sensing Mechanism

- a. Marking Contact Screws (see page E4-18 of this experiment).
- b. Spacing Contact Screws (page E4-18)
- c. Contact Tongues (page E4-18)
- d. Contact Lever Springs (page E4-18)
- e. Contact Levers (page E4-18)
- f. Contact Lever Bail (page E4-18)

2. Distributor Mechanism

- a. Outer Distributor Ring, consisting of seven segments. The reference mark is in the middle of the STOP segment. Moving clockwise you will find the START, #1, #2, #3, #4 and #5 segments.
- b. Inner Distributor Ring, which is a solid ring.

3. Tape Feed Mechanism
  - a. Adjusting Lever (for Feed Lever -page E4-19)
  - b. Feed Lever and Feed Pawl (page E4-19)
  - c. Feed Wheel Ratchet (page E4-19)
  - d. Detent Roller (page E4-19)
4. Tape Stop Magnet (page E4-16)
5. Clutch Assembly (page E4-6)
6. End-of-Tape Mechanism
  - a. Tape Pin and End-of-Tape Contacts (page E4-22)
7. Tape Transmitter Mechanism
  - a. Tape Guide (page E4-14)
  - b. Retaining Lid (page E4-36)
  - c. Lid Plate (page E4-36)

PROCEDURE II (Disassembly)

A. Mainshaft

1. Remove operating cam from bottom of main shaft by removing two bottom screws.
2. Remove Distributor Mechanism (has solid and segmented ring) by removing three screws.
3. Remove bearing caps from mainshaft bearings and remove mainshaft. Note caps and frame are numbered in most cases.
4. Replace Distributor Mechanism temporarily.
5. Disassemble mainshaft noting arrangement of various parts on the shaft. Reference page E4-6, do not separate the 135037 Bearing, Gear and 135034 Clutch Drum. Do not disassemble the internal mechanism of the clutch.  
  
Wipe all parts of mainshaft with clean rag and inspect for wear and note part numbers of worn parts. Instructor will furnish replacement part if available. If not available, make note on reverse of performance sheet with equipment serial number.

- B. Tape Transmitter Mechanism
  - 1. Remove four screws and transmitter top plate, exercising care not to allow end-of-tape pin to be misplaced or lost.
  - 2. Remove left hand bracket.
- C. Tape sensing Mechanism
  - 1. Remove the Spacing (upper) contacts and buss as a unit, by removing the two screws in line with the upper contact screws.
  - 2. Loosen the five contact springs at lower ends by means of screw and spade lug connections. Unhook feed lever spring. Remove two screws holding contact lever pivot shaft and lift out entire contact lever and spring assembly. DO NOT force this assembly, but work gently out until free. All contact lever springs should be soldered on both ends, because they pass Marking current. If not so soldered, please do so.
  - 3. Inspect lower (Marking) contact screws and lower side of contact tongues and if pitted, resurface with crocus cloth.
- D. Have Instructor Check Disassembly.

PROCEDURE III (Reassembly)

- A. Main Shaft
  - 1. Reassemble main shaft as shown on page E4-6.
    - a. Note two types of flat washers are used. The 72579 is thinner than 3288 (see page E4-7).
    - b. If the bearings have one covered and one uncovered side, install covered side down to avoid grease drippage.
    - c. The operating cam can be replaced two ways. When correctly replaced, and the lugs on the clutch are positioned forward, the peak of the operating cam is toward the left instead of the right. Center the screws in the slots of the cam.

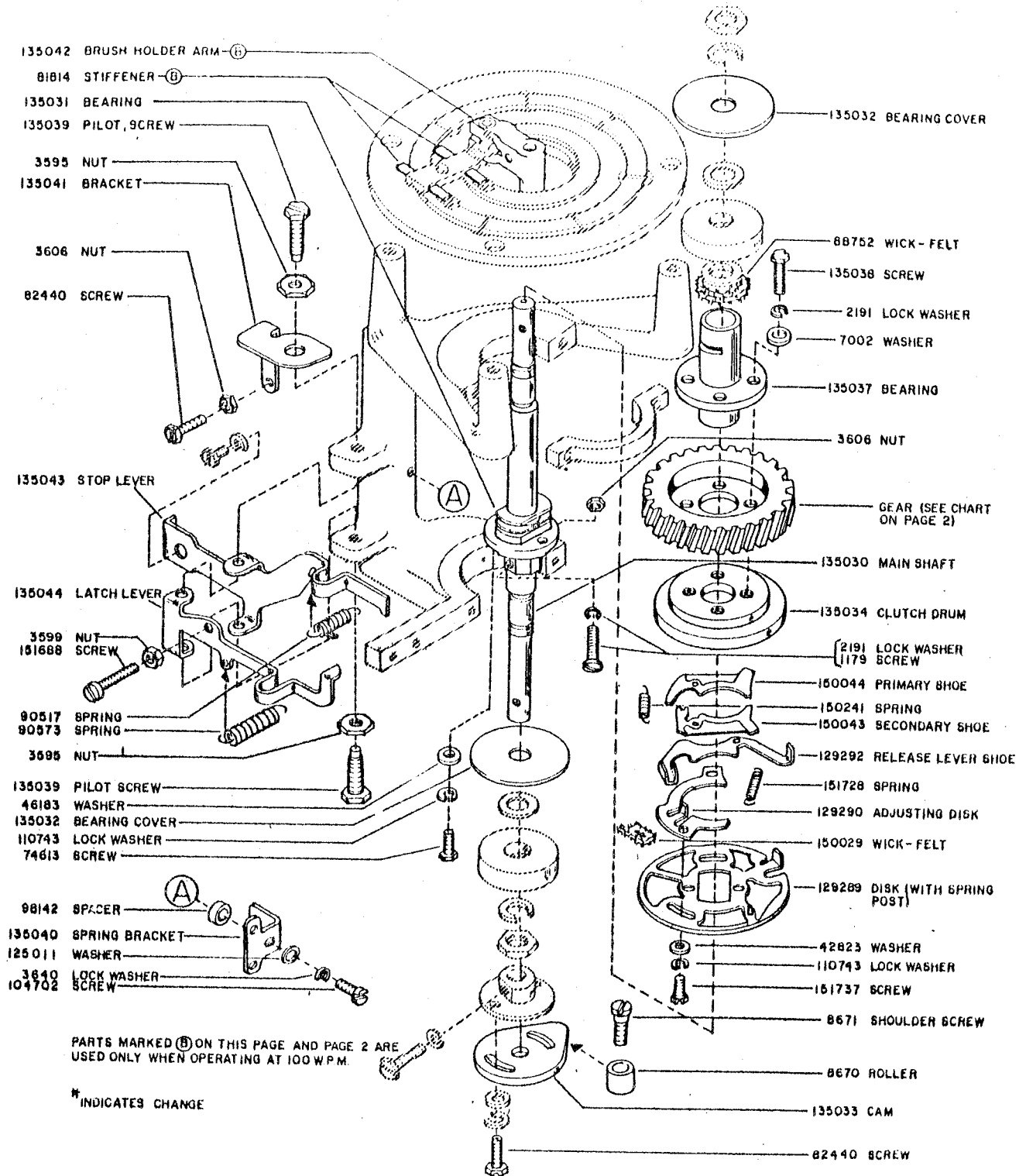
- d. Have Instructor check correct assembly of main-shaft.
  - e. Remove Distributor (collector ring) assembly.
  - f. Replace main shaft friction tight. Match numbers on bearing caps with numbers on frame.
  - g. Operating lever must be to left of operating cam.
  - h. Replace Distributor (collector ring) Mechanism, but not the Brush Holder Arm.
2. Replace contact lever assembly taking care not to force the assembly.
- a. The contact tongues must rest on top of the lower contact screws.
  - b. The right side of the lower end of the five contact levers and the one feed lever must be against the left side of the contact lever bail and adjusting lever. (page E4-19)
  - c. Position the top of the contact lever spring anchor eyes, even with the top of the terminal washers.
  - d. Rehook or replace the feed lever spring.
  - e. Do not replace the tape transmitter top plate at this time. Do not misplace end-of-tape contact pin.
  - f. Have Instructor check partial reassembly.

PROCEDURE IV (Adjustments)

- A. Proceed with the adjustments shown on the following adjustment sheets. Two students will use one Performance Sheet and alternately accomplish the adjustments. After one adjustment has been made, enter your initials in the left hand column and call for an Instructor to check. When checked, the Instructor will enter his initials in the right hand column. Each adjustment must be checked before the next adjustment is made.

MODEL 14 TRANSMITTER DISTRIBUTOR

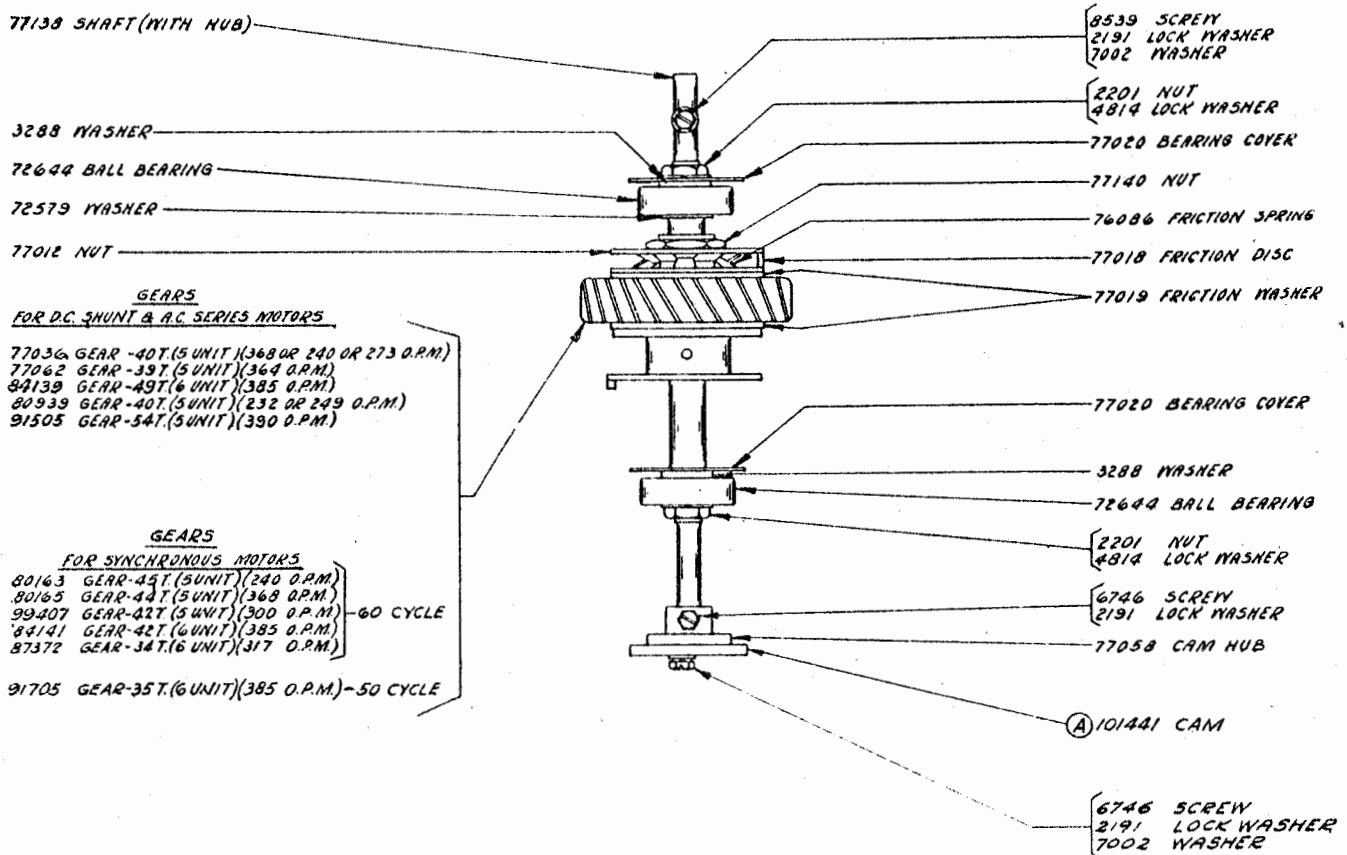
E4-6



Main Shaft, Using All Steel Internal Expansion Clutch

MODEL 14 TRANSMITTER DISTRIBUTOR

E4-7



Main Shaft  
Using Felt Washer Friction Clutch

1. MAIN SHAFT ADJUSTMENT (Figure 10)

Rotate the main shaft until the operating lever roller just starts to ride up the high part of the cam. Position the main shaft so that there is .002" or more clearance between the lower surface of the cam and the upper surface of the operating lever when all the play of the operating lever is taken up in a direction to make the clearance a minimum. With the play in the operating lever taken up in a direction to make the clearance a maximum, this clearance should not exceed .040". To adjust, loosen the main-shaft bearing cap screws and raise or lower the main shaft. Tighten the screws.

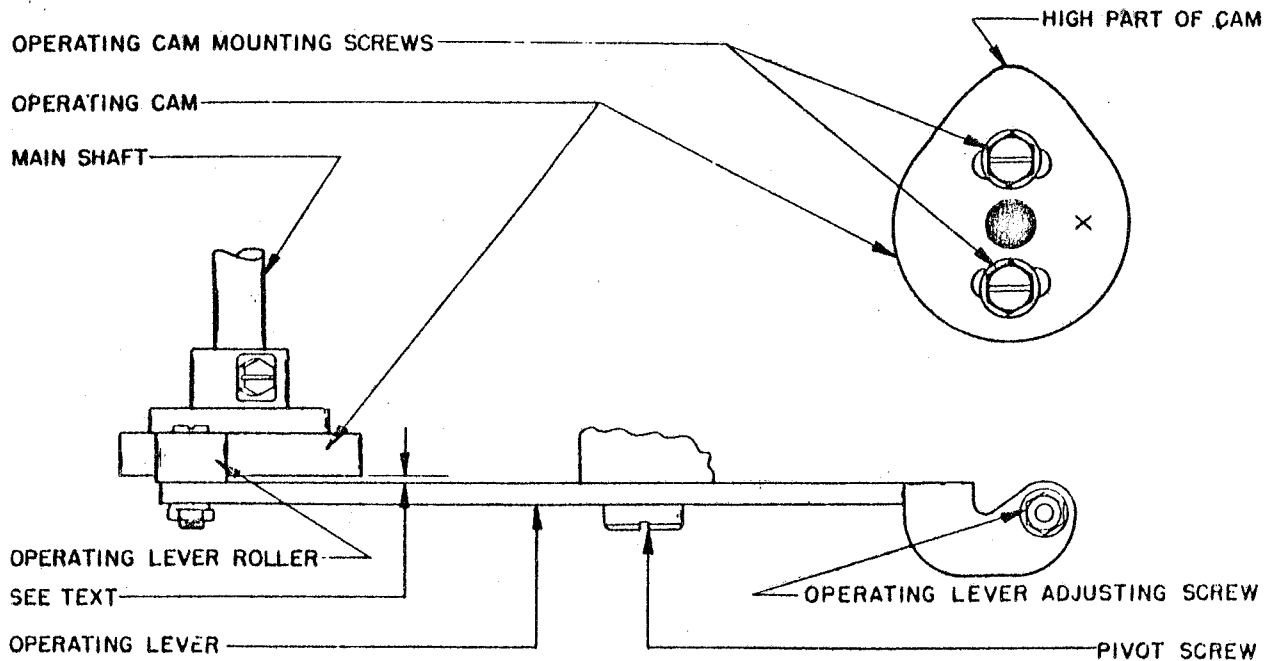
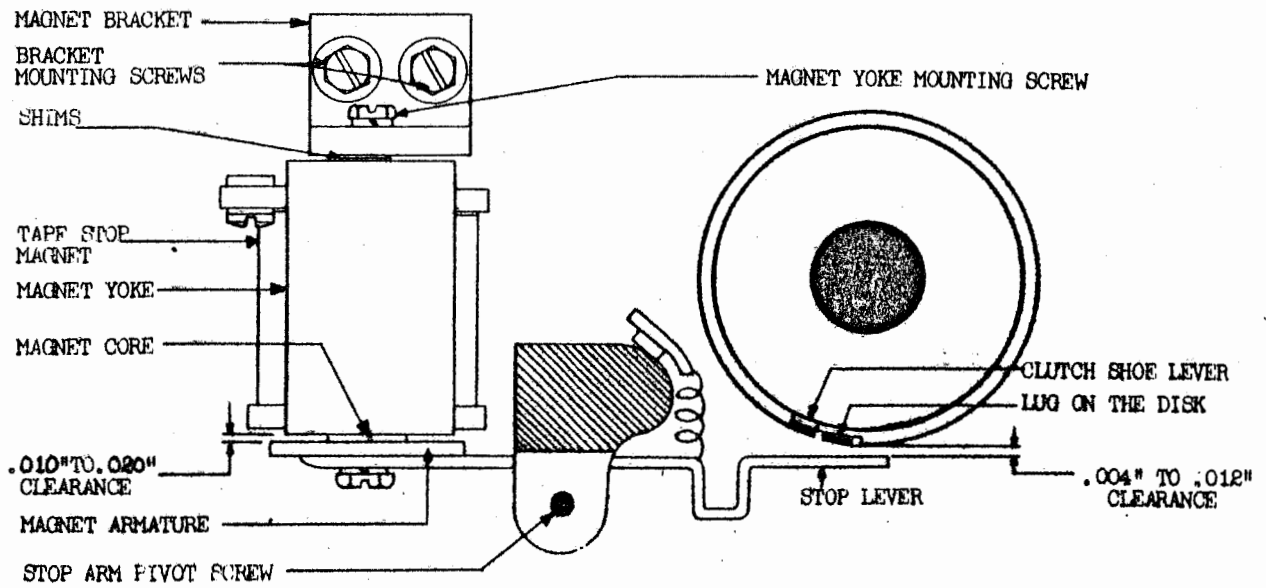


Figure 10



2. TAPE STOP MAGNET BRACKET (see next page)

The "C" (chrome) side of the magnet armature should be away from the magnet core (AC operation). To simulate energizing the magnet, hold the magnet armature firmly against the magnet yoke by applying finger pressure between the pivot screws and magnet core. The air gap between the upper and lower pole faces of the magnet yoke and the face of the armature should be .010" to .020" and equal, within .005", to each other, when the magnet is energized. To equalize, increase or decrease the shims around one of the two screws holding the magnet yoke to the bracket. To obtain the .010" to .020", increase or decrease the shims around the one screw holding the magnet core to the yoke. The clearance between the stop lever and the lug on the disk should be .004" to .012" when the magnet is energized and the main shaft is rotated until the clearance is a minimum. Both the upper and lower pole faces of the magnet yoke should be parallel to the face of the armature, and the pole faces should not extend beyond either side of the armature, when the magnet is energized. To adjust, loosen the two magnet bracket mounting screws, friction tight, position the bracket and tighten the screws.



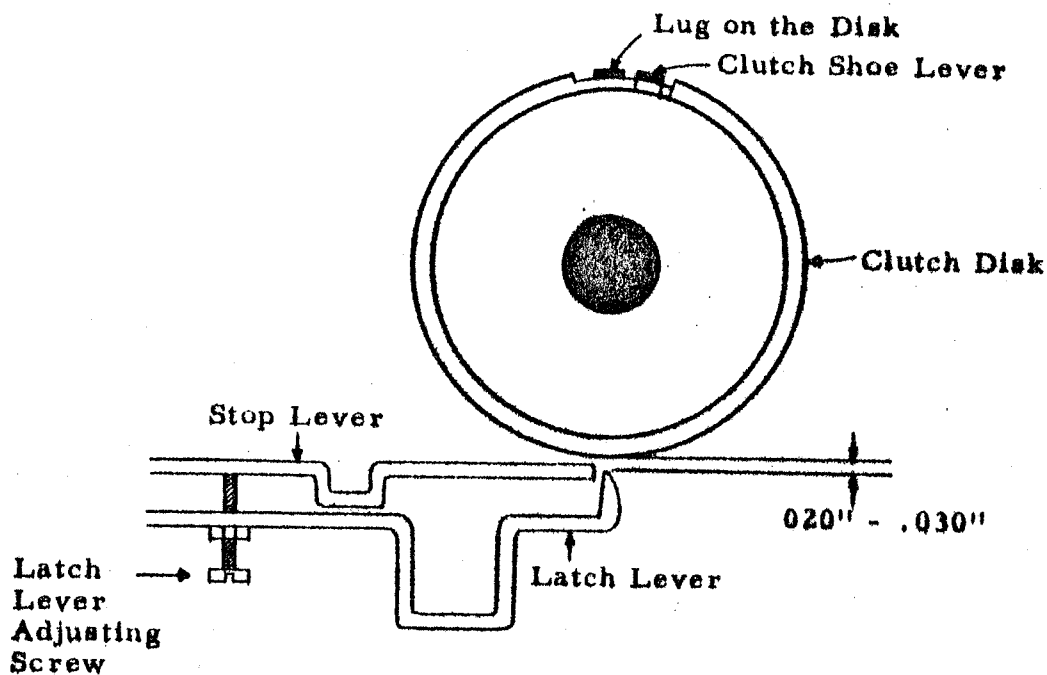
Tape Stop Magnet Bracket

3. STOP LEVER PILOT SCREWS AND ARMATURE BACKSTOP ADJUSTMENT (Page E4-6)

With the clutch magnet de-energized, the top surface of the 135044 latch lever should be flush to within .015" above the top surface of the 129289 disk, when the play in the latch lever is taken in an upward direction. To adjust, loosen the pilot screw locknuts and position the latch lever by means of the pilot screws, while holding the 135041 bracket firmly against the main casting. It may be necessary to back off the 82440 screw in the 135041 bracket, to allow positioning the bracket. The stop lever must be free on it's bearings with approximately .002" end play. Check for free movement and end play with 90517 spring unhooked. With the clutch magnet de-energized and the clutch disengaged, the inner surface of the stop lever and the inner surface of the release lever shoe should be approximately flush. To adjust, position the 82440 screw in the 135041 bracket.

4. LATCH LEVER STOP

With the magnet de-energized, rotate the mainshaft about  $180^{\circ}$  from the stop position and until the clearance between the clutch disk and the tip of the latch lever is maximum. This clearance should be  $.020''$  to  $.030''$ . To adjust, loosen the latch lever adjusting screw and rotate it in or out to meet the requirement. Tighten the locknut securely.



5. TAPE TRANSMITTER TOP PLATE REPLACEMENT(Figure 15)

Replace the tape transmitter top plate. When doing this, hold up the feed pawl so that it engages the feed wheel ratchet. Hold the end-of-tape contact operating pin to prevent it from falling out of its guide. There should be at least .020" clearance between the left side of the feed pawl spring and the right side of the tape contact lever guide as viewed from the front. There should also be at least .025" clearance between the upper right side of the feed pawl spring and the lower left side of the feed wheel ratchet as viewed from the front, when the feed pawl is in its uppermost position. If these clearances do not exist, modify the "Tape Feed Pawl Spring Tension Adjustment" within its specified limits to obtain the required clearance, or check Feed Lever Up-stop adjustment.

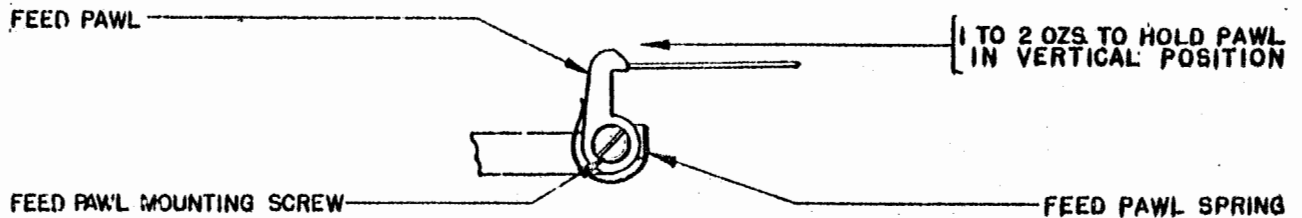


Figure 15

6. DETENT BRACKET ADJUSTMENT (Figure 17)

Obtain a piece of tape with a series of LETTERS perforations. Check the tape to determine if the spacing of the perforations meets the requirement of ten to the inch (use a tape gauge- a flat piece of metal with one hole per inch). Engage the feed perforations with the feed wheel so that a "Letters" combination is directly over the tape pins. Turn the motor fan counterclockwise as viewed from the fan end until the main shaft stops turning. Disengage the stop arm from the stop cam lug and rotate the fan until the tape pins just protrude through the tape code holes. The detent roller should be in an indent between two teeth of the feed wheel ratchet. The tape pins should be equal distance from the side of the tape code holes when the play in the tape is taken up to left and right. As further check, rock the fan to cause the tape pins to move up. The tape pins should not catch on the side of the tape code holes when the play in the tape is taken up to the left and right. To adjust, loosen the detent bracket mounting screw and position the bracket. Tighten the screw.

Check adjustments 7 and 8.

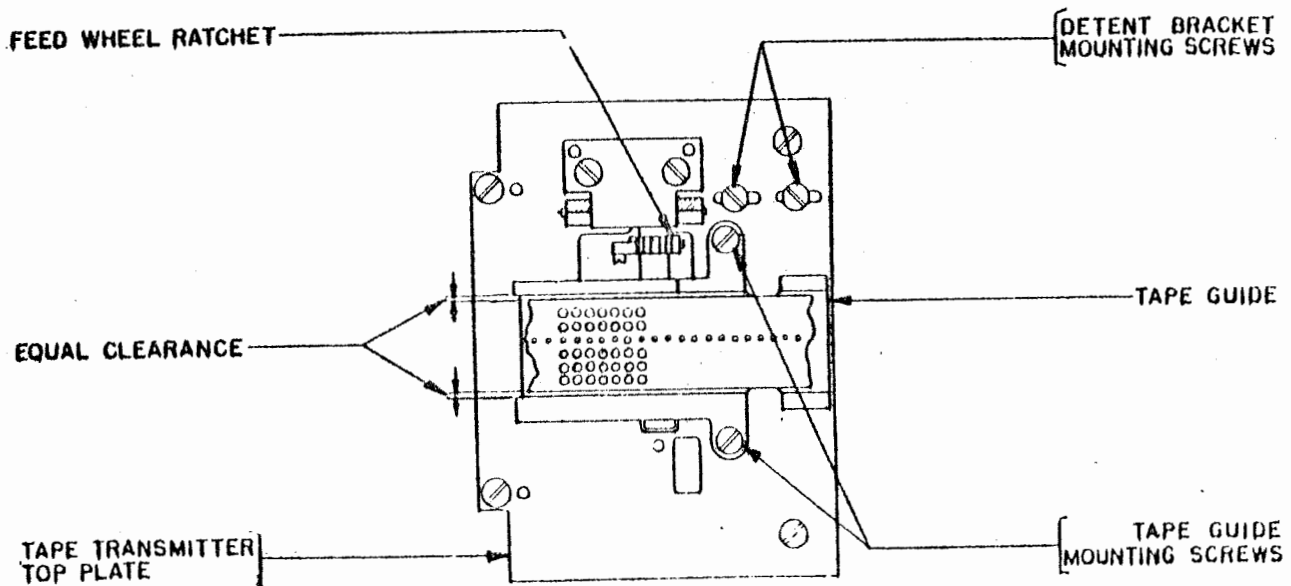


Figure 17

7. FEED LEVER ADJUSTING SCREW ADJUSTMENT (Figure 20)

With the operating lever roller on the low part of its cam and the lower end (underneath) of the contact lever bail pulled to the right by hand, the feed pawl should just touch the first tooth above the horizontal center of the feed wheel ratchet at the instant the highest tape pin is flush with the upper surface of the tape guide. With the line relay magnetic shunt on its long edge in the tape guide, the height of the tape pins can be observed. To adjust, loosen the feed lever adjusting screw lock nut with the 2" long "B" socket wrench turned by the 5/16" end wrench. Turn the adjusting screw, with the small "A" screwdriver inserted through the socket wrench, clockwise if the tape pins are below the top surface of the tape guide or counterclockwise if the tape pins extend above the top surface of the tape guide. Use very light pressure when tightening the lock nut; it is delicate. Check adjustment 9.

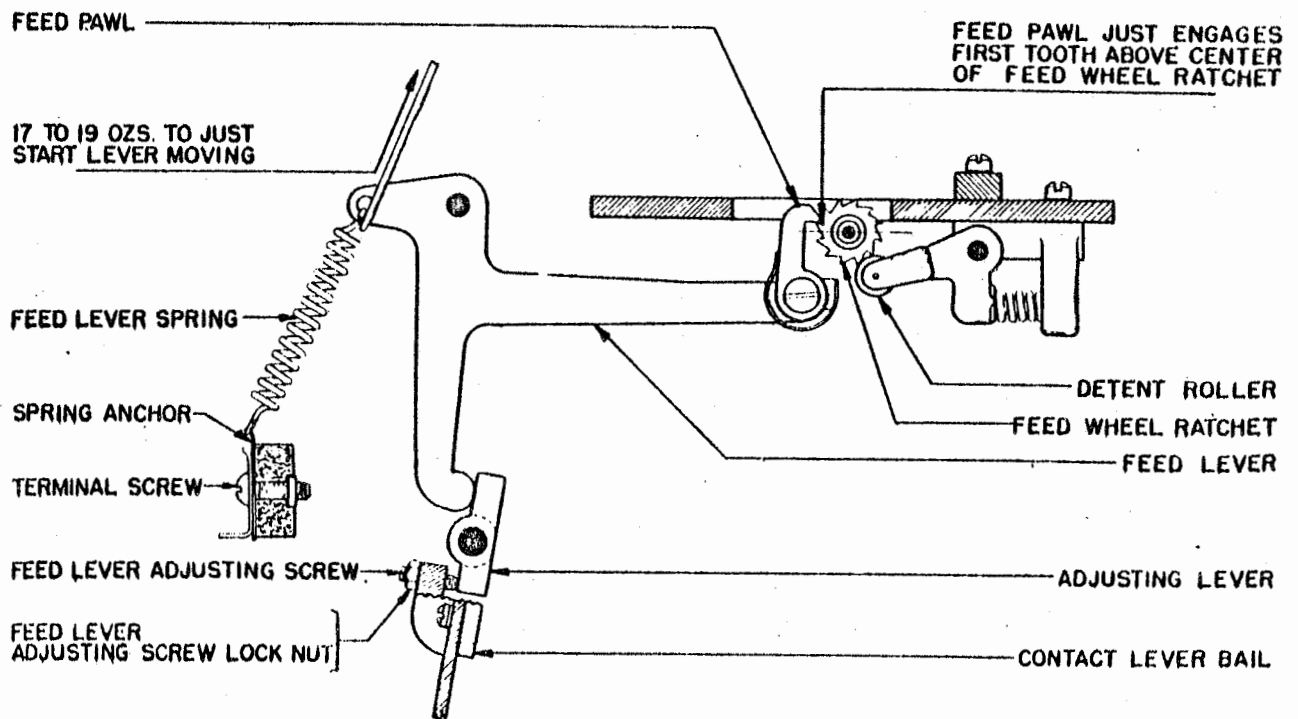


Figure 20

8. OPERATING LEVER ADJUSTING SCREW ADJUSTMENT(Figure 22)

Turn the motor fan so that the main shaft goes through one revolution. The feed wheel ratchet must be advanced one tooth.

Hold the stop cam clear of the stop cam lug and rock the motor fan until the feed pawl is in its lowest position. The detent roller must rest between two teeth on the feed wheel ratchet. There must be .002" to .010" between the top of a tooth on the ratchet wheel and the bottom of the feedpawl.

To check, insert a .010" round gauge from above and a .002" flat steel gauge from the front under the transmitter top plate. The .002" gauge must go all the way from left to right without drag. The .010" gauge should not go at all, unless the face of the tooth on the feed wheel ratchet is not horizontal, in which case it is permissible for the gauge to go part way. To adjust, loosen the operating lever adjusting screw lock nut and position the adjusting screw. Position the 110886 spring anchor so that the 42661 spring and the 82725 spring (page E4-25) are in line and tighten the lock nut.

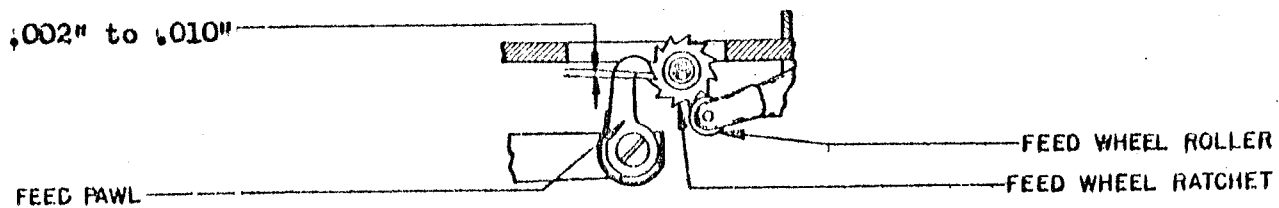


Figure 22



TAPE TRANSMITTER CONTACTS(Figure 23-next page)

The contacts require very little attention because no current is flowing through the contacts at the moment the contact tongues leave the contact screw. When periodic inspection is made, the contacts should be cleaned with a contact burnisher or crocus cloth. Particles of grit should be carefully wiped away after this operation.

For Units Designed to Use Chadless Tape (our type)

Replace upper contacts and buss. In order to check this adjustment it will be necessary to remake it. With the contact screw set screws loosened and the upper and lower contact screws backed off, rotate the main shaft until the operating lever roller is on the low part of its cam. Connect an Ohmmeter to the wire under the #1 (rear) contact terminal screw and the lower contact common wire. The battery in the ohmmeter runs down quickly. When not actually observing the meter or when the leads are lying loose, turn the ohmmeter selector switch to "Voltage" to avoid running down the battery.

9. LOWER CONTACT SCREW ADJUSTMENT (Figure 23-next page)

Advance the #1 lower contact screw until it touches the #1 contact tongue as indicated by the Ohmmeter. Make a reference mark on the screw head and advance it one more turn. Check adjustments 10, 11 and 14.

10. CONTACT LEVER SPRING TENSION ADJUSTMENT

(Figure 23-next page)

Hook an 8 oz. scale under the horizontal portion of the #1 contact lever, as shown on the next page and pull vertically upward. It should require 6 to 7 ozs. to separate the contacts, as indicated by the ohmmeter. To adjust, loosen, the contact lever spring anchor terminal screws and position the anchors.

Changing the spring tension will change the lower screw adjustment. Continue redoing the lower screw and spring tension adjustments in that order until the spring tension does not require adjustment after adjusting the lower screw.

Do the same for #2 through #5 contacts.

Check adjustments 11 and 14.

11. UPPER CONTACT SCREW ADJUSTMENT (Figure 23)

With the operating lever roller on the low part of its cam, there should be a gap of .006" to .010" between the contact point of each upper contact screw and its associated contact tongue. To adjust, loosen the upper contact screw set screws and adjust the upper contact screws. Turn the set screws in, using the small screwdriver, to avoid ruining the threads on the contact screws.

Check adjustment 14.

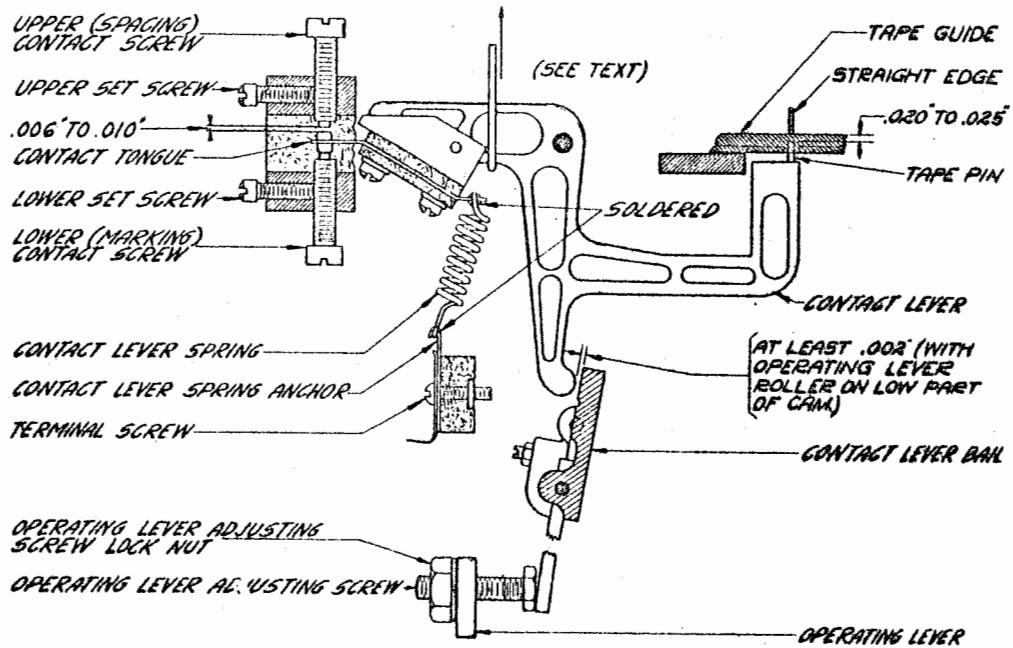


Figure 23

12. FEED LEVER SPRING TENSION ADJUSTMENT (Figure 20)

With the operating lever roller on the low part of its cam, hook a 32 oz. scale over the end of the feed lever (just below the spring hole) and pull upward in line with the spring. It should require 17 to 19 ozs. to start the feed lever moving. To adjust, loosen the terminal screw and position the spring anchor. Tighten the terminal screw. Loosen the terminal screw until it is friction tight. The spring will pull the spring anchor out of position completely if the terminal screw is loosened too much. The spring anchor is not soldered to the feed lever spring, but the spring anchors are soldered to the contact lever springs.

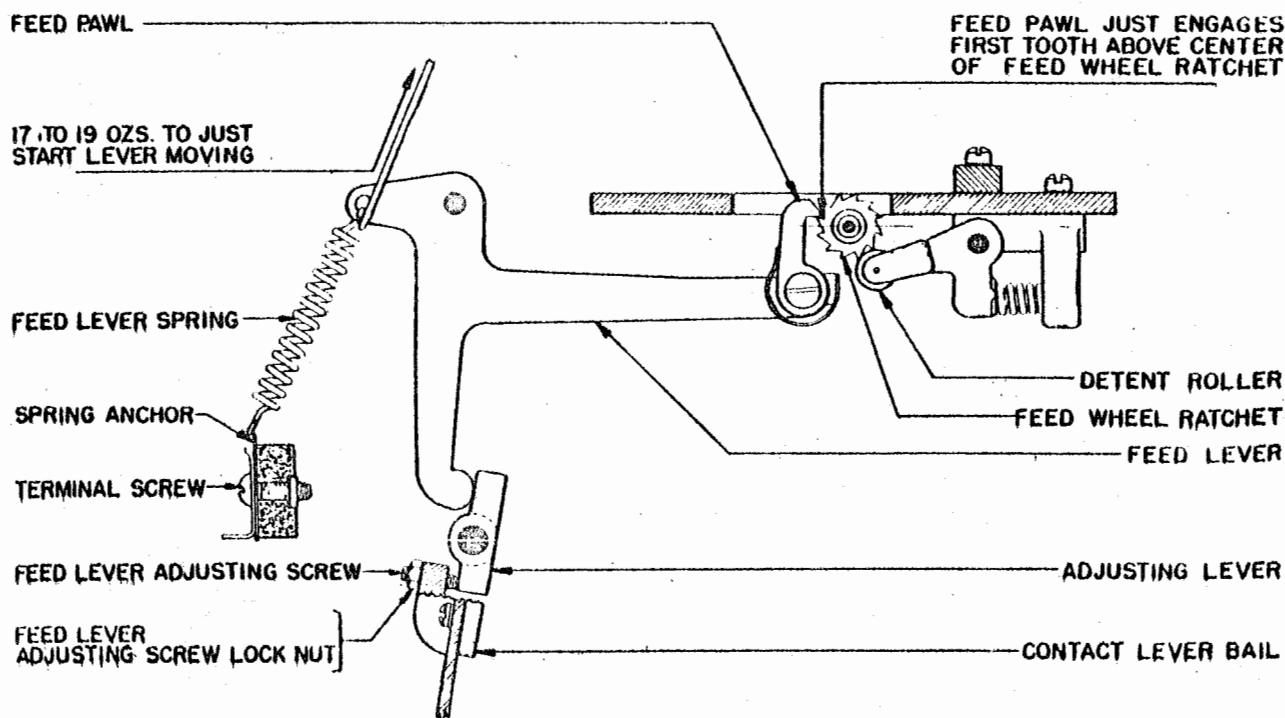


Figure 20

13. CARBON BRUSH ADJUSTMENT (Figure 27)

Replace Brush Holder Arm- Hold arm all the way down and tighten the screw.

- (a) **Brush Alignment-** With the main shaft in the stop position, and the clutch latched, the center of the brushes should make contact with their associated segments at a point in line with the line impressed in the disc. To adjust, loosen the brush spring clamp screw and position the brushes. Tighten the clamp screw so that the brush springs are friction tight. The brushes should also remain within the edges of the rings throughout a complete revolution of the main shaft. To adjust, loosen the brush holder clamp screw and position the brush holder, or utilize the play of the brush springs in their slots, to position the springs side ways. Tighten both clamp screws. The position of the collector ring assembly can be shifted slightly by loosening its three mounting screws, if required.
- (b) **Brush Contact Surface-** Both brushes must mate, over their entire contact surfaces, with the collector ring segment surface. Drag the brush across fine abrasive paper if necessary to accomplish this condition. Adjust the brush tension to 3-1/2 to 4 ozs. before using the abrasive paper.
- (c) **Brush Tension-** Hook an 8 oz. scale under the end of each distributor brush spring and pull upward at a right angle to the end of the brush spring. It should require 2-1/2 to 3-1/2 ozs. to lift the brush from the segment. To determine this point, use the Ohmmeter. To adjust, loosen the brush holder clamp screw, twist the brush holder as viewed from its end and tighten the screw.

Check Adjustment 14.

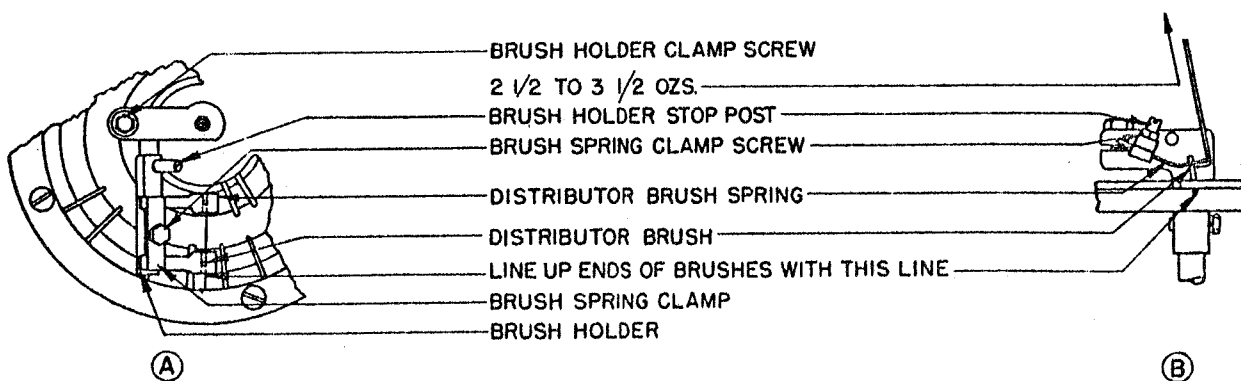


Figure 27

14. OPERATING CAM ADJUSTMENT

The operating cam should be positioned so that the No. 5 transmitter contact tongue leaves the lower (marking) contact screw when the distributor brush is on the "stop" segment and the trailing edge of the brush is  $1/32''$  to  $1/16''$  from the leading edge of the "stop" segment. The leading edge is the edge the brush first encounters. Use the Ohmmeter to determine when the No. 5 transmitter contact tongue leaves the lower (marking) contact screw. Measure the  $1/32''$  to  $1/16''$  in the center of the segment. Be sure that the brushes do not rotate backwards, catch in a crack between segments, and buckle the brushes while making this adjustment. To adjust, loosen the operating cam mounting screws and position the cam. Tighten the mounting screws.

15. END-OF-TAPE STOP CONTACT PIN GUIDE ADJUSTMENT  
(Figure 30)

The end-of-tape stop pin should be centrally located in the hole on the underside of the retaining lid (page E4-36). The feed wheel shaft should be free on its bearings with not over .002" end play. Hold the detent lever away from the feed wheel ratchet and turn the feed wheel shaft. There should be no drag. To adjust, loosen the mounting screws and position the front feed wheel shaft bearing and the stop pin guide. Tighten the screws.

16. END-OF-TAPE STOP CONTACT SPRING ADJUSTMENT (Figure 30)

- (a) Place a straight edge across the top of the tape guide plate, directly over the end-of-tape stop pin. There should be .020" to .025" clearance between the bottom of the straight edge and the upper end of the stop pin. To adjust, bend the upper contact spring.
- (b) When the lower contact spring is resting against its stiffener, the contact points should be separated by .008" to .012". To adjust, bend the lower contact spring stiffener.
- (c) Place a piece of tape in the guide and close the tape retaining lid. It should require a pressure of 20 to 25 grams with a gram gauge or .7 to .9 oz. with an 8 oz. scale (applied at the contact point of the lower contact spring) to just open the contact points. To adjust, bend the lower contact spring. Remove the tape and recheck adjustment (b).

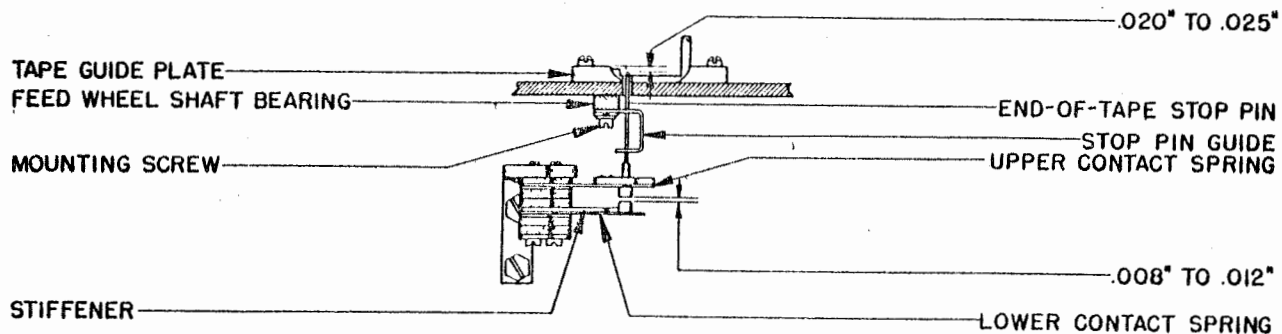


Figure 30

17. FEED LEVER UPSTOP ADJUSTMENT (Figure 21)

Transmitter distributors designed to handle chadless tape should be equipped with an operating cam identified by a letter "X". When this cam is used, an upstop is provided for the feed lever which should be adjusted as follows (some cams also have "XX"). Use the following adjustment for our TDs which use regular tape:

With the operating lever roller on the low part of the operating cam and the detent roller resting in the notch between two teeth of the feed wheel ratchet, there should be .050" to .070" clearance between the face of the feed pawl and the face of the first tooth above the horizontal center line of the feed wheel ratchet (measure where the clearance is the greatest- be sure that the feed wheel is not being advanced two notches instead of one. If it does, adjust clearance near .050"). The feed lever should be in contact with the blocking surface of the feed lever upstop. To adjust, loosen the feed lever upstop mounting screw and position the upstop. Tighten the mounting screw.

Rotate the motor manually until the adjusting lever (Figure 20-page E4-15) just contacts the lobe on the feed lever. With the contact lever bail in this position there should be at least .002" clearance between the bail and each contact lever lobe. If necessary, refine the feed lever upstop adjustment.

NOTE: With the operating lever on the low part of the operating cam, there should be at least .010" clearance between the radius of the feed pawl or the feed pawl spring and the feed wheel ratchet. If this clearance does not exist, refine the feed lever upstop adjustment.

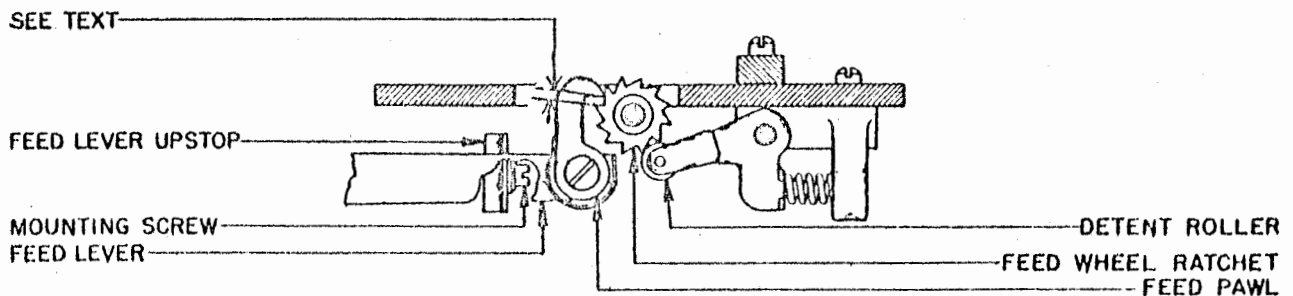


Figure 21

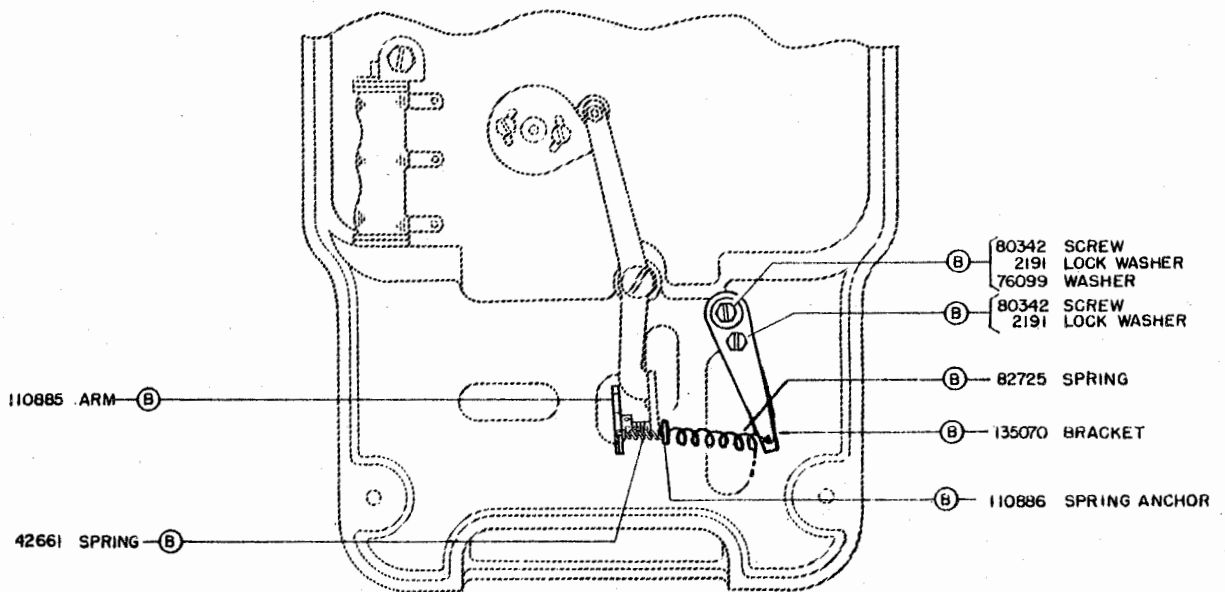
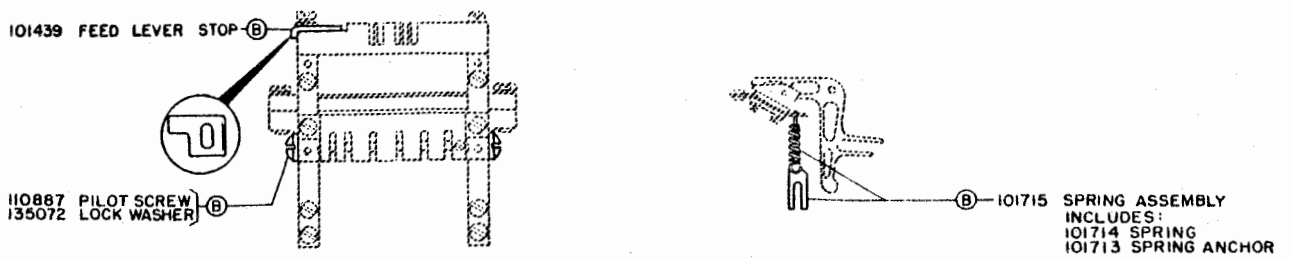
18. OPERATING LEVER AND BAIL SPRING TENSION  
(See next page)

With the operating lever roller on the low part of its cam, it should require 3-1/2 to 6-1/2 ozs, to stretch the 82725 spring to its position length, when one end is unhooked and using an 8 oz. scale. To adjust, rotate the 135070 bracket and tighten its mounting screws. With one end of the 42661 spring unhooked, it should require 2 to 3 oz. , using an 8 oz. scale, to stretch it to its position length. If out of tolerance, replace the spring.



# MODEL 14 TRANSMITTER DISTRIBUTOR

E4-25



GEAR CHART  
(WITH ASSOCIATED MOTOR AND PINION)

O.P.M.	W.P.M.	TYPE OF MOTOR	GEAR		PINION MATE (SEE NOTE)
			PART NO.	TEETH	
317	50	60 CYCLE A.C. SYNC.	135062	34	87371 (6T)
317	50	D.C. SHUNT & A.C. SERIES	135069	53	123717 (8T)
368	60	60 CYCLE A.C. SYNC.	135036	44	80166 (9T)
368	60	D.C. SHUNT & A.C. SERIES	135068	40	77034 (7T)
368	60	50 CYCLE A.C. SYNC.	135067	53	91131 (13T)
390	65	60 CYCLE A.C. SYNC.	136583	60	136582 (13T)
396	66	60 CYCLE A.C. SYNC.	135065	50	116767 (11T)
396	66	D.C. SHUNT & A.C. SERIES	135066	53	123711 (10T)
428	71.3	60 CYCLE A.C. SYNC.	136580	42	136579 (10T)
428	71.3	D.C. SHUNT & A.C. SERIES	*136585	49	121086 (10T)
460	75	60 CYCLE A.C. SYNC.	136525	47	91285 (12T)
460	75	D.C. SHUNT & A.C. SERIES	135064	32	91283 (7T)
(B) 600	100	60 CYCLE A.C. SYNC.	135035	36	110883 (12T)
(B) 600	100	D.C. SHUNT & A.C. SERIES	135061	35	77025 (10T)

(B) SEE PAGE 1 FOR EXPLANATION

NOTE:  
THE MOTOR PINION DOES NOT CHANGE WHEN CONVERTING TO THE ALL STEEL INTERNAL EXPANSION CLUTCH EXCEPT AT 100 W.P.M. OPERATION, OR WHEN A SPEED CHANGE IS INVOLVED.

19. MOTOR POSITION ADJUSTMENT

There should be a minimum amount of backlash between the motor pinion and the main shaft gear throughout a complete revolution of the main shaft. Some backlash must be felt throughout a complete revolution, when the fiber gear is rocked by hand against the inertia of the motor armature. To adjust, loosen the motor mounting screws and position the motor. Tighten the screws.

20. TAPE SPACE ADJUSTMENT (Figure 18)

The tape space adjustment can be made two ways. One for regular tape only, where the paper (chad) has been removed from the holes. The other for chadless tape, where no chad is made when the tape is perforated, and the chad remains in the tape. When the adjustment is made for chadless tape, both types of tape can be used. Because the ASR (Automatic Send Receive), when installed, will perforate chadless tape, we will make our adjustment for that type.

On transmitters designed to use chadless tape, the clearance between the tape guide and the retaining lid plate should be .011" to .014" throughout the area of the retaining lid plate when the retaining lid is latched closed. To check, a .010" round gauge should not drag anywhere, throughout the area of the retaining lid plate and a .015" round gauge should not go through at any point.

The adjustment for using regular tape only is .006" to .008".

To adjust, increase or decrease the number of shims installed between the retaining lid and the retaining lid plate.

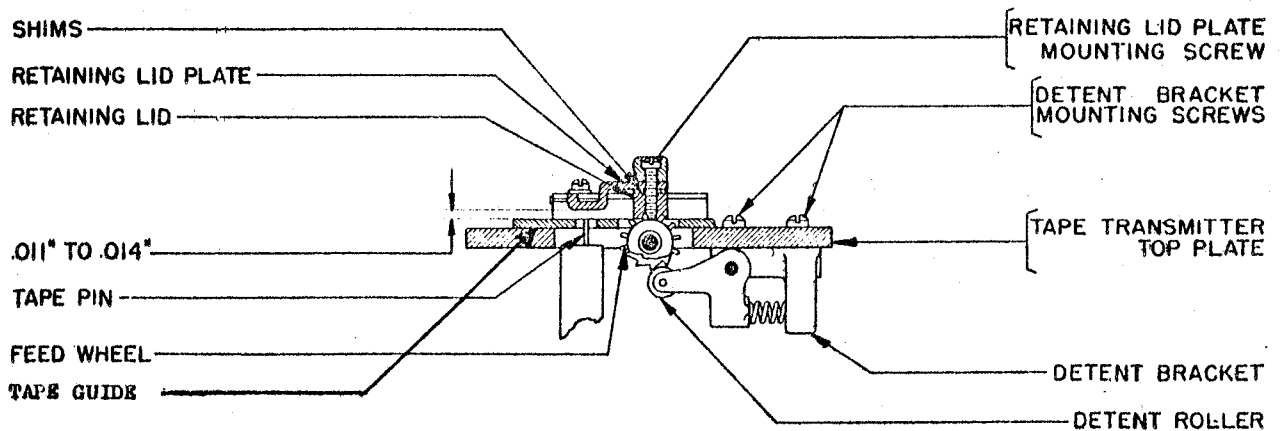


Figure 18

21. TAPE GUIDE ADJUSTMENT (Figure 17)

When a piece of perforated tape is engaged with the pins of the feed wheel, there should be equal clearance between the edges of the tape and the tape guide. Also, it should be possible to move the tape to the front and rear of the tape guide and the pins of the feed wheel should move from one side of the tape feed holes to the other. To adjust, loosen the tape guide mounting screws and position the guide. Tighten the screws.

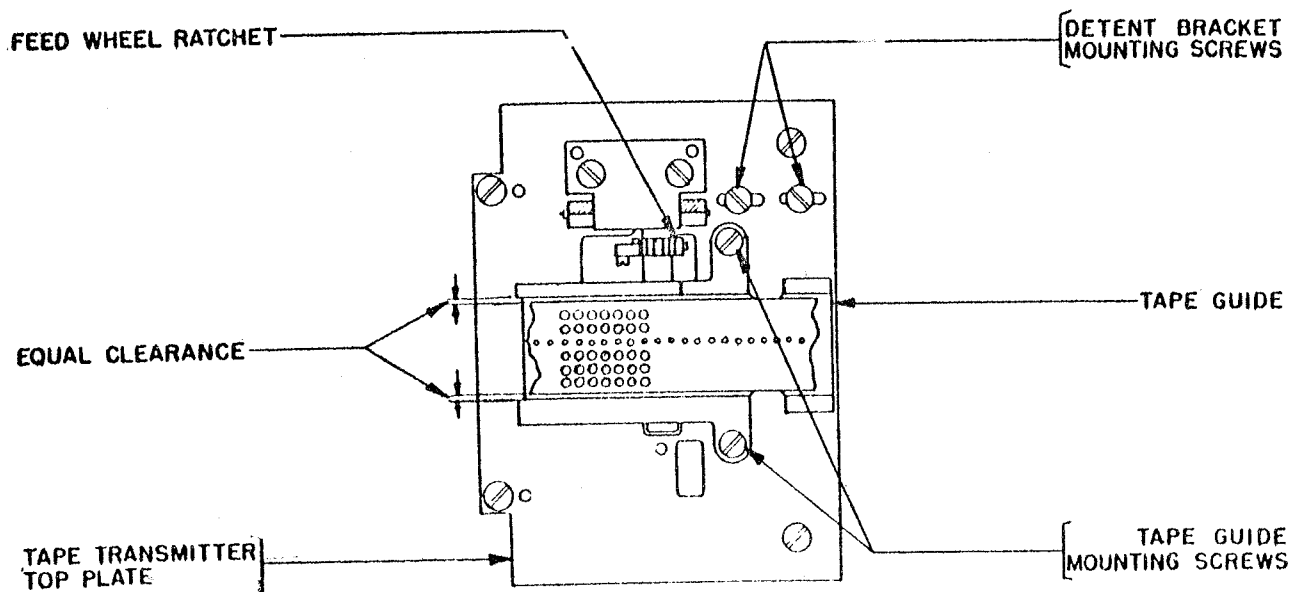
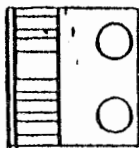


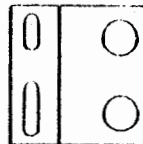
Figure 17

22. TAPE RETAINING LID PLATE ADJUSTMENT (Figure 19)

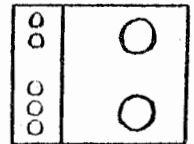
The three types of plates in use on transmitter tape retaining lids are shown in Figure 19. Either regular or chadless perforated tape may be used with the types shown at A or B, but only regular perforated tape can be used with the type shown at C. Type A, B or C should be adjusted so that the edges of the plate are parallel to the guide and so that the openings in the plate are centrally located with respect to the tape pins when the pins are in their uppermost position. To adjust, loosen the retaining lid plate mounting screws and position the plate. Tighten the screws. If chadless tape is being used position the plate so that the plate does not interfere with the lids of chadless tape when the lids are raised by the tape pins. In checking this, take up play of the tape on the feed wheel pins toward the right with the feed wheel detent resting in an indent between two teeth on the ratchet.



(A)



(B)



(C)

Figure 19

23. RETAINING LID LATCH SPRING TENSION

With the slope on the latch resting against the top plate (not latched), hook an 8 oz. scale over the upper end of the latch and pull at right angles to the formed upper end of the latch. It should require 1-1/2 to 7 ozs. to start the latch moving on its pivot. To do this, let the tape retaining lid down slowly by its own weight. Hold the lid in this position by its left front corner. Hook the scale over the top of the latch and pull backward and up at about a 45 degree angle.

24. STOP LEVER AND LATCH LEVER SPRING TENSION  
(Page E4-6)

With the main shaft rotated until the two lugs on the clutch are towards the rear and the 135044 latch lever held towards the front until its 151688 screw is clear of the stop lever, hook an 8 oz. scale over the extreme right end of the 135043 stop lever and pull towards the front. It should require 1-1/2 to 2-1/4 oz. to start the stop lever moving. With the two lugs on the clutch towards the rear and an 8 oz. scale hooked over the extreme right end of the 135044 latch lever and pulling towards the front, it should require 2 to 3 ozs. to start the latch lever moving. To adjust, loosen the 104702 screw in the 135040 spring bracket, friction tight, position the bracket and tighten the screw.

25. CLUTCH SHOE LEVER

With the clutch engaged, measure the gap between the clutch shoe lever and the clutch disk stop extension. With the clutch disengaged, measure the gap again. The difference between the two measurements should be .055" to .075". To adjust, loosen the two clamp screws on the underside of the disk and rotate the adjusting plate by engaging a wrench on the adjusting plate extension. Tighten the clamp screws. After the above adjustment, disengage the clutch and rotate the drum. There should be no drag on the drum. If the above adjustment is changed, it may affect the Carbon Brush and Operating Cam adjustments.



26. CLUTCH SHOE LEVER SPRING TENSION

With the clutch engaged and the disk held to prevent it from turning, apply the pull end of a 32 oz. scale tangent to the clutch. It should require 16 to 20 oz. to move the clutch shoe lever in contact with the stop lug. If out of tolerance, replace the 150241 spring or 151728 spring, page E4-6.

27. TAPE FEED PAWL SPRING TENSION ADJUSTMENT  
(Figure 15)

Rotate the motor shaft until the feed pawl is in its uppermost position. Apply the push end of an 8 oz. scale to the feeding tip of the tape feed pawl and push horizontally toward the left. It should require 1 to 2 ozs. to hold the pawl in a vertical position. Add 1/2 oz. to the observed reading, when the 8 oz. scale is held in the horizontal position. To adjust, loosen the feed pawl mounting screw and position the spring. Tighten the mounting screw.

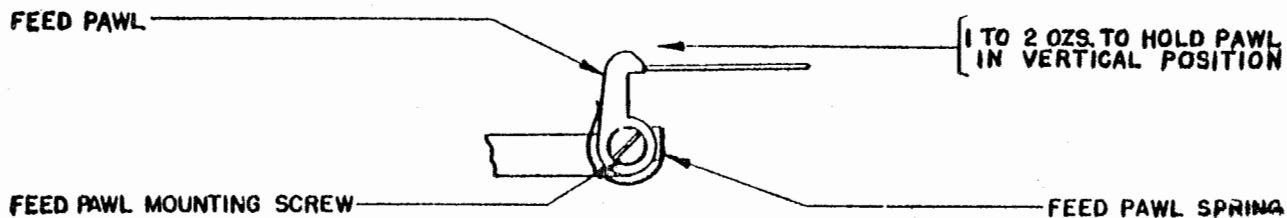


Figure 15

28. DETENT LEVER SPRING TENSION (Figure 16)

Hold the transmitter top plate upside down and in a horizontal plane. Make sure that the detent roller is resting in the hollow between two teeth on the feed wheel ratchet. Hook a 32 oz. scale over the end of the detent lever and pull horizontally against the tension of the spring. It should require 15 to 18 ozs. to start the detent lever moving when the detent lever is provided with a rounded surface opposite the round boss for the spring, as shown in Figure 16. When a new style detent lever having a protruding rib to facilitate hooking of the scale is provided, the spring tension should measure 12 to 15 ozs. If out of tolerance, replace the spring.

29. FEED WHEEL SHAFT ADJUSTMENT (Figure 16)

The feed wheel shaft should be free in its bearings and should have some end play, not over .002". To adjust, loosen the feed shaft bearing mounting screws and position the bearings. As a further check, hold the detent roller away from the feed wheel ratchet and rotate the ratchet. No bind should be felt as the ratchet is rotated. Tighten the screws.

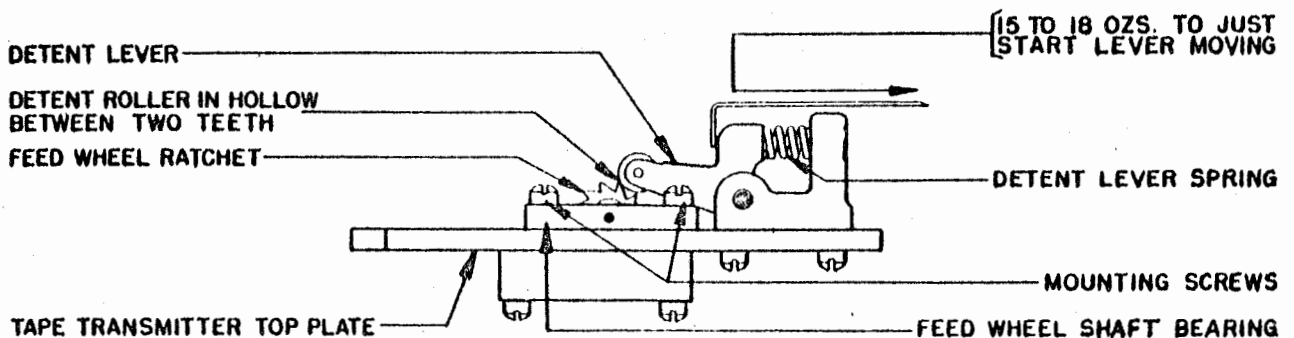


Figure 16

30. TAPE RETAINING LID LATCH WEARING STRIP SHIMS  
ADJUSTMENT

When the retaining lid is snapped down normally, the latch should mate with the wearing strip over at least half, but not all of the horizontal surface of the latch. To adjust, increase or decrease the number of shims installed between the wearing strip and the top plate.

PROCEDURE V (Performance Check)

- A. Replace remaining parts.
  - 1. Replace transmitter cover (left top)
  - 2. Replace transmitter snap panel
  - 3. Replace top cover
  
- B. Clean collector rings on distributor assembly, first with ammonia, and then, if necessary, with crocus cloth.
  
- C. Performance Check.
  - 1. Do the same now as was accomplished at the beginning of the experiment under "PROCEDURE I (Familiarization), A. Operational Check", except enter the results at the bottom of the Performance Sheet.
  
  - 2. An equal or better "Local Range" indicates your experiment was a success.



FAA AERONAUTICAL CENTER  
AIR NAVIGATION FACILITIES BRANCH  
COMMUNICATION EQUIPMENT UNIT

RELATED ADJUSTMENTS MODEL 28 PRINTER

TYPING UNIT - Numerals in parentheses indicate page where adjustment is located in Teletype Bulletin 226B.

Automatic Carriage Return Arm Adj. (2-60)

None

Carriage Return Latch Bail Adj. (2-38)

None

Carriage Return Lever Adj. (2-39)

None

Carriage Return Spring Adj. (2-37)

Dashpot vent screws adj. (2-40)

Carriage Wire Rope Adj. (2-36)

Oscillating rail slide position adj. (2-30)

Printing carriage position adj. (2-43)

Left hand margin adj. (2-41)

Right margin adj. (2-42)

Automatic carriage return arm adj. (2-60)

Margin indicating lamp adj. (2-64)

Clutch Drum Position Adj. (2-23)

None

Clutch Shoe Lever Adj. (2-22)

None

Clutch Trip Shaft Set Collars Adj. (2-19)

None

Code Bar Detent Adj. (2-63)

None

Code Bar Clutch Trip Lever Adj. (2-17)

None

Code Bar Shift Lever Drive Arm Adj. (2-15)

Code bar shift lever link guide adj. (2-16)

Code Bar Shift Lever Link Guide Adj. (2-16)

None

Dashpot Vent Screws Adj. (2-40)

None

Figures and Letters Code Bar Shift Mechanism Adj. (2-54)

None

Function Clutch Trip Lever Adj. (2-18)

None

Function Reset Bail Blade Adj. (2-34)

Carriage return lever adj. (2-39)

Horizontal Positioning Drive Linkage Adj. (2-33)

- Rocker shaft bracket eccentric stud adj. (2-27)
- Right vertical positioning lever eccentric stud adj. (2-28)
- Left vertical positioning lever eccentric stud adj. (2-29)
- Spacing trip lever bail cam plate adj. (2-31)
- Reversing slide brackets adj. (2-32)
- Vertical positioning lock lever adj. (2-35)
- Printing track adj. (2-45)
- Printing arm adj. (2-46)
- Ribbon feed lever bracket adj. (2-48)
- Stripper blade cam position adj. (2-55)

Intermediate Arm Backstop Bracket Adj. (2-14)

None



Left Hand Margin Adj. (2-41)

Right margin adj. (2-42)  
Automatic carriage return arm adj. (2-60)  
Margin indicating lamp adj. (2-64)

Left Vertical Positioning Lever Eccentric Stud Adj. (2-29)

Vertical positioning lock lever adj. (2-35)  
Ribbon feed lever bracket adj. (2-48)  
Stripper blade cam position adj. (2-55)

Line Feed Clutch Trip Lever Adjusting Screw Adj. (2-21)

Line feed clutch trip lever eccentric post adj. (2-21)

Line Feed Clutch Trip Lever Eccentric Post Adj. (2-21)

Line feed clutch trip lever adjusting screw adj. (2-21)

Line Feed Clutch Phasing Adj. (2-26)

Line feed spur gear detent eccentric adj. (2-57)

Line Feed Spur Gear Detent Eccentric Adj. (2-57)

None

Margin Indicating Lamp Adj. (2-64)

None

Oscillating Rail Slide Position Adj. (2-30)

Printing carriage position adj. (2-43)  
Shift Linkage adj. (2-44)  
Left hand margin adj. (2-41)  
Right margin adj. (2-42)  
Automatic carriage return arm adj. (2-60)  
Margin indicating lamp adj. (2-64)

Paper Finger Adj. (2-62)

None

Paper Straightener Collar Adj. (2-61)

None

Printing Arm Adj. (2-46)

None

Printing Carriage Lower Roller Adj. (2-43)

Printing track adj. (2-45)

Printing hammer stop bracket adj. (2-46)

Printing arm adj. (2-46)

Printing Carriage Position Adj. (2-43)

Shift linkage adj. (2-44)

Printing Hammer Bearing Stud Adj. (2-44)

None

Printing Hammer Operating Bail Spring Adj. (2-45)

Printing arm adj. (2-46)

Printing Hammer Stop Bracket Adj. (2-46)

Printing arm adj. (2-46)

Printing Track Adj. (2-45)

Printing arm adj. (2-46)

Reversing Slide Adjusting Stud Adj. (2-32)

Horizontal positioning drive linkage adj. (2-33)

Reversing Slide Brackets Adj. (2-32)

Horizontal positioning drive linkage adj. (2-33)

Ribbon Feed Lever Bracket Adj. (2-48)

None

Ribbon Reverse Spur Gear Adj. (2-47)

Ribbon reverse detent adj. (2-47)

Right Margin Adj. (2-42)

None

Right Vertical Positioning Lever Eccentric Stud Adj. (2-28)

Left vertical positioning lever eccentric stud adj. (2-29)  
Vertical positioning lock lever adj. (2-35)  
Ribbon feed lever bracket adj. (2-48)  
Stripper blade cam position adj. (2-55)

Rocker Shaft Bracket Eccentric Stud Adj. (2-27)

Right vertical positioning lever eccentric stud adj. (2-28)  
Left vertical positioning lever eccentric stud adj. (2-29)  
Spacing trip lever bail cam plate adj. (2-31)  
Reversing slide brackets adj. (2-32)  
Horizontal positioning drive linkage adj. (2-33)  
Vertical positioning lock lever adj. (2-35)  
Printing track adj. (2-45)  
Printing arm adj. (2-46)  
Ribbon feed lever bracket adj. (2-48)  
Stripper blade cam position adj. (2-55)

Rocker Shaft Left Bracket Adj. (2-26)

Rocker shaft bracket eccentric stud adj. (2-27)  
Right vertical positioning lever eccentric stud adj. (2-28)  
Left vertical positioning lever eccentric stud adj. (2-29)  
Spacing trip lever bail cam plate adj. (2-31)  
Reversing slide brackets adj. (2-32)  
Horizontal positioning drive linkage adj. (2-33)  
Vertical positioning lock lever adj. (2-35)  
Printing track adj. (2-45)  
Printing arm adj. (2-46)  
Ribbon feed lever bracket adj. (2-48)  
Stripper blade cam position adj. (2-55)

Selector Armature Adj. (2-6)

Selector magnet bracket adj. (2-7)  
Selector clutch stop arm adj. (2-11)

Selector Clutch Drum Adj. (2-9)

None

Selector Clutch Stop Arm Adj. (2-11)

None

Selector Magnet Bracket Adj. (2-7)

Selector clutch stop arm adj. (2-11)

Shift Linkage Adj. (2-44)

None

Spacing Clutch Trip Lever Adj. (2-20)

None

Spacing Gear Clearance Adj. (2-25)

None

Spacing Gear Phasing Adj. (2-25)

Left hand margin adj. (2-41)

Right margin adj. (2-42)

Automatic carriage return arm adj. (2-60)

Margin indicating lamp adj. (2-64)

Spacing Trip Lever Bail Cam Plate Adj. (2-31)

None

Stripper Blade Cam Position Adj. (2-55)

None

Transfer Lever Eccentric Adj. (2-13)

Intermediate arm backstop bracket adj. (2-14)

Code bar shift lever link guide adj. (2-16)

Type Box Clutch Trip Lever Adj. (2-22)

None

Type Box Clutch Trip Lever Eccentric Post Adj. (2-21)

None

Unshift on Space Function Pawl Adj. (2-53)

None

Vertical Positioning Lock Lever Adj. (2-35)

None



# MODEL 28 PRINTER

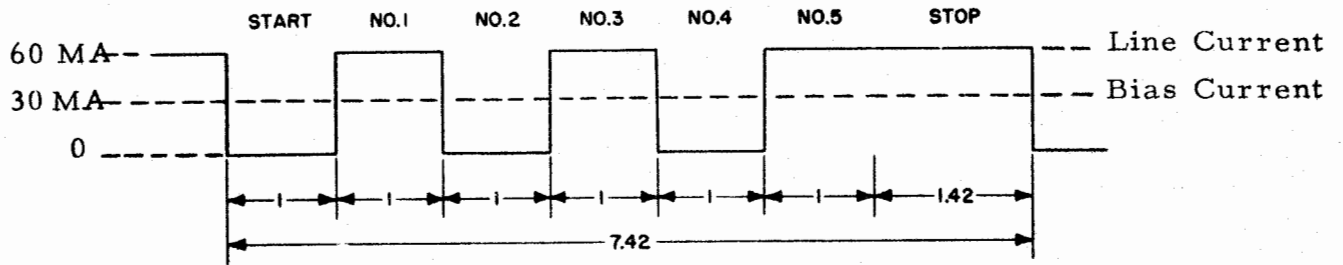


Figure I-1

FIGURES	-	?	:	\$	3	!	a	#	B	'	(	)	.	,	9	0	1	4	BELL	5	7	;	2	/	6	"	BLANK	LETTERS	FIGURES	SPACE	C.R.	L.F.	
LETTERS	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	BLANK	LETTERS	FIGURES	SPACE	C.R.	L.F.	
NUMBERS INDICATE MARKING IMPULSES	1	1		1	1	1				1	1						1	1		1	1		1	1	1	1		1	1				
	2	2					2	2	2	2					2	2	2			2	2	2	2	2			2	2					2
			3				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		3	3				
			4	4	4		4	4		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		4	4	4			
							5	5			5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		5	5				

Figure I-1a Signal Code

LETTERS				FIGURES											
M	N	H	SPACE	BLANK	T	C.R.	O	.	⊕	↓	SPACE	-	5	C.R.	9
X	F	Y	S	E	Z	D	B	/	→	6	BELL	3	+	↗	⊕
V	C	P	I	L.F.	L	R	G	⊕	⊙	∅	8	LF	↖	4	↘
LTRS	K	Q	U	A	W	J	FIGS	LTRS	←	1	7	↑	2	↙	FIGS

TYPE ARRANGEMENT "RE" (WEATHER)

SHADED POSITIONS DO NOT PRINT

Figure I-1b

MODEL 28 PRINTER

BAUDOT TAPE

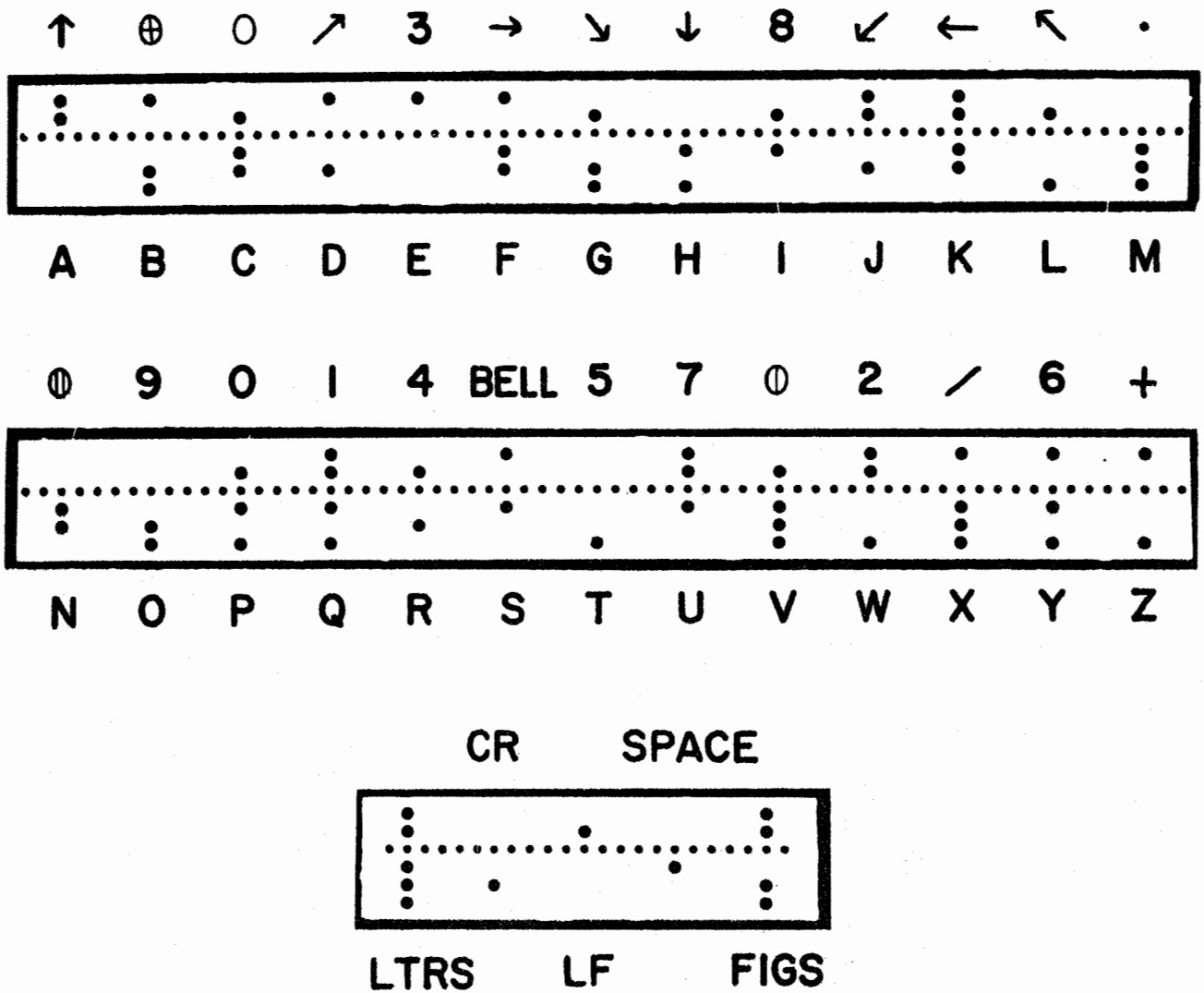


Figure I-2

MODEL 28 PRINTER

		40	60	75	100	Speed in W.P.M.
Time in Milli- seconds		33	22	18	13	Start
		33	22	18	13	#1
		33	22	18	13	#2
		33	22	18	13	#3
		33	22	18	13	#4
		33	22	18	13	#5
		47	31	25	18	Stop
		245	163	133	98	Time per Operation
		245	368	452	613	Operations per Minute

Figure I-3. Code Impulse Times at Various Speeds of Transmission



# MODEL 28 PRINTER

## TRUE POLAR OPERATION

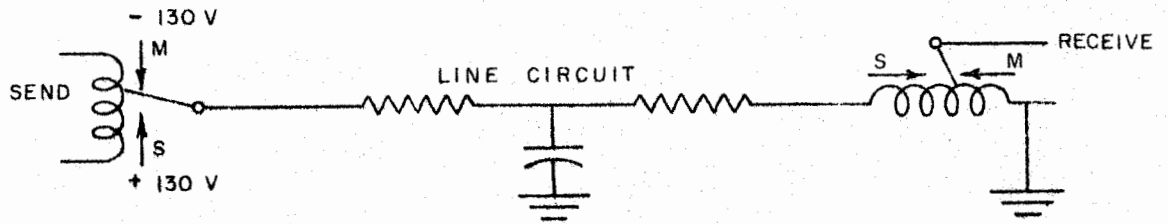


Figure I-4

## TYPICAL 120 V DC CIRCUIT

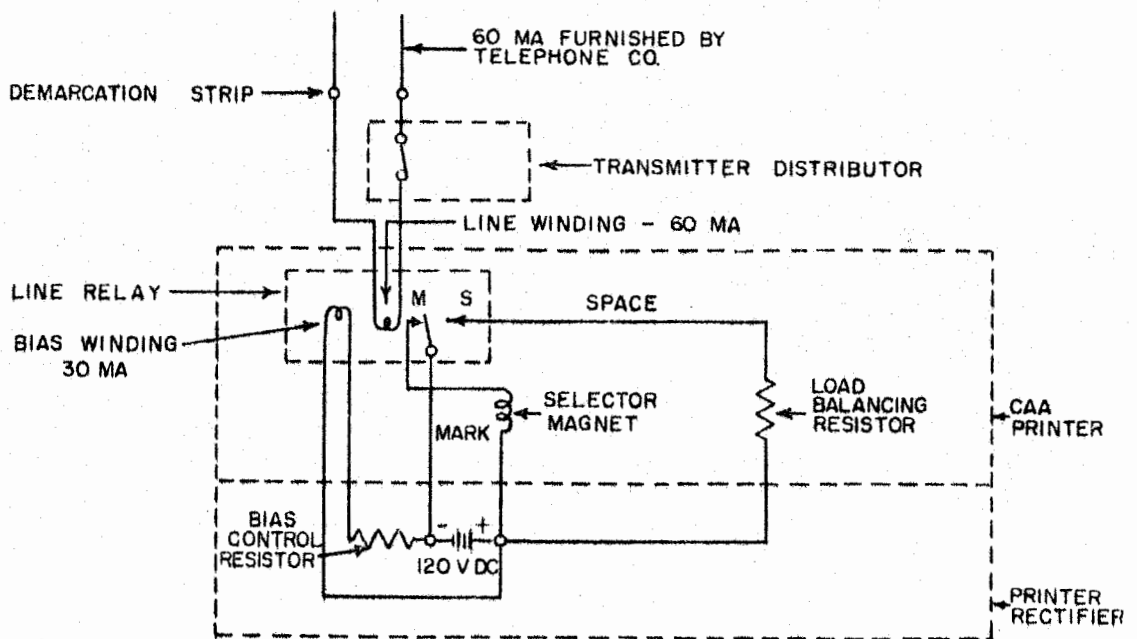


Figure I-5

# MODEL 28 PRINTER

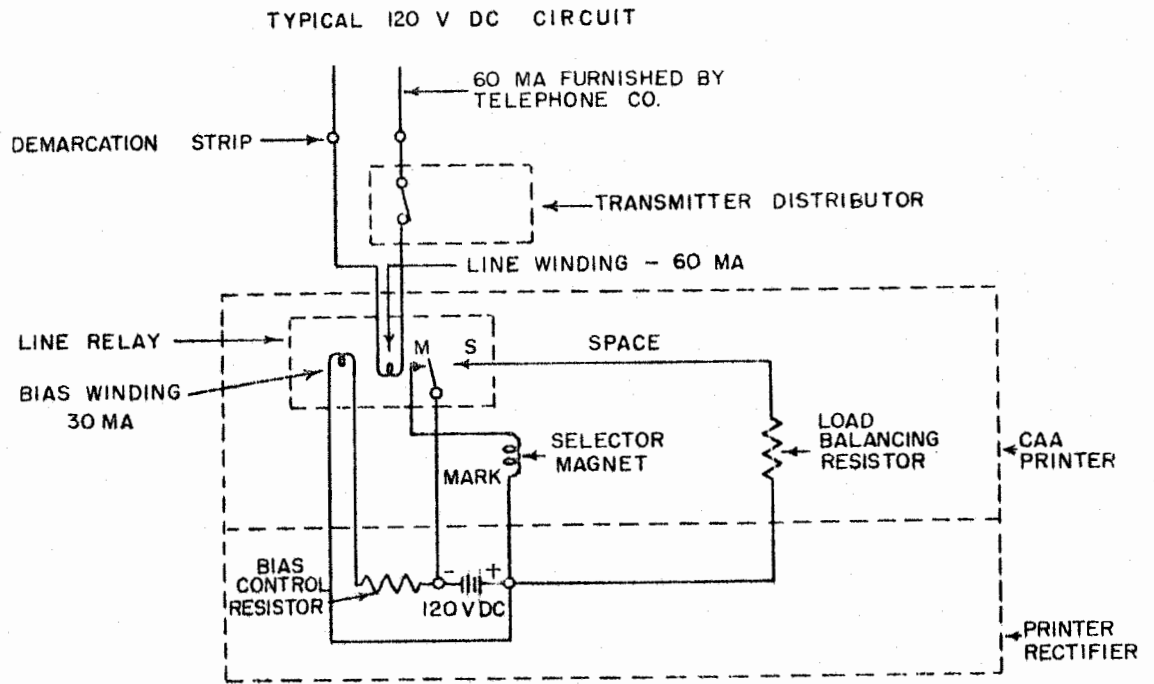


Figure 1-1

# MODEL 28 PRINTER

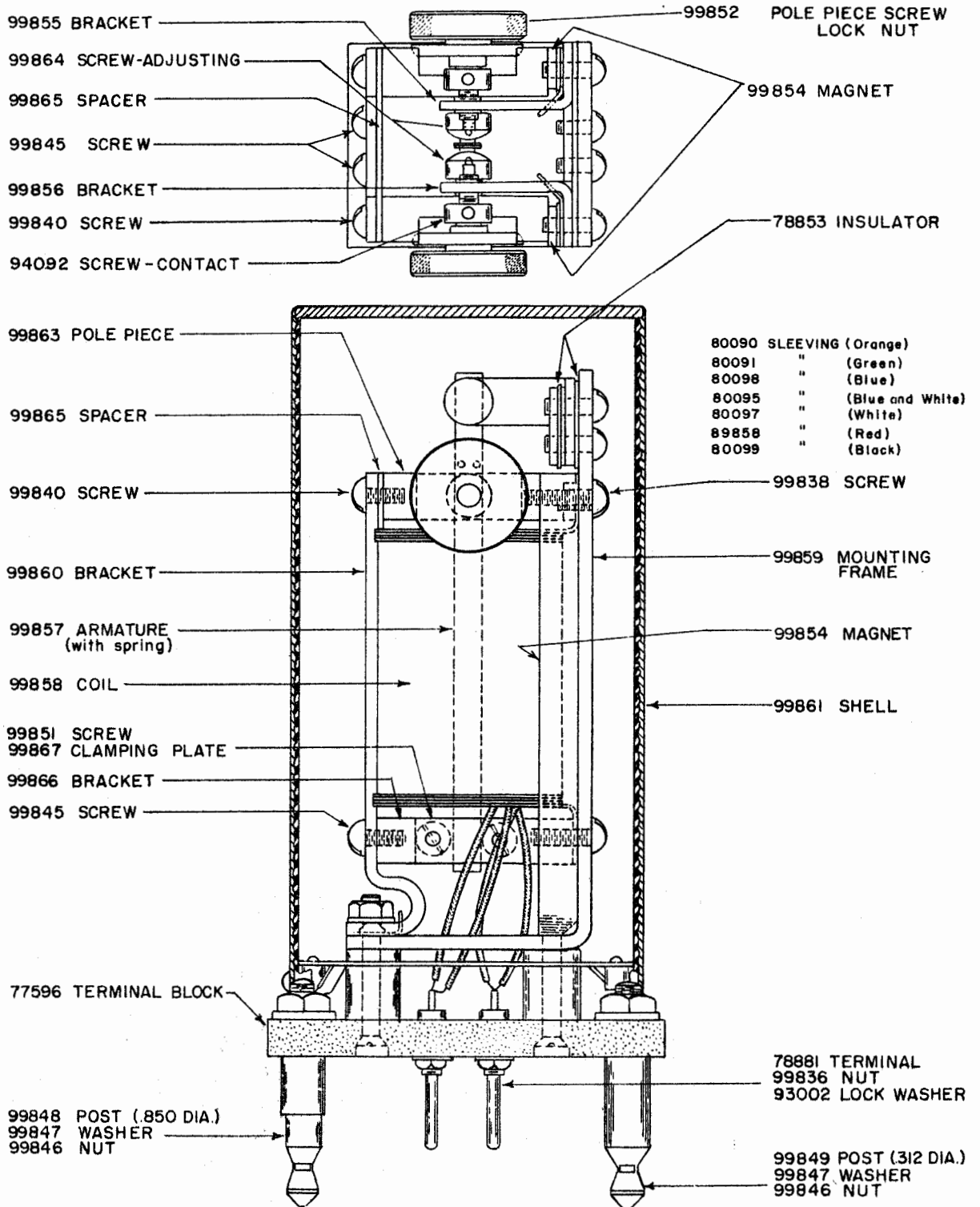


Figure 1-2 255A

MODEL 28 PRINTER

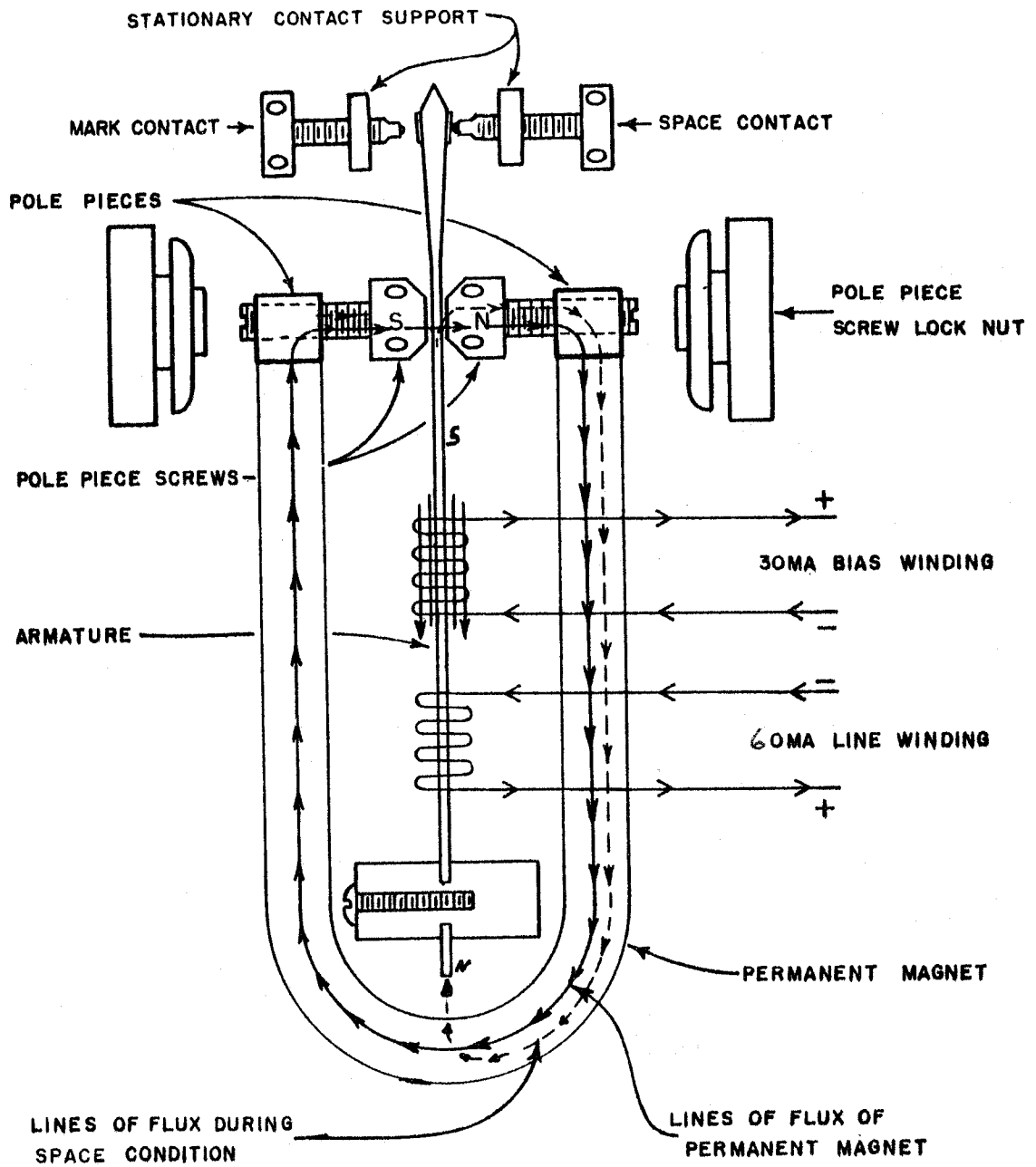


Figure 1-3

MODEL 28 PRINTER

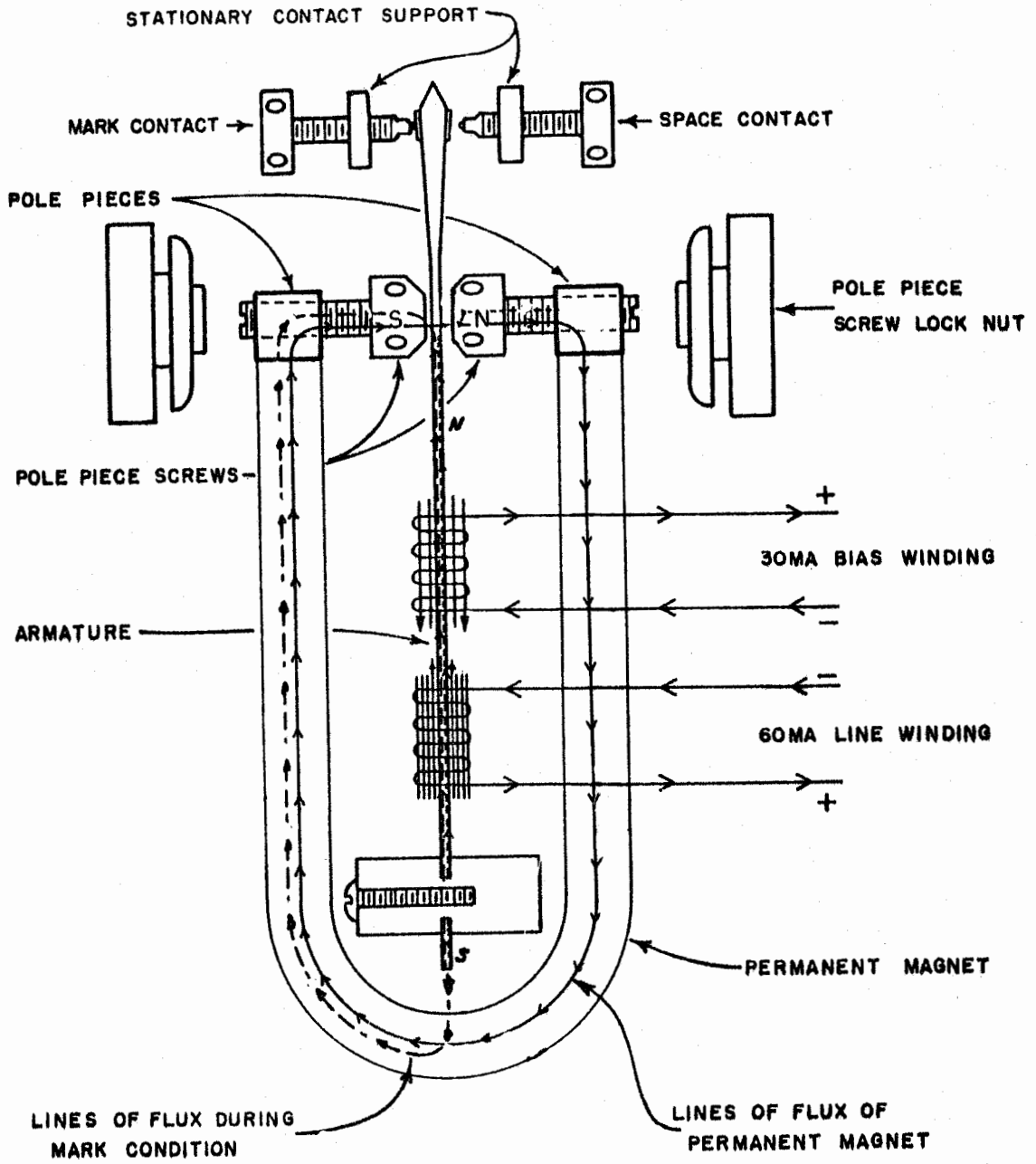


Figure 1-4

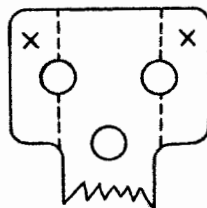


Figure 1-5

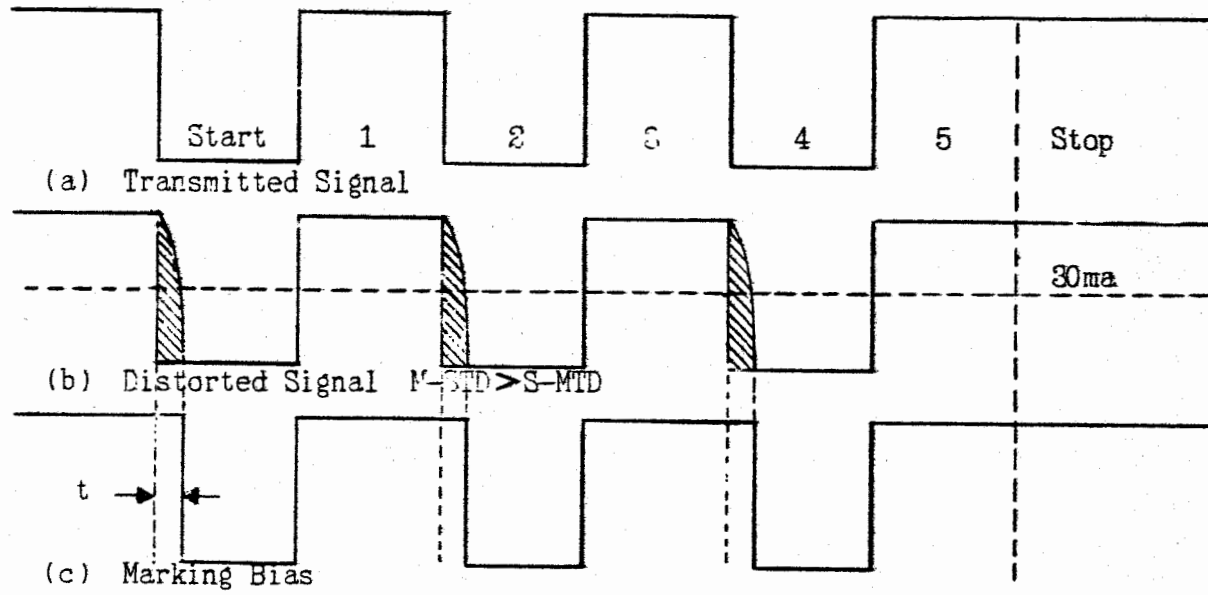
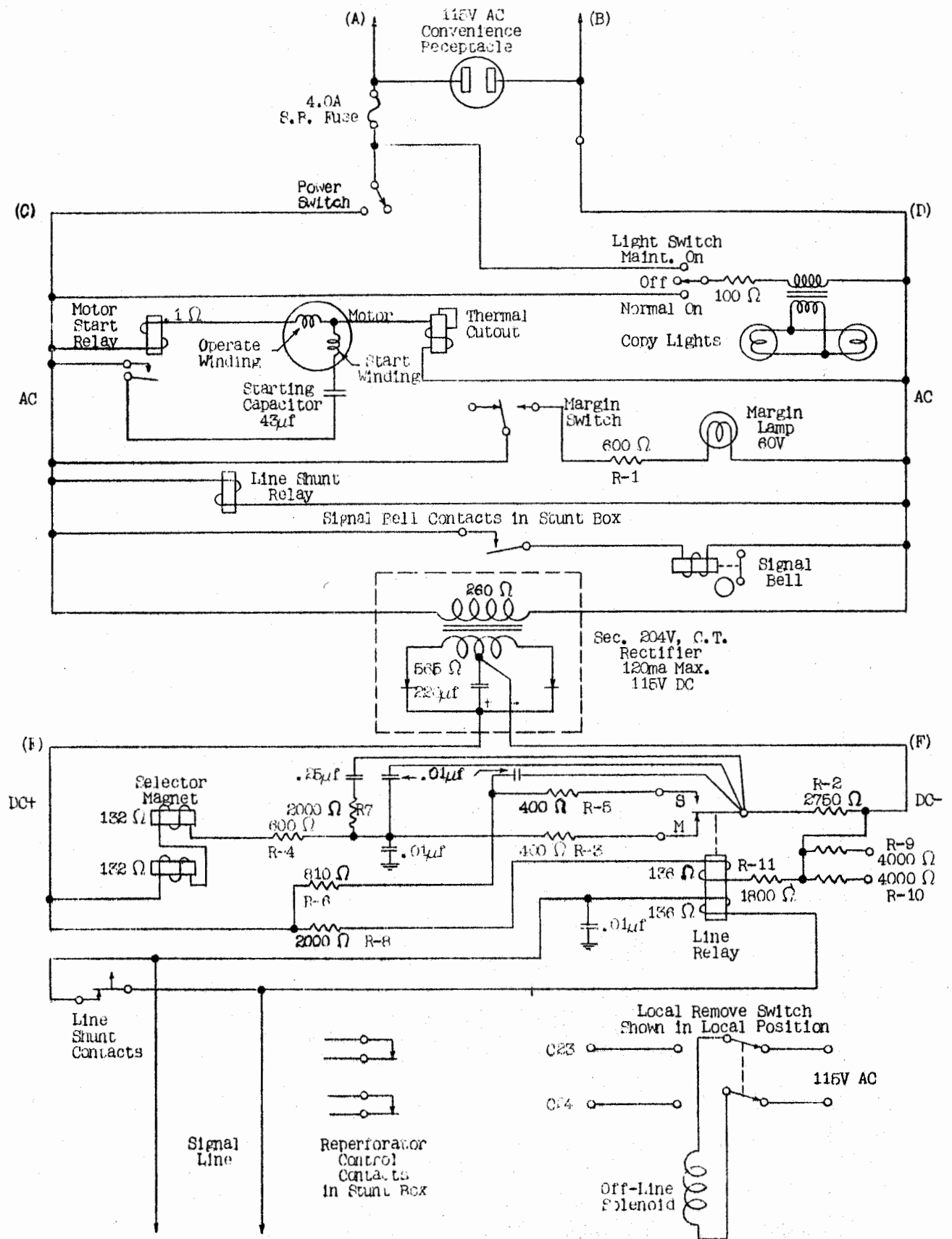


Figure 2-1

# MODEL 28 PRINTER



133/2  
Rev. 1/59

Figure 2-2 Model 28 Teletypewriter Electrical System

MODEL 28 PRINTER

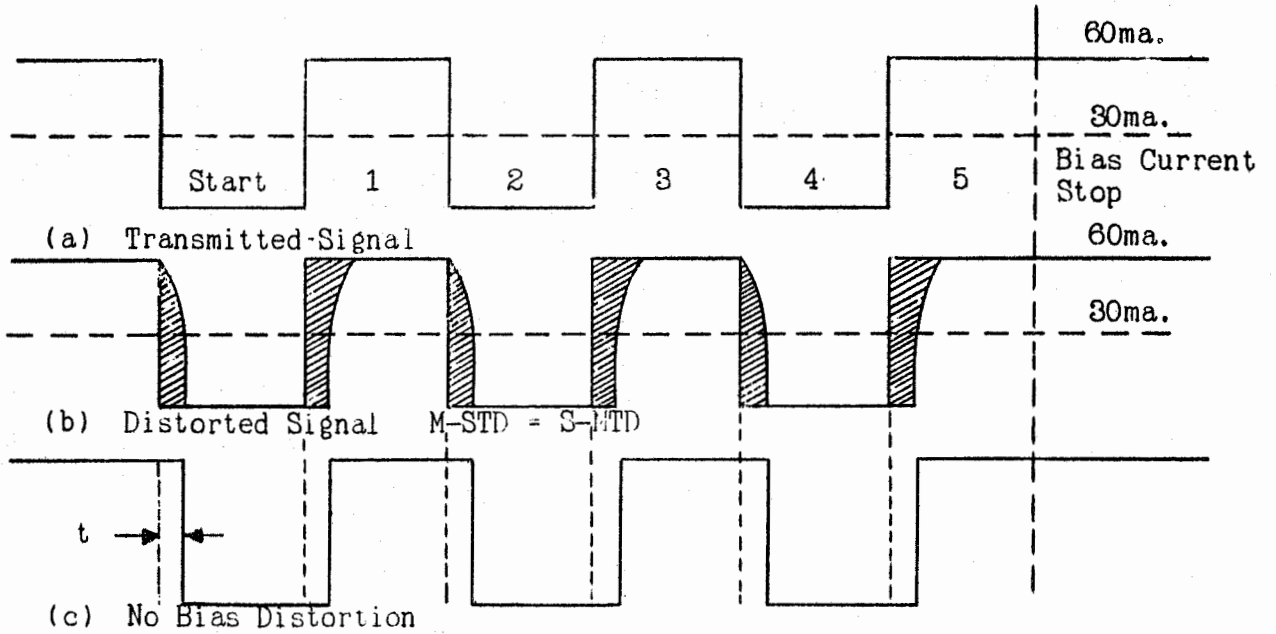


Figure 2-2

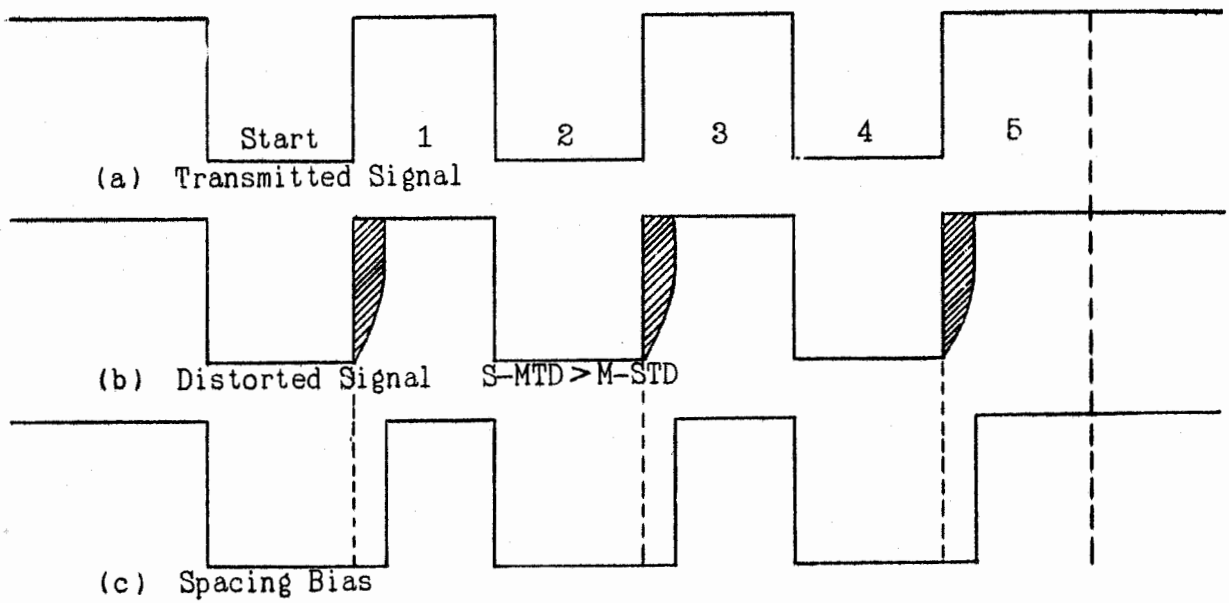


Figure 2-3



# MODEL 28 PRINTER

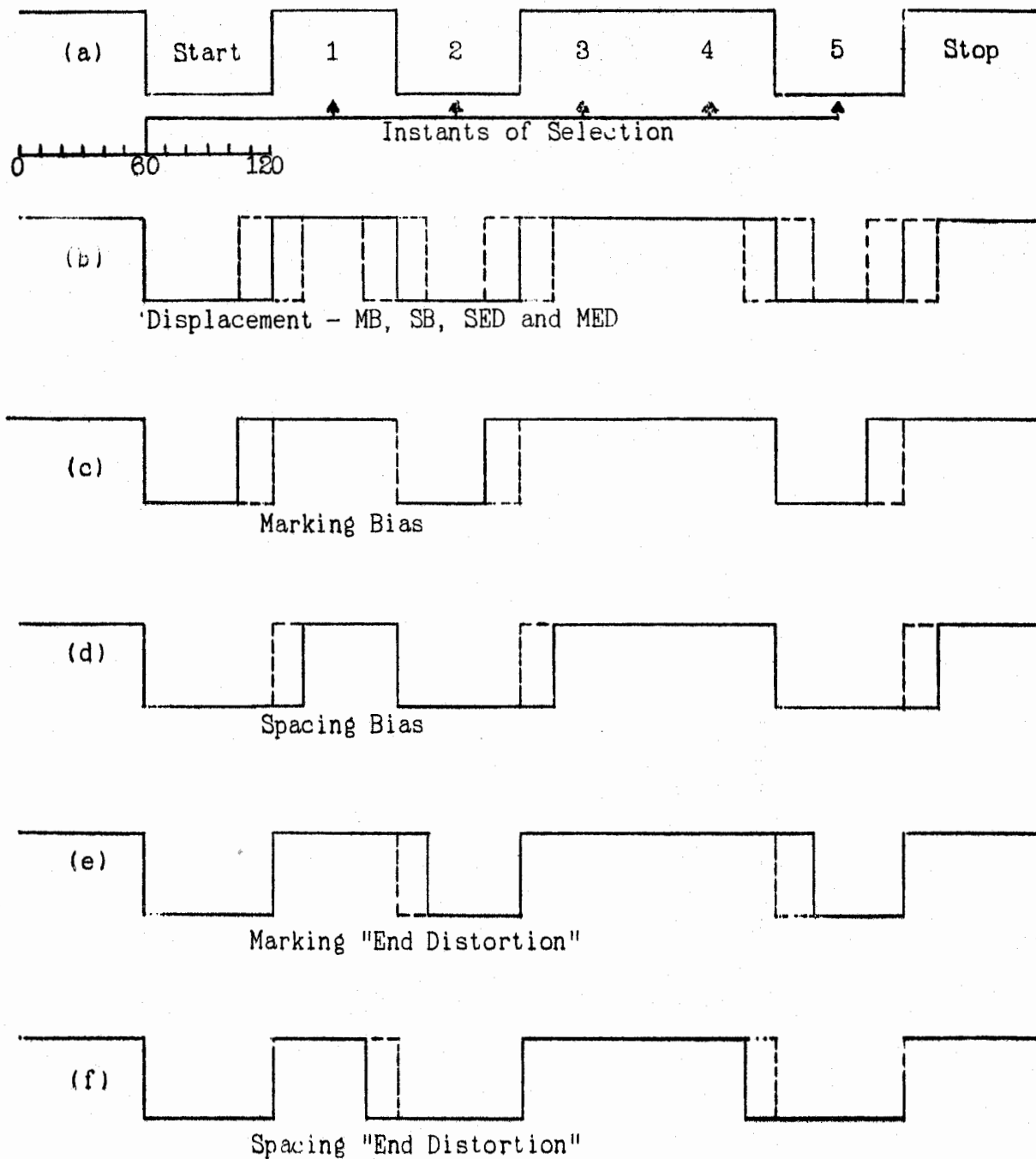


Figure 2-4 Start-Stop Displacement

MODEL 28 PRINTER

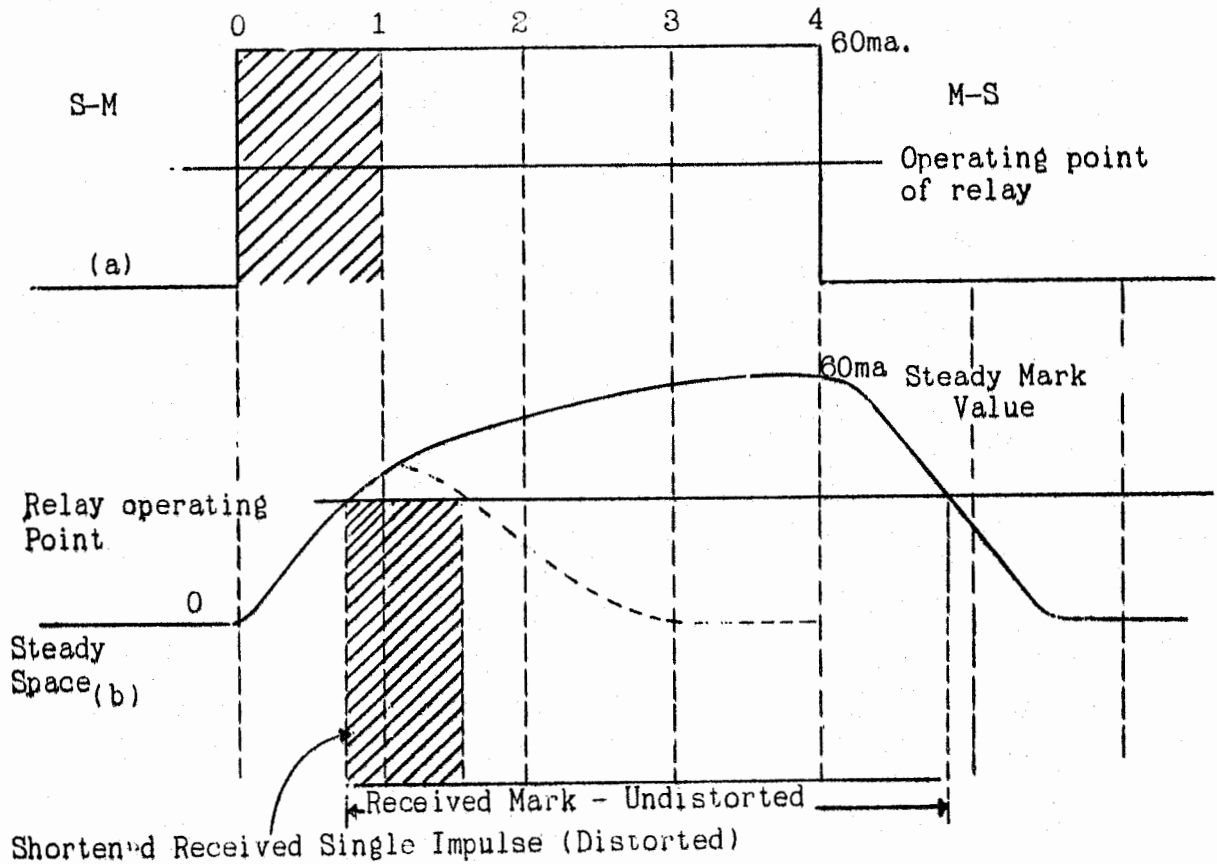


Figure 2-5 The Characteristic Distortion affected by increased teletypewriter speed.

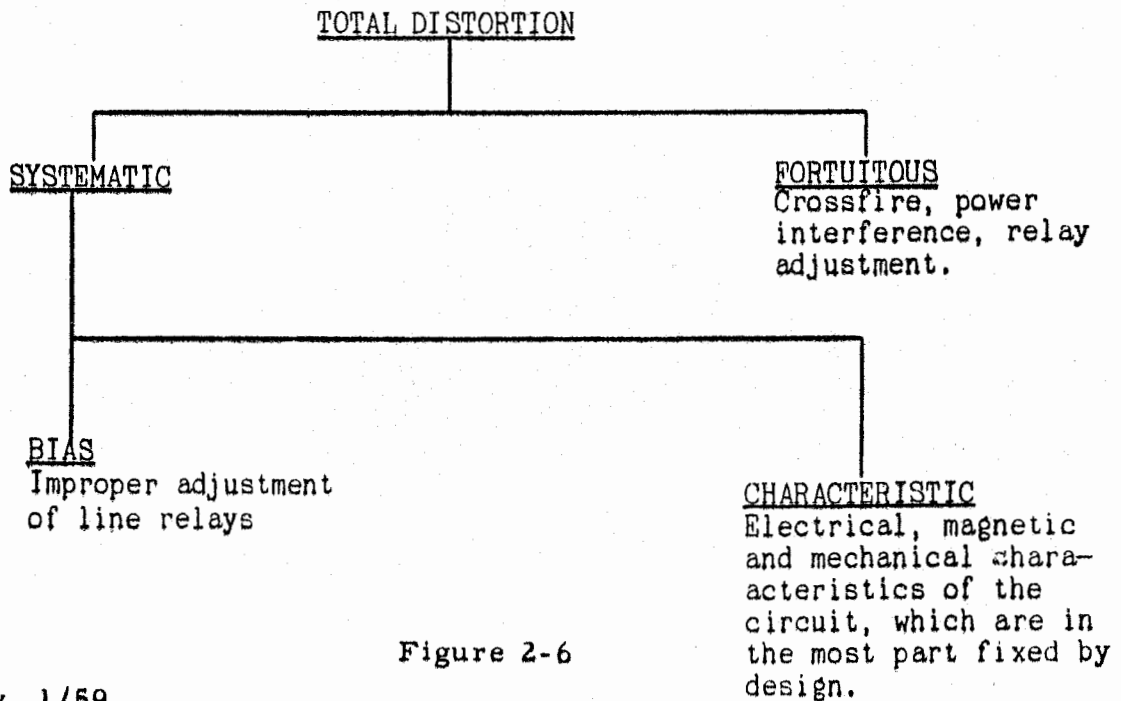


Figure 2-6

MODEL 28 PRINTER

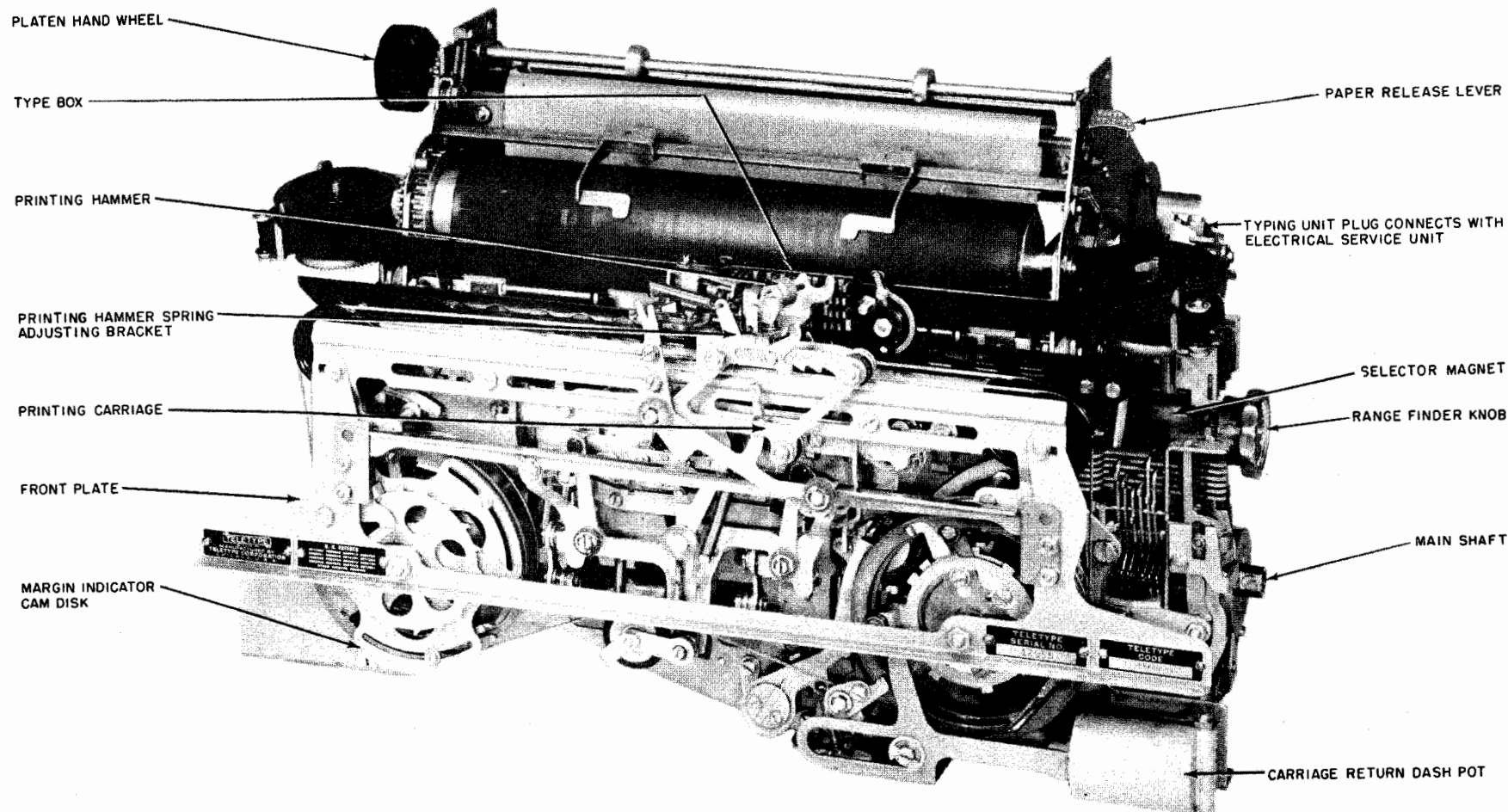


Figure 3-1 Typing Unit, Front View

MODEL 28 PRINTER

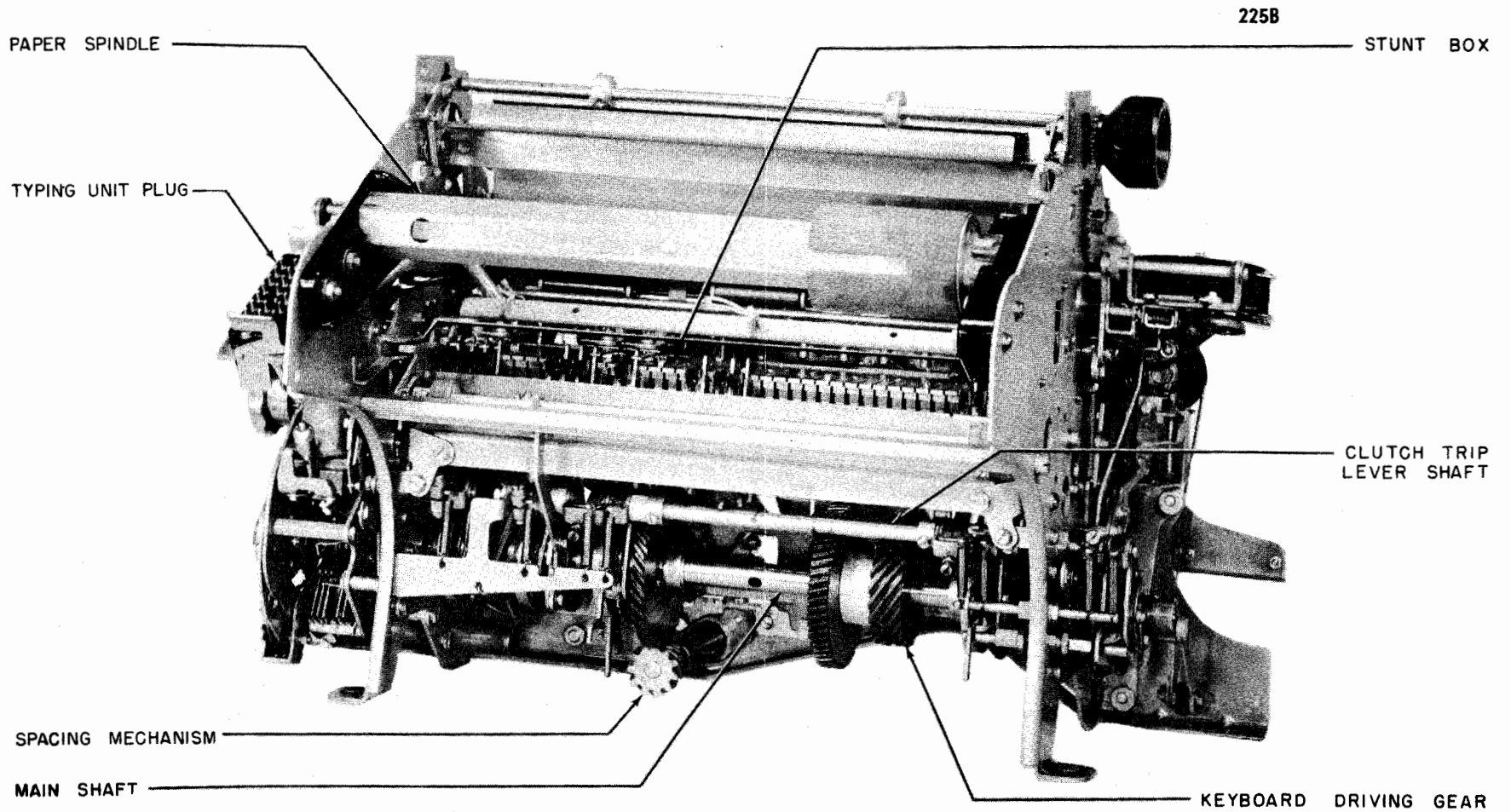


Figure 3-1a Typing Unit, Rear View

# MODEL 28 PRINTER

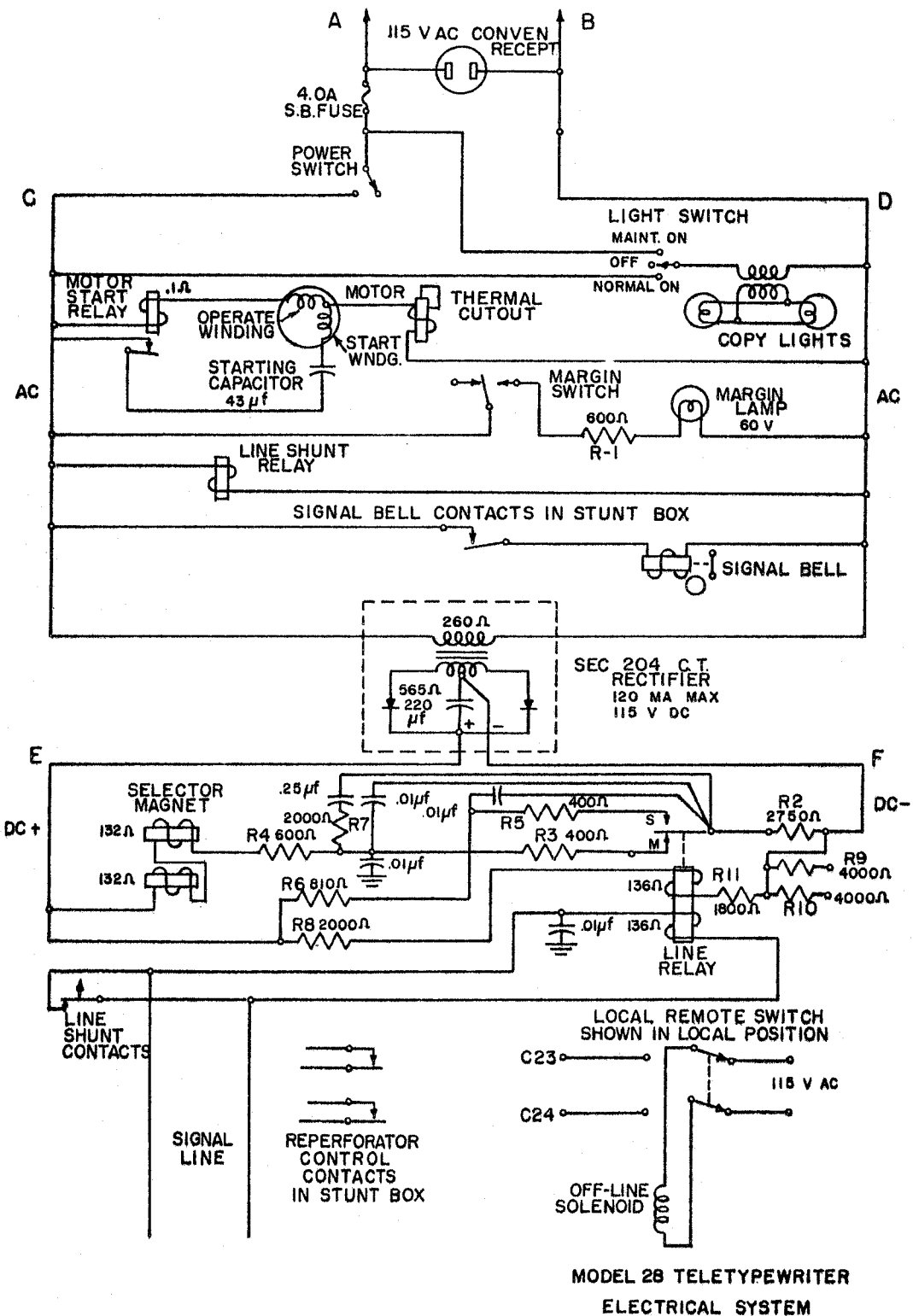


Figure 3-2 Model 28 Teletypewriter Electrical System

MODEL 28 PRINTER

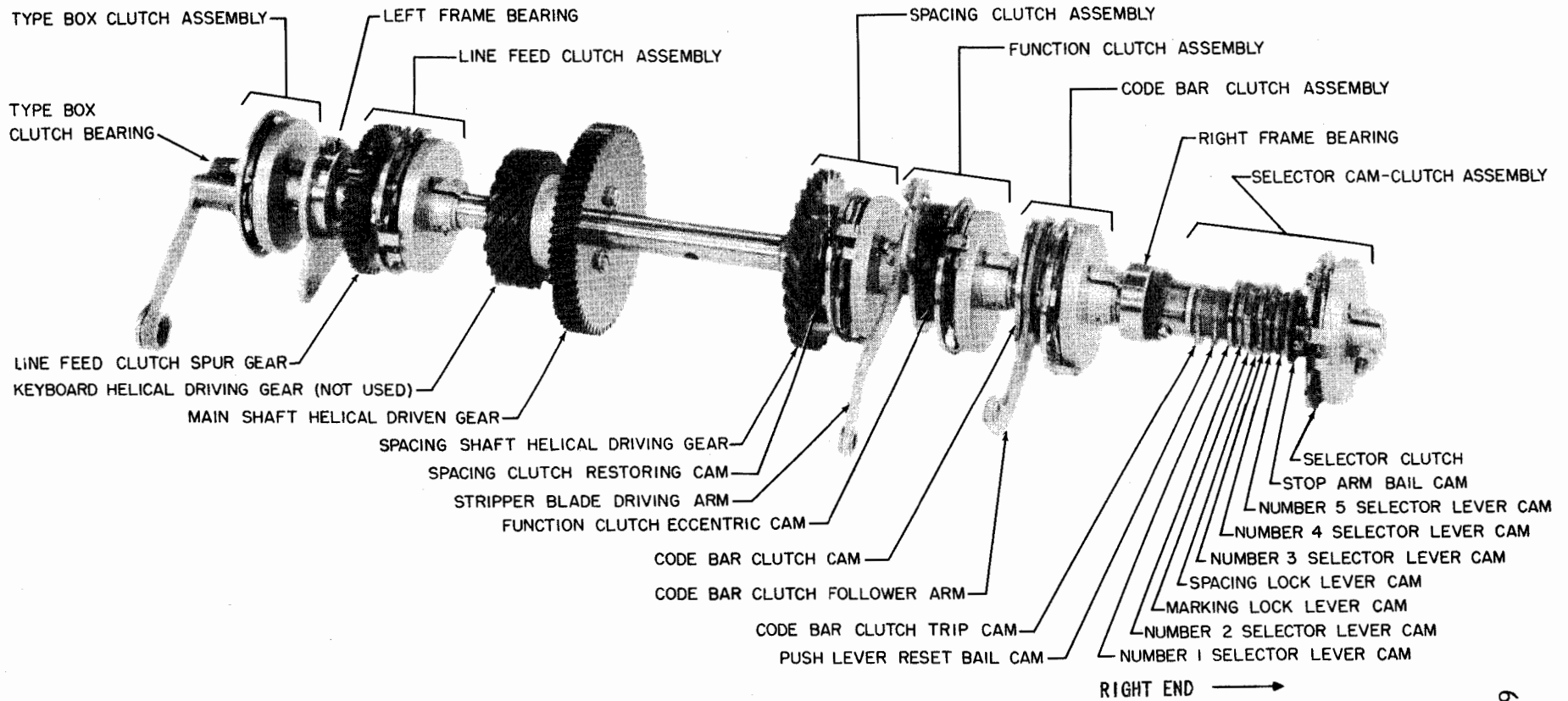


Figure 3-3 Typing Unit Main Shaft

MODEL 28 PRINTER

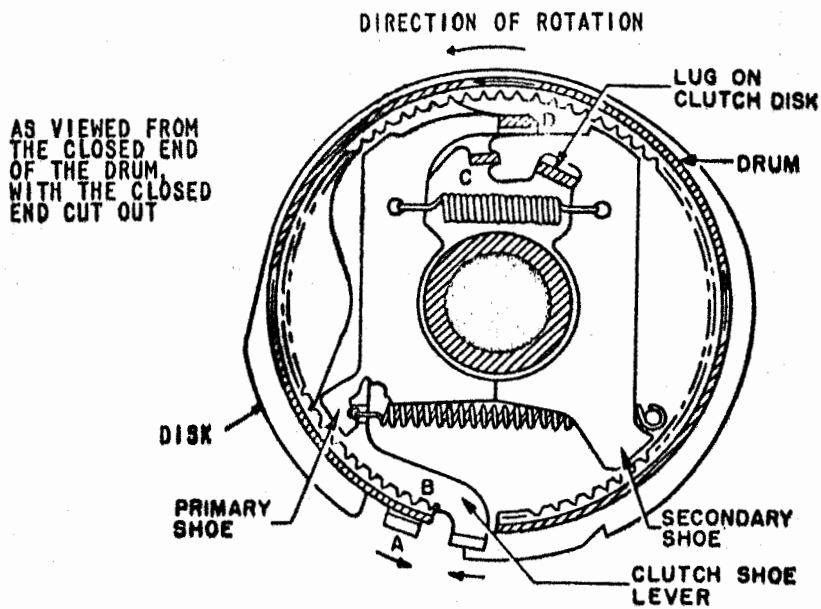


Figure 3-4 Clutch Disengaged - Right End View

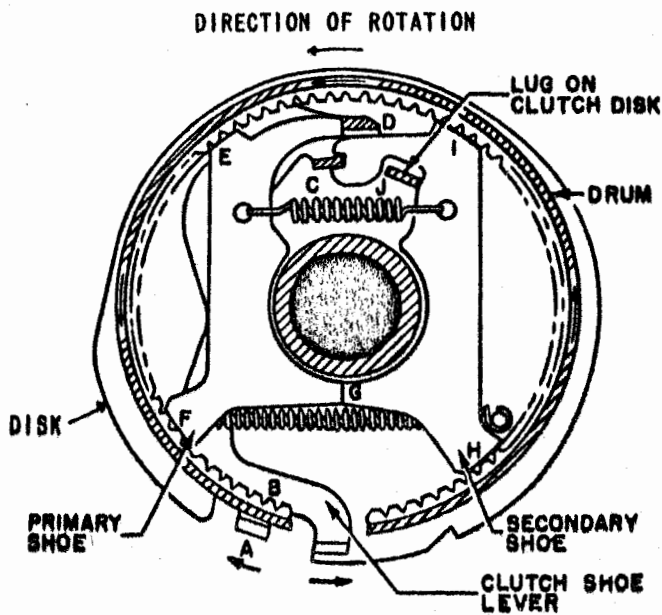


Figure 3-5 Clutch Engaged - Right End View

# MODEL 28 PRINTER

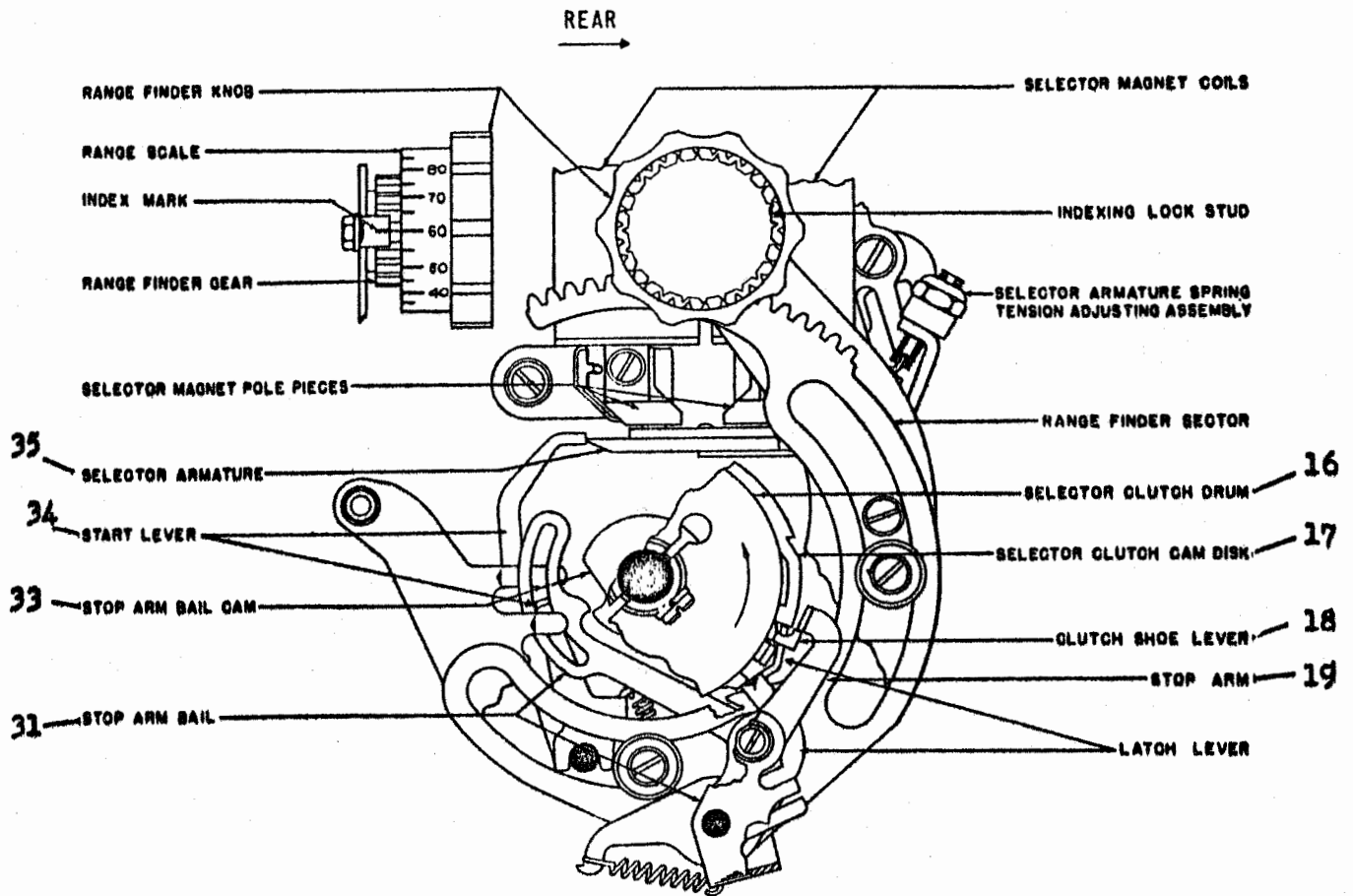


Figure 3-6 Selector Cam-Clutch Trip Mechanism - Right End View

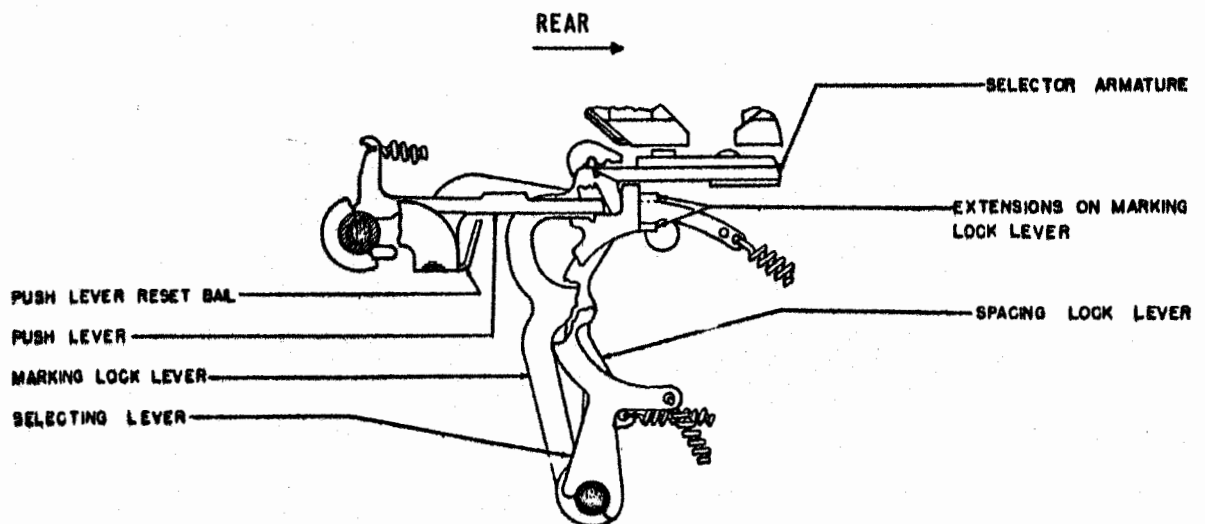


Figure 3-7 Selecting Mechanism - Right End View



MODEL 28 PRINTER

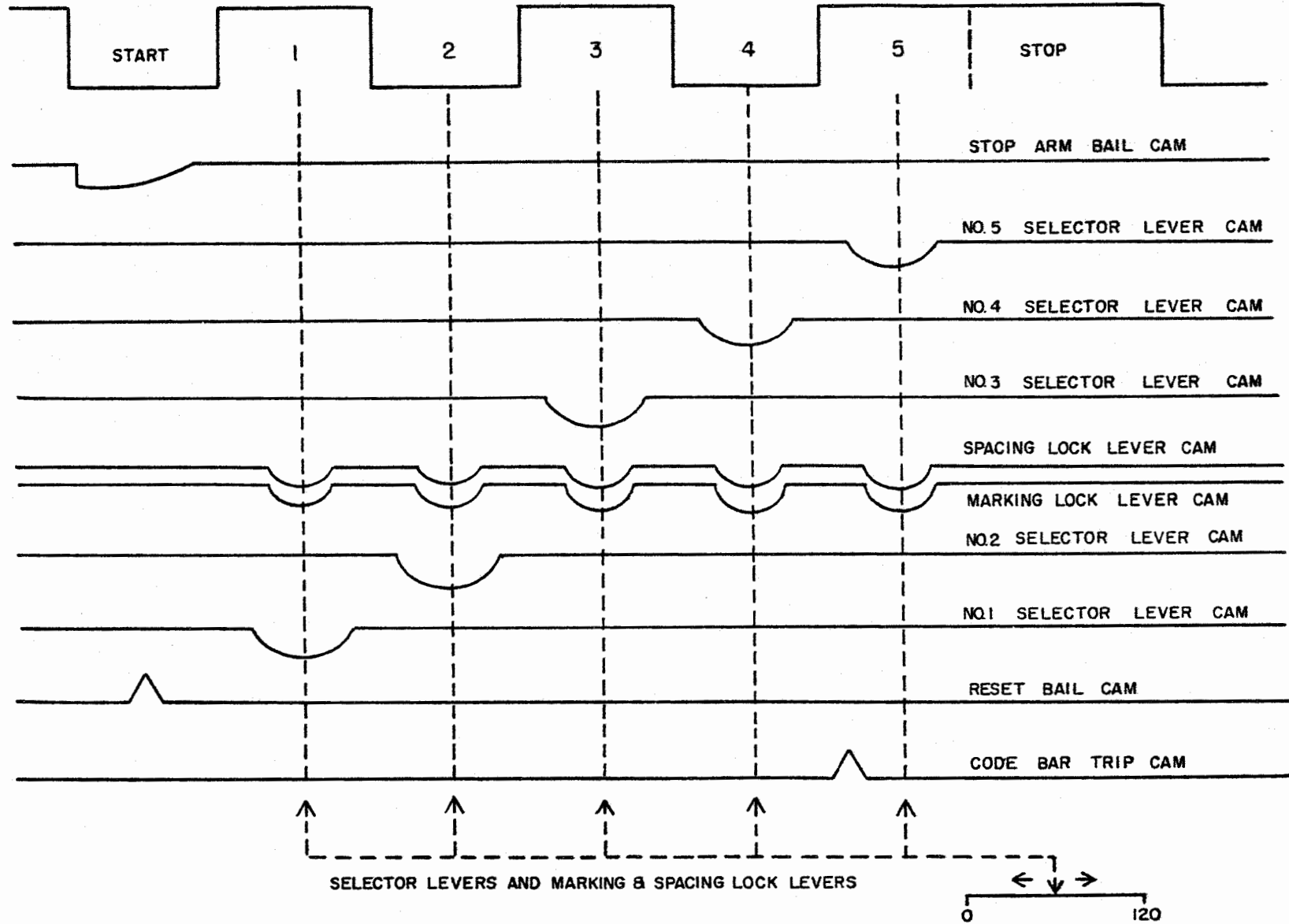


Figure 3-7A

MODEL 28 TELETYPEWRITER  
SELECTOR CAMS RELATIONSHIP CHART

MODEL 28 PRINTER

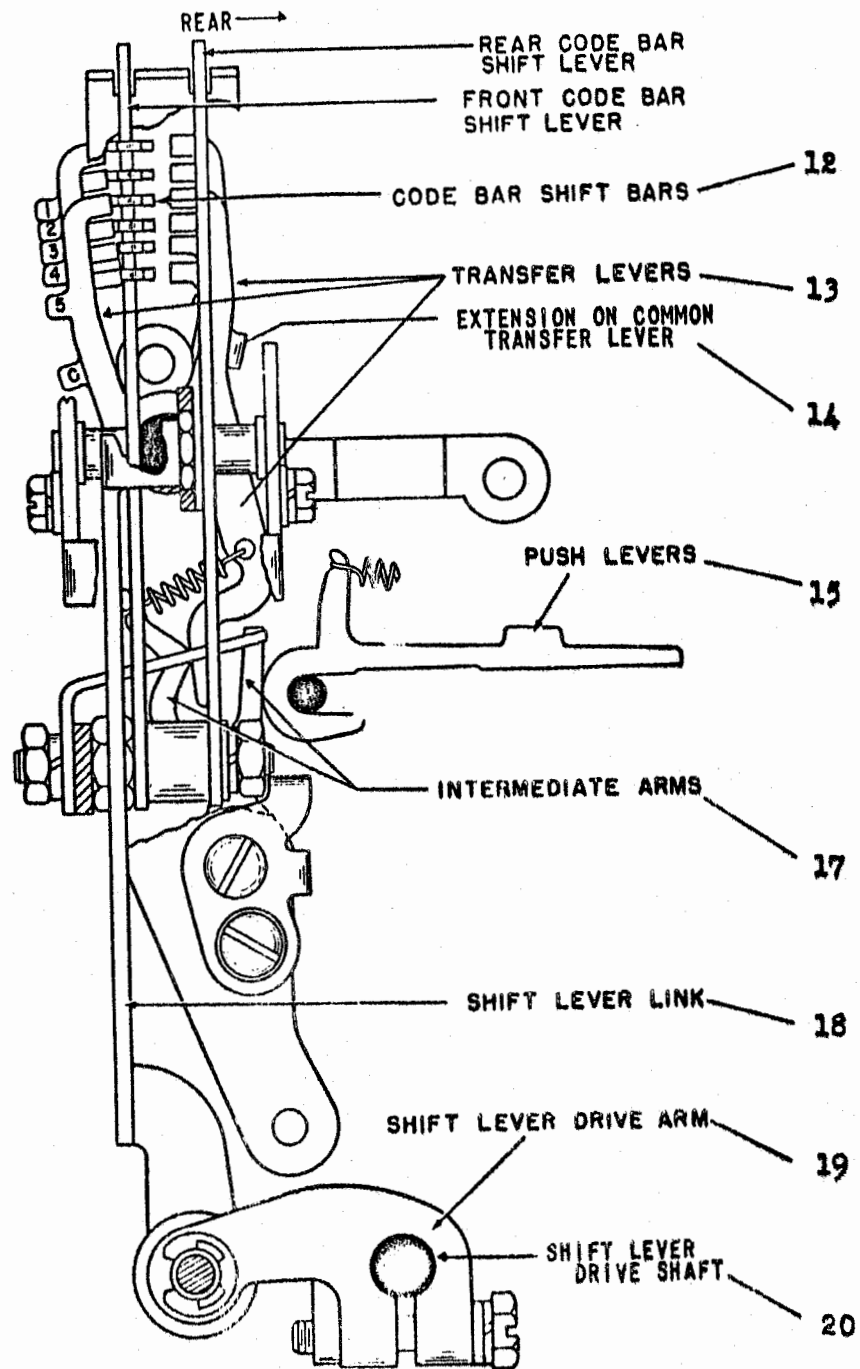


Figure 3-8 Code Bar Positioning Mechanism - Right End View

MODEL 28 PRINTER

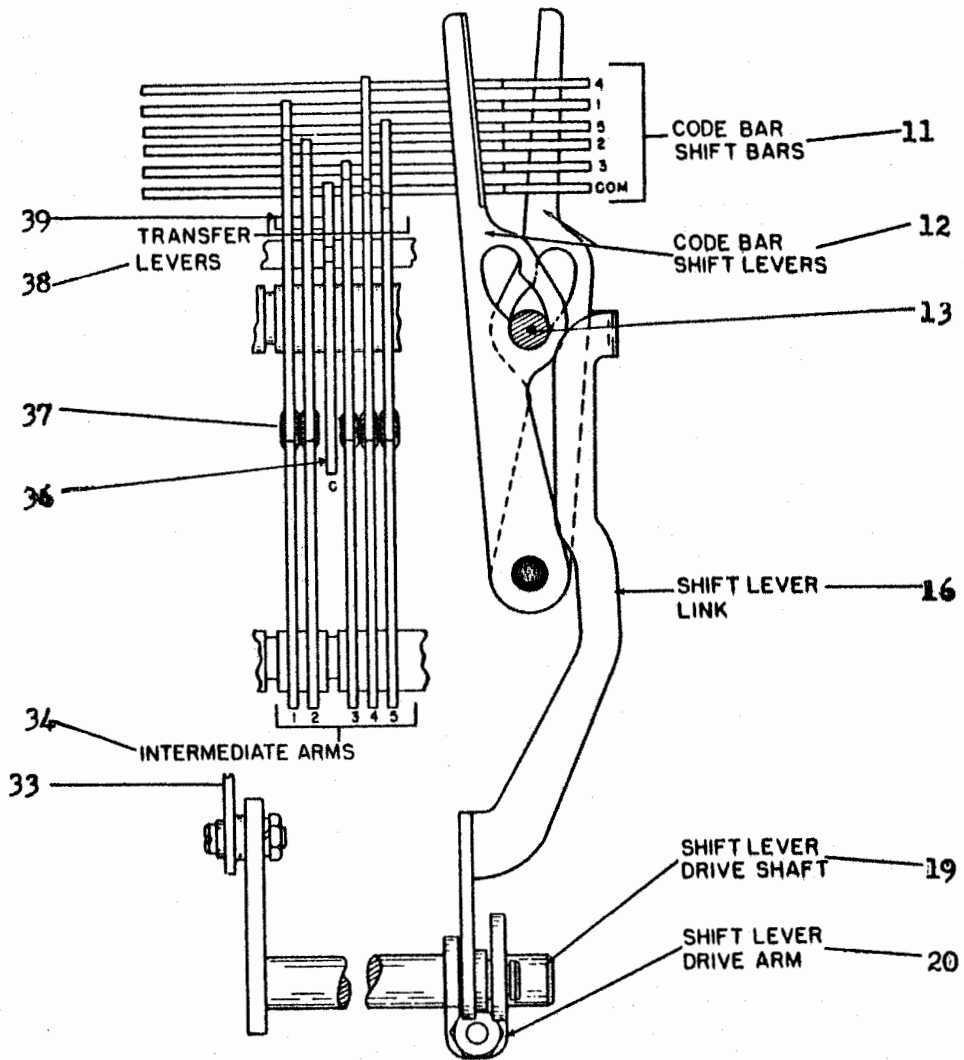


Figure 3-9 Code Bar Positioning Mechanism - Front View

MODEL 28 PRINTER

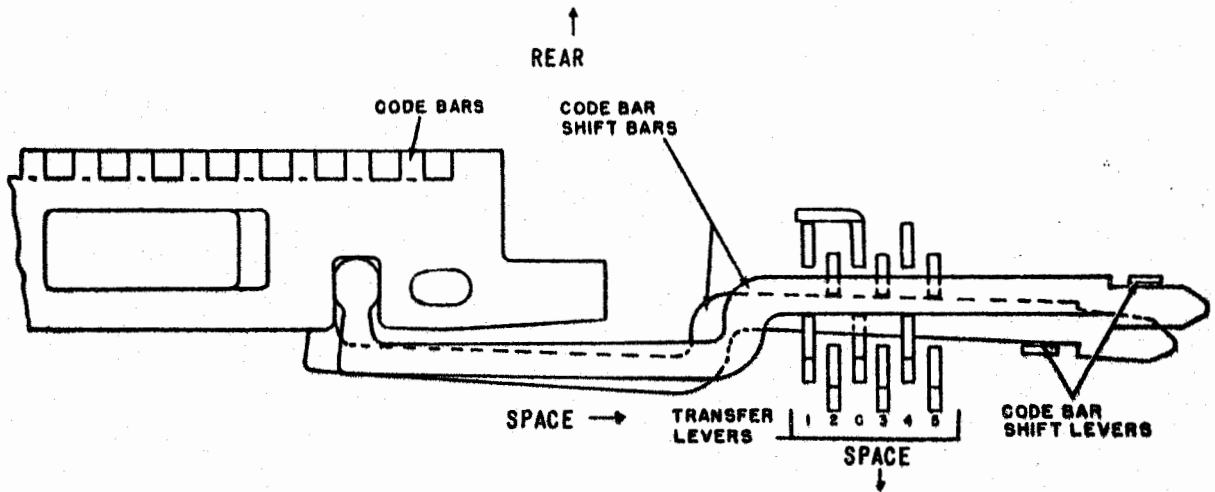


Figure 3-10 Code Bar Positioning Mechanism - Top View

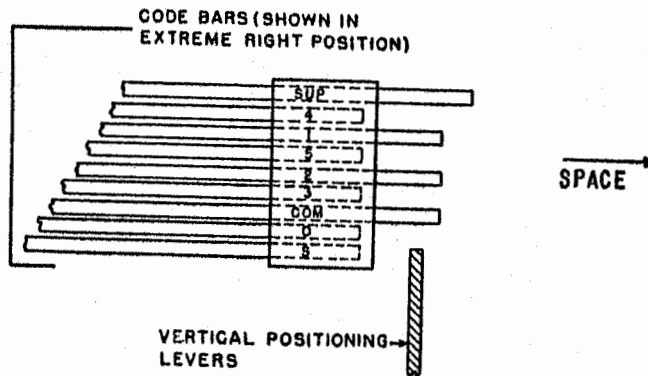


Figure 3-11 Front View - Right End

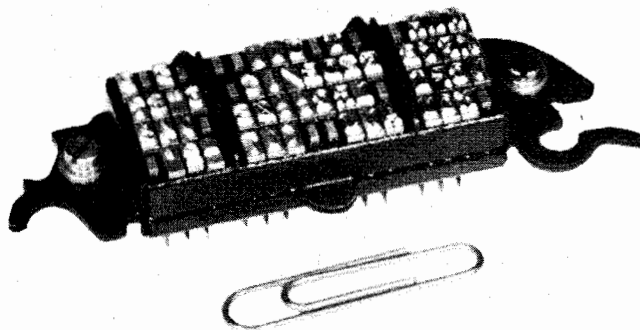


Figure 3-12 Type Box

MODEL 28 PRINTER

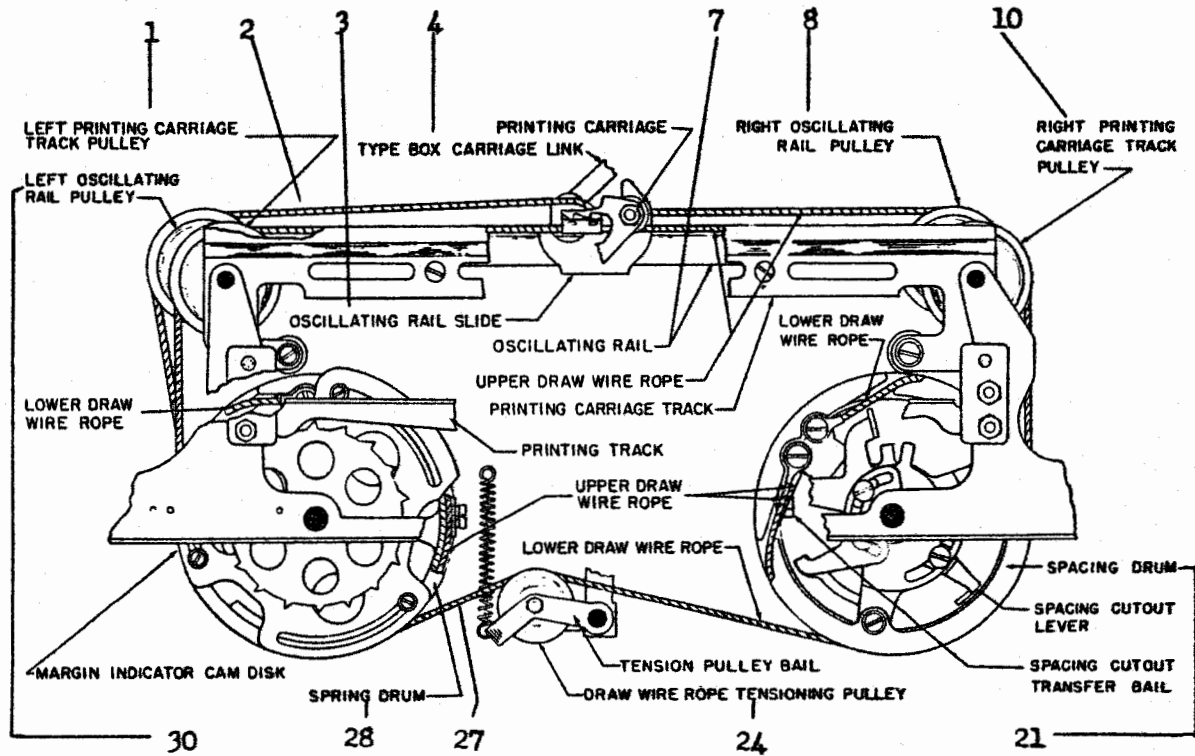


Figure 3-13 Draw Wire Rops Mechanism - Front View

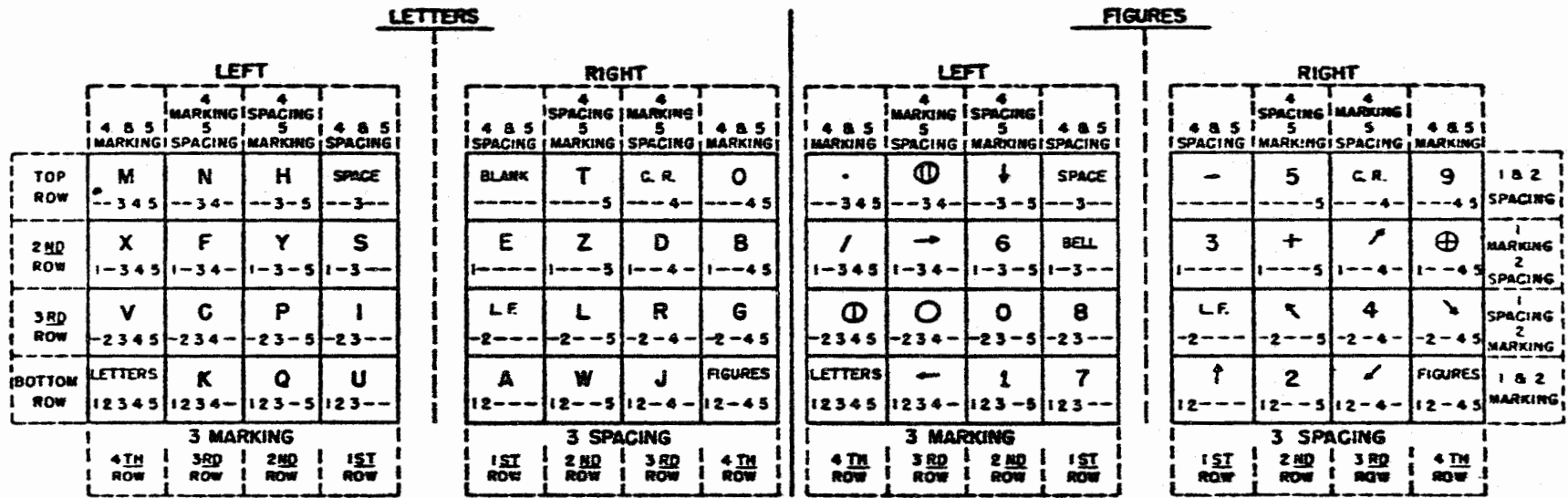


Figure 3-14 Type "RD" Type Box Arrangement, Viewed from Front of Typing Unit

MODEL 28 PRINTER

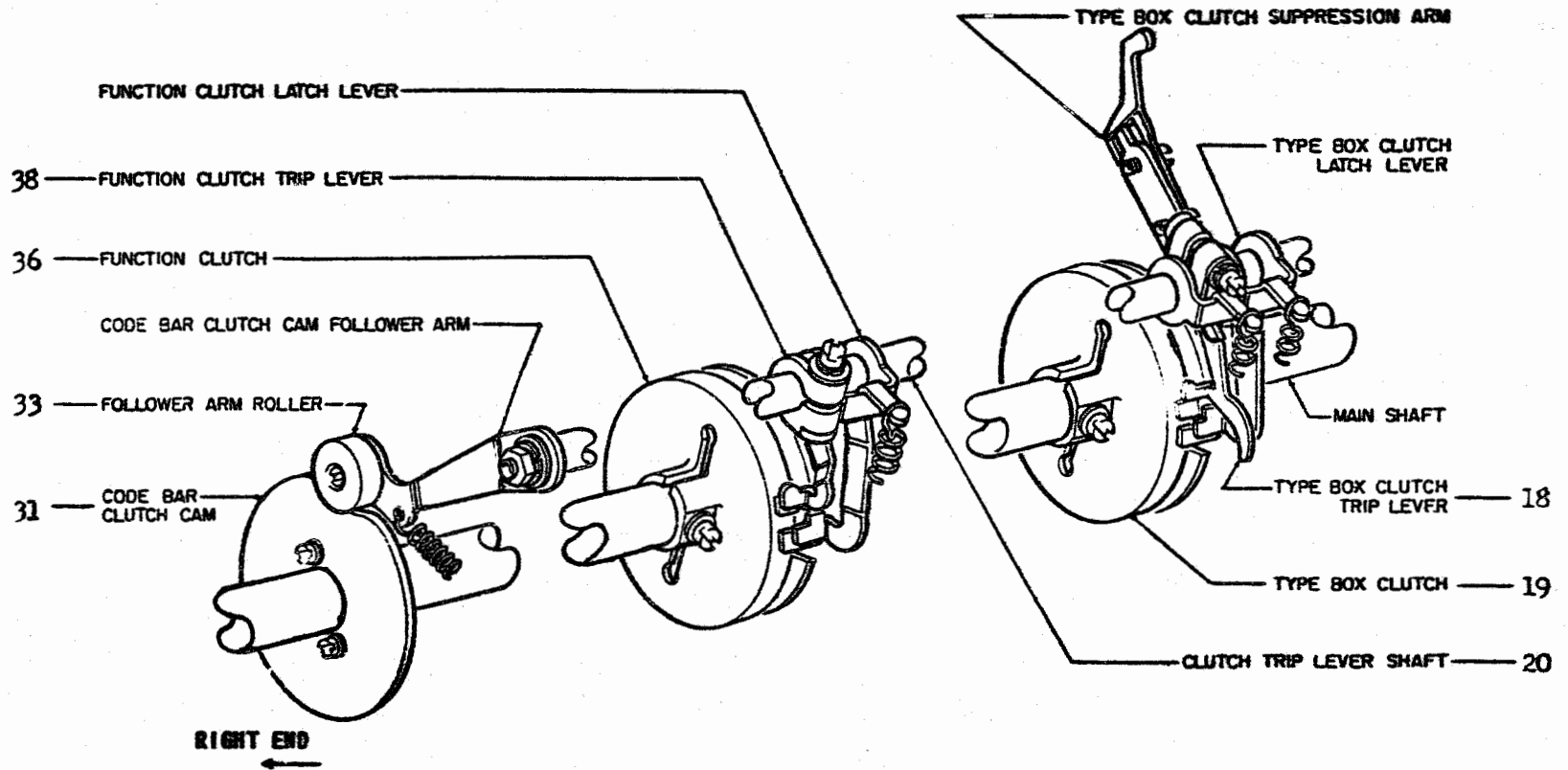


Figure 3-15 Trip Mechanism for Function and Type Box Clutches

MODEL 28 PRINTER

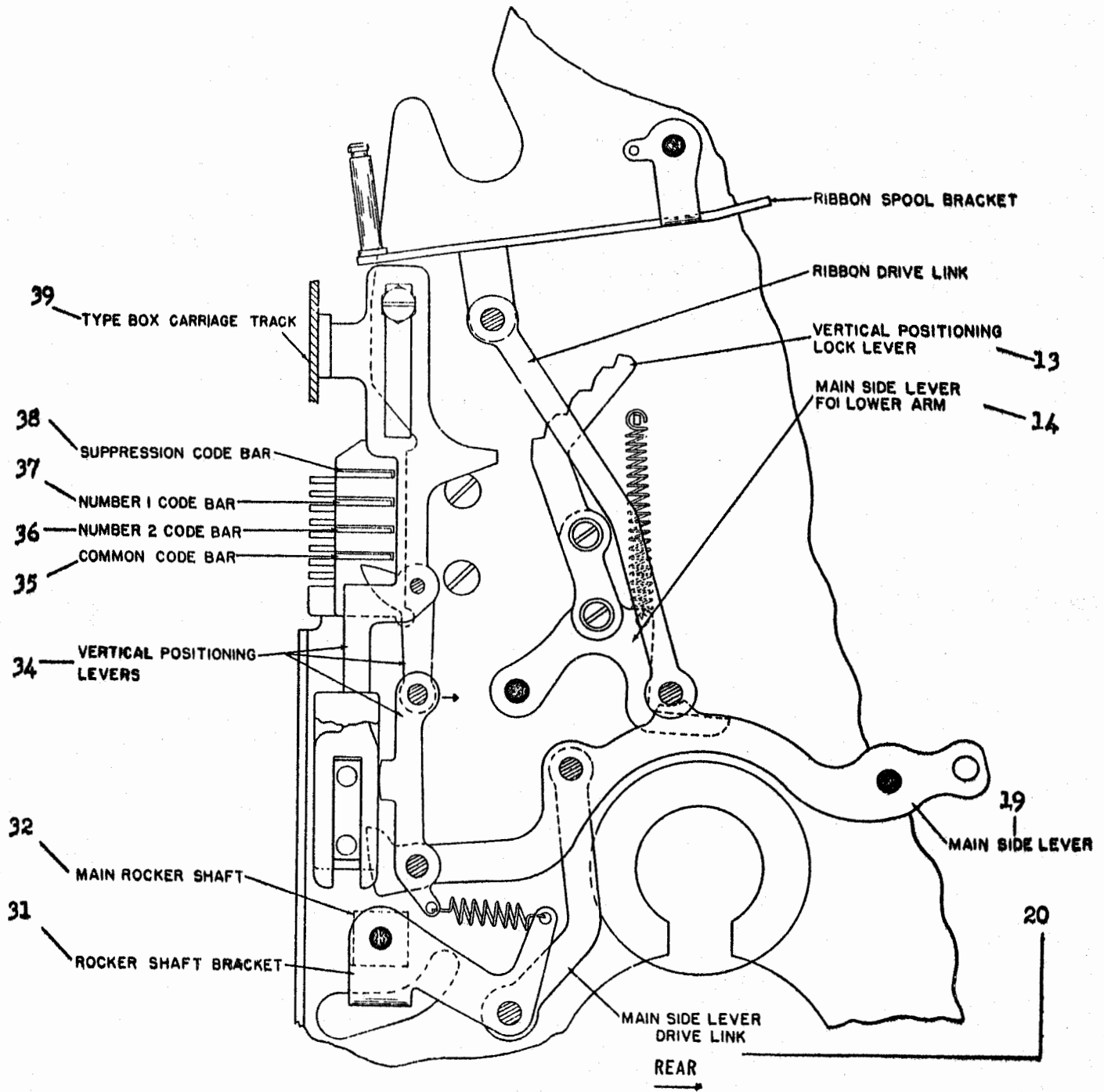


Figure 3-16 Right Side Mechanism



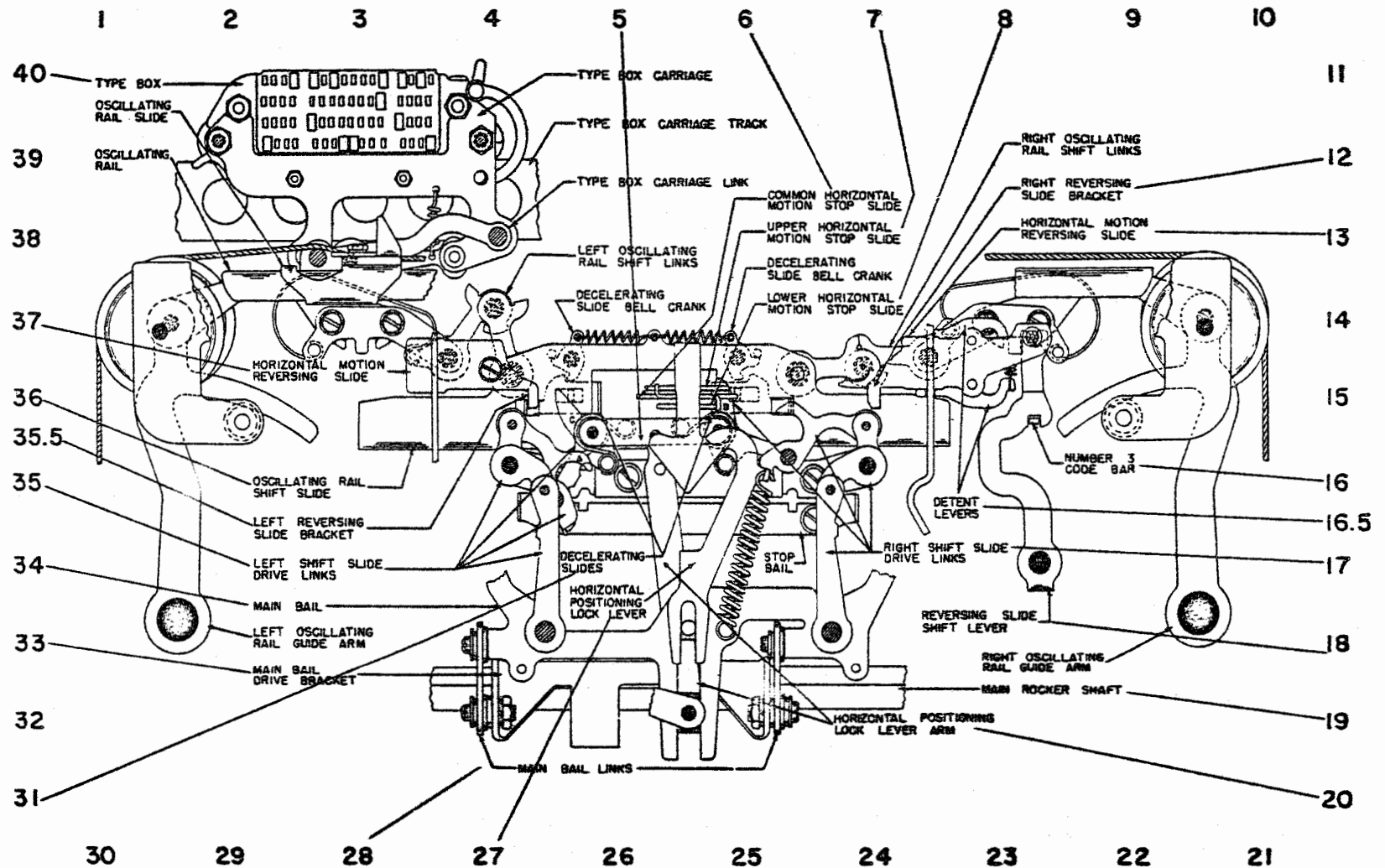


Figure 3-17 Front Plate Horizontal Positioning Mechanism - Front View

MODEL 28 PRINTER

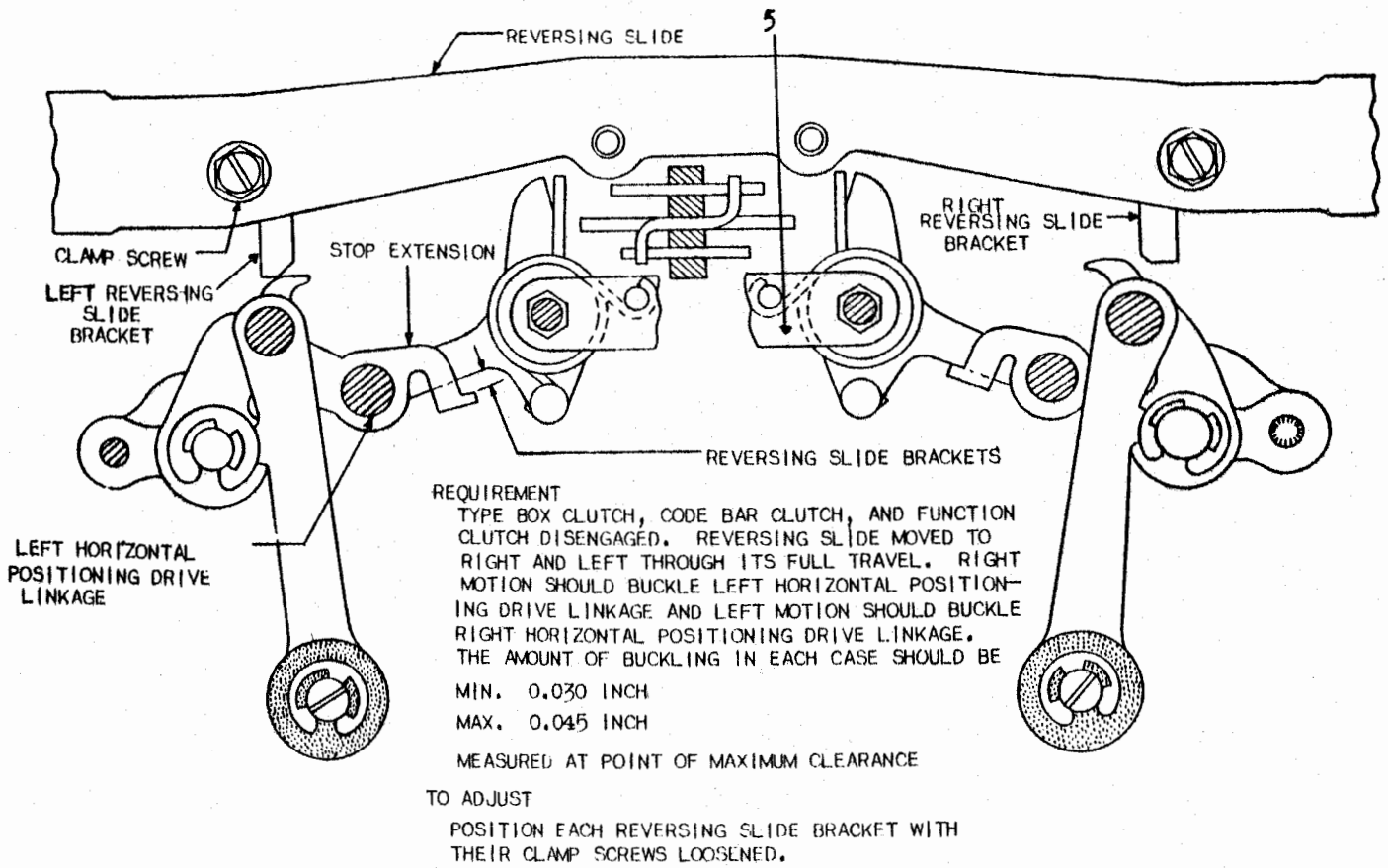


Figure 3-18 Typewriter Horizontal Motion Reversing Mechanism - Front View

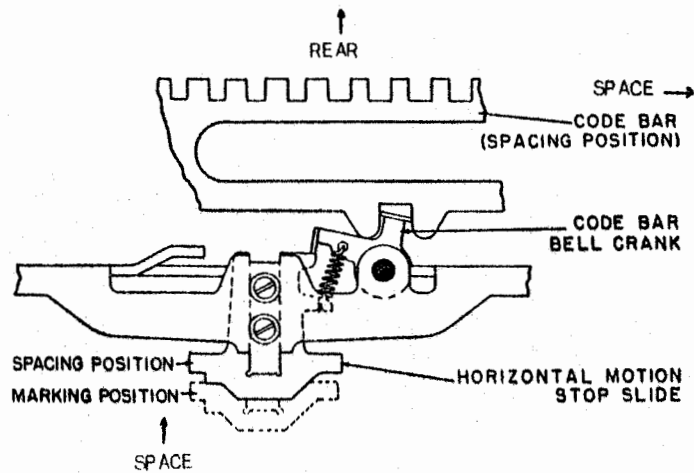
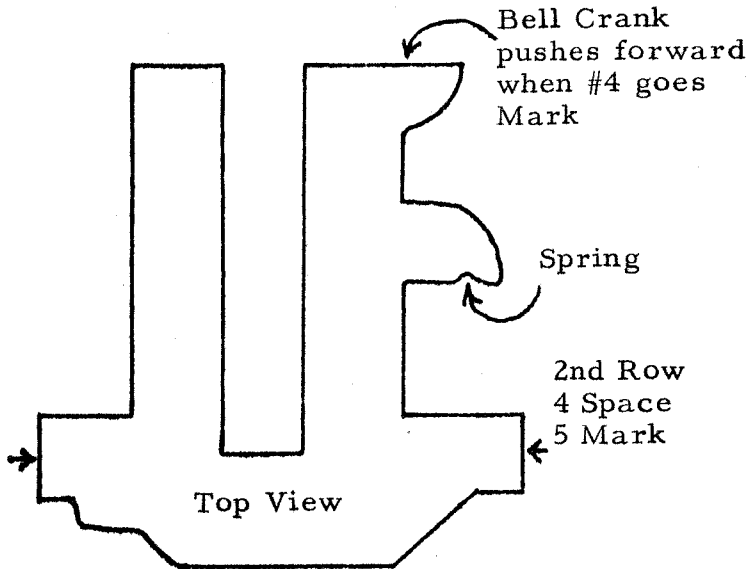


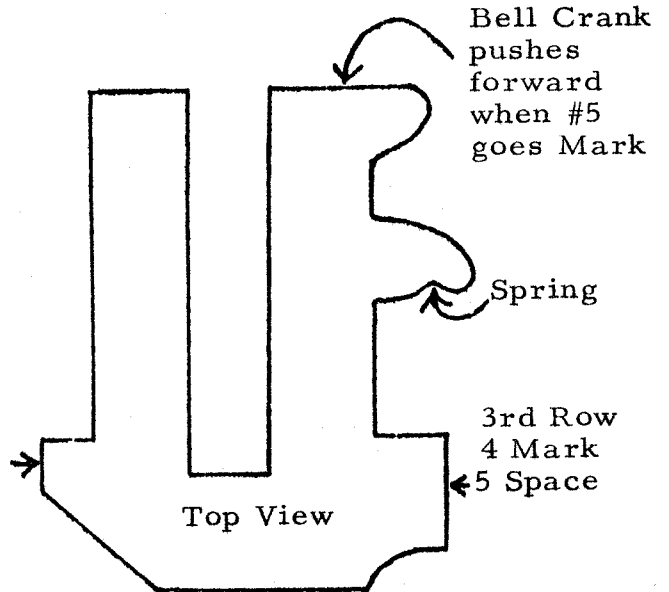
Figure 3-19 Top View

MODEL 28 PRINTER

Horizontal Motion Stop Slides



Upper Horizontal Stop Slide positioned by #4 Code Bar



Lower Horizontal Stop Slide positioned by #5 Code Bar

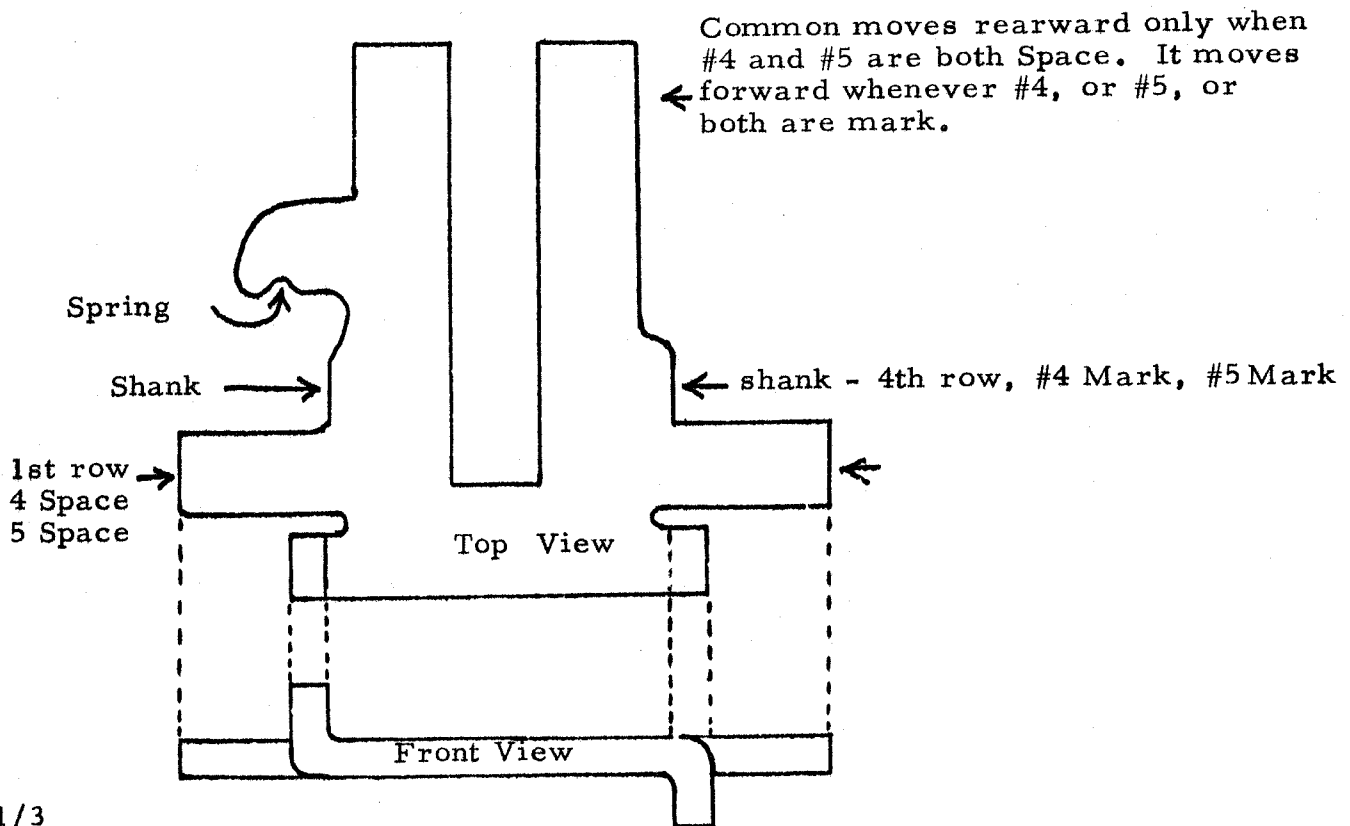


Figure 3-19a Common Horizontal Stop Slide

# MODEL 28 PRINTER

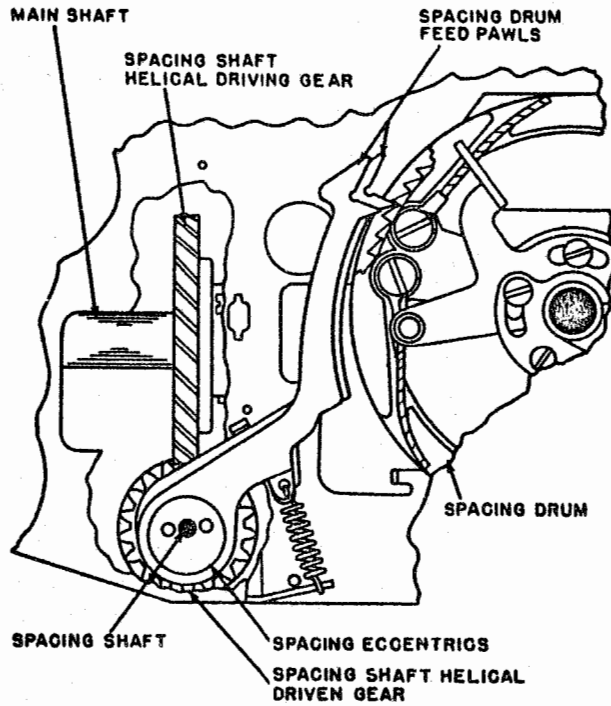


Figure 3-20 Front View

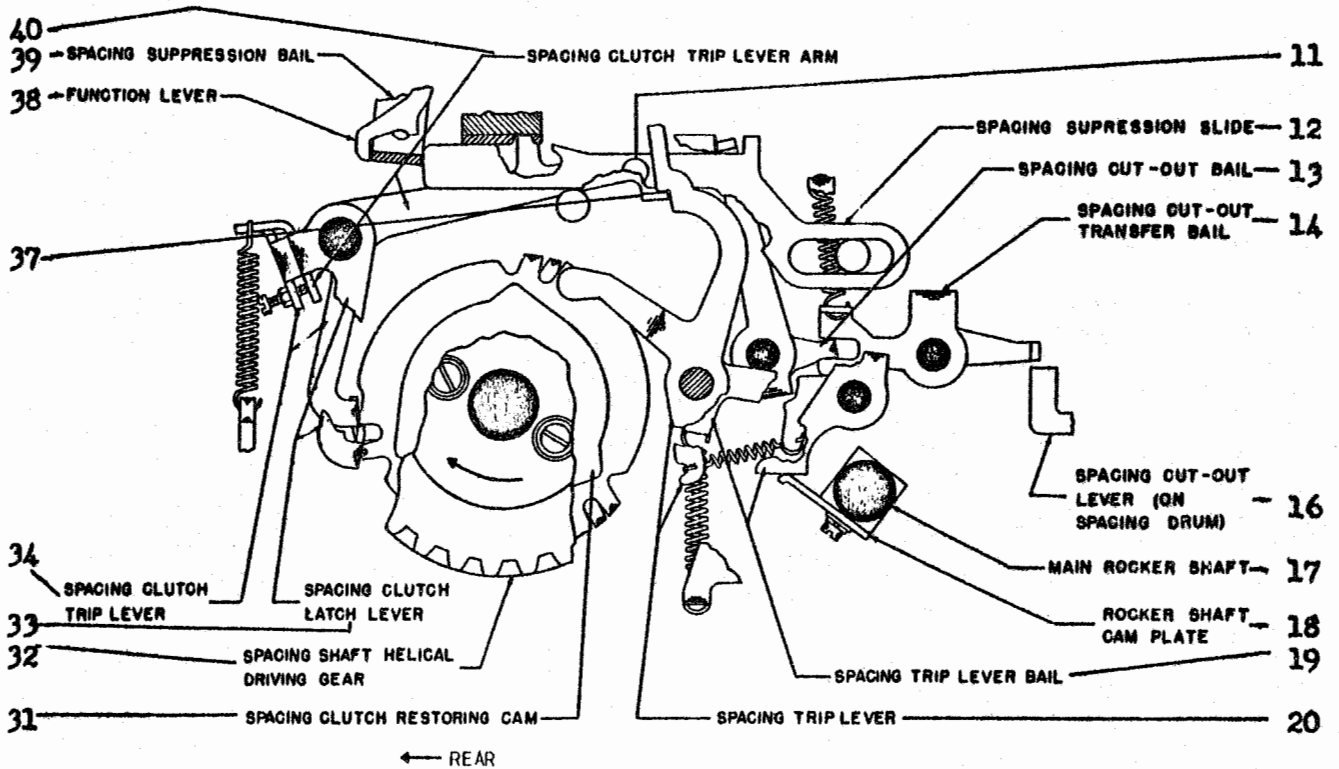


Figure 3-21 Left End View

MODEL 28 PRINTER

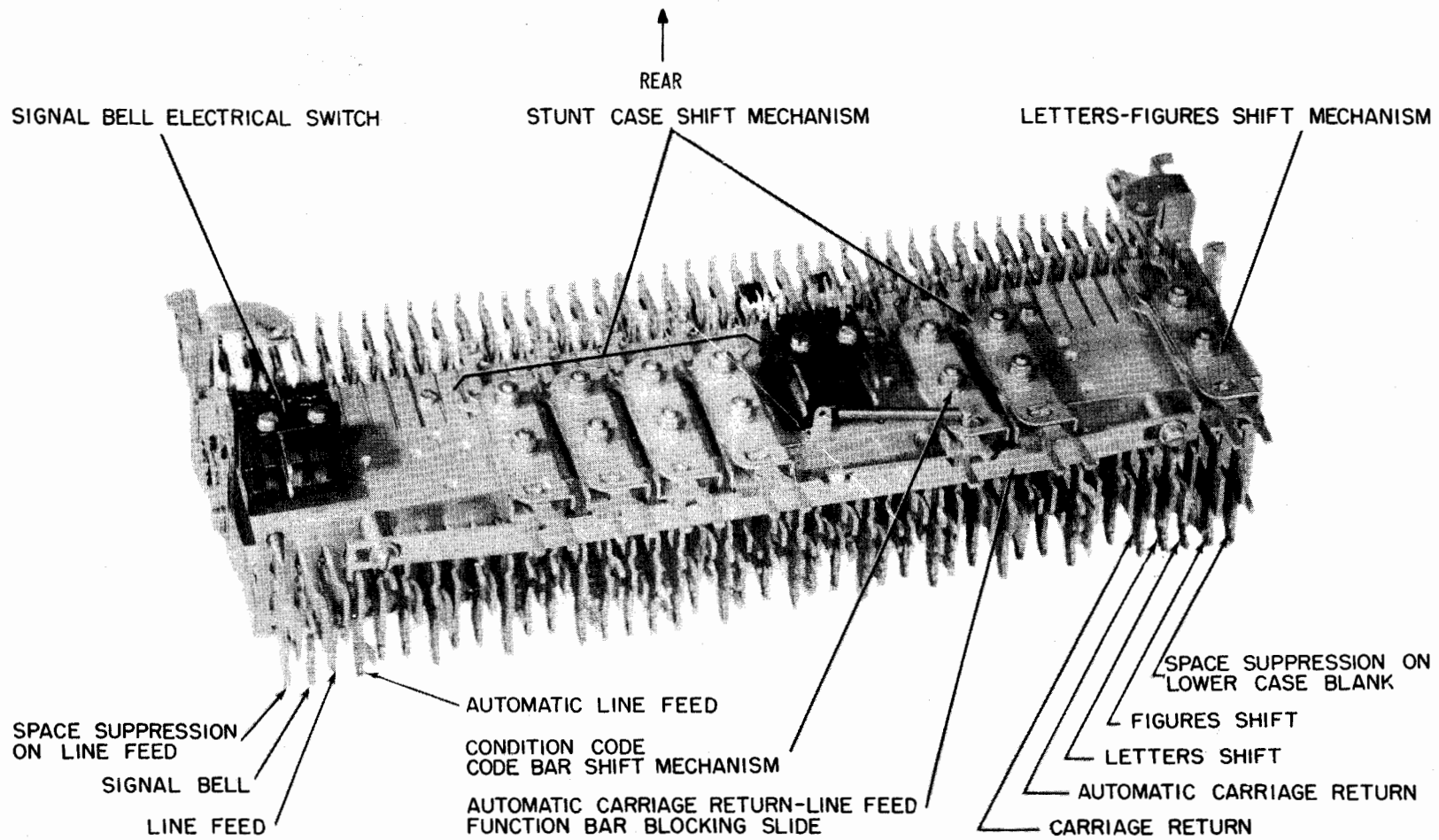


Figure 8-42 Stunt Box, Front View Showing Function Bars

MODEL 28 PRINTER

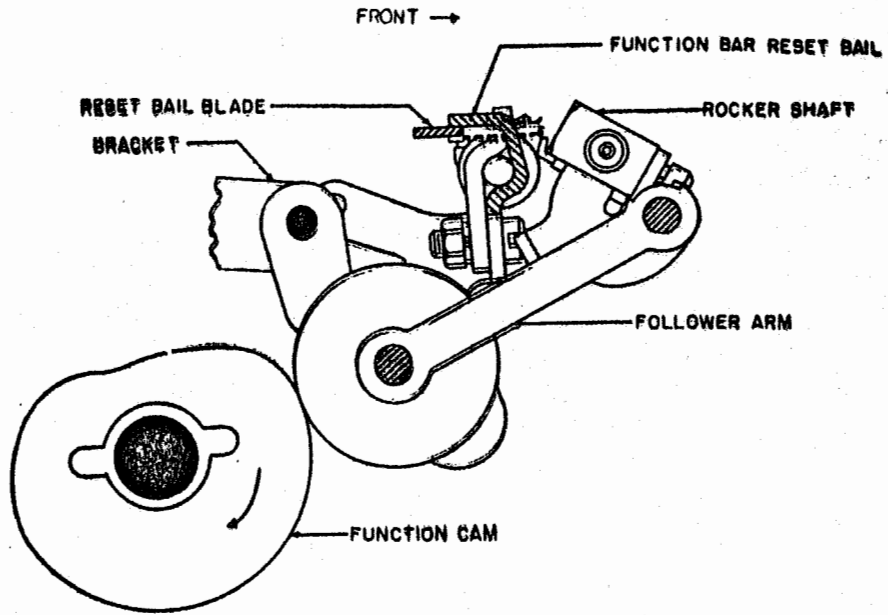


Figure 3-23 Function Reset Bail Driving Mechanism - Left End View

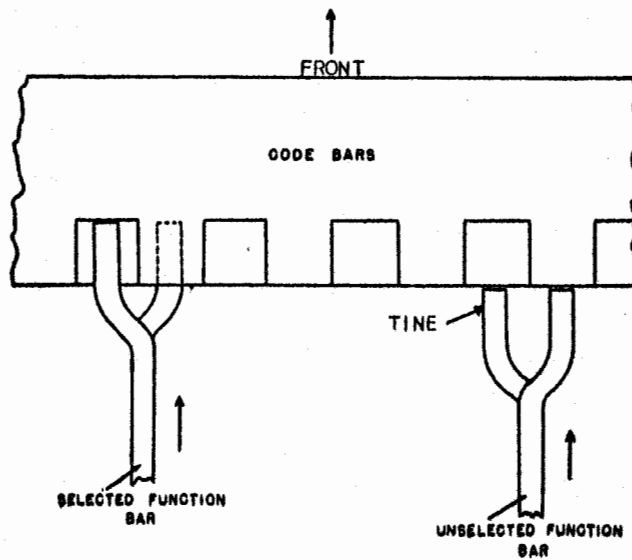


Figure 3-24 Top View

MODEL 28 PRINTER

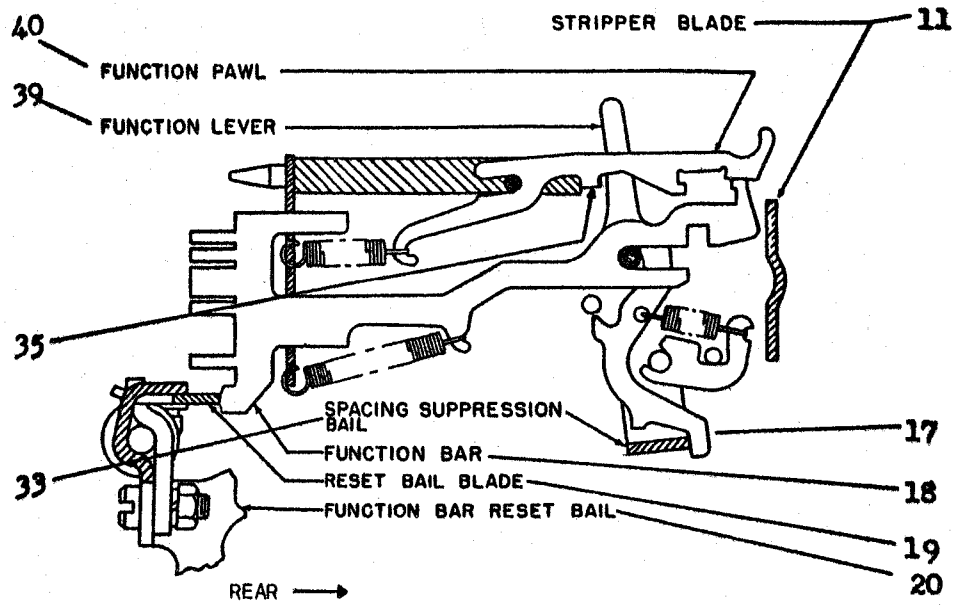


Figure 3-25 Right End View

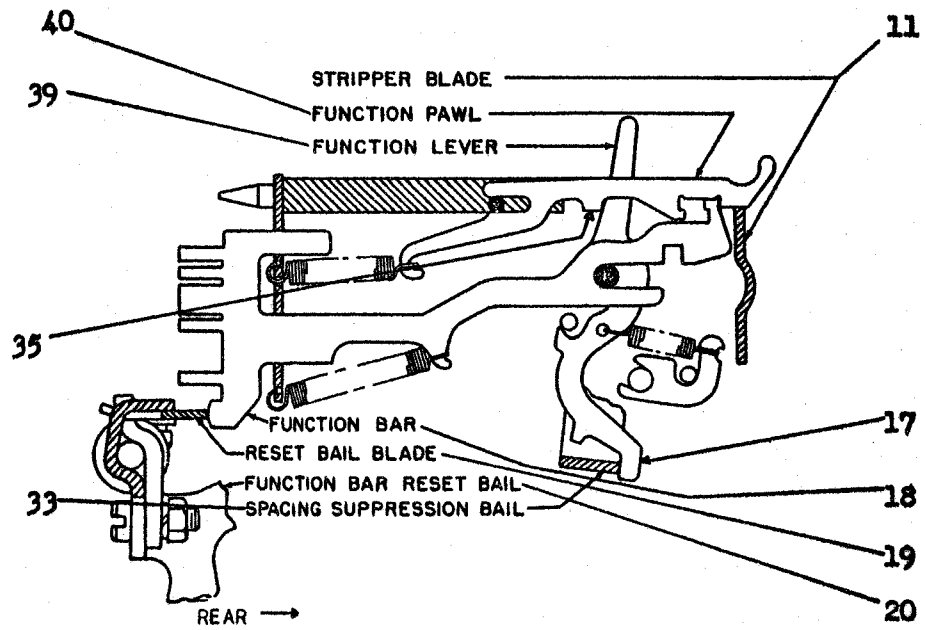


Figure 3-26 Right End View

MODEL 28 PRINTER

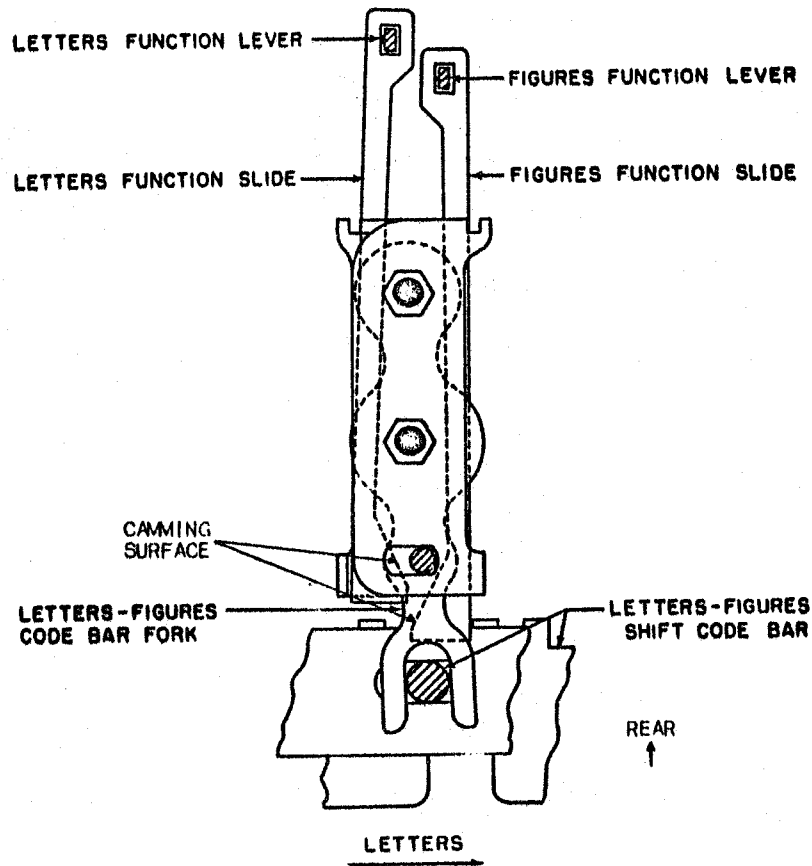


Figure 3-27 Letters - Figures Function Slides, Letters Position  
Top View

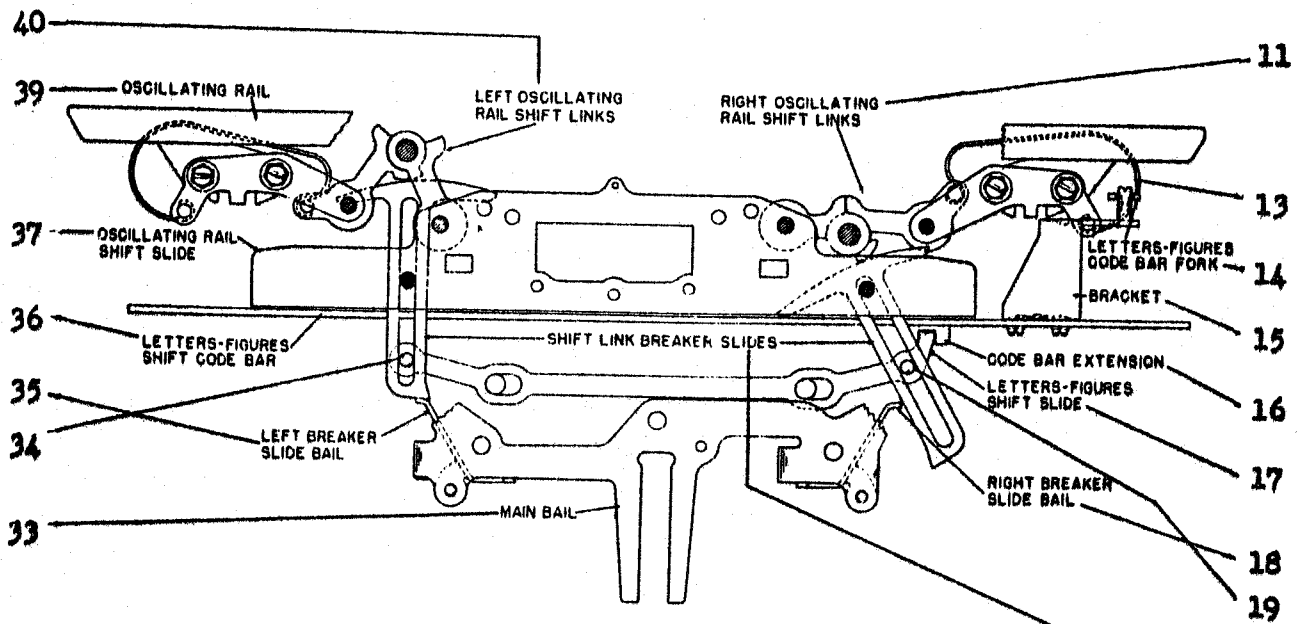


Figure 3-28 Letters - Figures Shift Mechanism,  
Letters Position - Front View



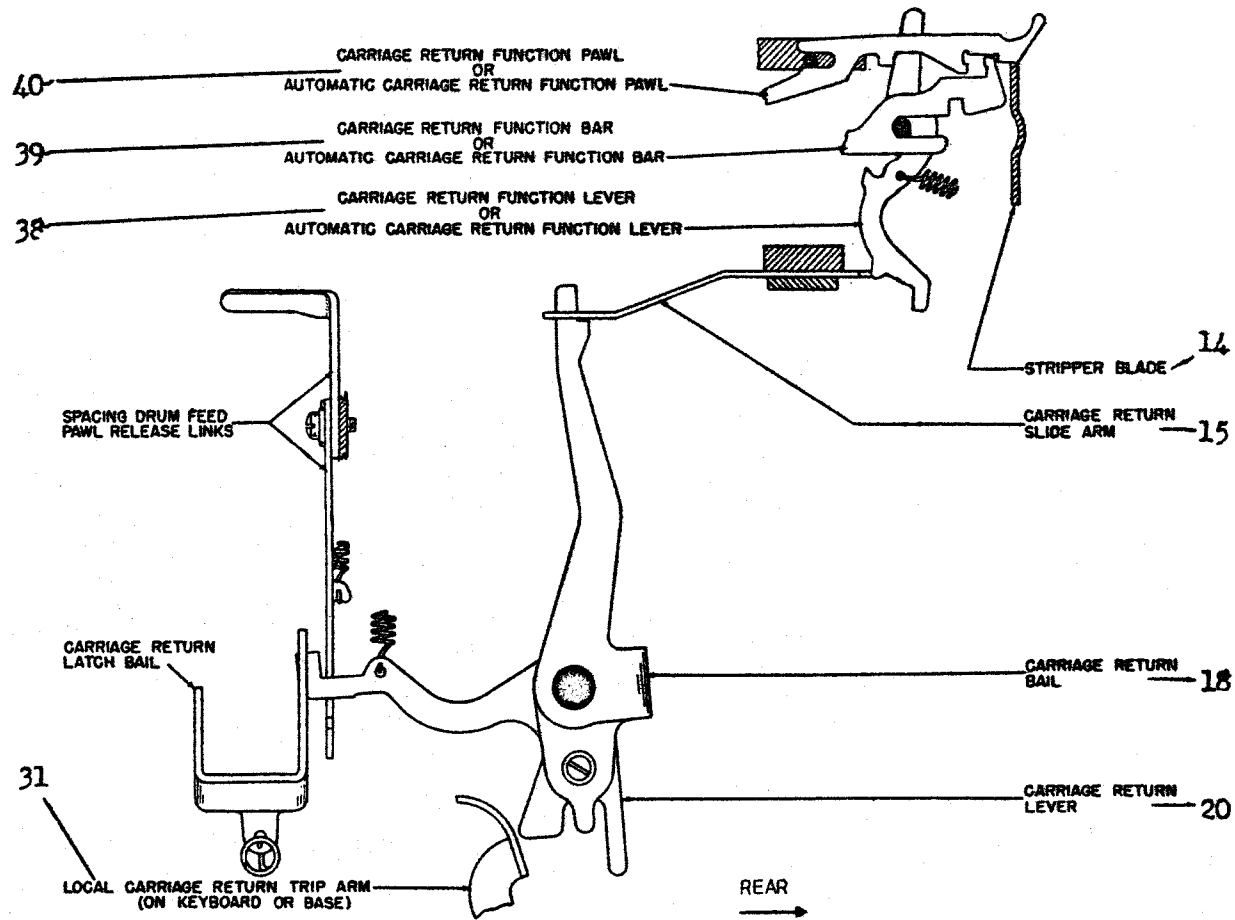


Figure 3-29 Carriage Return Function Mechanism - Right End View

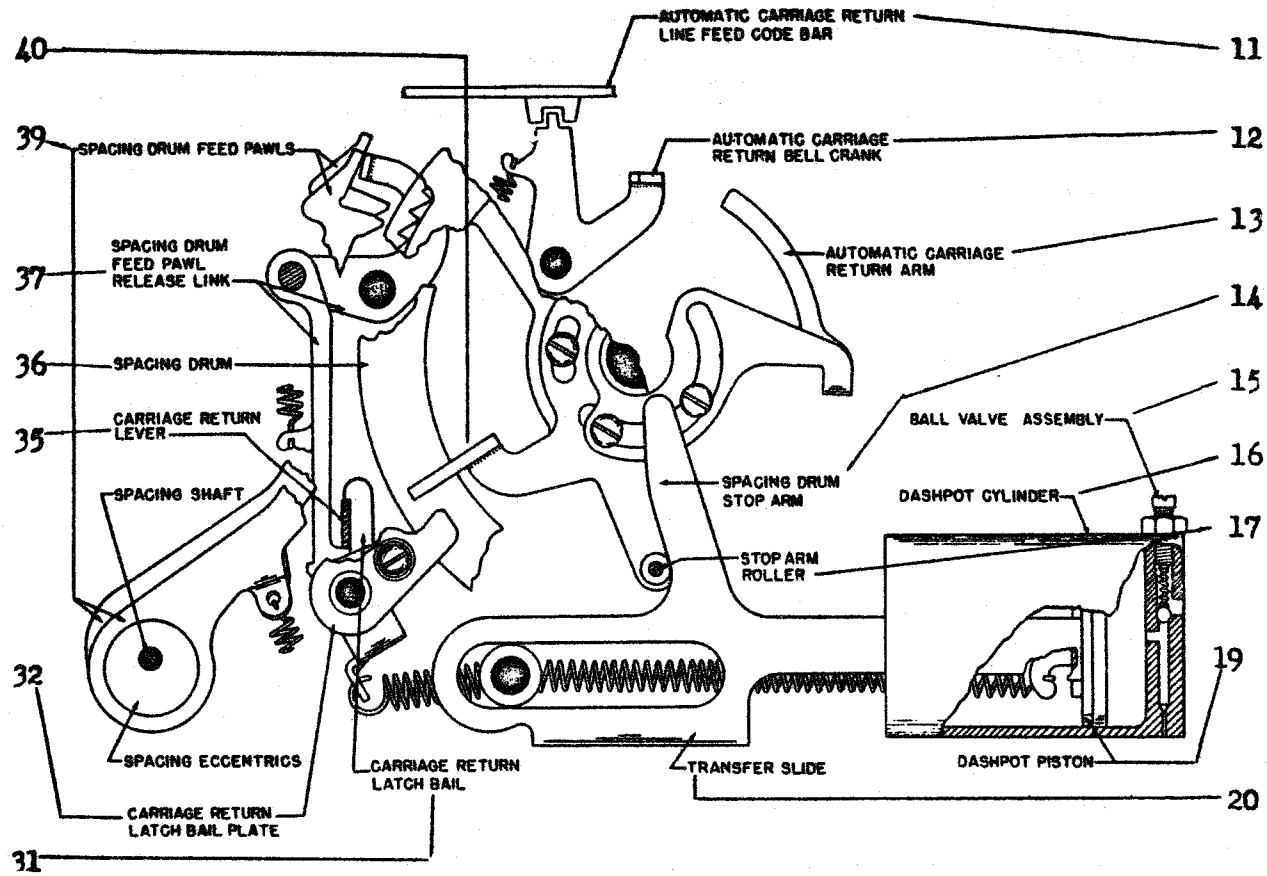


Figure 3-30 Carriage Return Mechanism - Front View

MODEL 28 PRINTER

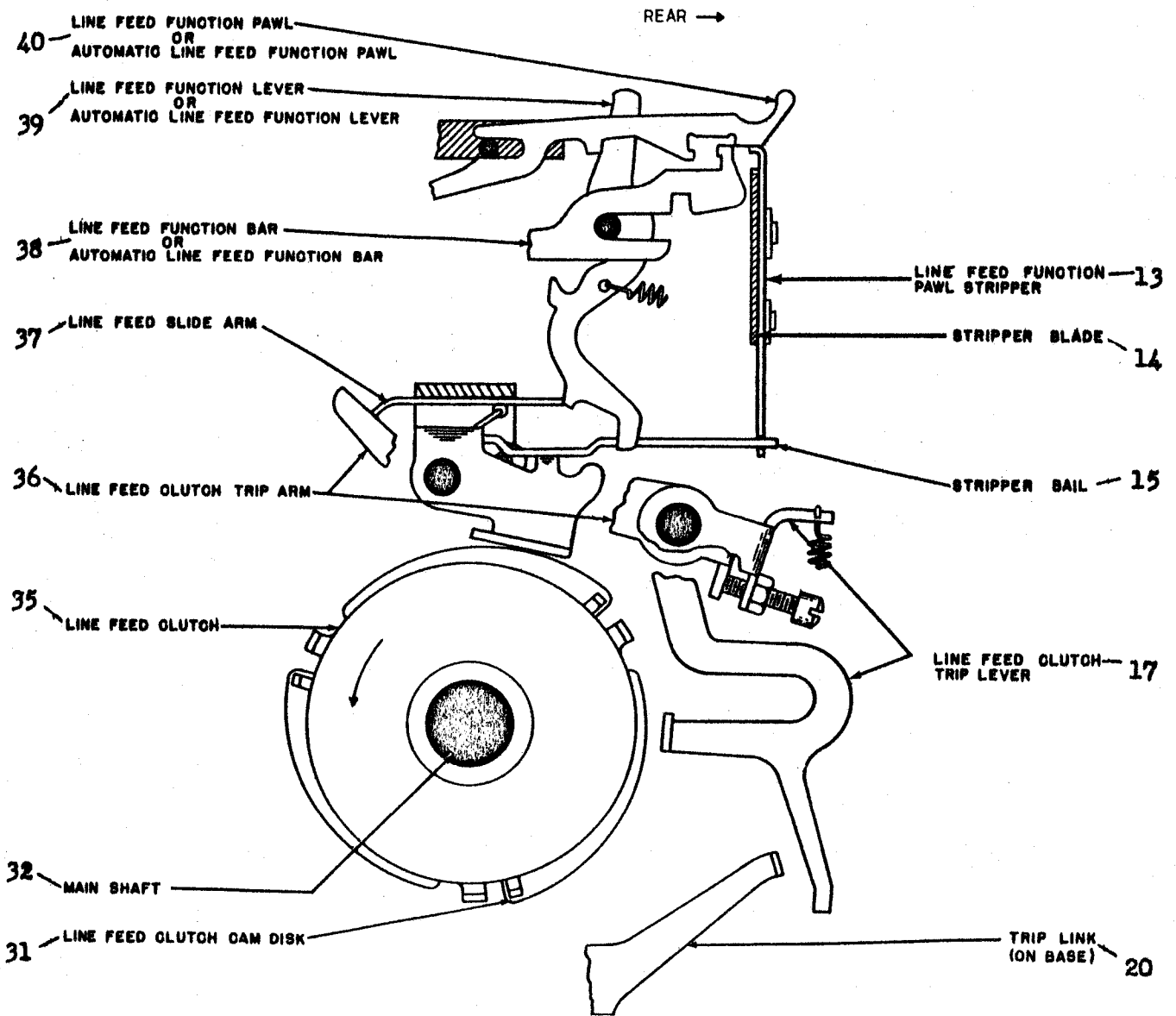


Figure 3-31 Line Feed Mechanism - Right End View

MODEL 28 PRINTER

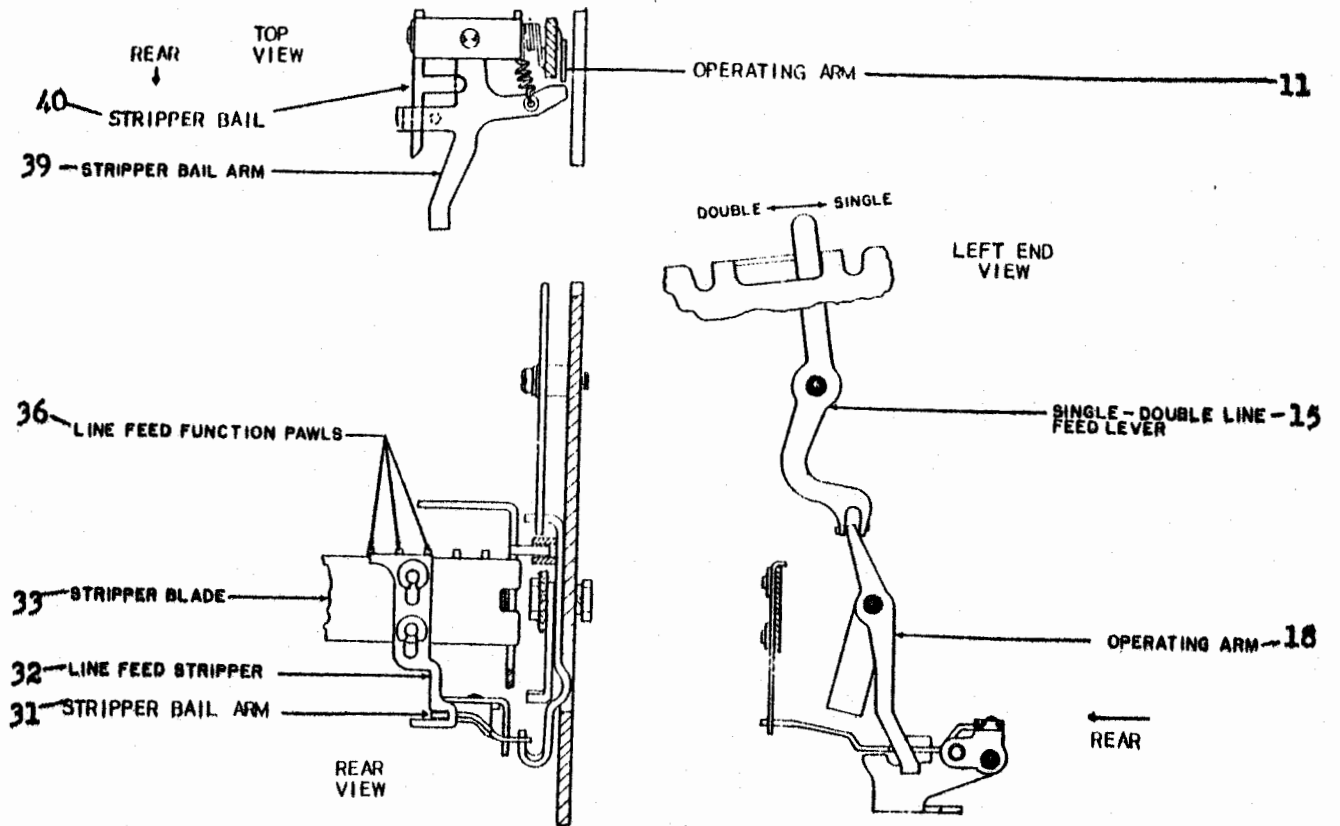


Figure 3-32 Positioning Mechanism for Single or Double Line Feed

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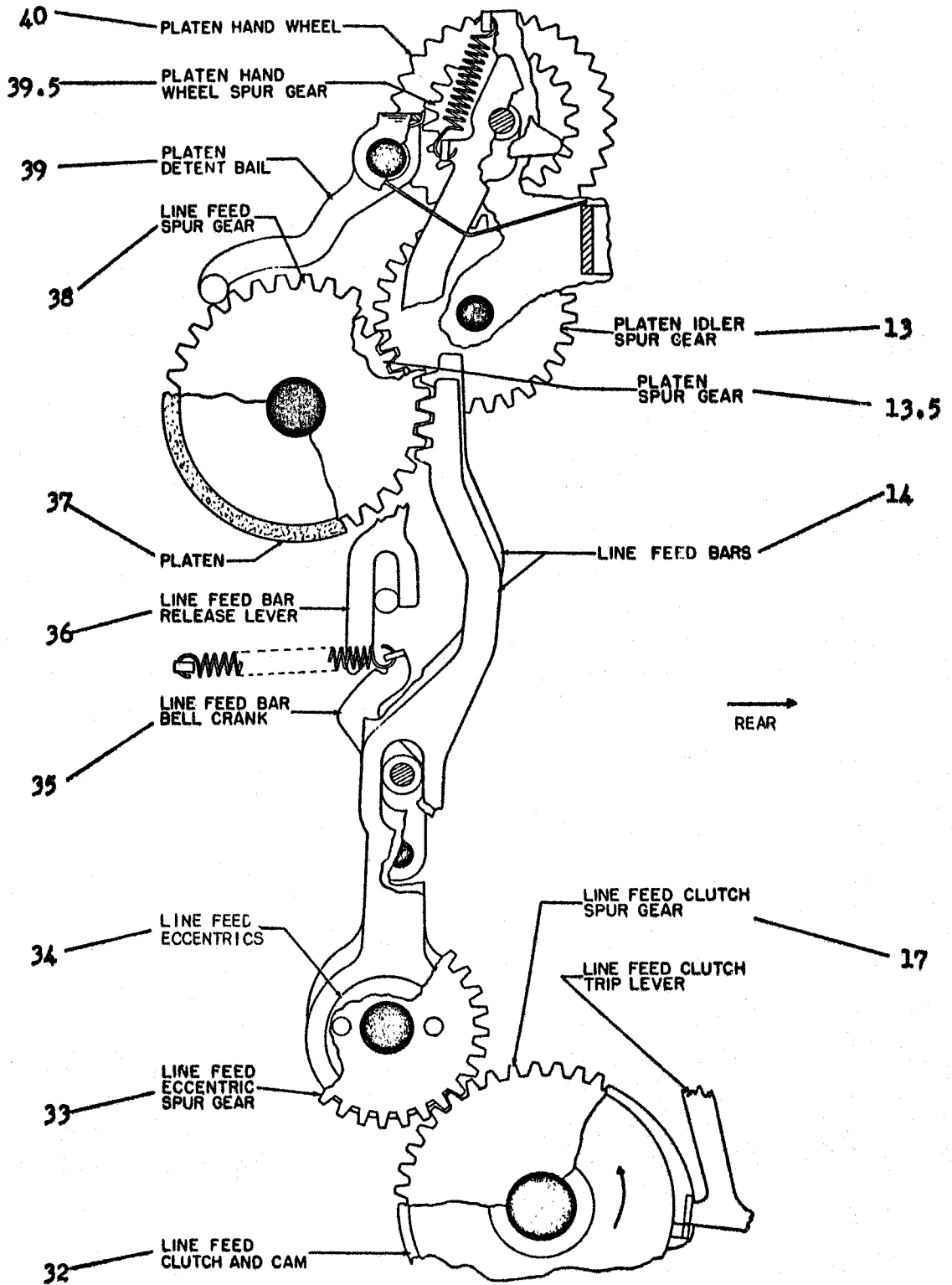


Figure 3-33 Line Feed Mechanism - Right End View

MODEL 28 PRINTER

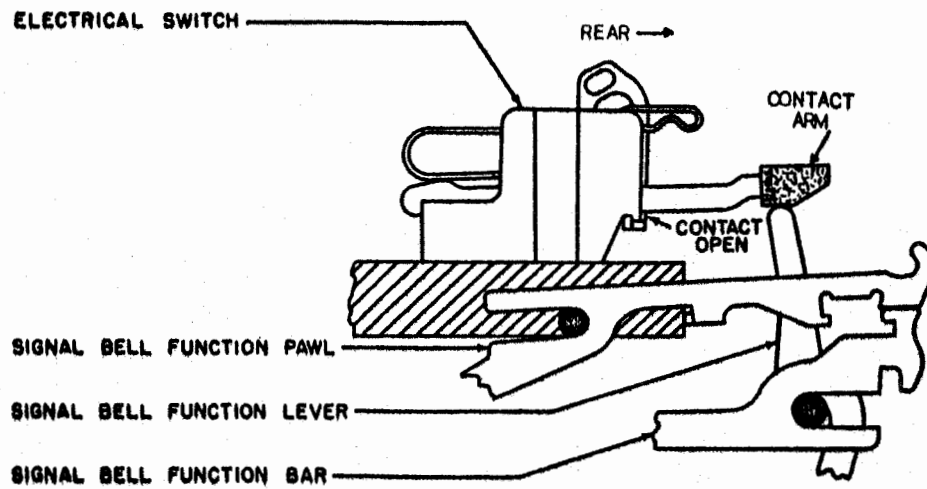


Figure 3-34 Signal Bell Contact Mechanism, Unselected  
Right End View

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PRINTING UNIT

- #1 Bar Selected
- #2 Bar Unblocked
- #3 Bar Blocked

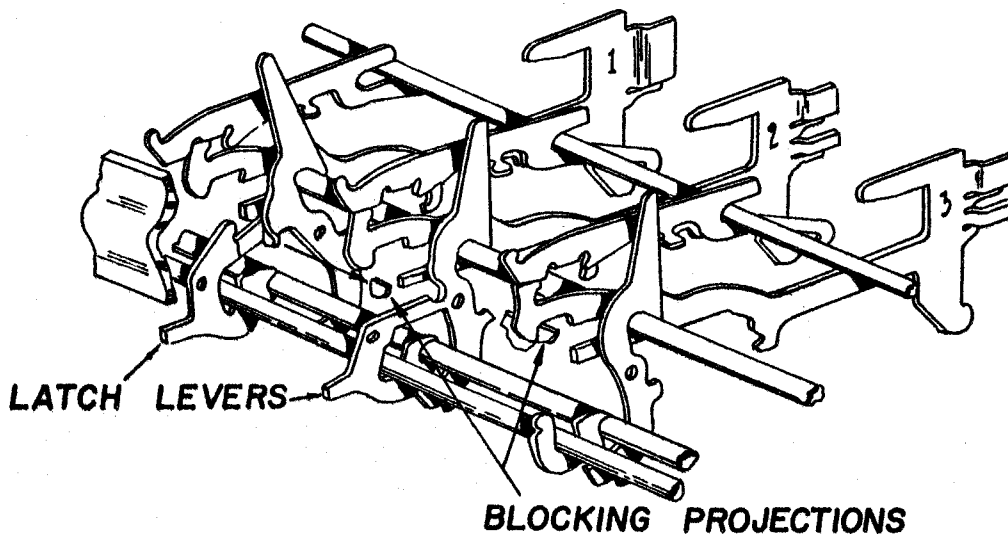


Figure 3-35

MODEL 28 R/O EQUIPMENT

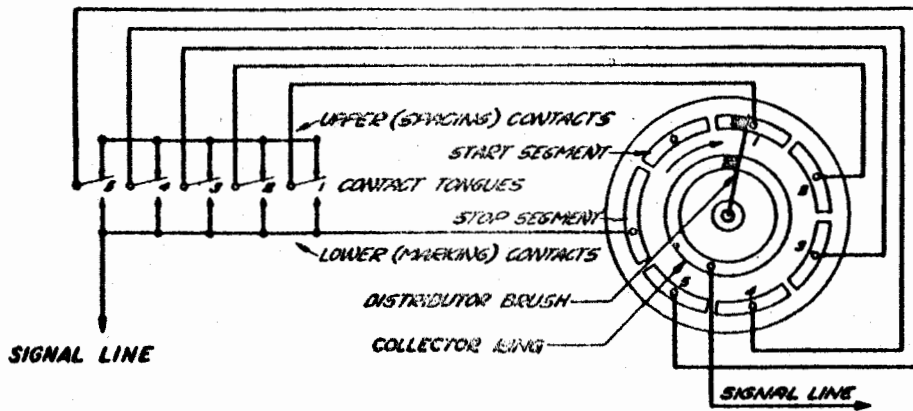


Figure 4-1.

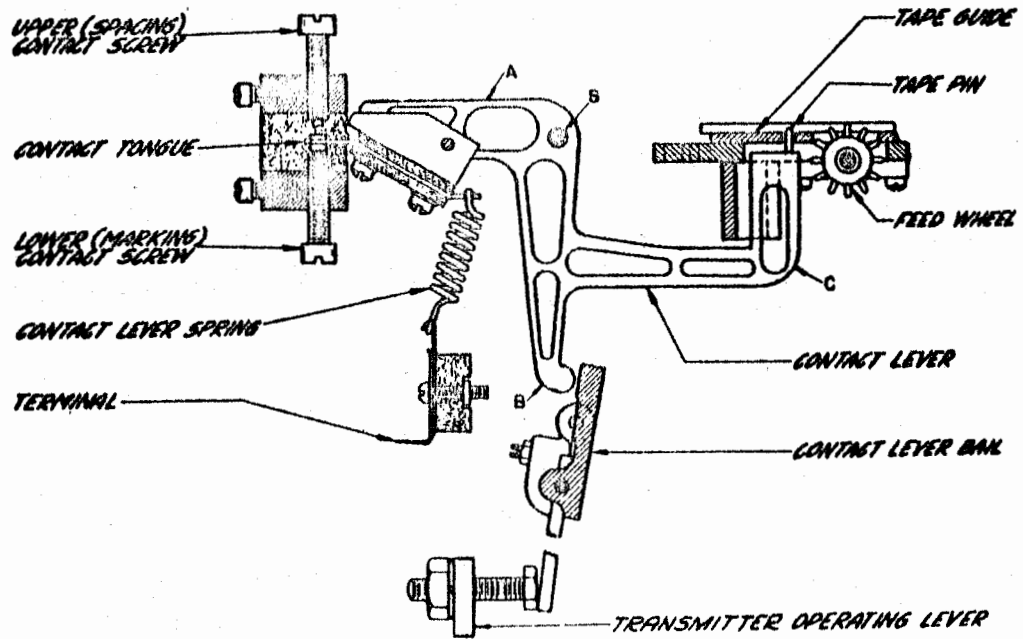


Figure 4-2.



MODEL 28 R/O EQUIPMENT

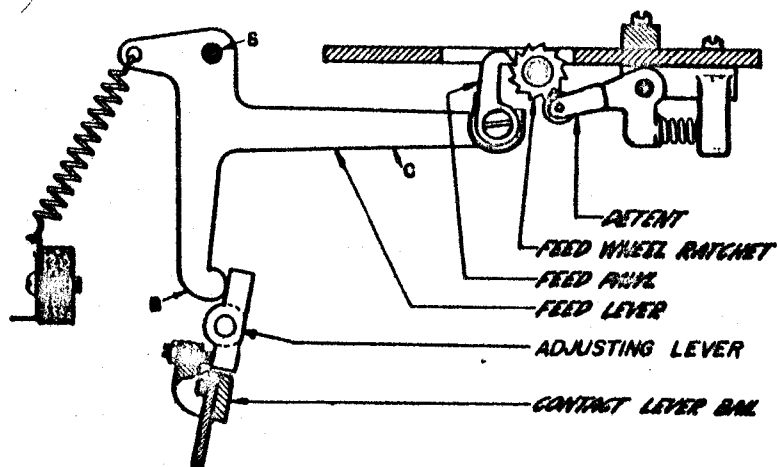


Figure 4-3.

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MODEL 28 R/O EQUIPMENT

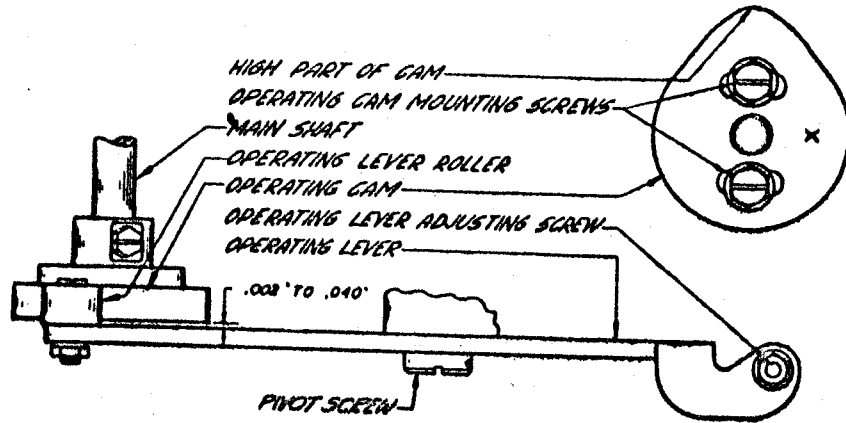


Figure 4-4.

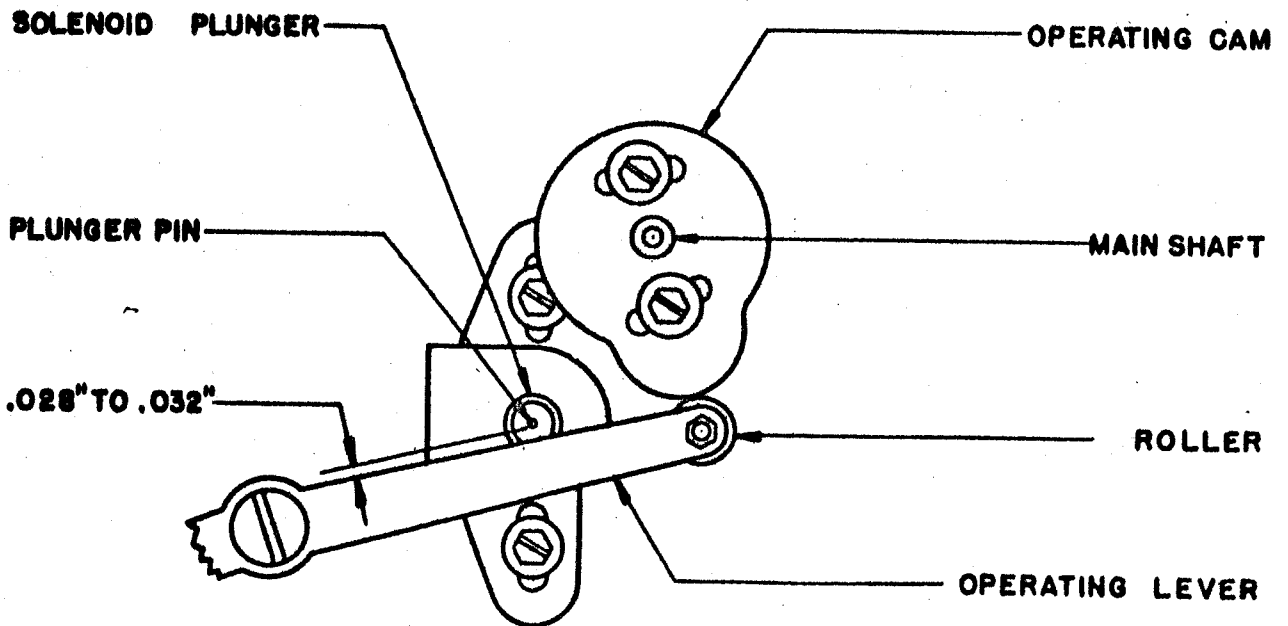


Figure 4-5.

MODEL 28 R/O EQUIPMENT

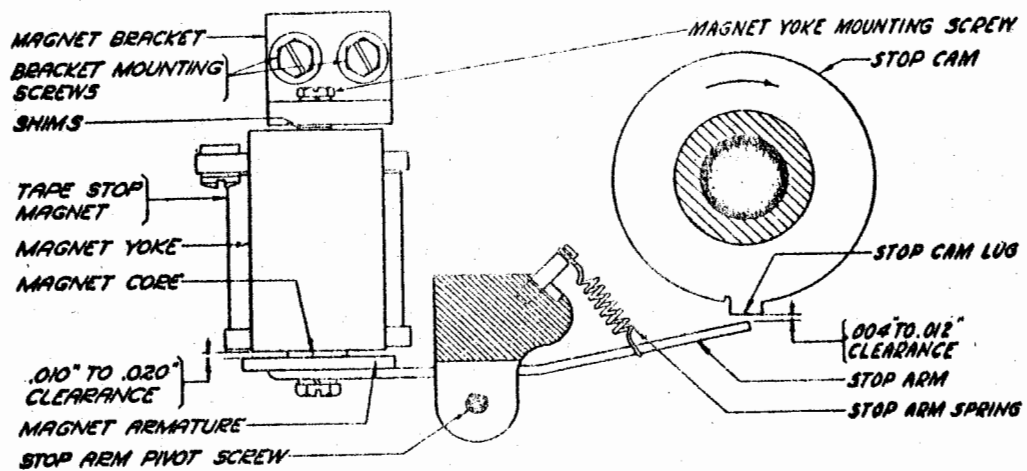
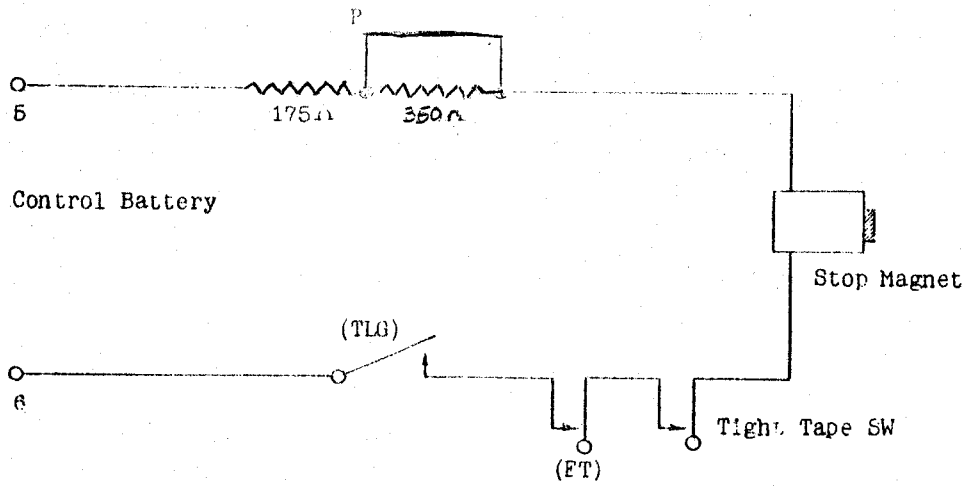
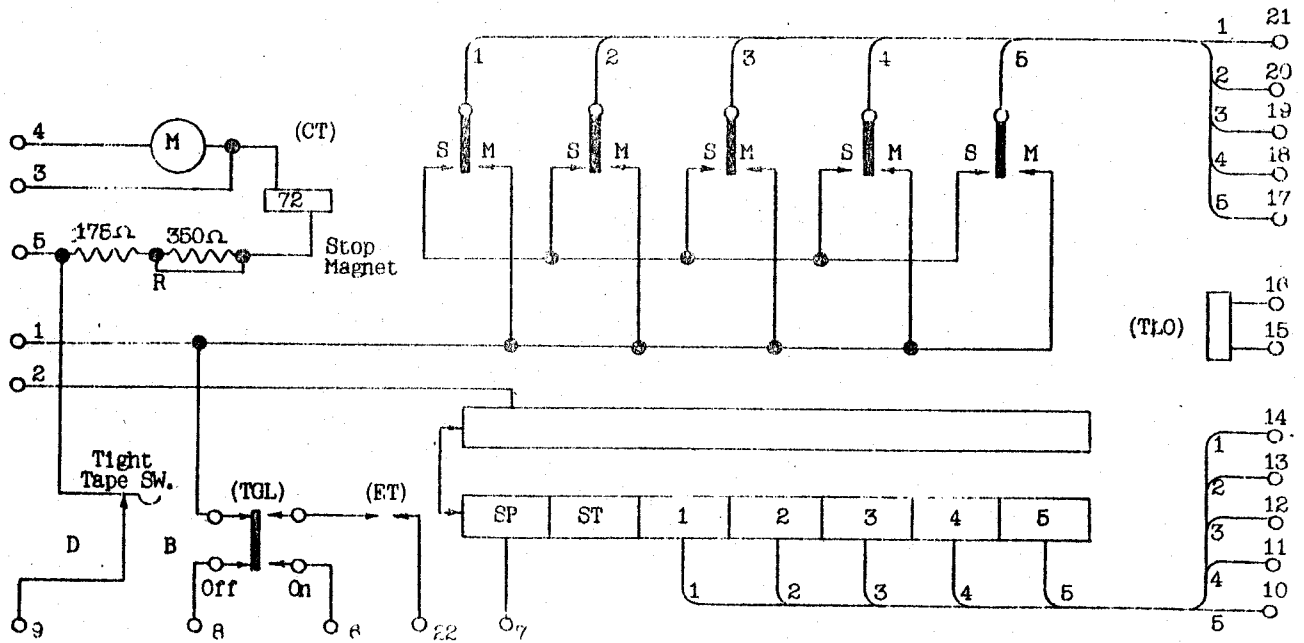


Figure 4-6.

# MODEL 28 R/O EQUIPMENT



A. BASIC TD CONTROL CIRCUIT



E. TD SCHEMATIC AS CONNECTED FOR ASID USE

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Figure 4-7.

MODEL 28 R/O EQUIPMENT

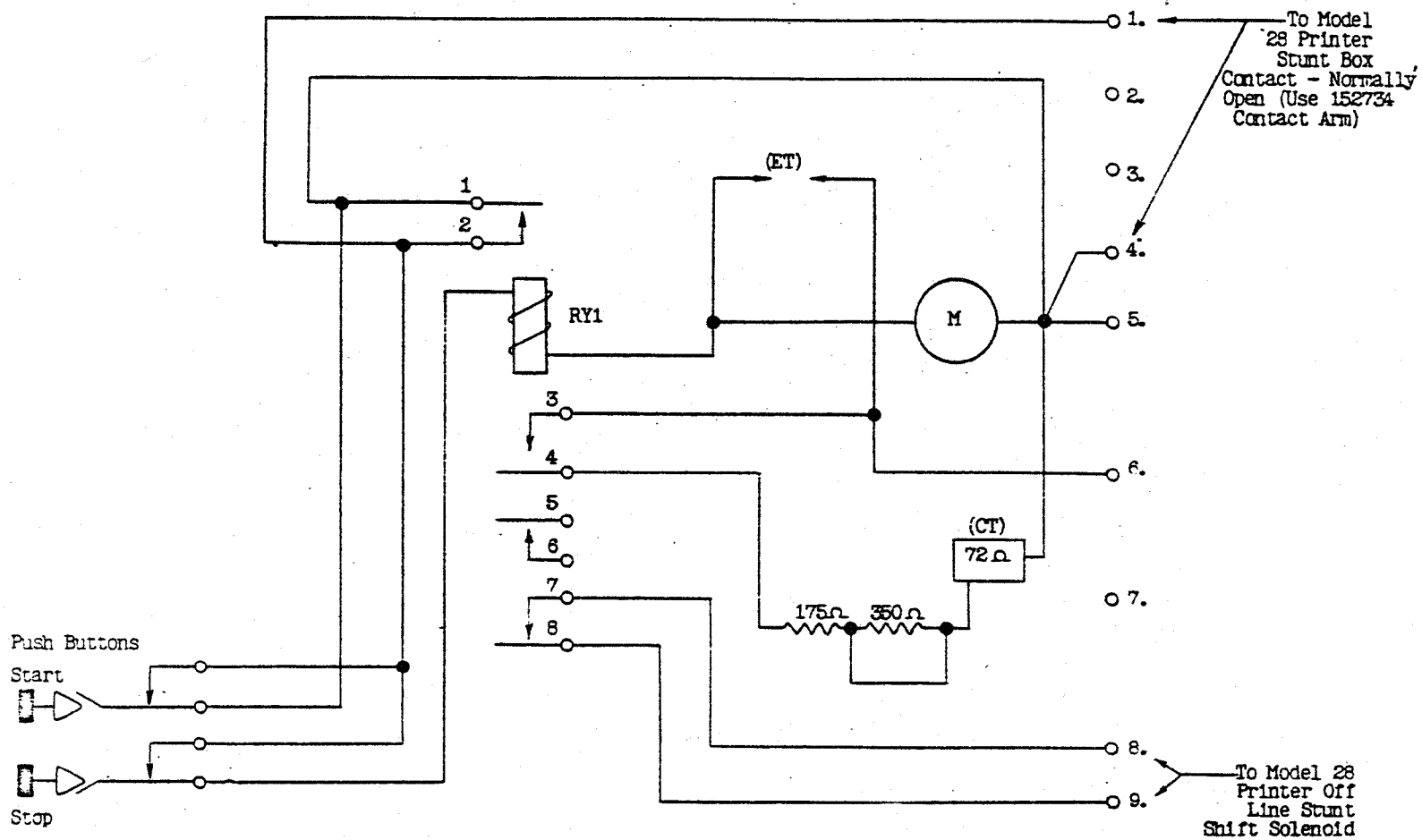
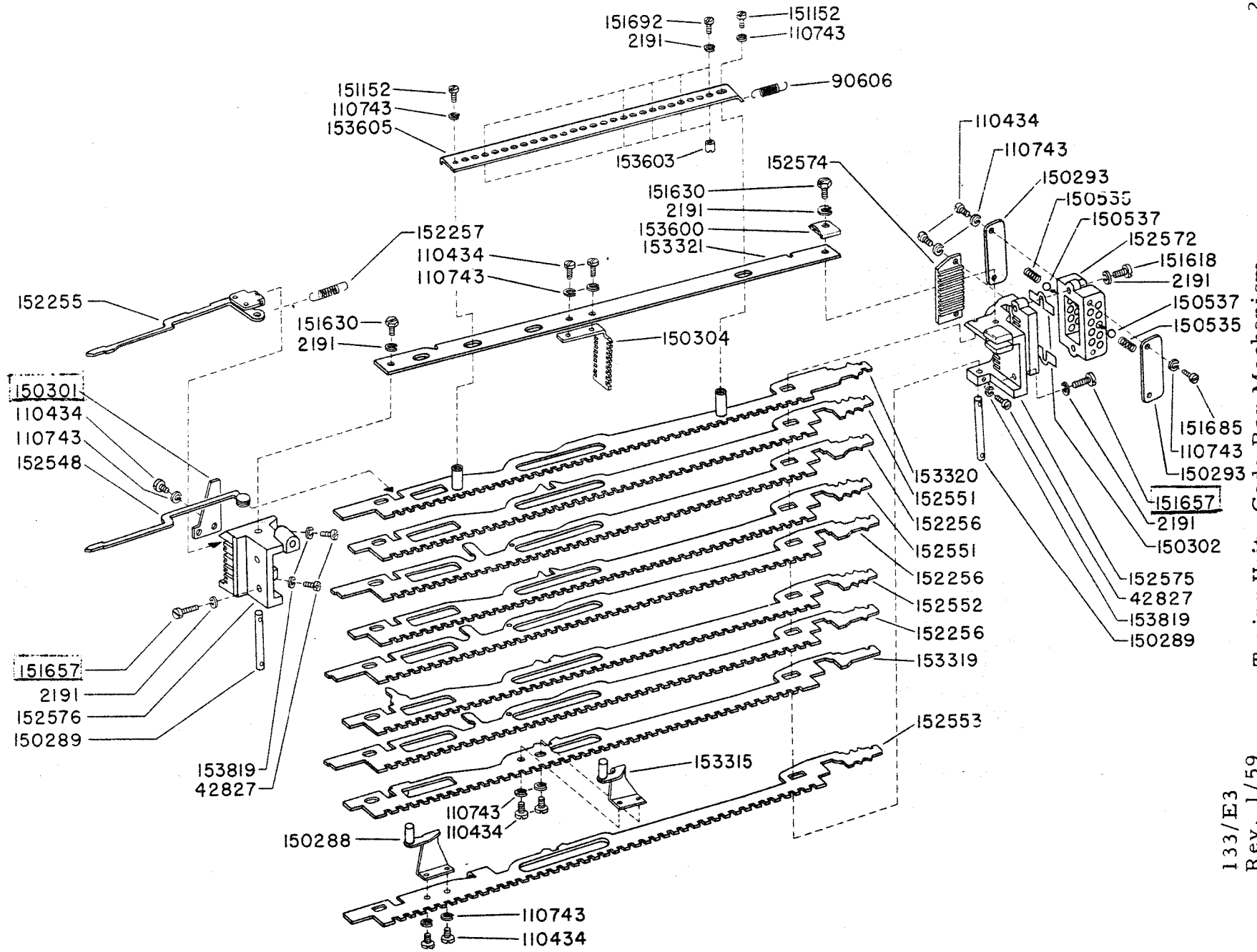


Figure 4-8. TD Modified for Automatic Scanning

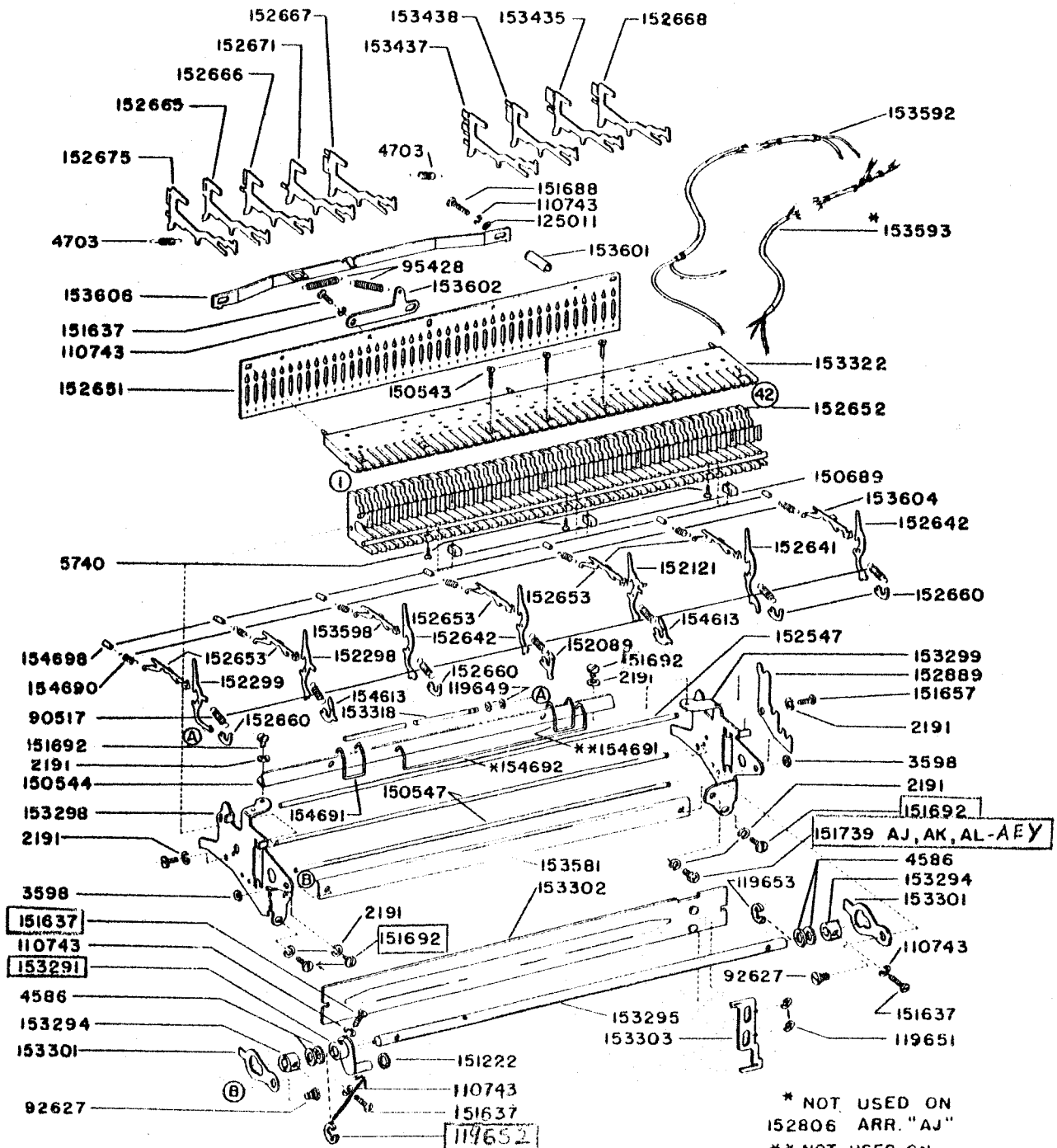
MODEL 28 PRINTER

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# MODEL 28 PRINTER

1157B



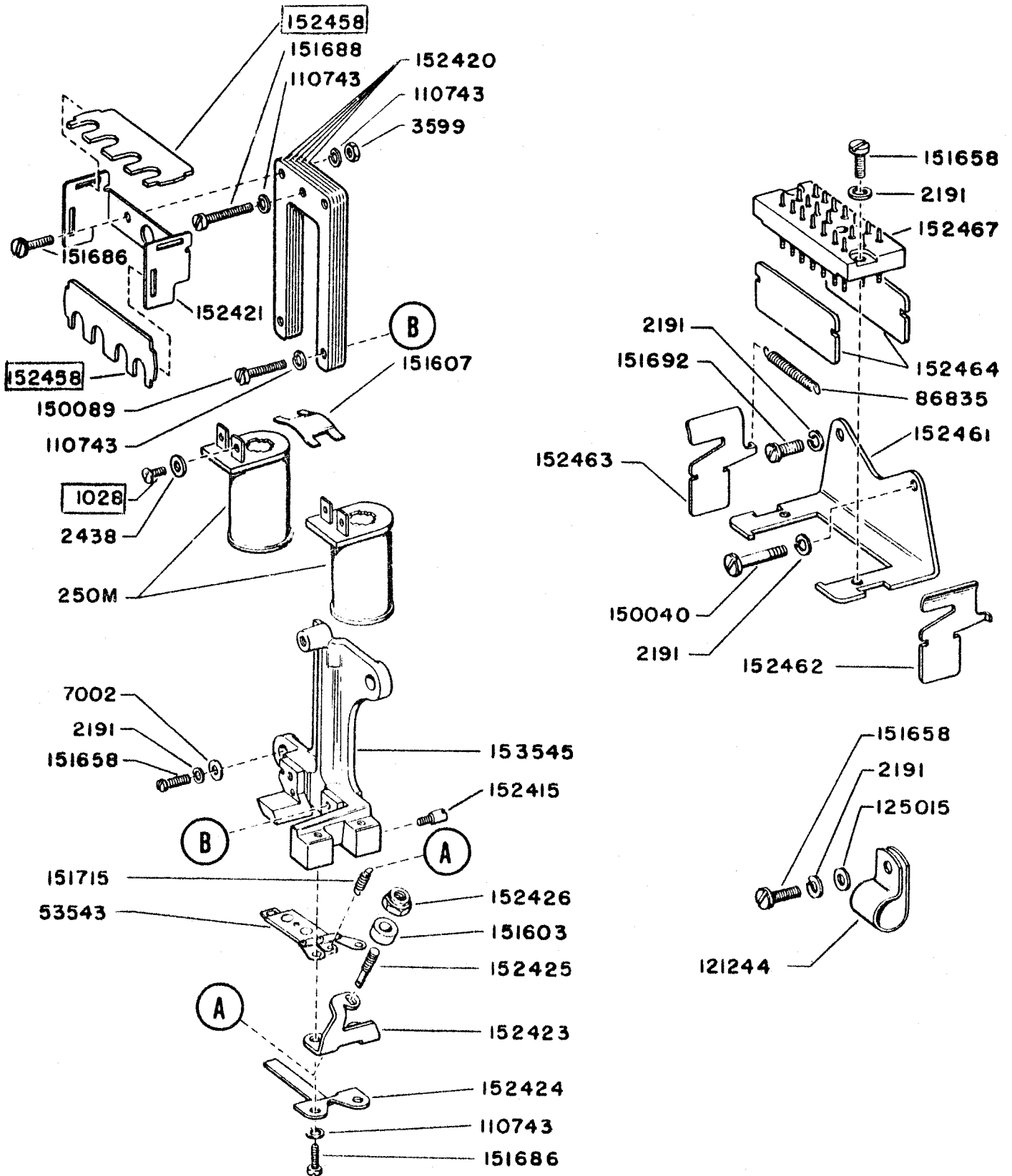
SEE CHART ON PAGES 69 AND 70  
 FOR STUNT BOX ARRANGEMENTS

\* NOT USED ON  
 152806 ARR. "AJ"  
 \*\* NOT USED ON  
 152807 AND 152808  
 ARR. "AK" AND "AL".

Typing Unit, Stunt Box Mechanism

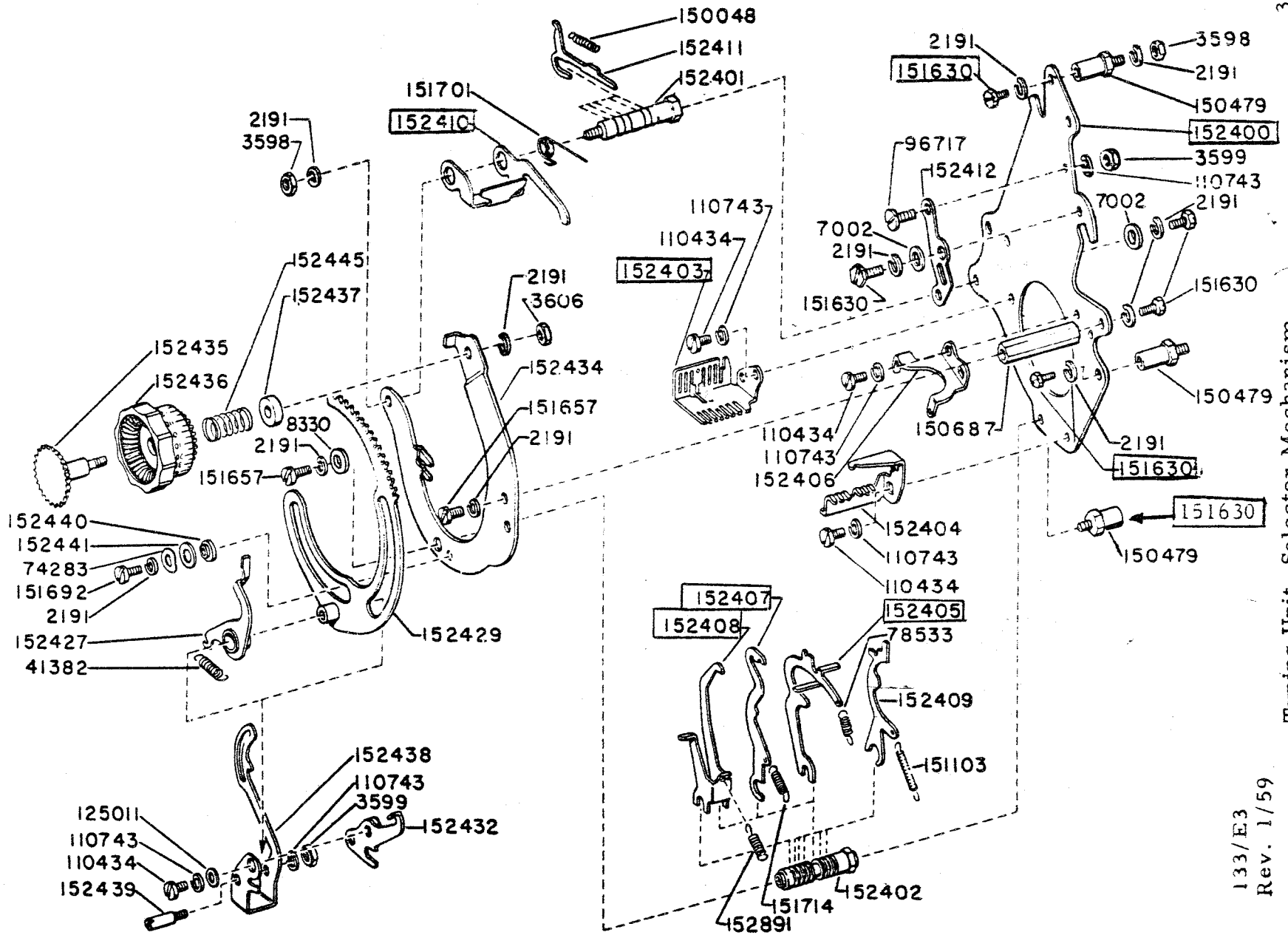
MODEL 28 PRINTER

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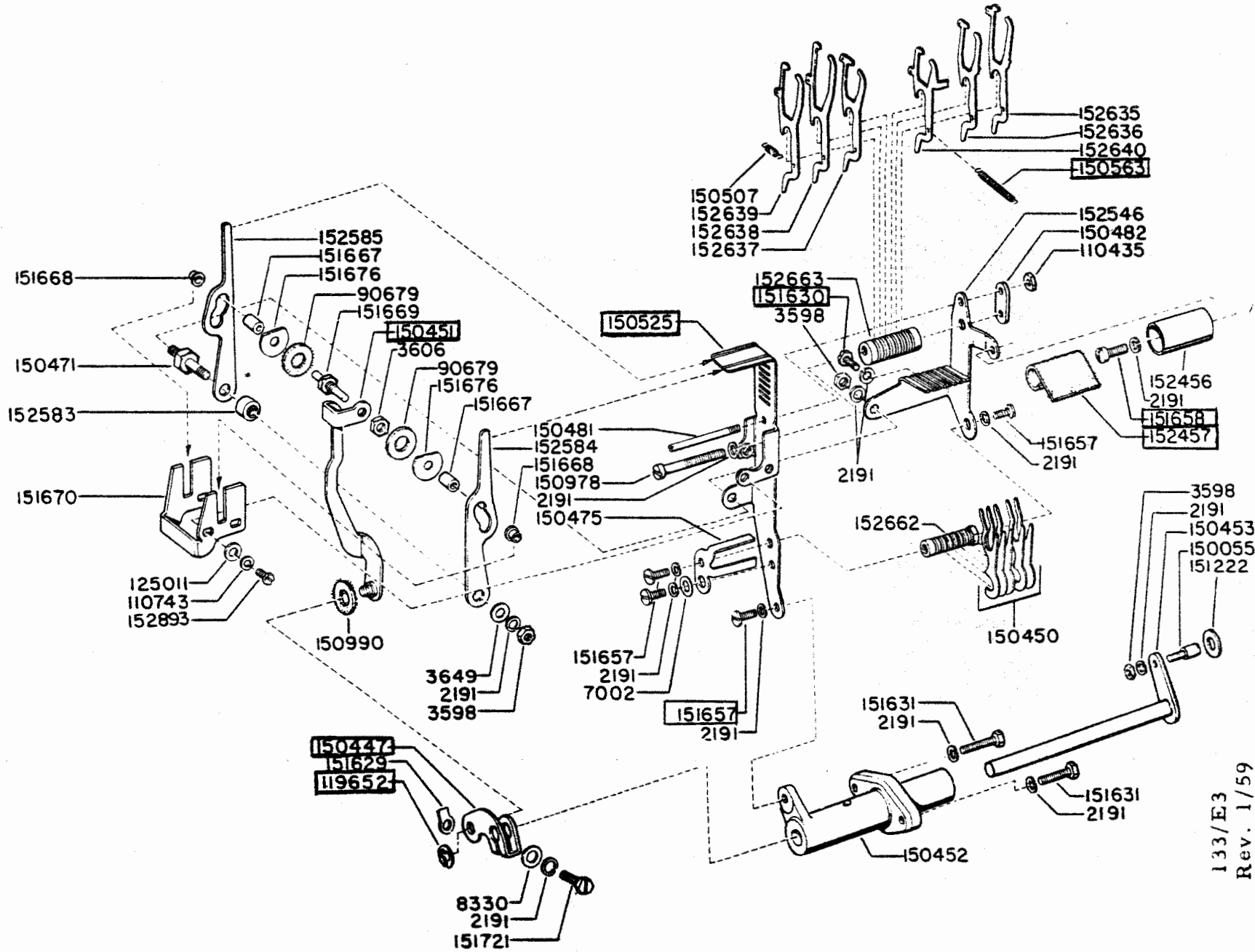
MODEL 28 PRINTER  
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Typing Unit, Selector Mechanism

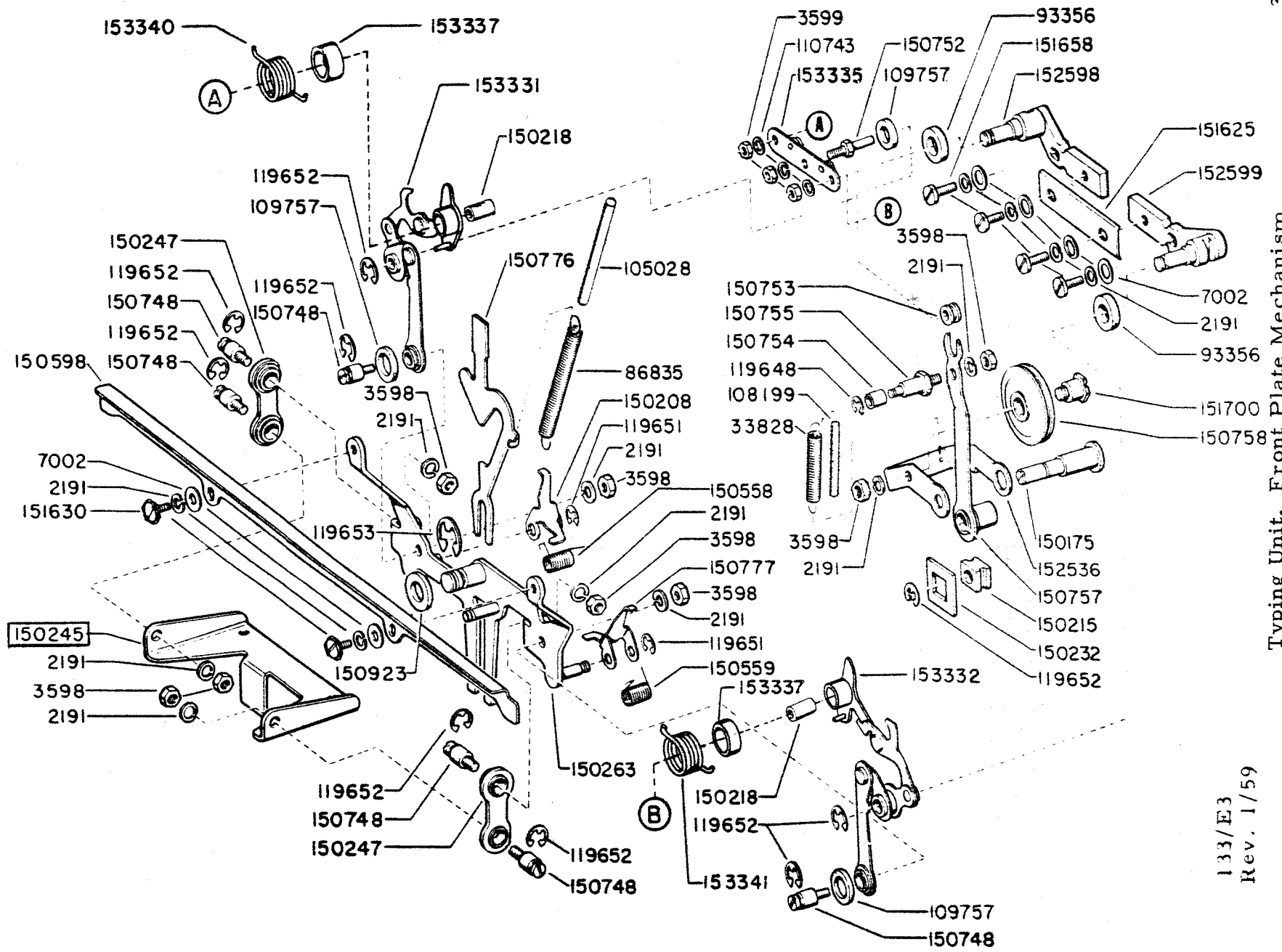
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MODEL 28 PRINTER  
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MODEL 28 PRINTER

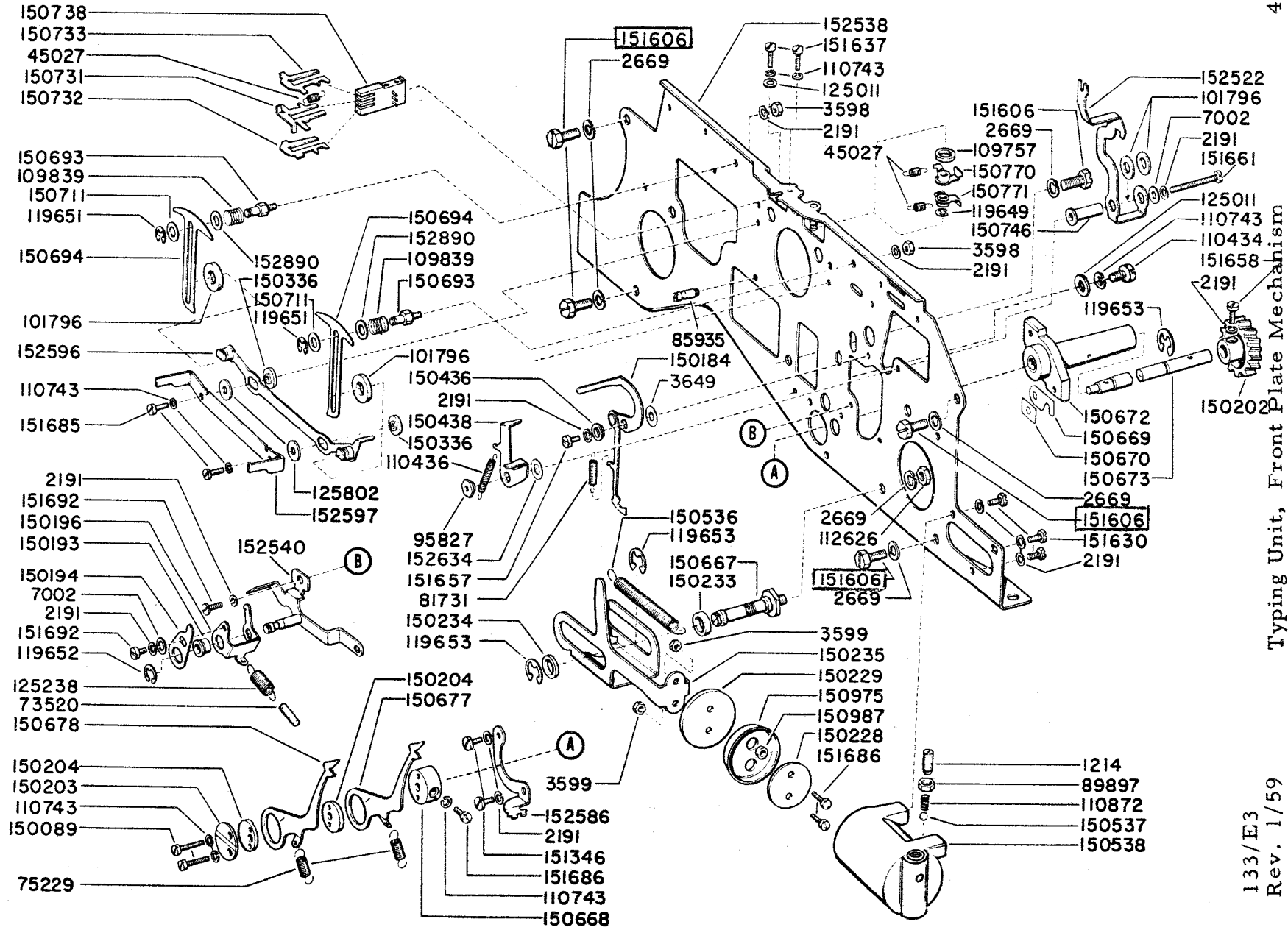
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Typing Unit, Front Plate Mechanism

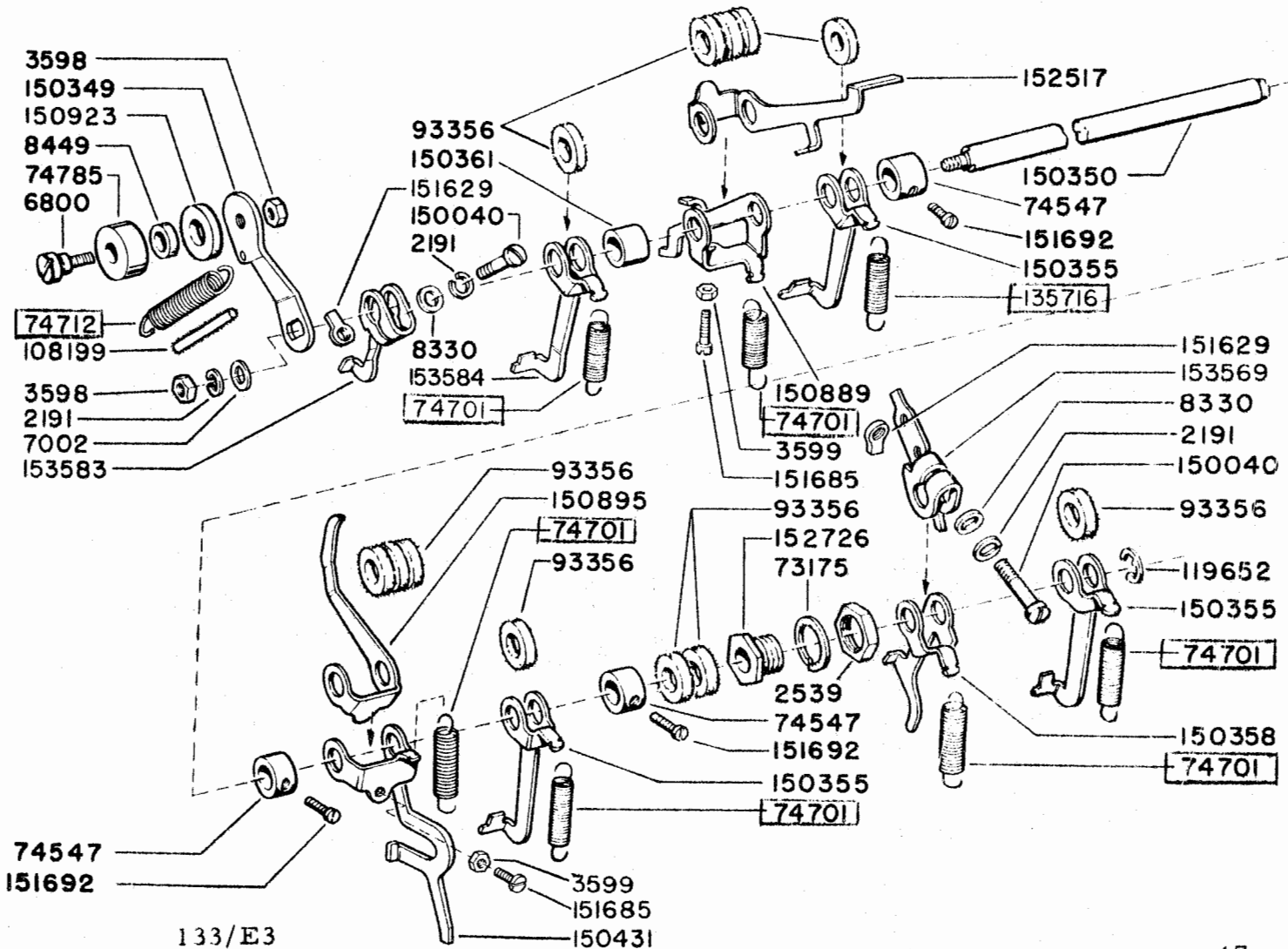
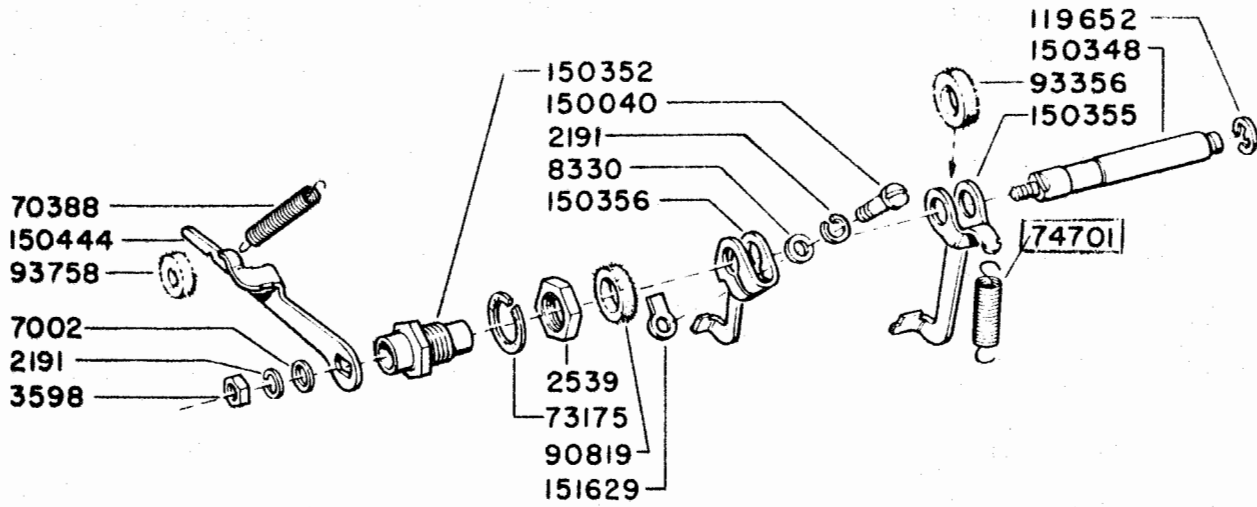
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MODEL 28 PRINTER  
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PRINTER 28 PRINTER

1157B

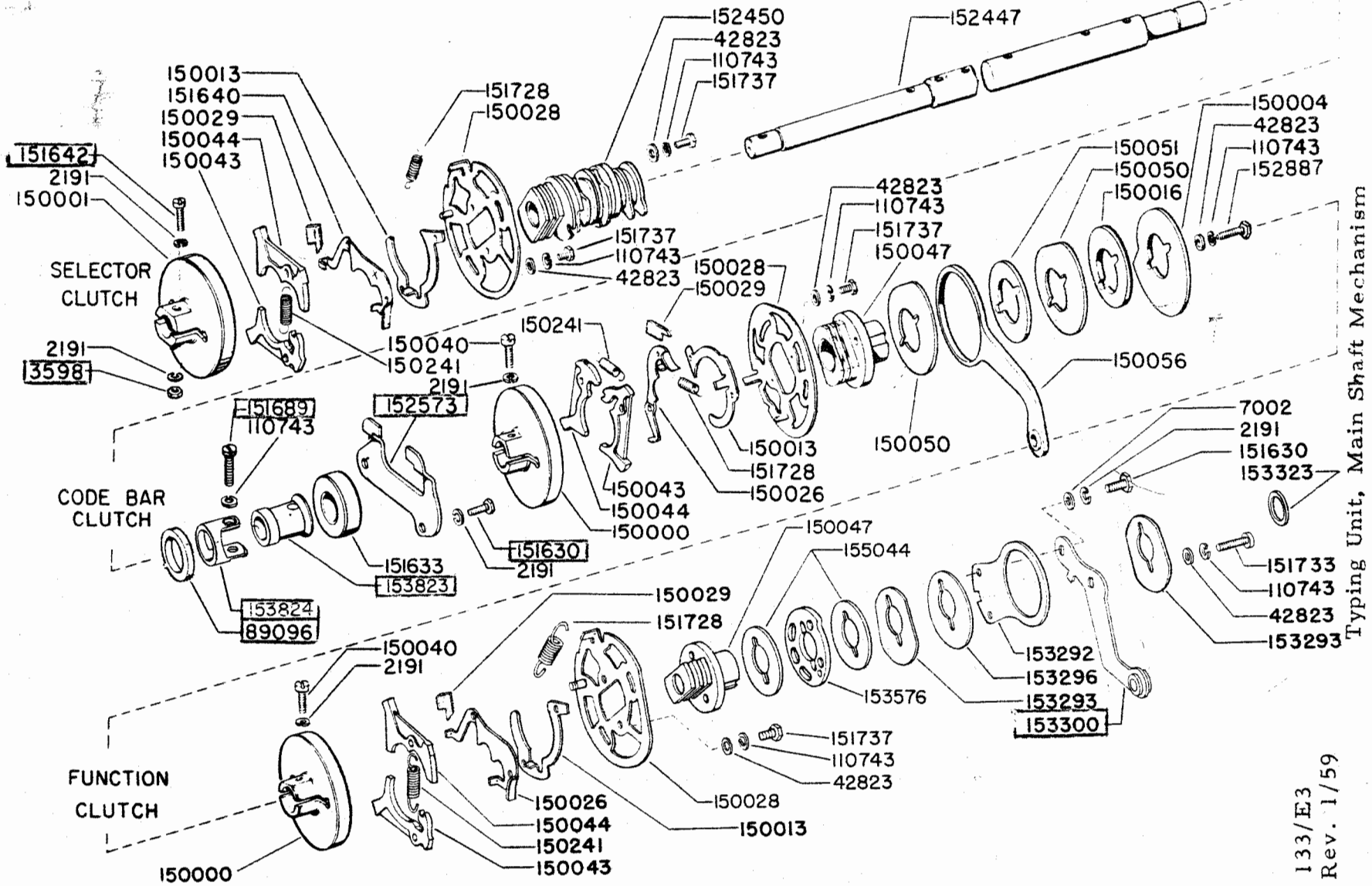


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Typing Unit, Trip Shaft Mechanism

MODEL 28 PRINTER

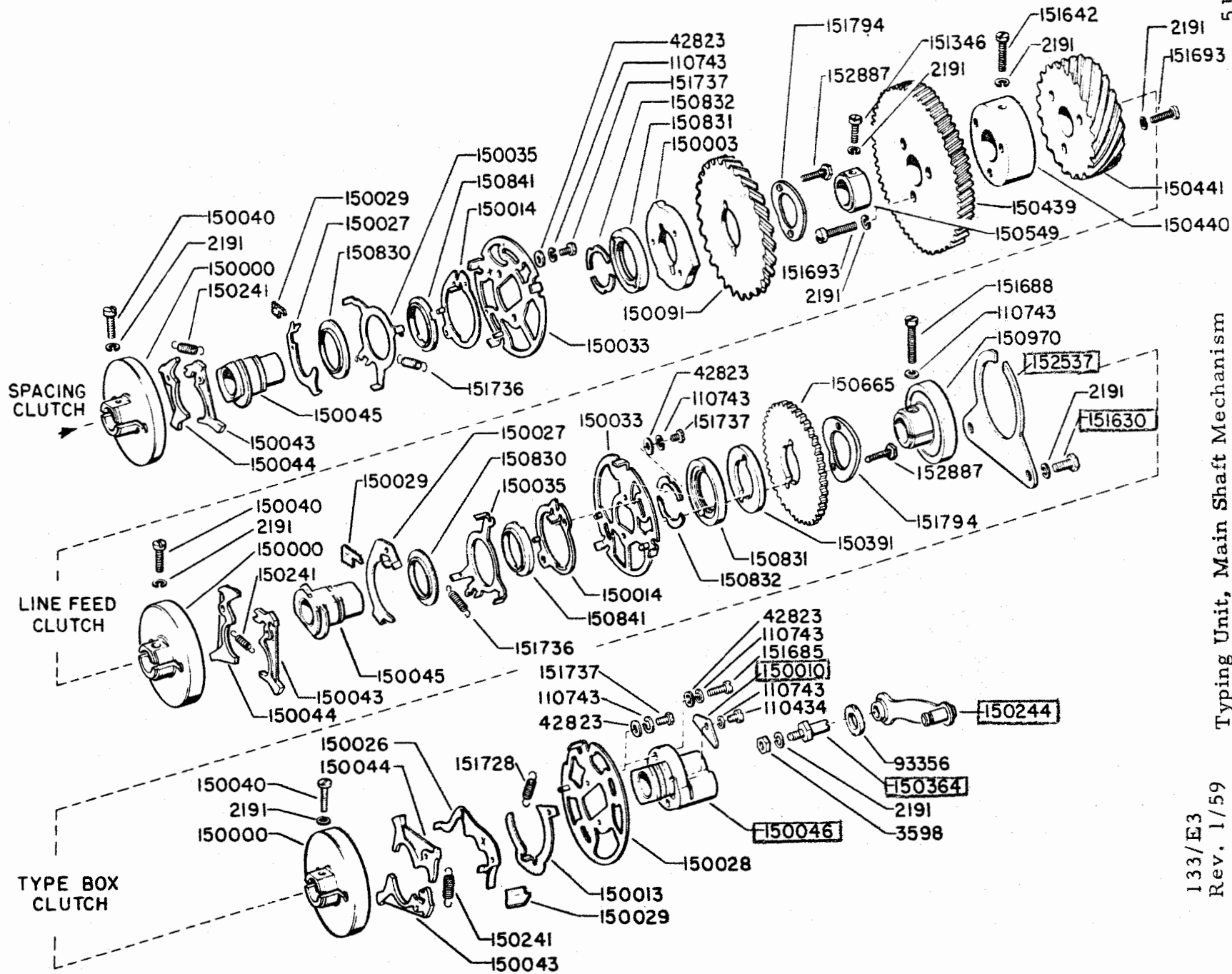
1157B



Typing Unit, Main Shaft Mechanism

MODEL 28 PRINTER

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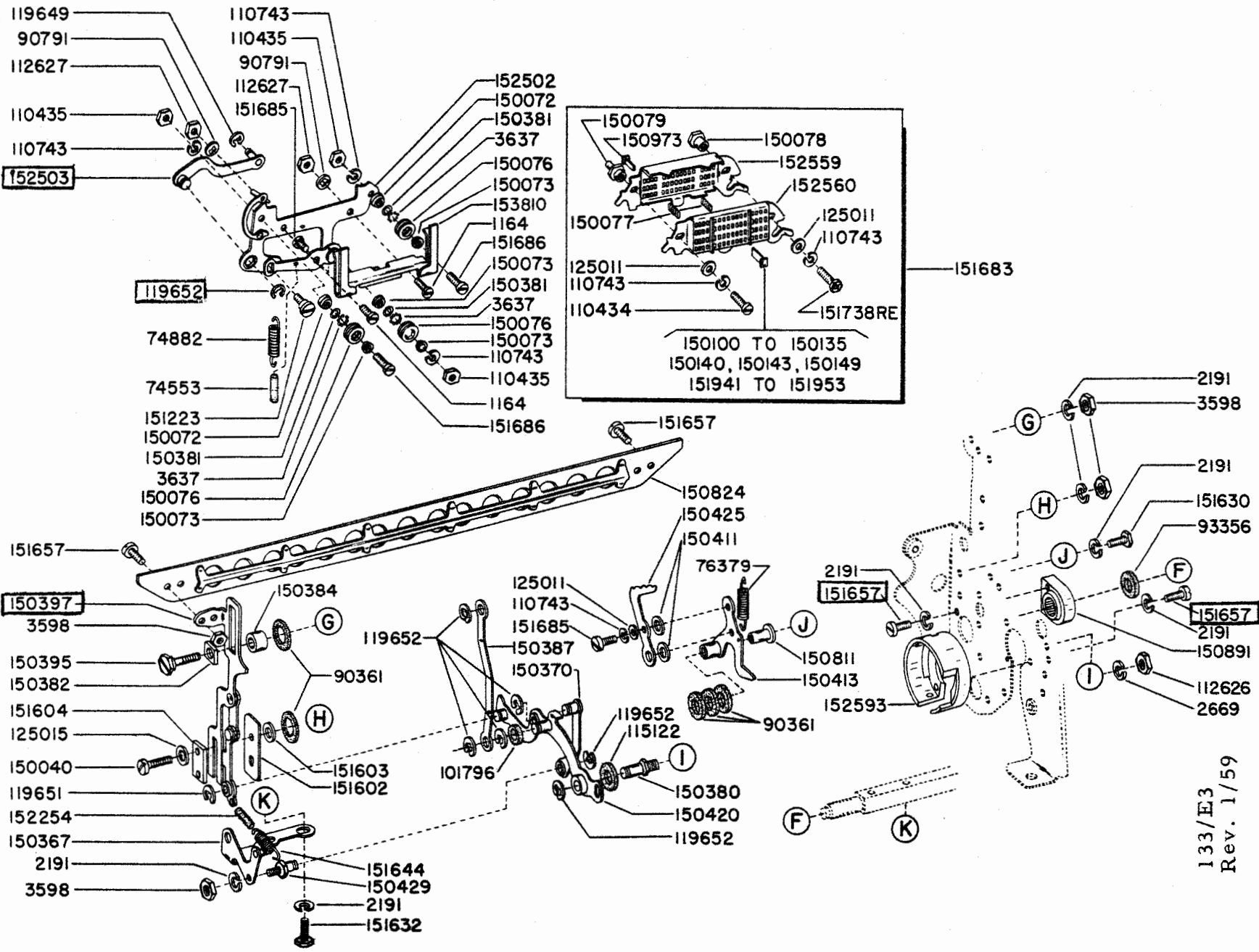


Typing Unit, Main Shaft Mechanism

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MODEL 28 PRINTER

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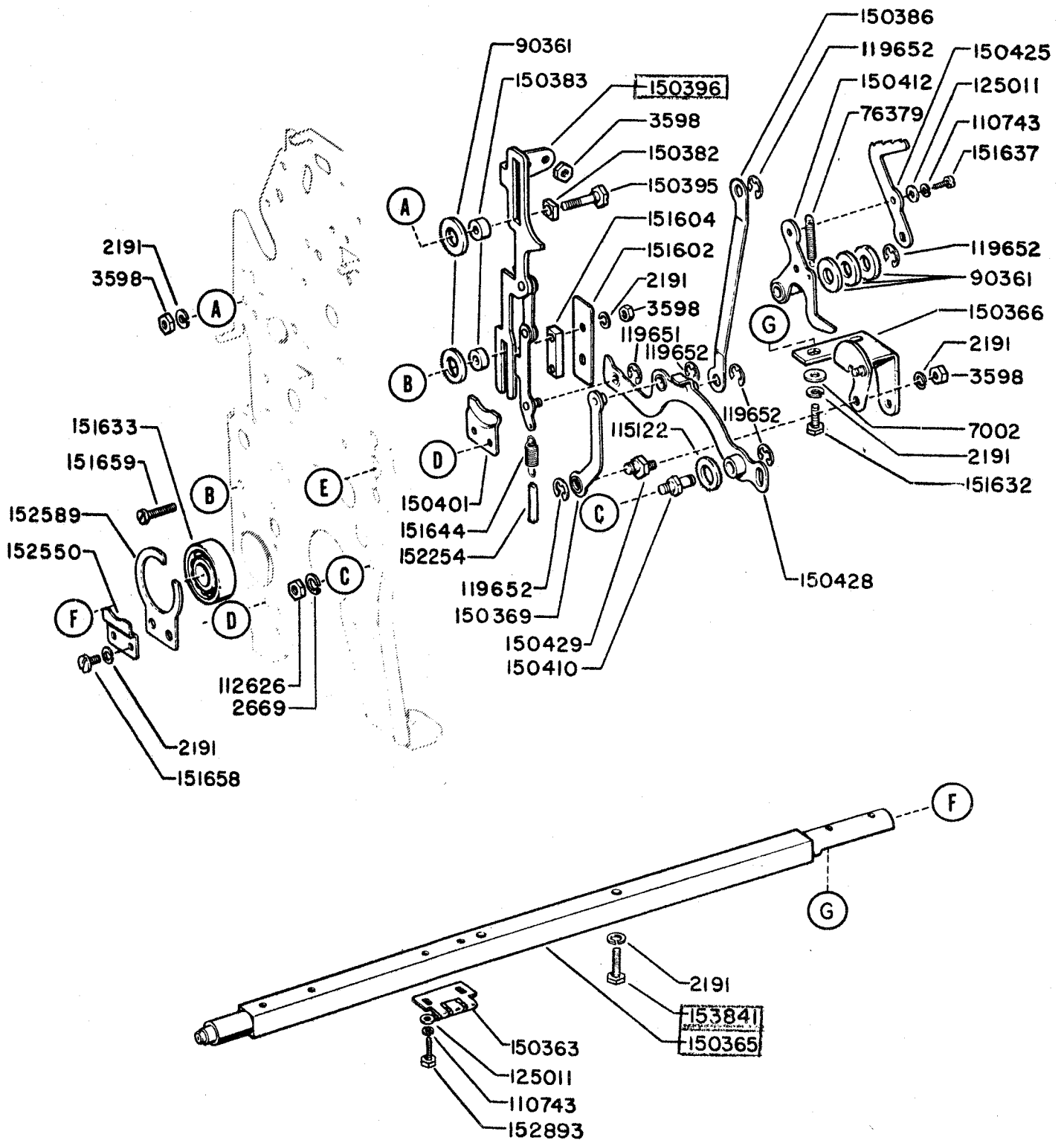


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MODEL 28 PRINTER

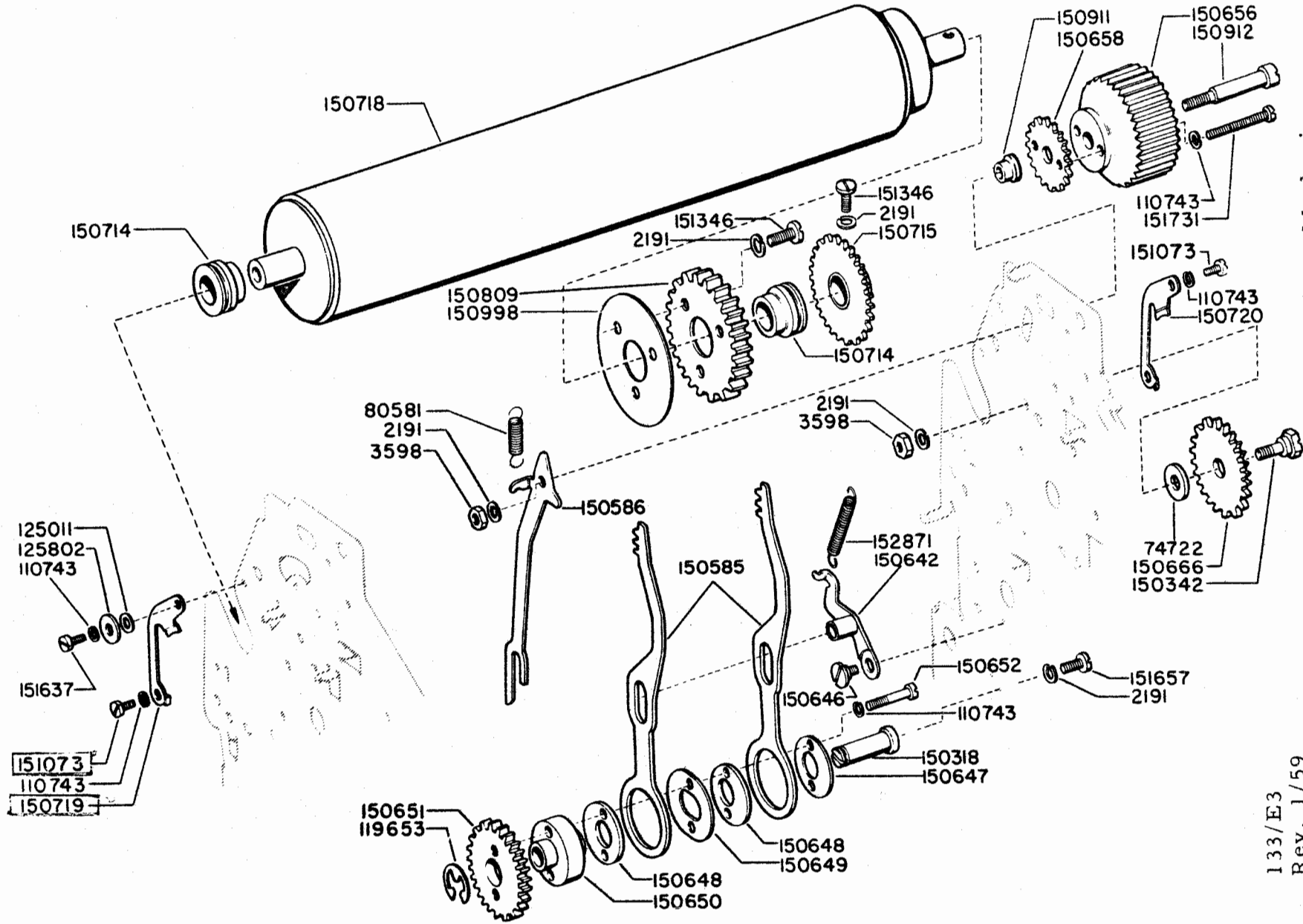
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Typing Unit, Left Side Linkage and Rocker Shaft Mechanism

MODEL 28 PRINTER

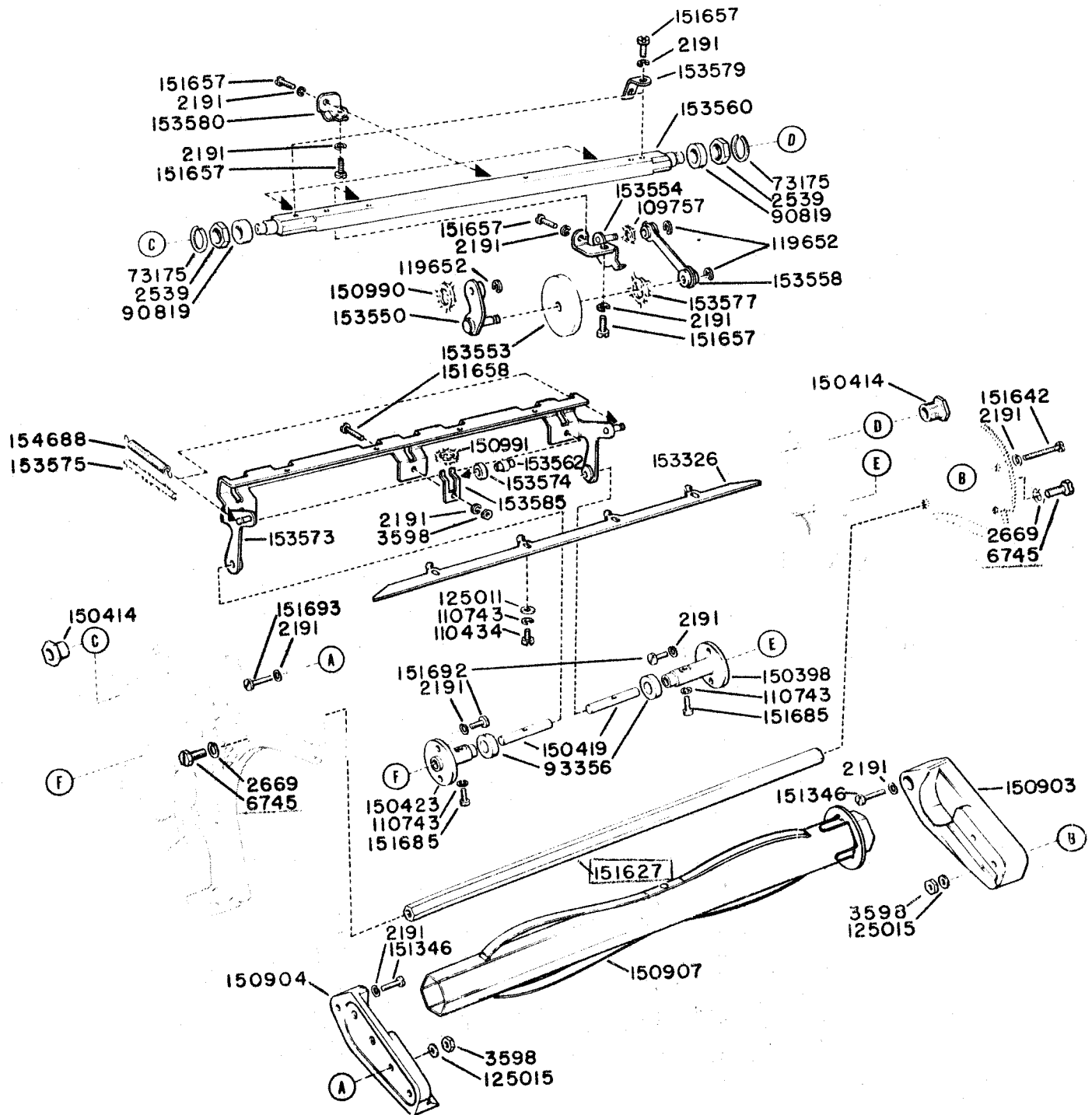
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Typing Unit, Line Feed and Platen Mechanism

MODEL 28 PRINTER

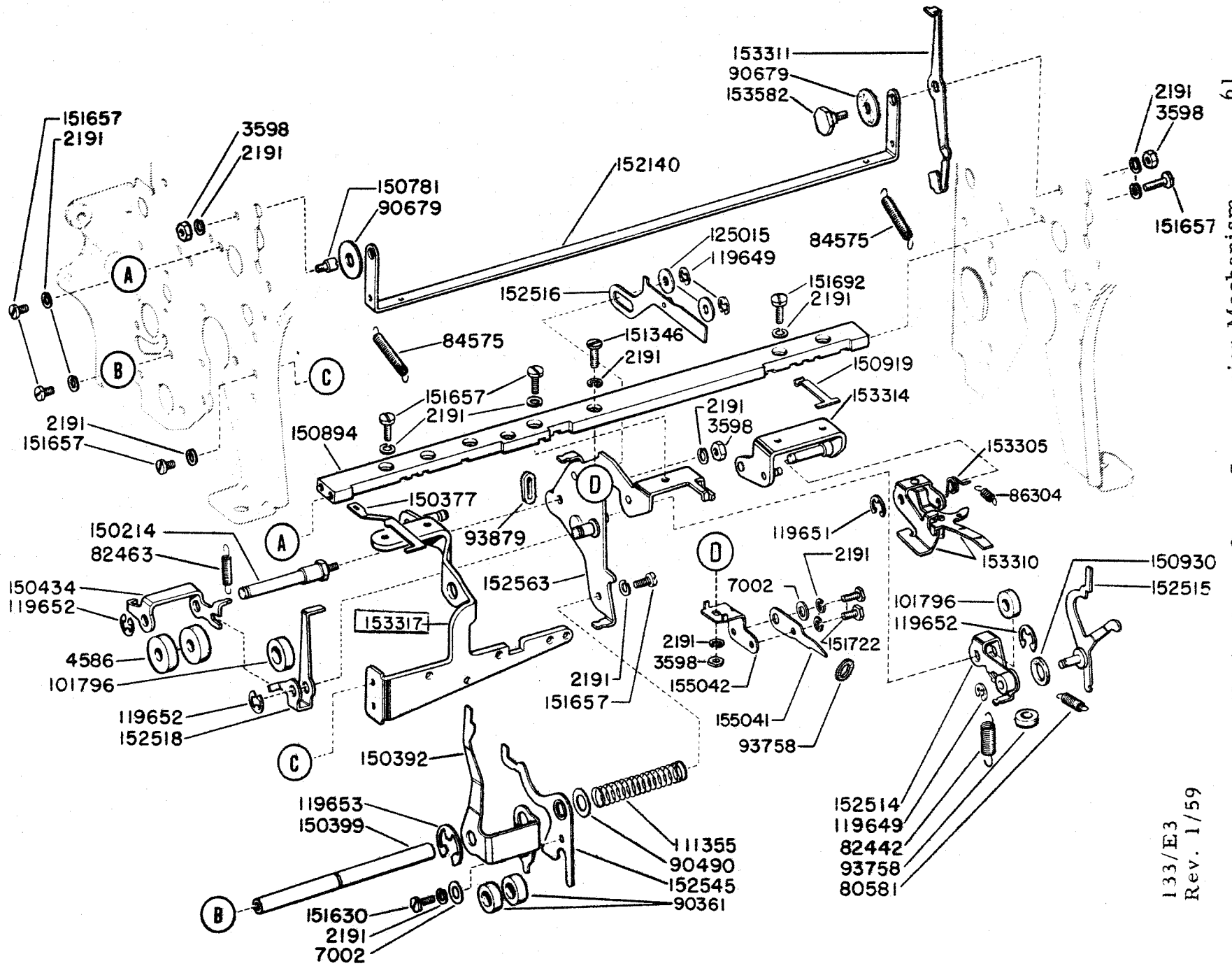
1157B



Typing Unit, Paper Spindle and Reset Bail Mechanism

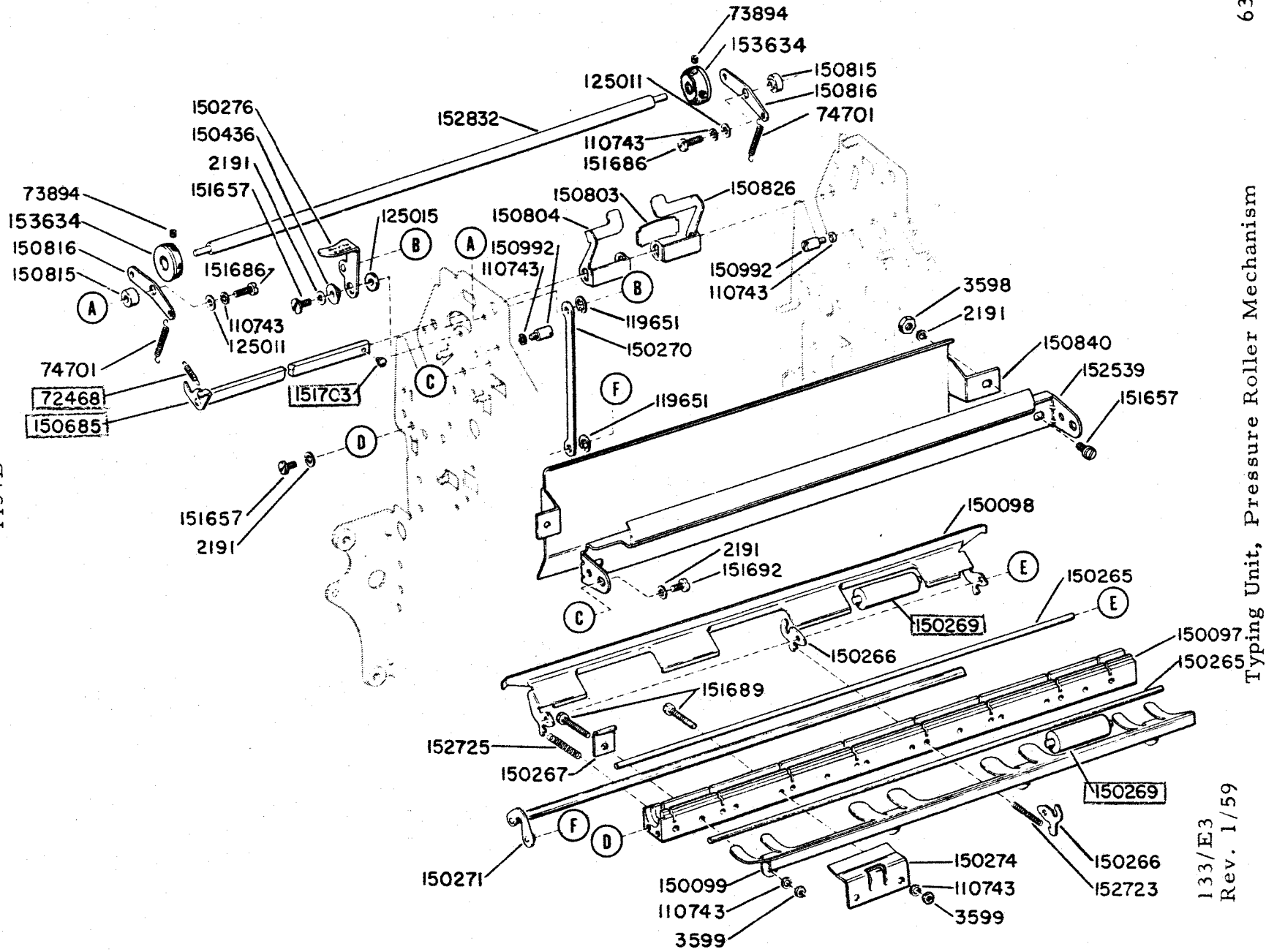
MODEL 28 PRINTER

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Typing Unit, Space Suppression Mechanism

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1157B

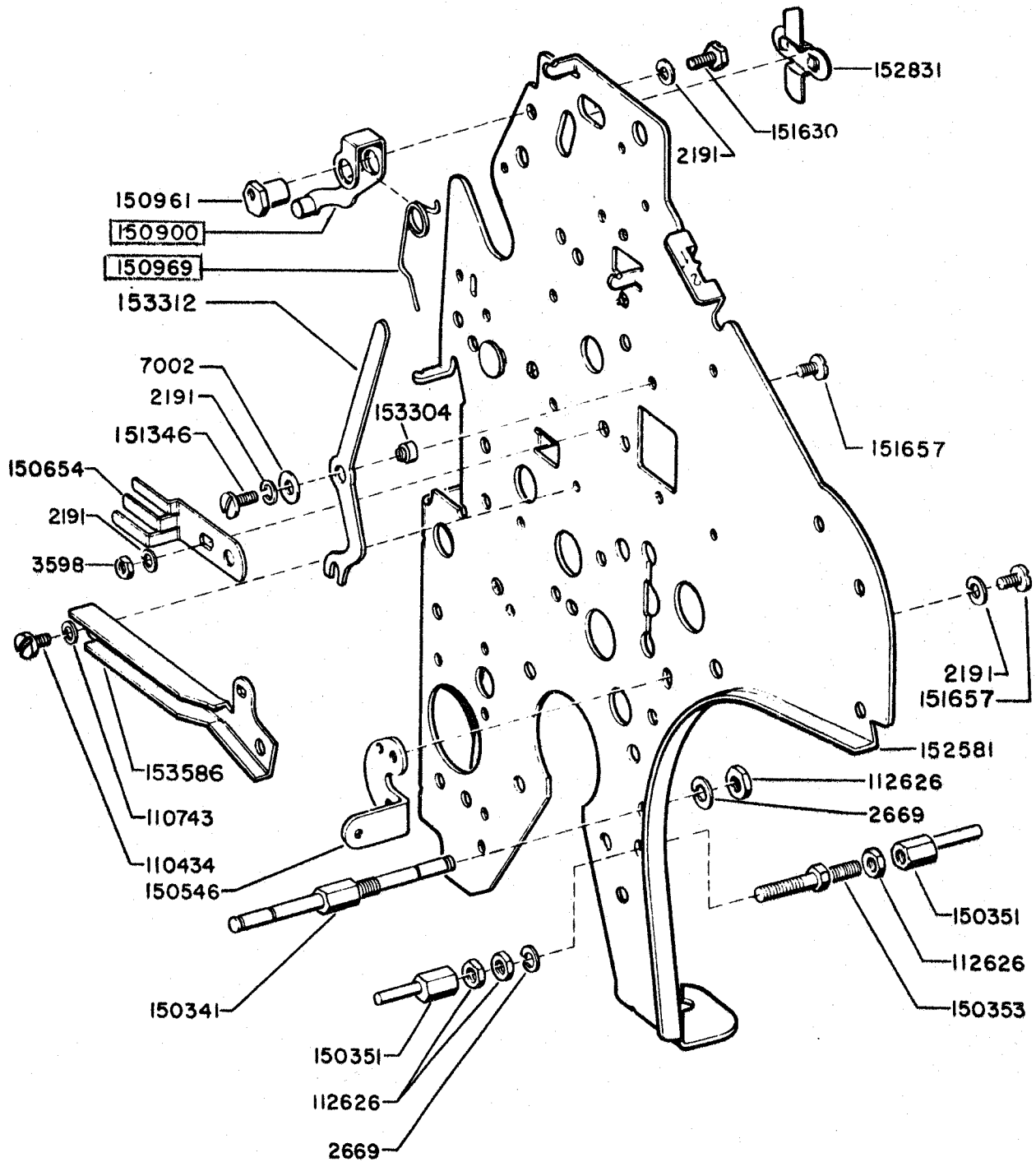


Typing Unit, Pressure Roller Mechanism

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MODEL 28 PRINTER

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Typing Unit, Left Side Frame Mechanism