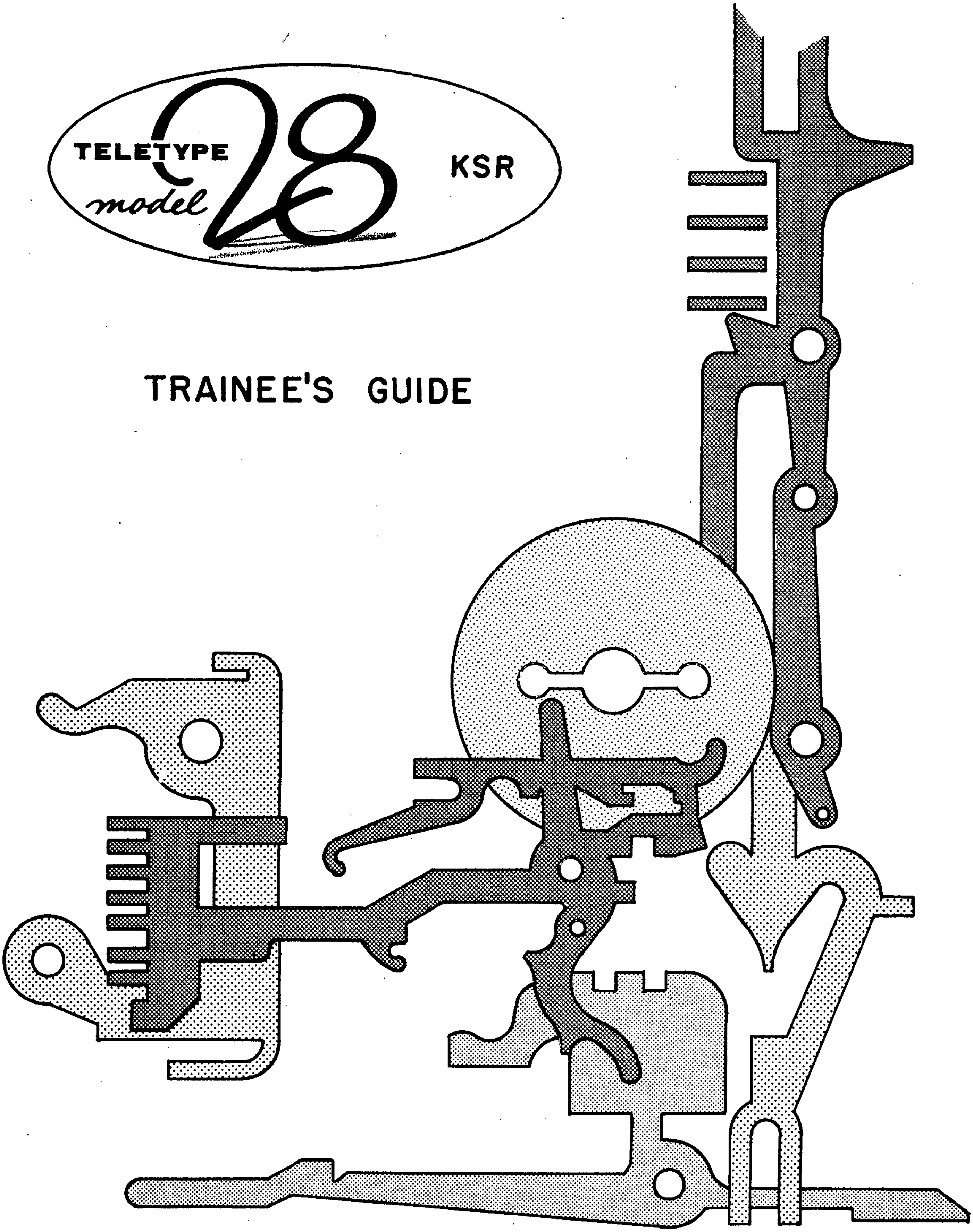
TELETYPE model 28 KSR

TRAINEE'S GUIDE



FOR INSTRUCTIONAL PURPOSES ONLY

(continued)

24. COMMON TRANSFER LEVER
25. CLUTCH TRIP SHAFT
26. TYPE BOX CLUTCH
27. ROCKER SHAFT AND VERTICAL POSITIONING LEVERS
28. TYPICAL TYPE BOX PALLET ARRANGEMENT
29. VERTICAL POSITIONING
30. NUMBER 3 CODE BAR AND REVERSING SLIDE
31. MAIN BAIL AND HORIZONTAL POSITIONING DRIVE LINKS
32. HORIZONTAL POSITIONING STOP SLIDES
33. WORK SHEET
34. PRINTING MECHANISM
35. BASIC FUNCTION SELECTION
36. FUNCTION STRIPPER BLADE
37. SPACING MECHANISM
38. SPACING FEED PAWLS
39. DRAW WIRE ROPES
40. SPACE SUPPRESSION
41. CARRIAGE RETURN MECHANISM
42. LINE FEED FUNCTION
43. LINE FEED BARS
44. SINGLE LINE FEED
45. DOUBLE LINE FEED
46. LETTERS FIGURES SHIFT SLIDES
47. LETTERS SHIFT
48. FIGURES SHIFT
49. UNIVERSAL FUNCTION BAR PROGRAMMING
50. STUNT BOX CONTACTS
51. STUNT BOX

ELECTRICAL SECTION

SCHOOL INFORMATION

The Customer Service School, under the supervision of the TELETYPE Sales Organization, provides tuition-free maintenance training on standard products primarily for customers, or their representatives.

Neither the TELETYPE CORPORATION or the Maintenance Training School will assume the responsibility for making student hotel reservations. For Military personnel the school will, upon request, issue a form indicating time of arrival and departure. No certificate of non-availability of aircraft, rations, or quarters will be issued.

Class hours are from 8:00 a.m. to 4:30 p.m. Monday through Friday, with a fifteen minute break in the a.m. and p.m. and one hour lunch period. Class will terminate approximately 3:30 p.m. of the last day. No classes are scheduled for Saturdays. Students may bring their lunch or eat at any of the numerous restaurants in the area.

Students are requested to observe class hours. A telephone call is expected from the student if he will be late or absent. Students who are repeatedly late will not receive make-up instruction and if such action continues, will be asked to leave.

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

At the end of the course the instructor will make a report on each student, which will cover starting and completion dates plus any absences occuring during the course, and a grade covering attitude and performance in theory, adjustments, and trouble shooting. This report is submitted to the customer sponsoring each student. (See example on following page.)

Teletype plant personnel may not leave the school during normal school hours, lunch and break periods excepted, without the express permission of their supervisor.

Mail addressed to the school should be addressed as follows:

(Students name)
c/o TELETYPE TRAINING SCHOOL
201 North Wells Street
Chicago, Illinois 60606

The school's telephone may be used ONLY by instructors and Teletype personnel on company business. The telephone number of the school is:

Area Code 312, 346-0585

TELETYPE CORPORATION

Training School Report

Date ______________

Student ______________ Class No. ______________

Organization ______________ Duration ______________

City ______________ State ______________ Began ______ Ended ______ 19___

1. Text Material furnished for apparatus studied _____ Bulletins _____ Specifications

2. GRADES (P - Poor, F - Fair, G - Good, VG - Very Good, EX - Excellent)

TELETYPE EQUIPMENT	Theory	Adjust	Trouble Shooting	TELETYPE EQUIPMENT	Theory	Adjust	Trouble Shooting
Fixed and Pivoted Head ASR Trans. Dist.				Printer (KSR) Keyboard			
Single Contact ASR Trans. Dist.				BRPE Punch			
ASR Keyboard Perf. Trans.				CX Reader			
ASR Typing & Non-typing Perf-Reperf.				M-29			
Strob. Test Set				M-33			
RT Set				M-35			

ATTITUDE ______________ MECHANICAL ABILITY ______________

COOPERATION ______________ CLASSROOM WORK ______________

3. We believe that the student is capable of maintaining the equipment studied:
   a. Under all conditions ______________ b. Under most conditions ______________
   c. With additional experience ______________ d. With supervision ______________

4. ABSENCES:

Date	Hours	Reason
______	______	______ Sickness
______	______	______ Pers. Bus.
______	______	______ Tardy

____
Instructor

B

____
SUPERVISOR

MODEL 28
KEYBOARD (SENDING) AND PRINTER (RECEIVING)
SET COURSE OF INSTRUCTION

Description of the Course

The purpose of this course is to train personnel in the maintenance of the MODEL 28 KEYBOARD (Sending) and **PRINTER** (Receiving) SET.

This course is scheduled for a two week period and will cover theory, disassembly, adjustments of principle components, and trouble shooting of the complete set.

All students are urged to take notes for future reference, and to ask questions so that they may derive the maximum benefit from the course.

Literature

The following Teletype Bulletins will be furnished to each student:

Bulletins		Teletype Code
Desc. & Theory	Keyboard & Printer	LK, LP
Adj. & Lubrication	Kybrd.,Base,Ptr.,Cabinet	LK, LB, LP, LAC

DISASSEMBLY AND REASSEMBLY

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

Replace parts in reverse order where practicable.

KEYBOARD

1. Contact Box
2. Signal Generator
3. Keylevers - Remove one
4. Lockball Channel
5. Code Bar Assembly

PRINTER

1. Front Plate
2. Stunt Box
3. Code Bar Shift Bars
4. Code Bar Positioning mechanism
5. Selector Cam assembly
6. Magnet Bracket
7. Main Shaft
8. Platen - Instructor demonstrate
9. Wire Ropes

ADJUSTMENTS

The course of instruction covering the Model 28 Keyboard and Printer is covered within a two week period. A Keyboard and Printer will be provided each student. The Keyboard and Printer theory is then presented to the class as a whole or in separate groups. Following disassembly and reassembly, the instructor will demonstrate a few pages at a time how adjustments are to be made. It will be the student's responsibility within his separate group to make all the adjustments required to put the equipment back in a first class working condition. It is felt that only by actually making the adjustment will the student understand how it is properly made and the difficulties that might be encountered.

1. Clearance: A measurement USING THE GAUGES PROVIDED, will be required. Should the requirement, for example, read: "Min: .002" "Max: .020", any point between the two limits will be satisfactory.

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

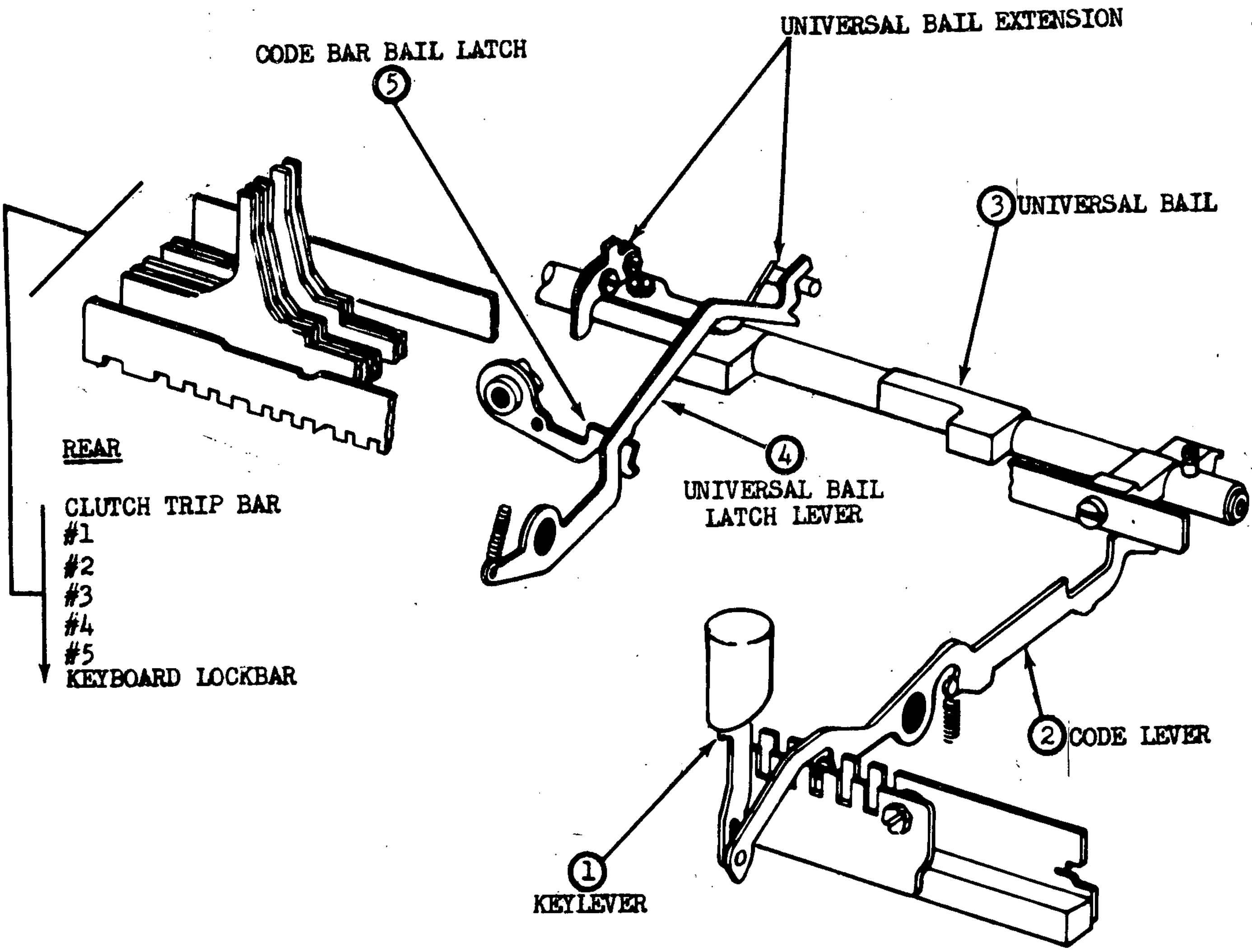
3. End Play: Although the adjustment manual will give the point at which the required end play may be measured, it is usually satisfactory to check the particular part for freedom from bind without excessive movement.

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

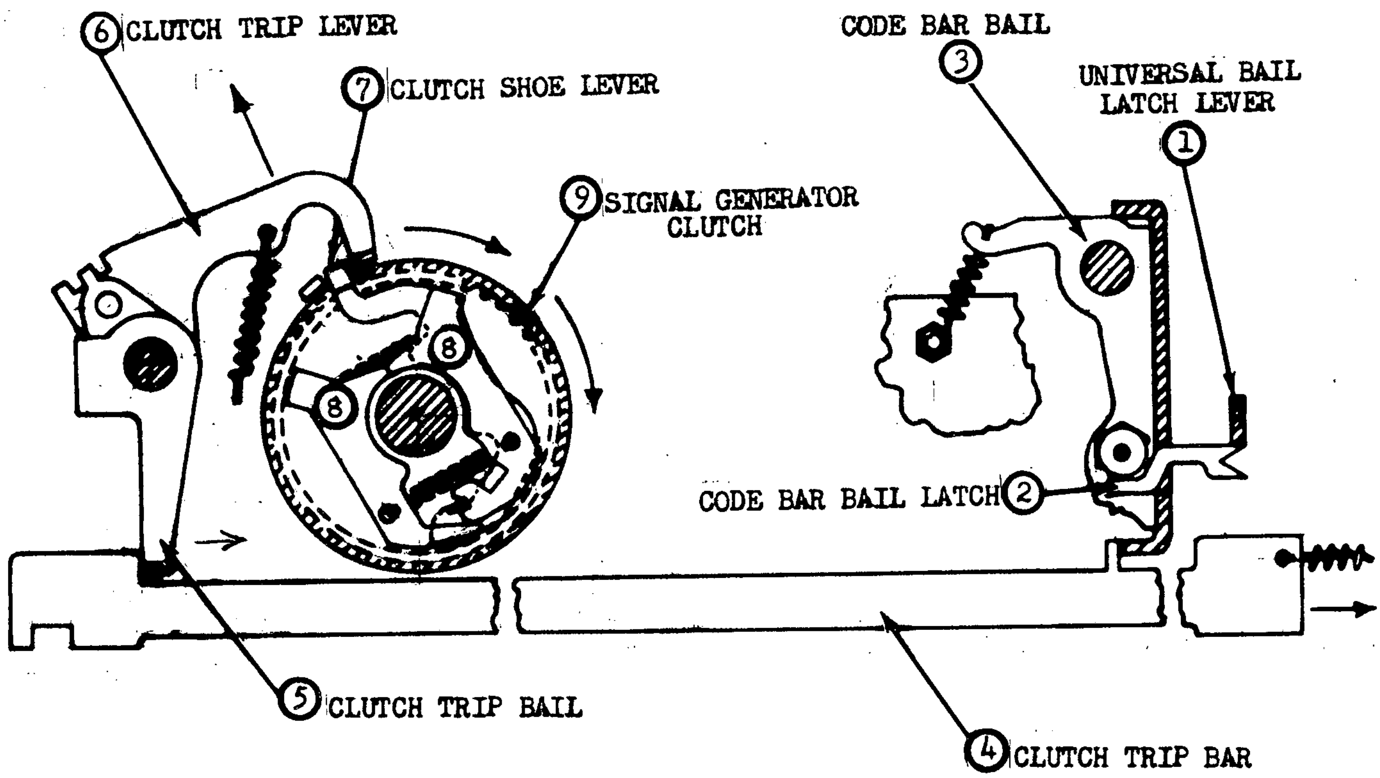
TOOLS

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

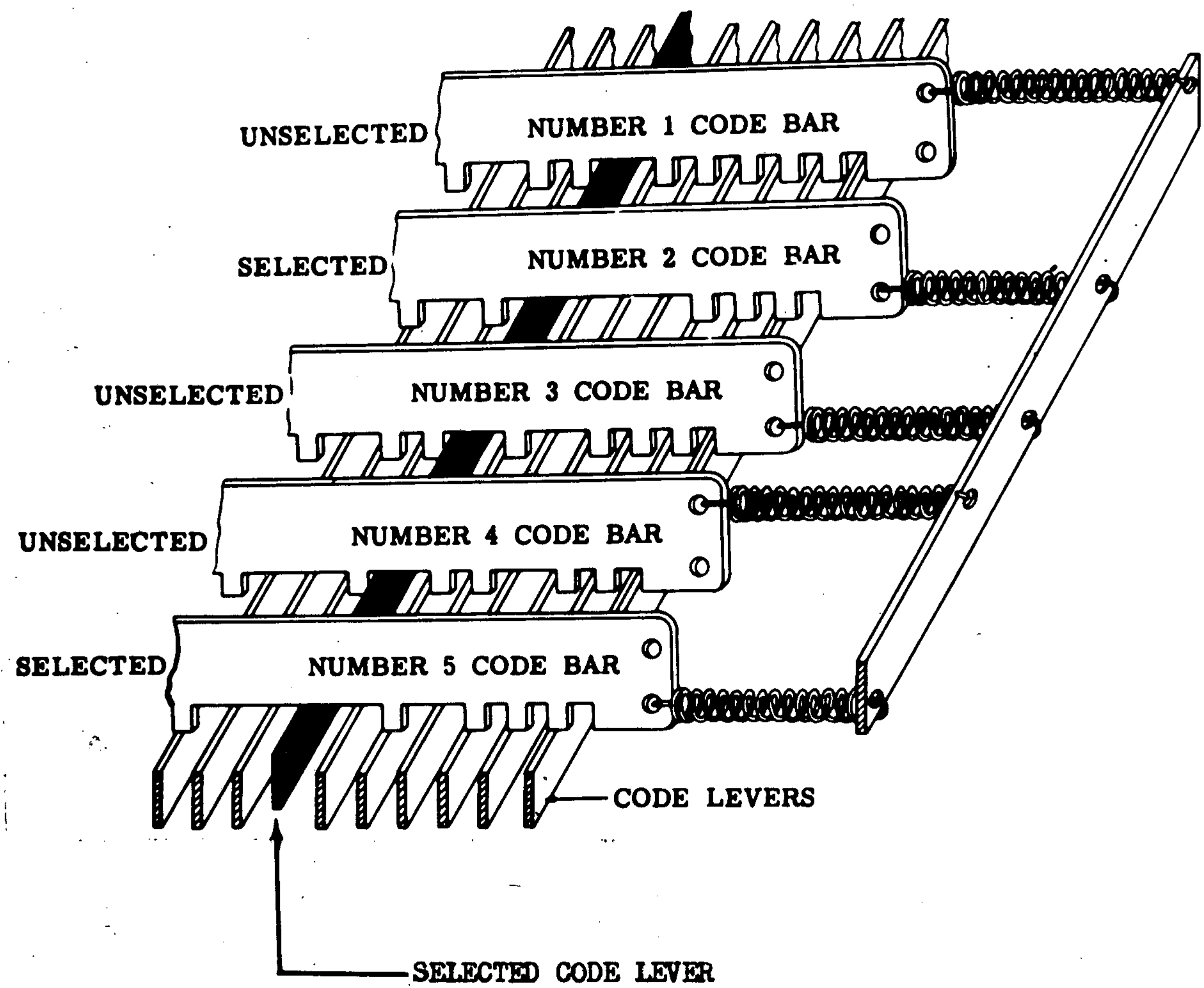
QTY	NAME	USE OR DESCRIPTION
1	Wrench	5/16" socket
1	Wrench	3/16" x 1/4"
1	Wrench	3/8" x 5/16"
1	Handwheel	Turn the printer mainshaft manually
1	Armature clip	To hold the armature in a MARKING position for off-line checks.
2	Spring Hooks	(1) Push hook (1) Pull hook
1	Crochet Hook	Small springs
1	Tweezers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



1. KEYLEVER depressed
2. CODE LEVER pivots
3. UNIVERSAL BAIL pivots (rearward)
4. UNIVERSAL BAIL LATCH LEVER drops
5. CODE BAR BAIL LATCH pushed down



1. UNIVERSAL BAIL LATCH LEVER drops
2. CODE BAR BAIL LATCH pushed down
3. CODE BAR BAIL released pivots (counterclock-wise)
4. CLUTCH TRIP BAR moves (right)
5. CLUTCH TRIP BAIL pivots (counterclock-wise)
6. CLUTCH TRIP LEVER releases
7. CLUTCH SHOE LEVER moves
8. PRIMARY and SECONDARY SHOES expand gripping drum
9. SIGNAL GENERATOR CLUTCH engages



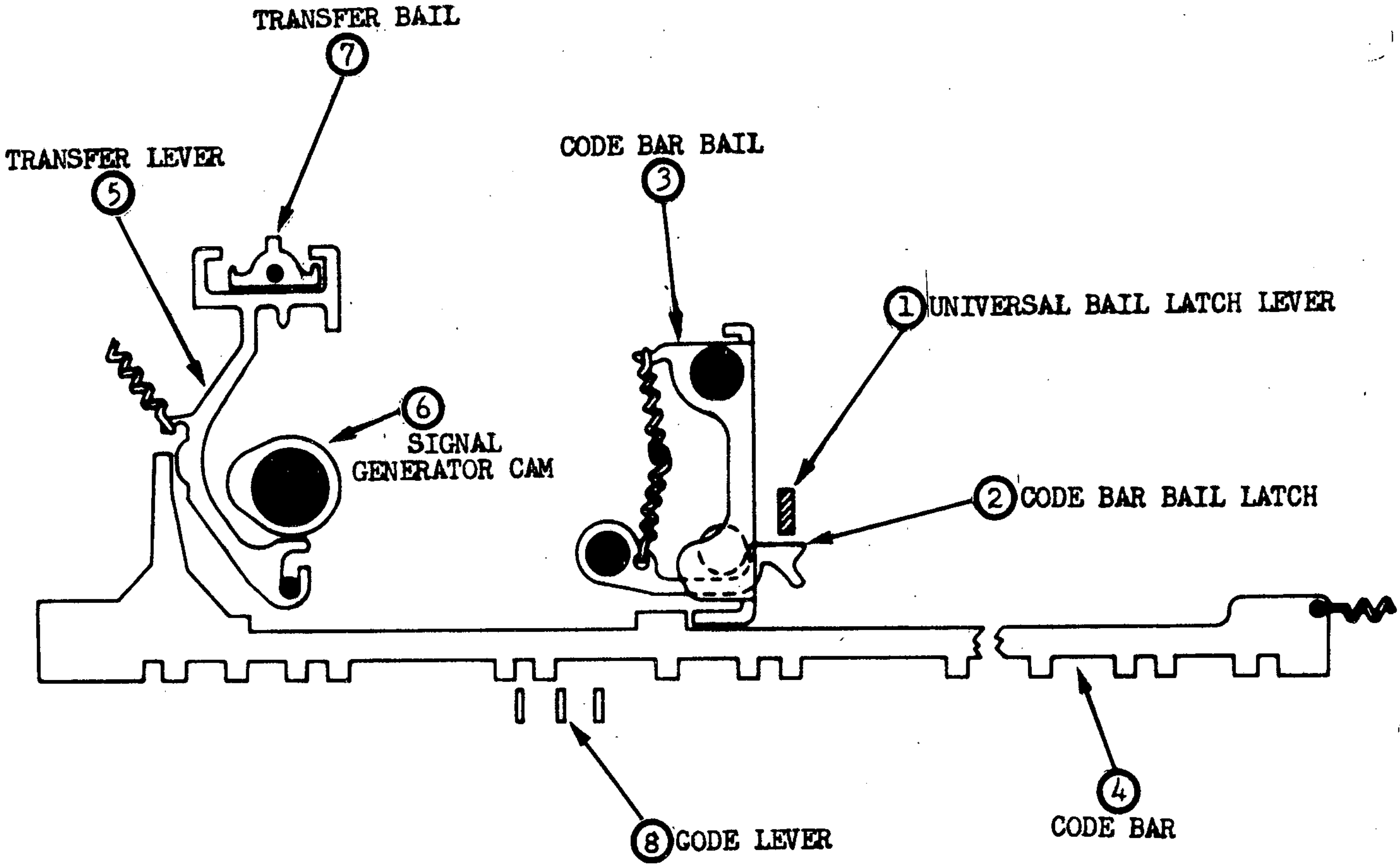
CODE BAR BAIL releases,

CODE LEVER pivots

SELECTED CODE BARS move (right)

UNSELECTED CODE BARS blocked by

CODE LEVER and TINES of code bars.



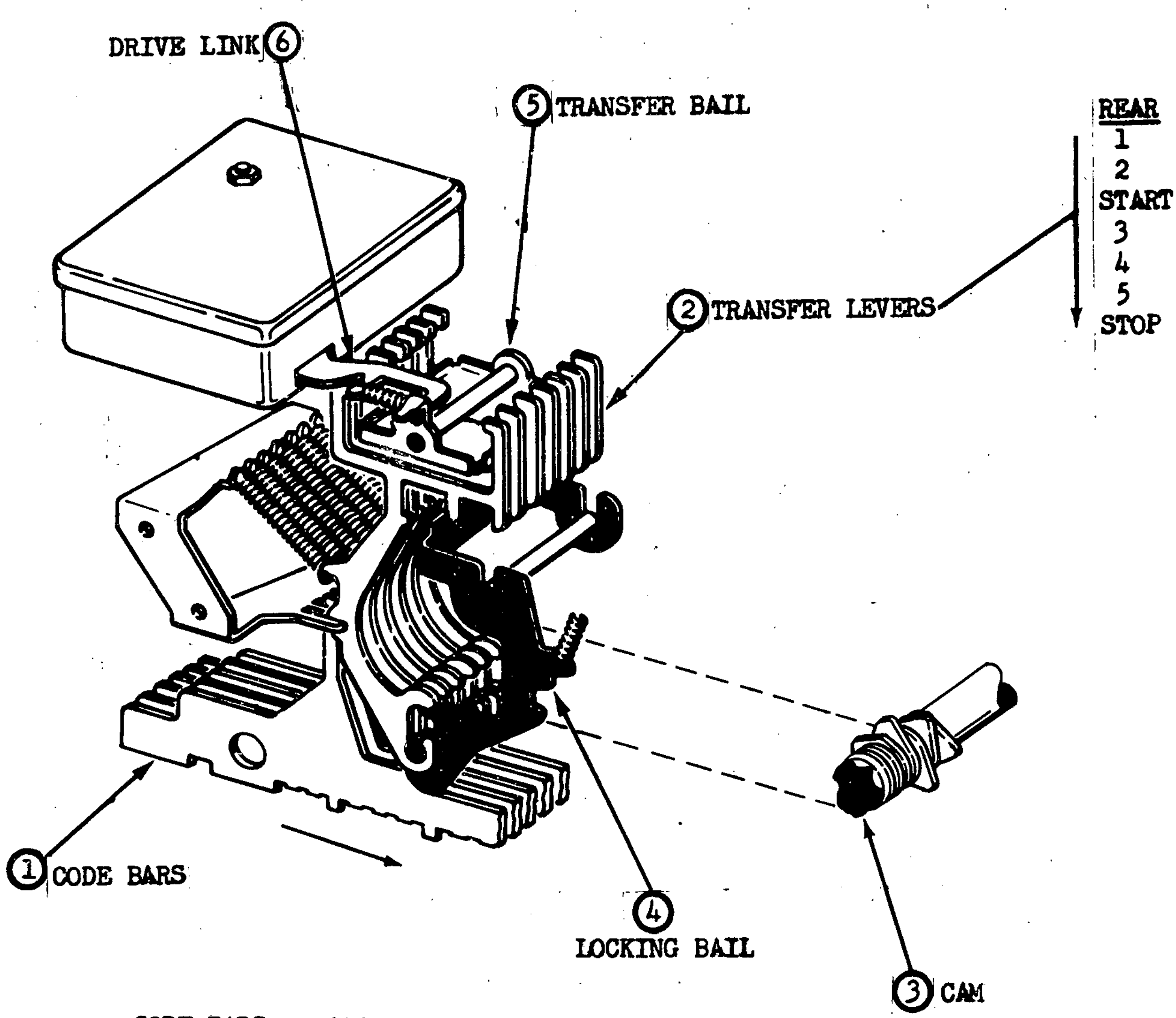
MARKING CONDITION

1. UNIVERSAL BAIL LATCH LEVER drops
2. CODE BAR BAIL LATCH pushed down
3. CODE BAR BAIL released pivots (counterclock-wise),
4. CODE BAR moves (right)
5. TRANSFER LEVER pulled (right)
6. SIGNAL GENERATOR CAM rotates
5. TRANSFER LEVER moves
7. TRANSFER BAIL (counterclock-wise)

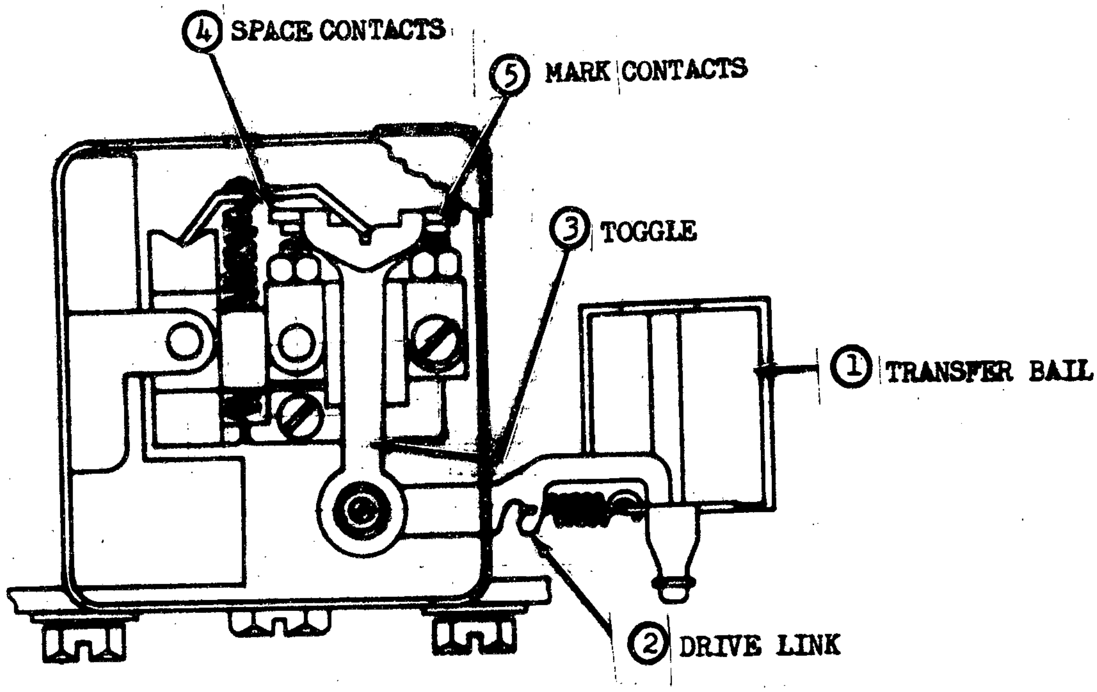
SPACING CONDITION

1. UNIVERSAL BAIL LATCH LEVER drops
2. CODE BAR BAIL LATCH pushed down
3. CODE BAR BAIL released pivots (counterclock-wise)
4. CODE BARS held (left) by SELECTED (8) CODE LEVER
5. TRANSFER LEVER held (left) by spring
6. SIGNAL GENERATOR CAM rotates
5. TRANSFER LEVER cammed down
5. TRANSFER LEVER moves (7) TRANSFER BAIL (clock-wise)

TRANSFER BAIL AND LOCKING BAIL



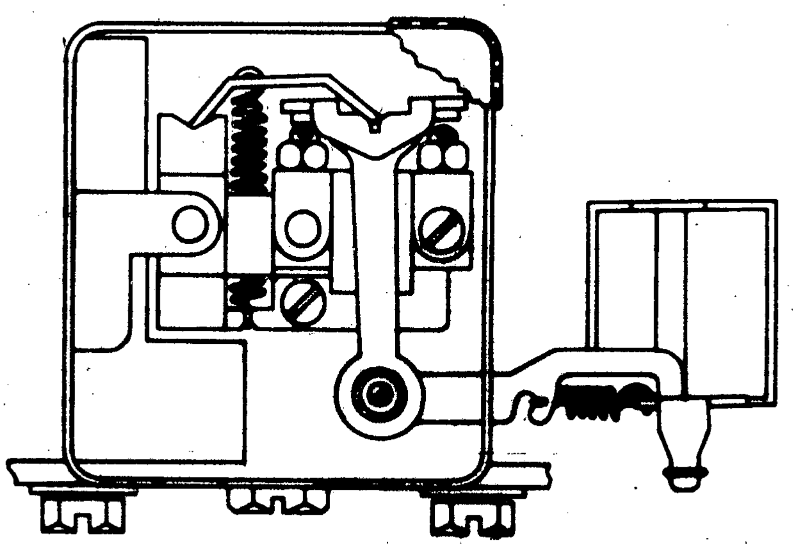
1. CODE BARS positioned
2. TRANSFER LEVERS selected
3. CAM rotates
4. LOCKING BAIL moves up, locking
2. TRANSFER LEVERS in MARKING or SPACING position
3. CAM continues to rotate CAMMING TRANSFER LEVERS down in sequence
5. TRANSFER BAIL rocking counterclock-wise (MARK) clock-wise (SPACE)
6. DRIVE LINK moves (LEFT-MARK) (RIGHT-SPACE)



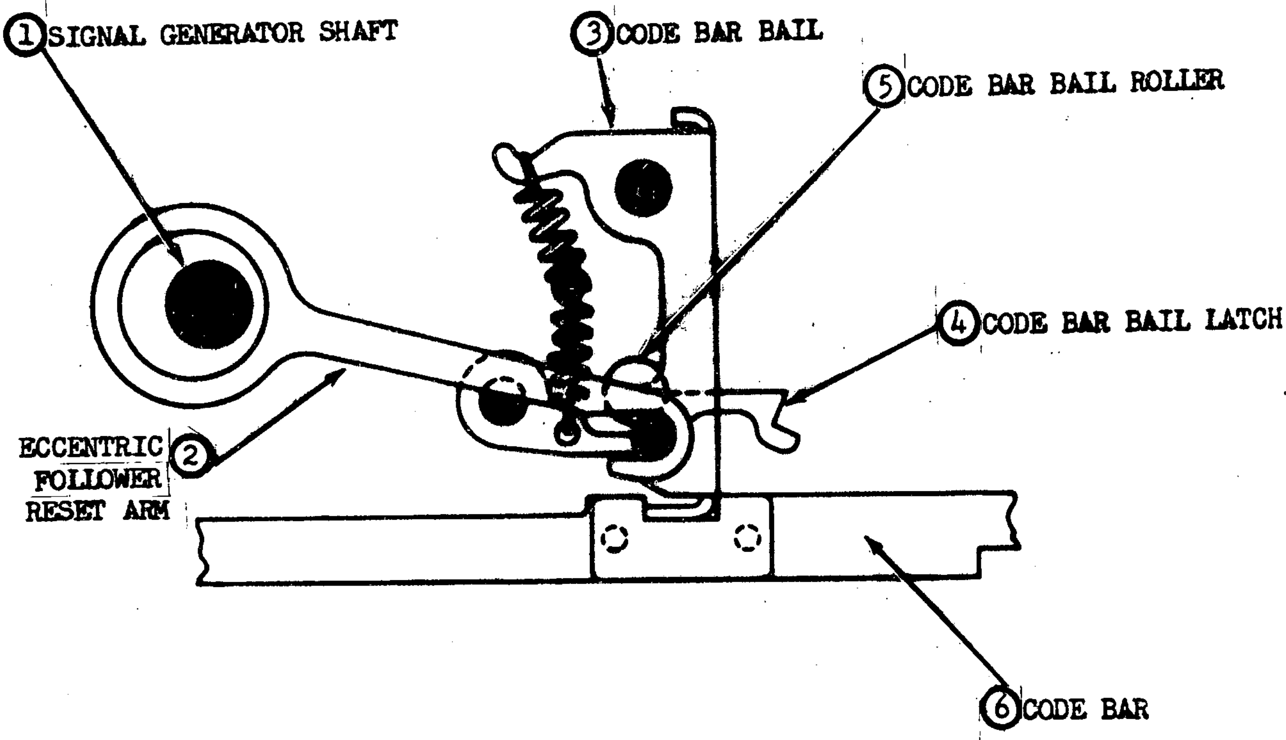
MARKING CONDITION

1. TRANSFER BAIL rocks
2. DRIVE LINK moves
3. TOGGLE operates
4. SPACE or
5. MARK contacts

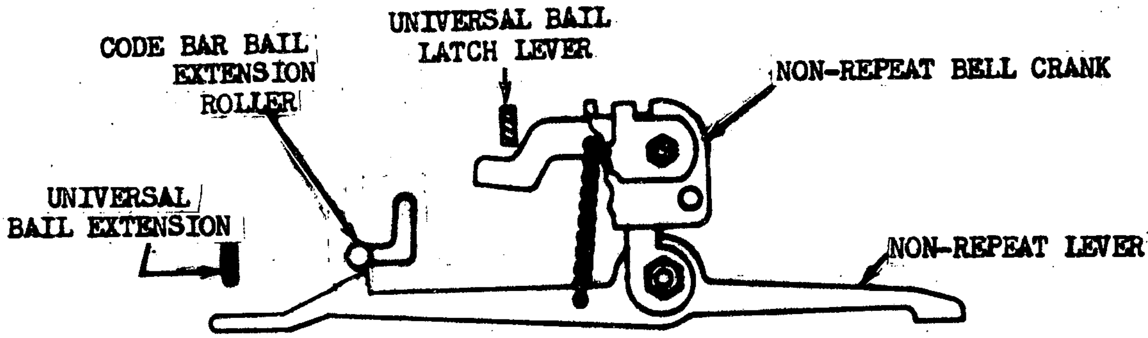
SPACING CONDITION



RESET OF CODE BAR BAIL AND CODE BARS



1. SIGNAL GENERATOR SHAFT rotates
2. ECCENTRIC FOLLOWER RESET ARM
3. CODE BAR BAIL pulled to left
4. CODE BAR BAIL LATCH moves up latching
5. CODE BAR BAIL ROLLER
3. CODE BAR BAIL resets
6. CODE BARS to left



UNIVERSAL BAIL rocked to rear

UNIVERSAL BAIL LATCH LEVER drops

CODE BAR BAIL EXTENSION with ROLLER moves right

NON-REPEAT LEVER moves up

CODE BAR BAIL pulls

NON-REPEAT LEVER left

NON-REPEAT BELL CRANK lifts

UNIVERSAL BAIL LATCH LEVER

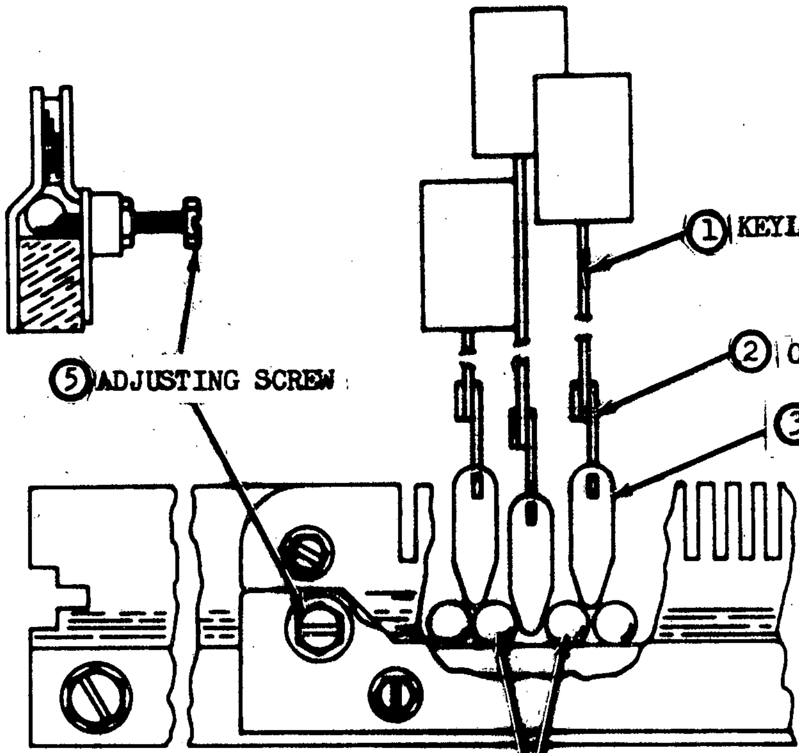
UNIVERSAL BAIL rocks forward

UNIVERSAL BAIL EXTENSION pushes

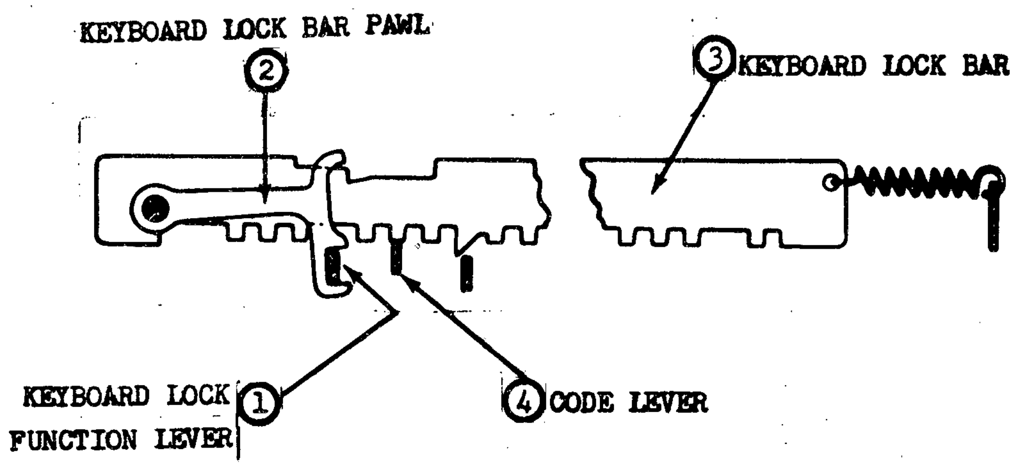
NON-REPEAT LEVER off

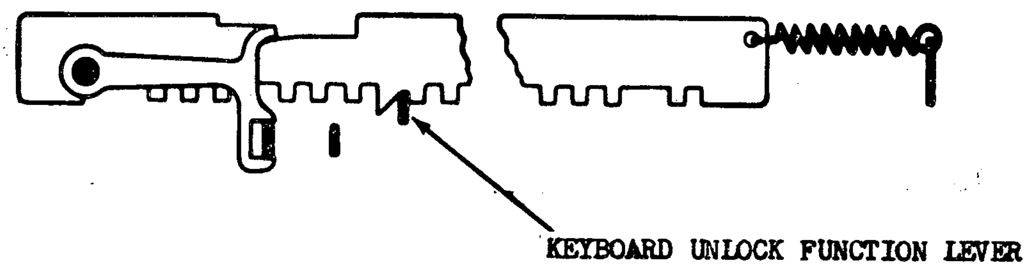
CODE BAR BAIL EXTENSION ROLLER

COMPLETE RESET POSITION



1. KEYLEVER depressed forces
2. CODE LEVER with
3. WEDGE downward,
4. LOCKBALLS separate,
5. ADJUSTING SCREW limits ball separation, preventing entry of more than one wedge simultaneously.





KEYBOARD LOCK OPERATION

KEYBOARD LOCK KEYLEVER depressed

1. KEYBOARD LOCK FUNCTION LEVER moves up
2. KEYBOARD LOCK BAR PAWL raises releasing
3. KEYBOARD LOCK BAR moves right placing tines over
4. CODE LEVER

UNLOCK OPERATION

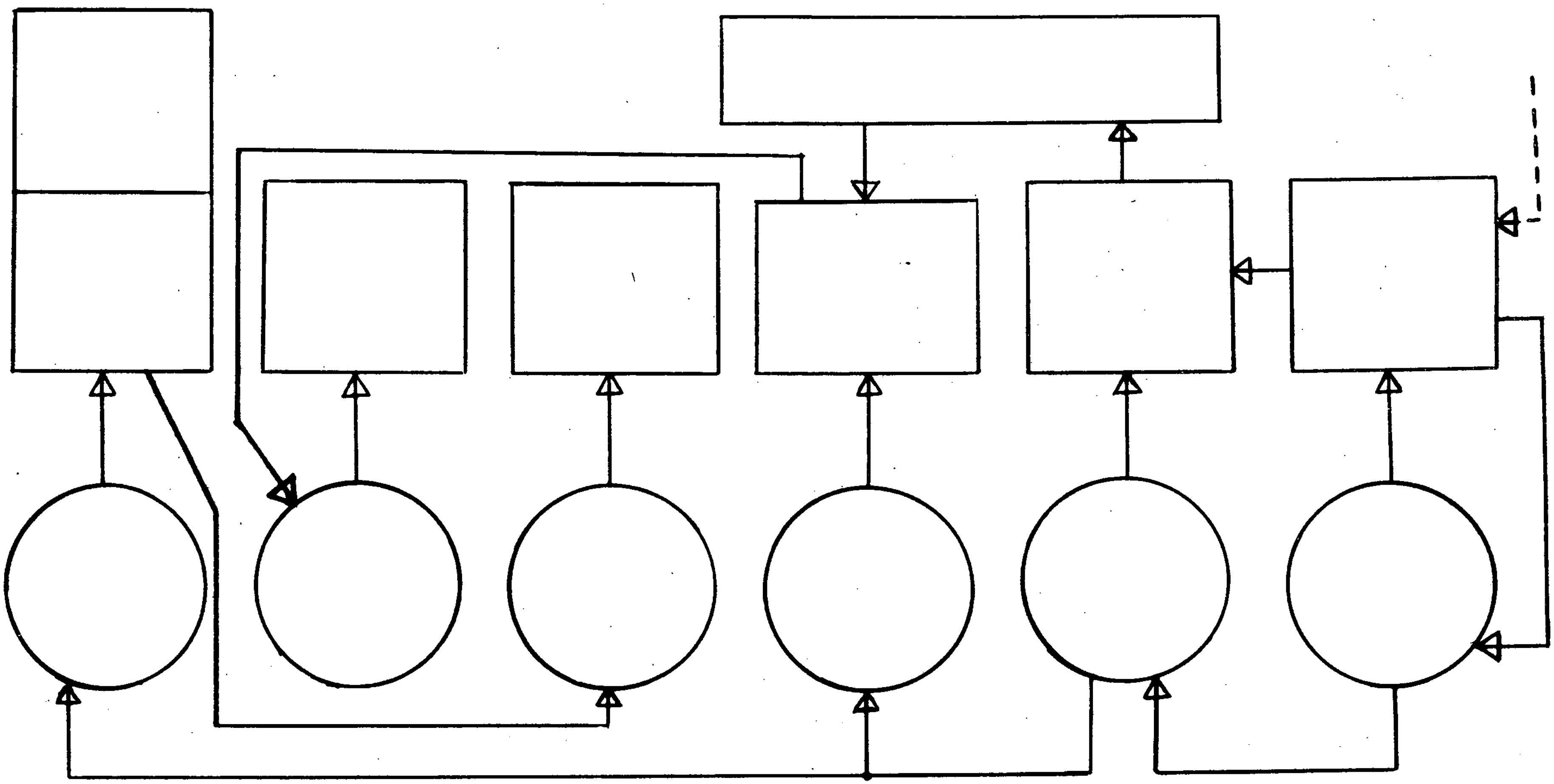
KEYBOARD UNLOCK KEYLEVER depressed

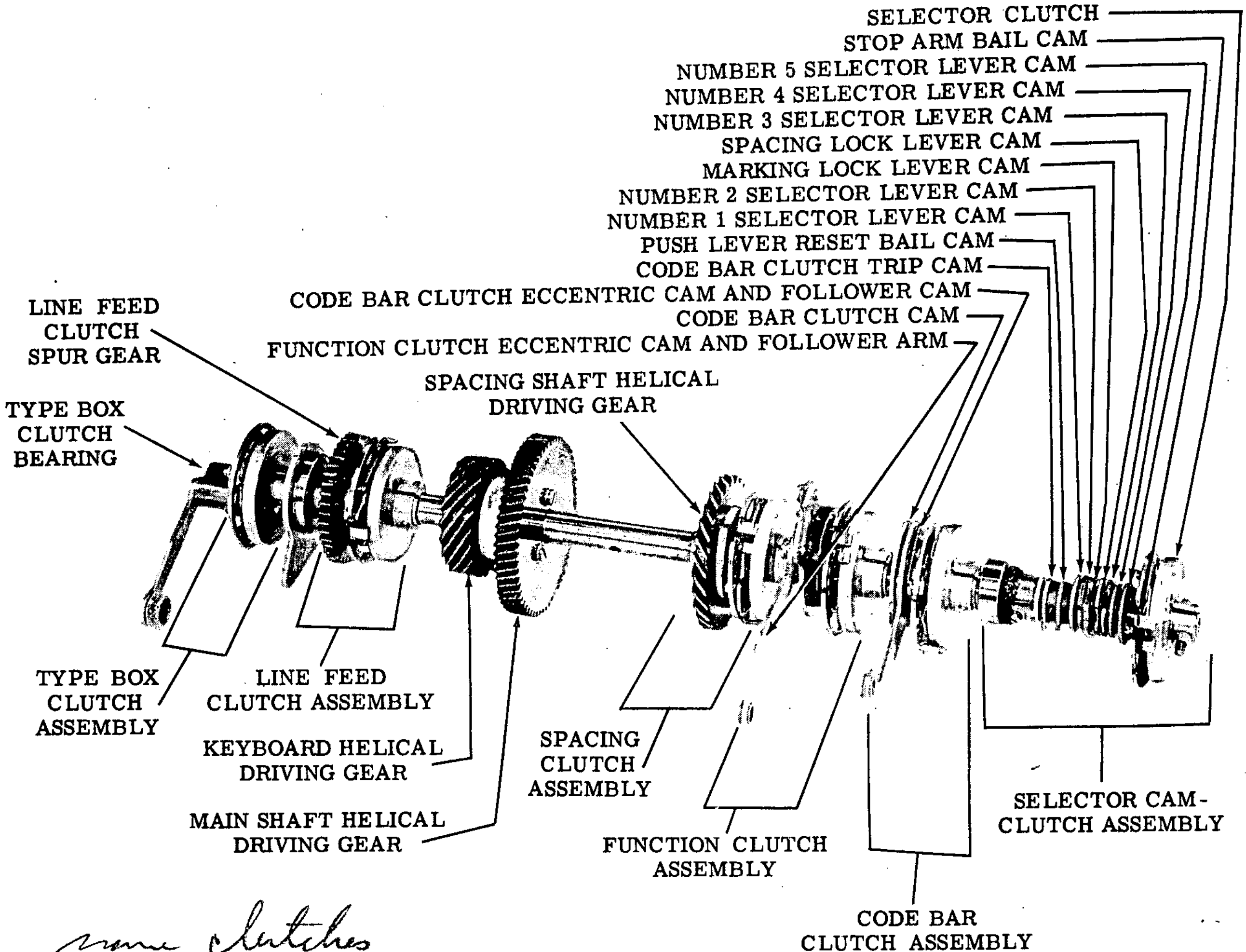
KEYBOARD UNLOCK FUNCTION LEVER moves up striking saw tooth

KEYBOARD LOCK BAR forced left

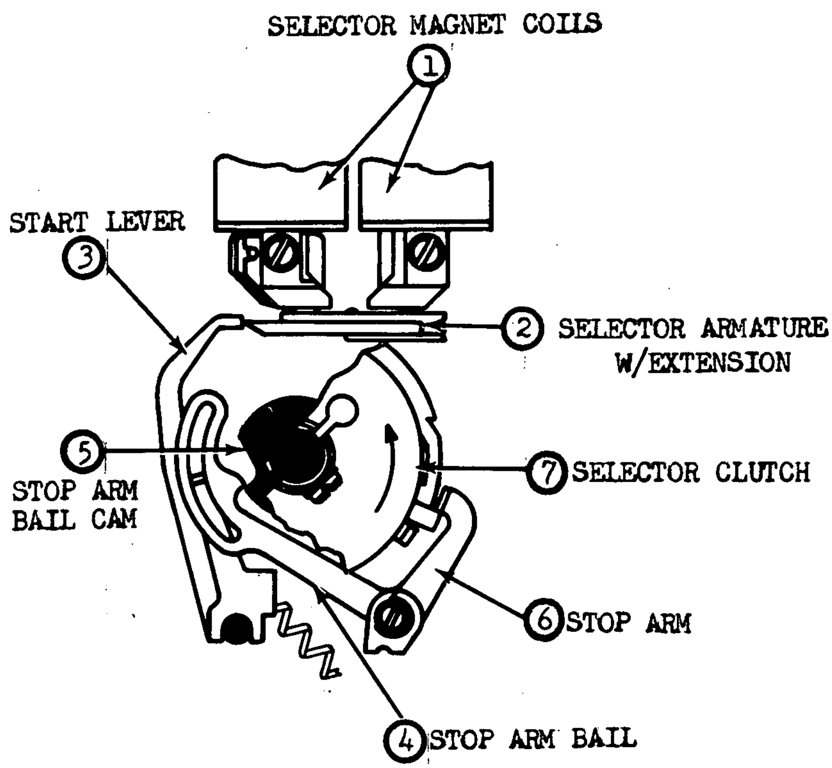
KEYBOARD LOCK BAR PAWL drops over step

MODEL 28 PRINTER FLOW CHART

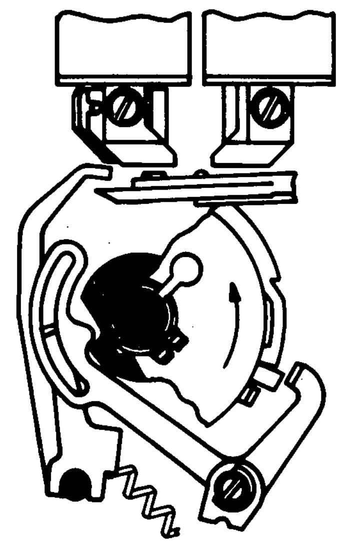




name clutches & order job



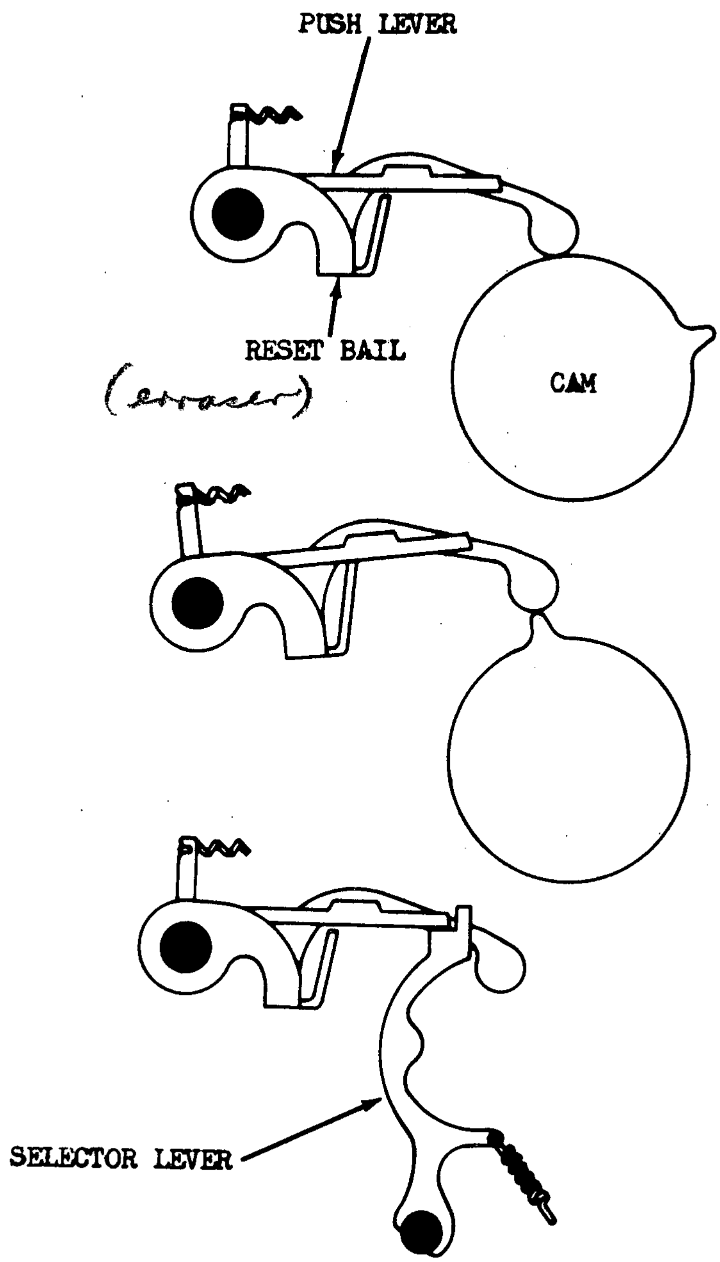
STOP CONDITION



START CONDITION

1. SELECTOR MAGNET COILS de-energize (spacing)
2. SELECTOR ARMATURE W/EXTENSION drops
3. START LEVER moves rearward
4. STOP ARM BAIL pulled into indent of
5. STOP ARM BAIL CAM
6. STOP ARM releases
7. SELECTOR CLUTCH with cam assembly rotate,
4. STOP ARM BAIL rides out of cam indent (forward)
6. STOP ARM moves forward
3. START LEVER forced forward (clearing selector armature).

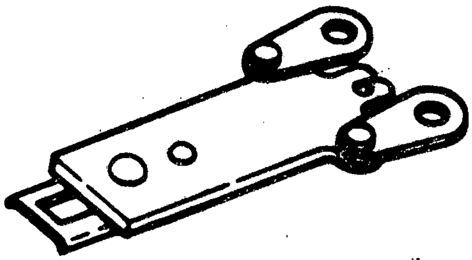
NOTE: START LEVER connected to STOP ARM BAIL.
ARMATURE EXTENSION riveted to SELECTOR ARMATURE.



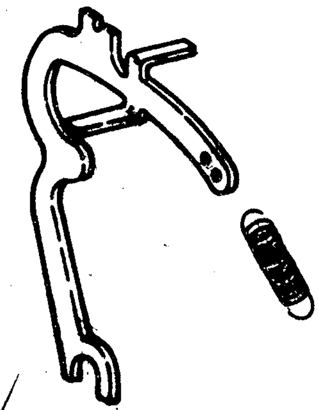
1. PUSH LEVER
2. RESET BAIL
3. CAM
4. SELECTOR LEVER

PUSH LEVER RESET BAIL rides to peak of its cam
PUSH LEVER lifted
PUSH LEVER RESET BAIL rides off cam peak
PUSH LEVER drops onto
SELECTOR LEVER (spacing condition)

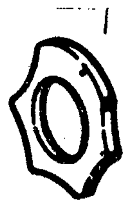
MARKING and SPACING LOCK LEVERS



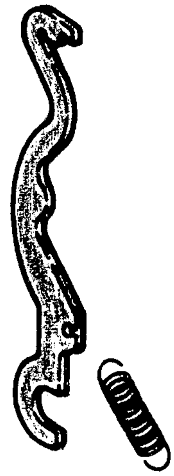
SELECTOR ARMATURE W/EXTENSION



MARKING LOCK LEVER



MARKING SPACING
LOCK LEVER CAM



SPACING LOCK LEVER

MARKING LOCK LEVER and

SPACING LOCK LEVER ride a common cam surface

SPACING LOCK LEVER and

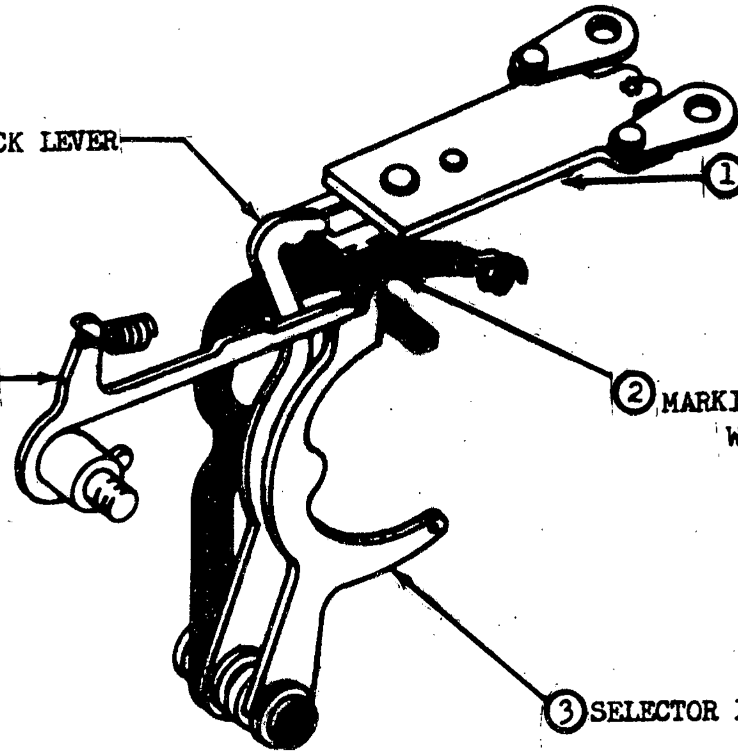
MARKING LOCK LEVER move rearward during each intelligence pulse

SELECTOR ARMATURE W/EXTENSION

MARK (attracted) SPACE (unattracted)

determines which lock lever will ride to indent of cam.

NOTE: During a spacing intelligence pulse the SPACING LOCK LEVER overtravels the ARMATURE EXTENSION

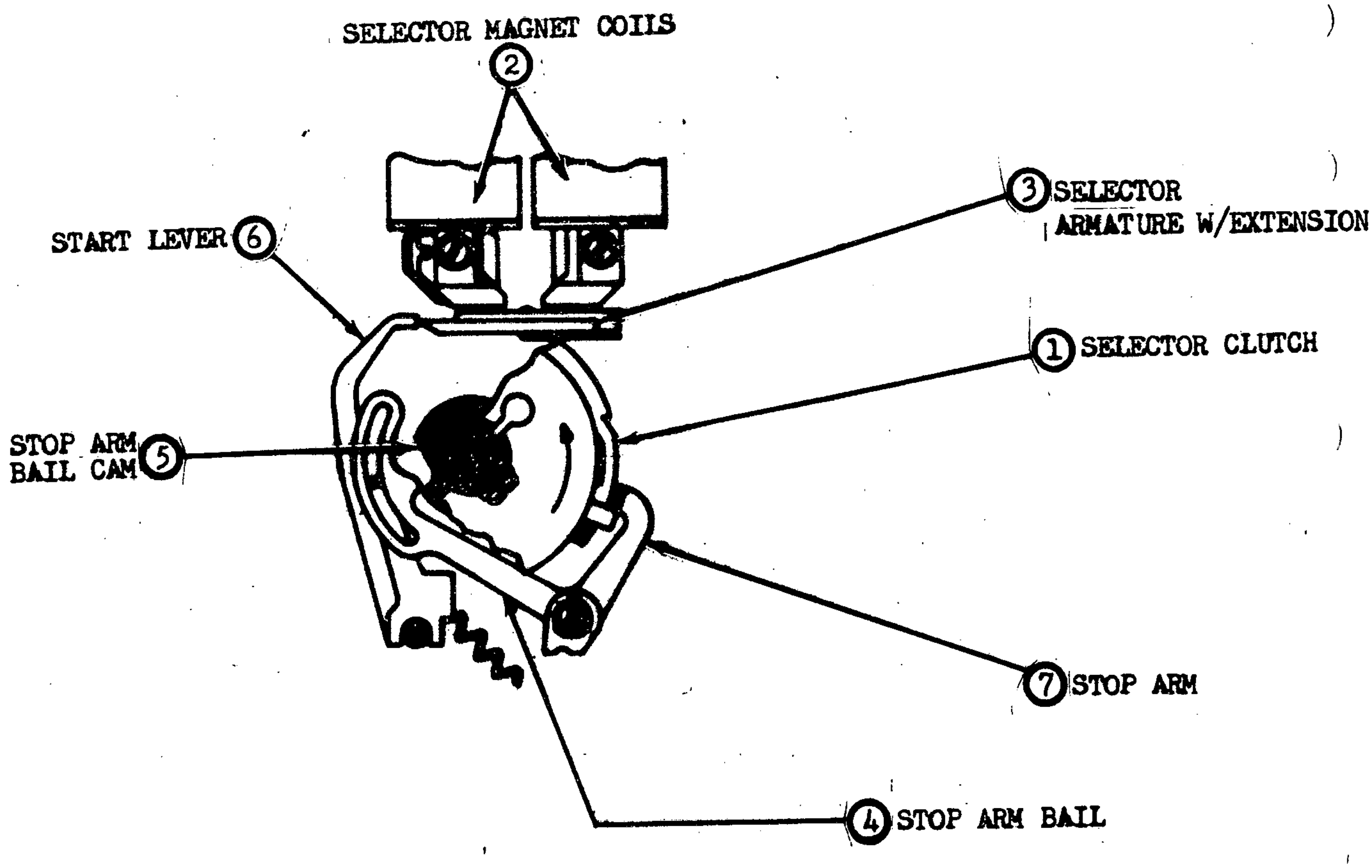


MARKING CONDITION

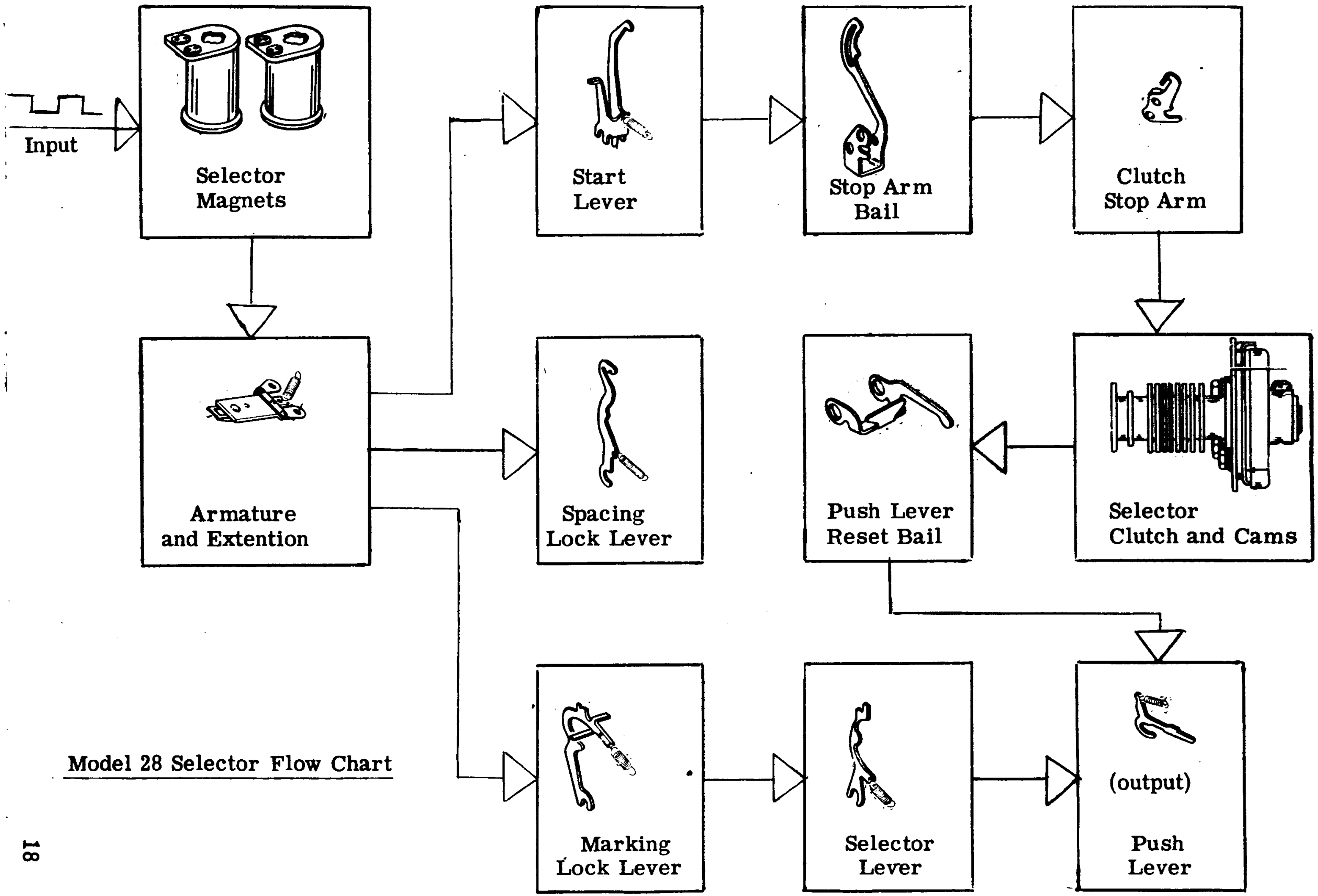
1. SELECTOR ARMATURE attracted (marking)
2. MARKING LOCK LEVER moves rearward (completely) under travels
1. ARMATURE EXTENSION
3. SELECTOR LEVER moves rearward (completely)
4. PUSH LEVER drops
3. SELECTOR LEVER cammed (forward)
4. PUSH LEVER moves forward (marking condition)

SPACING CONDITION

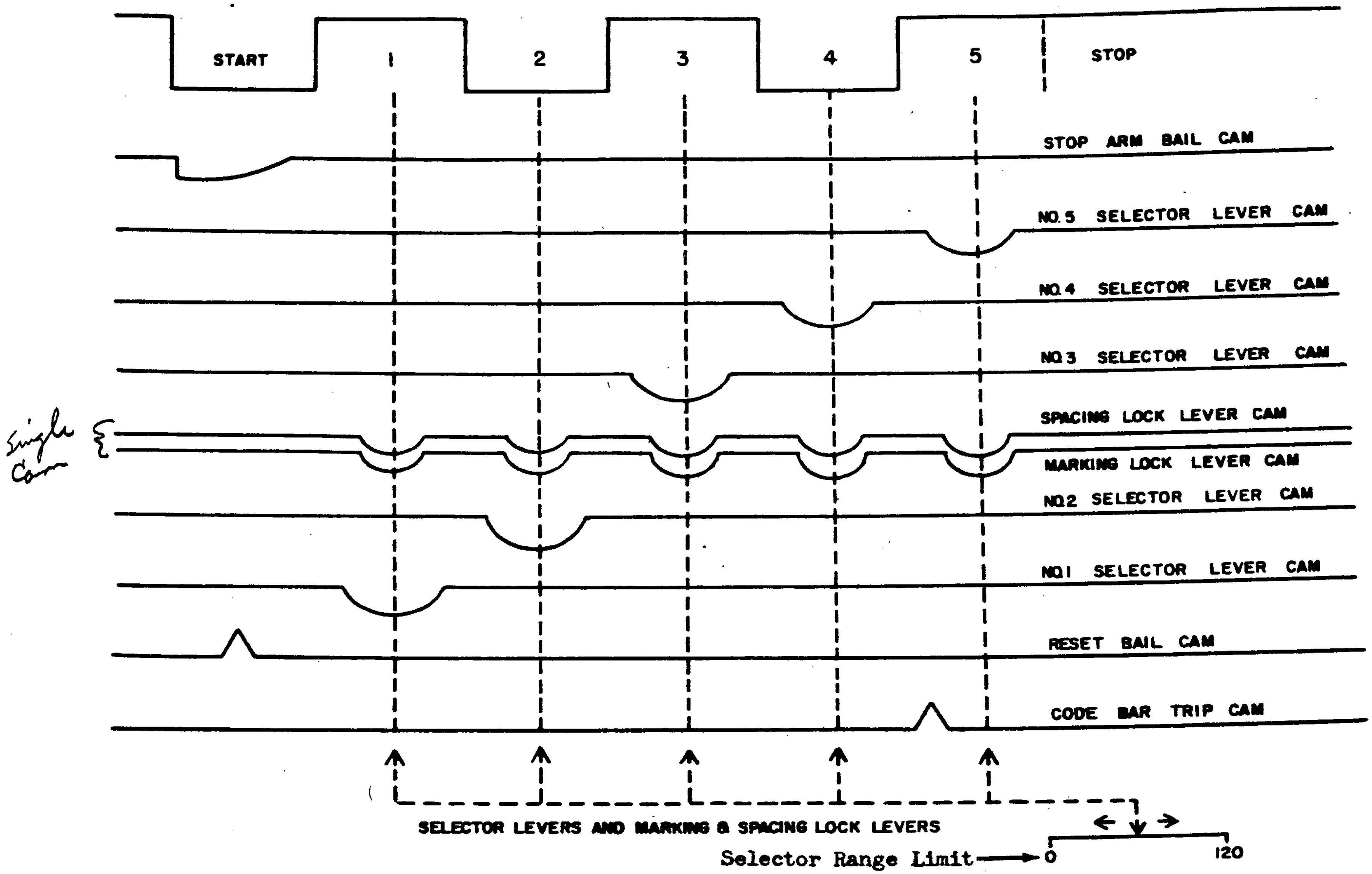
1. SELECTOR ARMATURE unattracted (spacing)
2. MARKING LOCK LEVER blocked by
1. ARMATURE EXTENSION
3. SELECTOR LEVER blocked by
2. MARKING LOCK LEVER EXTENSION preventing
3. SELECTOR LEVER from moving into cam indent
4. PUSH LEVER remains rearward (spacing condition)



1. SELECTOR CLUTCH and CAM rotating,
2. SELECTOR MAGNET COILS energize (marking-stop pulse)
3. SELECTOR ARMATURE W/EXTENSION attracts
4. STOP ARM BAIL attempts to drop into
5. STOP ARM BAIL CAM
6. START LEVER blocked by
3. SELECTOR ARMATURE W/EXTENSION
7. STOP ARM blocks
1. SELECTOR CLUTCH and CAM

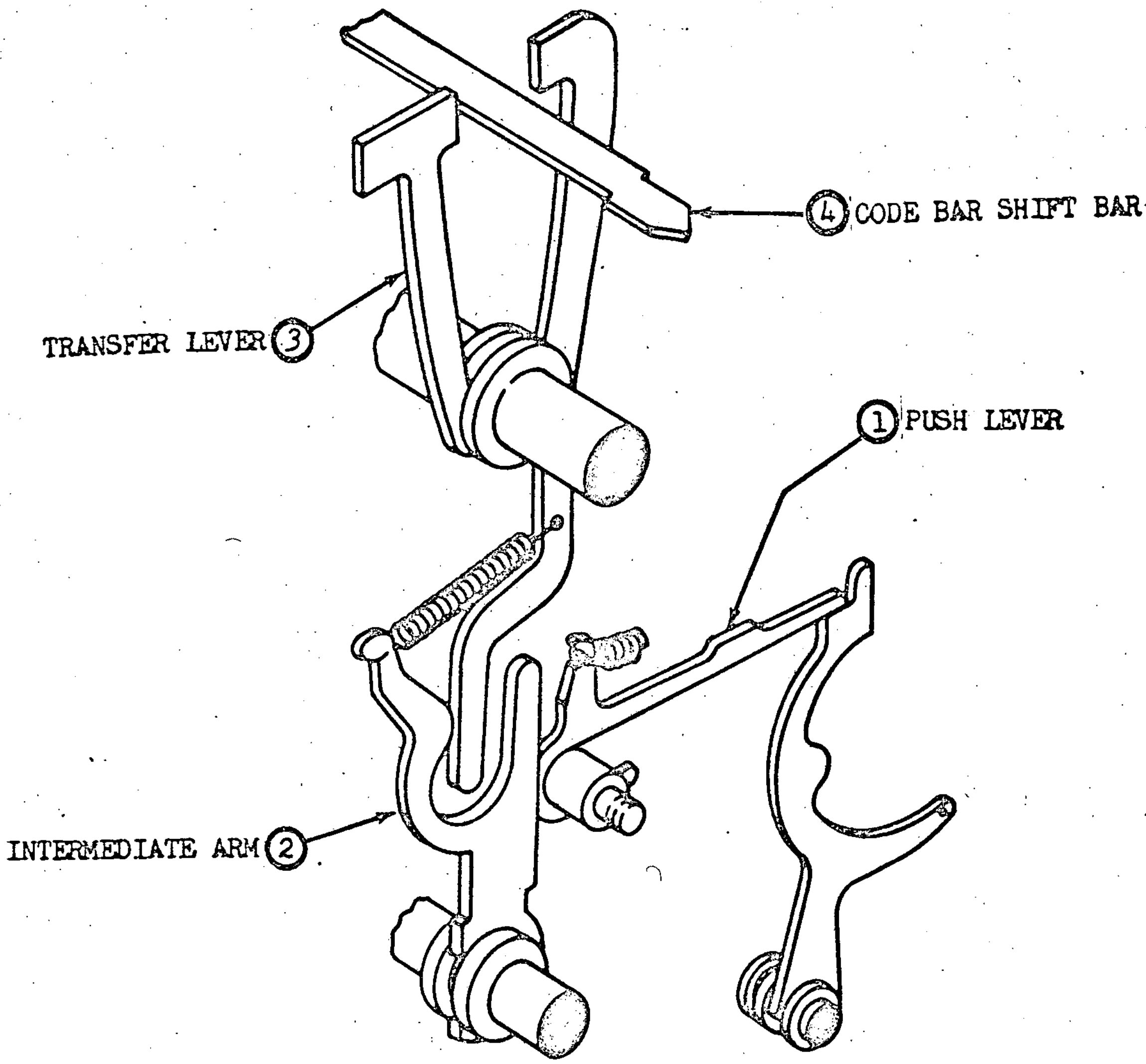


Model 28 Selector Flow Chart



MODEL 28 TELETYPEWRITER
SELECTOR CAMS RELATIONSHIP CHART

SELECTOR TIMING CHART



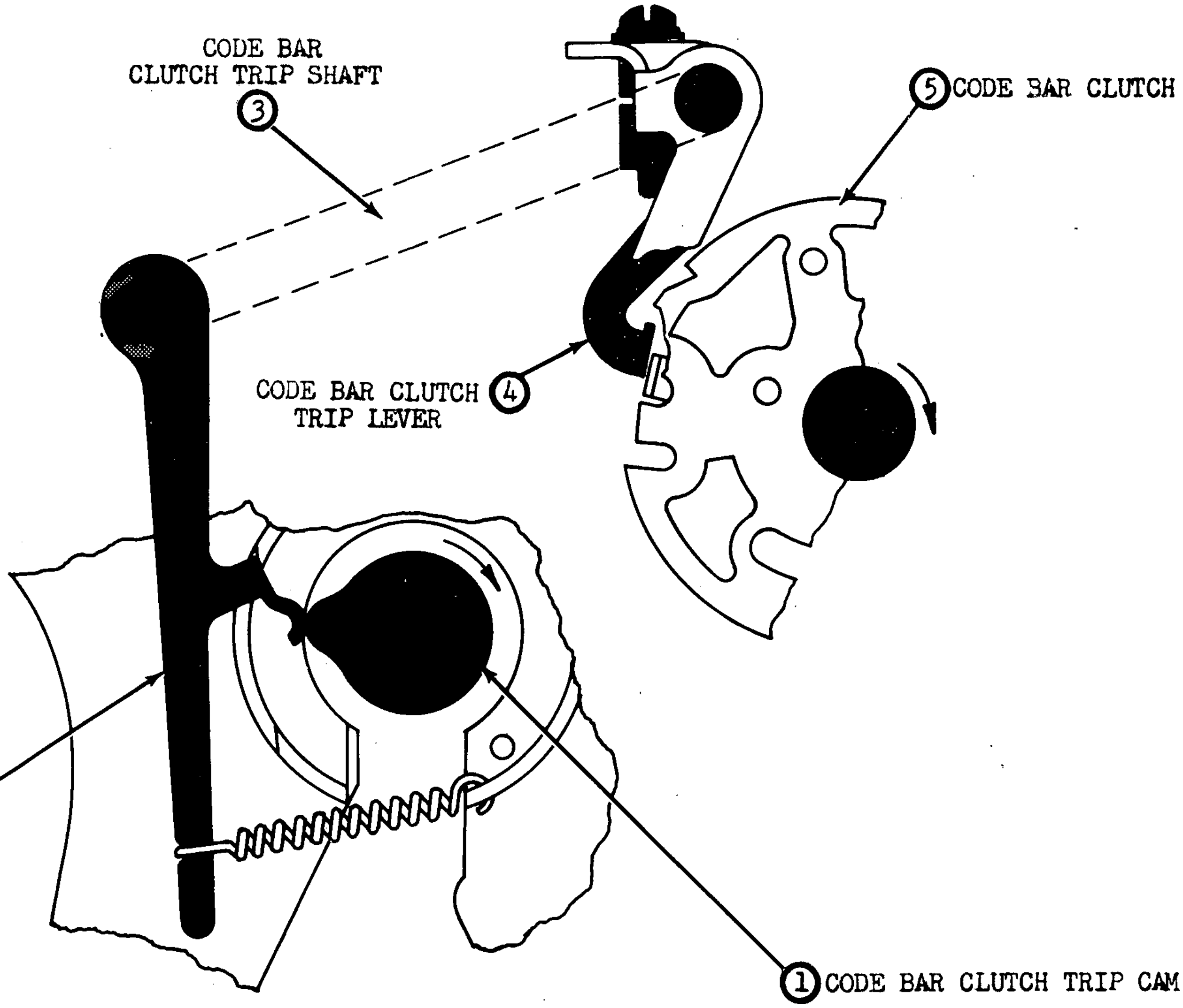
MARKING CONDITION

1. PUSH LEVER moves forward (MARKING) pushing
2. INTERMEDIATE ARM forward, spring pulls
3. TRANSFER LEVER (bottom) forward
3. TRANSFER LEVER (top) moves rearward positioning
4. CODE BAR SHIFT BAR rearward (MARKING)

SPACING CONDITION

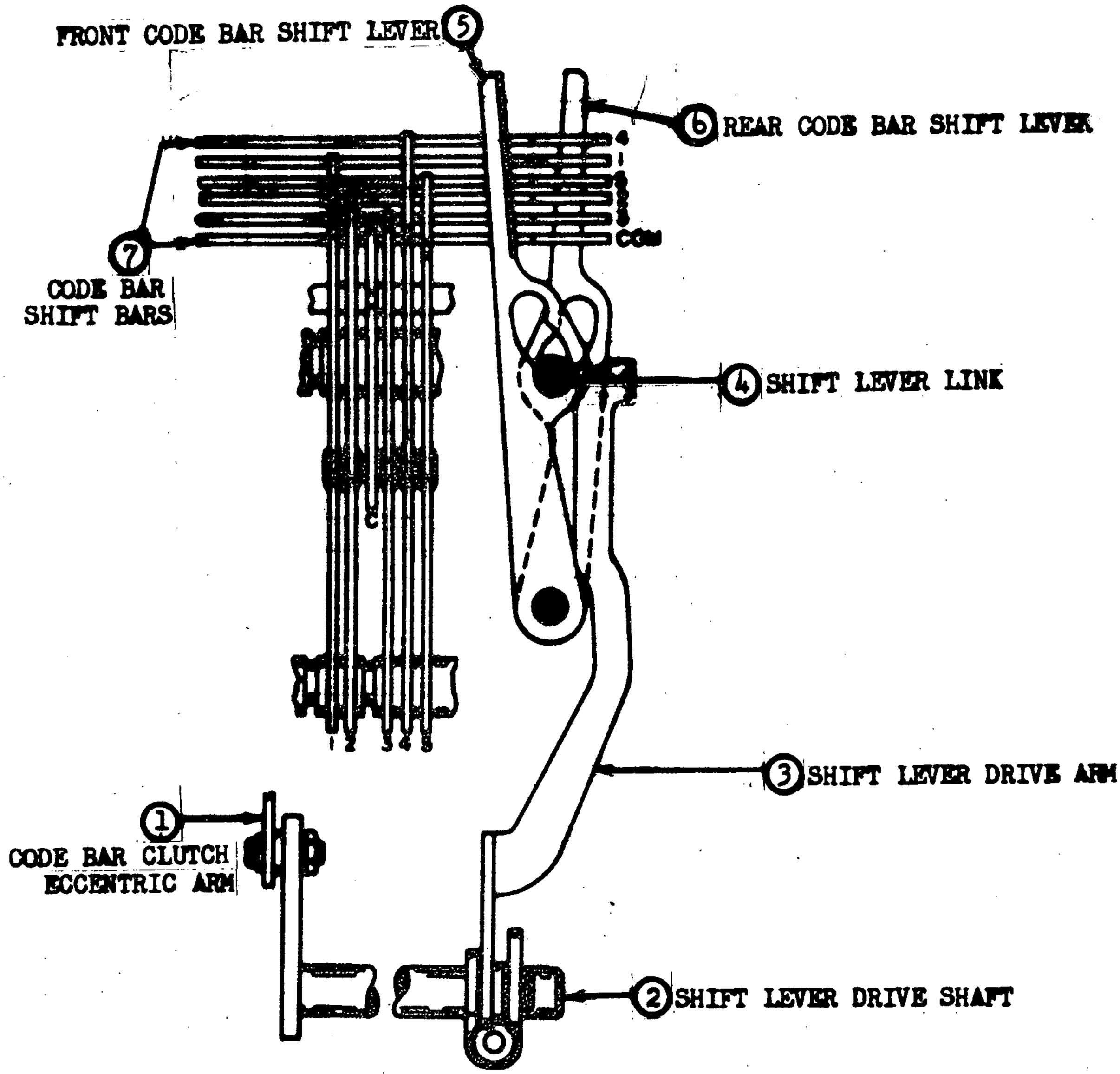
1. PUSH LEVER rearward (spacing)
2. INTERMEDIATE ARM rearward
3. TRANSFER LEVER (bottom) rearward
4. CODE BAR SHIFT BAR held (spacing)

CODE BAR CLUTCH TRIP



SELECTOR CAM ASSEMBLY rotates

1. CODE BAR CLUTCH TRIP CAM moves
2. CODE BAR CLUTCH TRIP SHAFT LEVER pivoting
3. CODE BAR CLUTCH TRIP SHAFT,
4. CODE BAR CLUTCH TRIP LEVER releases
5. CODE BAR CLUTCH



CODE BAR CLUTCH and

1. CODE BAR CLUTCH ECCENTRIC ARM rotates

2. SHIFT LEVER DRIVE SHAFT and

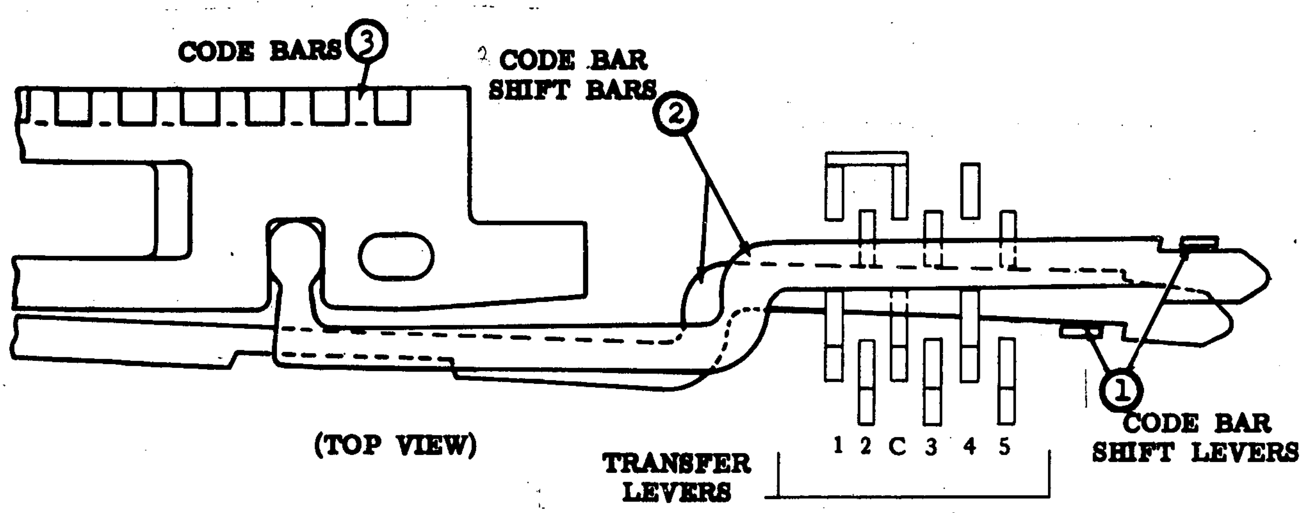
3. SHIFT LEVER DRIVE ARM pivots

4. SHIFT LEVER LINK moves up

5. FRONT CODE BAR SHIFT LEVER moves right

6. REAR CODE BAR SHIFT LEVER moves left

7. CODE BAR SHIFT BARS shift

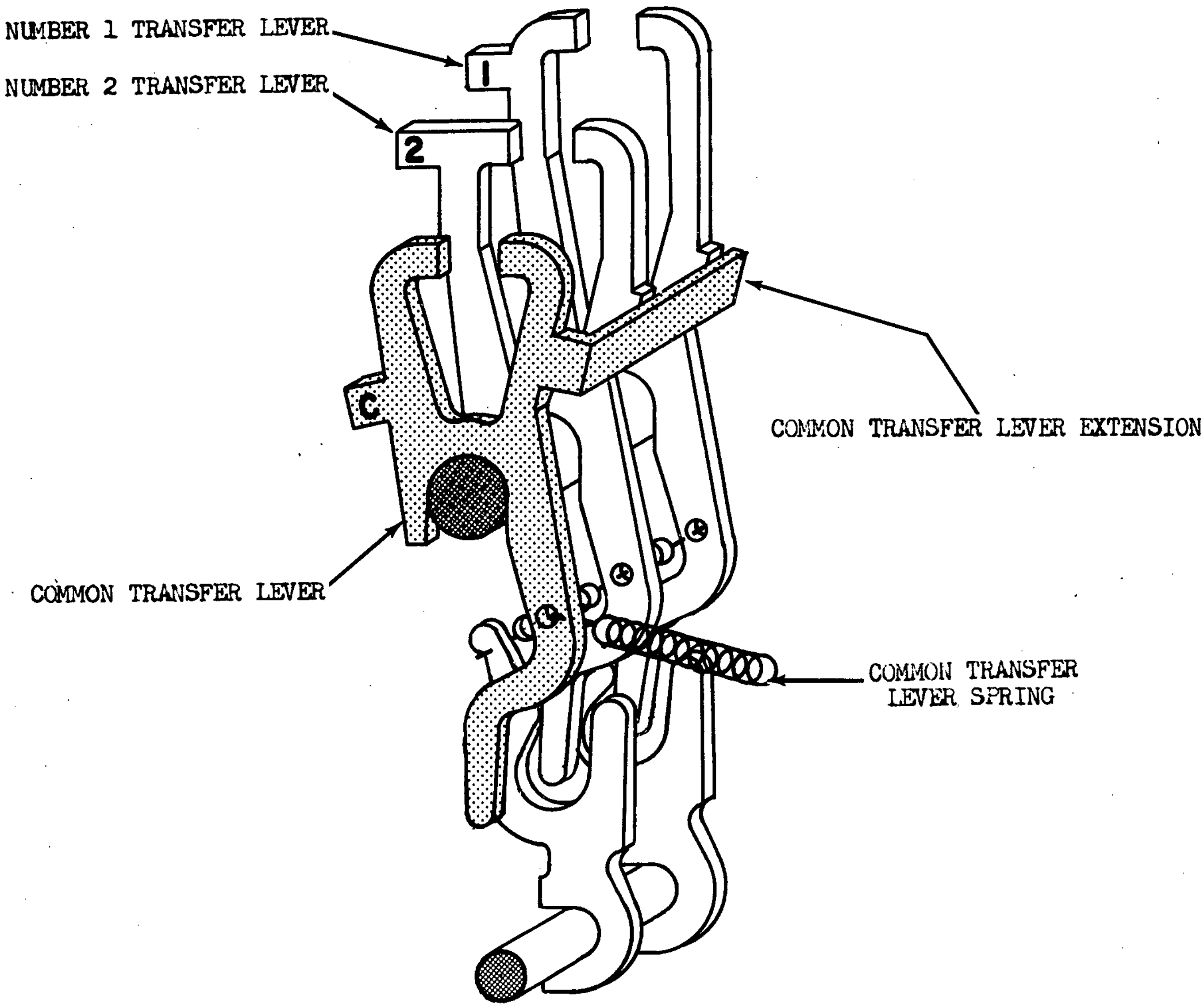


1. CODE BAR SHIFT LEVERS shift - moving
2. CODE BAR SHIFT BARS positions
3. CODE BARS

LEFT - MARKING

RIGHT - SPACING

COMMON TRANSFER LEVER



COMMON TRANSFER LEVER spring loaded (spacing)

COMMON TRANSFER LEVER EXTENSION to rear of

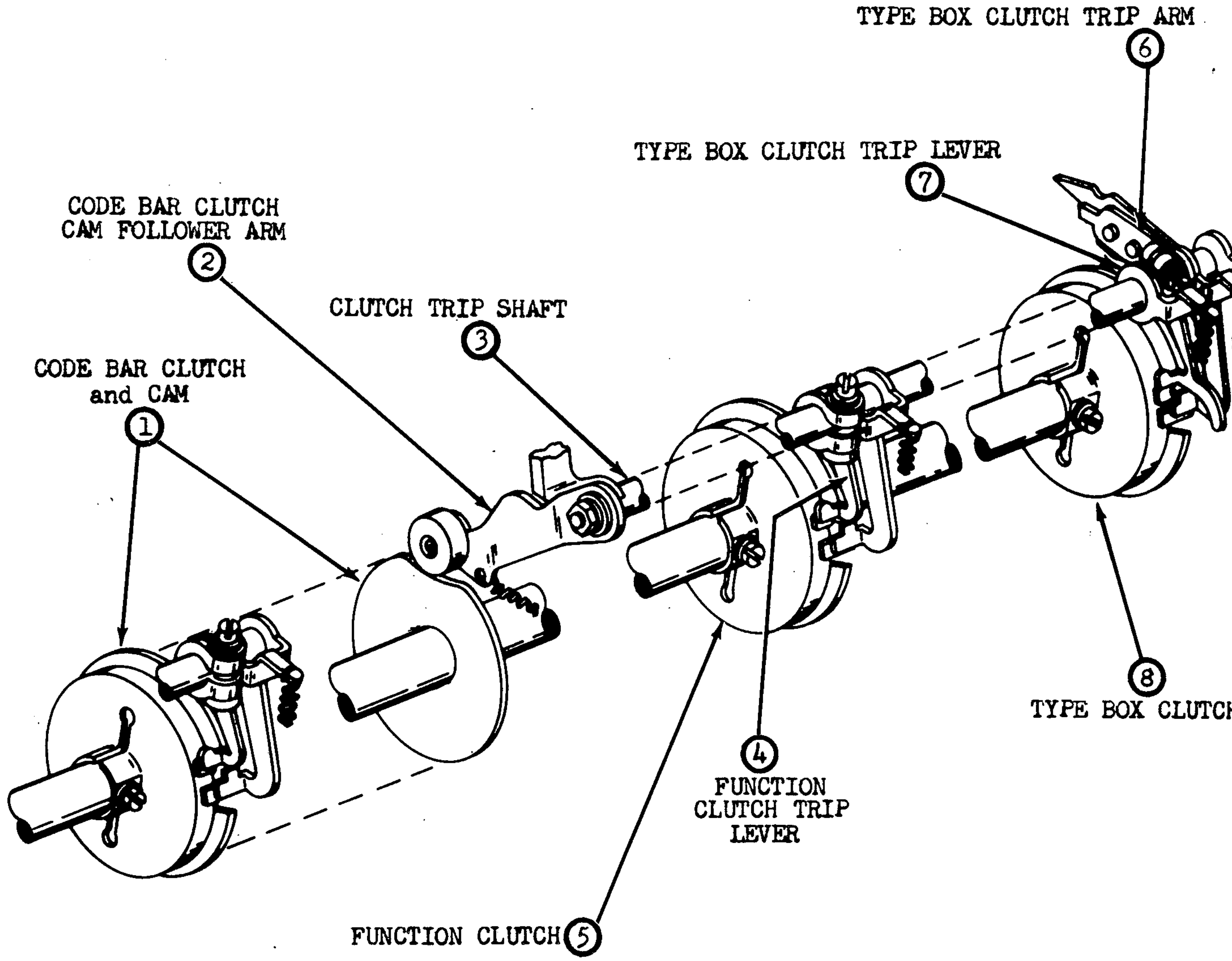
TRANSFER LEVERS #1 and #2

NUMBER 1 TRANSFER LEVER MARKING (rear) COMMON MARKS

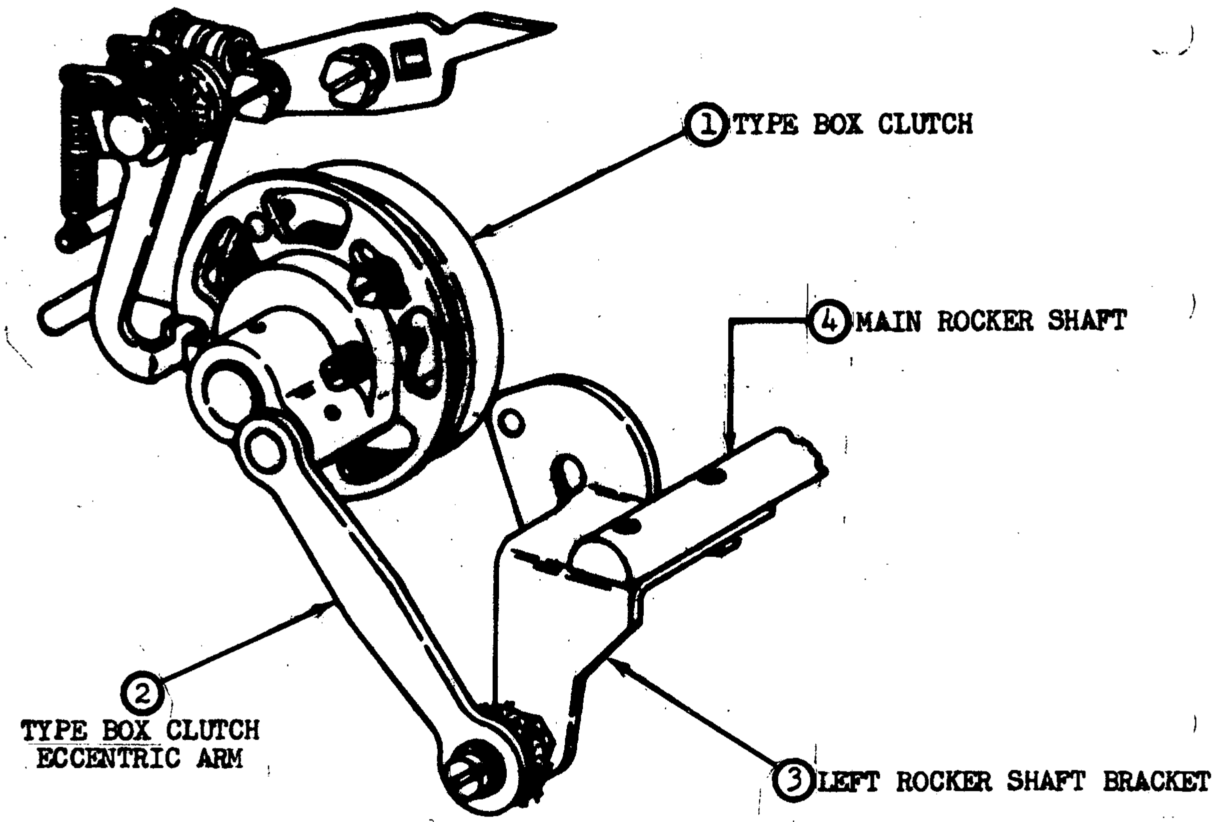
NUMBER 2 TRANSFER LEVER MARKING (rear) COMMON MARKS

NUMBER 1 & 2 TRANSFER LEVERS MARKING (rear) COMMON MARKS

NUMBER 1 & 2 TRANSFER LEVERS SPACING (front) COMMON SPACES



1. CODE BAR CLUTCH and CAM rotates
2. CODE BAR CLUTCH CAM FOLLOWER ARM rides cam indent
3. CLUTCH TRIP SHAFT pivots
4. FUNCTION CLUTCH TRIP LEVER releases
5. FUNCTION CLUTCH
6. TYPE BOX CLUTCH TRIP ARM pivots
7. TYPE BOX CLUTCH TRIP LEVER rotates
8. TYPE BOX CLUTCH released

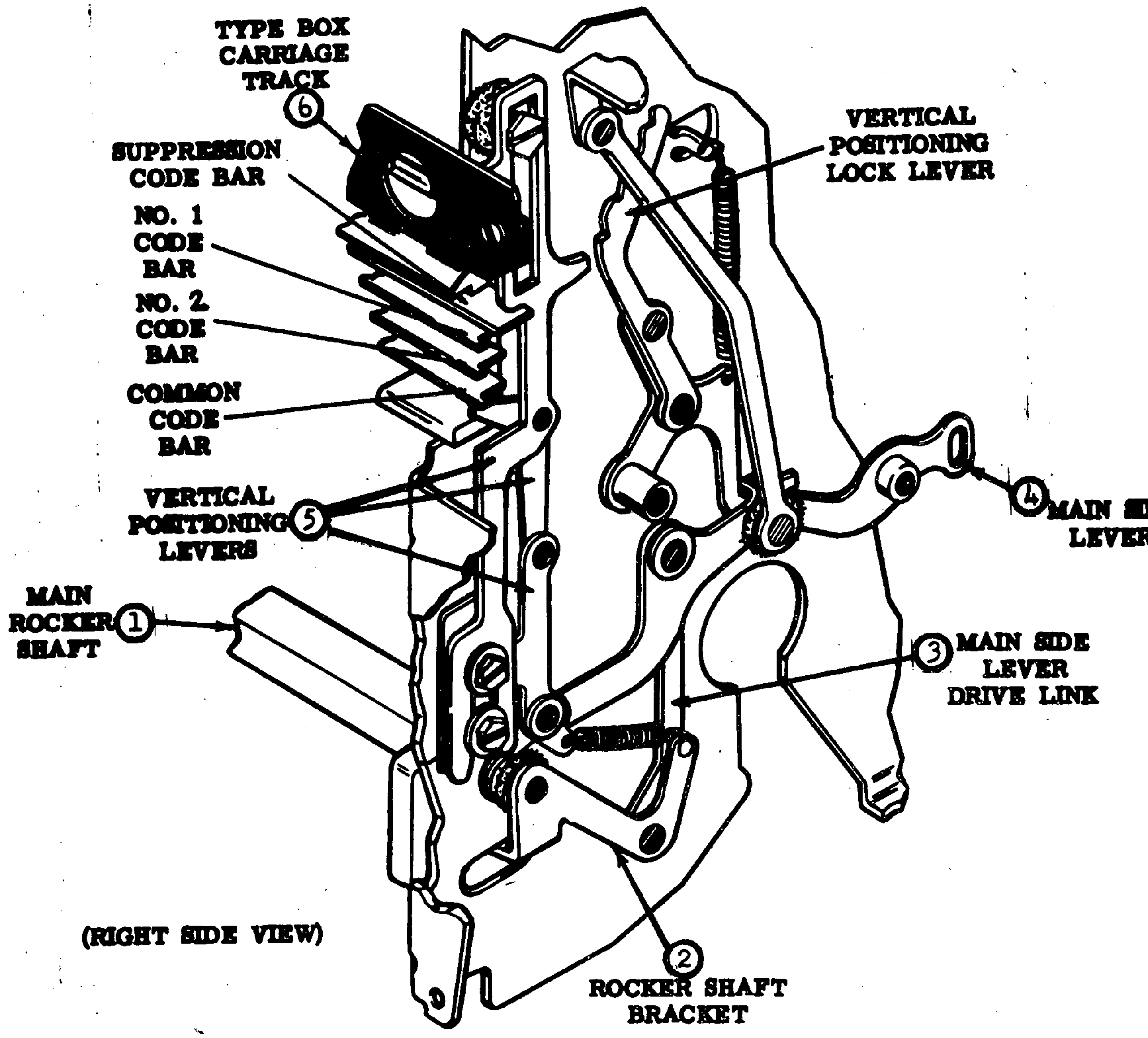


1. TYPE BOX CLUTCH and

2. TYPE BOX CLUTCH ECCENTRIC ARM rotates

3. LEFT ROCKER SHAFT BRACKET causes

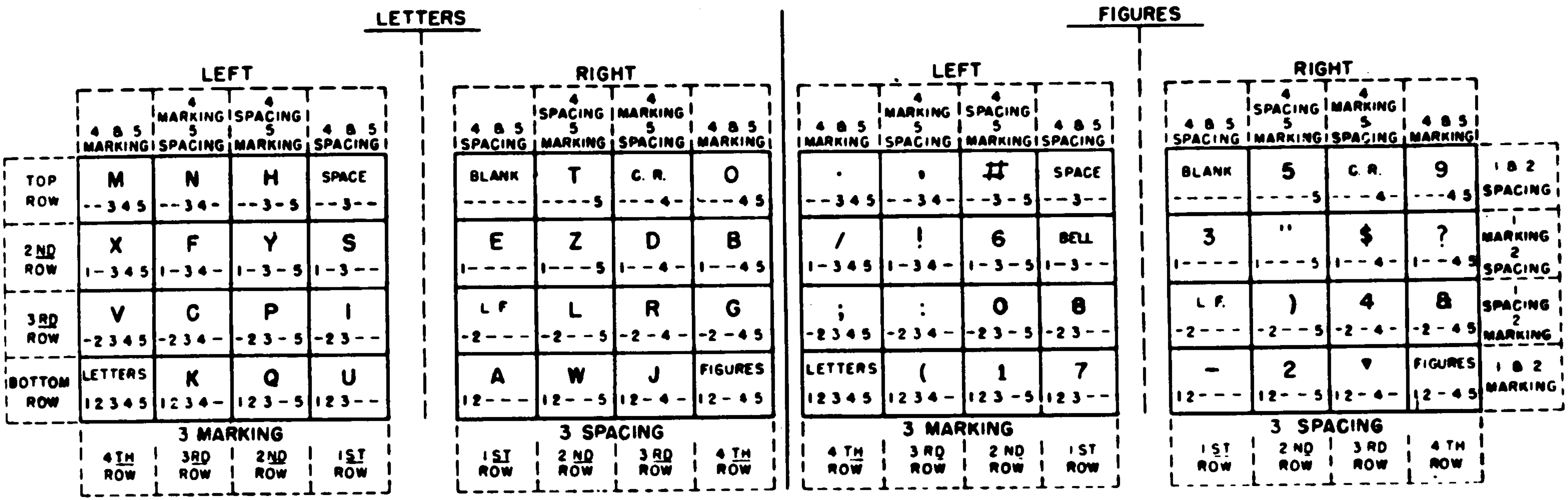
4. MAIN ROCKER SHAFT to pivot



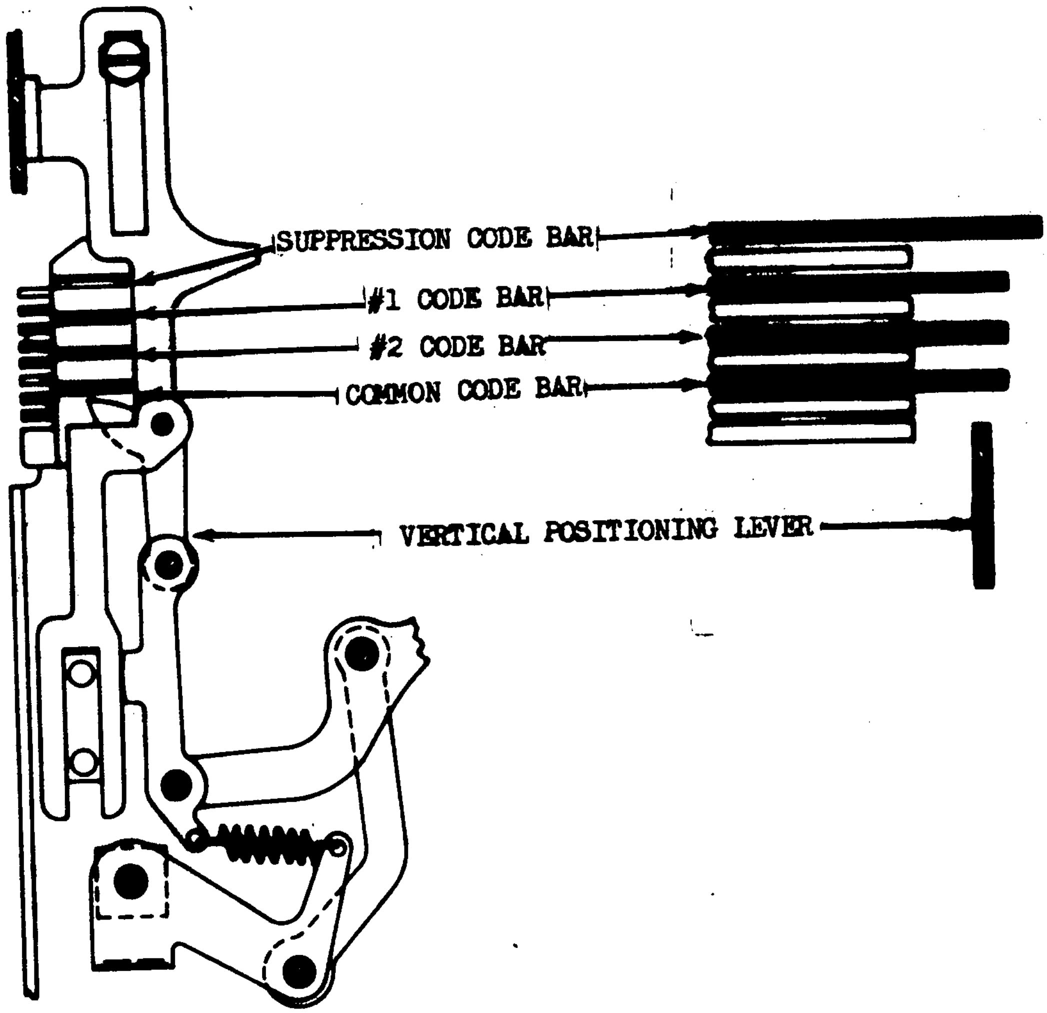
(RIGHT SIDE VIEW)

1. MAIN ROCKER SHAFT pivots
2. ROCKER SHAFT BRACKET moves
3. MAIN SIDE LEVER DRIVE LINK and
4. MAIN SIDE LEVER
5. VERTICAL POSITIONING LEVERS and
6. TYPE BOX CARRIAGE TRACK move up

NOTE: TYPE BOX rides on the TYPE BOX CARRIAGE TRACK



TYPICAL TYPE BOX PALLET ARRANGEMENT



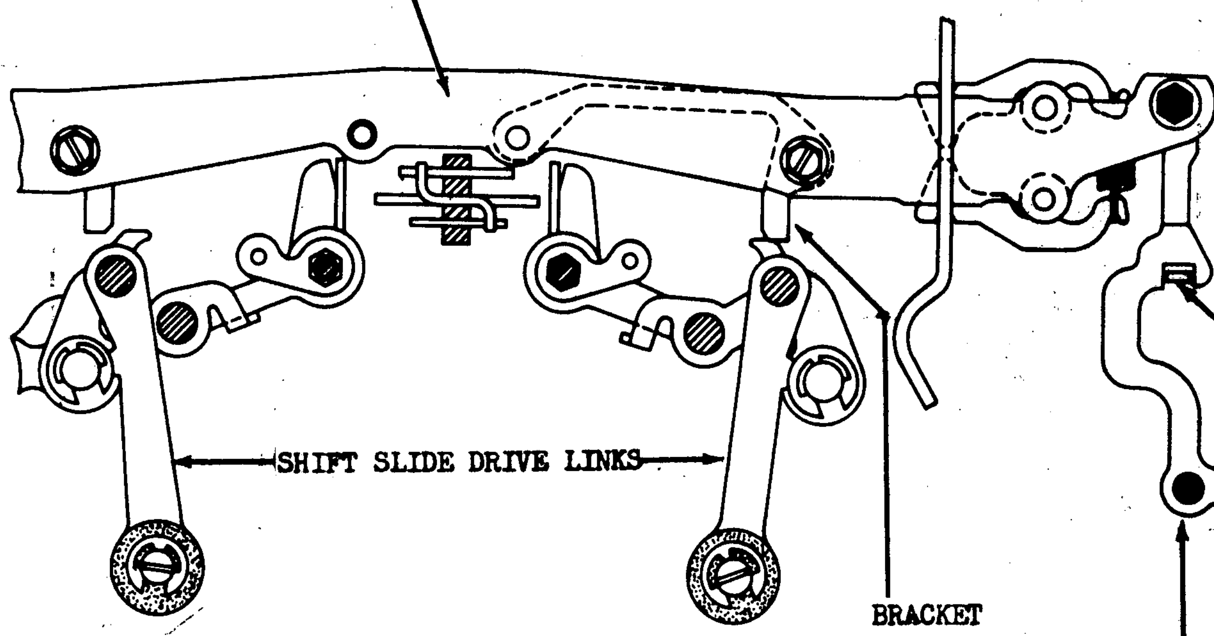
VERTICAL POSITIONING LEVER moves up until blocked by a projecting CODE BAR in a spacing (right) condition

TYPE BOX

- TOP ROW - STOP ON COMMON CODE BAR
- 2nd ROW - STOP ON NUMBER 2 CODE BAR
- 3rd ROW - STOP ON NUMBER 1 CODE BAR
- BOTTOM ROW - STOP ON SUPPRESSION CODE BAR

RULE

1 MARKS - COMMON MARKS
2 MARKS - COMMON MARKS
1 & 2 MARKS - COMMON MARKS
1 & 2 SPACE - COMMON SPACES



CODE BAR #3 moves

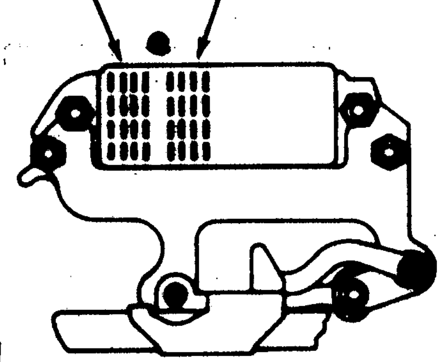
REVERSING SLIDE SHIFT LEVER and

REVERSING SLIDE (left, marking - right, spacing)

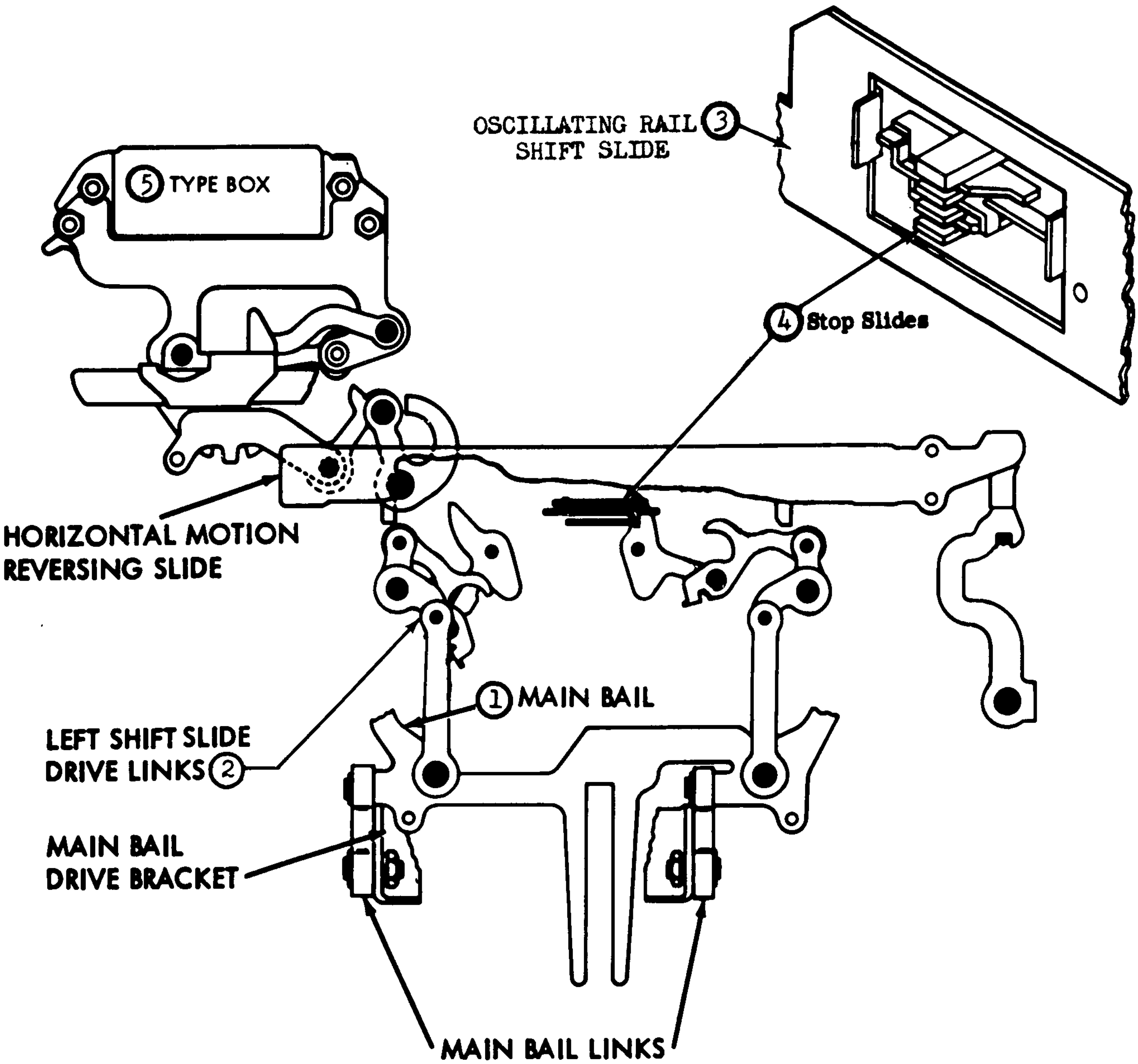
REVERSING SLIDE BRACKETS buckle

RIGHT SHIFT SLIDE DRIVE LINK (marking - as shown) or

LEFT SHIFT SLIDE DRIVE LINK (spacing)

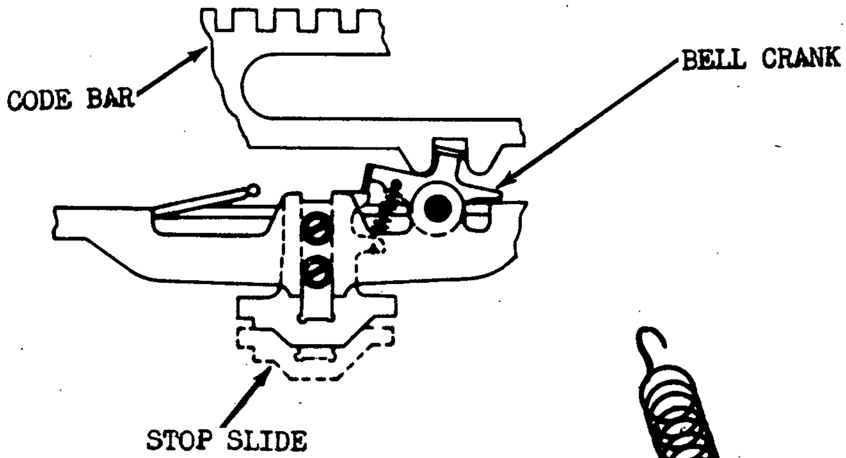


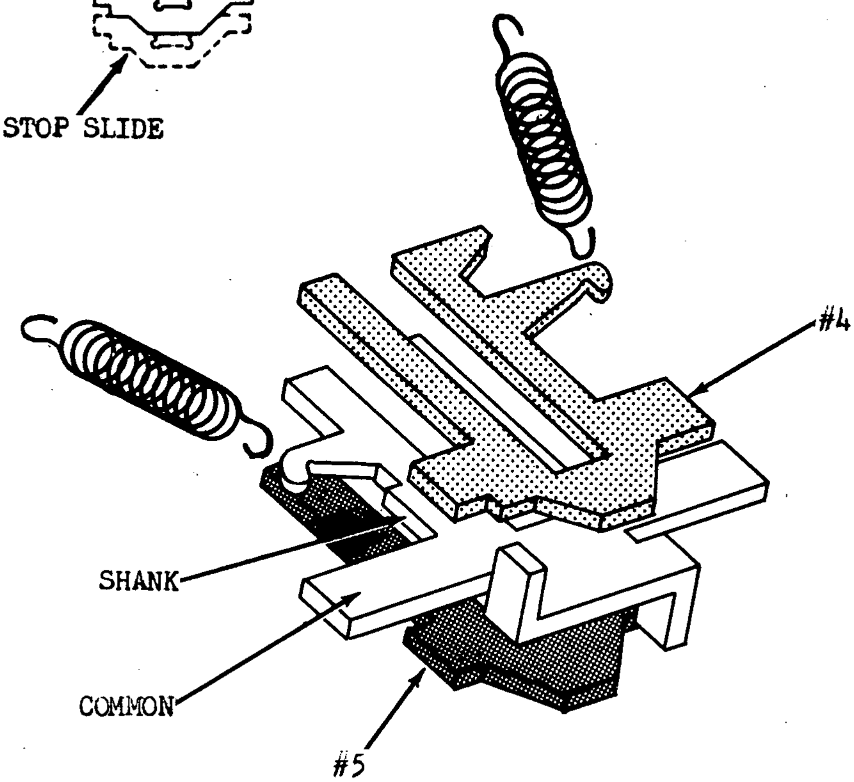
Reversing slide positions type box for printing to occur as illustrated.



ROCKER SHAFT pulls

1. MAIN BAIL down
2. SHIFT SLIDE DRIVE LINK drives
3. OSCILLATING RAIL SHIFT SLIDE against longest
4. HORIZONTAL STOP SLIDE in its path
5. TYPE BOX positioned to selected row





COMMON STOP SLIDE spring loaded spacing (rear)
COMMON STOP SLIDE EXTENSION extends into front path number 4 and 5 STOP SLIDES

INNER ROW - STOP on COMMON STOP SLIDE
2ND ROW - STOP on #4 STOP SLIDE
3RD ROW - STOP on #5 STOP SLIDE
OUTTER ROW - STOP on SHANK of COMMON STOP SLIDE

RULE

#4 MARKS COMMON MARKS

#5 MARKS COMMON MARKS

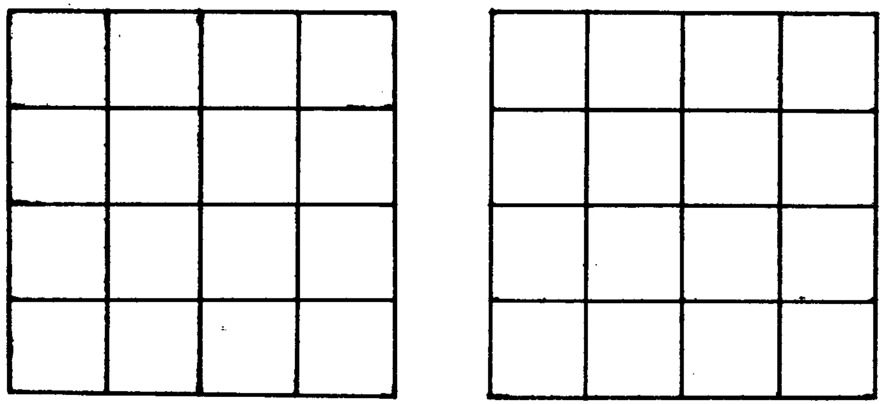
#4 & 5 MARKS COMMON MARKS

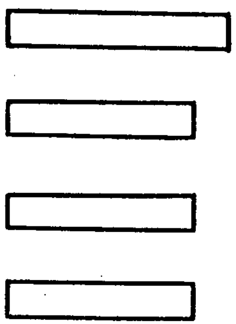
#4 & 5 SPACE COMMON SPACES

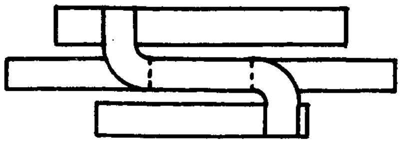
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK

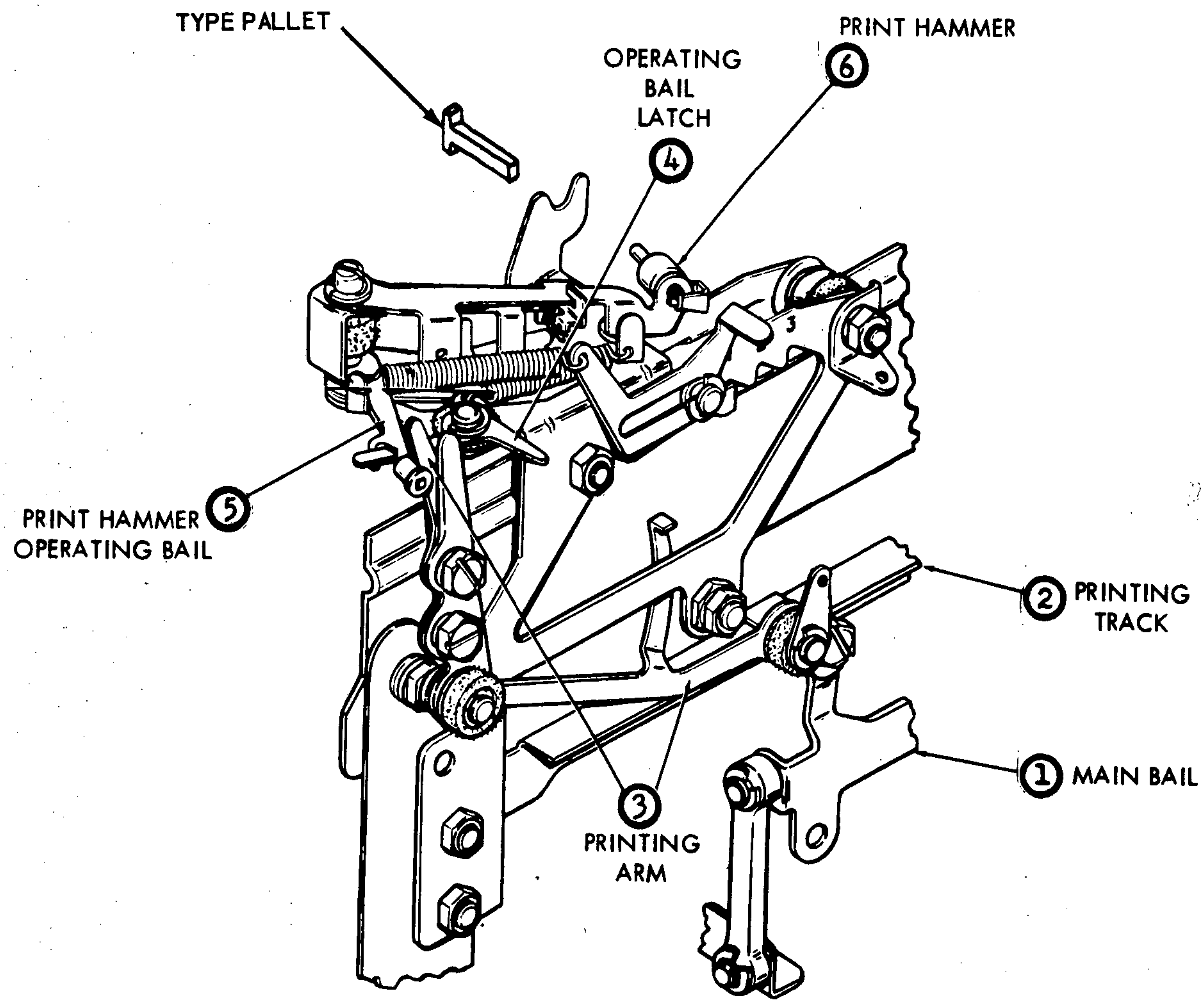
THE QUICK BROWN ●



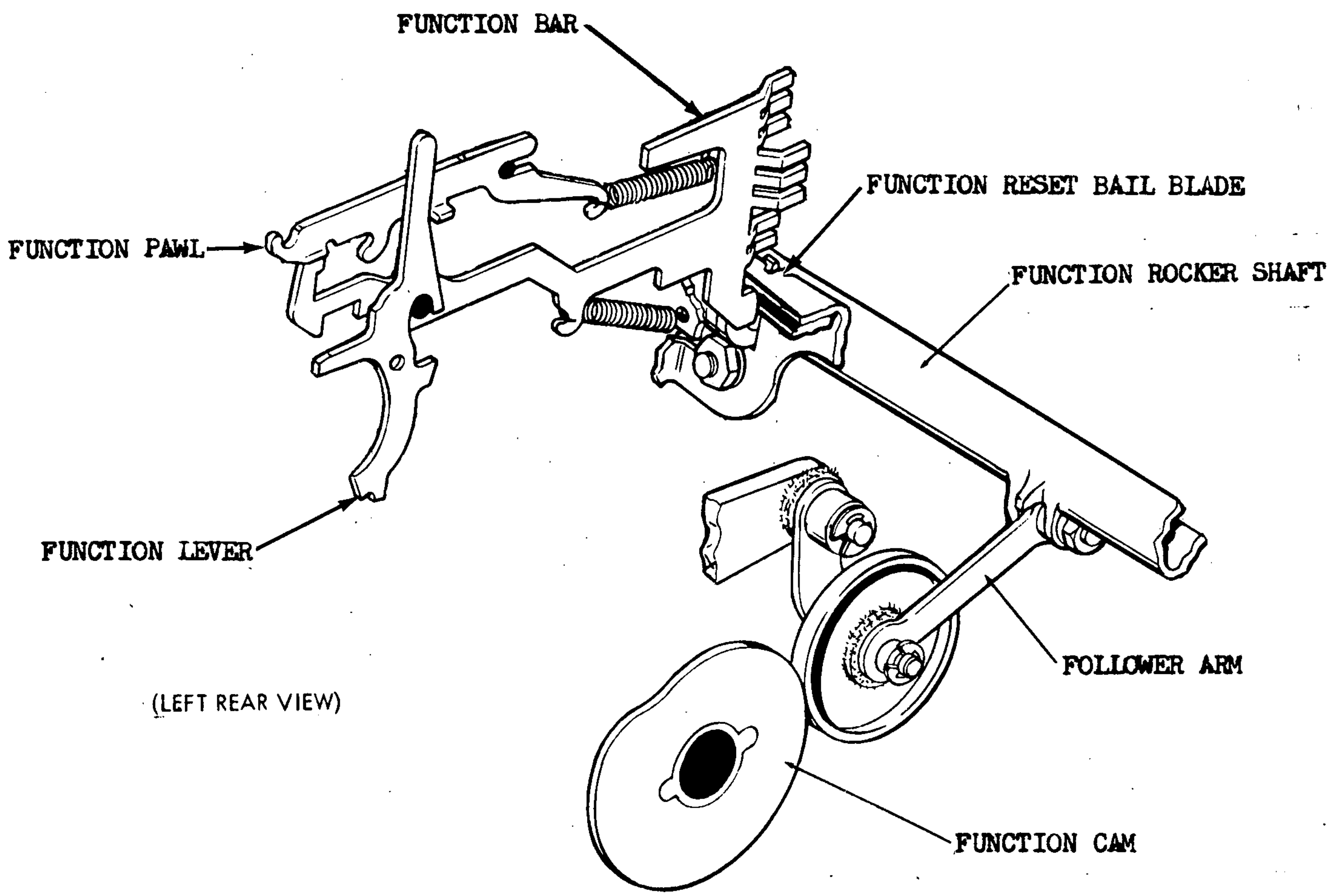


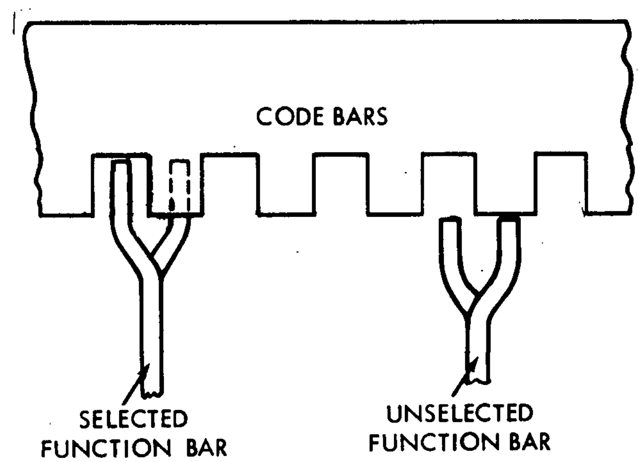


WORK SHEET



1. MAIN BAIL and
2. PRINTING TRACK move down
3. PRINTING ARM actuates
4. OPERATING BAIL LATCH releasing
5. PRINT HAMMER OPERATING BAIL,
6. PRINT HAMMER strikes selected type pallet



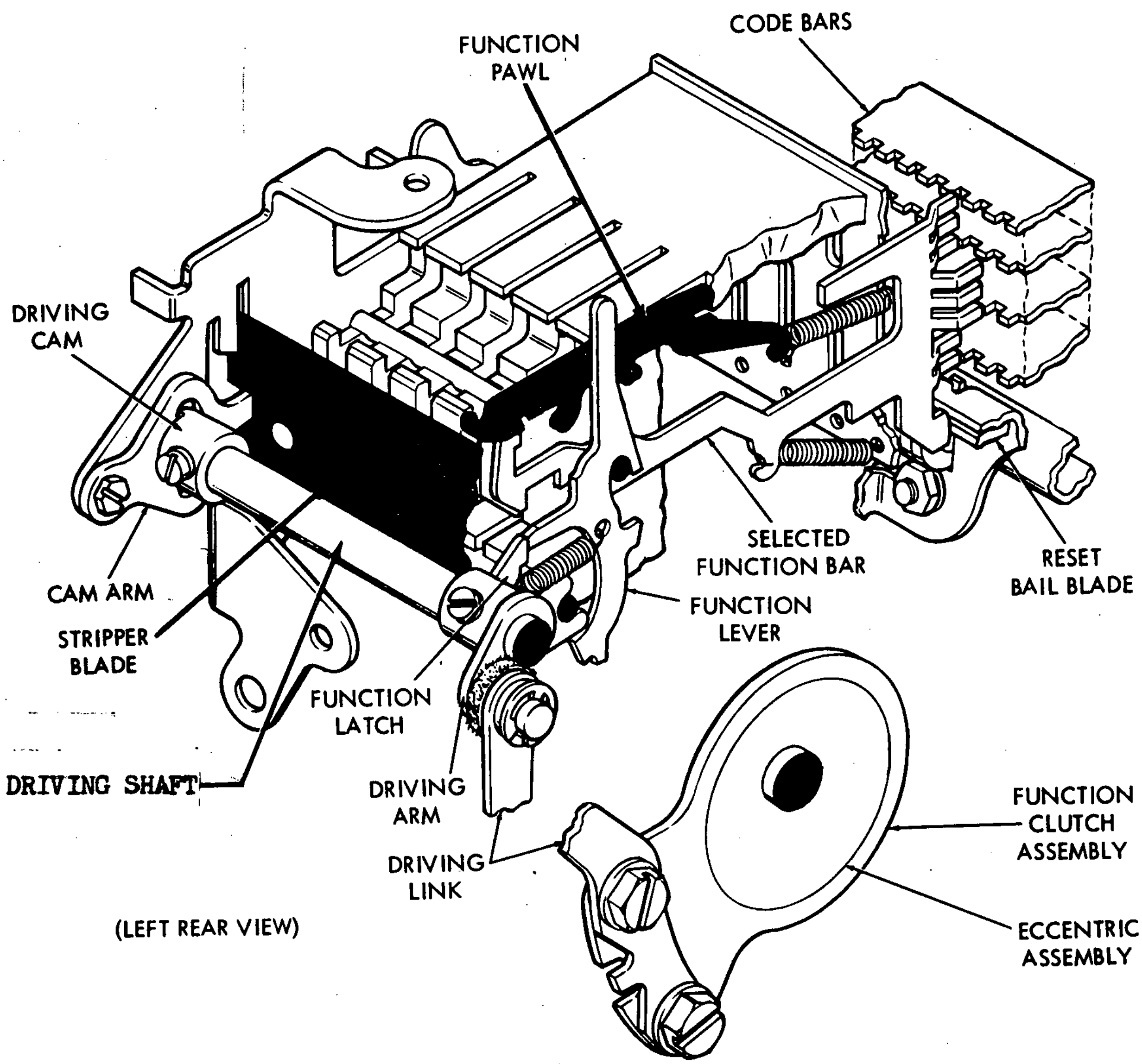


FUNCTION CLUTCH and
FUNCTION CAM rotating
FOLLOWER ARM rides cam,
FUNCTION ROCKER SHAFT pivots,
FUNCTION RESET BAIL BLADE moves (forward),
FUNCTION BARS sense
CODE BARS

CODE BARS block (unselected)
FUNCTION BARS

FUNCTION BAR (selected) moves forward,
FUNCTION PAWL drops over rear of
FUNCTION BAR

FUNCTION RESET BAIL BLADE moves (rearward)
FUNCTION BAR (selected) pushed (rearward) moving
FUNCTION PAWL actuates
FUNCTION LEVER



(LEFT REAR VIEW)

FUNCTION ASSEMBLY and

FUNCTION CLUTCH ASSEMBLY rotates actuating

DRIVING LINK

DRIVING ARM

DRIVING SHAFT and

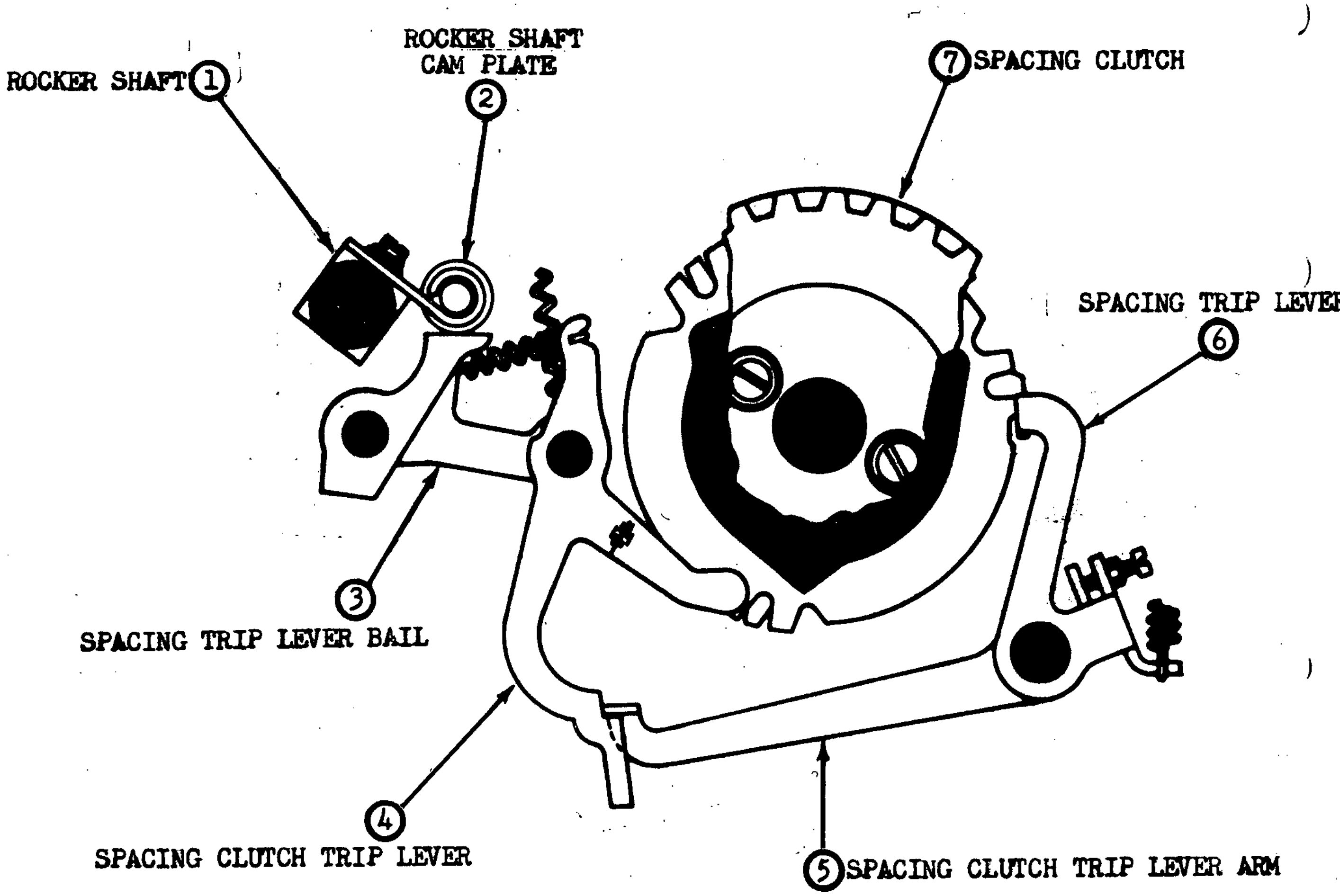
DRIVING CAM pivot

CAM ARM operates

STRIPPER BLADE moves <u>down</u> then <u>up</u> selected

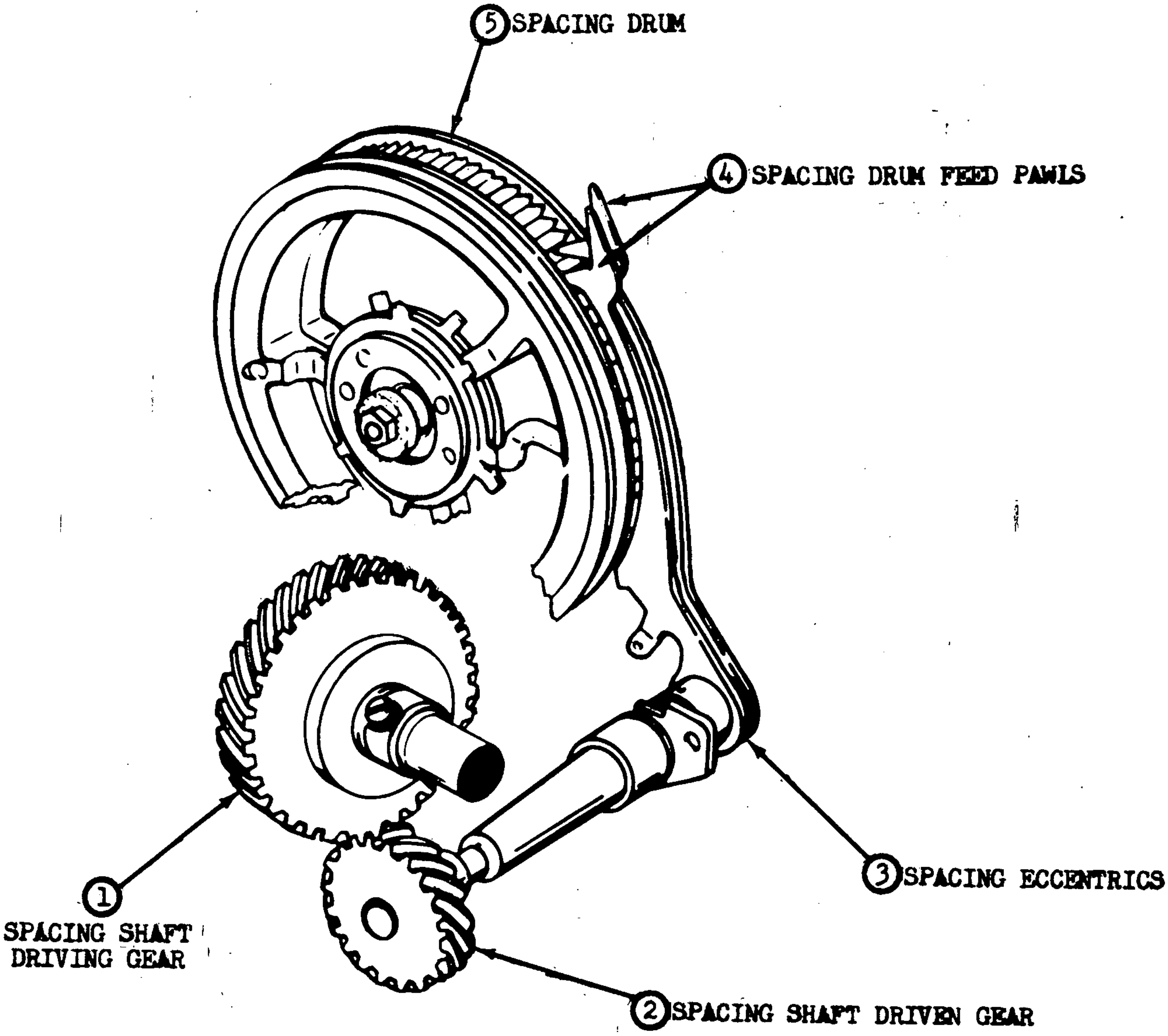
FUNCTION PAWL stripped from

FUNCTION BAR

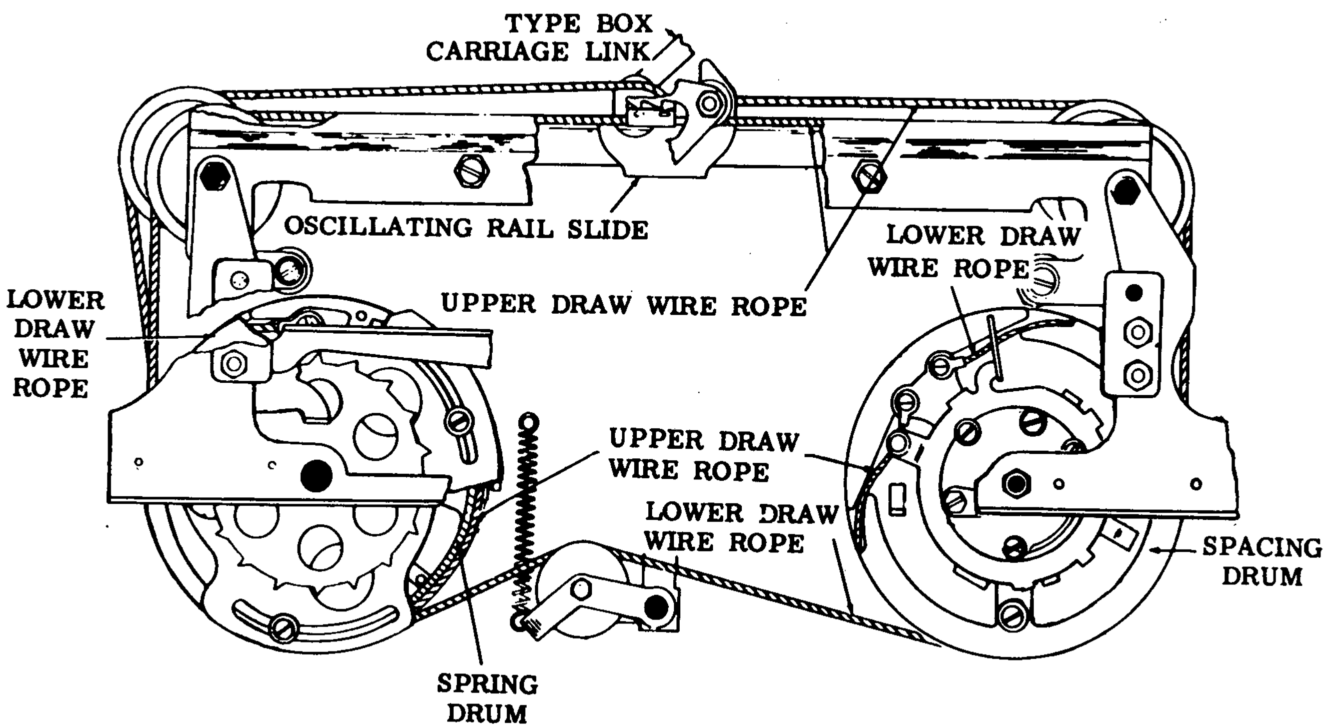


1. ROCKER SHAFT and
2. ROCKER SHAFT CAM PLATE pivot, driving
3. SPACING TRIP LEVER BAIL and
4. SPACING TRIP LEVER down, latching
5. SPACING CLUTCH TRIP LEVER ARM

1. ROCKER SHAFT and
2. ROCKER SHAFT CAM PLATE return, spring pulls
3. SPACING TRIP LEVER BAIL and
4. SPACING TRIP LEVER up, pulling
5. SPACING CLUTCH TRIP LEVER ARM up
6. SPACING CLUTCH TRIP LEVER pivots releasing
7. SPACING CLUTCH



1. SPACING SHAFT DRIVING GEAR rotates
2. SPACING SHAFT DRIVEN GEAR and
3. SPACING ECCENTRICS
4. SPACING DRUM FEED PAWLS move
5. SPACING DRUM rotates



UPPER DRAW WIRE ROPE connected to

SPACING DRUM and

SPRING DRUM

TYPE BOX CARRIAGE LINK and

OSCILLATING RAIL SLIDE clamped to

UPPER DRAW WIRE ROPE,

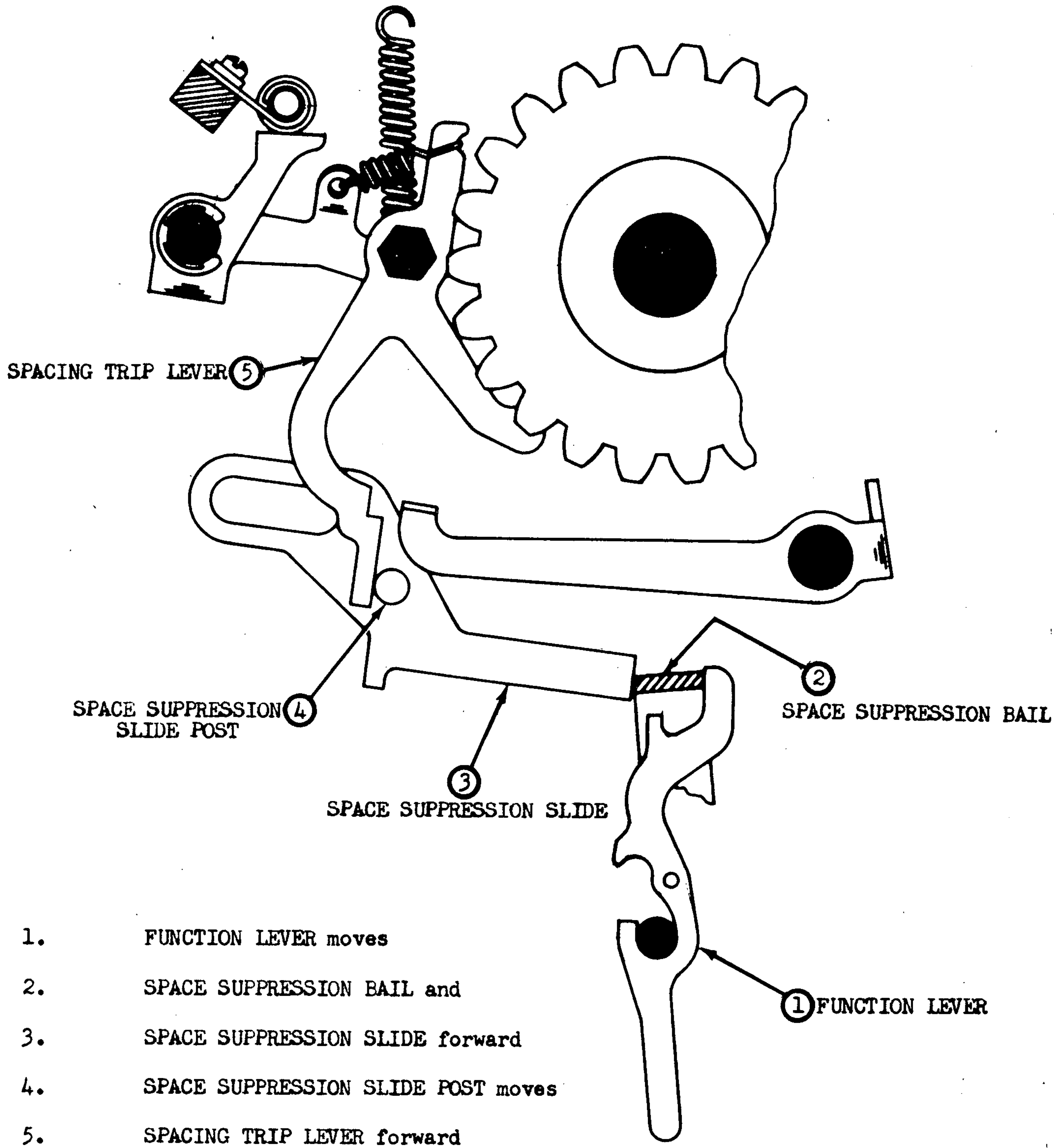
LOWER DRAW WIRE ROPE connected to

SPACING DRUM and

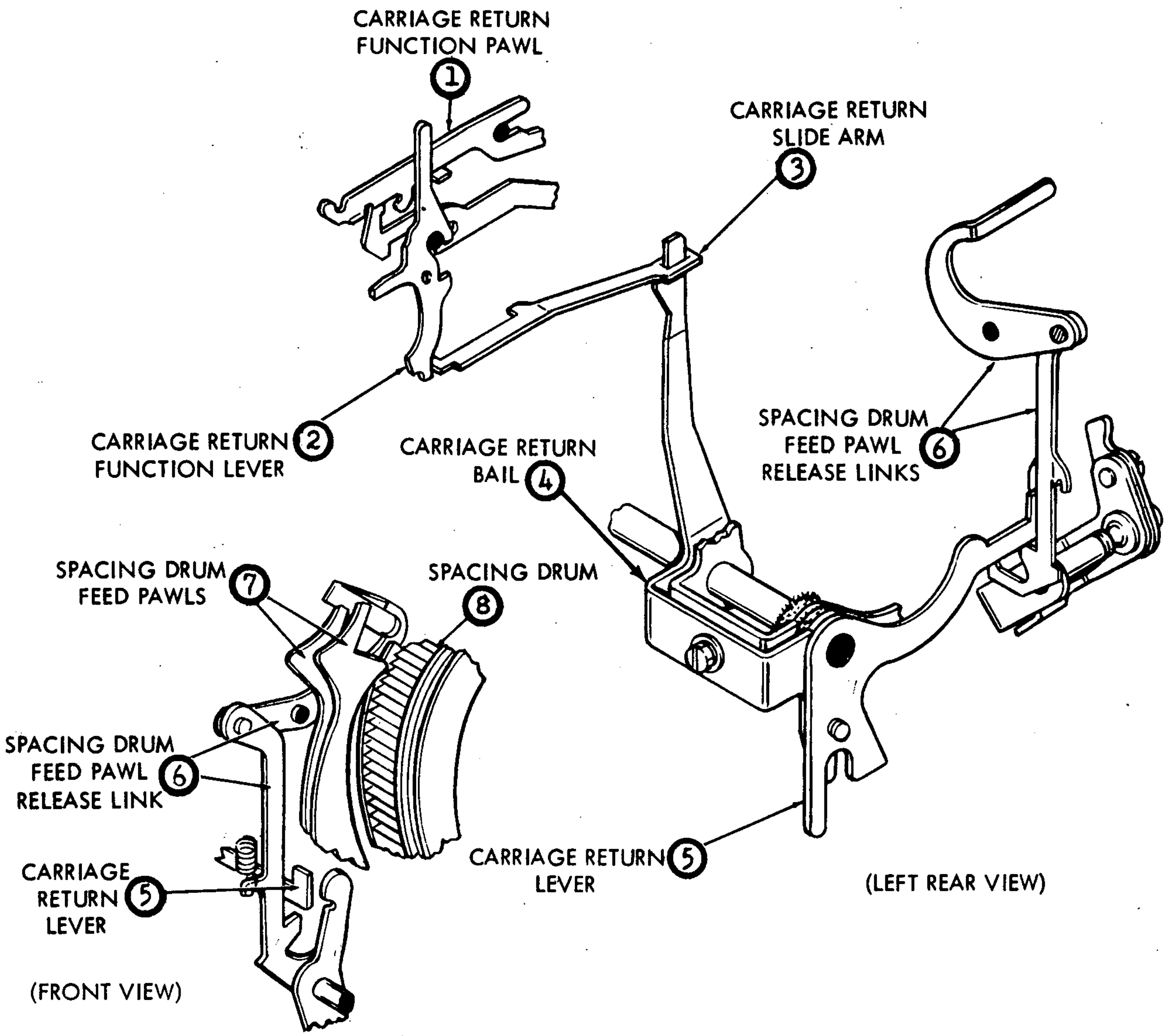
SPRING DRUM

SPACE SUPPRESSION

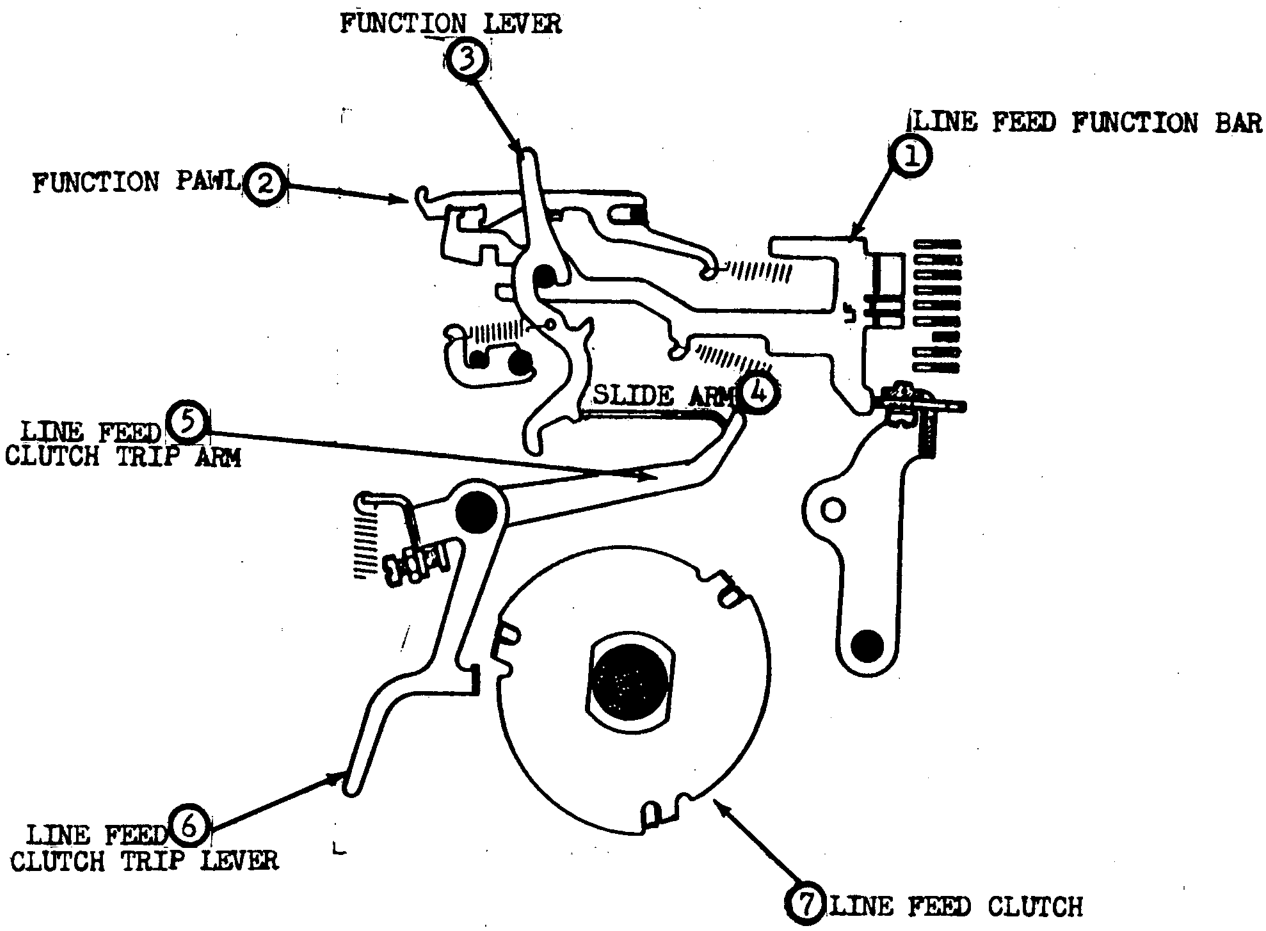
INVERTED VIEW



1. FUNCTION LEVER moves
2. SPACE SUPPRESSION BAIL and
3. SPACE SUPPRESSION SLIDE forward
4. SPACE SUPPRESSION SLIDE POST moves
5. SPACING TRIP LEVER forward

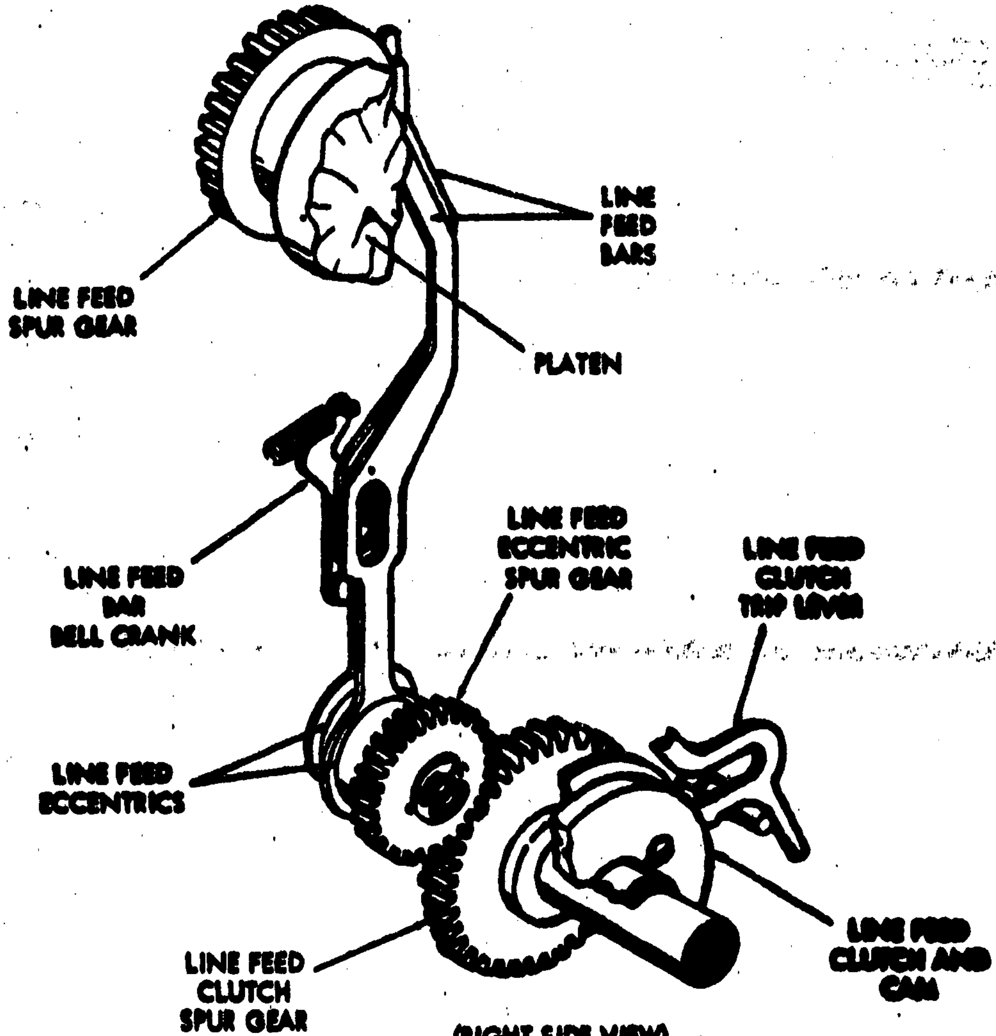


1. CARRIAGE RETURN FUNCTION PAWL actuates
2. CARRIAGE RETURN FUNCTION LEVER pivots, driving
3. CARRIAGE RETURN SLIDE ARM (forward)
4. CARRIAGE RETURN BAIL and
5. CARRIAGE RETURN LEVER pivots
6. SPACING DRUM FEED PAWL RELEASE LINK actuates, lifting
7. SPACING DRUM FEED PAWLS from
8. SPACING DRUM



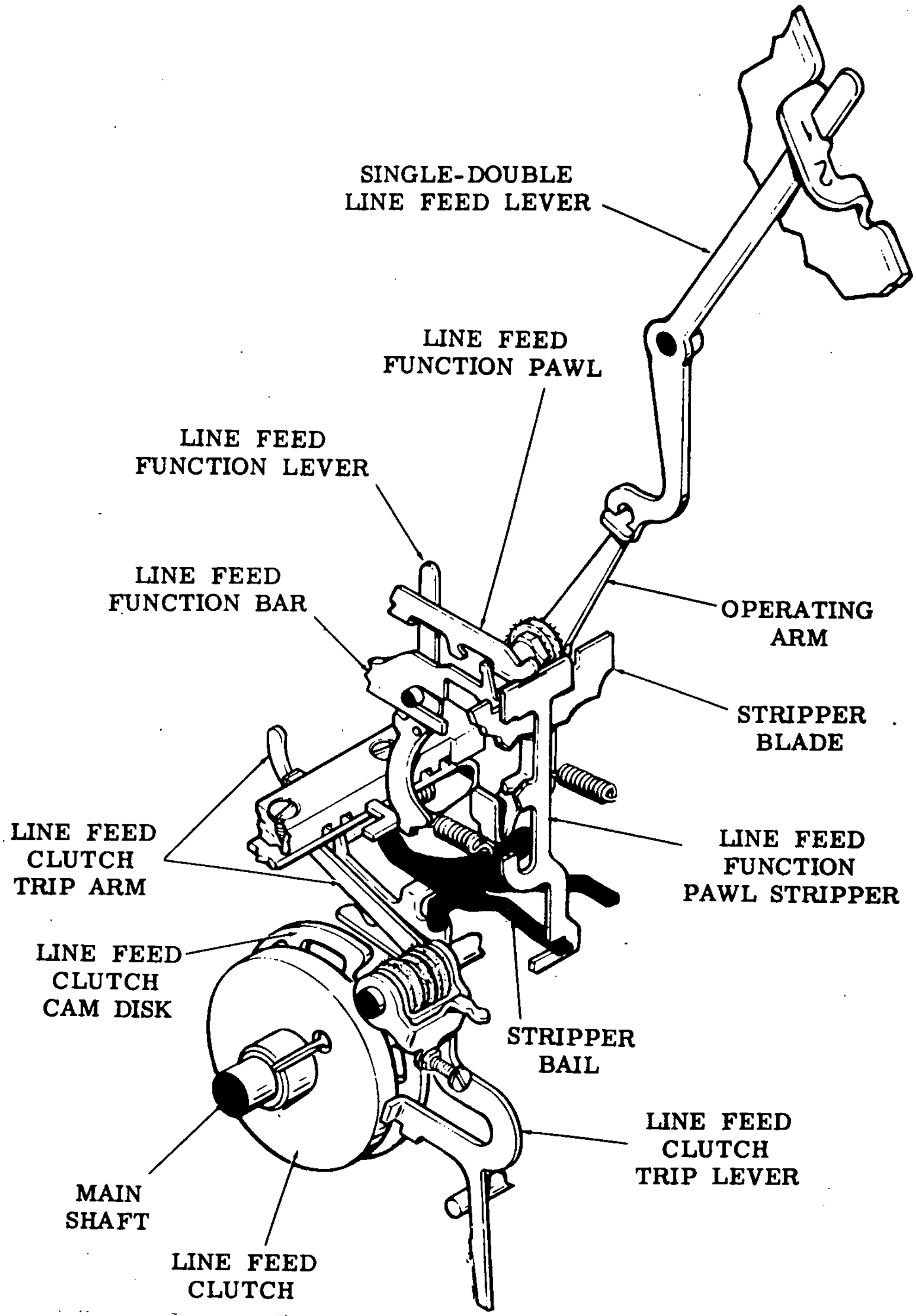
1. LINE FEED FUNCTION BAR
2. FUNCTION PAWL and
3. FUNCTION LEVER actuate
4. SLIDE ARM pushed (forward)
5. LINE FEED CLUTCH TRIP ARM pivots
6. LINE FEED CLUTCH TRIP LEVER releasing
7. LINE FEED CLUTCH

LINE FEED BARS



(RIGHT SIDE VIEW)

LINE FEED CLUTCH SPUR GEAR rotates
LINE FEED ECCENTRIC SPUR GEAR and
LINE FEED ECCENTRICS,
LINE FEED BARS activated, rotating
LINE FEED SPUR GEAR and
PLATEN (paper feeds)



LINE FEED CLUTCH CAM DISK rotating,

STRIPPER BAIL and

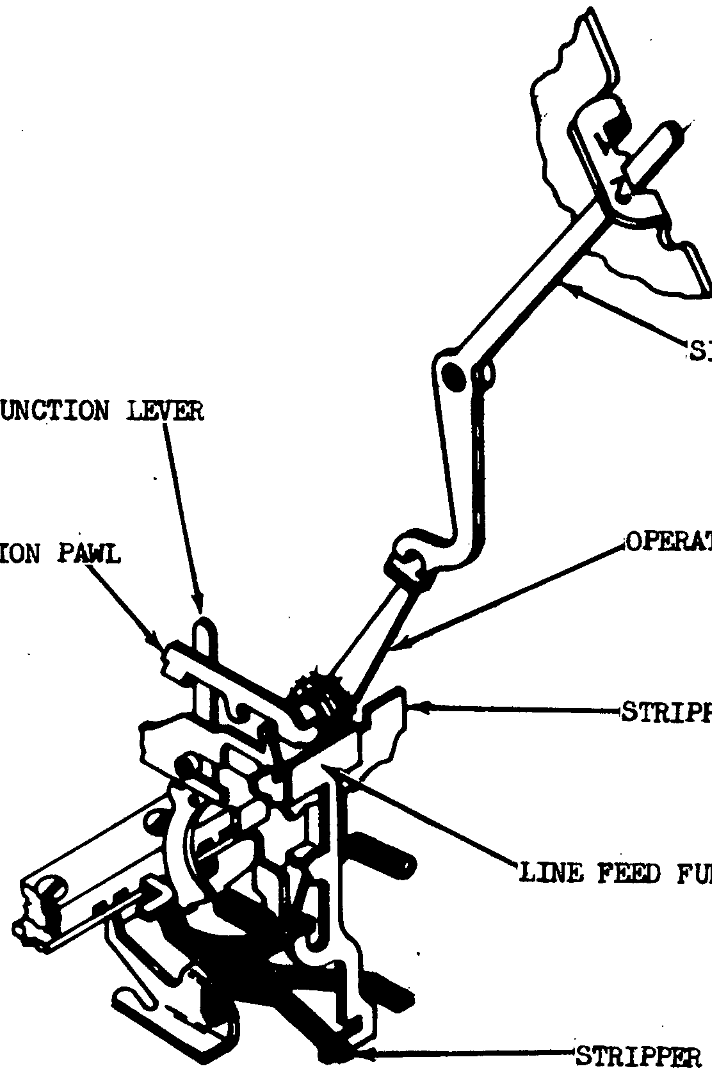
LINE FEED FUNCTION PAWL STRIPPER move up

LINE FEED FUNCTION PAWL stripped releasing

LINE FEED FUNCTION LEVER

LINE FEED CLUTCH stops after one third of a revolution

DOUBLE LINE FEED



SINGLE-DOUBLE LINE FEED LEVER pivots moving

OPERATING ARM moves

STRIPPER BAIL out of

LINE FEED FUNCTION PAWL STRIPPER

STRIPPER BLADE lifts

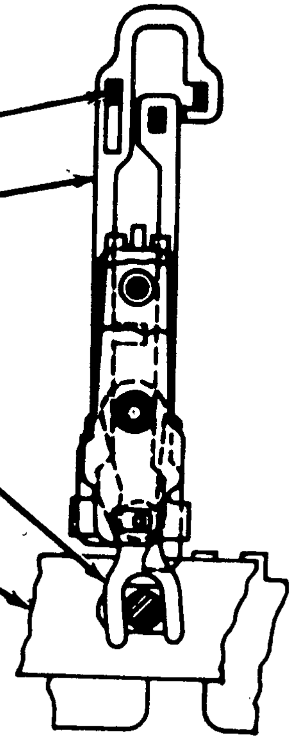
LINE FEED FUNCTION PAWL STRIPPER releasing

LINE FEED FUNCTION PAWL and

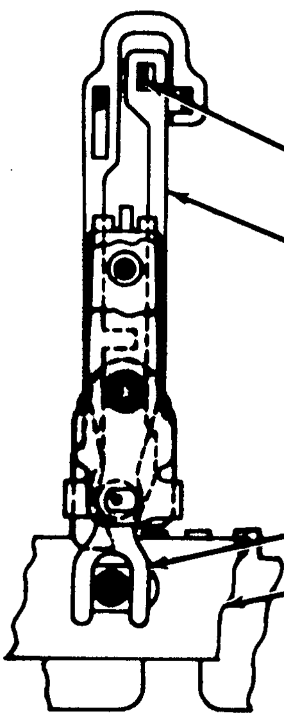
LINE FEED FUNCTION LEVER

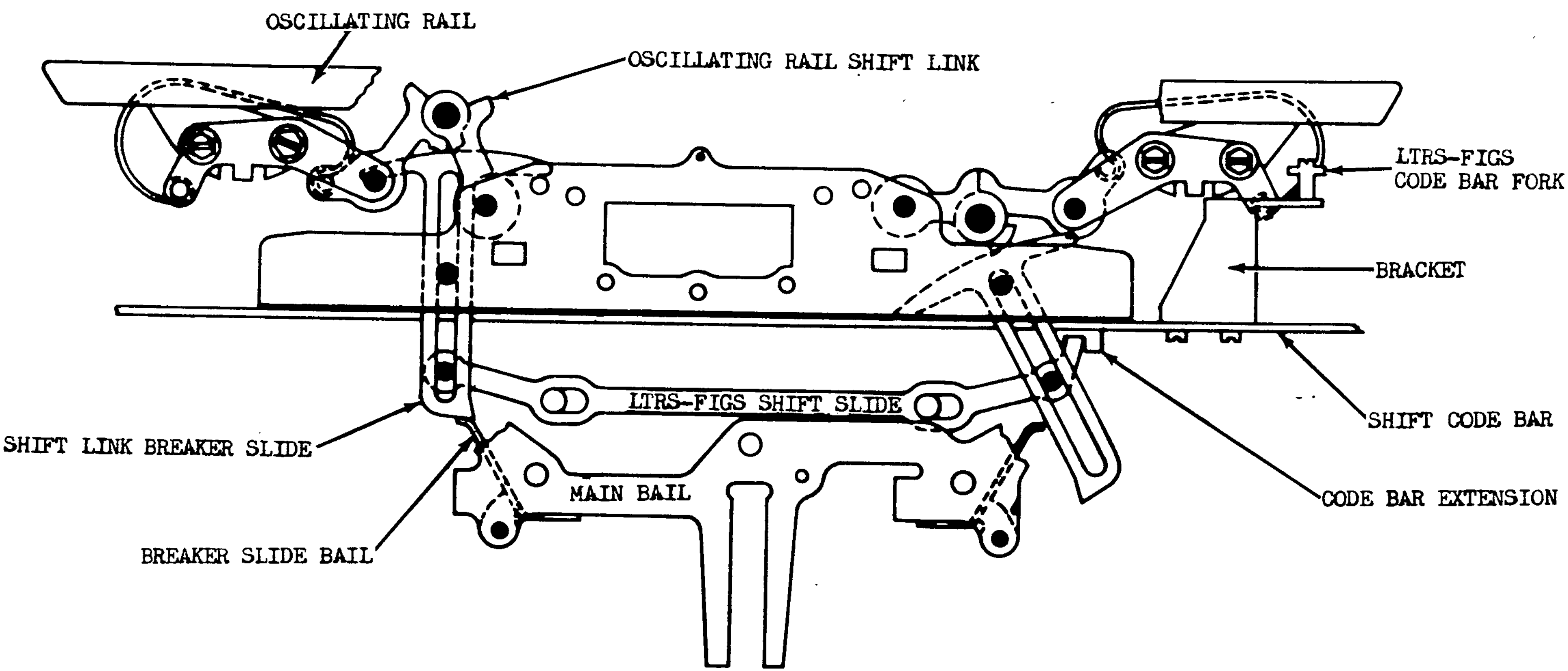
LINE FEED CLUTCH stops after two thirds of a revolution

LETTERS POSITION



FIGURES POSITION

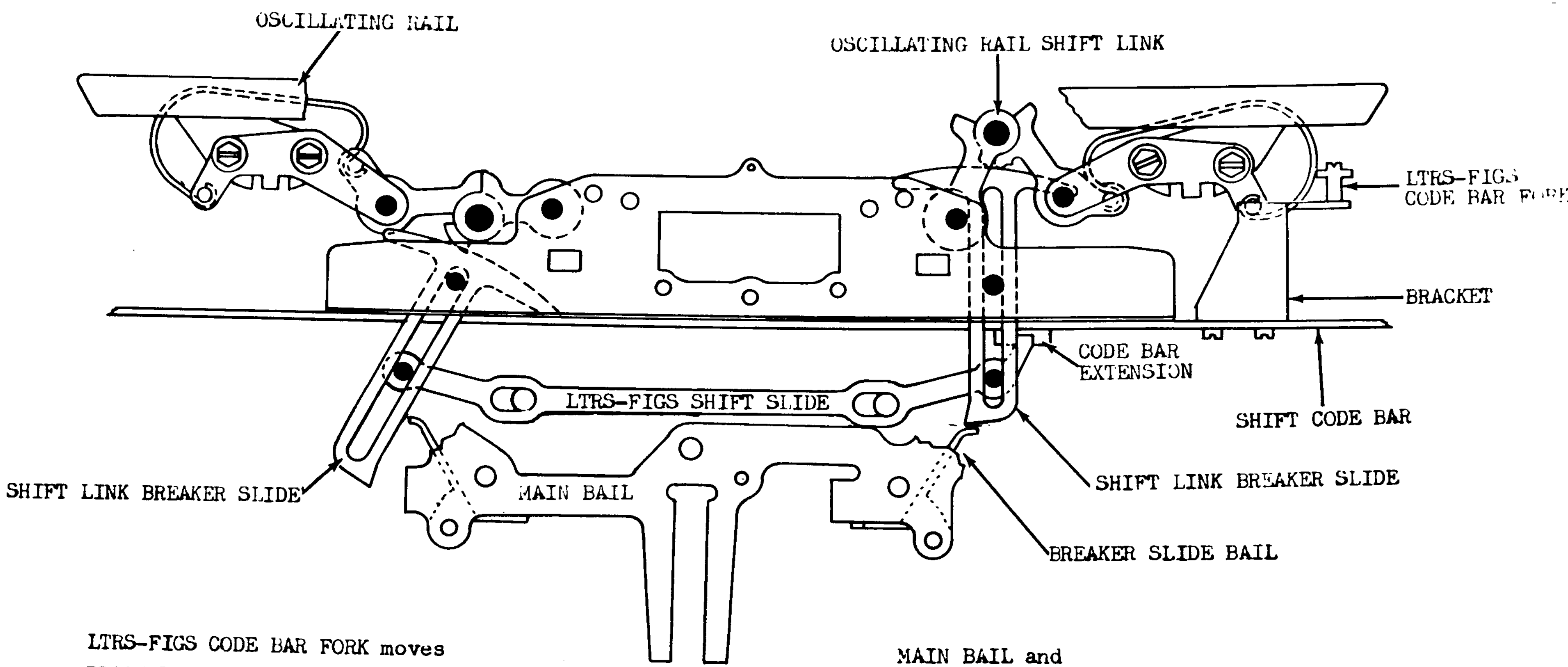




LTRS-FIGS CODE BAR FORK moves
BRACKET
SHIFT CODE BAR
CODE BAR EXTENSION and
LTRS-FIGS SHIFT SLIDE right
SHIFT LINK BREAKER SLIDE (left) straight
SHIFT LINK BREAKER SLIDE (right) pivots

MAIN BAIL and
LEFT BREAKER SLIDE BAIL moves up
LEFT SHIFT LINK BREAKER SLIDE pushed up
LEFT OSCILLATING RAIL SHIFT LINK buckle
OSCILLATING RAIL and
TYPE BOX move (right) LETTER POSITION

LETTERS SHIFT

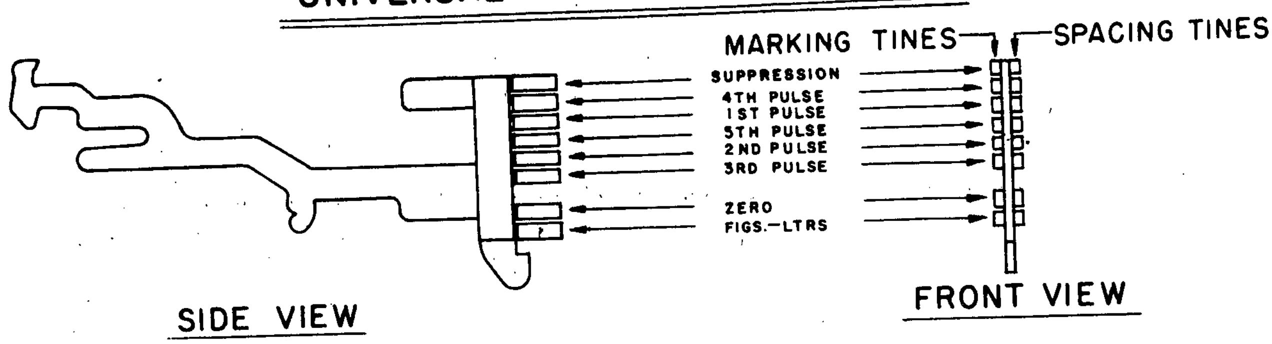


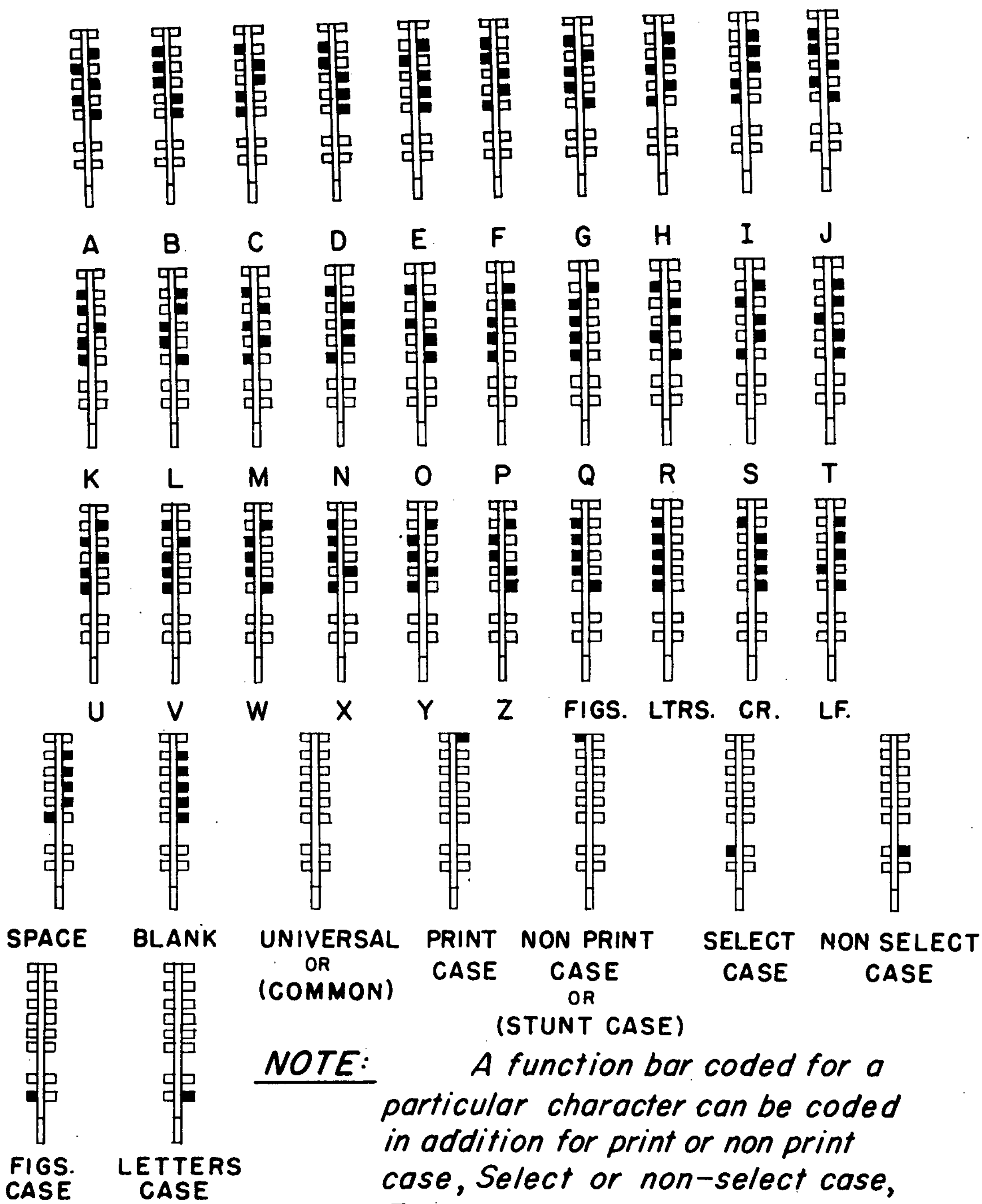
LTRS-FIGS CODE BAR FORK moves
BRACKET
SHIFT CODE BAR
CODE BAR EXTENSION and
LTRS-FIGS SHIFT SLIDE (left)
SHIFT LINK BREAKER SLIDE (right) straight
SHIFT LINK BREAKER SLIDE (left) pivots

MAIN BAIL and
RIGHT BREAKER SLIDE BAIL moves up
RIGHT SHIFT LINK BREAKER SLIDE pushed up
RIGHT OSCILLATING RAIL SHIFT LINK buckle
OSCILLATING RAIL and
TYPE BOX moves (left) FIGURES POSITION

FIGURES SHIFT

UNIVERSAL FUNCTION BAR 153440



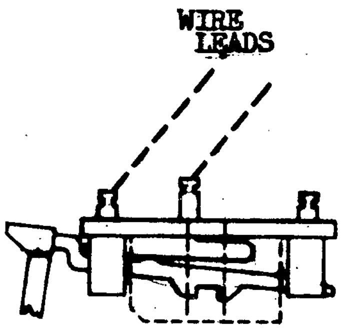


NOTE: *A function bar coded for a particular character can be coded in addition for print or non print case, Select or non-select case, Figs. or Ltrs. Case, or any combination thereof.*

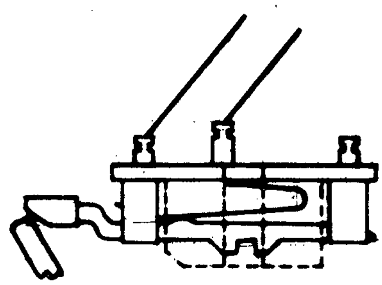
KEY

- ☐ BREAK OUT TINE
- ■ LEAVE IN TINE

NORMALLY OPEN

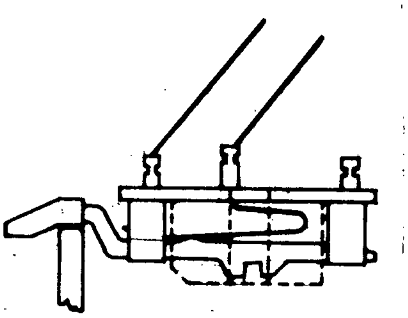


UNOPERATED
CONTACT OPEN

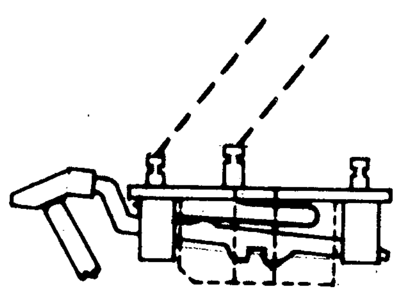


OPERATED
CONTACT CLOSED

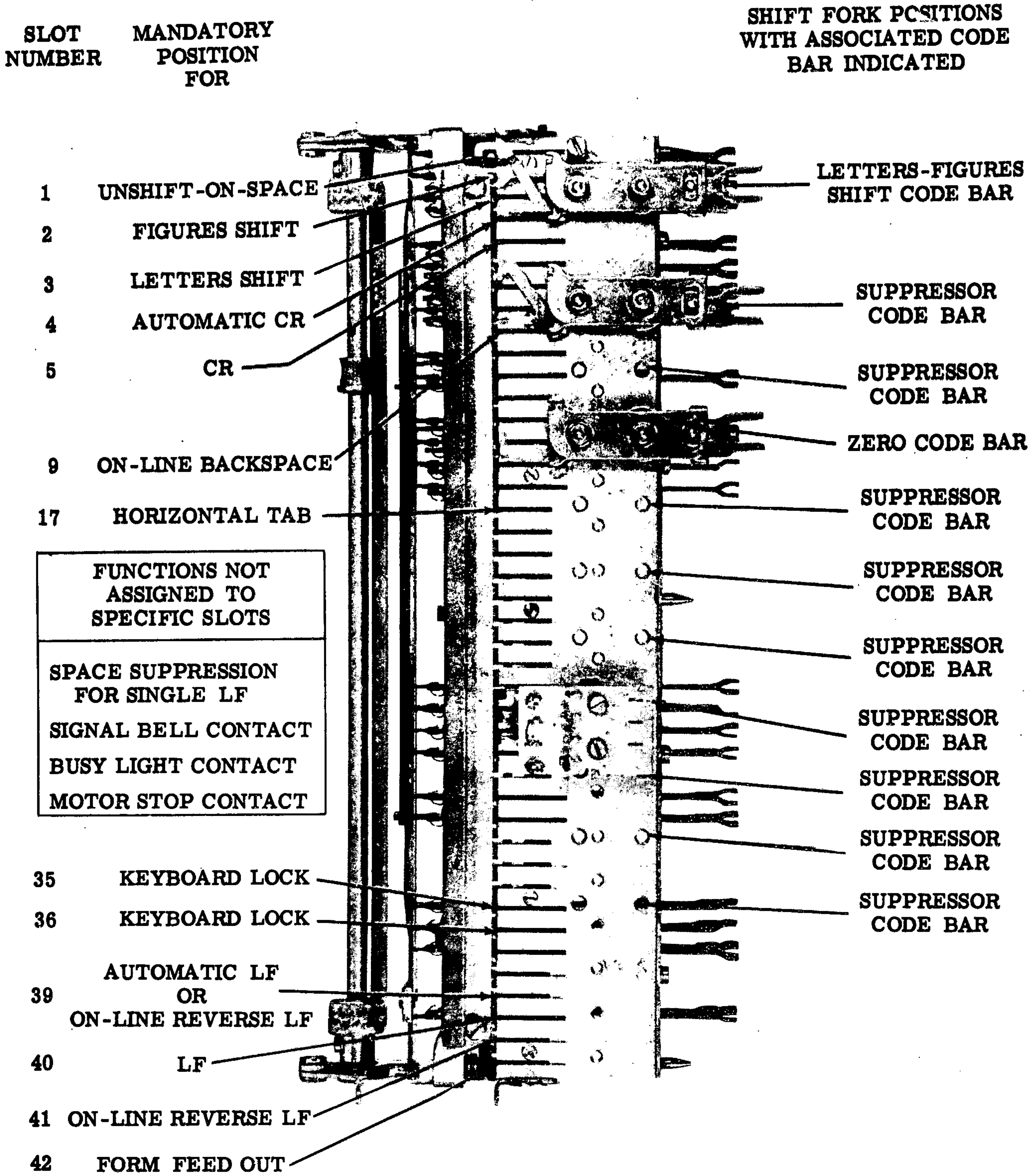
NORMALLY CLOSED

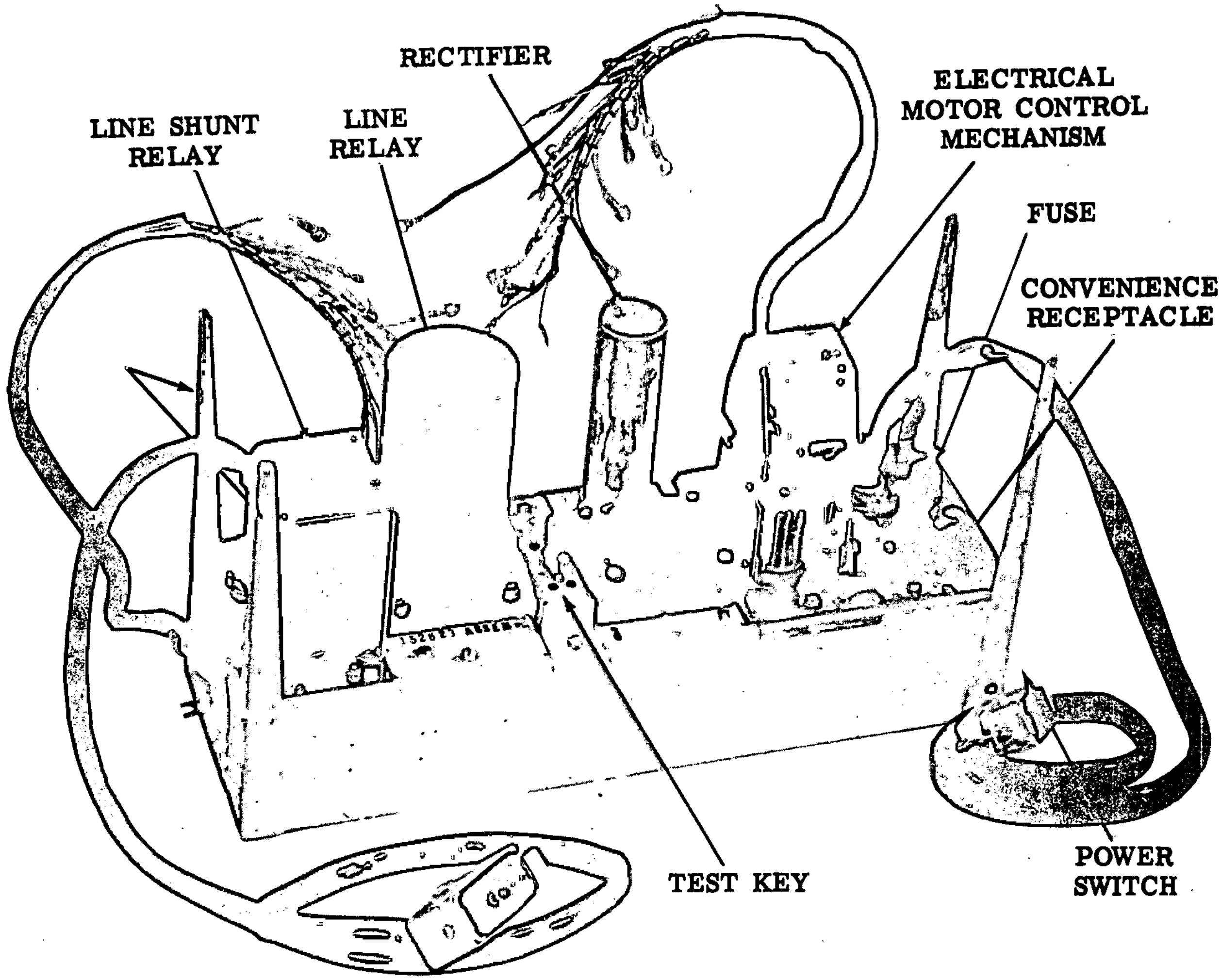


UNOPERATED
CONTACT CLOSED



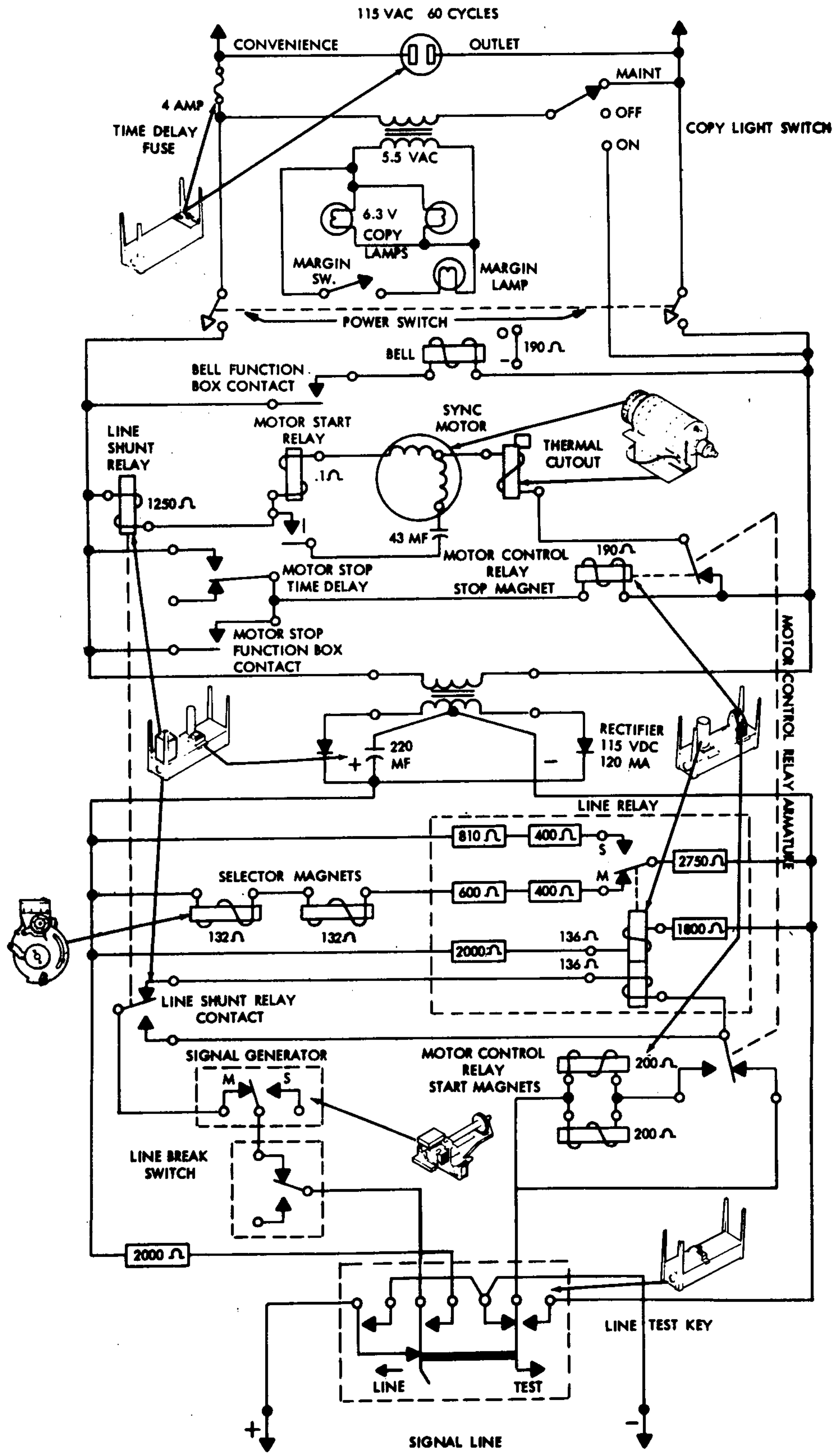
OPERATED
CONTACT OPEN


SLOT NUMBER
MANDATORY POSITION FOR
SHIFT FORK POSITIONS WITH ASSOCIATED CODE BAR INDICATED
1 UNSHIFT-ON-SPACE
2 FIGURES SHIFT
3 LETTERS SHIFT
4 AUTOMATIC CR
5 CR
9 ON-LINE BACKSPACE
17 HORIZONTAL TAB
FUNCTIONS NOT ASSIGNED TO SPECIFIC SLOTS
SPACE SUPPRESSION FOR SINGLE LF
SIGNAL BELL CONTACT
BUSY LIGHT CONTACT
MOTOR STOP CONTACT
35 KEYBOARD LOCK
36 KEYBOARD LOCK
39 AUTOMATIC LF OR ON-LINE REVERSE LF
40 LF
41 ON-LINE REVERSE LF
42 FORM FEED OUT
LETTERS-FIGURES SHIFT CODE BAR
SUPPRESSOR CODE BAR
SUPPRESSOR CODE BAR
ZERO CODE BAR
SUPPRESSOR CODE BAR
SUPPRESSOR CODE BAR
SUPPRESSOR CODE BAR
SUPPRESSOR CODE BAR
SUPPRESSOR CODE BAR
SUPPRESSOR CODE BAR
SUPPRESSOR CODE BAR



The electrical service unit serves as the area of concentration for the set's wiring. It also provides the mounting facilities for various electrical assemblies and components.

The electrical service unit may include such optional assemblies as are shown above. Terminal blocks and cables required for interconnection of the assemblies with other components may also be included.


115 VAC 60 CYCLES
CONVENIENCE
OUTLET
MAINT
4 AMP
TIME DELAY
FUSE
O OFF
O ON
COPY LIGHT SWITCH
5.5 VAC
6.3 V
COPY
LAMPS
MARGIN
SW.
MARGIN
LAMP
POWER SWITCH
BELL
190 Ω
BELL FUNCTION
BOX CONTACT
LINE
SHUNT
RELAY
MOTOR START
RELAY
SYNC
MOTOR
THERMAL
CUTOUT
.1 Ω
1250 Ω
43 MF
MOTOR CONTROL
RELAY
STOP MAGNET
190 Ω
MOTOR STOP
TIME DELAY
MOTOR STOP
FUNCTION BOX
CONTACT
MOTOR CONTROL RELAY ARMATURE
220
MF
RECTIFIER
115 VDC
120 MA
LINE RELAY
810 Ω
400 Ω
S
M
2750 Ω
SELECTOR MAGNETS
600 Ω
400 Ω
132 Ω
132 Ω
136 Ω
136 Ω
1800 Ω
2000 Ω
LINE SHUNT RELAY
CONTACT
SIGNAL GENERATOR
M
S
MOTOR CONTROL
RELAY
START MAGNETS
200 Ω
200 Ω
LINE BREAK
SWITCH
2000 Ω
LINE TEST KEY
LINE
TEST
SIGNAL LINE

POWER SWITCH

The POWER SWITCH when operated, provides 115 VAC for the

COPY LAMP TRANSFORMER

BELL FUNCTION

MOTOR START CIRCUIT

MOTOR STOP CIRCUIT

RECTIFIER

CONVENIENCE OUTLET

The CONVENIENCE OUTLET provides

115 VAC for maintenance purposes.

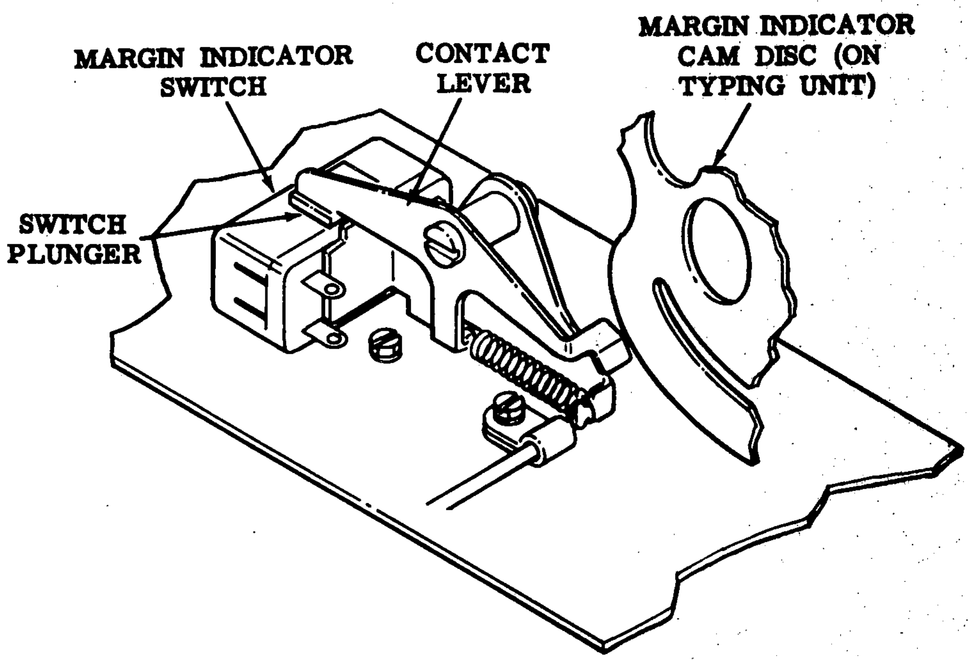
COPY LIGHT SWITCH

The COPY LIGHT SWITCH has three positions.

1. ON POSITION
   The copy lamp transformers input is dependent upon the main power switch to light the copy lamps.

2. OFF POSITION
   The copy lamp transformers input is maintained open, disabling the copy lamps.

3. MAINTENANCE POSITION
   The copy lamp transformers input is maintained energized by shunting the main power switch. This keeps the copy lamps illuminated.



as TYPING UNIT spaces,

SPRING DRUM rotates

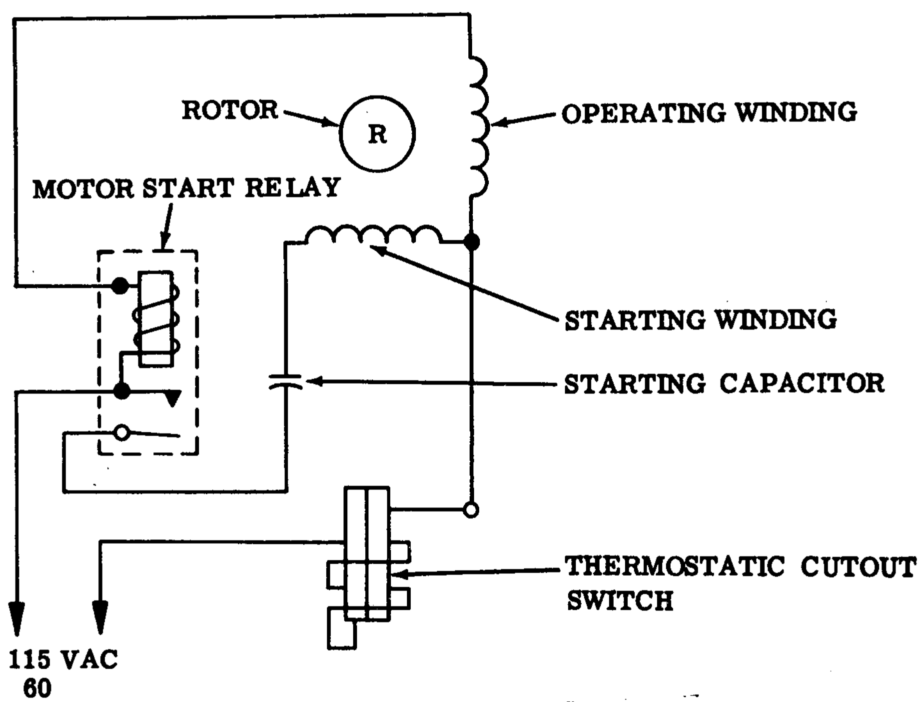
MARGIN INDICATOR CAM DISC contacts

CONTACT LEVER pivots, releasing

MARGIN INDICATOR SWITCH PLUNGER.

MARGIN INDICATOR SWITCH CONTACTS close, illuminating

MARGIN INDICATOR LAMP.



The stator of the motor has two windings: a starting winding and an operating (or run) winding. The starting winding, starting capacitor, and the normally-open contacts of the starting relay are connected in series. The coil of the starting relay is connected in series with the operating winding.

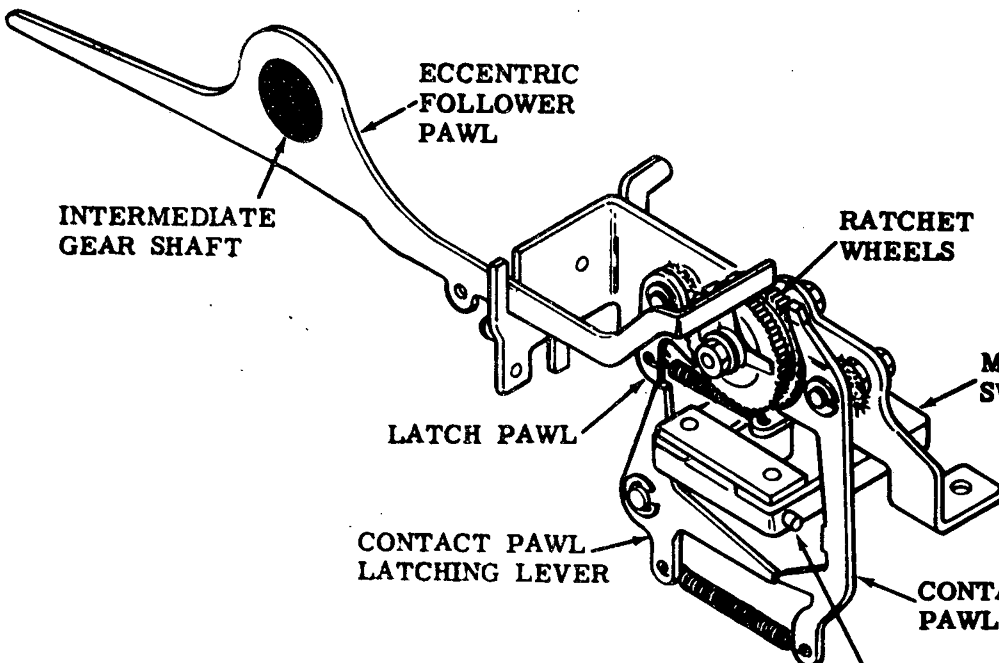
When power is applied, the initial current through the operating winding energizes the relay. The relay contacts close the circuit to the starting winding. As the speed of the rotor increases, the current in the operating winding decreases. When the current has decreased to a predetermined level, the starting relay de-energizes. The relay contacts open and remove the starting winding from the operating circuit. The rotor will continue to accelerate until it reaches the synchronous operating speed.

The thermostatic cut-out switch is connected in series with both stator windings. This temperature operated device opens the circuit to these windings whenever excessive current is drawn. The switch can be reset by depressing its push-button.

INTERMEDIATE GEAR SHIFT powers

ECCENTRIC FOLLOWER PAWL drives

RATCHET WHEELS.



if LINE SIGNAL not received within 756 revolutions

RATCHET WHEEL INDENTS line up.

LATCH PAWL drops into indent, pivoting

CONTACT PAWL LATCHING LEVER releases

CONTACT PAWL operates

MOTOR STOP SWITCH opens

MOTOR circuit.

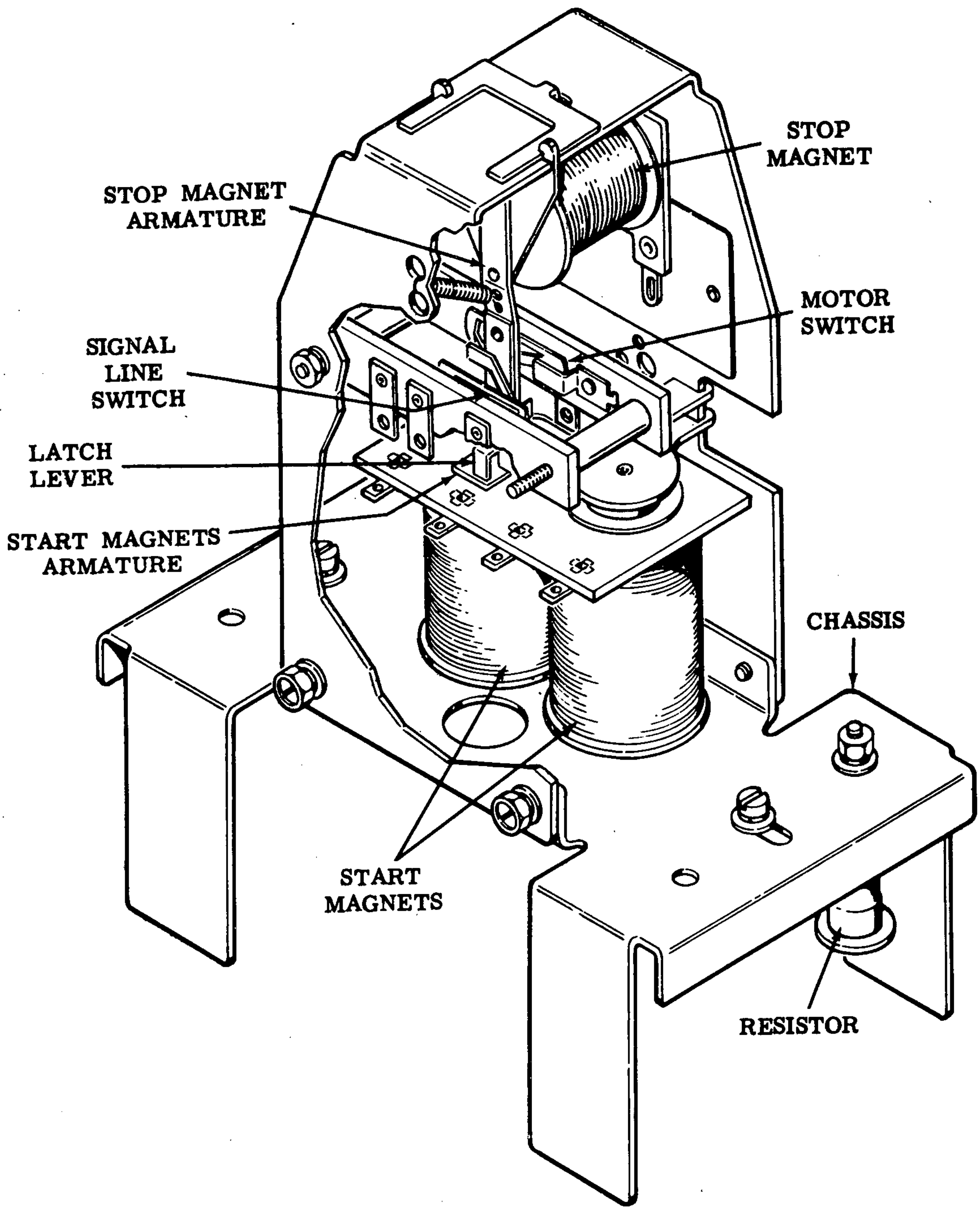
if LINE SIGNAL received withing 756 revolutions

TYPING UNIT MAIN BAIL DRIVE EXTENSION engages

CONTACT PAWL relatched by

CONTACT PAWL LATCHING LEVER.

TIMING CYCLE restarts.


STOP MAGNET
STOP MAGNET ARMATURE
MOTOR SWITCH
SIGNAL LINE SWITCH
LATCH LEVER
START MAGNETS ARMATURE
CHASSIS
START MAGNETS
RESISTOR

MOTOR STOP FUNCTION BOX CONTACT or

MOTOR STOP TIME DELAY operates

STOP MAGNET armature

opens MOTOR CONTROL CONTACTS, stopping MOTOR, and

transfers SIGNAL LINE CONTACTS, operating START MAGNETS.

START MAGNET ARMATURE locks

STOP MAGNET ARMATURE in operated position.

depressing LINE BREAK KEY releases

START MAGNET ARMATURE releases

STOP MAGNET ARMATURE, to first stop.

releasing LINE BREAK KEY operates

START MAGNET ARMATURE releases

STOP MAGNET ARMATURE

closes MOTOR CONTROL CONTACTS, starting MOTOR, and

transfers SIGNAL LINE CONTACTS, releasing START MAGNETS.

RECTIFIER

The Rectifier Assembly consists of a power transformer, two diode rectifiers, and a filter capacitor arranged in a full wave rectification circuit.

the RECTIFIER provides 115 VDC @ 120MA for

LINE RELAY BIAS winding

RECEIVING UNIT SELECTOR MAGNETS

LINE TEST KEY ASSEMBLY

LINE SHUNT RELAY

The coil of this relay is connected in series with the motor operating circuit. The signal line is connected through the relay contacts to the line winding of the line relay.

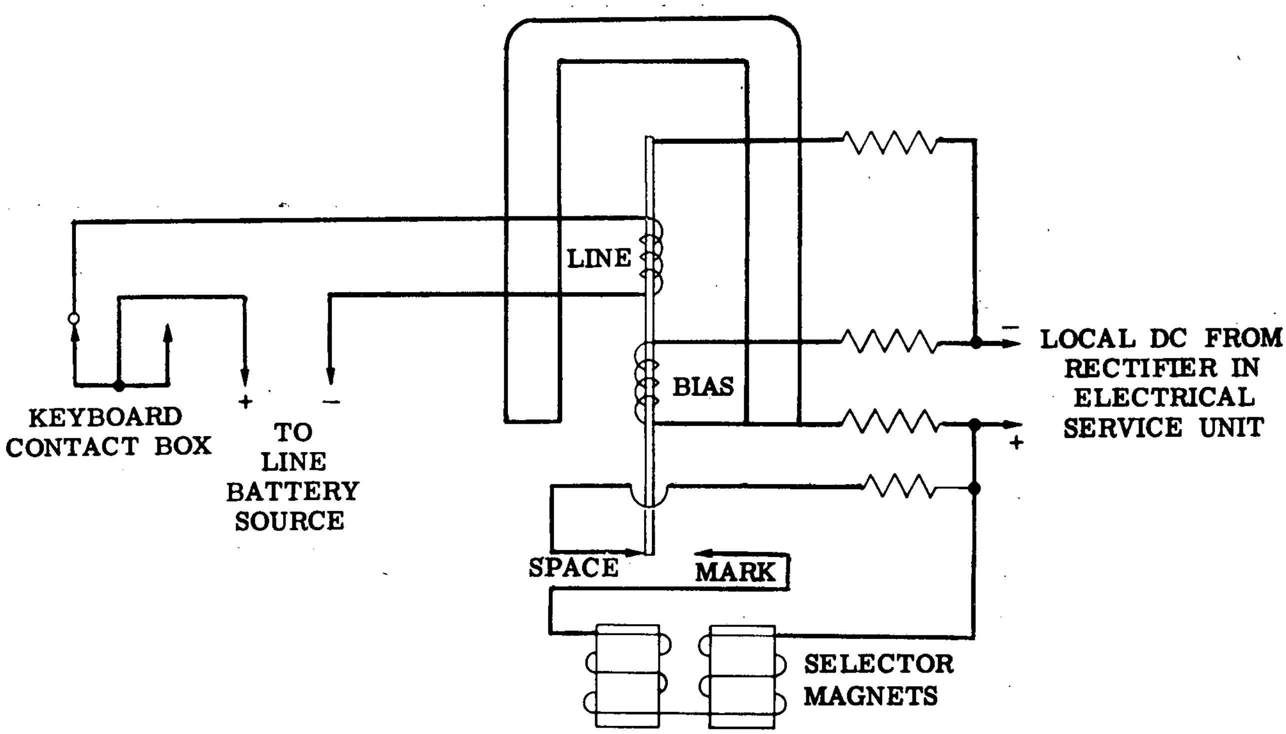
If power is removed from the set, through opening of the manual power switch or by action of the motor control mechanism, the relay will de-energize. The relay contacts will transfer, maintaining signal line continuity while bypassing the local unit.

LINE TEST KEY

The LINE TEST KEY permits manual shunting of the signal line for independent operation of the set.

BIAS WINDING energized by LOCAL RECTIFIER.

LINE WINDING in series with SIGNAL LINE.



SIGNAL LINE SPACING

ARMATURE attracted to SPACE CONTACT by

BIAS WINDING CURRENT.

SELECTOR MAGNETS de-energized.

SIGNAL LINE MARKING

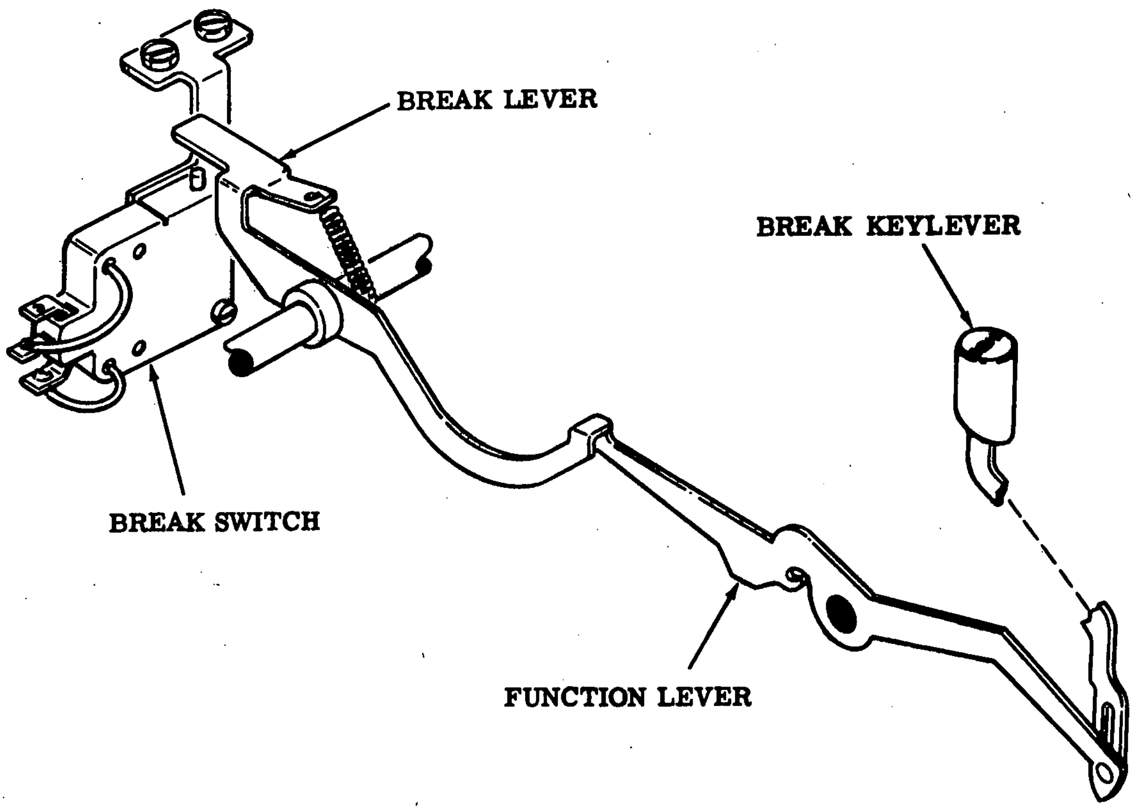
ARMATURE attracted to MARK CONTACT by

LINE WINDING CURRENT overcomes attraction of

BIAS WINDING.

SELECTOR MAGNETS energized by

LOCAL RECTIFIER.



depressing BREAK KEY LEVER pivots

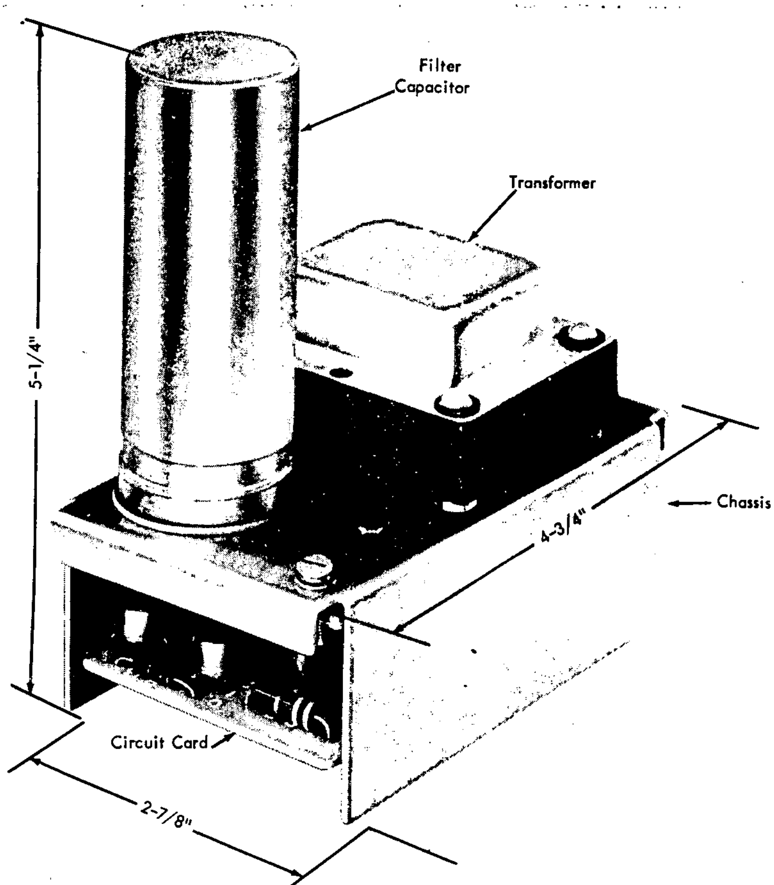
FUNCTION LEVER pivots

BREAK LEVER operates

BREAK SWITCH opens

SIGNAL LINE circuit

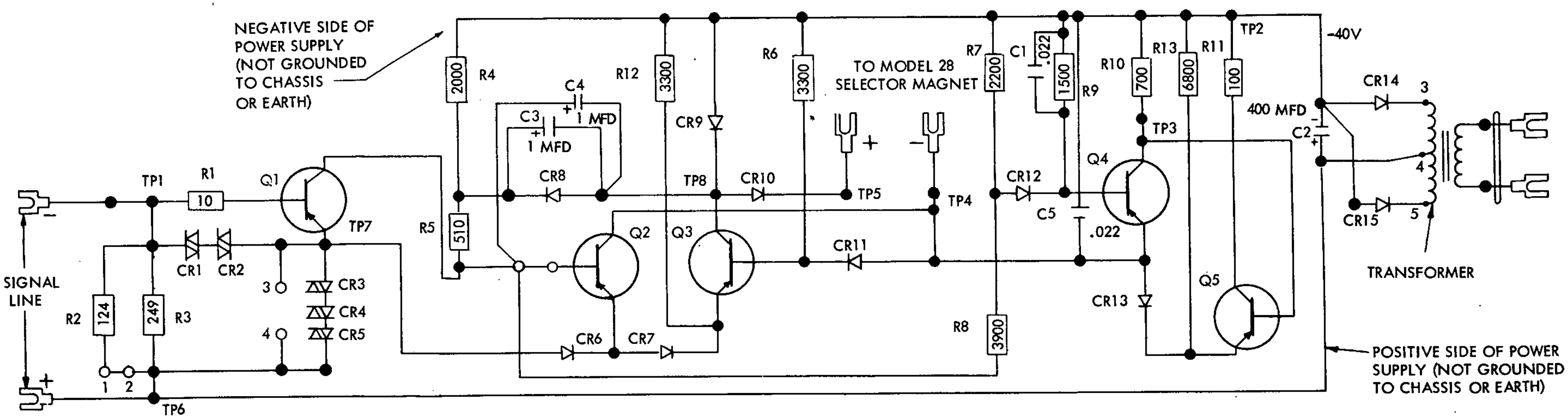
The SELECTOR MAGNET DRIVER is a solid-state device normally used in place of a line relay. When compared to a line relay, the selector magnet driver offers improved operation and greater reliability with reduced maintenance.



The SELECTOR MAGNET DRIVER assembly consists of a chassis mounted power supply and an etched circuit card. The power supply provides operating voltages for the various components, including five transistors, mounted on the circuit card.

The SELECTOR MAGNET DRIVER may be strapped to accept a neutral input signal at either 20 or 60 MA or a polar signal of up to 30MA. The output from the selector magnet driver is 60MA regardless of its input.

IT IS RECOMMENDED THAT FIELD SERVICING BE LIMITED TO REPLACING THE ENTIRE DRIVER.



Strapping for input options:

.020 Amp. neutral operation:

1-2 Open, 3-4 Open

.060 Amp. neutral operation:

1-2 Strapped, 3-4 Open

.020 to .030 Amp. polor operation:

1-2 Open, 3-4 Strapped.

Factory strapping: 1-2

Units wired for 117 VAC 50/60 cycle operation only.

Selector coils in parallel for all conditions of operation.

For neutral operation, current flows in the signal line circuit during the marking condition, and no current flows during the spacing condition. For polar operation, current flows during both conditions, but the polarity is reversed to differentiate between marking and spacing.

The transistors as used in the Driver either do not conduct or conduct into saturation. They do not operate at intermediate stages. Thus throughout this discussion they are referred to as being either "on" (conducting) or "off" (not conducting).

The elements referred to as "bias varistors" (CR1 through CR5) are used in the circuit to develop transistor bias voltages and low-voltage references that set the input switching level. They consist of two diffused-junction, silicon diodes mounted in opposite directions side by side. They have a forward diode characteristic in either direction and thus their voltage drop varies slightly with the current. At 0.10 a. the drop is 0.8 v.

INPUT CIRCUIT

The input circuit receives the teletypewriter signals and determines when the Driver shifts from marking to spacing. It includes R1 through R3, bias varistors CR1 through CR5, and transistor Q1. In neutral operation, it keeps the Driver spacing or marking until the line current rises above or drops below the switching value. In polar operation it does the same until the current rises above or drops below zero.

Resistor R1 protects transistor Q1 from high current surges that might damage it. It samples the current flowing into Q1's base, and, if the current exceeds a value of approximately 0.100 a., the voltage developed across R1 and the base-emitter junction exceeds the forward drop of CR1 and CR2, and most of the excess current is shunted around Q1. Since the bias varistors are bi-directional, Q1 is protected for inputs of either polarity.

For 0.020 ampere neutral operation, R2 is disconnected by removing the strap at terminals 1 and 2, and R3, CR3, CR4 and CR5 are left in the circuit. For 0.060 ampere neutral operation, R2, R3, CR3, CR4 and CR5 are all left in the circuit. For polar operation up to 0.030 a., R2 is disconnected by removing the strap at terminals 1 and 2; CR3, CR4, and CR5 are shunted out by placing a strap across points 3 and 4; and R3 alone is left in circuit.

SWITCHING CIRCUIT

Transistors Q2, Q3 and associated components form a snap-action trigger circuit. In the marking condition, Q2 is off and Q3 is on. The opposite exists for the spacing condition. The change from one state to the other occurs at the midpoint value of the input current and is very rapid regardless of the slope of the input wave form.

(continued)

OUTPUT CIRCUIT

The output circuit, which includes Q4, Q5 and associated components, controls the current in the selector magnet coils. During the space to mark transition, it places essentially the full supply potential across the coils and causes the current to rise rapidly to the operating value of 0.060 a. This rapid rise provides quick selector armature pick-up. Once the operating value is reached, the circuit adds resistance to maintain the operating current. During the mark to space transition, a controlled discharge circuit, which includes CR9 and Q2, rapidly dissipates the coil's energy without developing any high reverse voltage transients that might cause transistor damage.

POWER SUPPLY

The power supply provides d.c. for the Driver's circuits. It includes an isolation transformer, a full-wave rectifier, and single capacitor filter. It operates from a 117 v., 50-60 cps, a.c. source, and provides a nominal d.c. voltage of -40 v.

SPACING CONDITION

In the spacing condition transistors Q1, Q3 and Q5 are off; Q2 and Q4 are on; and no current flows in the selector magnet coils.

In neutral operation, no current flows in the signal line during spacing. Thus, the base of Q1 is connected to the positive side of the power supply either through R3 alone (for 0.060 a. operation). Internal current through varistors CR3, CR4 and CR5 places a -2.4v bias on the emitter of Q1 and keeps it off. In polar operation (R3 alone in circuit and CR3, CR4 and CR5 shunted), TP1 is positive and TP6 is negative during spacing. Thus the signal line through R1 drives the base of Q1 positive and keeps it off.

The base of Q2 is driven negative with respect to its emitter through resistors R4 and R5 and resistors R7 and R8. Thus Q2 is on, and the voltage drop from its emitter to collector is very small---Less than 0.1 v.

The output of Q2 is applied to the base of Q3 through germanium diode CR11. The current flow through CR11 and R6 to the negative side of the power supply causes a maximum drop of 0.4 v. R12 permits sufficient current to flow through CR7 that the latter's voltage drop is at least 0.6 v. Q3's emitter is more negative than its base; thus Q3 is off.

CR10 prevents current from flowing from the collector of Q2 through the selector coils, CR8 and R4 to the negative side of the power supply. Therefore, the selector magnet is not energized in the spacing condition.

The collector of Q2 is connected to the emitter of Q4 and to one side of CR13. The negative side of the power supply through R9 makes the base of Q4 negative in relation to its emitter and keeps it on. A 0.1 v. drop across Q4 is applied to the base of Q5. Because of the voltage drop across CR13 caused by the current flow through CR13 and R13, the emitter of Q5 is at least 0.55 v. more negative than the emitter of Q4. Thus there is a 0.45 volt back bias across Q5 which remains off.

MARKING CONDITION

In the marking condition, Q1, Q3 and Q4 are on; Q2 and Q5 are off; and a current of 0.060 a. flows in the selector magnet.

In both neutral and polar operation, the marking signal places a negative potential on the base of Q1 and keeps it on. Current flows from its collector to the negative side of the power supply through R5 and R4 and through R8 and R7. Current also flows through CR6, CR7 and R12 to the negative side of the supply. A drop of at least 0.65 v. across CR6 is applied to the emitter of Q2. The base of Q2, which is connected directly to the collector of Q1, is about -0.1 v. with respect to the emitter of Q1. Therefore, Q2 has a back bias of 0.55 v. and is off.

MARKING CONDITION

(continued)

Since Q2 is cut off, it does not back bias Q3 as it did in the spacing condition. The negative side of the supply through R6 puts a negative potential on the base of Q3 and keeps Q3 on. Current flows from the collector of Q3 through CR8 and R4 to the negative side of the supply, and through CR10 and the selector coils to the junction of Q4's emitter and CR13. Since the base of Q3 is only about -0.4 v. with respect to its emitter, the drop of almost 5 v. across Q3, CR10, and the selector coils back biases diode CR11. Q2 is unaffected since it is off and its collector is negative with respect to its base.

The collector of Q2 is connected to the emitter of Q4 and to one side of CR13. The negative side of the power supply through R9 makes the base of Q4 negative in relation to its emitter and keeps it on. A 0.1 v. drop across Q4 is applied to the base of Q5. Because of the voltage drop across CR13 caused by the current flow through CR13 and R13, the emitter of Q5 is at least 0.55 v. more negative than the emitter of Q4. Thus there is a 0.45 volt back bias across Q5 which remains off.

SPACE TO MARK TRANSITION

In neutral operation, varistors CR3, CR4 and CR5 places -2.4 v. on Q1 keeping it turned off during spacing. As the signal line changes from spacing to marking, current begins to flow in the input line and a negative potential is developed across the input resistor(s) (R3, or R3 and R2). Q1 remains off until this current exceeds its mid-point value of 0.010 a. for 0.020 a. or 0.030 a. for 0.060 a. operation. This mid-current value is detected when a voltage slightly greater than -2.4 v. is developed at the base of Q1 turning it on.

In polar operation R3 alone is in circuit and CR3, CR4 and CR5 are shunted. As soon as the current moves slightly beyond zero in the marking direction, it places a negative voltage on the base of Q1 and turns it on.

Q3 turns on, and Q2 turns off. Q2 and Q3 form a trigger circuit which utilizes positive feed back. The collector of Q2 is connected to the base of Q3, and the collector of Q3 is connected to the base of Q2. Q2 through CR11 switches Q3, and Q3 then feeds back to Q2 through CR8 controlling the resistor network of R4 and R5. As the signal changes from spacing to marking, Q1 turns on and causes Q2 to begin to turn off. Q2 in turn causes Q3 to begin to turn on. The collector of Q3 drives the junction of R4 and R5 positive. Less base current is supplied to Q2 which turns off even more. This trigger action removes any point of uncertainty and prevents the Driver from being damaged by locking up on an intermediate point or going into oscillation as the input switching level is crossed.

SPACE TO MARK TRANSITION

(continued)

Initially, the induced voltage of the magnet coil opposes the current flow from the collector of Q3 through the coils to the negative side of the supply. This prevents current from flowing through CR13 and Q4 (which was on during spacing). The collector of Q4 and the base of Q5 move toward the negative supply potential. Q5 is off and its collector is at the negative supply potential. Since its base and collector are negative, the emitter of Q5 also moves toward the negative supply potential.

A short time later, the voltage drop across the coils decreases, and current begins to flow in the coils, increasing nearly linearly with time. The negative terminal of the coils begins to move toward the positive supply potential. The emitters of Q4 and Q5 begin to go positive. Since the negative potential on the collector of Q4 is applied to the base of Q5, the latter turns on as its emitter goes positive and Q4 turns off.

Since R11 is small and Q5 is on, essentially the full supply potential is placed across the coils. The coils' current, limited only by R11 and the small resistance of the coil, increases rapidly. (It aims at point much higher than the desired 0.060 a. operating current.) Thus the operating current is reached very quickly, and effects a fast pickup of the selector magnet armature.

During the spacing condition, Q4 was on and its base was no more than -0.6 v. with respect to its emitter. As described above, during the space to mark transition, the current flow through Q4 drops to almost zero, and its emitter goes toward the negative supply potential. Capacitor C1 holds Q4's base at the conducting potential which is positive with respect to the emitter, and Q4 turns off. Q5 is still on. The base potential of Q4 drops exponentially toward the negative supply as C1 discharges through R9.

Normally the voltage divider network of R7 and R8 places a potential of +10 v. with respect to the negative supply on the anode of CR12 which is back biased. However, during the space to mark transition period, the base potential of Q4 drops exponentially toward the negative supply. When it gets just below the divider's voltage, CR12 becomes forward biased and clamps the base to this value.

As the current begins to flow through the coils, Q4's emitter drops from the negative supply potential until it is more positive than its base, and Q4 turns on. Its collector potential becomes nearly the same as its emitter and is applied to the base of Q5 which turns off. CR12 is again back biased, and the current to Q4's base is supplied through R9 as before. The current flow from the coil to the negative supply is not through Q4 and R10 which limits it to the operating value of 0.060 a. R9 and R13 are essentially in parallel with R10 and help to determine the current's value.

The voltage divider network of R7 and R8 determines the current value at which Q5 turns off and Q4 turns on. The closer the potential on the anode of CR12 approaches the negative supply, the sooner Q5 turns off. Current through the divider network always flows to the positive side of the supply either through the collector of Q1 or the base of Q2. CR12 remains back-biased except for the brief period described above during the space to mark transition.

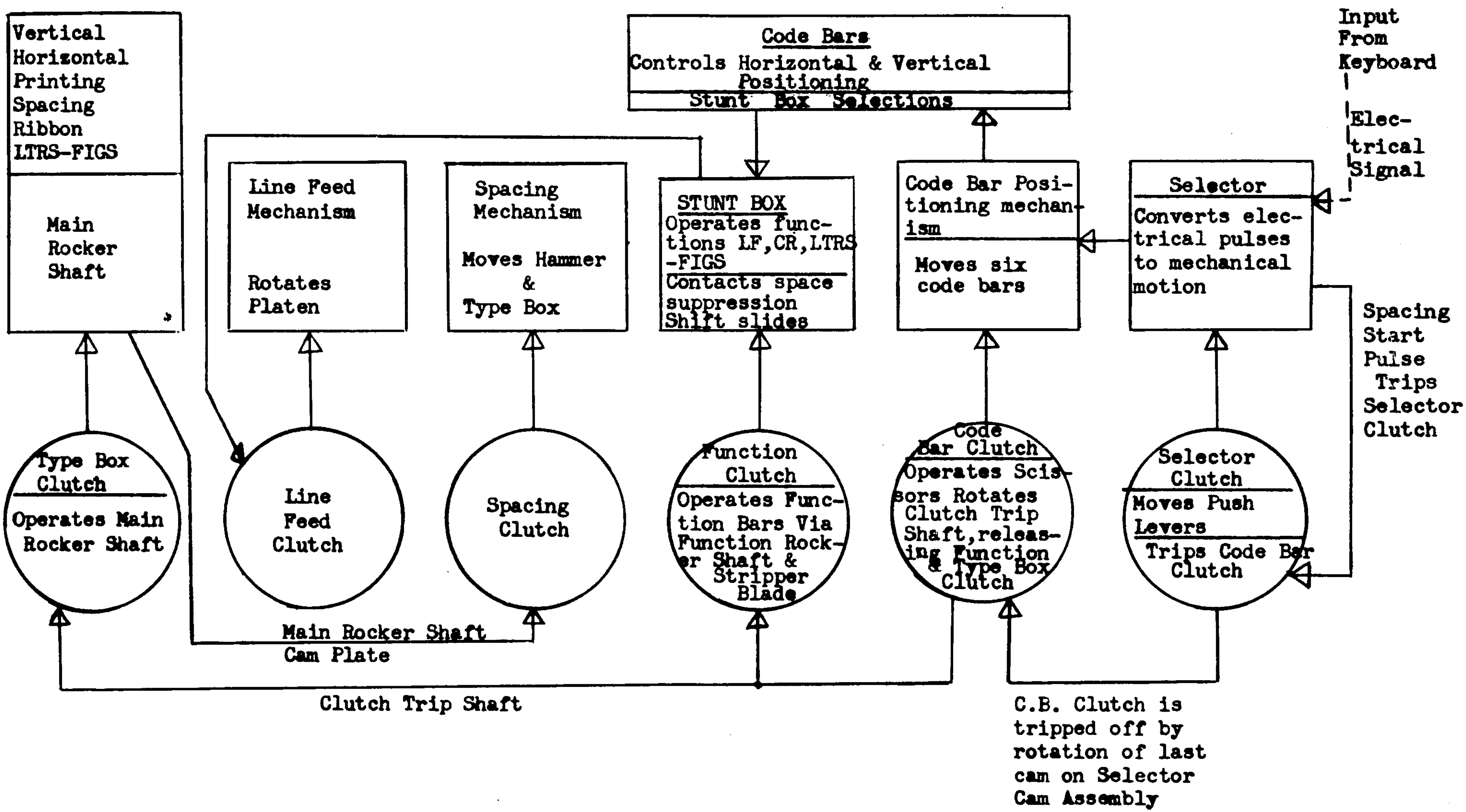
MARK TO SPACE TRANSITION

As the signal changes from marking to spacing, Q1 and Q3 turn off and Q2 turns on.

When Q3 turns off, it no longer supplies current to the selector coils. The coils resist a drop in their current by developing a negative voltage transient at their normally positive end. This transient is passed by CR10, blocked by CR8 and blocked by CR9 until it exceeds the negative supply potential at which time CR9 conducts. CR9 insures that the voltage rating of Q3 is not exceeded by clamping it at about -40 v.

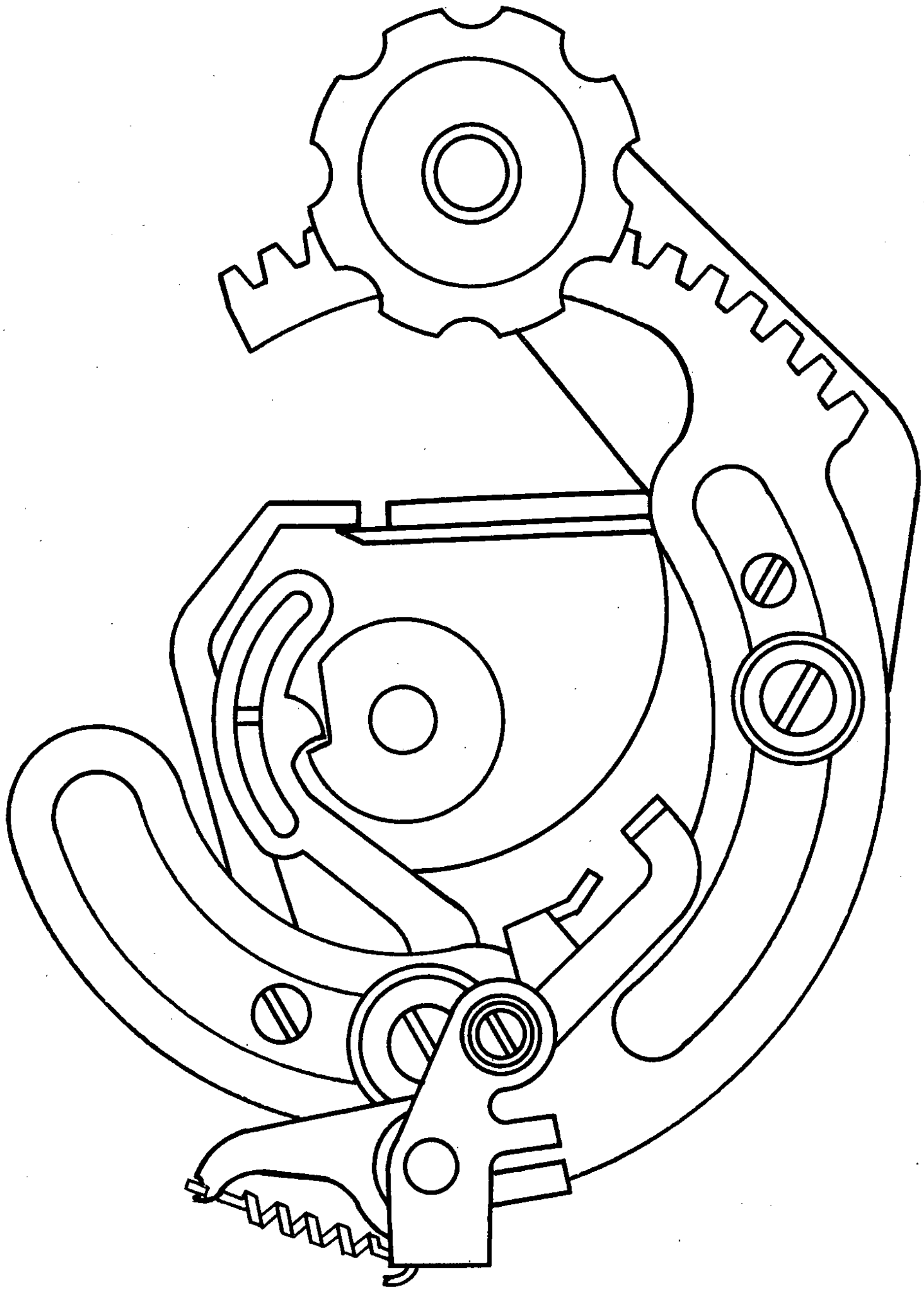
Q2 holds the normally negative end of the coil at near positive supply potential when Q3 turns off. A constant potential of about 35 v. is thus placed across the coils. The rate at which the current through the coil decreases is constant.

MODEL 28 PRINTER FLOW CHART



T E L E T Y P E   C O R P O R A T I O N
M A I N T E N A N C E   T R A I N I N G   S C H O O L
2 0 1   N O R T H   W E L L S   S T R E E T   C H I C A G O ,   I L L I N O I S   6 0 6 0 6
P H O N E   3 4 6 - 0 5 8 5   A R E A   C O D E   3 1 2   T W X   9 1 0 - 2 2 3 - 3 6 1 1

SIGNALING CODE



TRAINEE'S GUIDE

TELETYPE

FOR INSTRUCTIONAL PURPOSES ONLY

PREFACE

The objective of this guide is to outline the essential principles of the Teletype signaling code.

This guide will discuss the basic five-level code and the more advanced eight-level code, more commonly referred to as the American Standard Code for Information Interchange, (ASCII).

The data presented is the best information available at the time of this writing, but is subject to change, and is not intended to pre-empt subsequent information issued in current instruction.

HISTORY

In ordinary telegraph transmission, as devised by Samuel Morse, intelligence is relayed from one point to another by the making and breaking of the signal line. The operator at the transmitting end of the line opens and closes a key activating a sounder at the receiving station. These sounds are translated by the receiving station operator into the characters and symbols making up the message.

The drawbacks to this system are of course quite obvious. A network of telegraph stations can pass traffic only as fast as the slowest operator can send or receive. There is the constant possibility of a miss-sent or erroneously copied character with no way of verifying the transmission. Also, every station requires constant attendance.

To overcome these weaknesses a French signal officer, named Jean Baudot, envisioned a method of mechanically transmitting a signal that would activate a printing mechanism. The new method of printing telegraphy required modification of the basic Morse code. The primary change was the control over the time interval of each transmitted pulse. Specified time intervals or pulse lengths were to replace the arbitrary dot-dash system of each operator.

In order to encompass the 26 letters of the alphabet and a number of purely mechanical functions required to operate the printing mechanism, Mr. Baudot determined that the basic conditions, (current-on-line, no current-on-line), would have to be expanded. He accomplished this by taking the two basic conditions and raising them to the fifth power, (2^5 = 2x2x2x2x2), for a total of 32 possible combinations. Therefore, each character is a combination of five pulses, with each pulse having two possible conditions.

The two conditions referred to above shall be called by their more common names, current-on-line = MARKING, no current-on-line = SPACING, throughout the remainder of this guide.

Subsequent to the development of this basic code, a printer was developed with the addition of an upper case, referred to as FIGURES, thereby expanding the capabilities of the code to twice as many characters, or 64 possible characters. Since the figure ability is a mechanical function, we see that the same basic code combinations are used for both LETTERS and FIGURES.

ANALYZING A CHARACTER

As we saw on the preceding page, the basis for our present day Teletype code is the mechanical control of the combinations of MARK and SPACE conditions associated with the individual characters. The length of time duration of the individual pulses used to make a character is determined by the motor speed of the unit, which through a gear train, operates the various cams and levers that ultimately open and close the signal line. We may say then, that as the mechanical operating speed of the unit increases, the time interval of the total character decreases. A little later on we will show this graphically.

At the present time there are three basic transmitter shaft speeds in popular usage. They are 368 rpm, 460 rpm, and 600 rpm of shaft speed. A conversion of these speeds into the more widely used term "words-per-minute" may be accomplished by dividing each figure by 6. (This assumes that the average word contains five characters and a space between it and the next word.) Thus, 368 rpm becomes 60 wpm, 460 rpm is about 75 wpm, and 600 is 100 wpm. For maintenance or other technical purposes it is far more accurate to deal only with the actual shaft speed. If, for every revolution of the transmitting shaft a complete character is transmitted, we may state that a complete operation has been performed. Therefore, our rpm's become operations-per-minute.

The first step in determining the total time of a single character is dermining the operations-per-second.

(A) $\frac{600 \text{ rpm}}{60 \text{ sec.}}$ = operations-per-second = 10 ops

We now can say we transmit 10 characters-per-second, since each operation is a character.

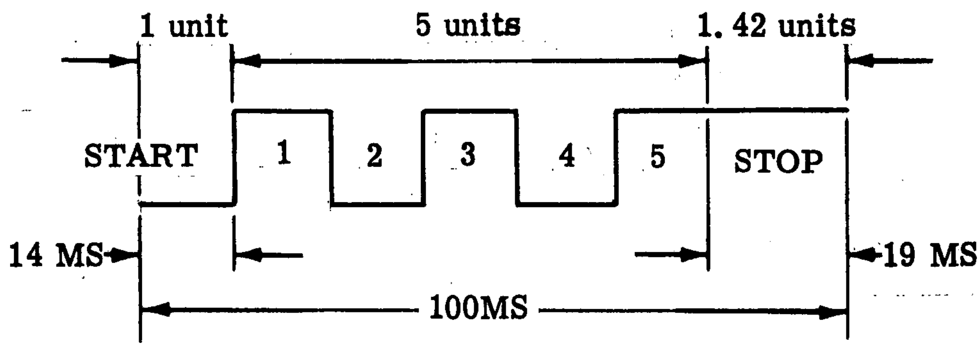
The next step is to break these 10 characters down to find the time of a single character.

(B) $\frac{1 \text{ sec.}}{10 \text{ ops}}$ = one character = .100 seconds

We now see that at 600 opm each character is .100 seconds, or 100 milliseconds (MS) long. This same method may be used for any operating speed to determine the character length.

Before we can start breaking the individual character into its separate pulses, and determining their length, we have to consider one other facet of our individual character. In order that both the transmitting and receiving units are operating together (synchronization) additional pulses are required. They are called the START and STOP pulses. Since these pulses are attached to every character they are not considered information pulses. In the majority of applications the START and five information pulses are of equal length, with the STOP pulse being of a longer duration. This added length, (usually 42%) is a safety feature to insure that the receiving unit has time to completely detect the last information pulse before the transmitter begins the next character.

Example: 5-Level Code



Start	=	1	unit
Information Pulses	=	5	units
Stop	=	1.42	unit
		7.42	units

The 7.42 unit character is known as the Standard Unit Code for five-level transmission. One exception to this standard is a straight 7 unit code. An example of this is Western Union, which uses a stop pulse the same length as the start and information pulses. This unit code plus a variance in shaft speed allows for 65 wpm operation. We will discuss this a little later in this guide.

Now to return to find the duration of each of the five individual information pulses and the start pulse:

(A) $\frac{\text{100 ms (time for one character)}}{\text{7.42 units}}$ = 13.47 or 14 ms = 1 unit

To find the length of the 42% longer stop pulse:

(B)
```
 13.47   (one unit)
x 1.42   (one + 42%)
 19.13   or 19 ms = stop pulse
```

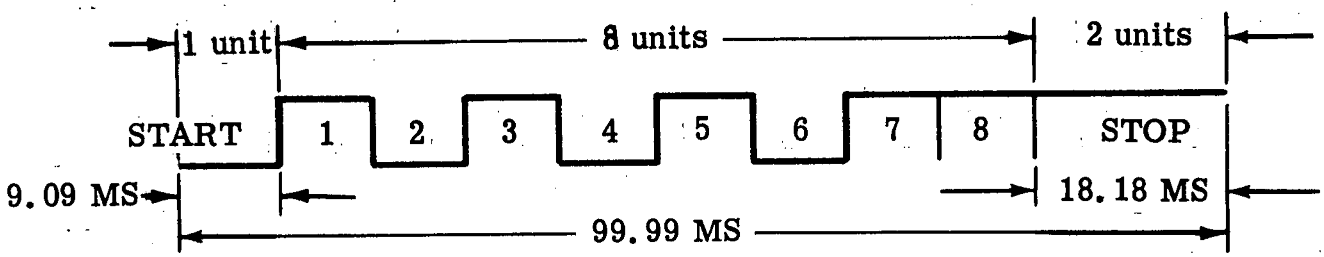
The above information applies to five-level only. Before trying to find the pulse length for the eight-level equipment we should note three things:

1. The total character length (in milliseconds), for any given shaft speed will be the same for both five and eight-level codes.

2. If the total character length (in milliseconds) is equal for both the 5 and 8 level codes; then it follows that the 8 level code employing 3 information code levels more than the 5 level must necessarily have each of its code pulse correspondingly shorter timewise.

3. Two units are used as the safety feature in the eight-level stop pulse.

Example: 8-Level Code



Start	=	1	unit
Information Pulses	=	8	units
Stop Pulses	=	2	units
		11	units

We now have an 11 Unit Code for eight-level transmission.

To determine the length of each pulse in the eight-level code we use the same formula as in the five-level:

(A) $\frac{100 \text{ ms}}{11 \text{ units}}$ (time for one character) = 9.09 ms = 1 unit

To find the length of the double stop pulse:

(B) 9.09 (one unit)
x 2 (double stop pulse)
18.18 ms = stop pulse

As you have probably noticed in the signal diagrams, the start pulse has been represented as a no current-on-line (SPACING) condition, and that the stop pulse has been drawn as a current-on-line (MARKING) condition. This holds true for both five and eight-level because the normal, or "REST" condition of the signal line is with current-on-line. If the normal condition is MARKING the beginning of the next character must alter that condition. Obviously then, the start pulse must be no current or SPACING. The end of the character must return the signal line to its normal condition so the stop pulse or pulses must be MARKING.

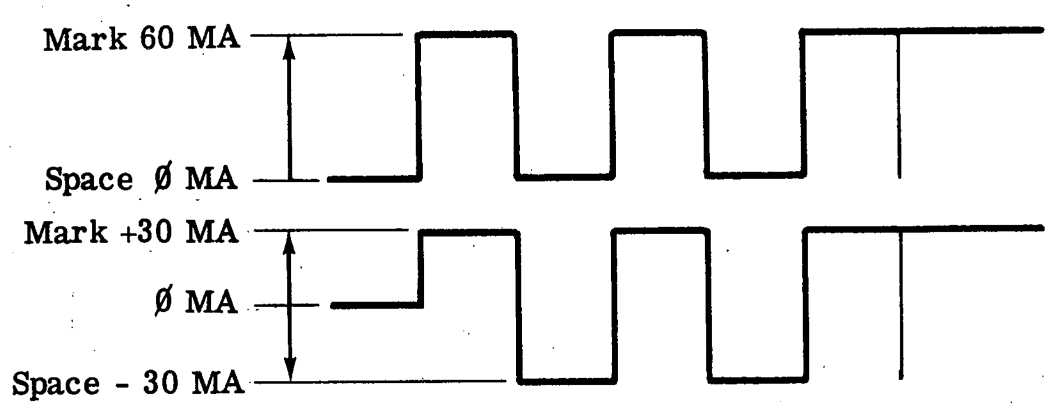
POLAR OPERATION

Until now only NEUTRAL operation has been discussed. We have seen in NEUTRAL operation a SPACE has been the NO current-on-line condition, and a MARK is the current-on-line condition. In POLAR operation, there is current on the signal line at all times. It is the polarity of the current that determines whether a MARK or a SPACE is being transmitted. The MARKING signal will have a positive voltage, and the SPACING signal will use a negative voltage of the same amplitude.

Obviously, the receiving machine could not be directly connected to a POLAR signal line because current, no matter what polarity, would energize the magnets in the selector mechanism. That is to say, a magnet cannot differentiate between a positive or negative voltage, and we would initiate the same actions and responses for both a MARKING and SPACING inpulse. Therefore, a relay or selector magnet driver mechanism is used between the receiver and the signal line.

Either of these devices converts the POLAR signal line transmission to a NEUTRAL signal for use by the selector assembly in the receiving equipment.

The following signal diagram graphically portrays the difference between NEUTRAL and POLAR operation for any current, code level, or speed.



BAUD RATE

The word baud is derived from the name Baudot (Ref. p.1). The baud rate, sometimes called the bit rate, is simply an expression which combines both shaft speed (operations-per-second) and the particular unit code being used into one usable term or figure. It indicates the maximum usable number of pulses-per-second that a given piece of equipment can handle.

The main use for the baud rate is compatibility between equipment. If we have a transmitter and receiver with equal baud rates we know that traffic can be passed between them. An unequal baud rate tells us that without modification, or additional equipment we cannot transmit between the equipment in question.

To find the baud rate multiply the operations-per-second by the unit code being used.

Example: 5-level 60 wpm

$$\frac{368 \text{ opm}}{60 \text{ sec.}} = 6.13 \text{ ops} \times 7.42 \text{ unit code} = 45.5 \text{ baud}$$

Let's do the same computation using the Western Union shaft speed and 7.00 unit code, (Ref. p.3).

$$\frac{390 \text{ opm}}{60 \text{ sec.}} = 6.5 \text{ ops} \times 7.00 \text{ unit code} = 45.5 \text{ baud}$$

We can see from the above examples that although the shaft speeds and unit codes differ, these units would be compatible because of equal baud rates.

One more example of baud rate is the eight-level code.

Example: 8-level 100 wpm

$$\frac{600 \text{ opm}}{60 \text{ sec.}} = 10.0 \text{ ops} \times 11.0 \text{ unit code} = 110 \text{ baud}$$

The increase of either the operations-per-second, or the unit code increases the baud rate. Remember, baud rate is simply a term of compatibility. Before leaving the baud rate we should clarify the difference between baud rate and bit rate. The speed of a unit in bits-per-second is not equal to the speed in bauds unless all pulses or bits of a character are of equal duration. The following chart will illustrate the relationship between shaft speed (opm), bits and bauds.

WPM	UNIT CODE	OPM	BAUD	BITS	UNIT INTR.	CHAR. INTR.
61.3	7.42	368	45.5	42.9	22 MS	163 MS
65	7.00	390	45.5	45.5	22 MS	154 MS
75	7.42	460	56.9	52.5	17.6 MS	130 MS
100	7.42	600	74.2	70.0	13.5 MS	100 MS

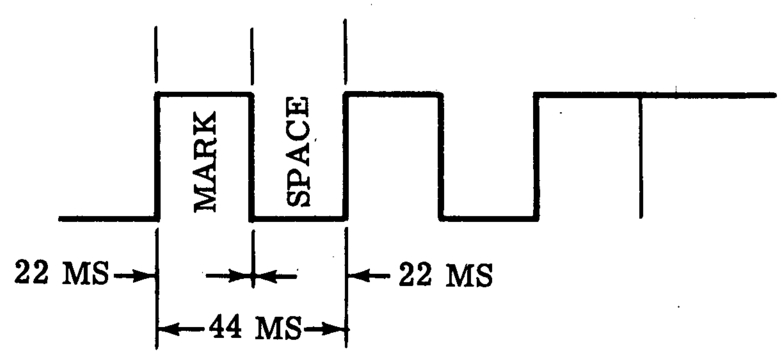
DOT CYCLE FREQUENCY

The constantly changing signal impressed on the transmission line by the MARKING and SPACING pulses represents a rectangularly shaped wave form. This wave form is actually made up of many fundamental sine waves plus a number of sub-harmonic frequencies. We will see that based on the number of mark-to-space and space-to-mark changes that occur within each character, a separate frequency will be established.

The fundamental, or DOT CYCLE FREQUENCY, of any character may be determined by dividing the length of its mark-to-space transitions into one. The following examples will graphically show the maximum and minimum dot cycle frequencies for the five-level code at 60 wpm, and the eight-level code at 100 wpm.

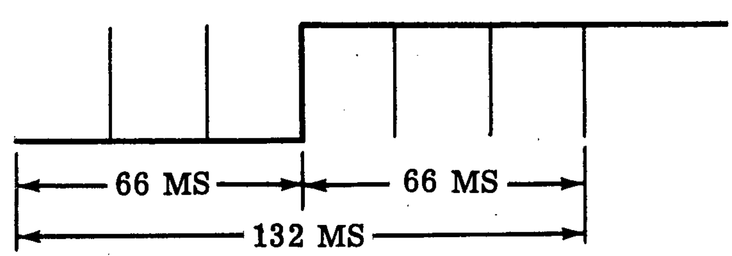
Example: 5-level 60 wpm; maximum frequency.

Because the character "Y" changes from MARK to SPACE every other pulse, its transition time is two pulses or .044 seconds.



$$\frac{1}{.044 \text{ sec.}} = \text{approximately 23 cps} = \text{maximum frequency}$$

Example: 5-level 60 wpm; minimum frequency.

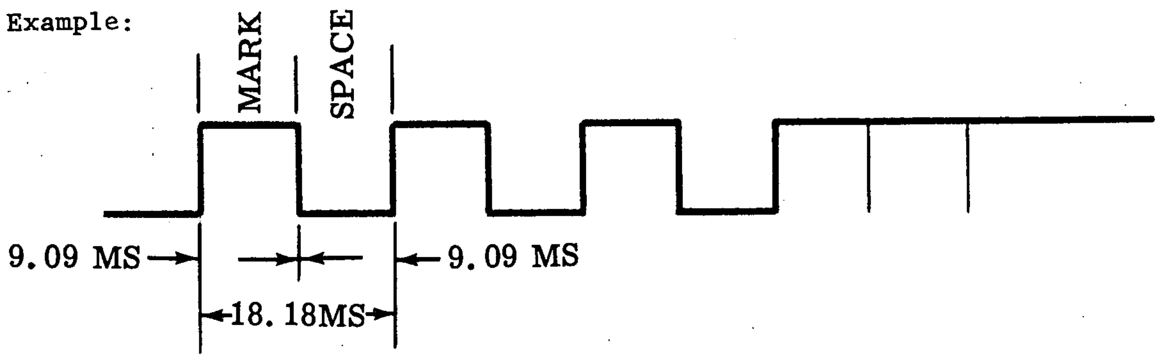


The character "M" in the preceding illustration, is composed of a single transition. For "M" the START, first, and second pulses are the first part of the wave form. Pulses three, four, and five constitute the second half of the wave form. Therefore, our formula would work out as follows:

$$\frac{1}{.132 \text{ sec.}} = \text{approximately 8 cps} = \text{minimum frequency.}$$

For the eight-level code, the character "U" will present the maximum number of transitions, (as did the "Y" in five-level), thereby giving us our maximum frequency.

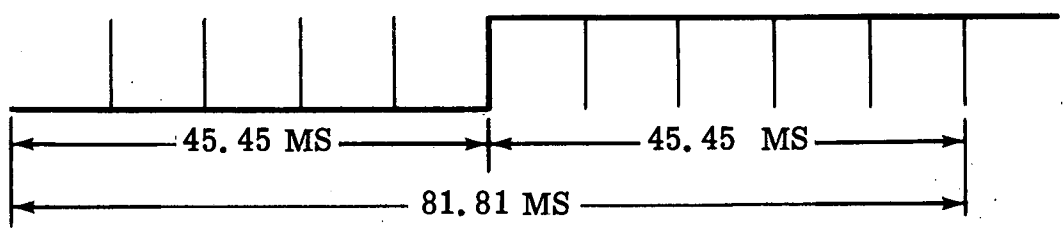
Example:



$$\frac{1}{.01818 \text{ sec.}} = \text{approximately 55 cps} = \text{maximum frequency.}$$

Since there is no actual character to correspond to the minimum frequency, our example is hypothetical.

Example:



$$\frac{1}{.08181} = \text{approximately 12 cps} = \text{minimum frequency.}$$

The Dot Cycle Frequency is used to determine the value of the bandpass filter for Teletype transmission. If we allow the highest frequency through the filter, we will also pass the lower frequencies. Within the Bell System the filters are designed for the third or fourth harmonic of our highest basic frequencies, or about 89 cps.

SIGNAL DISTORTION

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

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

Bias Distortion
Characteristic Distortion
Fortuitous Distortion

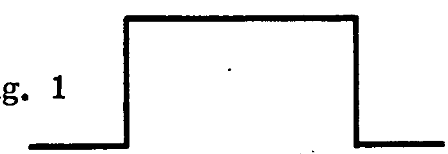
Bias and characteristic distortion are combined in the term Systematic Distortion because both occur in response to natural law and, consequently, either is roughly predictable. With the third element, Fortuitous Distortion, uncontrolable occurrences (hits on the line, Loose ground connections , etc.), are accounted for. With the introduction of the selector magnet driver, distortion has been greatly reduced. Inasmuch as signal distortion does still exist, the following may prove helpful.

BIAS DISTORTION:

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

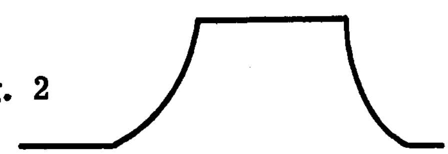
Before illustrating Bias, it will be necessary to indicate the effect, upon a signal pulse, by the resistive, inductive and capacitive elements in the signal line.

Fig. 1



1. Perfect MARK impulse.

Fig. 2



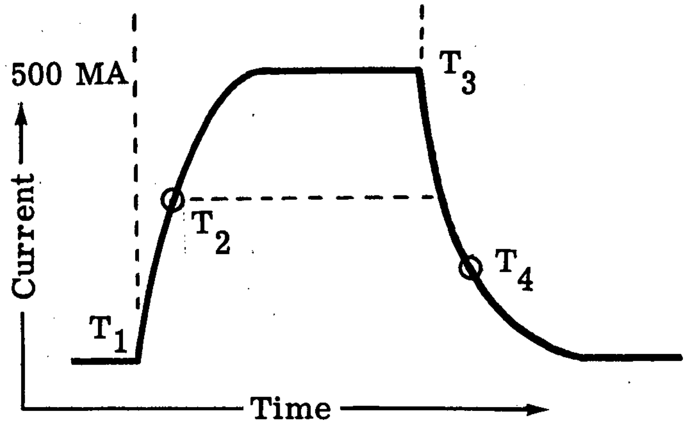
2. Line INDUCTANCE opposes sudden transition of current. Inductance fron Line Relays and/or selector magnet coils.

Fig. 3

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

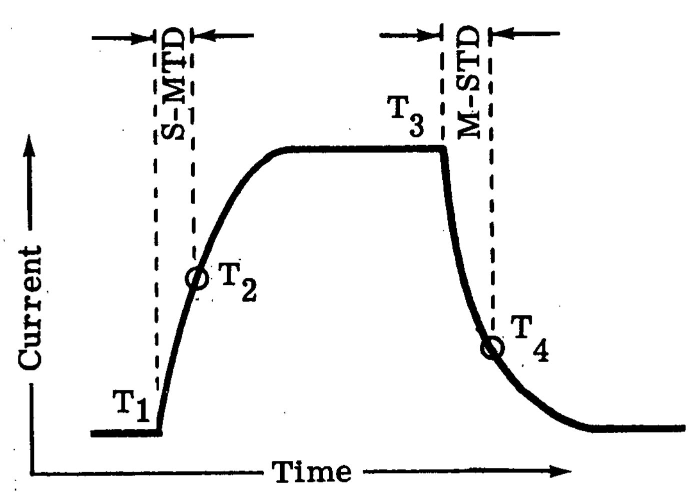
The impulse in Figure 3 is more likely to be found at the receiving printer than the one impressed at the transmitter, (Figure 1). The impulse seen in Figure 3, as applied to the selector magnets of the printer, will be used to illustrate Bias Distortion. It will be noted that this waveshape builds up to its 500 ma level gradually.

Instead of picking up at the leading edge of the pulse (T1), the selector magnet will energize at a somewhat later time -- say, for example, at T2 -- or, whenever the current has reached a level where it generates sufficient magnetic attraction. This point, T2, would be the beginning of the MARK impulse as far as the selector was concerned.



When, at the end of the transmitted pulse, the current again starts towards Ø ma, the selector armature should, theoretically, fall away at T3. The trailing edge of the impulse, however, also slopes, consequently, a definite time will have elapsed before the armature will drop away (T4). Notice that T2 and T4 are not identical current values. The de-energization point will be of lower value due to residual magnetism in the coils.

The time between when the armature should attract (T1) and when it does attract (T2) is known as SPACE-to-MARK TRANSITION DELAY. (Abbr. S-MTD). The time between when the armature should drop away (T3) and when it does drop away (T4) is known as MARK-to-SPACE TRANSITION DELAY. (Abbr. M-STD).



If the S-MTD is equal to the M-STD, the pulse as seen by the selector would be undistorted.

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

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

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

M-STD - S-MTD = ms. Bias

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

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

CHARACTERISTIC DISTORTION

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

Characteristic Distortion has varying effects upon different characters because the circuit's reactance will have less chance to become stabilized when characters with many current transitions are applied (U for example) than when characters with few transitions are applied (SPACE for example).

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

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

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

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

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

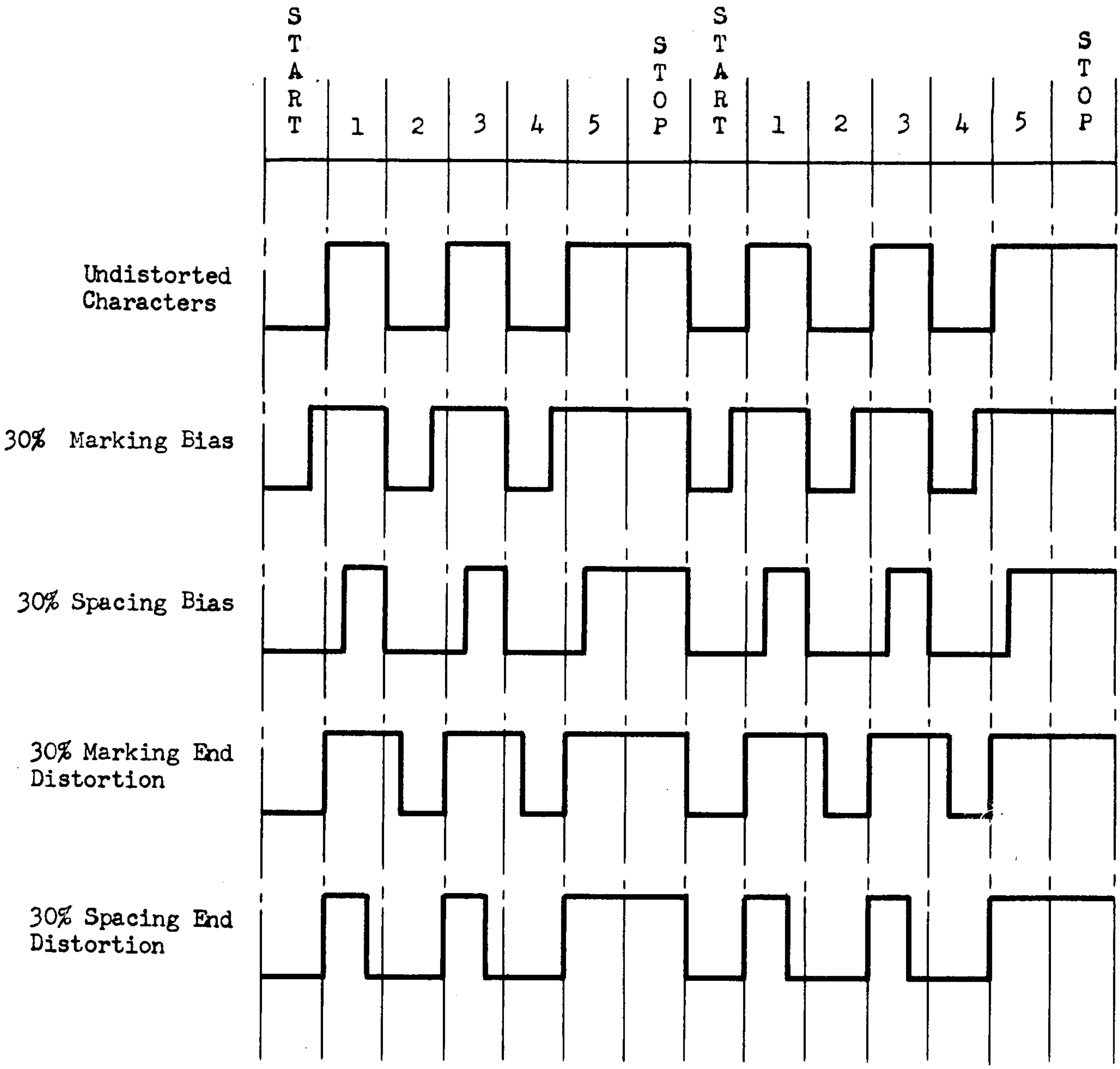
5. Characteristic Distortion, because it is due to the capacitance, inductance and resistance of a circuit, which except for the resistance, are unchanging in value, varies only a small amount from day to day. Bias, because it is caused by uneven potentials, relays losing adjustment, etc., may vary from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

FORTUITOUS DISTORTION

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

DISTORTION CHART

The illustration on the following page presents the various types of distortion we have discussed in a comparitive chart.



NOTE:

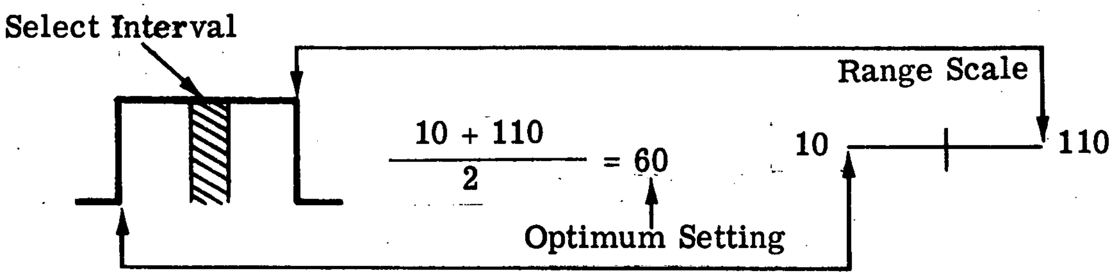
1. Bias distortion displaces the S-MTD.
   A. Marking Bias advances the transition.
   B. Spacing Bias delays the transition.
2. End distortion displaces the M-STD.
   A. Marking end delays the transition.
   B. Spacing end advances the transition.
3. Fortuitous and characteristic distortion may displace both transitions.

RANGE

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

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

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



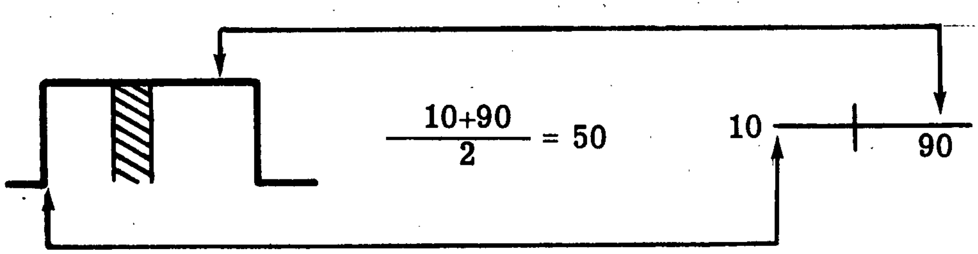
In any situation, there is a standard procedure for determining the proper setting for the range scale:

a) Determine the high and low points on the range scale by moving the range scale indicator toward the upper limit until errors are observed in copy, then toward the lower limit until errors are again observed, (one error per two lines of copy).

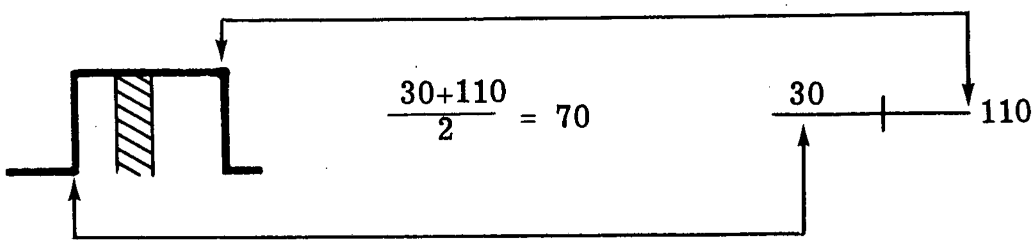
b) Add the high point to the low point and divide by two, for optimum setting.

(See examples in range illustrations)

If 20% MARKING END DISTORTION were introduced, the optimum setting would shift. To maintain the selecting interval in the middle of the pulse, will require the reorientation of the range scale indicator.



If 20% SPACING END DISTORTION were introduced the range would shift in an opposite direction, also requiring reorientation of the range scale indicator.



GLOSSARY OF TERMS

BAUD

The number of bits transmitted per second. Arrived at by dividing the speed of the transmitting shaft by 60. Then multiplying the quotient by the stated unit code. Example: $\frac{600 \text{ OPM}}{60 \text{ Sec.}} = 10 \text{ OPS} \times 11 = 110$ BAUD. Ref. P.6
NOTE: 11 is the unit code in this example but this figure can vary.

BAUDOT CODE

A five-level teletypewriter code consisting of a start impulse and five information impulses all of equal length, and a stop impulse whose length is 1.42 times that of the start impulse. Also known as the 7.42 unit code. Ref. p.2 and p.3.

BIAS DISTORTION

A form of teletypewriter distortion which displaces the SPACE-to-MARK transition. Ref. p.9.

BIT

One impulse, or the time interval normally occupied by one impulse. Ref. p.6.

CHARACTERISTIC DISTORTION

A fixed distortion which results in either shortened or lengthened impulses. It generally does not change in degree from day to day. Ref. p.11.

EIGHT-LEVEL

Any teletypewriter code which utilizes eight impulses, in addition to a stop and start impulses, for describing a character. Ref. p.4.

END DISTORTION

A form of distortion which displaces the MARK-to-SPACE transition. Ref. p.11.

FIVE-LEVEL

Any teletypewriter code which utilizes five impulses, in addition to the stop and start impulses, for describing a character. Ref. p.3.

FORTUITOUS DISTORTION

An intermittent distortion which results in either shortened or lengthened impulses. It may be caused by battery fluctuation, hits on the line, etc. Ref. p.12.

HIT ON THE LINE

A momentary open circuit on a teletypewriter loop. Ref. p.12.

MARK

An impulse which causes the signal loop to be closed. A current-on line condition. Ref. p.1.

MARKING END DISTORTION

End distortion which lengthens the marking impulse by delaying the MARK-to-SPACE transition. Ref. p.11.

MARK-HOLD

The normal no-traffic line condition whereby a steady mark is transmitted. Ref. p.4.

MARKING BIAS

Bias distortion which lengthens the marking impulse by advancing the SPACE-to-MARK transition. Ref. p.11.

NEUTRAL CIRCUIT

A teletypewriter circuit in which current flows in only one direction. The circuit is closed during the marking condition and open during the spacing condition. Ref. p.5.

POLAR CIRCUIT

A circuit in which current flows in one direction on a marking impulse and in the opposite direction during a spacing impulse. Ref. p.5.

RANGE FINDER

An adjustable mechanism on a teleprinter selector receiver which allows the selector to be properly oriented to an incoming signal.

RECEIVING MARGIN

The useable range over which the range finder may be adjusted. The normal range for a properly adjusted machine is approximately 75 points on a 120 point scale. Ref. p.13.

SPACE

An impulse which causes the signal loop to open. A no current-on-line condition. Ref. p.1.

SPACING BIAS

Bias distortion which lengthens the spacing impulse by delaying the SPACE-to-MARK transition. Ref. p.11.

SPACING END DISTORTION

End distortion which lengthens the spacing impulse by advancing the MARK-to-SPACE transition. Ref. p.11.

TRANSITION

A change in state of a teletypewriter line. The act of a line going from a marking state to a spacing state, or vice versa, is known as a transition. Ref. p.7.