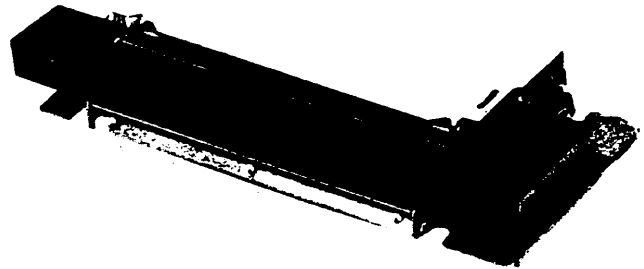


E3

technical manual micro dot printer

M160



English

INTRODUCTION

This Technical Manual for the EPSON Micro Dot Printer Model-160 provides the specifications of the printer, descriptions of its functions and mechanisms, and instructions for maintenance and repair.

Major technical modifications or improvements of the printer, if made in future, will be described in SERVICE BULLETINS, which can be used in conjunction with this book.

Should any discrepancy exist between the contents of this Technical Manual and the provisions of "Master Contract" or the Specifications, the latter shall take precedence over the former.

EPSON shall not be responsible for any troubles that might occur from the customer's applying this Manual to machines other than the EPSON Micro Dot Printer Model-160 or his applying to said printer a drive circuit or other device which is a third party's industrial property.

If you desire to produce copies of the whole or part of this Manual for the purpose of distributing to third parties, notify us in advance.

* The contents of this book are subject to change without prior notice.

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CHAPTER 1

GENERAL SPECIFICATIONS AND OPERATING PRINCIPLES

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1.1 GENERAL SPECIFICATIONS

1.1.1 Features

The EPSON Dot Printer MODEL-160 has the following features;

1. Slim (12.8 mm), compact, light-weight design (75g).
2. Ordinary paper of 58 mm in width can be used.
3. Power is supplied by battery cells when necessary.

Moreover, the EPSON Micron Dot Printer MODEL-160 also has a function to perform alphanumerical printing and graphic display. Therefore, it is an epoch-making printer which can be used for a wide range of applications such as personal computers to be held by hand, function electronic calculators, etc.

1.1.2 General Specifications

The general specifications of EPSON MODEL-160 are shown below. For further details needed for your circuit design refer to the separate "SPECIFICATIONS OF MODEL-160" and "GUIDE TO CIRCUIT AND HOUSING DESIGN FOR MODEL-160".

1. Printing System : Mechanical type dot printer (Print Solenoid: x4)
2. Print Format
 - 1) Maximum number of dots per line : 144
 - 2) Print column capacity : 24 columns max. (with 5x7 dot-matrix and column spacing equivalent to one dot-space) (6 columns/Print Solenoid: x4)
3. Printing Speed
 - 1) One dot-line : Approx. 150 ms (by continuous printing)
 - 2) 5x7 dot-matrix : Approx. 0.7 line/sec (continuous printing; with line spacing equivalent to three dot-spaces)
4. Character Formation
 - 1) Dot spacing : 0.33 mm (horizontal); \pm 0.33 mm (vertical)
 - 2) 5x7 dot-matrix : 1.7 mm (width) x 2.4 mm (height)
5. Printing paper
 - 1) Type : Ordinary type
 - 2) Width : 57.5 + 0.5 mm
 - 3) Outside diameter of roll : 50 mm max.
 - 4) Thickness : 0.07 mm
 - 5) Basis weight : 52.3 g/m² (45kg/1,000 sheets/1,091 sheets x 788)
6. Paper Feeding : The paper is automatically fed dot-line by dot-line. Paper feeding mechanism is provided in connection with paper feeding.
7. Inking : Ribbon cassette type; continuous ribbon feeding is performed automatically during operation of the motor.
 - 1) Color : Purple
 - 2) Dimensions: : Approx. 91 mm (W) x 25 mm (D) x 7 mm (H)
 - 3) Service life, Purple : Approx. 10,000 lines of print
 - 4) Standard : ERC-09

8. Motor	
1) Terminal voltage	: $45^{+0.5}_{-0.7}$ V DC
2) Mean current	: Approx. 0.20A (at 4.5V DC, 25°C)
9. Timing Detector	: Tachogenerator (directly coupled to the motor)
10. Resetting Detector	: Reed switch
11. Print Solenoid	
1) Terminal voltage	: $4^{+0.5}_{-1.0}$ V DC
2) Ohmic resistance	: $1.5\Omega \pm 0.15\Omega$ (at 25°C)
12. Connectors	
1) Printer side	: P.C.B. of 2.54mm pitch copper foil patterns fixed to the printer frame
2) Calculator side	: Flexible printed cable or lead wire
13. Guaranteed Operating Temperature Range	: 0°C to 50°C
14. Reliability (MCBF)	: 500,000 lines
15. Overall Dimensions	: 94 mm width × 42.6 mm depth × 12.8 height
16. Weight	: Approx. 75g

1.1.3 Outline of Mechanisms

Photo 1.1 illustrates exterior view of the EPSON Dot Printer MODEL-160.

The Model-160 is a mechanical type dot printer whose printing head having four print solenoids arranged in a line in the column direction moves in the column direction for a space equivalent to 36 dot-spaces. The printing head moving in the column direction performs one way printing as the four print solenoids are energized one after another.

At the time when the head set returns to the home position, paper is automatically fed by one pitch. The repetition of this operation makes it possible to obtain the prescribed print format.

These operations are performed mainly by a power transmission mechanism, a detecting mechanism, a printing mechanism, a paper feeding mechanism and a ribbon feeding mechanism. (The details of each mechanism are described in "1.2 Operating Principles").

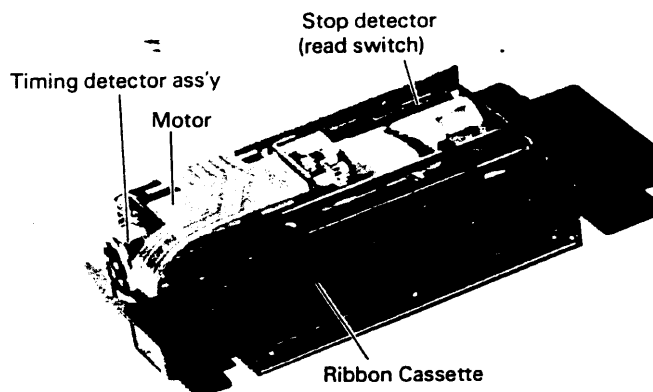


Photo 1.1 (a) Exterior View of Model-160 Printer
(from frame R side)

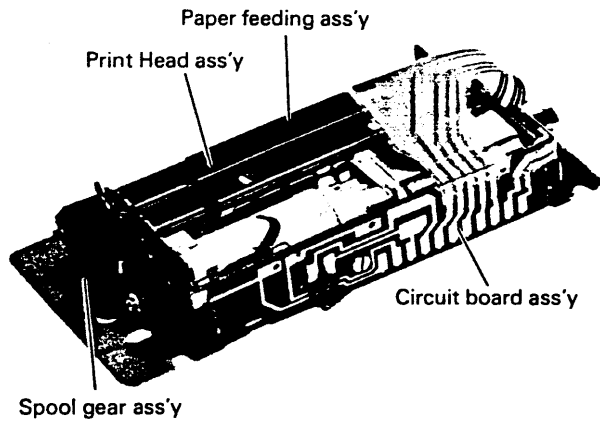


Photo 1.1 (b) Exterior View of Model-160 Printer
(from frame L side)

1.2 OPERATING PRINCIPLES

The operating principles of the functional sections will be described below.

1.2.1 Transmission Mechanism

The transmission mechanism is composed of a reduction gear train, a paper feeding gear train (a part of the paper feeding mechanism), and a ribbon feeding gear train (a part of the ribbon feeding mechanism).

(1) Reduction Gear Train

The reduction gear train consists a motor gear secured on a motor shaft, a reduction gear (large and small position) and an intermediate gear (large and small position) placed in a reduction unit, and an internal gear formed integral with a lead cam. The reduction gear (large) is in mesh with the motor gear. The reduction gear (small) is in mesh with the intermediate gear (large). The intermediate gear (small) is in mesh with the lead cam internal gear. The rotational speed of the motor is reduced to 1/18 at the lead cam by the reduction gear.

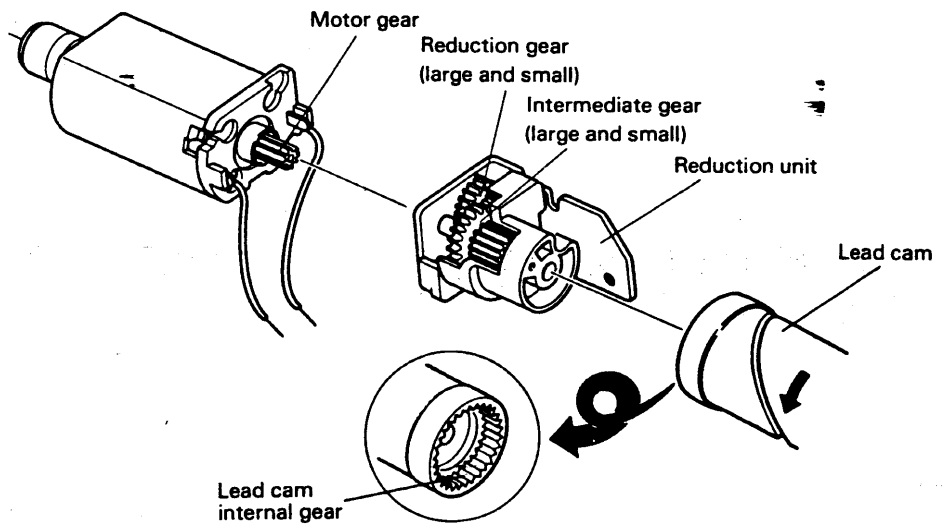


Fig. 1.1 Reduction Gear Train

(2) Ribbon Feeding Gear Train

The ribbon feeding gear train consists of a specially shaped ribbon feeding cam placed on a shaft, a ribbon feeding gear placed on a shaft on frame L side and consisting of a bevel gear portion and a small gear portion, and a spool gear placed on a shaft. These gears rotate in the directions shown by the respective arrows in Fig. 1.2. The reduction ratios are: ribbon feeding cam: ribbon feeding gear (bevel gear portion) = 9 : 1, and ribbon feeding gear (small gear portion): spool gear = 33 : 13. The ribbon is fed at a rate of 13.6 mm/sec.

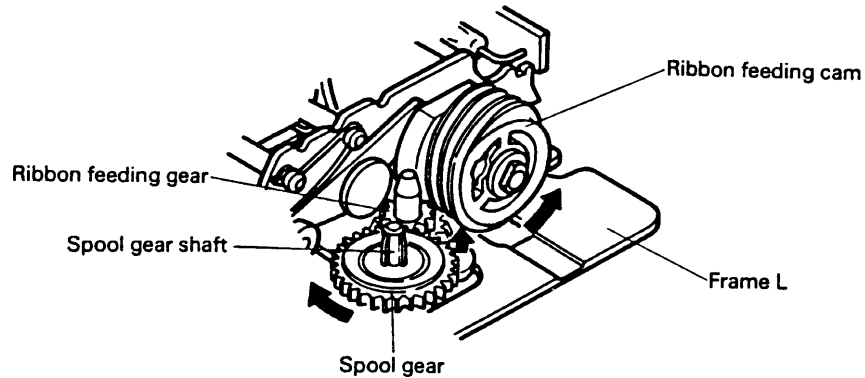


Fig. 1.2 Ribbon Feeding Gear Train

(3) Paper Feeding Gear Train

The Paper feeding gear train consists of a paper feeding transmission gear and a paper feeding gear both secured on a paper feeding roller shaft. The paper feeding gear is in engagement with a paper feeding lever, movements of the latter in directions A and B Fig. 1.3 causing the former to rotate in two directions. The paper feeding transmission gear enters into mesh with the paper feeding gear each time the latter rotates in direction C, and is made to rotate by one tooth in direction D.

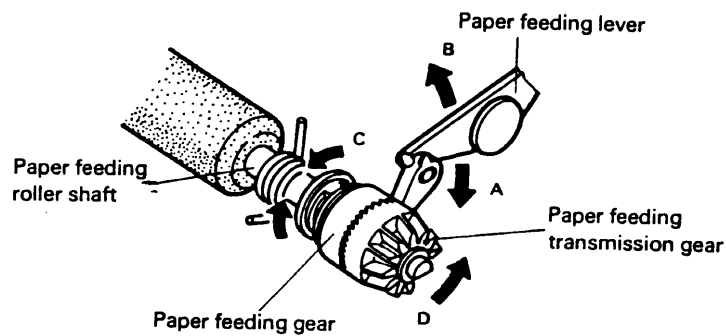


Fig. 1.3 Paper Feeding Gear Train

1.2.2 Detecting Mechanism

The detecting mechanism of this printer consists of a timing detector and a resetting detector.

(1) Timing Detector

The timing detector is a tachogenerator coupled directly to the motor. It generates sinusoidal waves T_n (timing pulses: T_1 to T_{252} for each dot-line) of which the frequency is proportional to the motor speed.

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(2) Resetting Detector

The resetting detector consists of a reed switch (normally open) and a permanent magnet fixed to the lead cam. It generates one pulse per dot-line. One reset pulse per print cycle is used for resetting the timing pulse counter.

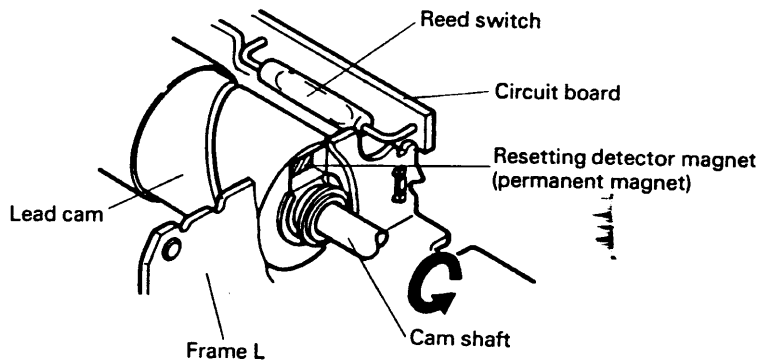


Fig. 1.4 Resetting Detector Mechanism

1.2.3 Printing Mechanism

The printing mechanism has two functions: moving the print head, and printing.

(1) Moving the Print Head

As shown in Fig. 1.5, the print head is mounted on a carriage which smoothly moves reciprocally between frames L and R along two print head guide shafts and in parallel with the platen.

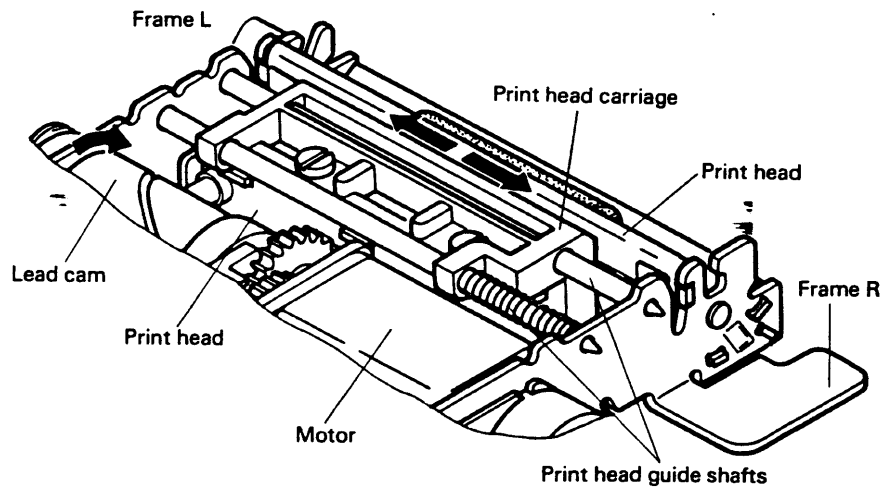


Fig. 1.5 Printing Mechanism

Movements of the print head take place as follows:

- 1 The lead cam has a groove (cam groove) formed as shown in Fig. 1.6 and a print head drive pin secured to one end of the print head is engaged in this cam groove. Rotation of the lead cam in direction A causes the print head drive pin to move along the cam groove and consequently the print head to reciprocate as shown by arrow B.

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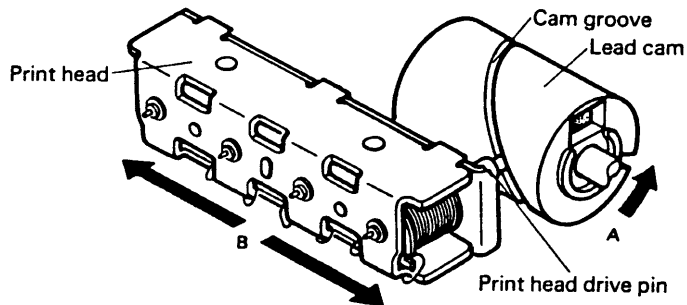


Fig. 1.6 Principle of Print Head Movement

- 2 The print head is rigidly secured to the carriage by two screws and therefore they make reciprocative movement in just the same way.

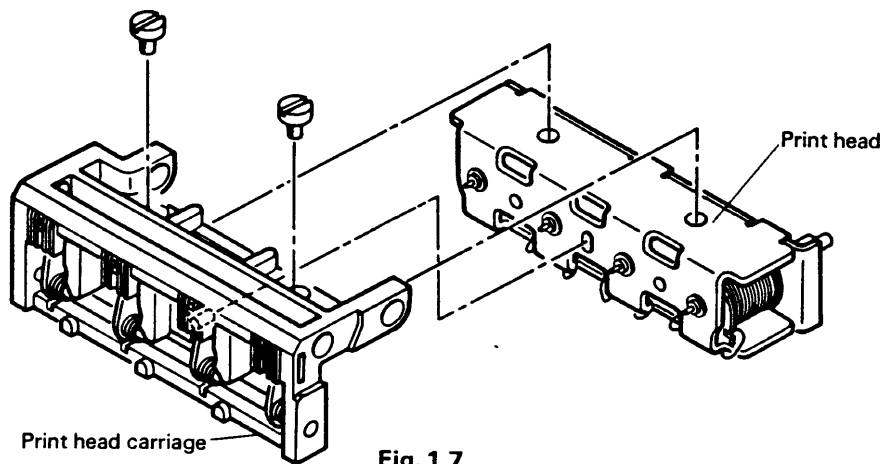


Fig. 1.7

(2) Printing Operation of Print Head

The print head contains four coil units, each of which consists of a core, a plunger and a push rod. In the print head carriage are provided four printing levers corresponding to the four coil units in the print head.

- 1) In printing a dot, the mechanism operates as follows:

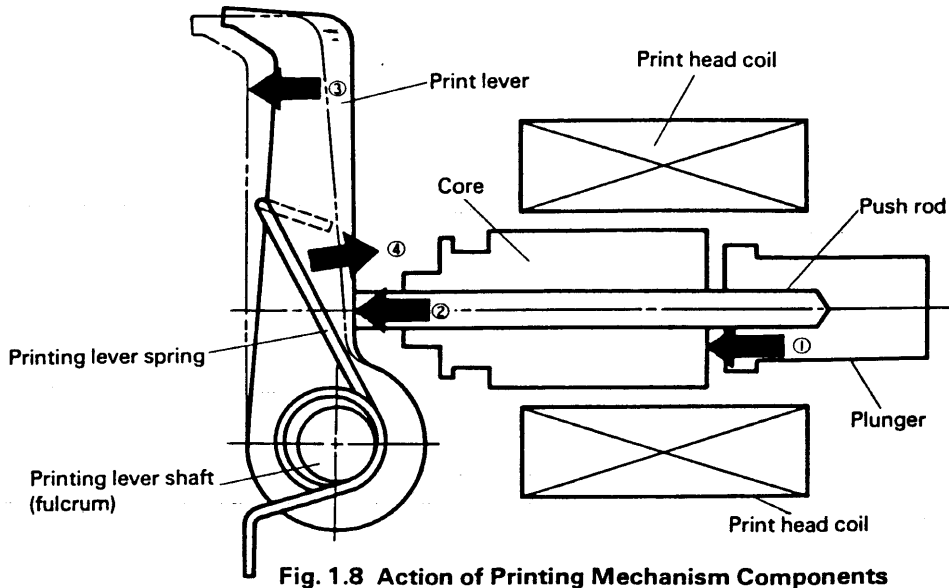


Fig. 1.8 Action of Printing Mechanism Components

- 1 When the coil of a coil unit in the print head is energized, the associated plunger is attracted by the core (arrow ①). As the push rod is securely fitted in the plunger, it is pushed by the plunger in the direction of arrow ②.
 - 2 The push rod then pushes the corresponding printing lever placed on a shaft (fulcrum) in the print head carriage in face of the platen, and consequently the lever is made to turn round the fulcrum in the direction of arrow ③.
 - 3 The printing lever thus pushed strikes the ribbon and paper against the platen to print a dot.
 - 4 When the print head coil is deenergized, the printing lever is returned to home position by the action of spring (arrow ④).
- 2) In printing a dot-line, the print head operates as follows (with 5x7 dot-matrix):
- 1 When the motor rotates, the tachogenerator directly coupled to it generates timing pulses of cycle time of approx. 0.6 msec (at 4.5V DC). Rotation of the motor also causes the lead cam to displace the print head approx. 0.33 mm in each 2.4 msec (at 4.5V DC).
- How a dot-line is formed will be described referring to Fig. 1.9.

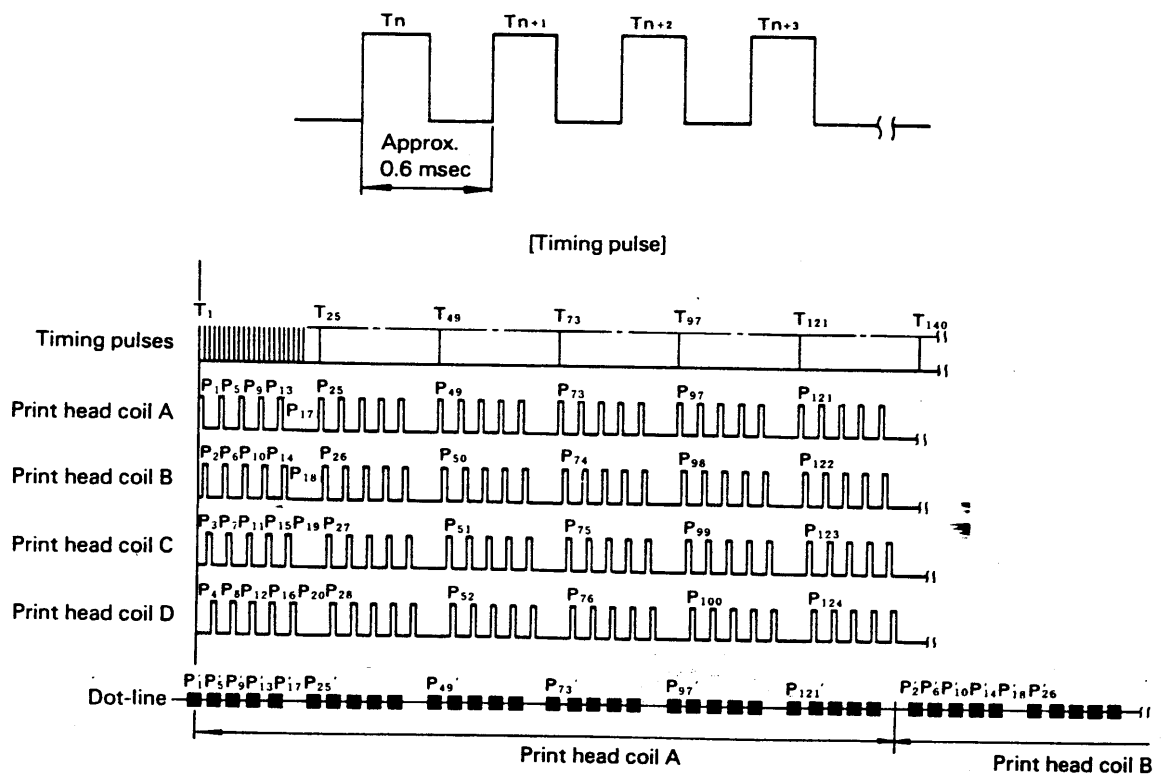


Fig. 1.9 Print Timing Chart

First, print head coil A is energized by print pulse P_1 to make dot P_1' be printed. Then print head coil B is energized by print pulse P_2 to print dot P_2' . Coil C is then energized for dot P_3' and coil D for dot P_4' , and then coil A for dot P_5' Repetition of this cycle in necessary number makes a complete dot-line be printed. On completion of printing of a dot-line, the paper is fed 0.33 mm and the printing of the next line is ready to start.

1.2.4 Paper Feeding Mechanism

The paper feeding mechanism consisting of the components shown in Fig. 1.10 has normal paper feeding function and paper freeing function which permits drawing the paper out of the printer by pulling in the direction of feeding or the reverse direction. The arrows and encircled numbers in the figure below represent the directions of components' actions and the order in which the actions take place, respectively.)

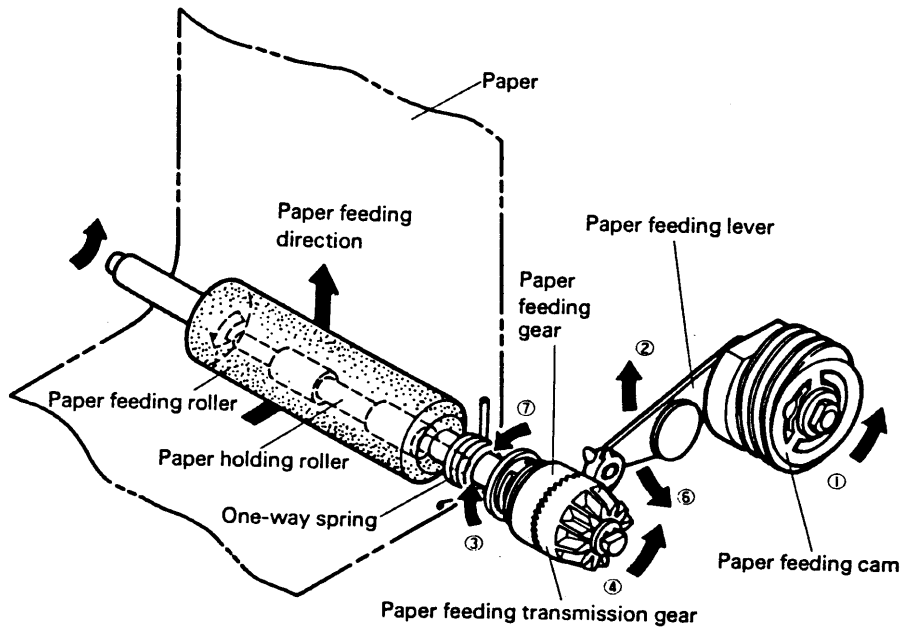


Fig. 1.10 Paper Feeding Mechanism

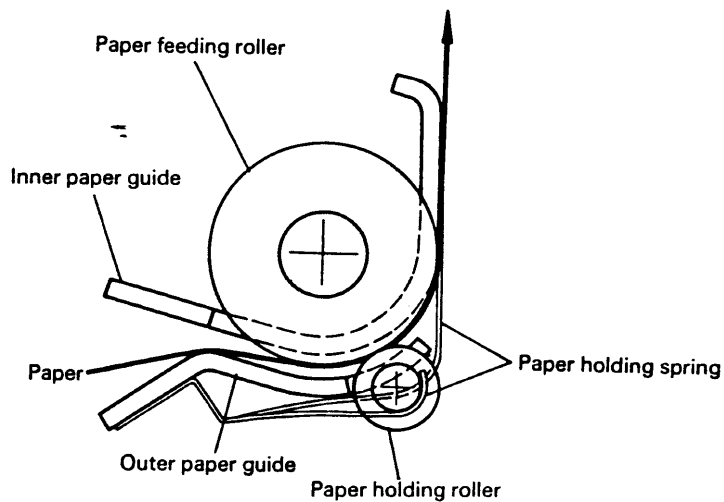


Fig. 1.11 Path of Printing Paper

(1) Operation of Paper Feeding Lever

A cam groove is formed internally of the ribbon feeding cam and the paper feeding lever is engaged in this internal cam groove at one end (A, Fig. 1.12). The paper feeding lever is thus moved round fulcrum C as the ribbon feeding cam rotates, and therefore the other end of the paper feeding lever shows a movement as shown by arrow B.

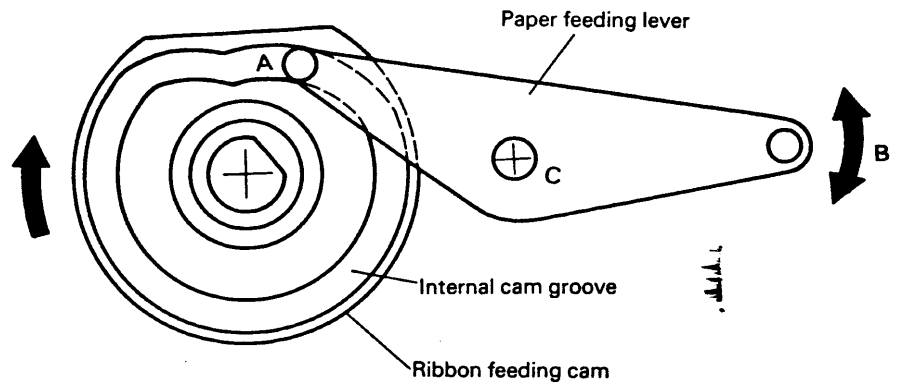


Fig. 1.12 Action of Paper Feeding Lever

(2) Operation of Paper Feeding Gear and Paper Feeding Transmission Gear

The paper feeding gear is driven in two directions alternately by the paper feeding lever, and the paper feeding transmission gear rotates intermittently by meshing with paper feeding gear only when the latter rotates in the predetermined one to the two directions.

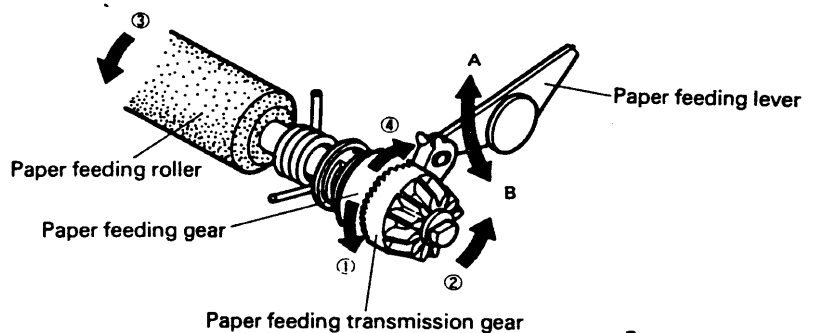


Fig. 1.13

1 Paper feeding phase (refer to Fig. 1.13):

When the paper feeding lever moves in direction A, it rotates the paper feeding gear in direction ① and this gear enters into mesh with the paper feeding transmission gear, which is thus rotated one tooth in direction ②. Consequently, the paper feeding roller securedly placed on the same shaft as with the paper feeding transmission gear is rotated in direction ③ to feed the paper through a length of 0.33 mm.

2 Return phase

Referring to Fig. 1.13, the paper feeding gear rotates in direction ④ when the paper feeding lever moves in direction B. At this moment, the paper feeding transmission gear is prevented from rotating by the one-way spring placed on the paper feeding roller shaft and it goes out of mesh with the paper feeding gear (see Fig. 1.14). Consequently the paper feeding gear alone rotates in the reverse direction and thus returns to the initial position.

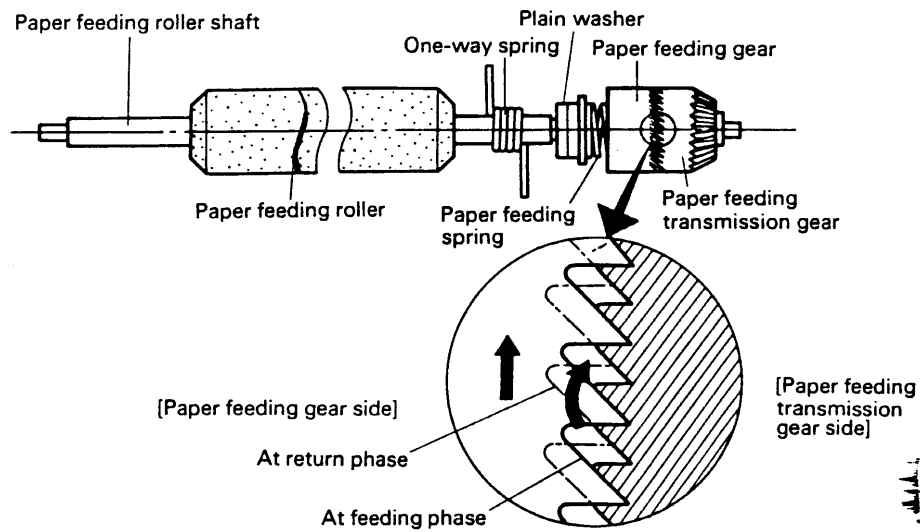


Fig. 1.14 Return Phase

1.2.5 Ribbon Feeding Mechanism

The ribbon feeding mechanism consists of the components shown in Fig. 1.15 (the arrows indicate the directions of the respective components' movements).

When the specially shaped ribbon feeding cam rotates in direction ①, the ribbon feeding gear in engagement with this cam and the spool gear rotate in direction ② and ③, respectively. The rotation of the spool gear causes rotation of the spool gear shaft, which rotates only in the same direction as with the spool gear: The spool gear is in engagement with the ribbon feeding roller of the ribbon cassette, and therefore the ink roll securely placed on the ribbon feeding roller rotates in direction ④. The inked ribbon contained in the ribbon cassette is kept, by a holding spring, in contact with the ink roll under appropriate pressure over a part of its length, and therefore it can be frictionally driven (fed) in direction ⑤. In the cassette is provided a brake spring for ensuring appropriate tension in the ribbon between points A and B.

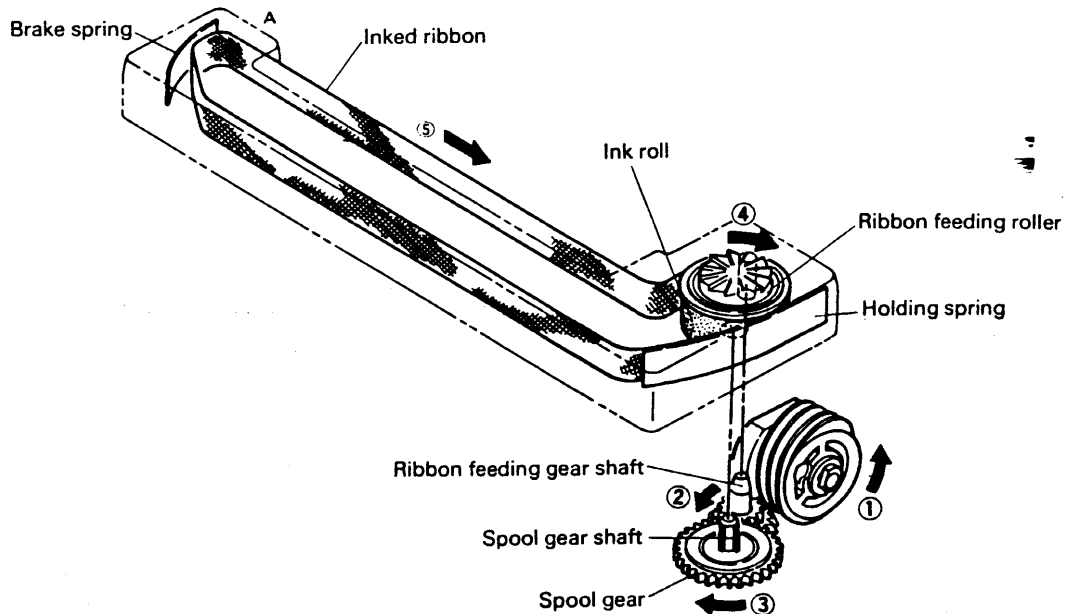


Fig. 1.15 Ribbon Feeding Mechanism

1.2.6 Sequence of Printing Operation

Fig. 1.16 and Fig. 1.17 show the timing chart of the pulse signals to perform a printing cycle.

(1) Printing and paper feeding

First, print solenoid A is energized by pulse P_1 lasting from T_1 to T_2 to print the top left dot for the character to be printed in No. 24 column. Then, print solenoid B is energized by pulse P_2 lasting from T_2 to T_3 to print the top left dot for the character to be printed in No. 18 column. Such operation is repeated, and print solenoid D is energized by pulse P_{140} lasting from T_{140} to T_{141} to print the top right dot for the character to be printed in No. 1 column.

After printing in the rightmost columns (Nos. 19, 13, 7 and 1 columns) to be covered by the respective solenoids, the print head is moved for another dot space and then returned to the home position while timing pulses T_{144} to T_{252} pass. At the same time, the paper is automatically fed one dot-line. The above operation is repeated continuously for seven dot-lines. Then printing in the seventh dot-line starts. After print solenoid D has been energized by pulse P_{1652} lasting from T_{1652} to T_{1653} to print the right lowermost dot desired for the character to be printed in No. 1 column for completing the 5x7 matrix character in No. 1 column.

Next, the paper is fed three dot-lines (eighth, ninth, and tenth dot-lines) to provide a characterline spacing equivalent to three dot-spaces, and one print cycle ends at T_{2520} .

(2) Designation of reset pulses R_1 and R_n

The first reset pulse appearing after 95 timing pulses have been counted since application of motor drive signal is designated as R_1 . The reset pulses to come first after another 95 timing pulses are designated as $R_2 - R_n$.

Initial setting for ascertaining that the printing head is in home position is automatically finished with detection of R_1 . Timing pulse T_1 to indicate the line start position for each print cycle is determined through detection of R_1 .

(3) Continuous printing or continuous paper feeding

This can be performed by continuing application of motor drive signal for the desired period.

(4) Reset signal

It may occur that no reset pulse is generated when the print head is in halted state.

NOTES:

1. 95 or more timing pulses appear during the period from the start of motor to appearance of R_1 .
2. Periods when print solenoids must not be energized:
 - 1) From start of motor to rise of R_1 (from the moment when the motor starts to the moment when it attains normal speed).
 - 2) From $T_{145} + 252n$ to $T_{252} + 252n$ (during return of printing head) ($n =$ one of the integers from 1 to 10 in case of printing with 5x7 dot-matrix and line spacing equivalent to three dot-spaces).
 - 3) The print solenoids must not be energized nor deenergized by noise.
 - 4) Ascertain the generation of R_1 for each print cycle and count timing pulses anew for each print cycle.

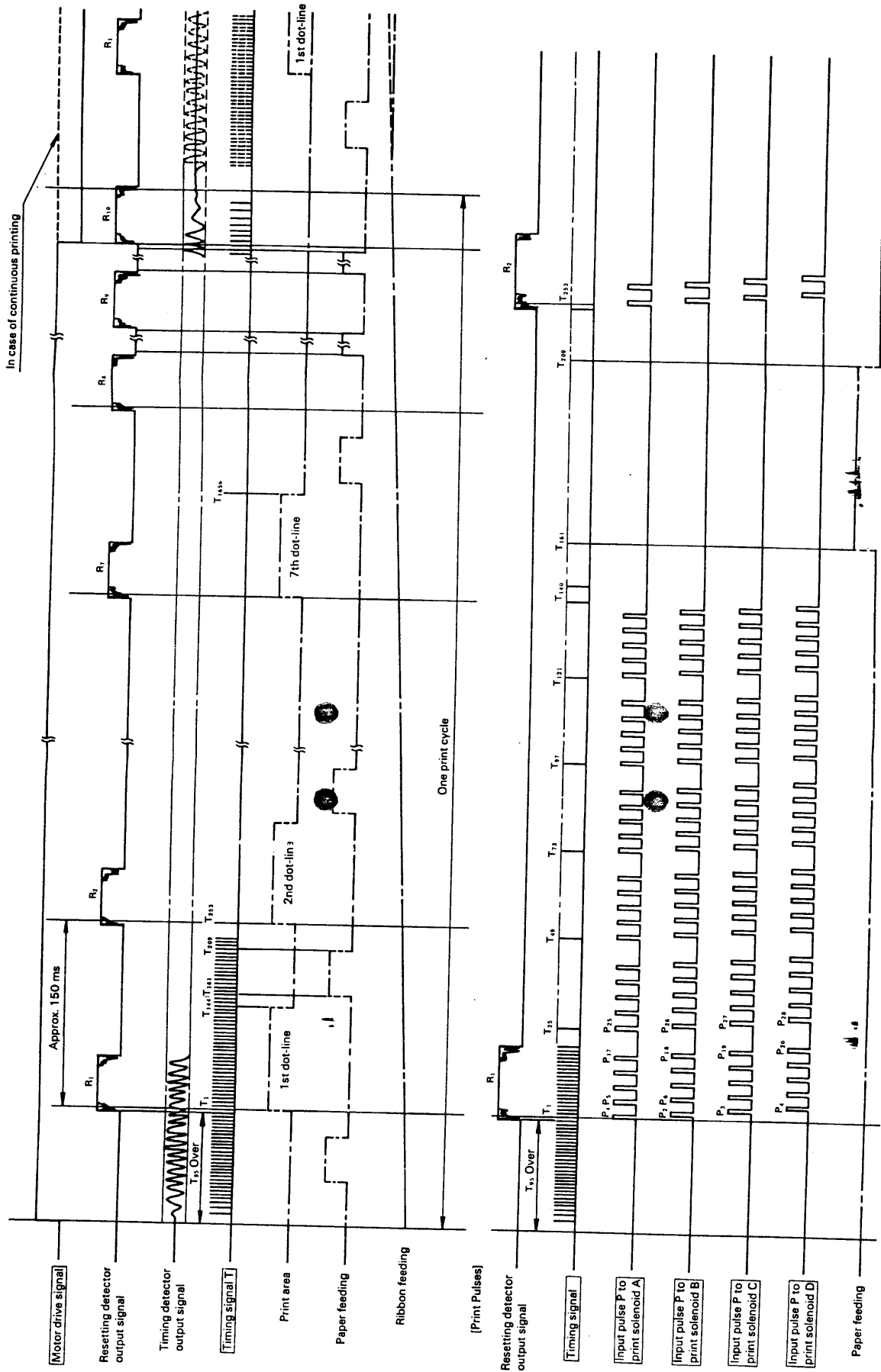


Fig. 1.16 Timing chart for printing with 5x7 dot-matrix and line spacing equivalent to three dot spaces: The pulses enclosed in are to be provided by the customer.

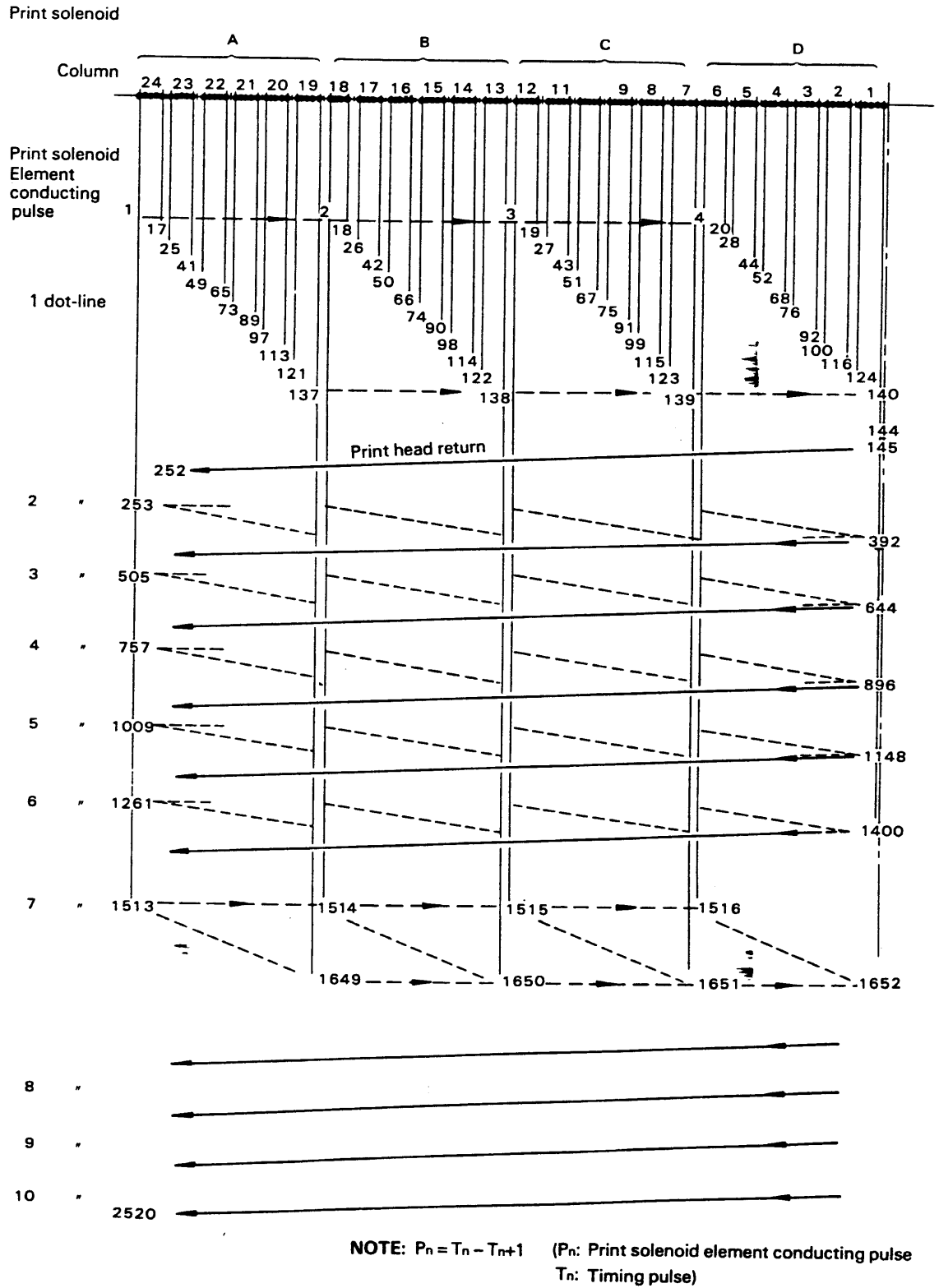


Fig. 1.17 Timing pulse assignment (for printing with 5x7 dot-matrix and line spacing equivalent to three dot spaces)

CHAPTER 2

MAINTENANCE, LUBRICATION AND REPAIR

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2.1 MAINTENANCE

Proper maintenance is essential for the EPSON Micro Dot Printer Model-160 to keep its designed performance for the longest possible period, and to minimize the occurrence of trouble. Carry out maintenance according to the following instructions:

2.1.1 Cleaning

(1) **Removal of dirt and stains:**

Remove any dirt and stains using alcohol or benzene.

NOTE:

Never employ thinner nor trichloroethylene—or ketone—based solvents, which might deteriorate plastic parts.

(2) **Removal of paper particles, dusts and naps:**

To remove any paper particles, dusts and naps from the surface and inside of the printer, it is recommended that a vacuum cleaner be used.

NOTE:

After cleaning, check the lubrication points for quantity of lubricant. If the removal of paper particles, dusts and naps has resulted in insufficient quantity of lubricant, re-supply the specified lubricant as required. (Refer to Par. 2.2.2 "Lubrication Requirements".)

2.1.2 General Instruction on Daily Use of Printer

(1) **Insertion and removal of printing paper:**

(a) Be sure to employ a paper as specified in Par. 1.2-5, Chap. 1.

(b) Before passing the paper into the printer, cut squarely the top of the paper.

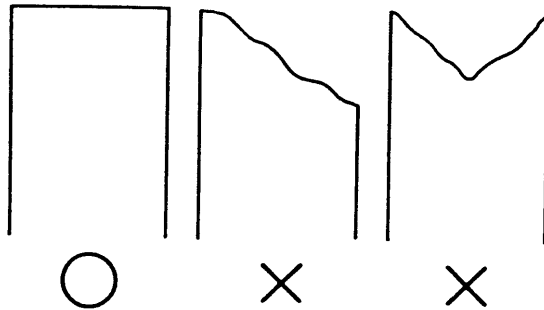


Fig. 2.1 Processing of Paper Top for Insertion

(c) **Insertion of the paper:**

1) Insert the paper top straight into the paper inlet of the printer. Never attempt to insert the paper with its top faced obliquely to the inlet.

2) Pushing the paper in the feeding direction facilitates its engagement with the paper feeding roller, thus permitting easy insertion.

(d) **Removal of the paper:**

1) Feed the paper out of the printer by electrical operation (turn the power ON and push the PAPER FEED button).

2) Alternatively, remove the paper by pulling straight. If the paper is pulled obliquely, it may be caught by the internal parts of the printer.

(2) Replacement of Ribbon Cassette

- (a) Be sure to employ a ribbon cassette as specified in Par 1.2-7, Chap. 1.

NOTE:

The ribbon cassette is of the throwaway type; replenishment of ink is absolutely impossible.

- (b) Replacing procedure:

- 1) Push down the cassette at one end marked "PUSH" until the other end is disengaged.

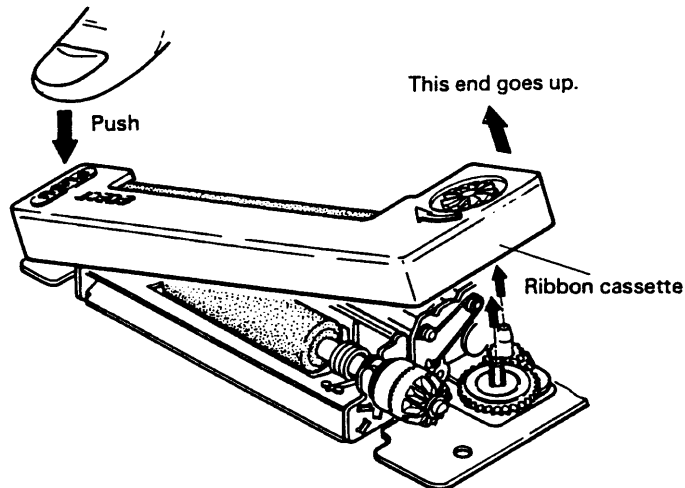


Fig. 2.2 Removal of Ribbon Cassette

- 2) In setting the new cassette into position, pay attention to the following points:

- Prior to setting the cassette (as well as to removing it), be sure to remove the paper from the printer.
- Before placing the cassette, turning the button at one end in the direction of the arrow until the ribbon becomes tense (Fig. 2.3).
- Turning the button also during the operation of placing the cassette on the printer facilitates the setting.

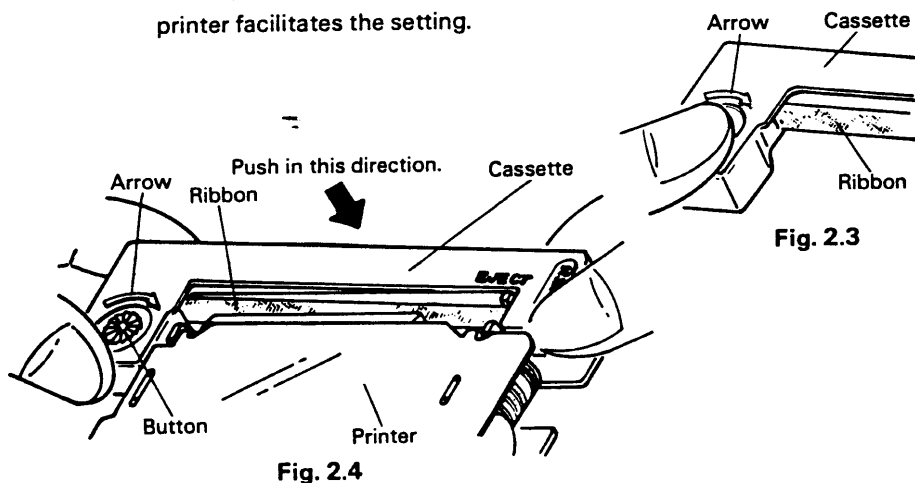


Fig. 2.4

Fig. 2.3

- After placing the cassette, give two or three turns to the button.
- Finally, check the condition of the ribbon.

(3) Handling of Printer as a Separate Unit

(a) Carrying:

- 1) When carrying the printer as a separate unit, be careful not to hold by the FPC (flexible printed cable), the patterns on the circuit board, the ribbon cassette nor the gears (see Photo 2.1).
- 2) Be careful that the printer be not subjected to shock from fall onto the floor or collision against other objects or printers.

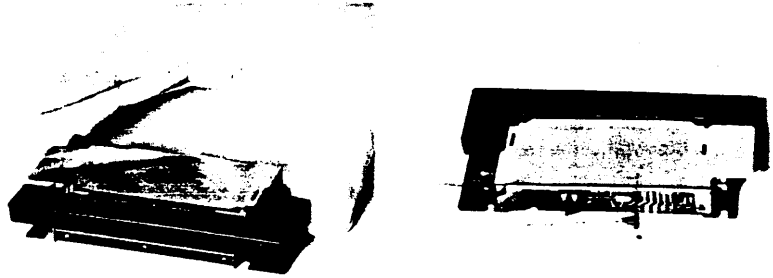


Photo 2.1 Handling of Printer as a Separate Unit

(b) Storage:

- 1) Avoid storing the printer in a very dusty or humid place or in a place subject to direct sunlight.
- 2) When the printer is to be stored for a relatively long period of time, wrap in anticorrosive paper (VPI paper), place in a polyethylene bag and store in a dry place.

(c) Other precautions:

- 1) Since this printer uses permanent magnets (in detectors) and electromagnets, avoid using it in a place where a nonnegligible amount of iron dust exists, or in a very dusty place.
- 2) Never operate the printer with the printing paper not being in position.
- 3) Since a reed switch is used for the reset detector, never place any magnetic equipment within the range of 7 mm from the top cover to prevent the reed switch from being subject to its adverse effect.

2.1.3 Inspection

Inspection of the Model-160 Printer is divided into the following categories:

(1) Daily Inspection

This can easily be carried out by the operator of the printer.

As part of his routine work, the operator should verify that the printer is properly used in accordance with the Instructions on Daily Use given in Par. 2.1.2 so that the printer may always serve in the best condition.

(2) Periodic Inspection

This can be carried out only by those persons who have sufficient knowledge of the operating principle, construction and mechanism of the printer.

Have the printer inspected by such persons every six months for the check items given in the table below and have the necessary maintenance actions performed.

Check item	Condition to be remedied	Action
1) Deposit of dust, dirt and/or nap	<ul style="list-style-type: none"> ● Too much deposit of dust, dirt and/or nap; presence of foreign matters inside the printer. ● Presence of torn pieces of paper or foreign matters in and/or on paper guide. ● Deposit of dust, dirt and/or nap on detectors. 	<ul style="list-style-type: none"> ● Such materials can effectively be removed with vacuum cleaner. ● Remove all such materials. ● Remove.
2) Condition of spring	<ul style="list-style-type: none"> ● Deformation 	<ul style="list-style-type: none"> ● Replace deformed springs
3) Lubrication	<ul style="list-style-type: none"> ● Refer to Par. 2.2.2 "Lubrication Requirements". 	<ul style="list-style-type: none"> ● Quantity of lubricant being found insufficient, resupply the specified lubricant.
4) Operation of printer mechanism	<ul style="list-style-type: none"> ● Abnormal action of printing mechanism ● Abnormal feeding of paper. ● Check all mechanisms for abnormal action due to worn, deformed or paper-clogged parts or loosened screws. 	<ul style="list-style-type: none"> ● Refer to Par. 2.3.4 "Troubleshooting Table". ● Ditto. ● Replace; retighten loosened screws, if any, to specified torque in accordance with the instructions in Par. 3.2 "ASSEMBLY".

2.2. LUBRICATION

Proper lubrication is essential for the EPSON Micro Dot Printer Model-160 to keep its designed performance for the longest possible period, and to minimize the occurrence of trouble. Carry out lubrication according to following instructions:

2.2.1 Lubricants

The properties of lubricants used have a great influence on the performance and durability of the printer. In particular, attention must be paid to the low temperature characteristics. It is strongly recommended to use only those lubricants that EPSON has selected after an extensive study of technical information and a series of tests on many types of lubricants. EPSON can supply such lubricants in a metallic can or a plastic container of 40cc (40g), which is the minimum supply unit available.

REMARKS:

The number of Model-160 Printer units for which 40cc of lubricant is sufficient is as follows:

<u>Lubricant</u>	<u>Number of printer units</u>
G-2	Approx. 100

2.2.2 Lubrication Requirements

The lubricant to be used for the Model-160 Printer is G-2. Supply the specified quantity of G-2 to the lubrication points indicated in the table below. Prior to application of lubricant, be sure to thoroughly clean the printer elements or parts concerned.

NOTE:

The Ref. Nos. in the table below correspond to the Nos. used in Fig. 2.5.

The application quantity of lubricant increases with the number of black points (●)

Ref. No.	Lubrication points	Lubricant	Application quantity
L-1	Part to receive spool gear shaft	G-2	●●
L-4	Lead cam internal gear (Whole perimeter)		●●
L-5	Lead cam groove (Whole perimeter)		●●●
L-6	Contacting parts of cam shaft and cam shaft bearing		●●
L-7	Tip of push rod (four points)		●
L-8	Circumference of plunger (four points)		●
L-9	Contacting parts of printing lever and its shaft		●●
L-10	Engagement parts of printing lever and its spring		●
L-11	Contacting parts of print head carriage and print head guide shaft (two points on R side)		●●●
L-12	Contacting parts of print head carriage and print head guide shaft (two points on L side)		●●●
L-13	Contacting parts of paper holding and paper holding roller spring (two points)		●
L-14	Part to receive paper feeding roller shaft on R side	G-2	●●
L-15	Contacting parts of paper feeding roller shaft and its bearing		●●
L-16	Contacting parts of paper feeding roller shaft and one-way spring		●●
L-17	Engagement parts of paper feeding lever pin and paper feeding gear		●
L-18	Contacting parts of paper feeding lever shaft and paper feeding lever		●●●
L-19	External toothed part of ribbon feeding cam (whole perimeter)		●●
L-20	Internal cam part of ribbon feeding cam (whole perimeter)		●●●
L-21	Contacting parts of paper feeding lever spring and paper feeding lever		●●
L-22	Reduction gear		●●
L-23	Part of holder to receive motor gear		●
L-24	Contacting parts of head cam and frame L	●●	
L-25	Intermediate gear (large and small)	●●	

Note: Oil quantity ● less
 ●● ordinary
 ●●● much

2.2.3 Periodic Lubrication

Carry out periodic lubrication on every occasion of overhaul of the printer and every 500,000 lines printed. Lubrication must also be performed when the quantity of lubricant at any lubrication point has become insufficient as a result of cleaning of the printer parts concerned and on the occasion of disassembly or replacement of the parts concerned.

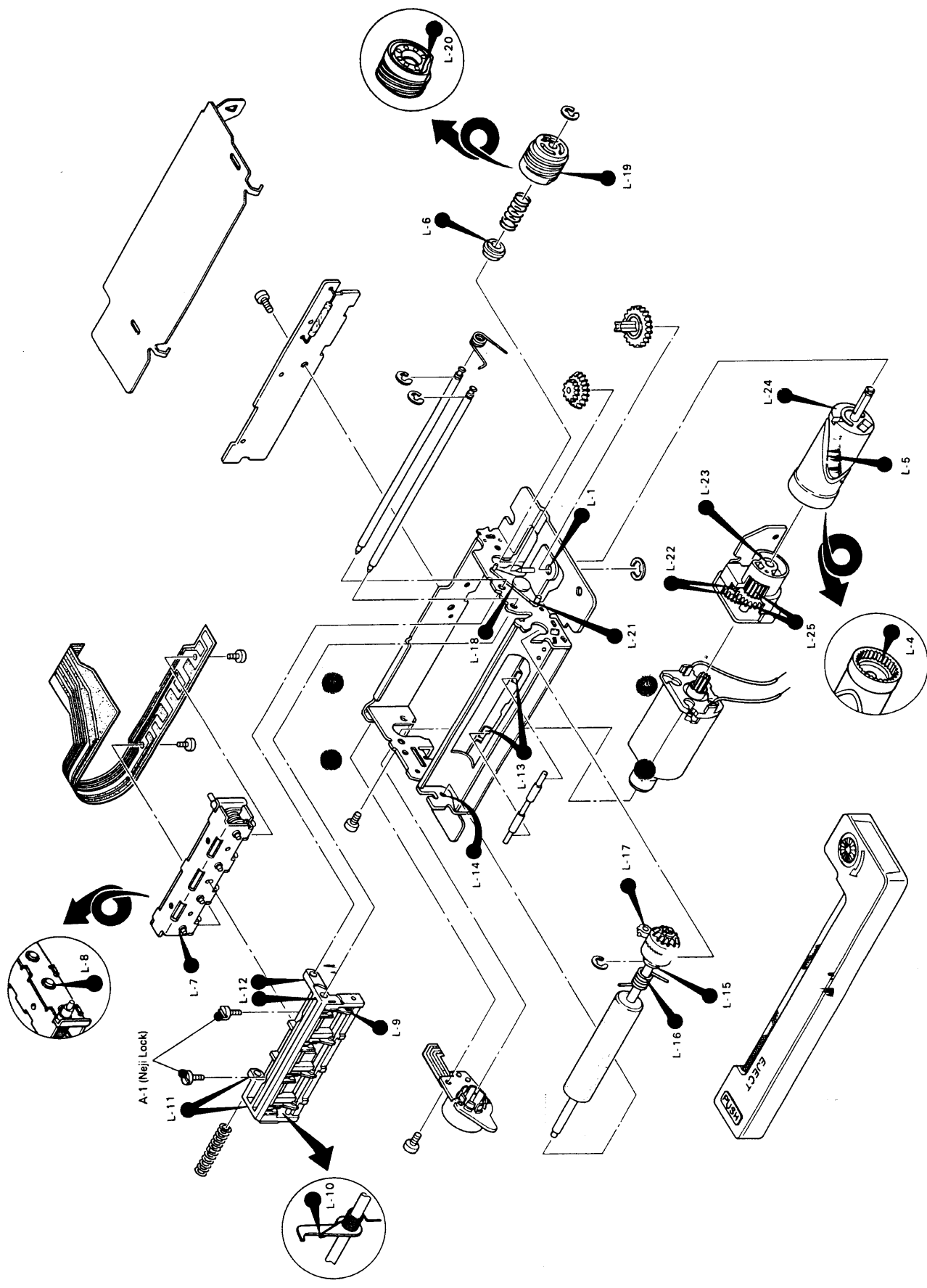


Fig. 2.5 Lubrication Points

2.3 REPAIR

Repairs of the Model-160 Printer are grouped into three classes (A, B and C) as defined in Paragraph 2.3.1 below, according to the difficulty involved. The person who is going to repair the printer must ascertain whether or not he is qualified for the class of repair he is faced with.

2.3.1 Repair Classification

- Class A: General knowledge of the construction and operating principle of the printer, as well as basic repair technique is required. Neither special experience nor trained skill is required.
- Class B: Advanced knowledge of the construction and operating principle of the printer is required. Techniques for handling jigs and measuring instruments in disassembly and assembly as well as practical repair experience are required.
- Class C: Highly specialized knowledge of the construction and operating principle of the printer is required. Highly developed skill and techniques for handling special jigs and measuring instruments in disassembly and assembly as well as thorough experience in repair are required.

2.3.2 Troubleshooting

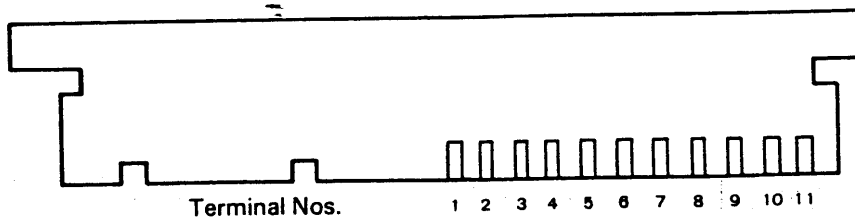
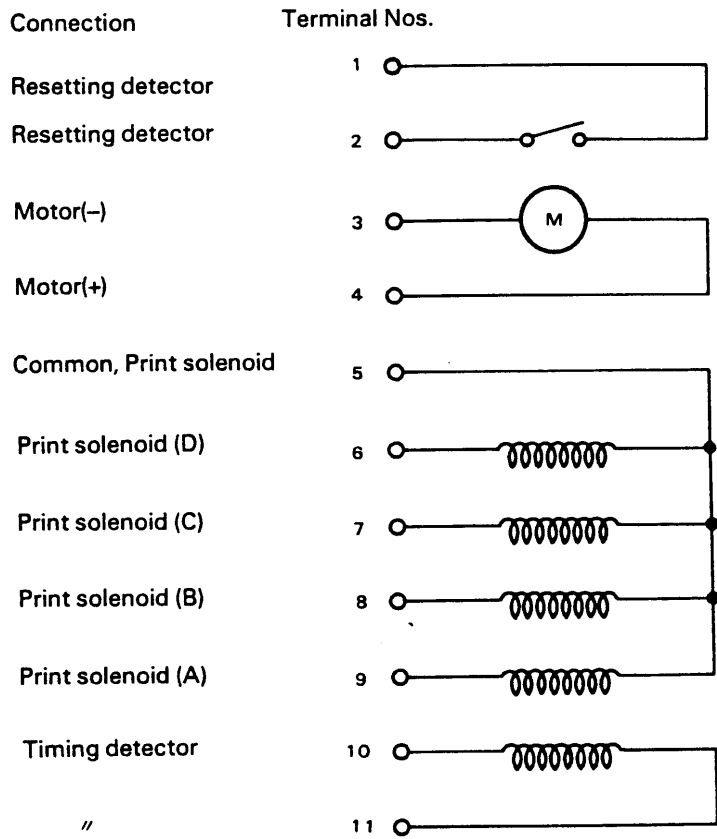
Should a trouble occur, refer to the "Troubleshooting Table" given in Paragraph 2.3.4 to confirm the nature and condition of the trouble and determine the cause of trouble. Then, check the defective part(s) and carry out the suggested remedy. The Troubleshooting Table contains six columns:

- 1) NATURE OF TROUBLE: Find the nature of the trouble in this column.
- 2) CONDITION OF TROUBLE: Compare the actual condition of the trouble with the description given in this column, then confirm whether or not they are identical.
- 3) POSSIBLE CAUSE: Possible causes of the trouble are listed in this column for the respective trouble conditions. Determine the cause.
- 4) CHECK POINT: The points to be checked with respect to the trouble in question are listed in this column. Check each item according to the instruction and locate the defective part.
- 5) REMEDY: The remedy for the corresponding cause of trouble is suggested in this column. If the trouble persists after implementation of the suggested remedy, check other items in the "POSSIBLE CAUSE" column and carry out the corresponding remedy.

Following the procedure described above will minimize misjudgement and ensure an efficient repair work.

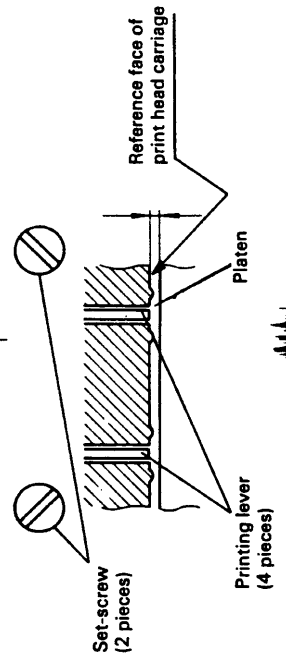
The numbers parenthesized after part or assembly names indicated in the Troubleshooting Table correspond to those used in Fig. 3.1 Exploded View of Model-160 Printer, Chapter 3.

2.3.3 Terminal Contacts Arrangement



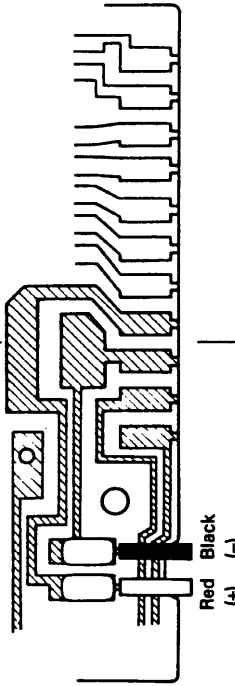
2.3.4 Troubleshooting Table

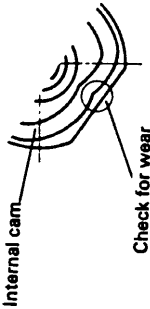
NATURE OF TROUBLE	CONDITION OF TROUBLE	POSSIBLE CAUSE	PAIR CLASSIFICATION	CHECK POINT	REMEDY
1. No dot can be printed.	Motor rotates normally, but no dot can be printed.	1) Rupture of FPC (flexible printed cable) common wire.	A	<ul style="list-style-type: none"> ● Check FPC common wire for electrical continuity. 	<ul style="list-style-type: none"> ● Discontinuity being confirmed, replace FPC (5-2).
		2) Bad contact between FPC common wire and circuit board terminal.	A	<ul style="list-style-type: none"> ● Check solder connecting circuit board terminal and FPC common wire for electrical continuity. 	<ul style="list-style-type: none"> ● Discontinuity being confirmed, resolder the parts.
		3) Faulty relative position of platen and print head.	B	<ul style="list-style-type: none"> ● Check distance between platen and printing lever's impact face. ● Proper distance: 0.6 mm 	<ul style="list-style-type: none"> ● Distance being improper, correct as follows: <ol style="list-style-type: none"> 1) Loosen the two set-screws. 2) Displace print head so that reference face of print head carriage and impact face of printing lever become flush, as illustrated below.

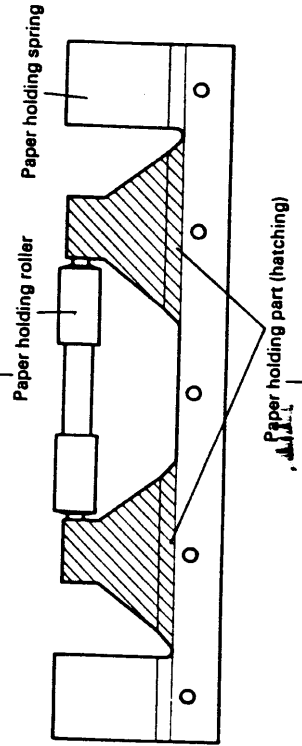


- 3) Proper distance between platen and printing lever's impact face is approx. 0.6 mm
- 4) Retighten the screws.

NATURE OF TROUBLE	CONDITION OF TROUBLE	POSSIBLE CAUSE	REPAIR CLASSIFICATION	CHECK POINT	REMEDY
2. Constant omission of dots at particular dot positions.	A particular print solenoid does not operate. (Printing is not done for the four columns to be covered by a particular solenoid.)	1) Rupture of FPC.	A	● Check FPC for electrical continuity.	● Discontinuity being confirmed, replace FPC (5-2).
		2) Bad contact of FPC.	A	● Check corresponding FPC terminal and circuit board terminal for electrical continuity.	● Discontinuity being confirmed, resolder terminals.
		3) Bad contact of print solenoid wire.	A	● Check for electrical continuity the solder connecting the corresponding print solenoid terminal wire and FPC terminal.	● Discontinuity being confirmed, resolder.
		4) Rupture of print solenoid.	B	● Check resistance of corresponding solenoid, (For the value of resistance, refer to Par. 1.2-11, Chap. 1.)	● The measured value being lower than specified, replace print head assy (5-1)
		5) Faulty operation of print head.	B	● Check corresponding push rod for smooth operation.	● Faulty operation being confirmed, replace print head assy (5-1).
		6) Faulty operation of printing lever.	B	● Faulty operation of printing lever.	● Check corresponding printing lever for smooth operation. ● Faulty operation being confirmed, replace print head carriage assy (5-3).
3. Inconstant omission of dots at particular print position.	Inconstant omission of dots occurs at dot position to be covered by a particular print solenoid.	1) Bad contact of FPC.	A	● Same as with POSSIBLE CAUSE 2), NATURE OF TROUBLE 2.	● Discontinuity being confirmed, resolder.
		2) Bad contact of print head solenoid wire.	A	● Same as with POSSIBLE CAUSE 3), NATURE OF TROUBLE 2.	● Discontinuity being confirmed, resolder.
		3) Faulty operation of print head.	B	● Same as with POSSIBLE CAUSE 5), NATURE OF TROUBLE 2.	● Faulty operation being confirmed, replace print head assy (5-1).
		4) Faulty operation of printing lever.	B	● Same as with POSSIBLE CAUSE 6), NATURE OF TROUBLE 2.	● Faulty operation being confirmed, replace print head carriage assy (5-3).
Inconstant omission of dots occurs at unparticular dot positions.	Inconstant omission of dots occurs at unparticular dot positions.	Bad contact of FPC.	A	● Check electrical continuity between FPC common wire terminal and circuit board terminal.	● Discontinuity being confirmed, resolder.

NATURE OF TROUBLE	CONDITION OF TROUBLE	POSSIBLE CAUSE	REPAIR CLASSIFICATION	CHECK POINT	REMEDY
4. Character width changes.	Character width changes at a particular column.	1) Wear or damage of gears. 2) Wear of lead cam groove.	B B	<ul style="list-style-type: none"> ● Check motor gear, reduction gear and lead cam internal gear for wear or damage. ● Check lead cam groove for wear. 	<ul style="list-style-type: none"> ● Replace worn or damaged part, if any: motor ass'y (2-1), reduction unit (3-7), lead cam ass'y (3-1). ● Cam groove being found worn, replace lead cam ass'y (3-1).
5. Motor does not rotate.	Motor does not rotate in spite of application of Print Command.	1) Improper power supply to motor.	B	<ul style="list-style-type: none"> ● Check motor terminal voltage using tester or oscilloscope. <p>Rated voltage: $4.5^{+0.5}_{-0.7}$ V DC</p>  <p>Red (+) Black (-)</p>	<ul style="list-style-type: none"> ● Check power supply circuit and repair it, if necessary.
6. Motor won't stop.		2) Bad contact of motor lead wire. 3) Defective motor.	A B	<ul style="list-style-type: none"> ● Check electrical continuity between motor lead wire and circuit board terminal of motor terminal. ● Apply 3.8V across motor and check if it rotates. 	<ul style="list-style-type: none"> ● Discontinuity being confirmed, resolder the parts concerned. ● If motor does not rotate, replace motor ass'y (2-1).
7. Paper feeding cannot be performed.	Paper cannot be fed and consequently printing is repeated at the same spot on the paper.	Faulty resetting detector. 1) Faulty feeding of paper.	B A	<ul style="list-style-type: none"> ● Rotate lead cam and check if signal appears at resetting detector output terminal by means of oscilloscope. ● Check paper for width, thickness and roll diameter. ● For specifications of paper, refer to Par. 1.2-5, Chap. 1. ● Check paper feeding course for clogging. 	<ul style="list-style-type: none"> ● If reset signal does not appear, replace circuit board ass'y (4-2) including reed switch. ● Paper not being as specified, replace.

NATURE OF TROUBLE	CONDITION OF TROUBLE	POSSIBLE CAUSE	REPAIR CLASSIFICATION	CHECK POINT	REMEDY
		2) Wear of internal cam of ribbon feeding cam.	B	● Check for wear the internal cam of ribbon feeding cam. 	● Internal cam being worn, replace ribbon feeding cam (3-4).
		3) Paper feeding lever being broken or worn.	C	● Check paper feeding lever for break or wear.	● Break or wear being found, replace frame assy (1-1).
		4) Damage or wear of paper feeding assy.	B	● Check gears and other elements of paper feeding assy for damage or wear.	● Damage or wear being found, replace paper feeding assy (6-1).
		5) Rupture or damage of one-way spring.	B	● Check one-way spring for rupture or damage.	● Rupture or damage being confirmed, replace one-way spring (6-2).
		6) Damage of paper holding roller.	B	● Check paper holding roller for damage.	● Damage being found, replace paper holding roller (6-3).
		7) Permanent deformation of paper holding spring.	C	● Check paper holding spring for permanent deformation.	● Permanent deformation being confirmed, replace frame assy (1-1).



NATURE OF TROUBLE	CONDITION OF TROUBLE	POSSIBLE CAUSE	REPAIR CLASSIFICATION	CHECK POINT	REMEDY
8. Irregular pitch of paper feeding.	Characters are not printed at regular line spacing or lines overlapping.	1) Faulty feeding of paper	A	● Same as with POSSIBLE CAUSE 1, NATURE OF TROUBLE 7.	● If paper not being as specified, replace.
		2) Wear of internal cam of ribbon feeding cam.	A	● Same as with POSSIBLE CAUSE 2, NATURE OF TROUBLE 7.	
		3) Wear or damage of paper feeding lever.	C	● Same as with POSSIBLE CAUSE 3, NATURE OF TROUBLE 7.	
		4) Wear of damage of paper feeding assy.	B	● Same as with POSSIBLE CAUSE 4, NATURE OF TROUBLE 7.	
		5) Fatigue of one-way spring	B	● Check one-way spring for fatigue.	● The spring being found fatigued, replace it (6-1).
		6) Faulty operation (unsmooth rotation) of paper holding roller.	B	● Check paper holding roller for wear, damage or quantity of lubricant.	● Wear or damage being found, replace paper holding roller (6-3). Quantity of lubricant being insufficient, supply specified lubricant (refer to Par.2.2.2 "Lubrication Requirements").
		7) Permanent deformation or fatigue of paper holding spring.	C	● Same as with POSSIBLE CAUSE 7, NATURE OF TROUBLE 7.	
9. Inking mechanism does not operate at all.	Printing mechanism operates normally, but inking mechanism does not operate at all.	1) Damage of spool gear assy.	A	● Check spool gear assy for damage.	● Spool gear assy being found damaged, replace it (7-1).
		2) Damage of ribbon feeding cam.	A	● Check external toothed part of ribbon feeding cam for damage.	● Damage being found, replace ribbon feeding cam (3-4).
		3) Damage of ribbon feeding gear.	A	● Check ribbon feeding gear for damage.	● Replace ribbon feeding gear (3-6), if damaged.
		4) Defective ribbon cassette.	A	● Check ribbon cassette for smooth rotation.	● Replace ribbon cassette (7-2), if it does not rotate.

2.4 TOOLS AND LUBRICANTS

2.4.1 List of Tools

The list below covers the tools which are indispensable for the maintenance or repair of the Model-160 Printer.

No.	Designation	Specification	Remarks*
T-2	Soldering iron	15 cm long 15 mm wide ETH 1.2 ETH 1.5 ETH 2	○
T-5	Diagonal cutting nipper		○
T-10	Tweezers		○
T-14	Brush for lubrication # 1		○
T-15	Brush for lubrication # 2		○
T-16	Brush for lubrication		○
T-68	Retaining plier # 1.2		○
T-69	Retaining plier # 1.5		○
T-34	Retaining plier # 2		○
T-62	Precision screw driver # 3		○
T-70	Precision screw driver # 4	○	
T-40	Plier No. 0	○	

○: Commercially available products.

ⓔ: EPSON's special products

2.4.2 Lubricant and Adhesive

Classification	Designation	Capacity of container	Remarks*
Grease	G-2	40g	ⓔ
Adhesive	Neji Lock (Threebond # 1406)	1,000g	○

○: Commercially available products.

ⓔ: EPSON's special products.

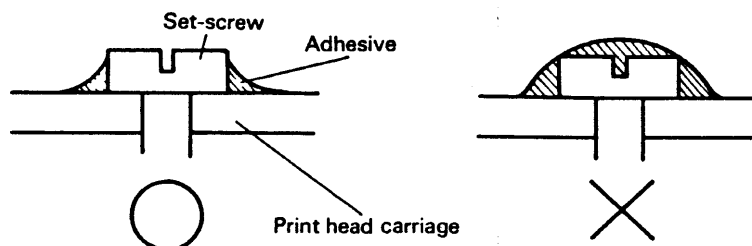
(1) Adhesive Application Point

No.	Application point	Application quantity
A-1	Around set-screw for print head carriage	See the illustration below.

NOTE:

No. is the same as used in Fig. 2.5.

● Application quantity.



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CHAPTER 3

DISASSEMBLY AND ASSEMBLY

CONTENTS

3.1	DISASSEMBLY	3- 1
3.2	ASSEMBLY	3- 1
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	ASSEMBLY STAGE D	3- 9
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3.1 DISASSEMBLY

The disassembly work can easily be carried out by reversely following the assembly procedure illustrated by the assembly flow diagram in Par. 3 "ASSEMBLY": begin the disassembly work by removing the ribbon cassette, which is to be placed in position at the last step of assembly (STEP 20), and end the work by dismounting the manual paper feeding knob, which is to be put into position at ASSEMBLY STEP 2. Never disassemble the printer into more elementary units than stated in Fig. 3.1 "Exploded View of Model-160 Printer", or reassembly and adjustment become very difficult and the reassembled printer may not function very well.

3.2 ASSEMBLY

- The assembly work is divided into four stages (A, B, C and D). In proceeding the work, pay attention to the POINTS OF ASSEMBLY WORK.
- Orderly following of ASSEMBLY STEPS 1 to 20 ensures efficient and smooth work of assembly.
- The REF. NOS. correspond to the NOS. used in Fig. 3.1 "Exploded View of Model-160 Printer". Verify the shape and position of parts or assemblies by these NOS., which are the same as used in Chap. 2 "MAINTENANCE, LUBRICATION AND REPAIR".
- For lubrication, refer to Par. 2.2.2 "Lubrication Requirements."

NOTE:

Symbols of "REF. NO." show the small parts as follows.

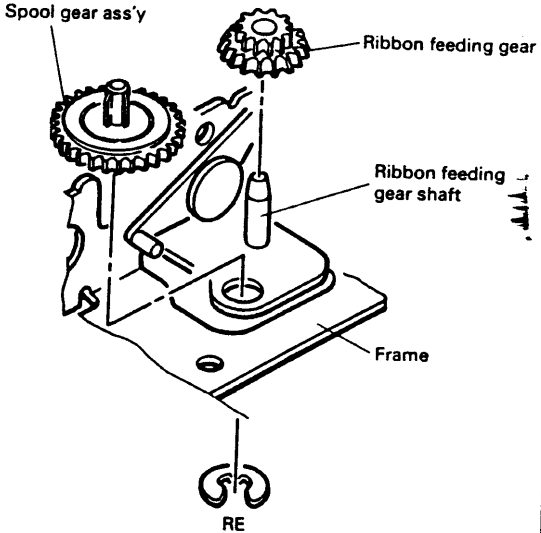
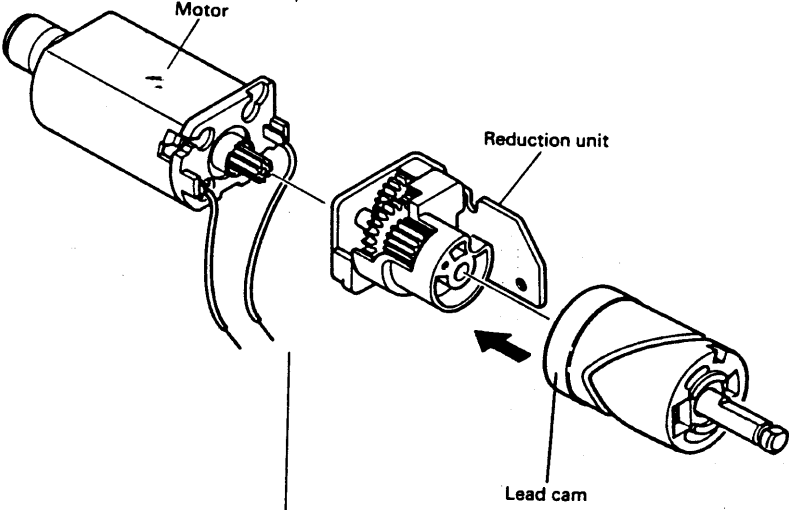
SF: Slotted head machine screw-Flat head.

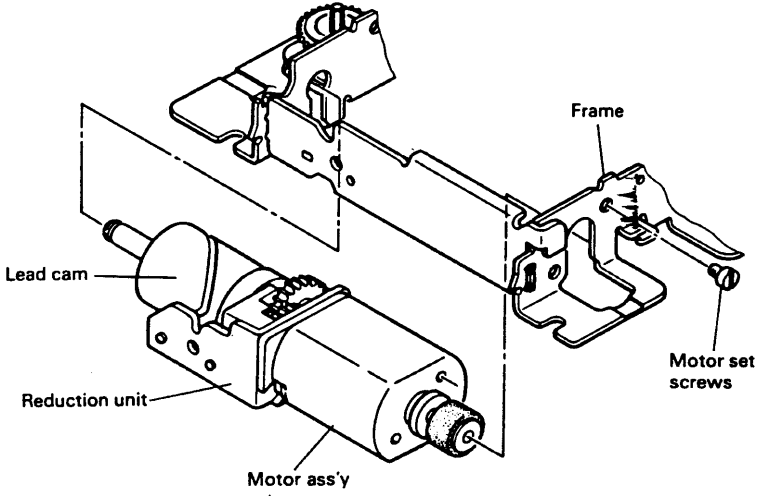
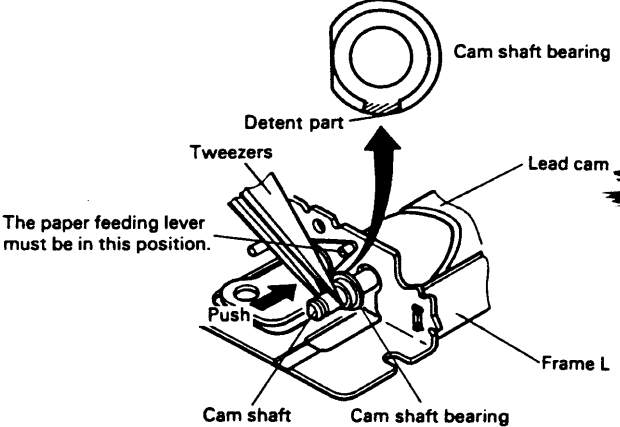
RE: Retaining ring TYPE-E.

PW: Plain washer.

ASSEMBLY STAGE A

(Ribbon Feeding Gear, Motor, Lead Cam Ass'y, etc.)

ASSEMBLY STEP	REF. NO.	NAME OF PART or ASSEMBLY	POINTS OF ASSEMBLY WORK
<p>1 2 3</p>	<p>1-1 3-6 7-1 RE</p>	<p>Frame ass'y Ribbon feeding gear Spool gear ass'y Retaining ring TYPE-E</p>	<p>● Lubrication (L-1).</p> 
<p>4</p>	<p>3-7</p>	<p>Reduction unit</p>	<p>● Lubrication (L-22, L-23)</p>
<p>5</p>	<p>3-1</p>	<p>Lead cam ass'y</p>	<p>● Lubrication (L-4, L-5) ● Set to reduction unit (3-7)</p> 

ASSEMBLY STEP	REF. NO.	NAME OF PART or ASSEMBLY	POINTS OF ASSEMBLY WORK
6	2-1 SF	Motor ass'y Slotted flat head machine screw (1 psc.) (M1.6 × 2)	<ul style="list-style-type: none"> ● Assembly motor unit, reduction unit and lead cam assy, then set the assembly in the frame and secure the motor to the frame by means of screws. ● Lubrication (L-24) 
7	3-2	Cam shaft bearing	<ul style="list-style-type: none"> ● Lubrication (L-6). ● Push the bearing paying attention to the position of its detent part with respect to the corresponding notch in the frame. 

ASSEMBLY STAGE B

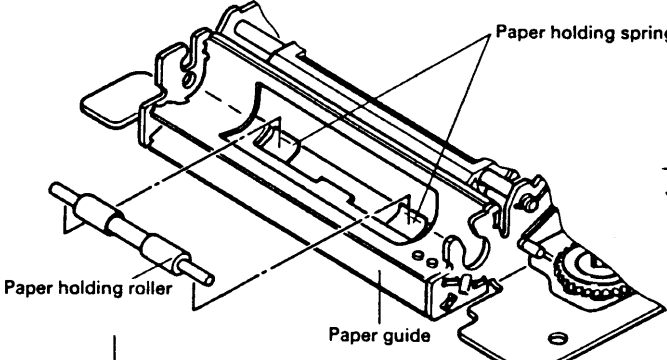
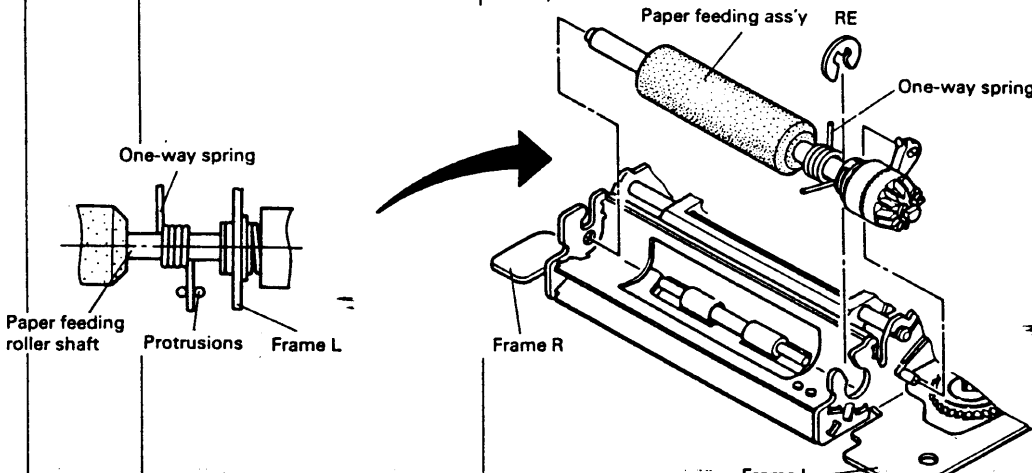
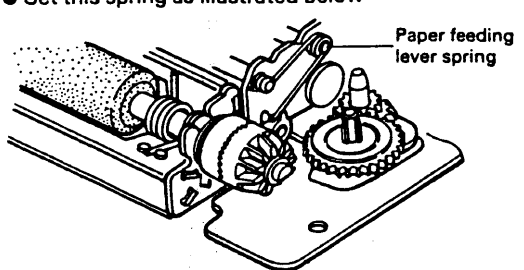
(Print Head, Print Head Carriage, etc.)

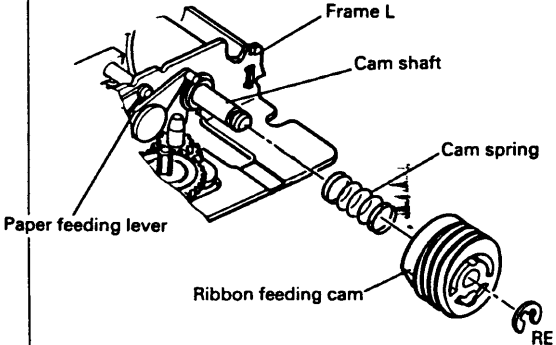
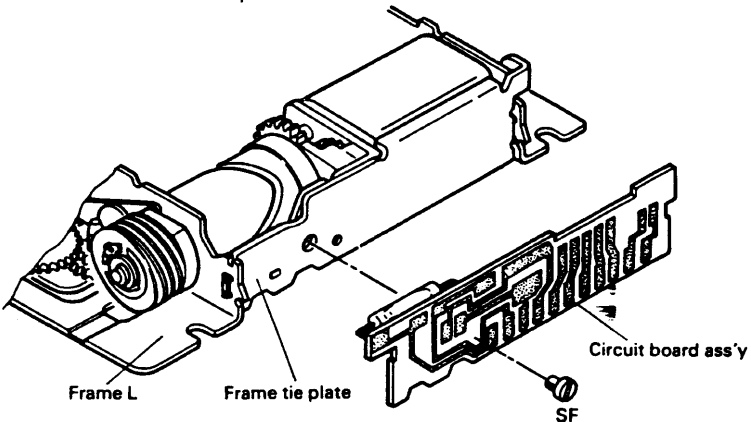
ASSEMBLY STEP	REF. NO.	NAME OF PART or ASSEMBLY	POINTS OF ASSEMBLY WORK
8	5-1 5-3 SF	Print head ass'y Print head carriage ass'y Slotted flat head machine screw (2 pcs.) (M1.6 × 3)	<ul style="list-style-type: none"> ● Lubrication (L-7, L-8). ● Lubrication (L-9, L10). ● Align the carriage guide pins with the guide holes in the print head, and temporarily assemble the carriage and the print head by means of screw (at this step, do not fully tighten the screws).
9	Adjustment of print head position		<ol style="list-style-type: none"> ① Adjust the position of the print head so that the impact face of printing lever becomes flush with the reference face of print head carriage, as illustrated below. ② Now tighten the screws fully.
10	5-4 5-5 RE	Print head guide shafts (2 pcs.) Return support spring Retaining ring TYPE-E (2 pcs)	<ul style="list-style-type: none"> ● Lubrication (L-11, L-12) ● Engage the print head drive pin in the lead cam groove, then put into position the print head guide shafts from frame L side.

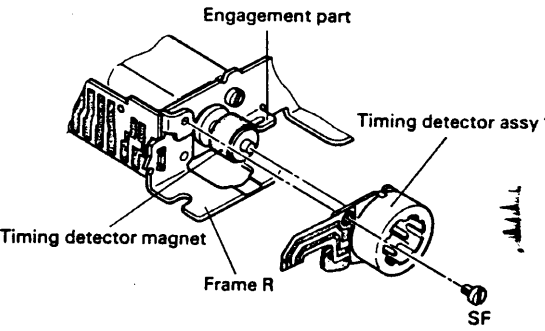
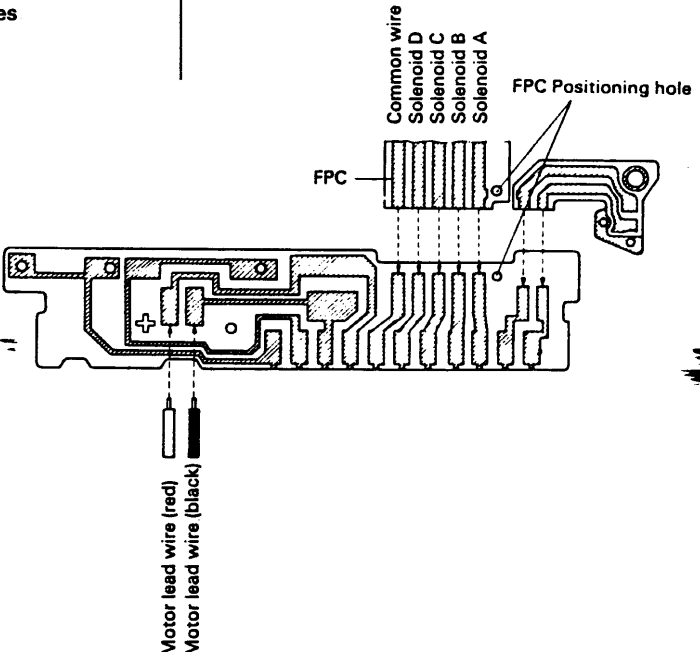
ASSEMBLY STEP	REF. NO.	NAME OF PART or ASSEMBLY	POINTS OF ASSEMBLY WORK
11	5-2 SF	FPC Slotted flat head machine screw (2 psc.) (M1 × 2)	<div data-bbox="746 338 1412 913" data-label="Image"> </div> <p data-bbox="927 1032 1171 1055">● Solder FPC as follows:</p> <ol data-bbox="951 1061 1469 1263" style="list-style-type: none"> ① Secure FPC to the back of the print head by means of screws. ② Cut the two wires of print solenoid A to the same length, and so with solenoids B, C and D. (Solenoid A is the solenoid to be located nearest to frame L.) ③ Solder the wires of solenoids A, B, C and D in this order. <p data-bbox="951 1270 1102 1292">PRECAUTIONS:</p> <ul data-bbox="951 1299 1437 1346" style="list-style-type: none"> · Do not apply the iron to FPC for too long a time. · Be careful that solenoid wires be not broken. <div data-bbox="660 1391 1422 1585" data-label="Image"> </div>

ASSEMBLY STAGE C

(Paper Feeding Mechanism, Timing Detector Assy, Circuit Board, etc.)

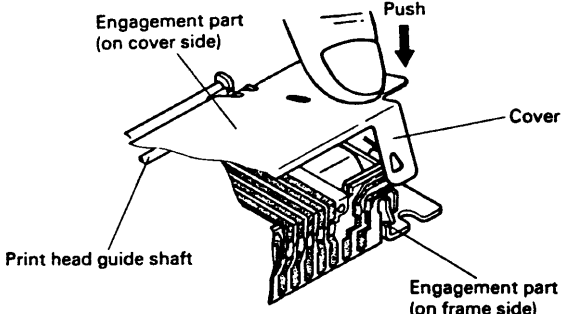
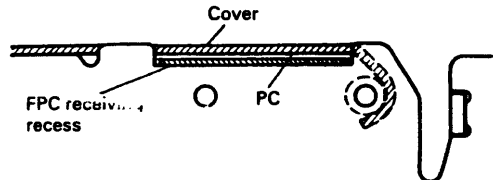
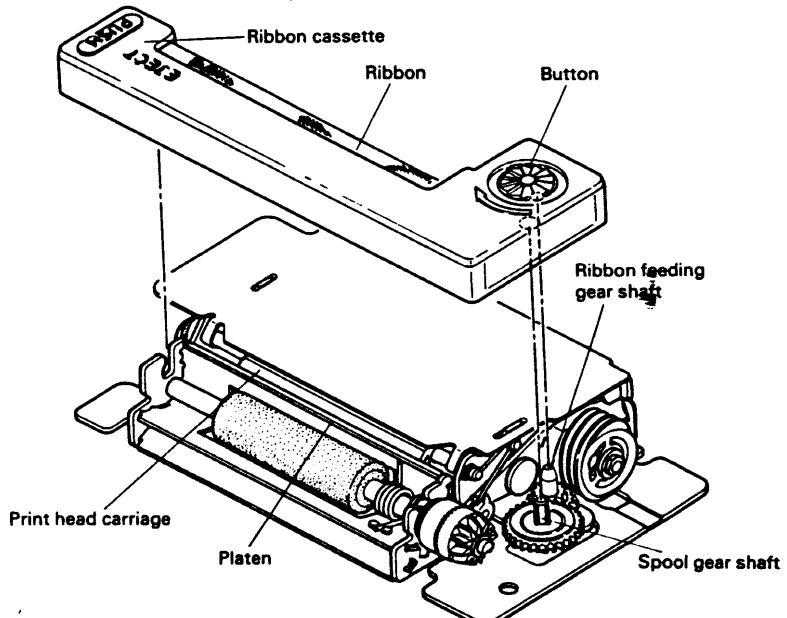
ASSEMBLY STEP	REF. NO.	NAME OF PART or ASSEMBLY	POINTS OF ASSEMBLY WORK
12	6-3	Paper holding roller	<ul style="list-style-type: none"> ● Lubrication (L-13). ● Set the roller on the paper holding spring. 
13	6-1 RE 6-2	Paper feeding assy Retaining ring TYPE-E (2) One-way spring	<ul style="list-style-type: none"> ● Lubrication (L-14 to L-18). ● Place the one-way spring on the paper feeding assembly, then set the assembly in the frame, as illustrated below. ● Put the detent part of the plane bearing in the corresponding notch in the frame. ● Be careful not to damage gear teeth, which are very fine. 
14	6-4	Paper feeding lever spring.	<ul style="list-style-type: none"> ● Set this spring as illustrated below 

ASSEMBLY STEP	REF. NO.	NAME OF PART or ASSEMBLY	POINTS OF ASSEMBLY WORK
15	3-4 3-5 RE	Ribbon feeding cam Cam spring Retaining ring TYPE-E (1.5)	<ul style="list-style-type: none"> ● Lubrication (L-19 to L-21). ● Place the ribbon feeding cam in position as follows: <ol style="list-style-type: none"> ① Turn the timing detector magnet until the D-groove of the cam shaft faces toward the frame bottom. ② Place on the cam shaft the plain washer, cam spring and ribbon feeding cam, in this order. ③ Place the retaining ring TYPE-E in position. 
16	4-2 SF	Circuit board ass'y Slotted flat head machine screw (1 pcs.) (M1.6 × 3)	<ul style="list-style-type: none"> ● Press the circuit board against the frame tie plate, then against frame L. After that, push it down and finally secure to the tie plate by means of screws. 

ASSEMBLY STEP	REF. NO.	NAME OF PART or ASSEMBLY	POINTS OF ASSEMBLY WORK
17	4-1 SF	Timing detector ass'y Slotted flat head machine screw (M1.4 × 1.8)	<ul style="list-style-type: none"> ● Place the timing detector ass'y on the timing detector magnet, and secure with screw. ● Clearance between the timing detector ass'y and the timing detector magnet must be uniform. 
18		FPC Timing detector ass'y Motor lead wires	<ul style="list-style-type: none"> ● Connect by soldering.  <ul style="list-style-type: none"> ● Align the positioning hole in the FPC with that in the circuit board, then solder these elements. ● Do not apply the iron to the FPC for too long a time.

ASSEMBLY STAGE D

(Cover and Ribbon Cassette)

ASSEMBLY STEP	REF. NO.	NAME OF PART or ASSEMBLY	POINTS OF ASSEMBLY WORK
19	8-1	Cover	 <ul style="list-style-type: none"> ● Engage the engagement part of the cover on the print head guide shaft, and push the cover to lock it on the frame. (Carry out this operation on both ends of the cover.) ● Check if the FPC is in the FPC receiving recess on frame R side. 
20	7-2	Ribbon cassette	<ul style="list-style-type: none"> ● Set the ribbon cassette in position as illustrated below. 

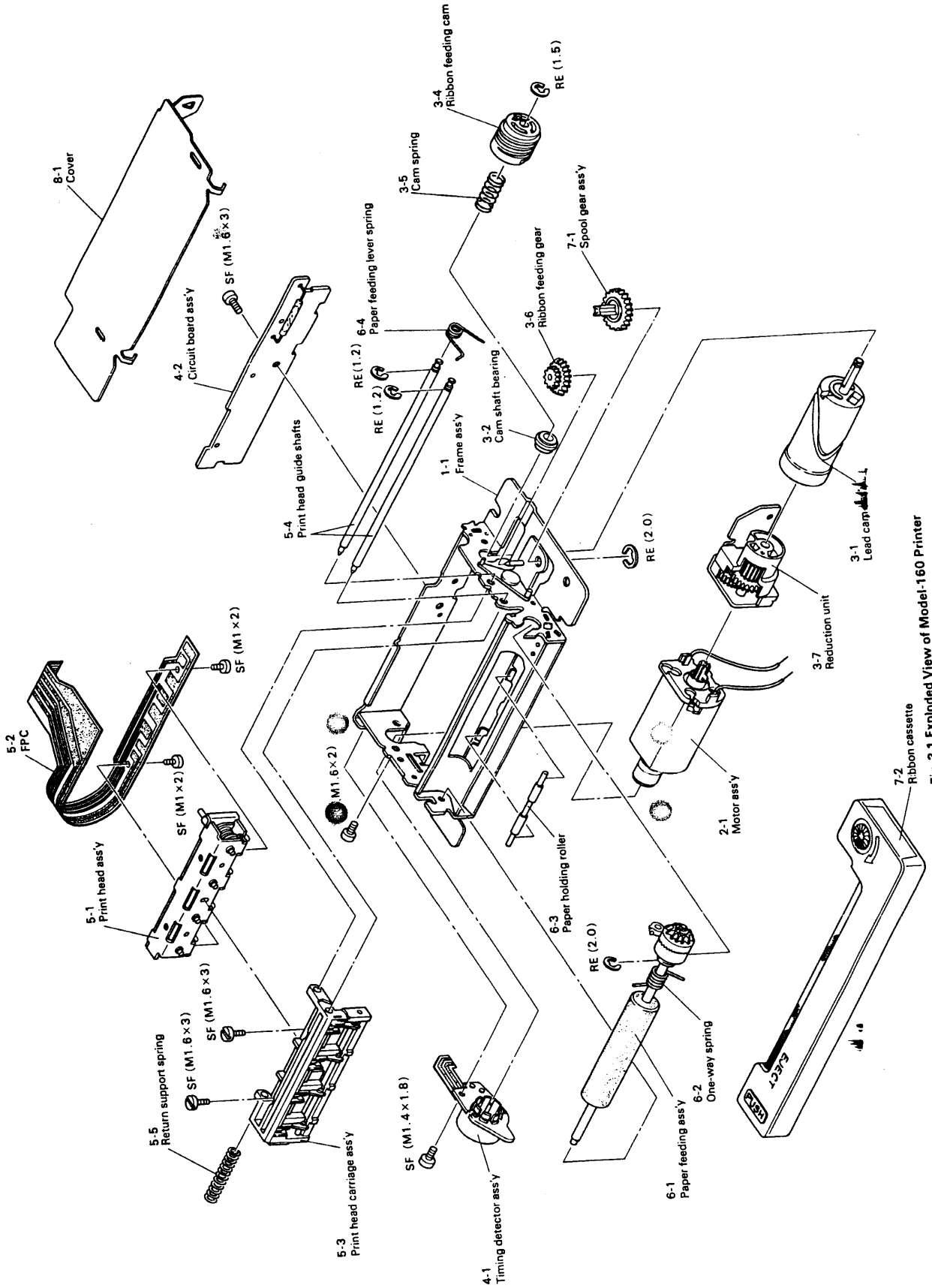


Fig. 3.1 Exploded View of Model-160 Printer

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