D.D. MOTOR

# PXM-049

Additional

# *Service Manual*

PIONEER®

# CONTENTS

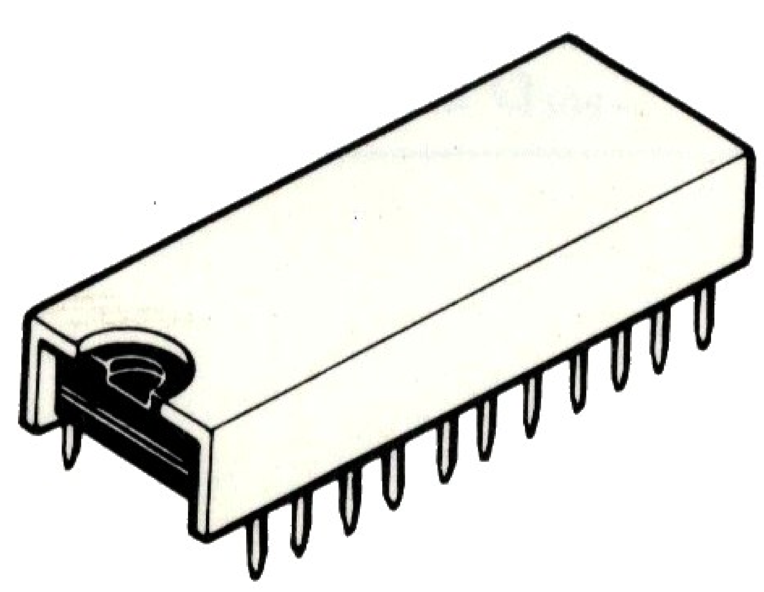


**CAUTION**

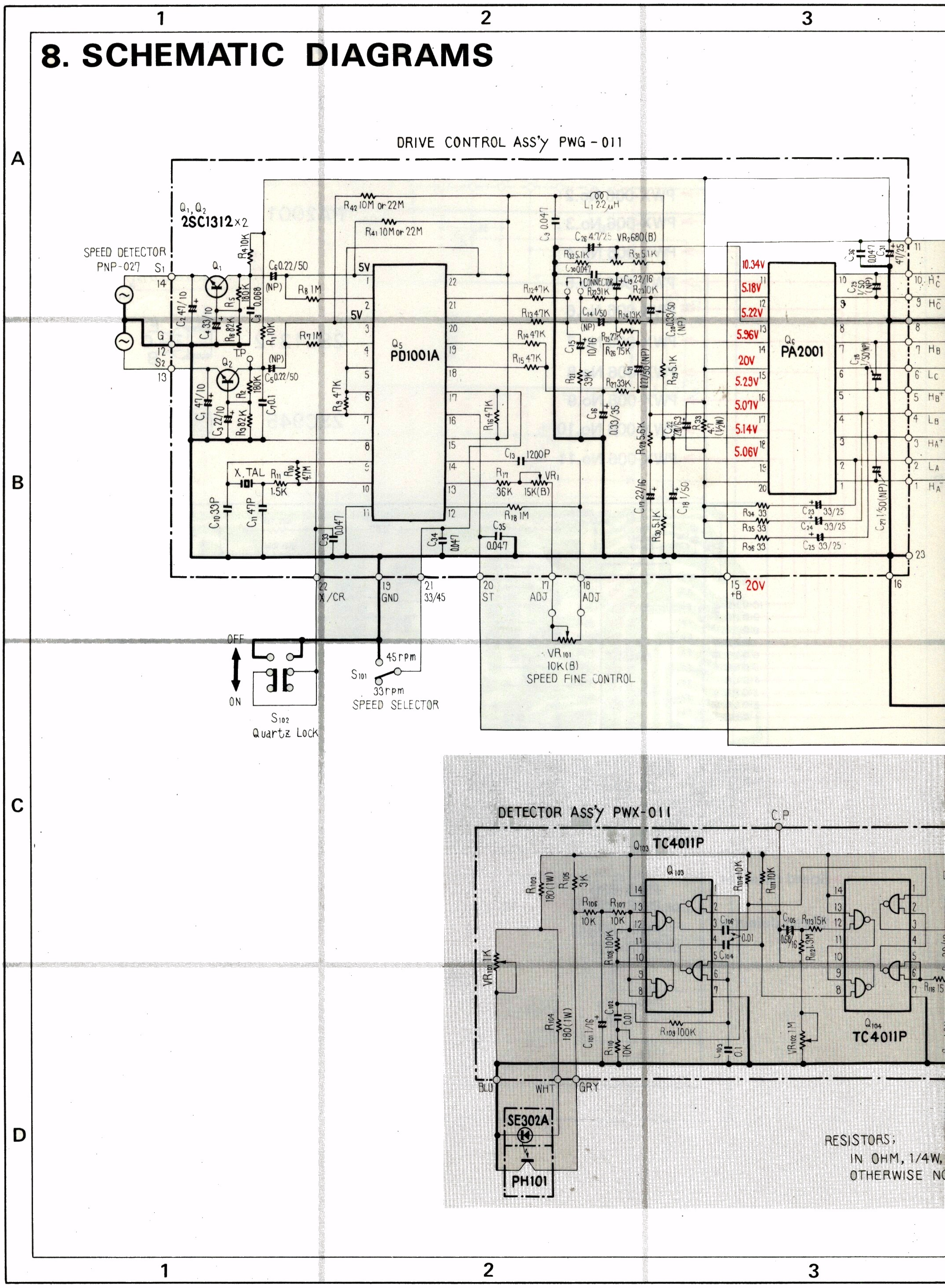
**When Handling IC PD1001A, Please Observe:**

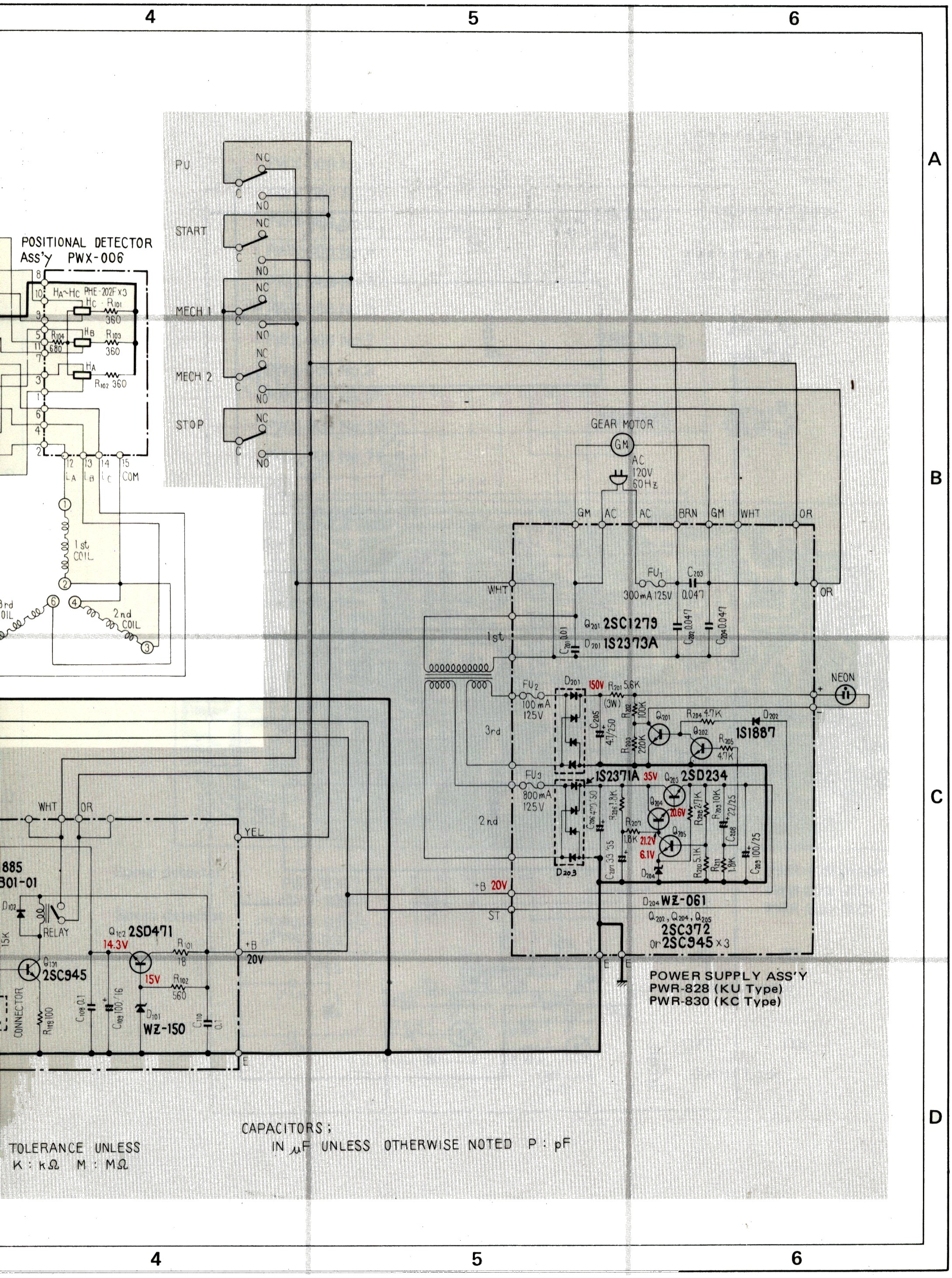
IC PD1001A(Q5 in the Drive Control Ass'y PWG-011) is a C-MOS IC of extremely low power consumption and very high input impedance. Unless handled with special care, it could be damaged by static electricity induction. This IC is supplied with a shorting cap (of aluminum foil) attached. When soldering or performing other repair work, always attach this cap as shown below. Remove the cap after the repair has been completed.

Also, this type of IC must not be inserted in a polystyrene package for storage.



# 8. SCHEMATIC DIAGRAMS






TOLERANCE UNLESS
K : kΩ M : MΩ

CAPACITORS ;
IN μF UNLESS OTHERWISE NOTED P : pF

1 2 3

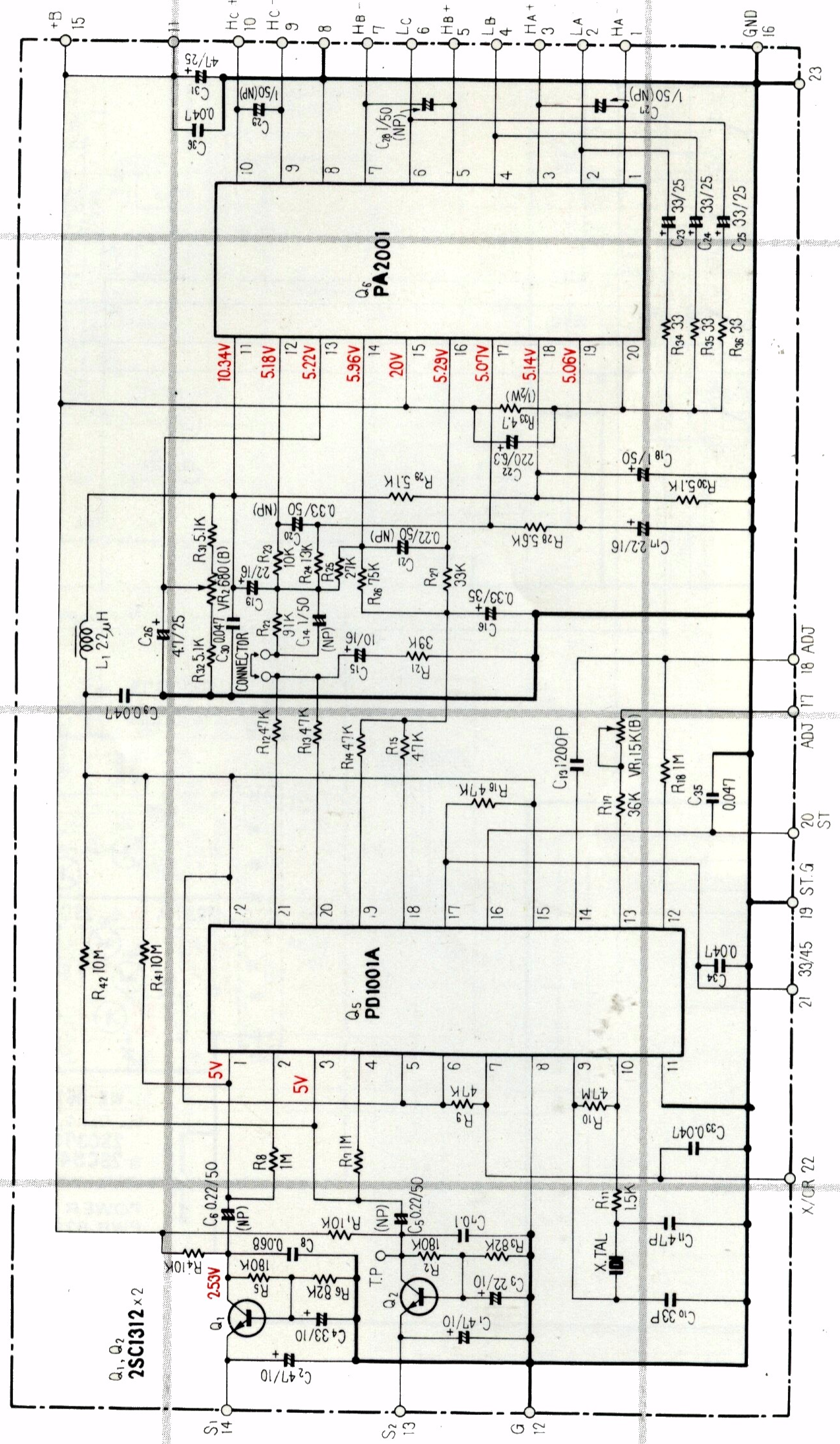
## 8.1 DRIVE CONTROL ASSEMBLY (PWG-011)

A A

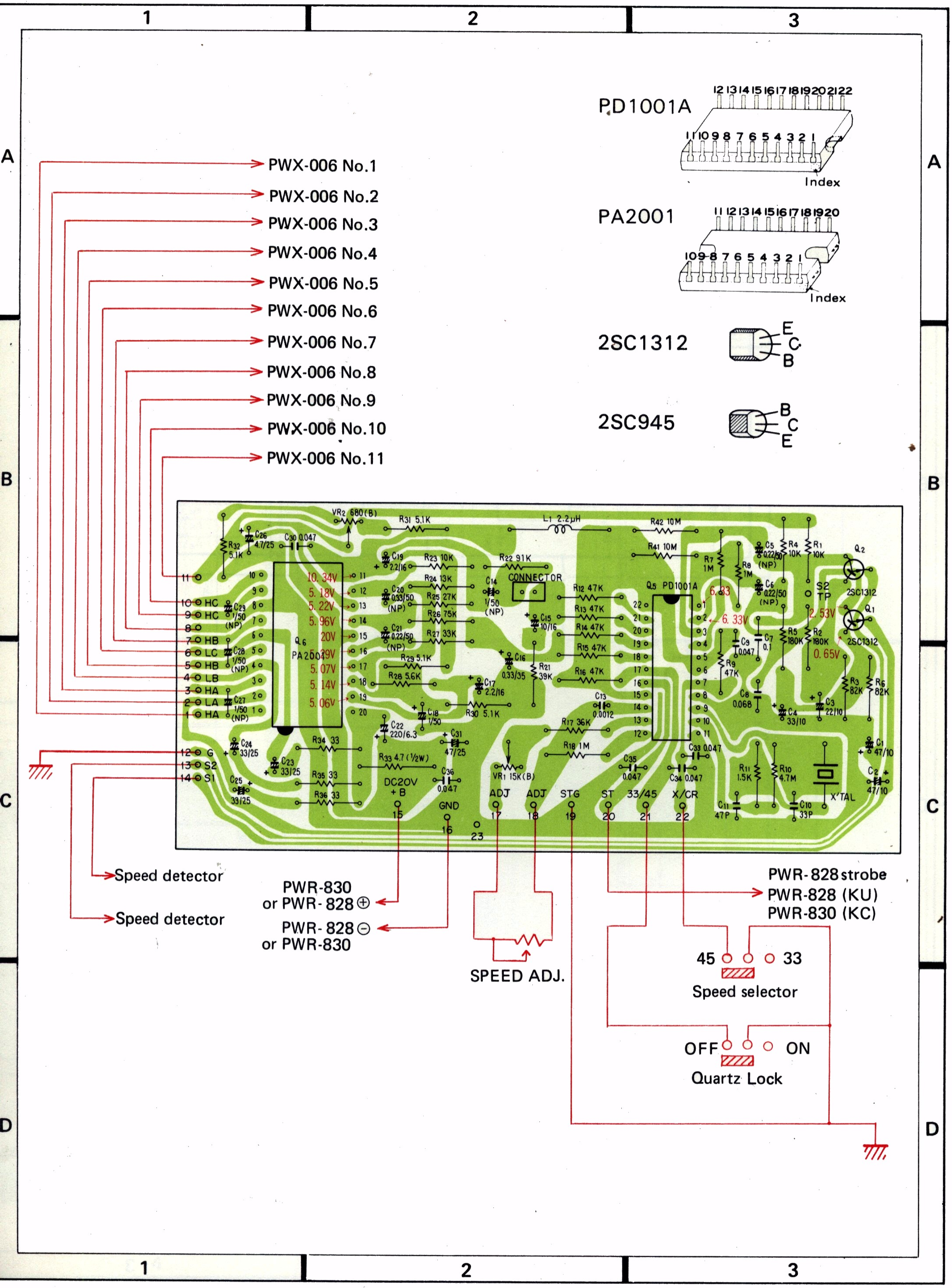
B B

C C

D D




1 2 3



PD1001A
Index
PA2001
Index
2SC1312
E
C
B
2SC945
B
C
E
PWX-006 No.1
PWX-006 No.2
PWX-006 No.3
PWX-006 No.4
PWX-006 No.5
PWX-006 No.6
PWX-006 No.7
PWX-006 No.8
PWX-006 No.9
PWX-006 No.10
PWX-006 No.11
HC
HC
HB
LC
HB
LB
HA
LA
HA
G
S2
S1
PA2001
PD1001A
CONNECTOR
L1 2.2μH
X'TAL
10. 34V
5. 18V
5. 22V
5. 96V
20V
29V
5. 07V
5. 14V
5. 06V
6. 33
6. 33V
2. 53V
0. 65V
DC20V +B
GND
ADJ
ADJ
STG
ST
33/45
X/CR
Speed detector
Speed detector
PWR-830
or PWR-828 ⊕
PWR-828 ⊖
or PWR-830
SPEED ADJ.
PWR-828 strobe
PWR-828 (KU)
PWR-830 (KC)
45
33
Speed selector
OFF
ON
Quartz Lock

## Parts List of Drive Control Assembly (PWG-011)

### SEMICONDUCTORS

| Symbol | Description | Part No. |
|---|---|---|
| Q1 | Transistor | 2SC1312 H or G |
| Q2 | Transistor | 2SC1312 H or G |
| Q5 | IC | PD1001 A |
| Q6 | IC | PA2001 |

### RESISTORS, AND COIL

| Symbol | Description | | | Part No. |
|---|---|---|---|---|
| VR1 | Semi-fixed | 15k-B | | PCP-006 |
| VR2 | Semi-fixed | 680-B | | PCP-007 |
| R1 | Carbon film | 10k | | RD¼PS 103J |
| R2 | Carbon film | 180k | | RD¼PS 184J |
| R3 | Carbon film | 82k | | RD¼PS 823J |
| R4 | Carbon film | 10k | | RD¼PS 103J |
| R5 | Carbon film | 180k | | RD¼PS 184J |
| R6 | Carbon film | 82k | | RD¼PS 823J |
| R7 | Carbon film | 1M | | RD¼PS 105J |
| R8 | Carbon film | 1M | | RD¼PS 105J |
| R9 | Carbon film | 47k | | RD¼PS 473J |
| R10 | Carbon film | 4.7M | | RD¼PS 475J |
| R11 | Carbon film | 1.5k | | RD¼PS 152J |
| R12 | Carbon film | 47k | | RD¼PS 473J |
| R13 | Carbon film | 47k | | RD¼PS 473J |
| R14 | Carbon film | 47k | | RD¼PS 473J |
| R15 | Carbon film | 47k | | RD¼PS 473J |
| R16 | Carbon film | 47k | | RD¼PS 473J |
| R17 | Carbon film | 36k | | RD¼PS 363J |
| R18 | Carbon film | 1M | | RD¼PS 105J |
| R21 | Carbon film | 39k | | RD¼PS 393J |
| R22 | Carbon film | 91k | | RD¼PS 913J |
| R23 | Carbon film | 10k | | RD¼PS 103J |
| R24 | Carbon film | 13k | | RD¼PS 133J |
| R25 | Carbon film | 27k | | RD¼PS 273J |
| R26 | Carbon film | 75k | | RD¼PS 753J |
| R27 | Carbon film | 33k | | RD¼PS 333J |
| R28 | Carbon film | 5.6k | | RD¼PS 562J |
| R29 | Carbon film | 5.1k | | RD¼PS 512J |
| R30 | Carbon film | 5.1k | | RD¼PS 512J |
| R31 | Carbon film | 5.1k | | RD¼PS 512J |
| R32 | Carbon film | 5.1k | | RD¼PS 512J |
| R33 | Carbon film | 4.7 | ½W | RD½PS 4R7J |
| R34 | Carbon film | 33 | | RD¼PS 330J |
| R35 | Carbon film | 33 | | RD¼PS 330J |
| R36 | Carbon film | 33 | | RD¼PS 330J |
| R41 | Carbon film | 10M | | RD¼PS 106J |
| R42 | Carbon film | 10M | | RD¼PS 106J |
| L1 | RF cork coil | | | PTL-002 |

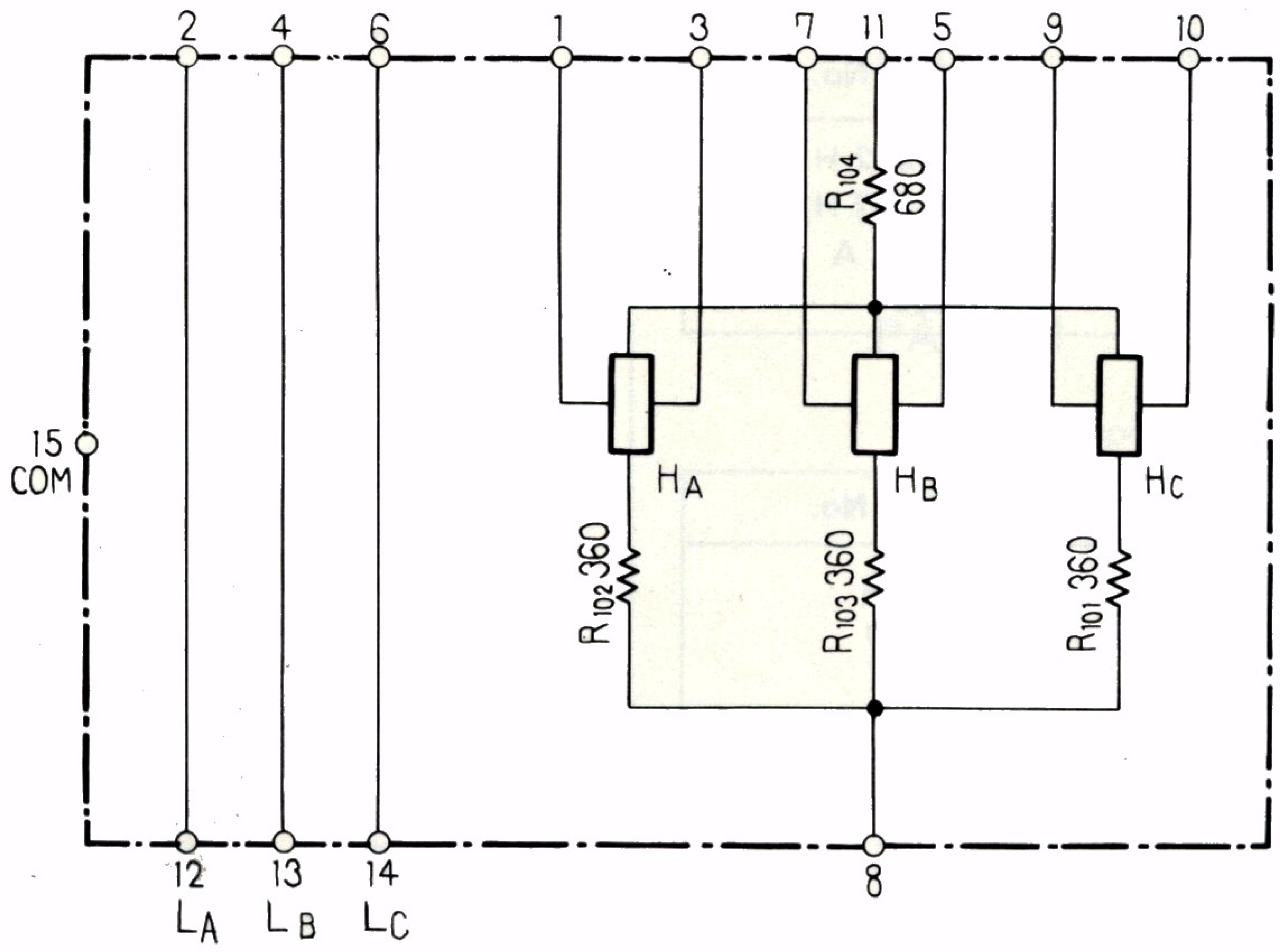
### CAPACITORS

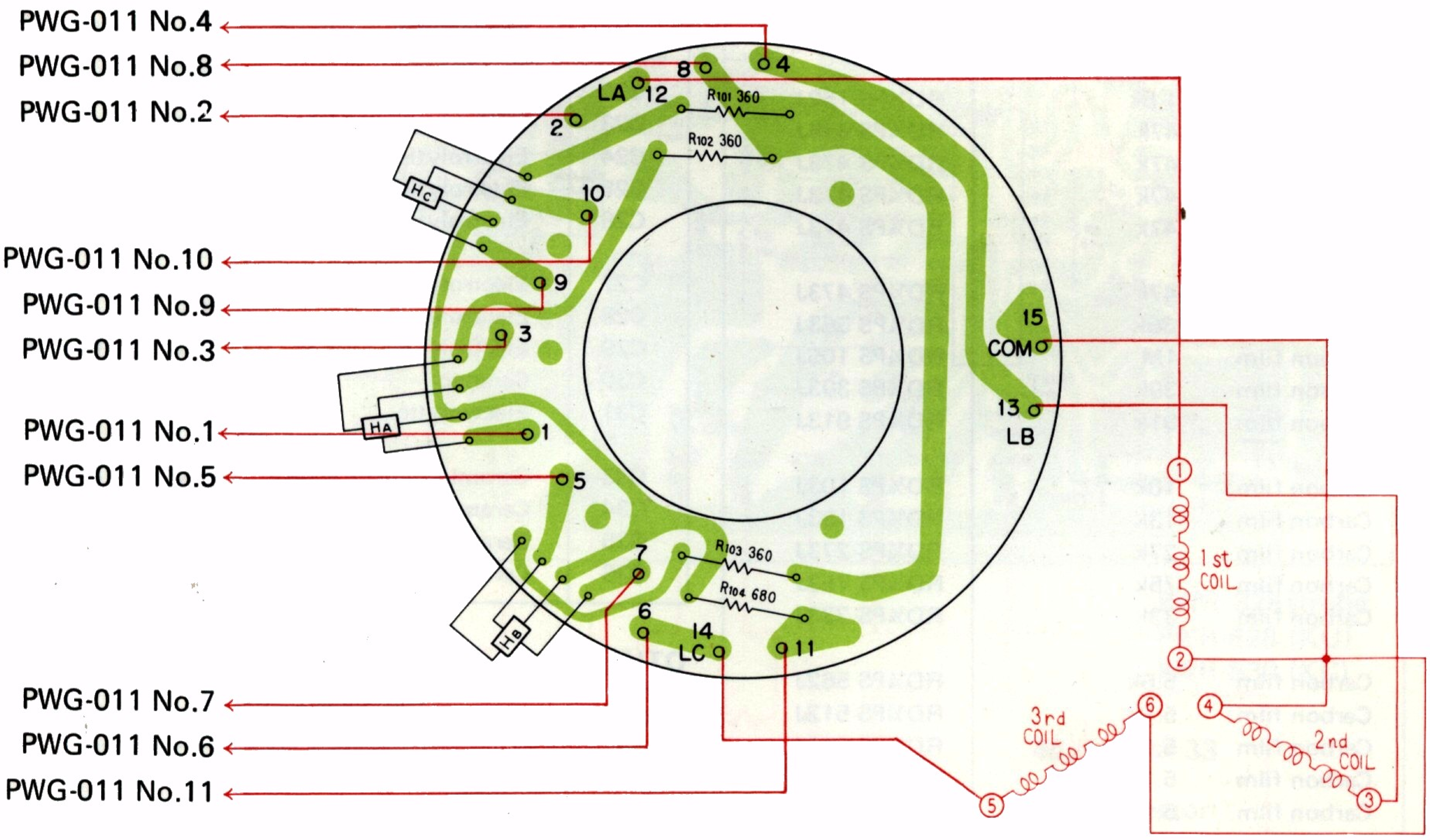
| Symbol | Description | | | Part No. |
|---|---|---|---|---|
| C1 | Electrolytic | 47 | 10V | CEA 470P 10 |
| C2 | Electrolytic | 47 | 10V | CEA 470P 10 |
| C3 | Electrolytic | 22 | 10V | CEA 220P 10 |
| C4 | Electrolytic | 33 | 10V | CEA 330P 10 |
| C5 | Electrolytic | 0.22 | 10V | CEA R22M 50NP |
| C6 | Electrolytic | 0.22 | 10V | CEA R22M 50NP |
| C7 | Mylar | 0.1 | 50V | CQMA 104K 50 |
| C8 | Mylar | 0.068 | 50V | CQMA 683K 50 |
| C9 | Ceramic | 0.047 | 50V | CKDYF 473Z 50 |
| C10 | Ceramic | 33p | 50V | CCDCH 330J 50 |
| C11 | Ceramic | 47p | 50V | CCDCH 470J 50 |
| C13 | Mylar | 0.0012 | 50V | CQMA 122J 50 |
| C14 | Electrolytic | 1 | 50V | CEA 010M 50NP |
| C15 | Electrolytic | 10 | 16V | CEA 100P 16 |
| C16 | Electrolytic | 0.33 | 35V | CSZA R33M 35 |
| C17 | Electrolytic | 2.2 | 16V | CSZA 2R2M 16 |
| C18 | Electrolytic | 1 | 50V | CEA 010P 50 |
| C19 | Electrolytic | 2.2 | 16V | CSZA 2R2M 16 |
| C20 | Electrolytic | 0.33 | 50V | CEA R33M 50NP |
| C21 | Electrolytic | 0.22 | 50V | CEA R22M 50NP |
| C22 | Electrolytic | 220 | 6V | CEA 221P 6 |
| C23 | Electrolytic | 33 | 25V | CEA 330P 25 |
| C24 | Electrolytic | 33 | 25V | CEA 330P 25 |
| C25 | Electrolytic | 33 | 25V | CEA 330P 25 |
| C26 | Electrolytic | 4.7 | 25V | CEA 4R7P 25 |
| C27 | Electrolytic | 1 | 50V | CEA 010M 50NP |
| C28 | Electrolytic | 1 | 50V | CEA 010M 50NP |
| C29 | Electrolytic | 1 | 50V | CEA 010M 50NP |
| C30 | Ceramic | 0.047 | 50V | CKDYF 473Z 50 |
| C31 | Electrolytic | 47 | 25V | CEA 470P 25 |
| C33 | Ceramic | 0.047 | 50V | CKDYF 473Z 50 |
| C34 | Ceramic | 0.047 | 50V | CKDYF 473Z 50 |
| C35 | Ceramic | 0.047 | 50V | CKDYF 473Z 50 |
| C36 | Ceramic | 0.047 | 50V | CKDYF 473Z 50 |

### OTHERS

| Symbol | Description | Part No. |
|---|---|---|
| | Crystal | PSS-001 |
| | Heat sink | PNS-002 |
| | Angle | PNB-195 |
| | Connector socket assembly (G) | PXA-169 |
| | Connector pin (A) | PKP-008 |
| | Connector pin (E) | PKP-011 |
| | Connector pin (F) | PKP-012 |

## 8.2 POSITIONAL DETECTOR ASSEMBLY (PWX-006)




### Parts List

#### RESISTORS

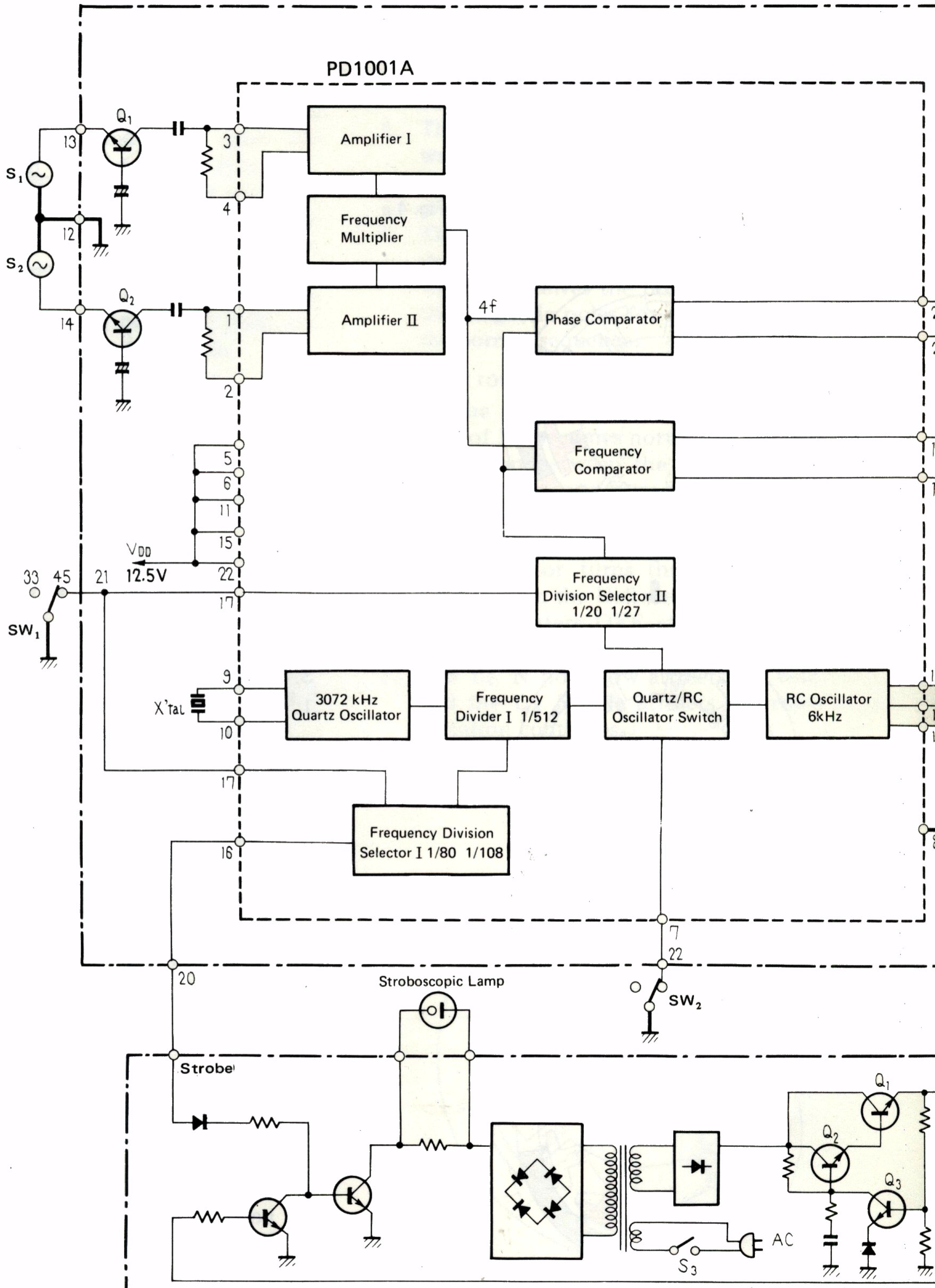
| Symbol | Description | | Part No. |
|---|---|---|---|
| R101 | Carbon film | 360 | RD¼PS 361J |
| R102 | Carbon film | 360 | RD¼PS 361J |
| R103 | Carbon film | 360 | RD¼PS 361J |
| R104 | Carbon film | 680 | RD¼PS 681J |

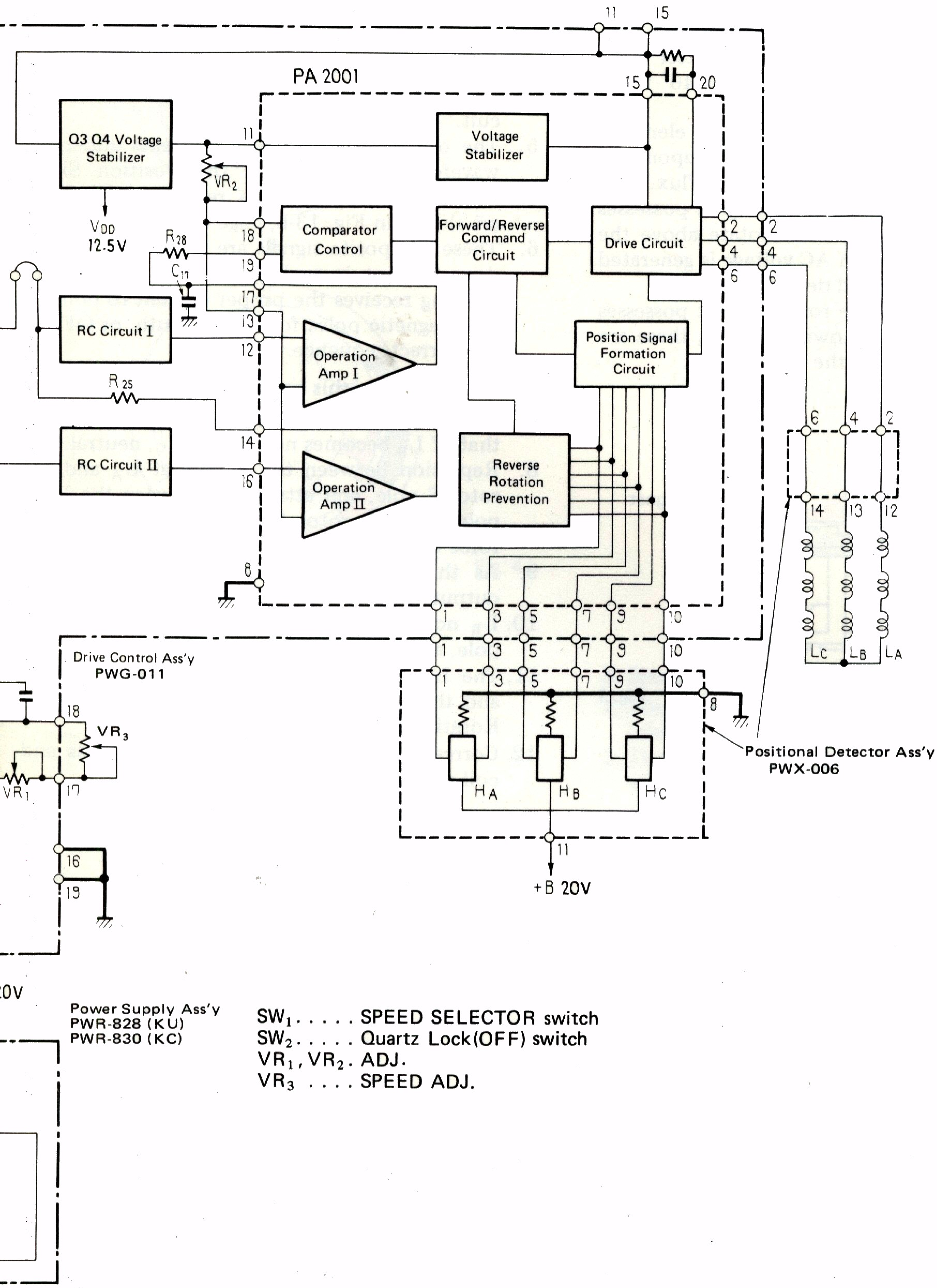
#### OTHERS

| Symbol | Description | Part No. |
|---|---|---|
| HA | Hall element | PCX-012 |
| HB | Hall element | PCX-012 |
| HC | Hall element | PCX-012 |

# 9. OPERATING PRINCIPLES, CIRCUIT DESCRIPTION

## BLOCK DIAGRAM






$SW_1$ . . . . . SPEED SELECTOR switch
$SW_2$ . . . . . Quartz Lock (OFF) switch
$VR_1$, $VR_2$ . ADJ.
$VR_3$ . . . . SPEED ADJ.

## 9.1 MOTOR OPERATION

### 1 Motor Construction

1. The PXM-049 is an outer-rotor brushless DC motor with 6 poles and 9 slots.
2. Motor windings are arranged in a 3-phase Y configuration. For detection of the platter position, 3 Hall elements are mounted at 40° intervals.
3. As the motor rotates, these Hall elements generate an AC voltage dependent upon the strength and direction of the magnetic flux.
4. The bottom side of the rotor magnet possesses 200 magnetic poles. As these rotate above the speed detection plate, an AC voltage is generated which serves as the speed detection signal.
5. The inner surface of the rotor magnet possesses 6 magnetic poles. As shown in Fig. 2, these are tilted by 10° relative to the vertical axis.

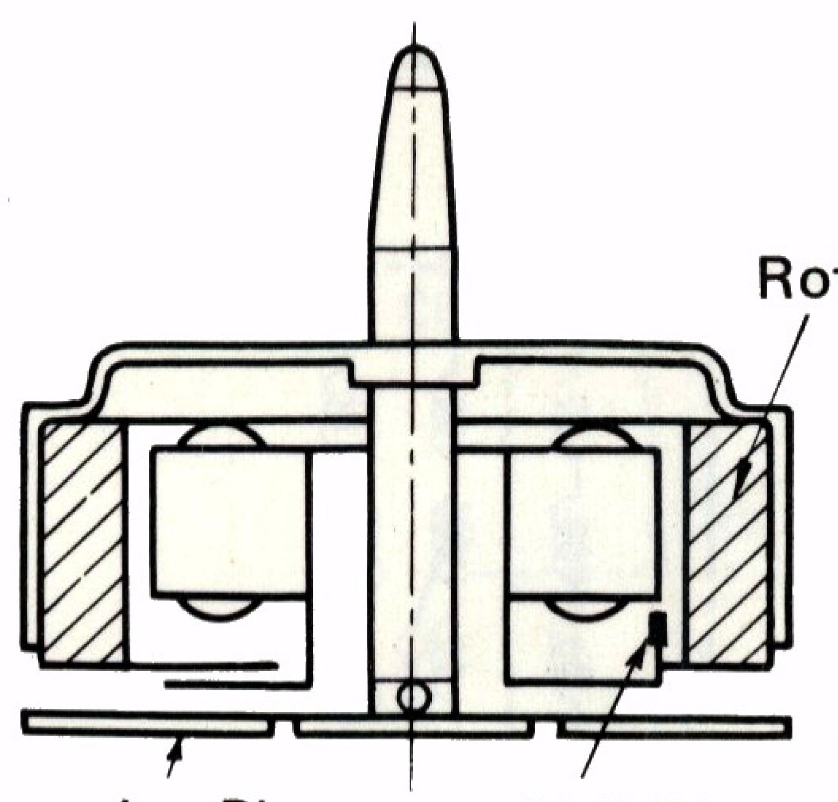



Fig. 1

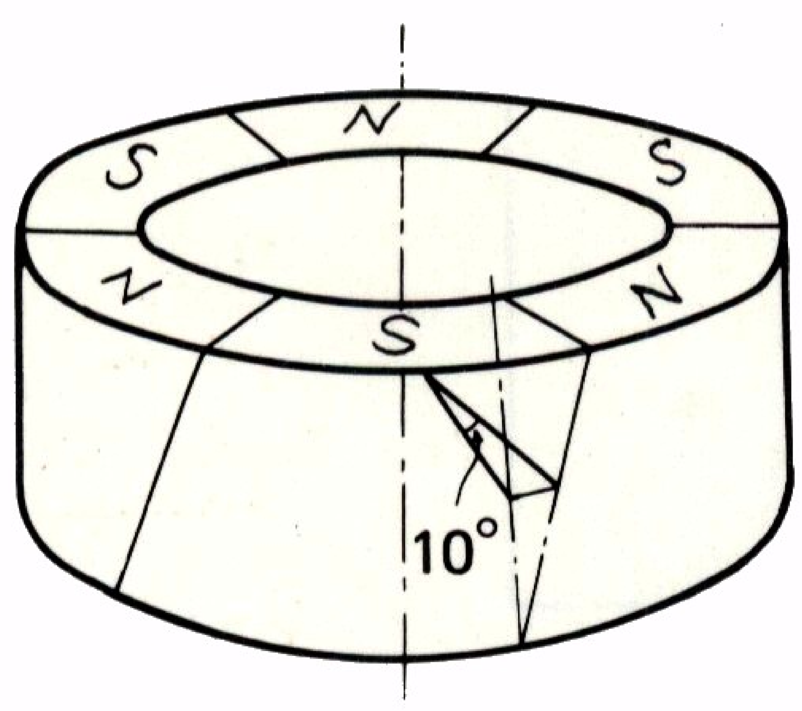



Fig. 2

### 2. Principle of Motor Rotation

1. Let us assume that the motor is at standstill, in the position shown in Fig. 3.
2. In this position, Hall element $H_A$ is located next to a borderline between south and north poles, $H_B$ next to a south pole, and $H_C$ next to a north pole.
3. When the unit is switched on, the output voltages of the respective Hall elements will be as shown in Fig. 13-a, page 63.
4. The Hall element output is applied to the Position Signal Combination Circuit contained in IC PA2001 and utilized to control the current flowing to the motor drive coils.
   For further details, see paragraph "Drive Circuit." on page 61.
5. The output from the Hall elements undergoes waveform formation in the Position Signal Combination circuit. The resulting waveforms are shown in Fig. 13-b, page 63.
6. These composite signals are used to switch the drive current in such a way that each motor winding receives the proper current to polarize the magnetic poles for north, south, or OFF in the correct sequence.

**In actual rotation, this happens as follows.**

7. As the pole of coil $L_A$ becomes a south pole, that of $L_B$ becomes north, and $L_C$, neutral.
8. Repulsion between the S pole at $L_A$ and the rotor S pole, and attraction between the $L_B$ N pole and the rotor S pole exert a propulsive force on the rotor.
9. As the rotor turns through 20° of arc, the output from the Hall elements changes.
10. $L_B$ now enters OFF state, $L_C$ becomes a N pole, and $L_A$ a S pole.
11. The $L_C$ N pole now attracts the rotor S pole, and the $L_A$ S pole attracts the rotor N pole. Rotation continues.
12. Correspondences between rotor positions and coil polarities are shown in Fig. 4, a-f.

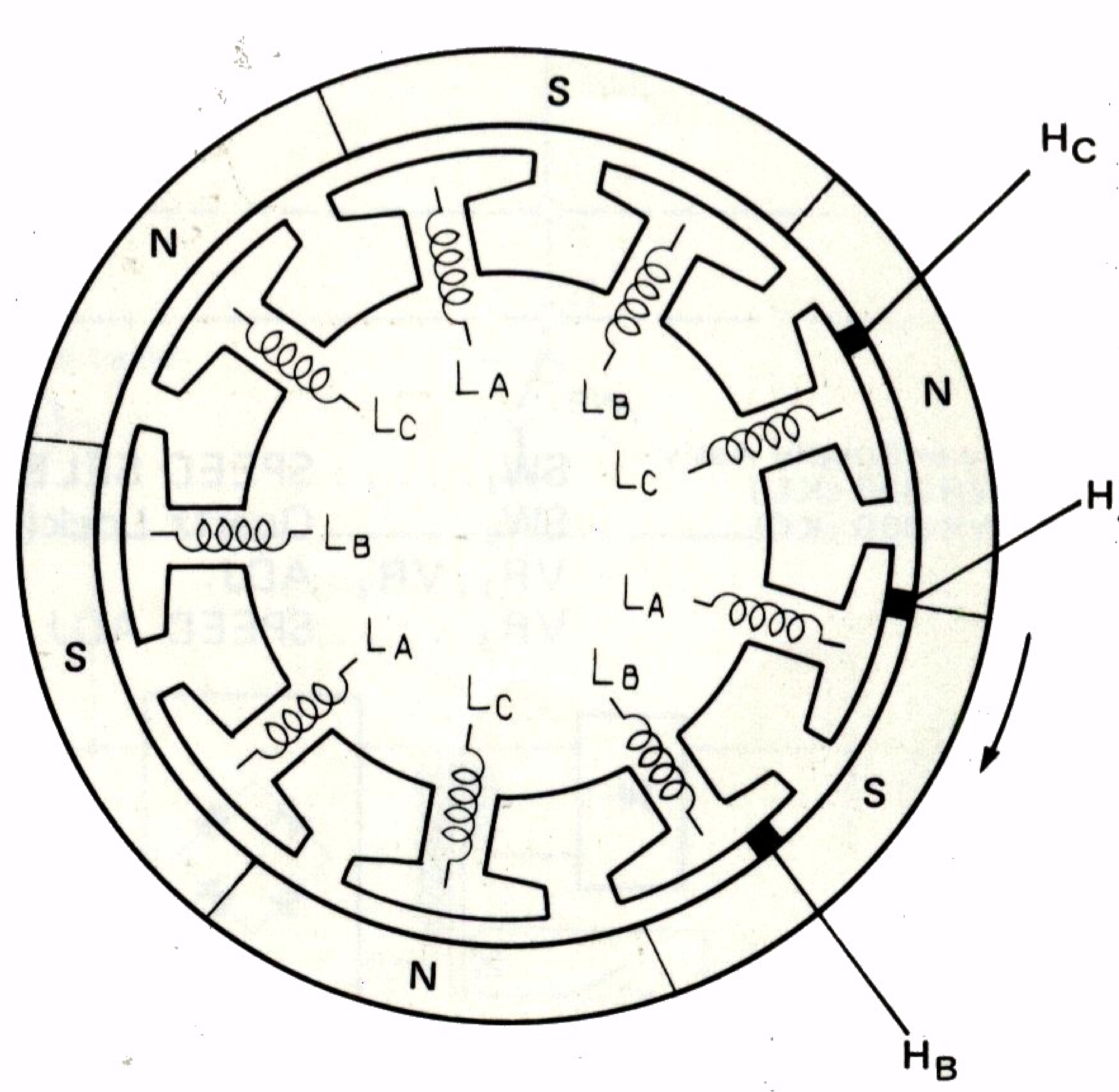



Fig. 3

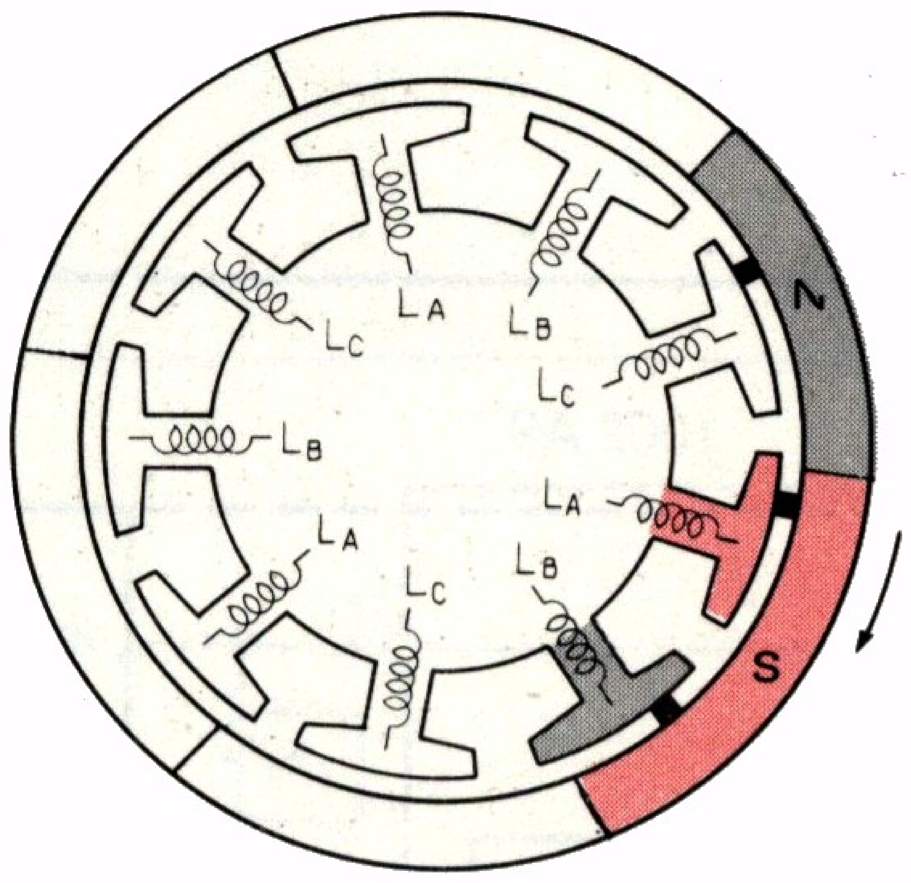



Fig. 4-a

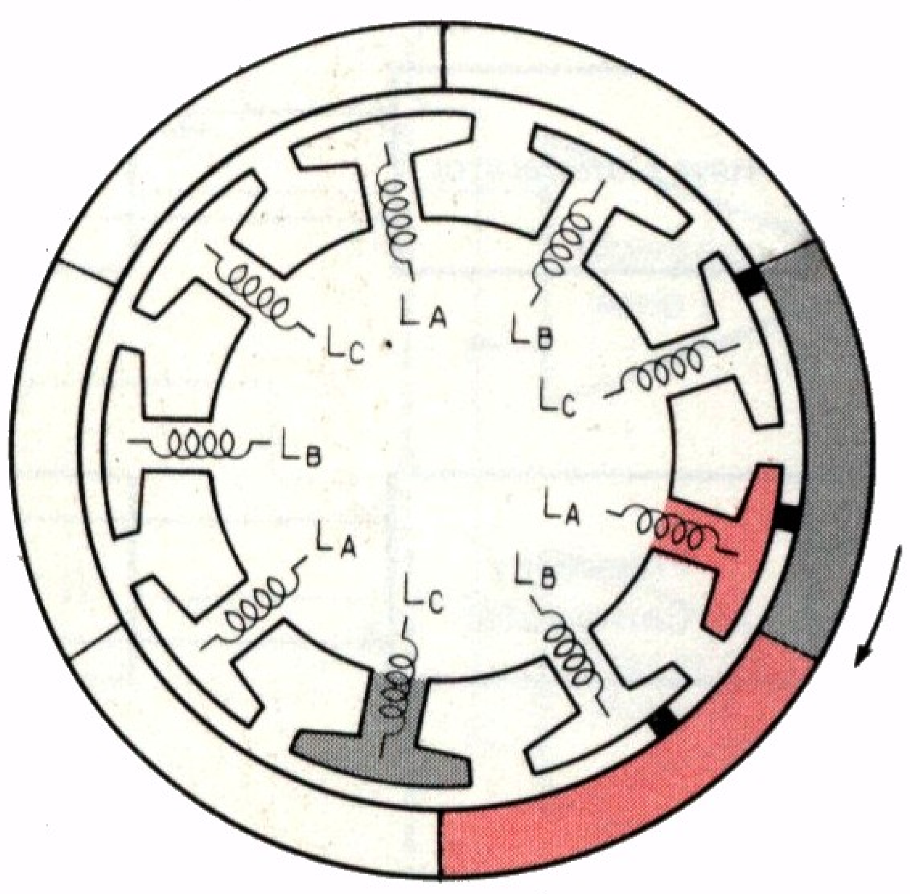


Fig. 4-b

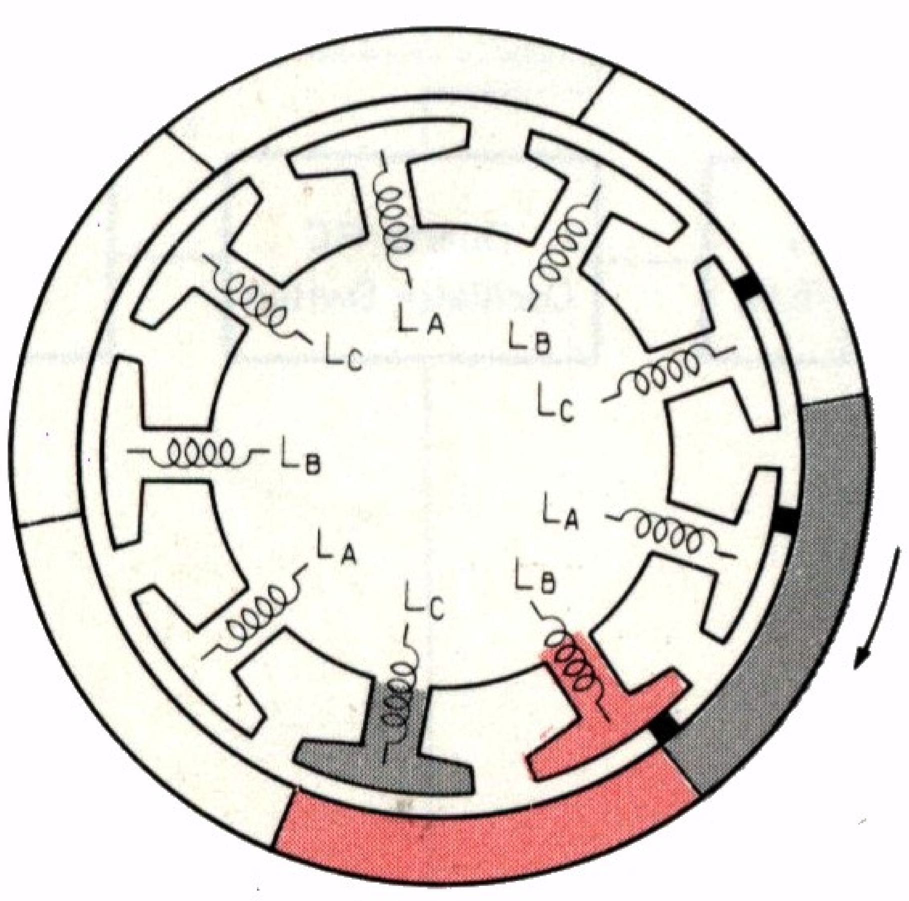


Fig. 4-c

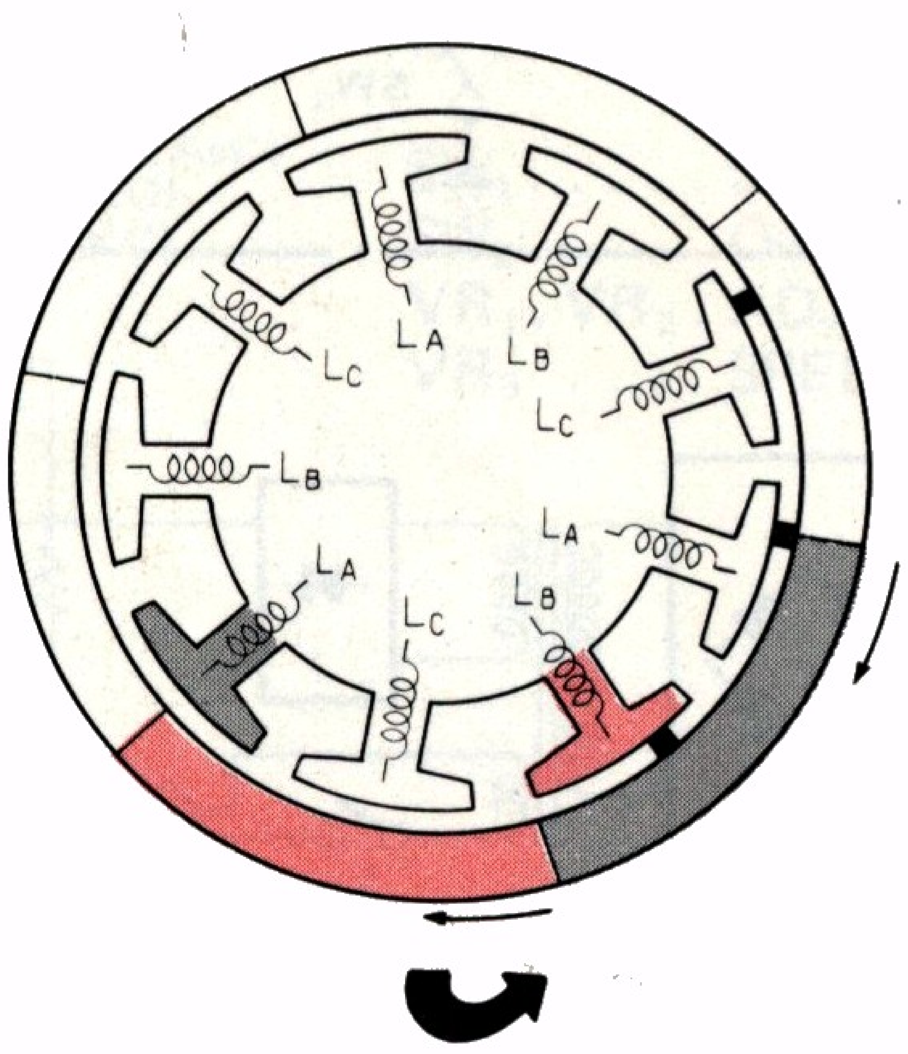


Fig. 4-d

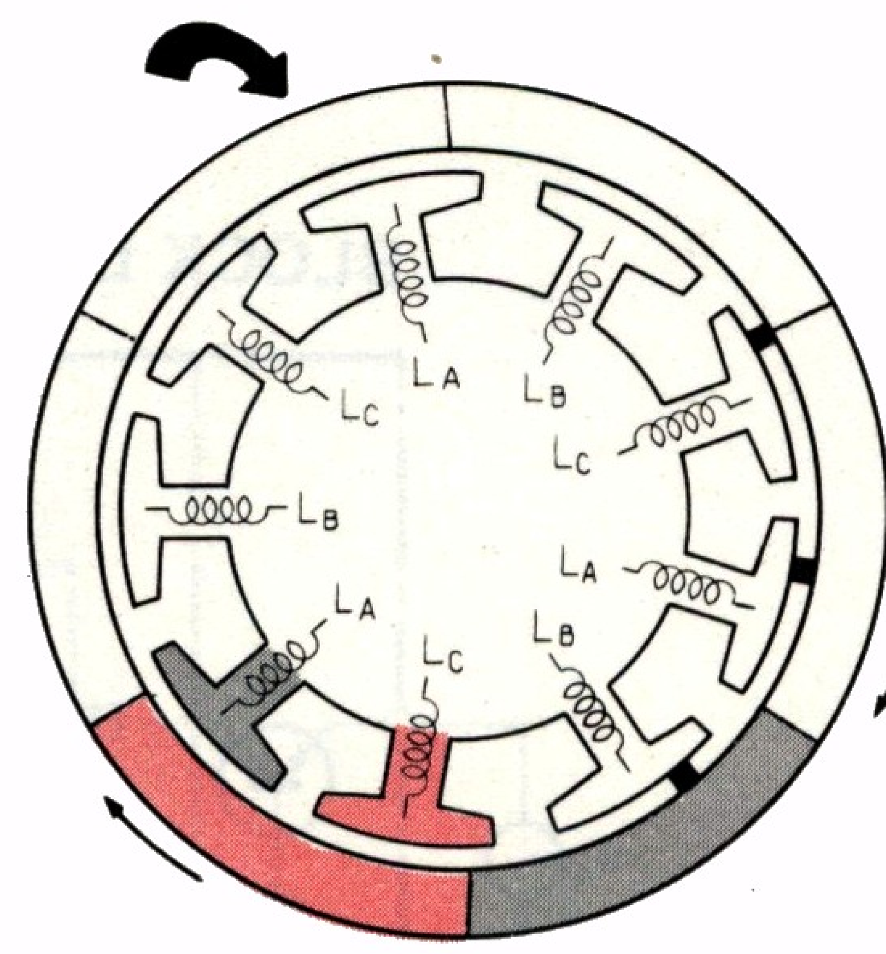


Fig. 4-e

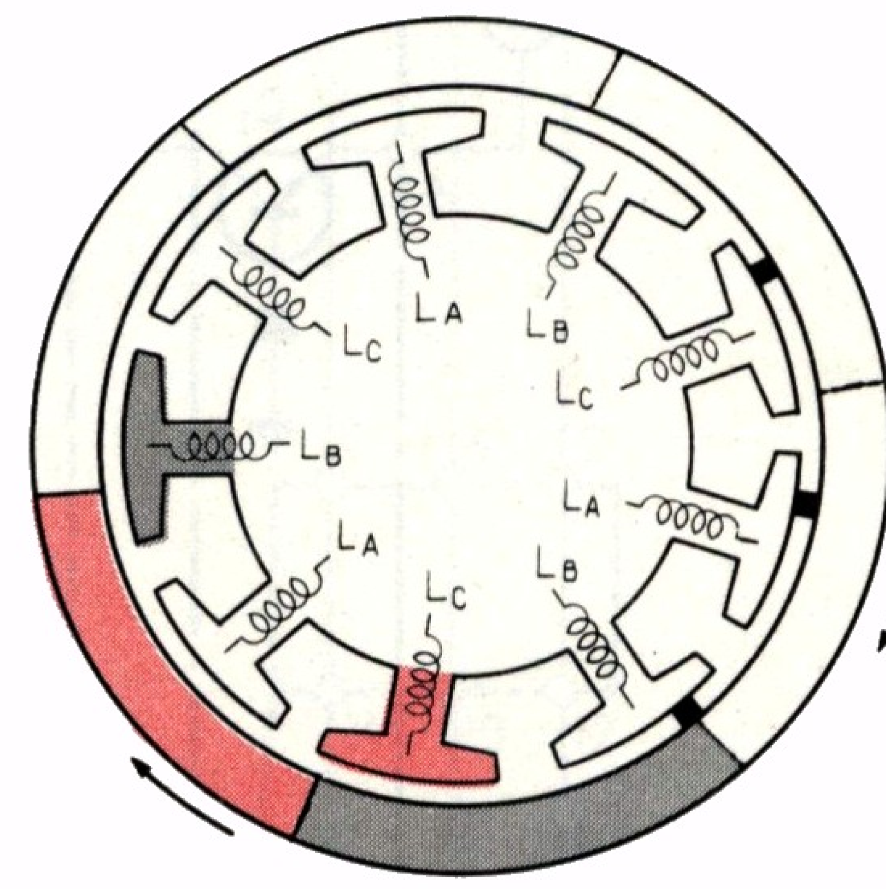


Fig. 4-f

### 3. Speed Detection Section

1. The speed detection plate has two rows of "detection patterns."
2. The bottom surface of the rotor is magnetized with 200 magnetic poles, and these rotate at a short distance above the speed detection plate.
3. The output voltages obtained from the inner and outer detection patterns differ 90° in phase.
4. The output voltage from the detection patterns has a frequency of 55.5Hz at 33-1/3 rpm, and of 75Hz at 45 rpm.
5. The two signals are amplified by transistors Q1 and Q2, respectively, and then supplied to IC PD1001.

### 4. Functions of IC=PD1001A

1. When the power is turned on, the Quartz Oscillator supplies a quartz-controlled signal of 3072kHz.
2. This frequency is divided by 512 ($512 = 2^9$ ), becoming 6kHz. This signal then passes through the Quartz/RC Oscillator Switch and on to the Frequency Division Selector II.

3. The Frequency Division Selector I supplies a signal for the stroboscopic lamp. For this purpose, it divides by 80 (giving a signal of 75Hz for 45 rpm) or by 108 (giving a signal of 55.5Hz for 33-1/3 rpm).
4. Division in the Frequency Division Selector II is by 20 (giving 300Hz for 45 rpm) or by 27 (giving 222Hz for 33 rpm). The output signal is then passed on to the Phase Comparator and the Frequency Comparator where it is compared with the speed detection signal.
5. The speed detection signals, after amplification by Q1 and Q2 (waveforms shown in Fig. 5-a) undergo waveform formation in amplifiers AMP I and AMP II. The resultant waveforms are shown in Fig. 5-b. They then enter the Frequency Multiplication Block.

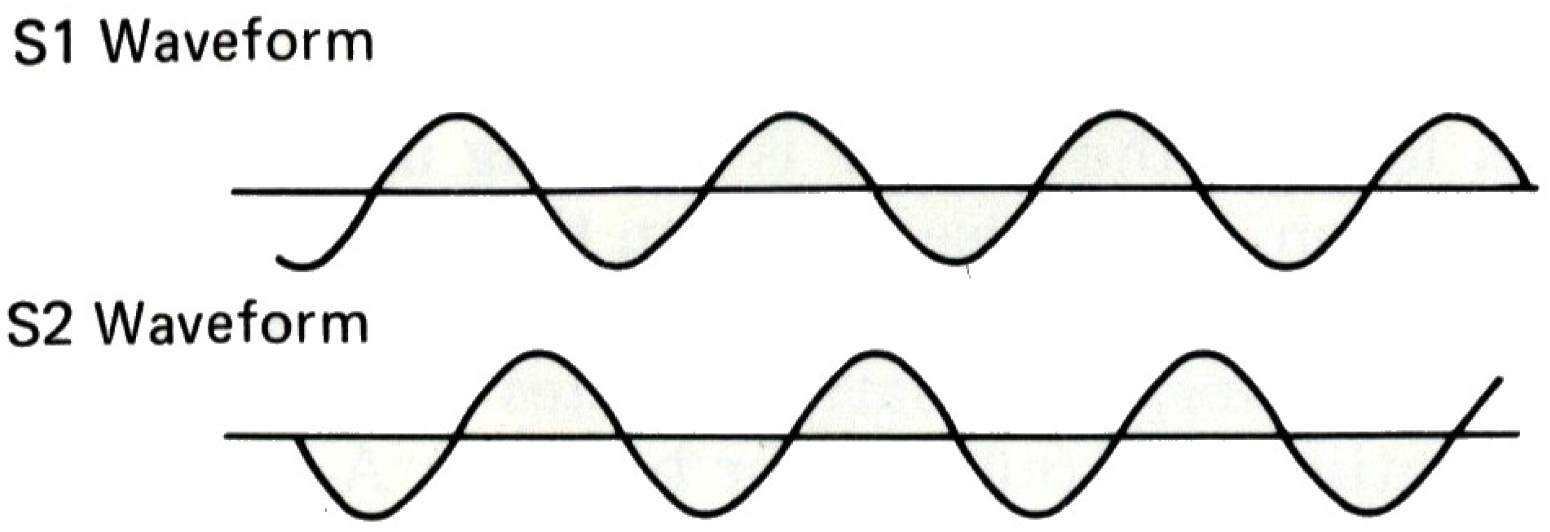



Fig. 5-a

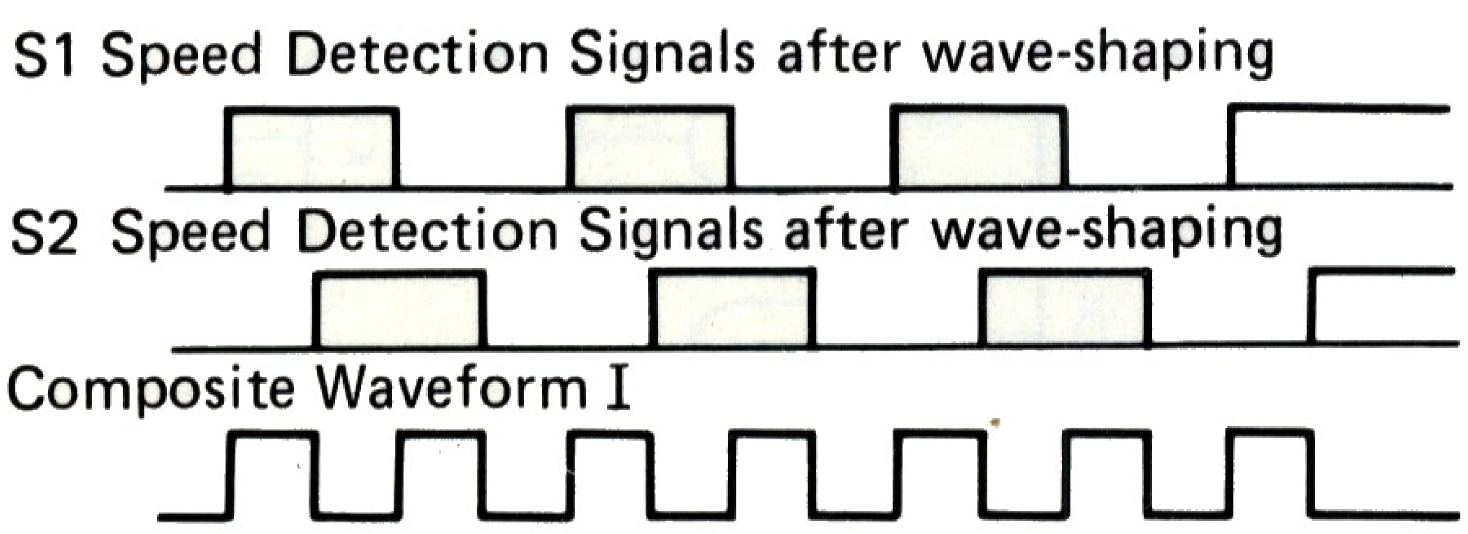



Fig. 5-b

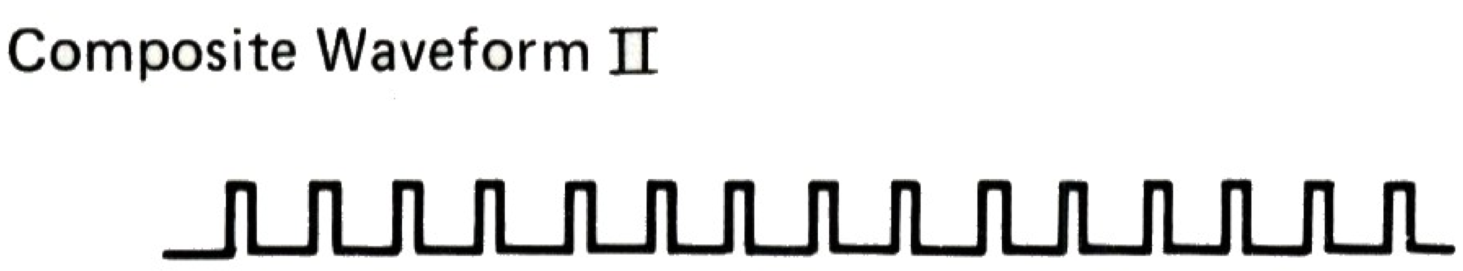
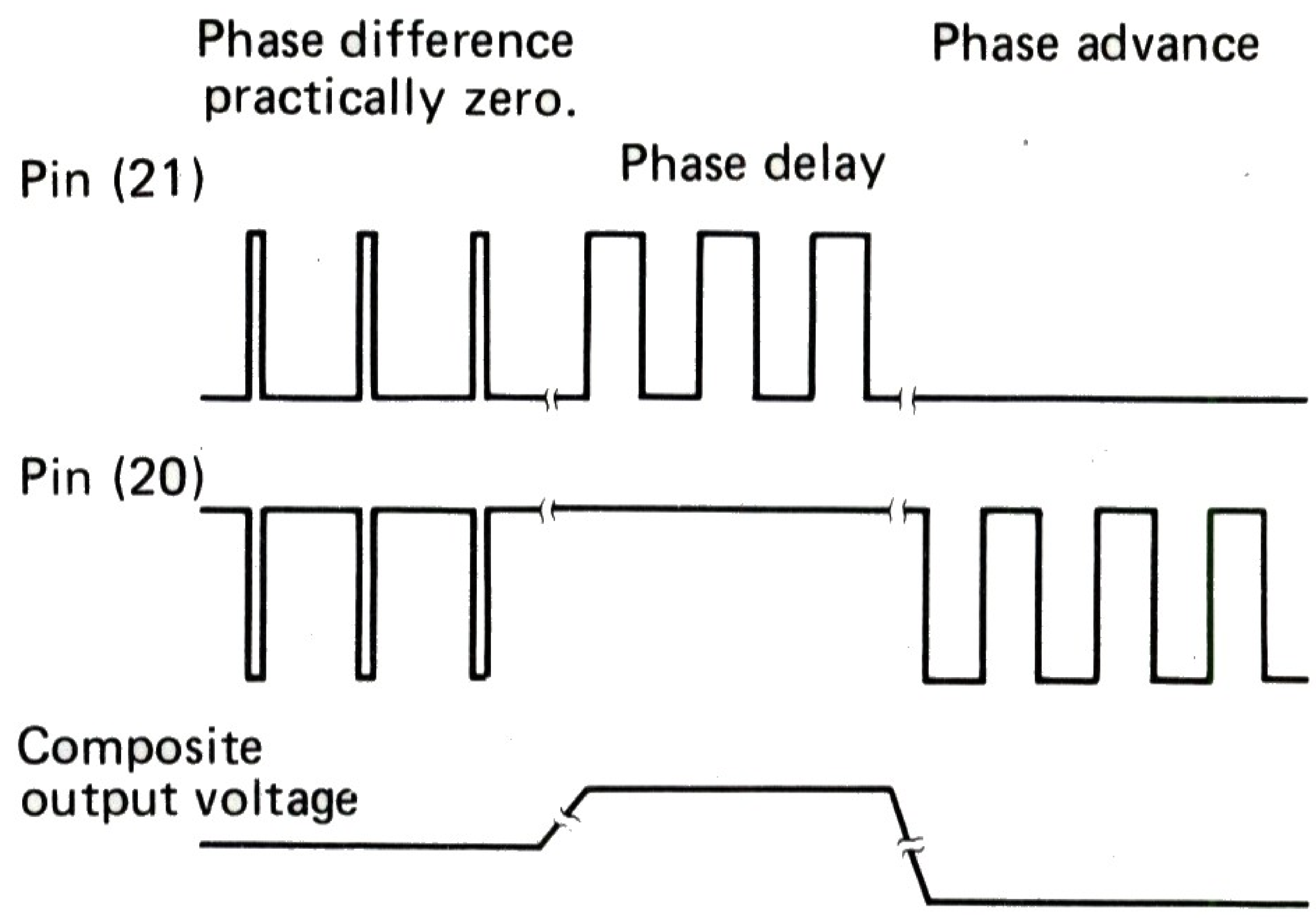


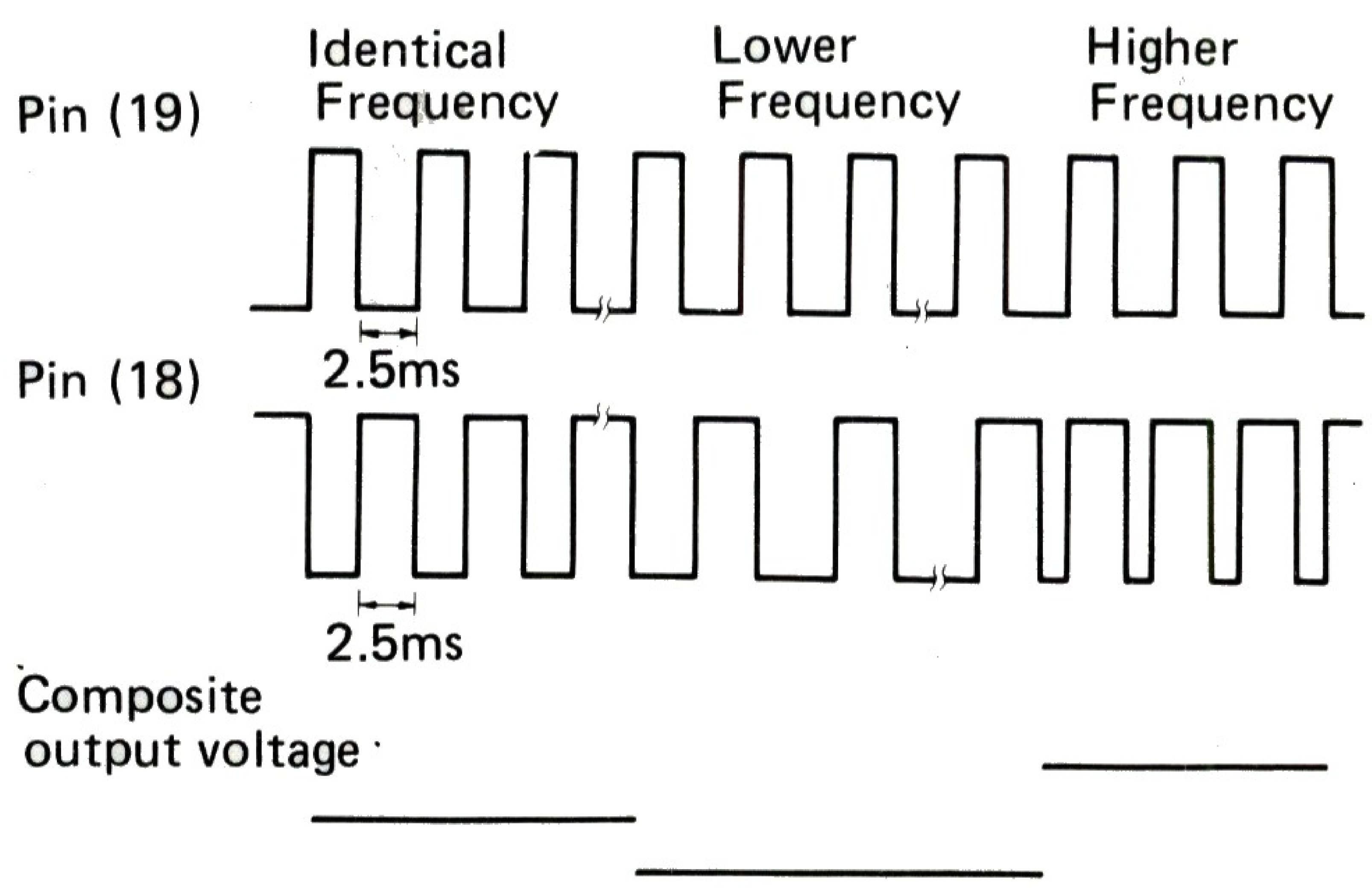

Fig. 5-c

6. In the Frequency Multiplier, the 90° phase difference between the two signals is utilized to produce, in a logic circuit, a composite signal of double frequency; this is then multiplied by 2 once again, resulting in four times the original frequency. See Fig. 5-c.
7. This Speed Detection Signal x 4 is then compared with the quartz-derived reference signal in the Phase and Frequency Comparators.
8. If the phase of the detection signal lags that of the reference signal, the combined PC output voltage (at pins 21 and 22 of PD-1001) will rise; conversely, if the detection signal phase leads that of the reference signal, PC output will drop. See Fig. 6-a. The former case indicates that turntable rotation is too slow. The latter case means that the turntable is rotating too fast.
9. Similarly, if the frequency of the detection signal is lower than that of the reference signal, the voltage of the combined FC output signal (pins 18 and 19 of PD1001) will drop. Conversely, this voltage will rise if the detection signal frequency is higher than the reference signal frequency. See Fig. 6-b. Again, the former case indicates slower than rated turntable rotation, while the latter case means faster than rated rotation.




Output of Phase Comparator

Fig. 6-a




Output of Frequency Comparator

Fig. 6-b

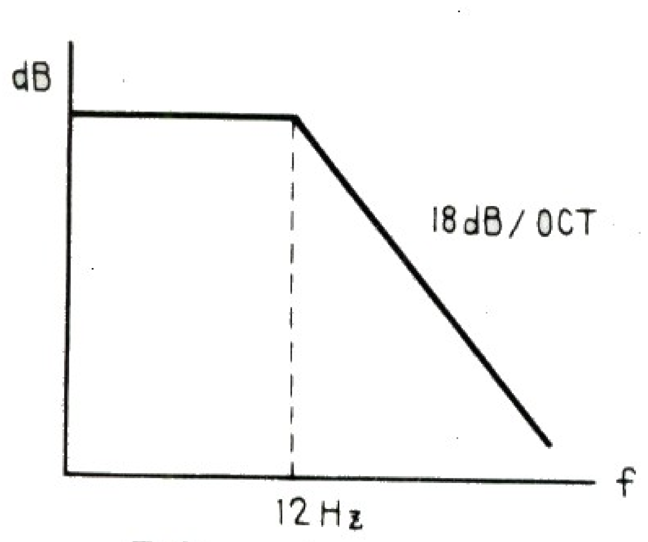
10. The RC Oscillator is a 6kHz nonstable multivibrator. With the Quartz Lock switch in OFF position, the reference signal is obtained from the RC Oscillator and passed on to the Phase

and Frequency Comparators via the Frequency Division Selector II, much in the same way as with the quartz-derived signal.

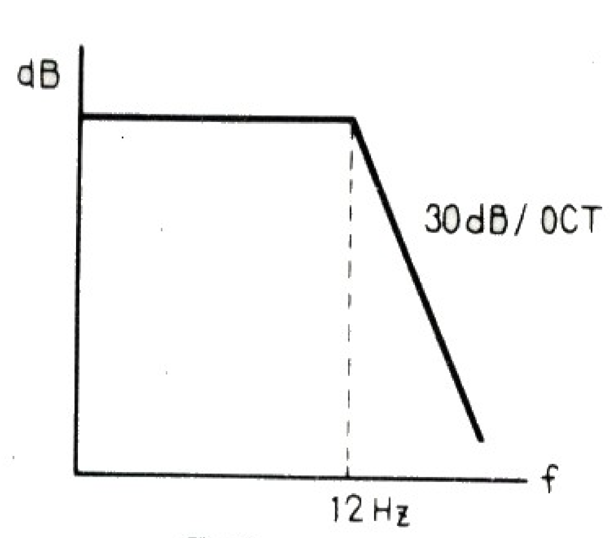
11. In QUARTZ LOCK OFF position, the frequency of the RC Oscillator can be adjusted with the SPEED ADJ control by ±6%.
12. This adjustment of the RC oscillator derived reference frequency results in an equivalent change in turntable speed.

## 5. The Active Filter

1. The output from the Phase and Frequency Comparators contains unwanted harmonics resulting from the reference frequency and the (multiplied) speed detection signal frequency (222, 300Hz).
2. In order to remove these harmonics, an active filter is provided in the IC PA2001 (as an RC circuit in the Operation Amplifiers I & II).
3. To remove these harmonics with a low pass filter, it is necessary to provide a large amount of attenuation at the higher frequencies without causing major phase changes at the low frequencies.
4. For the output of the Phase Comparator, this attenuation is obtained in two steps: a 12dB/oct. active filter made up of a RC circuit I and Operation Amplifier I; and a passive 6dB/oct. filter consisting of R28 and C17; resulting in an overall attenuation of 18dB/oct. See Fig. 7-a.
5. For the output of the Frequency Comparator, the necessary attenuation of 12dB/oct. is obtained in the active filter formed by RC circuit II and Operation Amplifier II. The signal then passes through R25 and is combined with the Phase Comparator output.
6. Since the Frequency Comparator output passes through two active (and one passive) filters, its total high range attenuation amounts to 30dB/oct. See Fig. 7-b.
7. The cut-off frequency of each filter is set at 12Hz.
8. The active filters also function as inverting amplifiers. Their output phases are inverted relative to the Phase Comparator output. The output is the supplied to the Comparator Control Circuit.



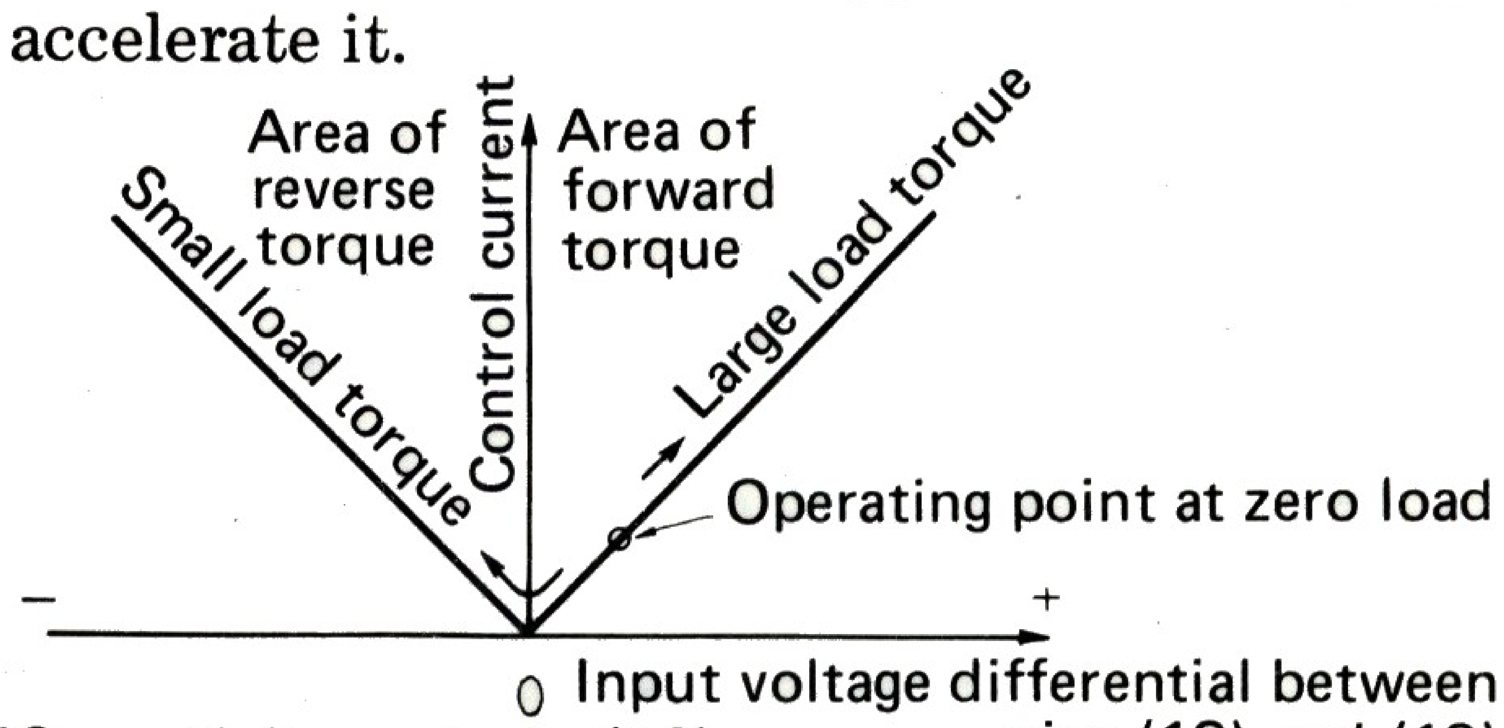
PC output
Fig. 7-a



FC output
Fig. 7-b

## 6. Comparator Control and Forward/Reverse Command Circuit

1. Two inputs are supplied to the Control Comparator: a) a 5V reference voltage from the voltage stabilizer; and b) the output from the active filters, which serves as the detection signal.
2. If the turntable rotates faster than rated speed, the detection signal is higher than the 5V reference.
3. When this happens, the Comparator Control sends a command to the Forward/Reverse Command Circuit, telling it to apply a reverse torque to the motor to slow it down.
4. Conversely, if turntable rotation is below rated speed, the detection signal voltage will be below the 5V reference.
5. In this case, the Comparator Control indicates to the Forward/Reverse Command Circuit that forward torque must be applied to the motor to accelerate it.



V18. . . Voltage at pin (18)
V19. . . Voltage at pin (19)
Fig. 8

## 7. Drive Circuit

1. Switching signals obtained from the three Hall elements and having been processed in the Position Detection Signal Formation Circuit, applied to terminals a, b and c in Fig. 9, in order to switch transistors Q2 ~ Q7.
2. These signals are step waves as shown in Fig. 10, with relative phase differences of 120° between them.

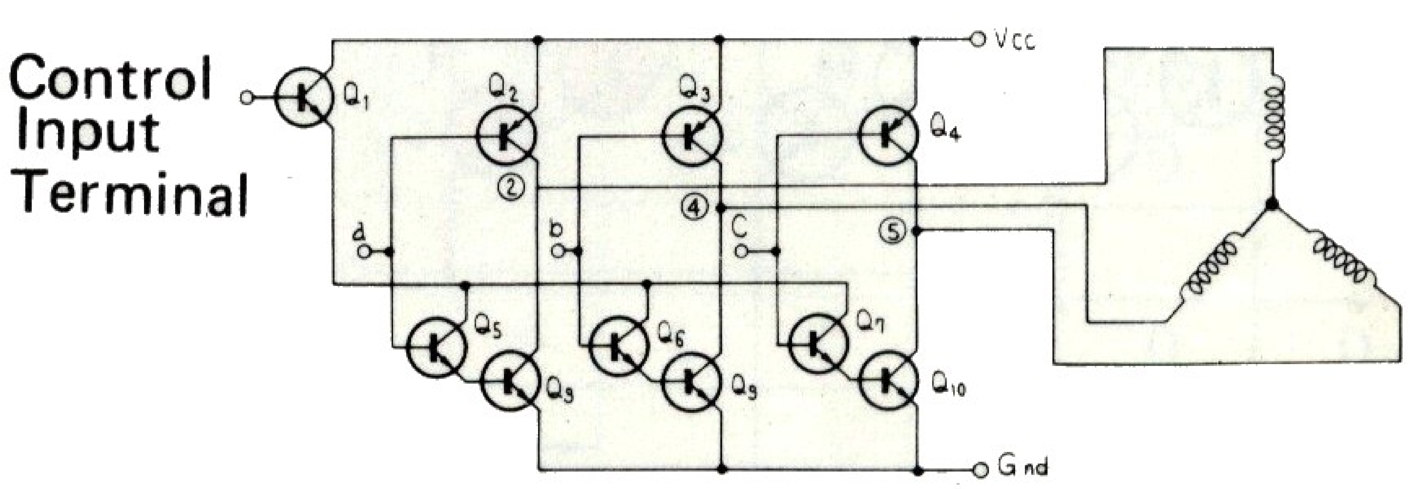
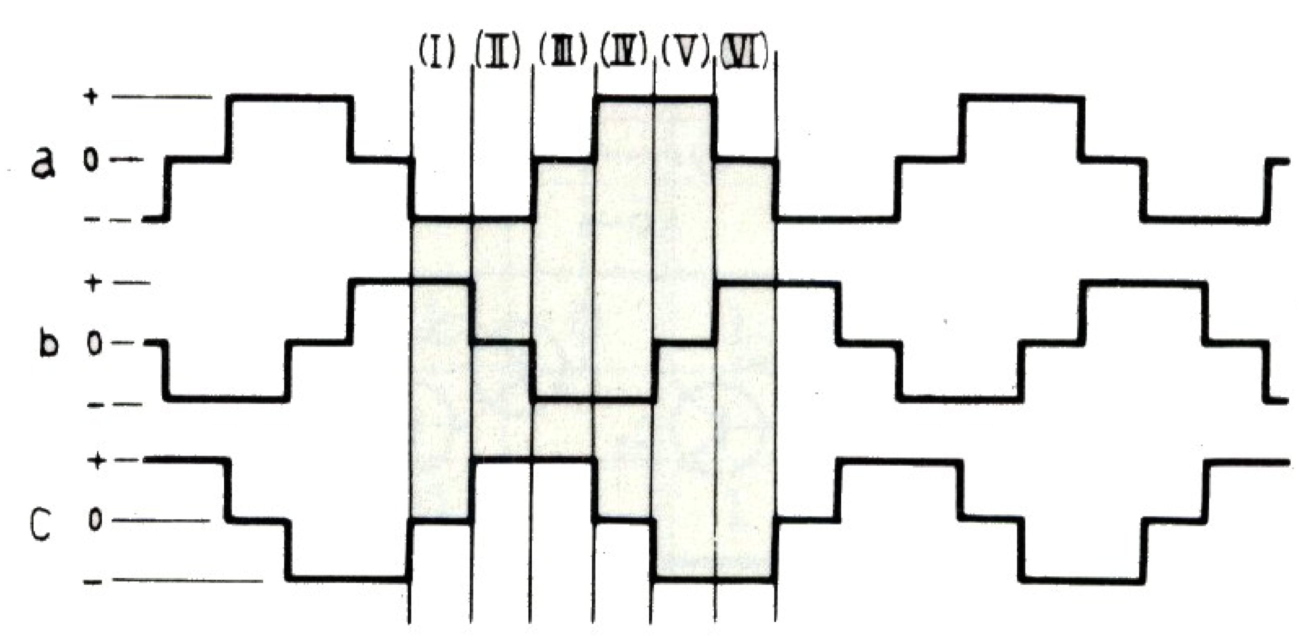


Fig. 9



ig. 10

3. Because of the low potential at pin (a), Q2 is ON. Pin (b) is at high potential, so Q6 and Q9 are ON. Pin (c) is at standard potential — a standard bias is applied which keeps transistors Q4, Q7 and Q10 OFF.
4. A current caused by voltage $V_{CC}$ flows through Q2 — (2) — coil $L_A$ — coil $L_B$ — (4) — Q9, causing a north pole to appear at $L_B$ and a south pole at $L_A$.
5. This magnetism causes the rotor to start rotating. After 20 degrees of rotation, the signal levels at terminals a, b and c will be come as shown in Fig. 11-b II, and the current path of the drive current is changed. After another 20 degrees of rotation, the signals become as in Fig. 11-c III, and the drive current path is changed again. This process continues, with current path changes every 20 degrees and signal levels as in Figs. 11-d IV, 11-e V, and 11-f VI, whereupon the cycle returns to 11-a and repeats.
6. Also, a control signal from the Forward/Reverse Command Block is applied to the control input terminal, and this controls the current flow through the motor windings.

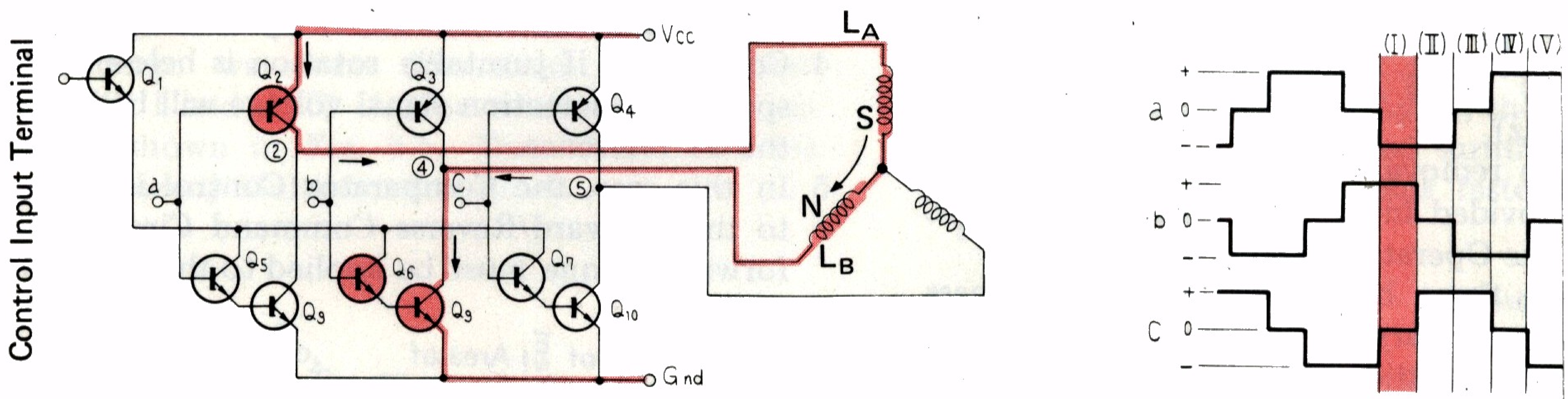


Fig. 11-a

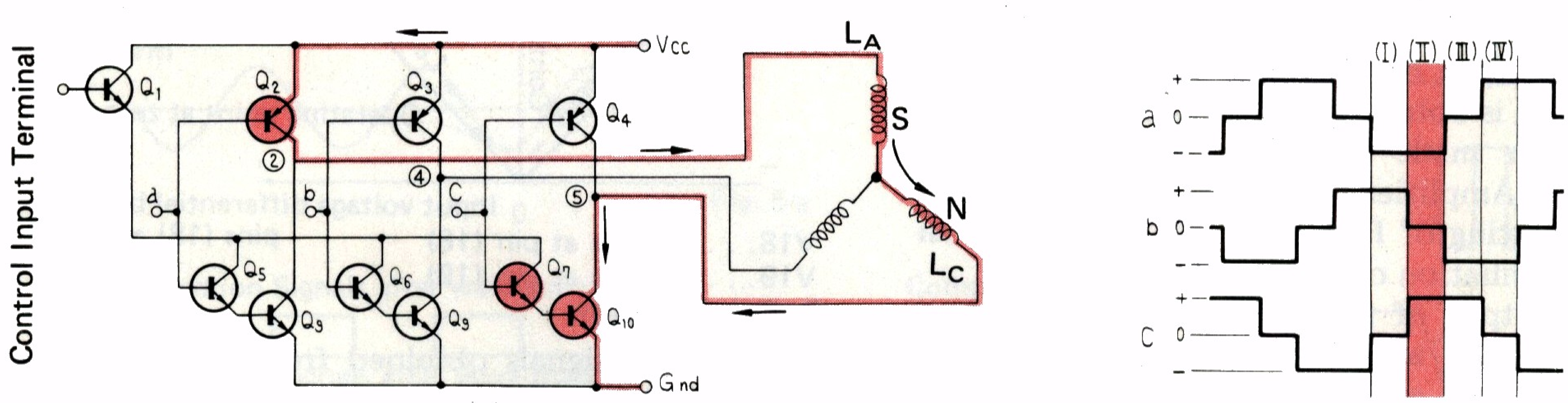


Fig. 11-b

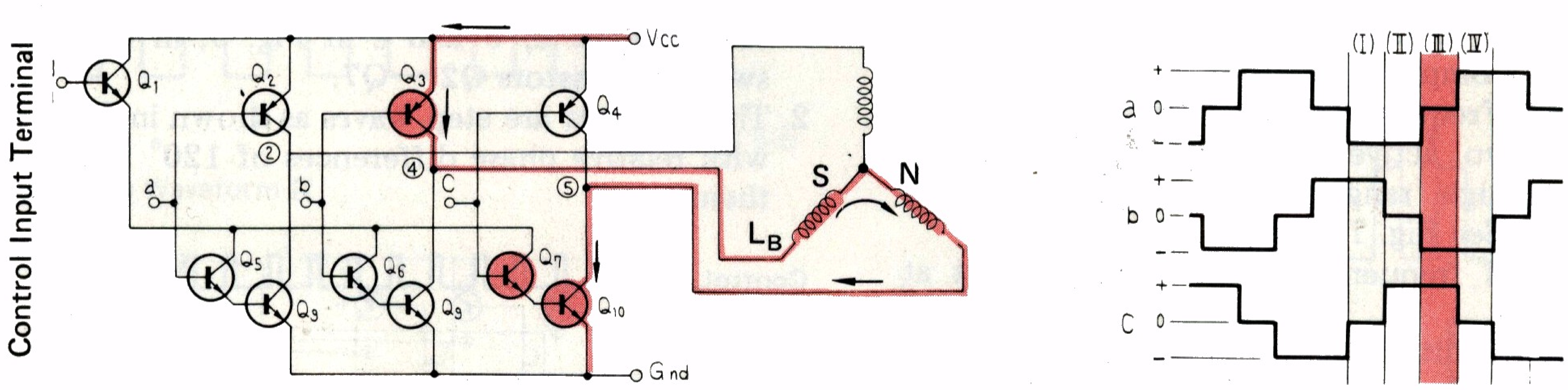


Fig. 11-c

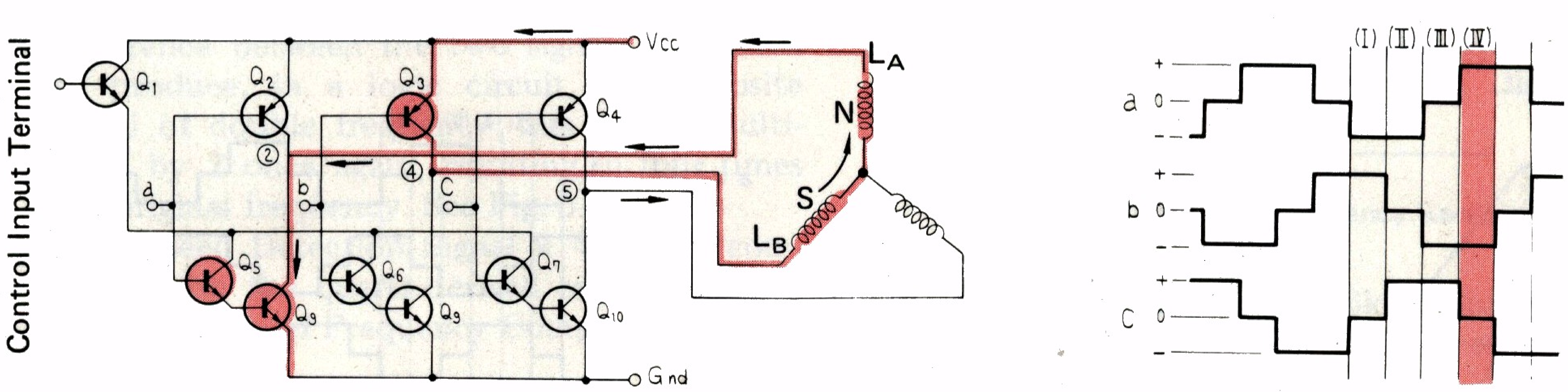
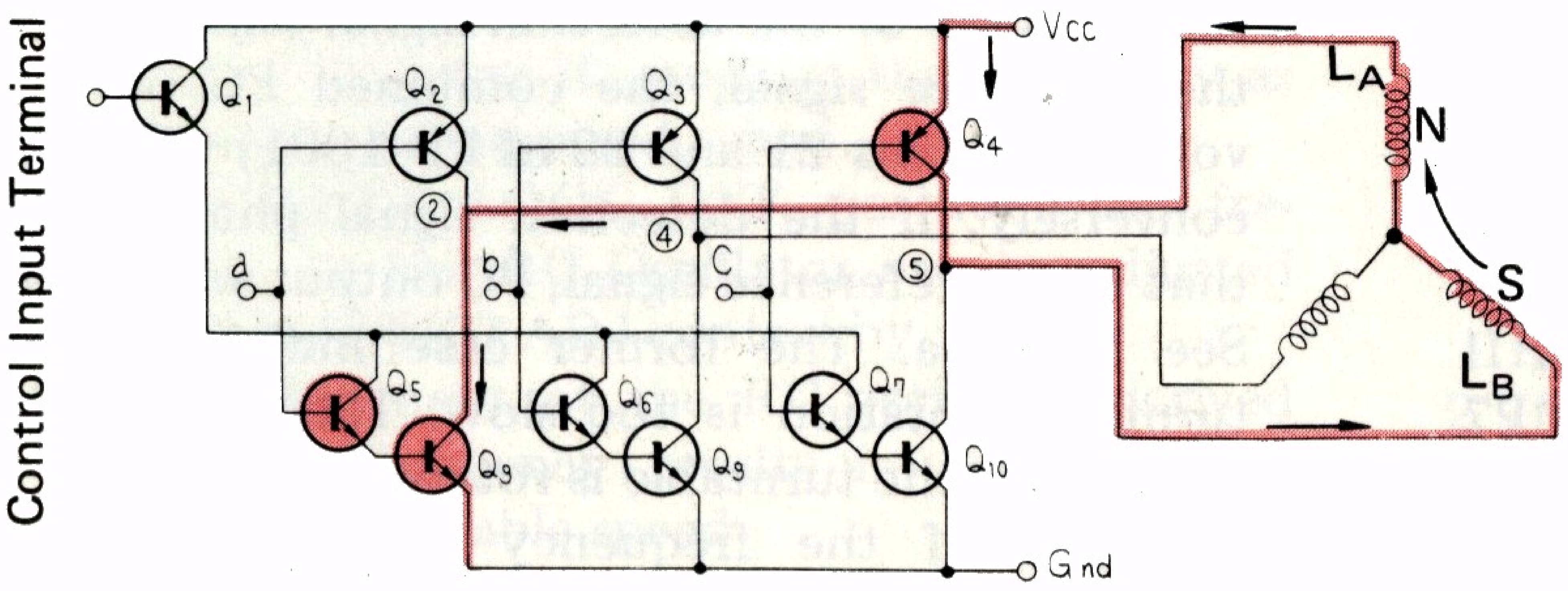


Fig. 11-d



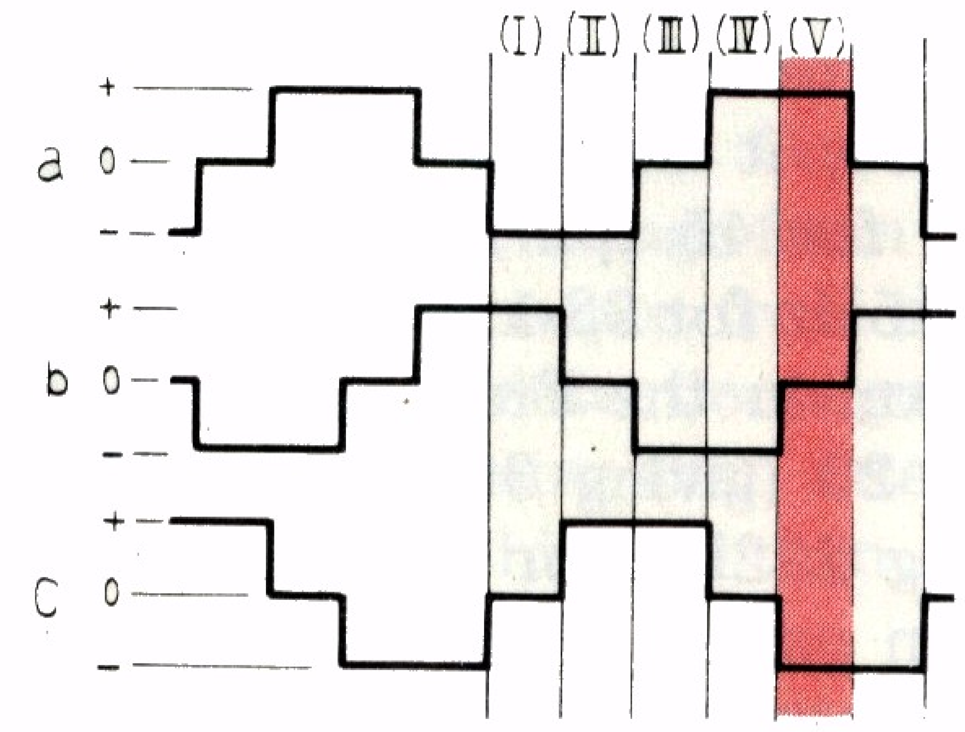
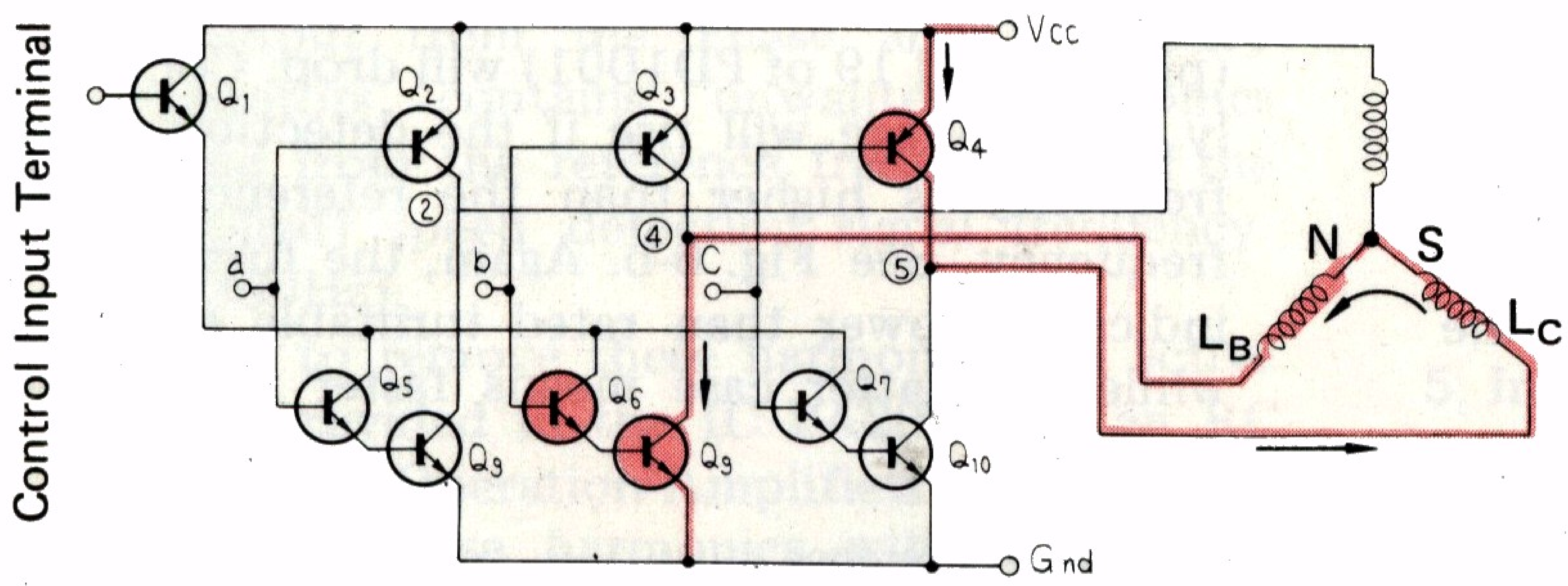




Fig. 11-e



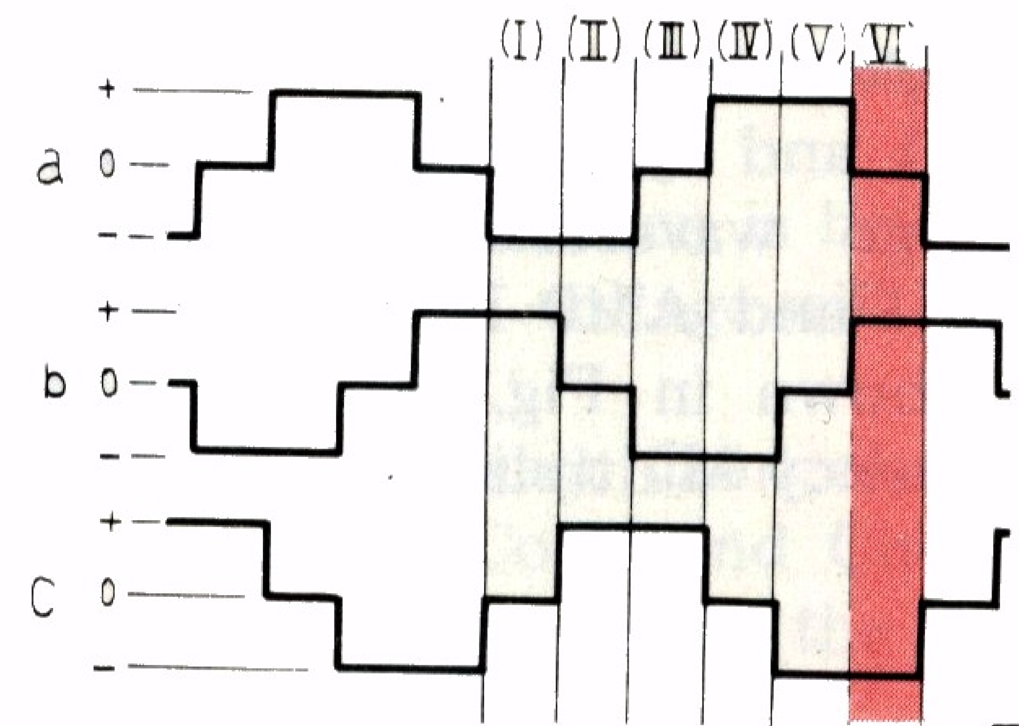




Fig. 11-f

## 8. Stroboscope Pulse Circuit

1. The platter has only a single row of stroboscopic markings. Switchover for 45 and 33 rpm is effected by changing the frequency of the pulse to the stroboscopic lamp.
2. From the Frequency Divider Selector I, a frequency of either 75Hz (for 45 rpm, representing 1/80 of 6000Hz) or 55.5Hz (for 33 rpm, representing 1/108) is obtained and supplied to the transistor that drives the stroboscopic lamp.

## 9. Reverse Rotation Prevention

1. PXM-049 operates indiscriminately in regard to the direction of rotation. If the platter is turned slowly in the reverse direction by hand, a forward torque will be applied until the platter stops, reverses its rotation and reaches rated speed in the proper direction.
2. If, however, the rotational speed in the reverse direction is in excess of 33 or 45 rpm, the Forward/Reverse Command Block may "misread" this as simply excessive speed ("overrun") and apply a reverse torque until rated speed is attained.
3. This reverse torque will further accelerate the turntable rotation in the reverse direction. This is known as "reverse run-away."
4. To prevent this from happening, a Reverse Rotation Prevention circuit has been included.
5. This Reverse Rotation Prevention circuit consists of two flip-flops and AND gates See Fig. 12.
6. The input for this circuit is derived from the Hall element position detection signals processed in the Reverse Rotation Prevention circuit.
7. As long as the platter is rotating in the proper direction, this pulse enters in the order B — A — C, and no "reverse" command is generated.
8. If, however, the platter rotates in the reverse direction, the pulse order becomes A — B — C, and a corrective command is given to the Forward/Reverse Command Circuit.

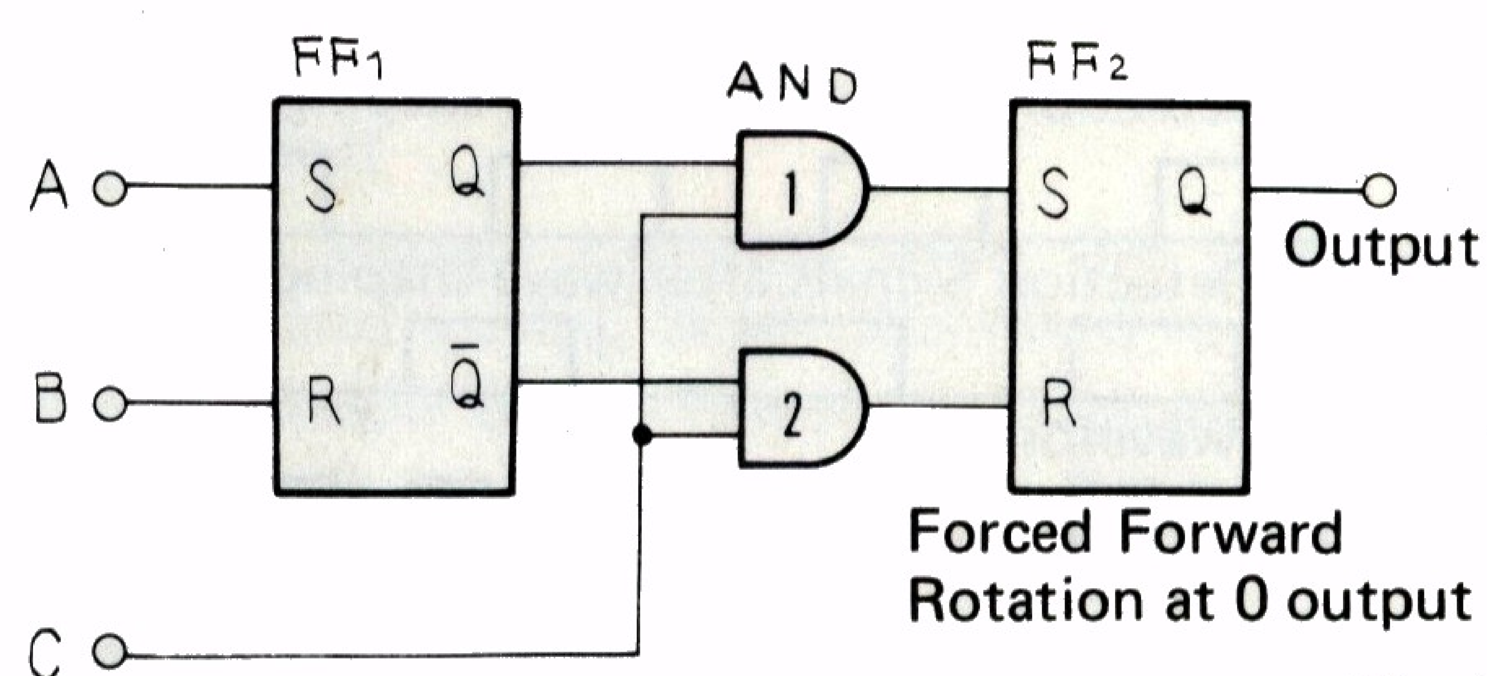



Fig. 12

| | | FF₁ | | | | C | AND | | FF₂ |
|---|---|---|---|---|---|---|---|---|---|
| | | S | R | Q | $\bar{Q}$ | | 1out | 2out | Q |
| Forward rotation | B | 0 | 1 | 0 | 1 | 0 | 0 | 0 | — |
| | ↓ | | | | | | | | |
| | A | 1 | 0 | 1 | 0 | 0 | 0 | 0 | — |
| | ↓ | | | | | | | | |
| | C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| Reverse rotation | A | 1 | 0 | 1 | 0 | 0 | 0 | 0 | — |
| | ↓ | | | | | | | | |
| | B | 0 | 1 | 0 | 1 | 0 | 0 | 0 | — |
| | ↓ | | | | | | | | |
| | C | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |

Fig. 12 Truth table

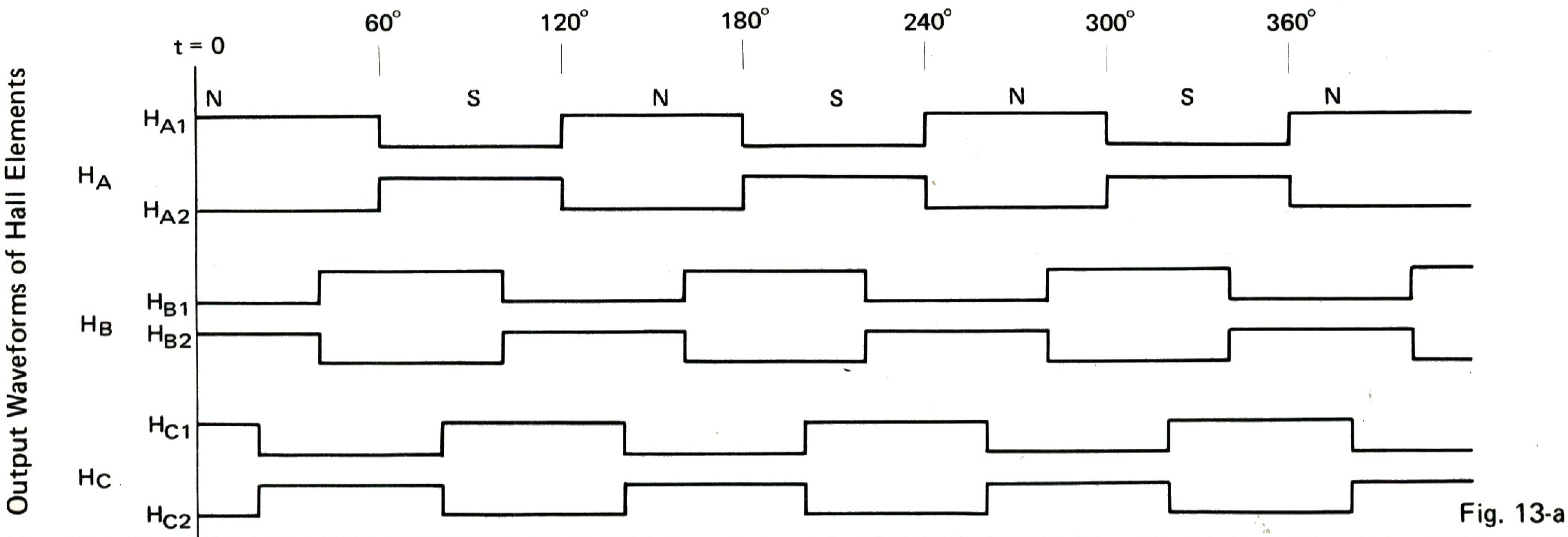



Fig. 13-a

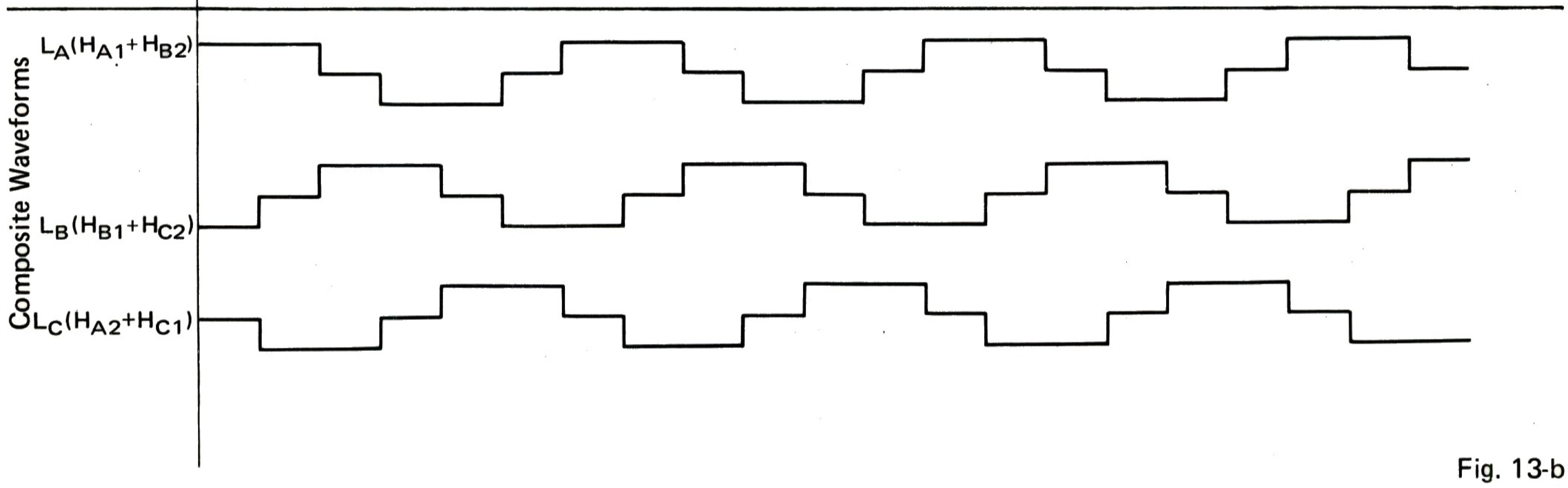



Fig. 13-b

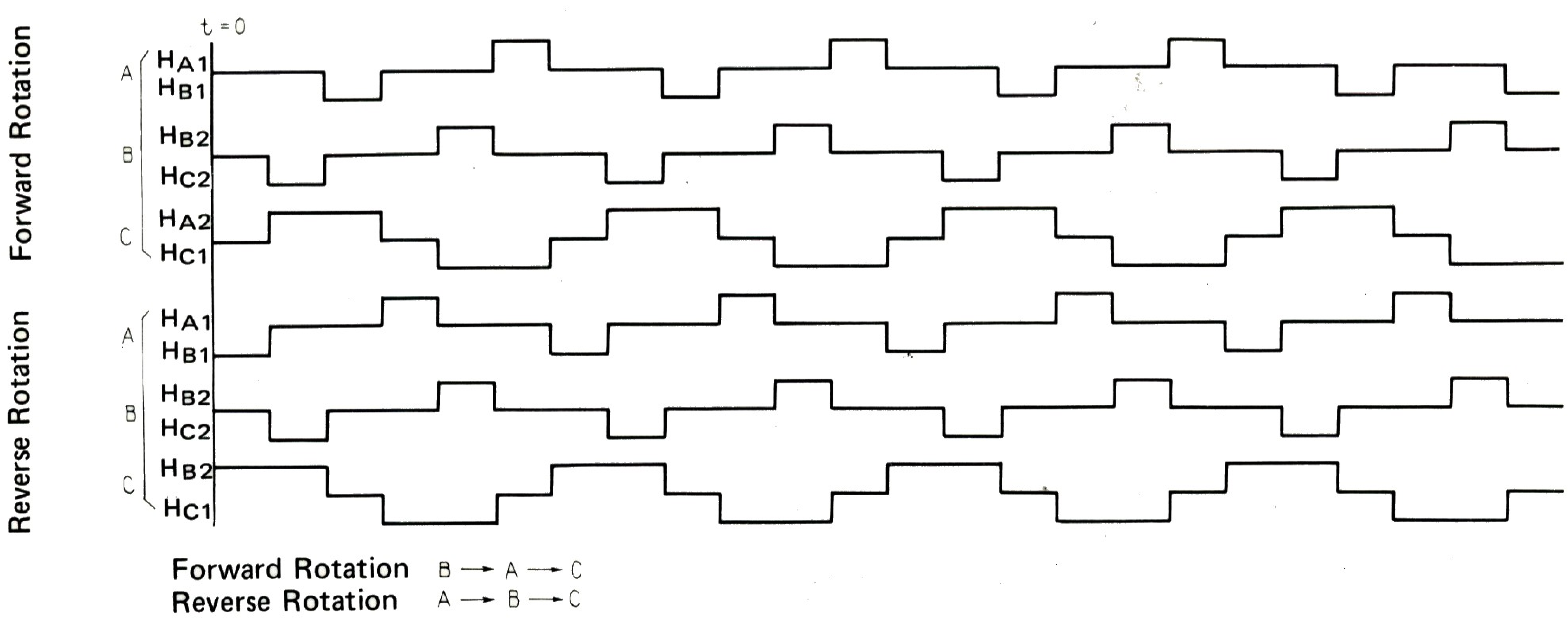
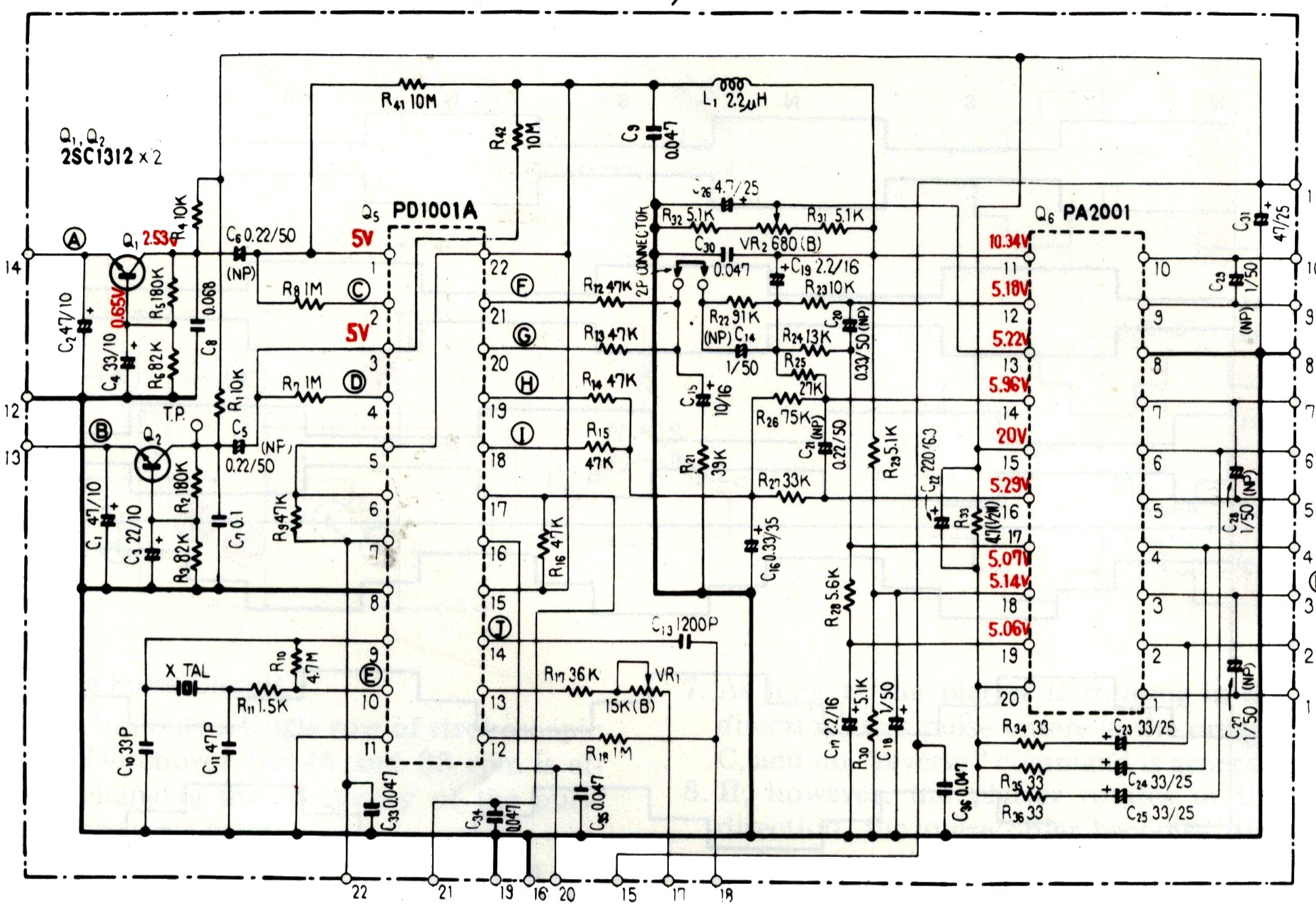
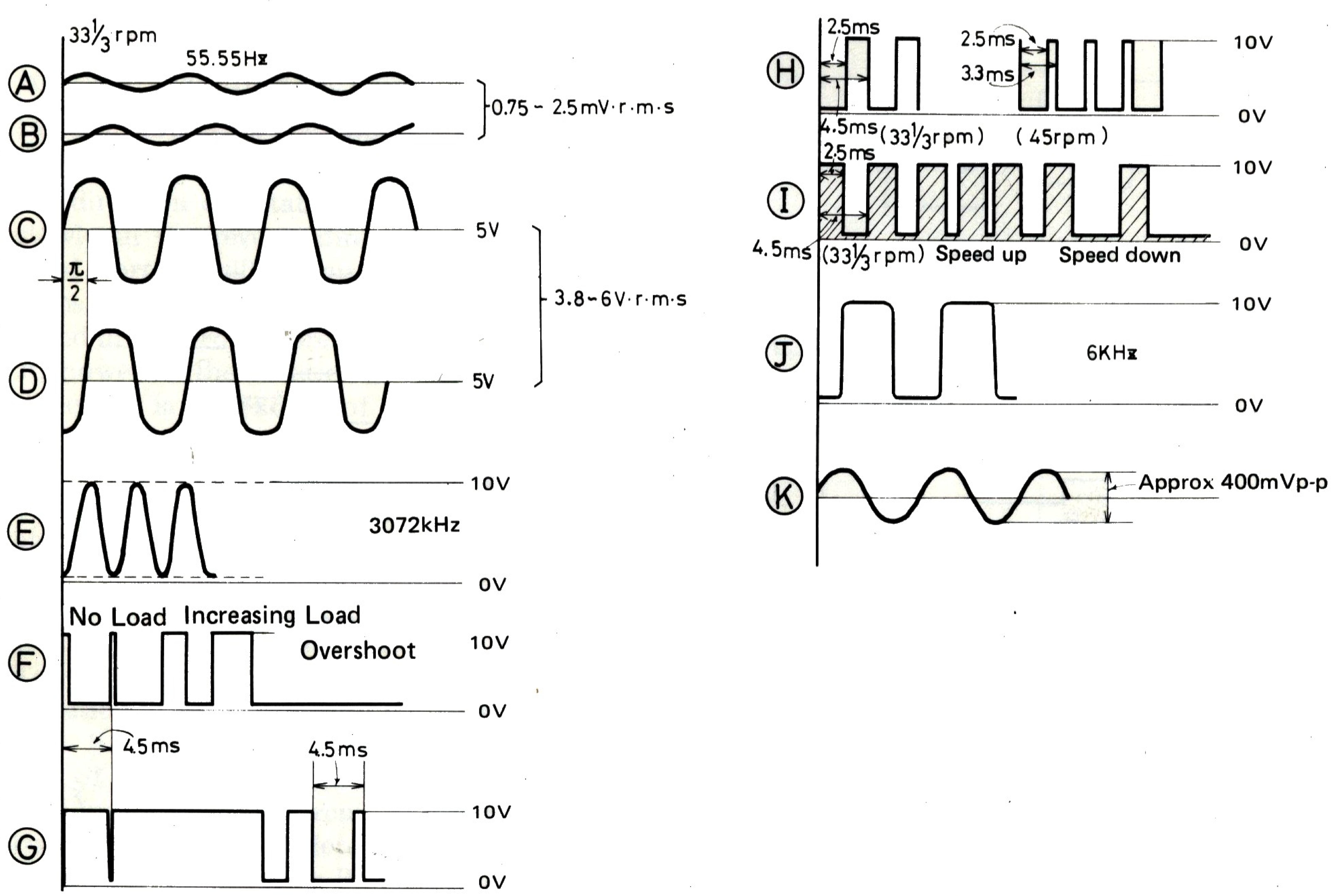



Fig. 14

## 9.2 WAVEFORMS

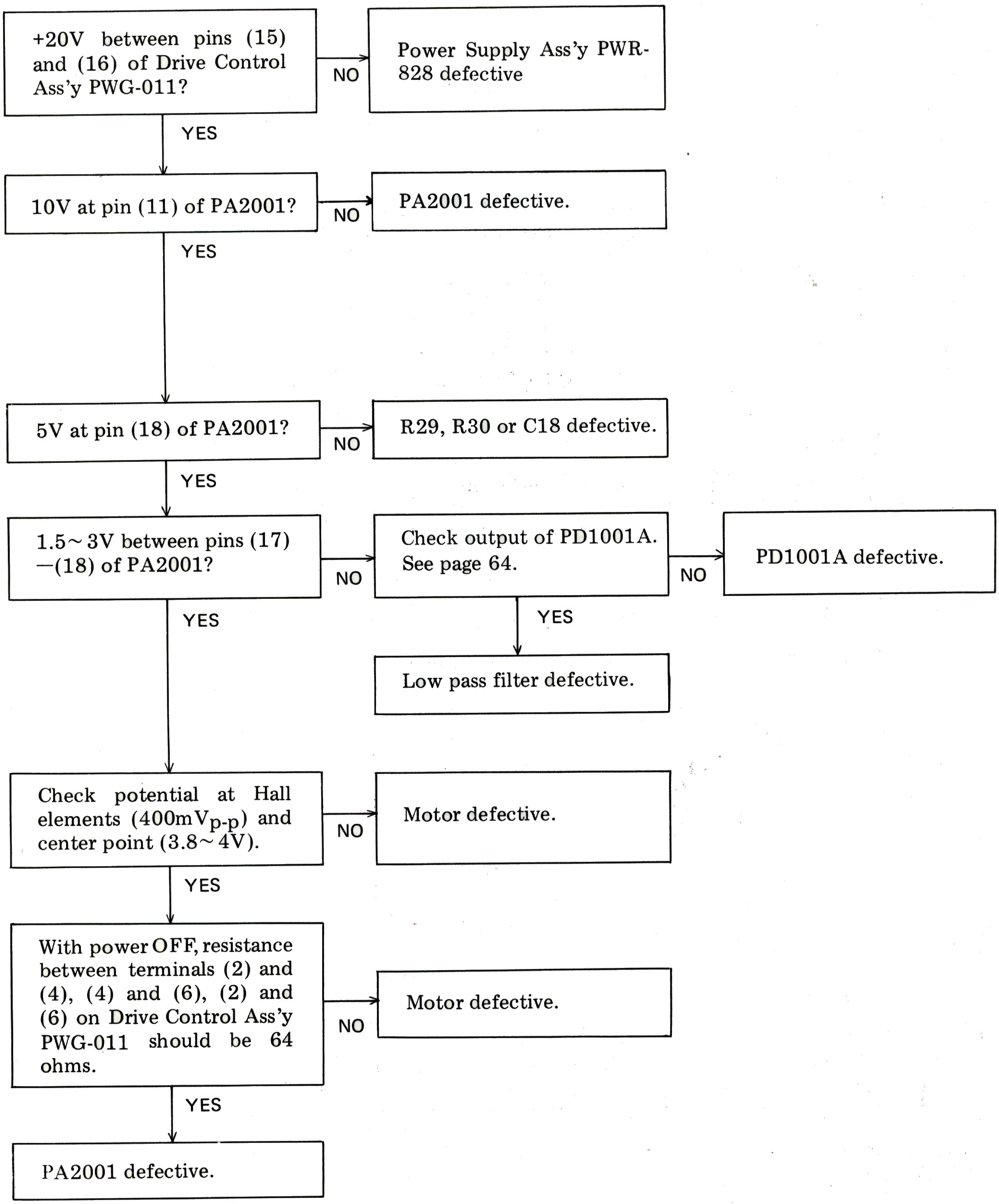
DRIVE CONTROL ASS'Y PWG-011



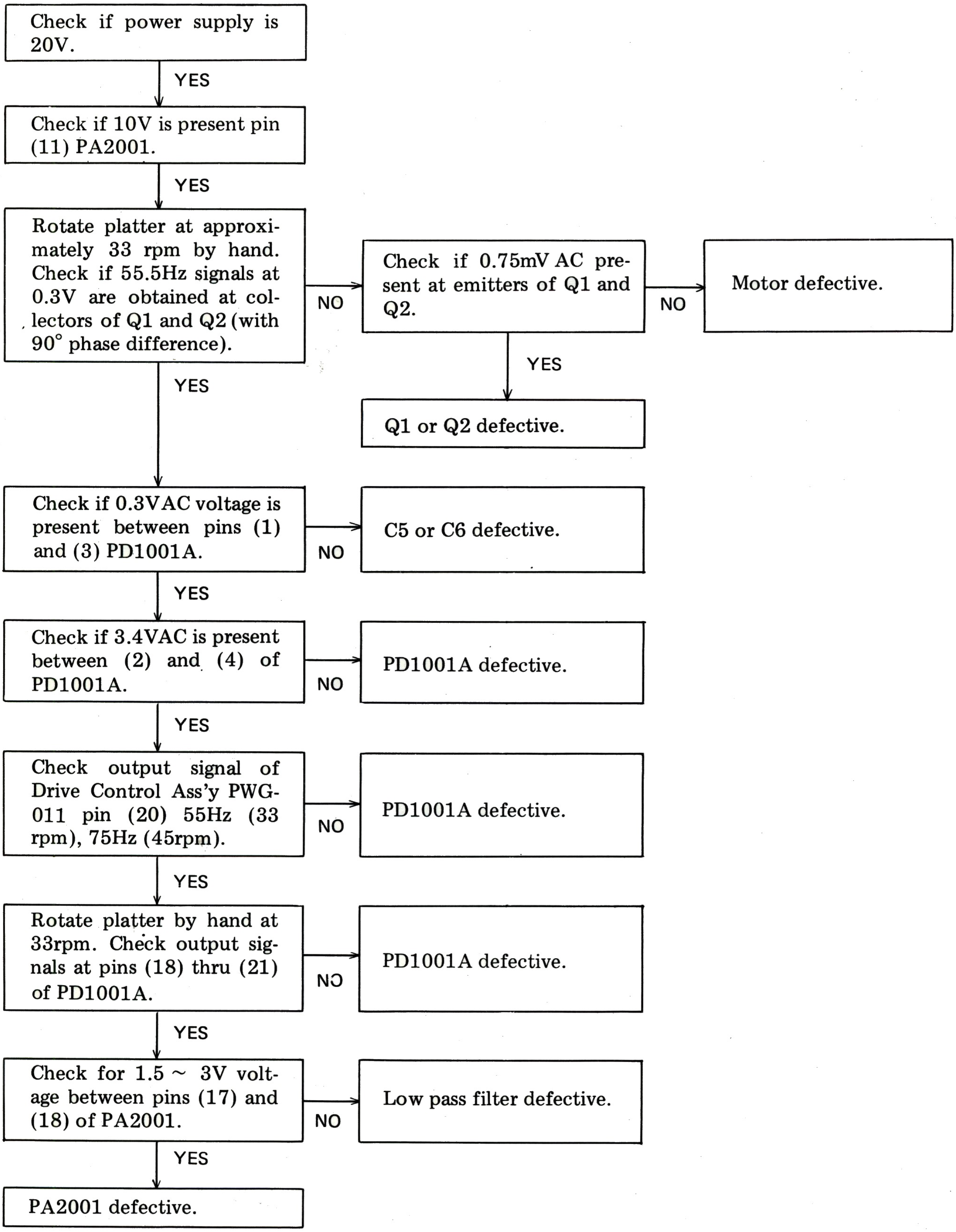



# 10. TROUBLE SHOOTING GUIDE

## 10.1 MOTOR DOES NOT ROTATE



## 10.2 MOTOR RUN-AWAY



## 10.3 MOTOR ALTERNATES BETWEEN FORWARD AND REVERSE ROTATION

Check output signal at pin (20) of Drive Control Ass'y — 55.5Hz (33rpm), 75Hz (45rpm).

NO → Quartz Oscillator or PD1001A defective.

YES ↓

Check output at pin (14) of PD1001A — 6kHz.

NO → RC Oscillator or PD1001A defective.

YES ↓

PA2001 defective.

## 10.4 UNSTABLE ROTATION NEAR RATED SPEED

Check power supply voltages +20V.

YES ↓

Check signals at pins (1), (3) of PD1001A and at collectors of Q1, Q2. Also check for proper phase relationships.

NO → PD1001A or Q1, Q2 defective.

YES ↓

Motor defective.

# 11. ADJUSTMENT PROCEDURES

## 1. Adjustment of PA2001 Operating Point

This adjustment is necessary whenever PA2001 has been replaced or repairs have been performed on the RC low pass filter ass'y or the power supply circuits.

As the PXM-049 utilizes a phase comparator and frequency comparator combination, the operating points of these comparators must be adjusted.

- Set unit in QUARTZ LOCK ON mode, 33 rpm.
- Unplug jumper connector from Drive Control Ass'y PWG-011
- Adjust white potentiometer VR2 until stroboscope comes to a standstill. See Fig. 15.

## 2. Speed Adjustment

This adjustment is needed when proper speed cannot be obtained with the SPEED ADJ control in QUARTZ LOCK OFF mode.

- Set SPEED ADJ control at mechanical center position.
- Adjust blue potentiometer VR1 on Drive Control Ass'y PWG-011. until stroboscope comes to a standstill. See Fig. 16.

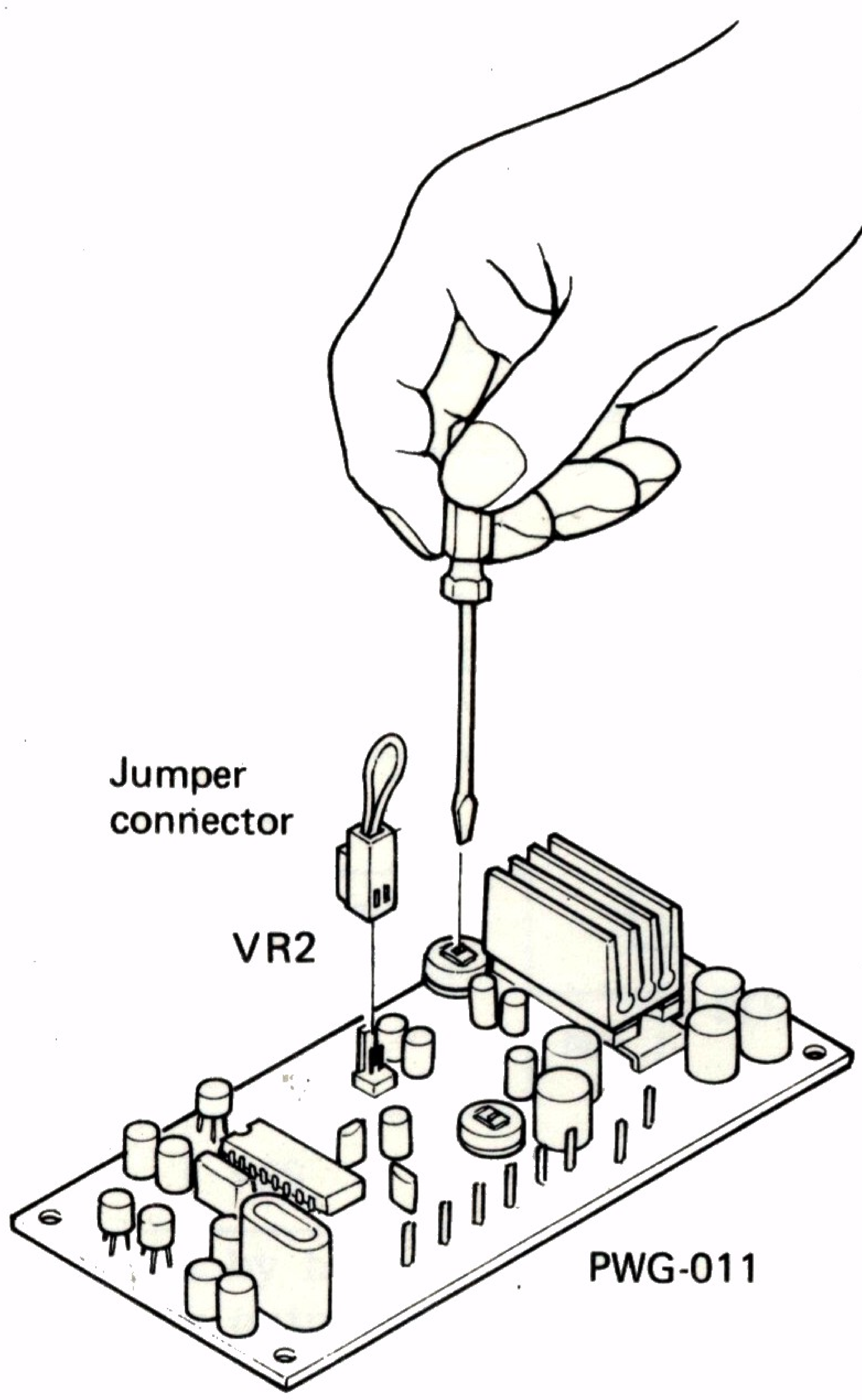



Fig. 15

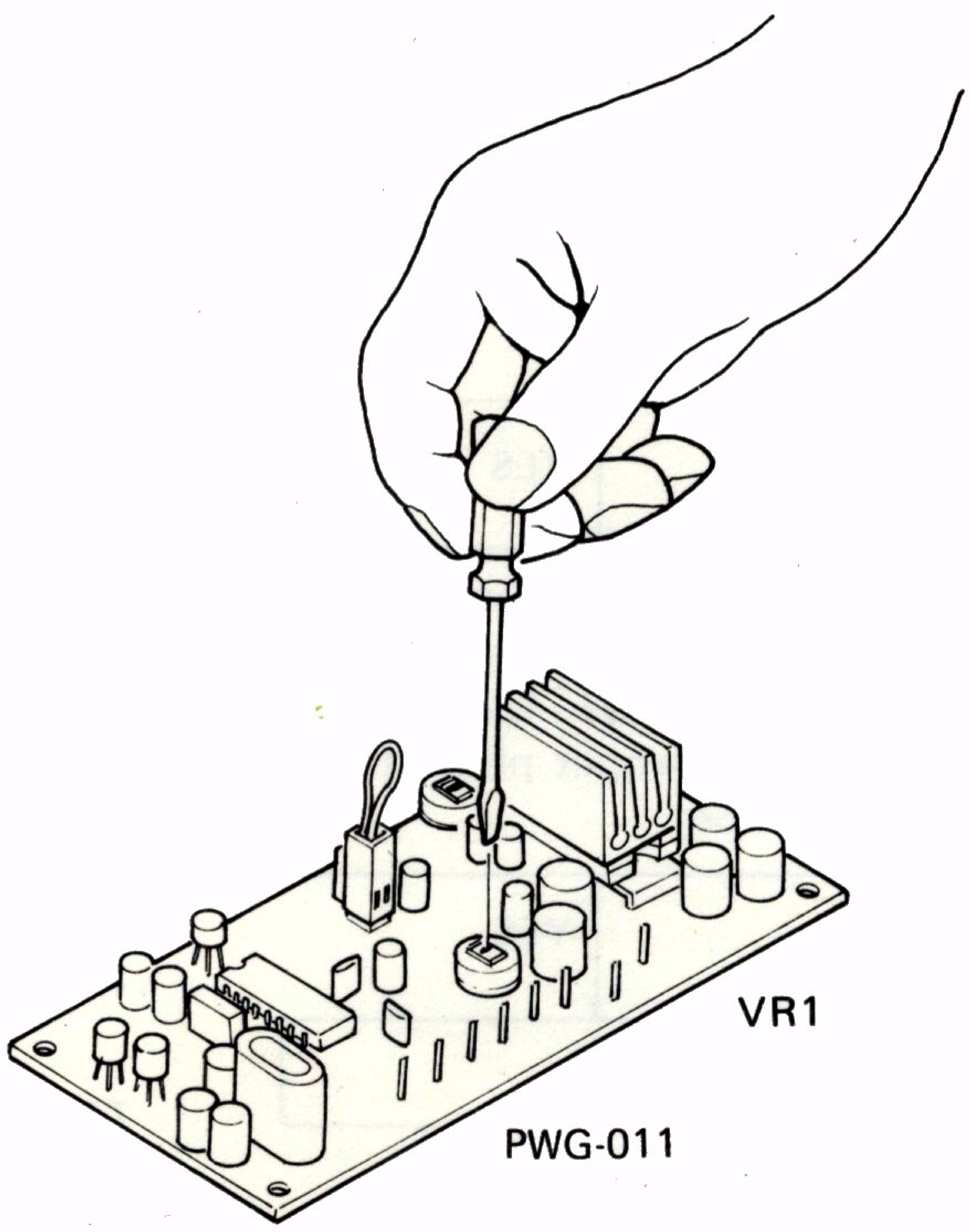



Fig. 16

# 12. D.D. MOTOR EXPLODED VIEW

**NOTE:**
Parts indicated in green type cannot be supplied.