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PS-X6/X7

SONY-00830

US Model
Canadian Model
AEP Model
UK Model
E Model



PS-X7: AEP, UK, E model



PS-X6: AEP, UK, E model

Cartridge is only supplied with the turntable system of E model.

FULL AUTOMATIC STEREO TURNTABLE SYSTEM

SPECIFICATIONS

GENERAL

Power Requirements:	120 V ac, 60 Hz (US, Canadian model) 110, 120, 220 or 240 V ac, 50/60 Hz (AEP, UK, E model)
Power Consumption:	8 W (US, Canadian model) 12 W (AEP, UK, E model)
Dimensions:	Approx. 445 (w) x 150 (h) x 375 (d) mm 17 1/2 (w) x 5 7/8 (h) x 14 3/4 (d) inches including projecting parts and controls
Weight:	US, Canadian model Approx. 10.3 kg, 22 lb 12 oz (net) Approx. 12.1 kg, 26 lb 11 oz (in shipping carton) AEP, UK, E model Approx. 10.9 kg, 24 lb (net) Approx. 12.7 kg, 28 lb (in shipping carton)

TURNTABLE

Platter:	31.7 cm (12 1/2 inches), aluminum-alloy diecast
Motor:	DC servo-controlled motor (brushless and slotless)
Drive System:	Direct drive, crystal lock control system
Speed:	33 1/3 rpm, 45 rpm
Starting Characteristics:	Comes to nominal speed within a third revolution (33 1/3 rpm)

Wow and Flutter:	±0.045% (DIN) 0.025% (WRMS)
S/N Ratio:	73 dB (DIN-B)
Initial Drift:	Within 0.0003%
Load Characteristics:	At 150 g tracking force 0%
Speed Deviation:	Within 0.003%

TONEARM

Type:	Statically balanced, universal pivot
Pivot to Stylus Length:	216.5 mm, 8 1/2 inches
Overall Arm Length:	300 mm, 11 7/8 inches
Overhang:	16.5 mm, 21/32 inches
Tracking Error:	+3°, -1°
Tracking-force Adjustment Range:	0-3 g
Shell Weight:	10.5 g
Cartridge Weight Range:	2.5-9.5 g 8-14.5 g (with extra weight)

- Continued on page 2 -

SAFETY-RELATED COMPONENT WARNING!!

COMPONENTS IDENTIFIED BY SHADING ON THE SCHEMATIC DIAGRAMS AND IN THE PARTS LIST ARE CRITICAL TO SAFE OPERATION. REPLACE THESE COMPONENTS WITH SONY PARTS WHOSE PART NUMBERS APPEAR AS SHOWN IN THIS MANUAL OR IN SUPPLEMENTS PUBLISHED BY SONY.

SONY®

SERVICE MANUAL

PS-X6/X7

CARTRIDGE (XL-15: E model)

Type: Moving magnet type
Frequency Range: 10–30,000 Hz
Channel Separation: 25 dB at 1 kHz
Output Voltage: 4 mV at 1 kHz, 5 cm/sec. 45°
Load Impedance: 50 kΩ
Tracking Force: 1.2–2.5 g (1.7 g recommended)
Stylus: Sony ND-15G (conical 0.6 mil diamond)
Weight: 5.2 g

MODEL IDENTIFICATION

— Specification Label —

PS-X6: US, Canadian model

SONY	STEREO TURNTABLE SYSTEM		
	MODEL NO. PS-X6		
	AC 120V	60Hz	8 W
	SERIAL NO. _____		
	MADE IN JAPAN		

PS-X6: AEP, UK, E model

SONY	STEREO TURNTABLE SYSTEM		
	MODEL NO. PS-X6		
	~ 110. 120. 220. 240V 50/60Hz 12 W		
	SERIAL NO. _____		
	MADE IN JAPAN		4-853-094-01

PS-X7: US, Canadian model

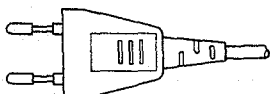
SONY	STEREO TURNTABLE SYSTEM		
	MODEL NO. PS-X7		
	AC 120V	60Hz	8 W
	SERIAL NO. _____		
	MADE IN JAPAN		

PS-X7: AEP, UK, E model

SONY	STEREO TURNTABLE SYSTEM		
	MODEL NO. PS-X7		
	~ 110. 120. 220. 240V 50/60Hz 12 W		
	SERIAL NO. _____		
	MADE IN JAPAN		4-853-092-01

— Power Cord of E model —

Euro-plug



Parallel-blade plug



SECTION 1 OUTLINE

1-1. MECHANICAL DESCRIPTION

Automatic Operation Mechanism

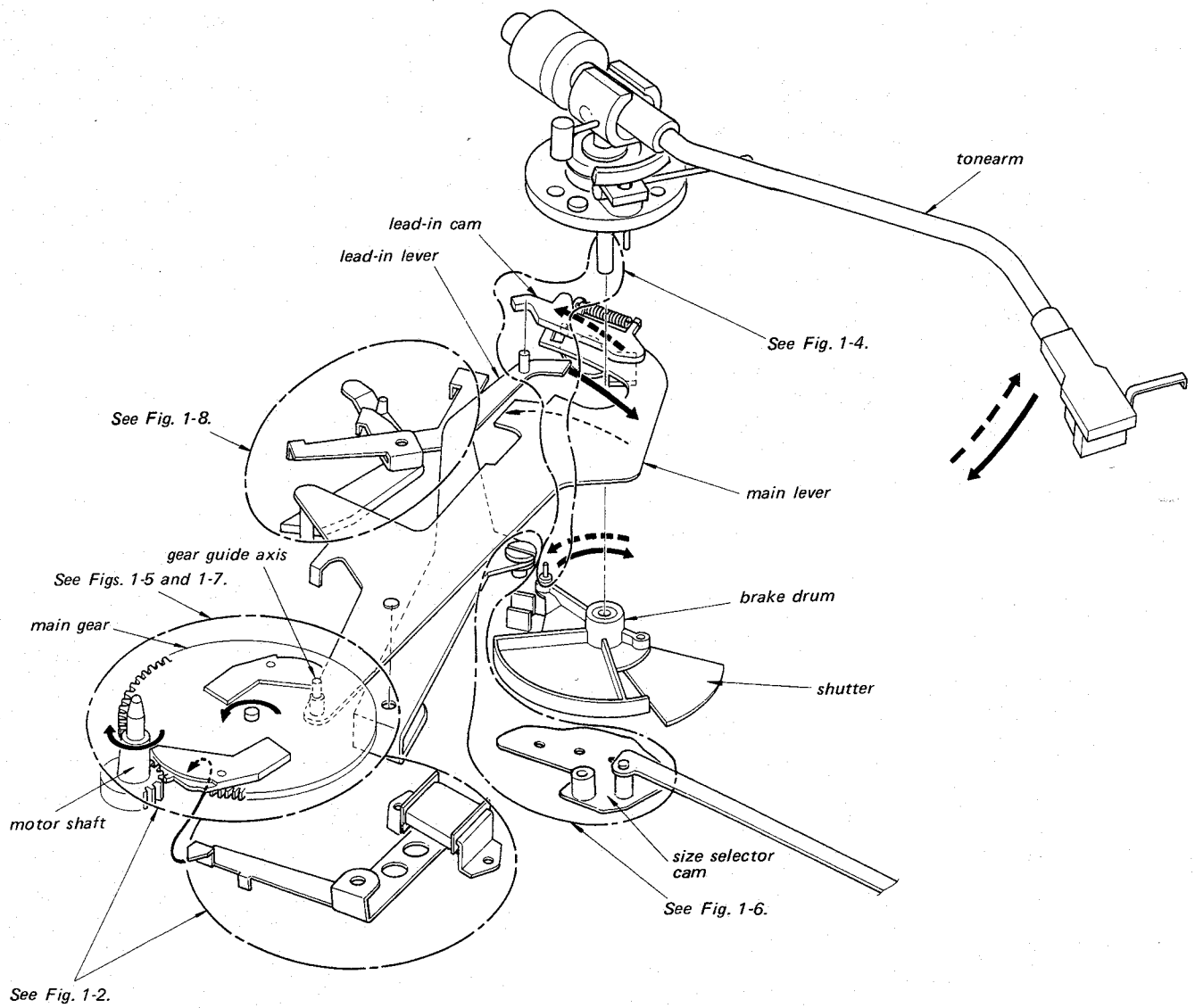


Fig. 1-1.

The PS-X6 and PS-X7 are a full-automatic turntable system, which means that the tonearm will move across to the record and commence to play, and then return to the arm rest again after the completion of the record, simply by the operation of control buttons. This cycle of operations is performed by the transfer of a series of changes from the main gear cam to the main lever. This series of changes is described below.

Operations During Start of Play

1. The tonearm's horizontal movement

1. When the metal part of the START/STOP button is touched by the hand, the system control circuit is activated, resulting in the motor commencing to rotate, and current flowing through the solenoid (PM).
2. With current flowing through the solenoid, the kick lever is pulled in direction ①, resulting in tip ① of the kick lever pushing against part ② of the sub-gear (L). This sub-gear is thus pushed out in direction ② to engage the center gear mounted on the motor shaft. (See Fig. 1-2.)

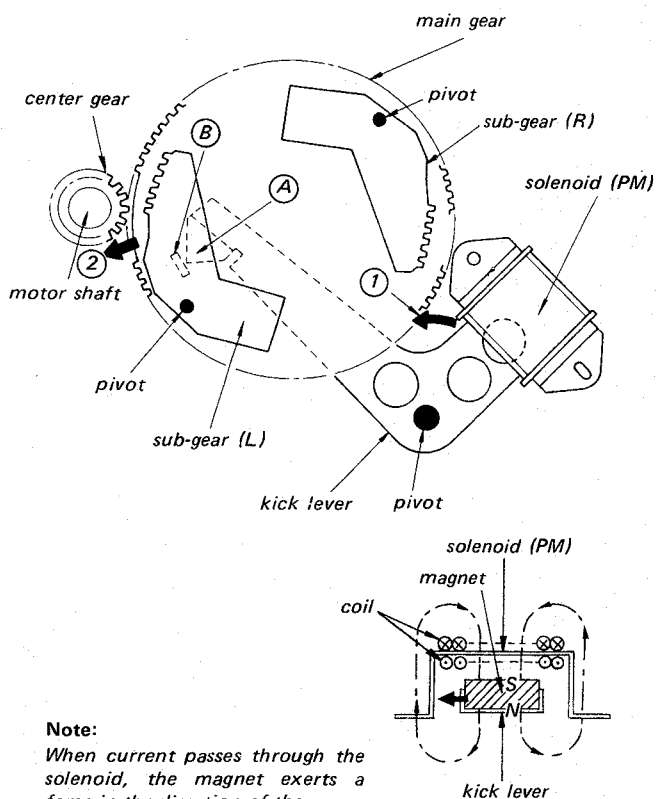


Fig. 1-2.

3. Once the revolving center gear engages the sub-gear (L), the main gear will commence to rotate in the counterclockwise direction due to the driving force supplied by the motor. It will stop again in the position shown in Fig. 1-7.
4. The gear guide axis at the tip of the main lever, is guided by the shaded section of the heart-shaped cam groove located on the main gear, moving across in a curved path ③ to position ④. Therefore, the main lever moves in the direction of arrow ③. (See Fig. 1-3.)

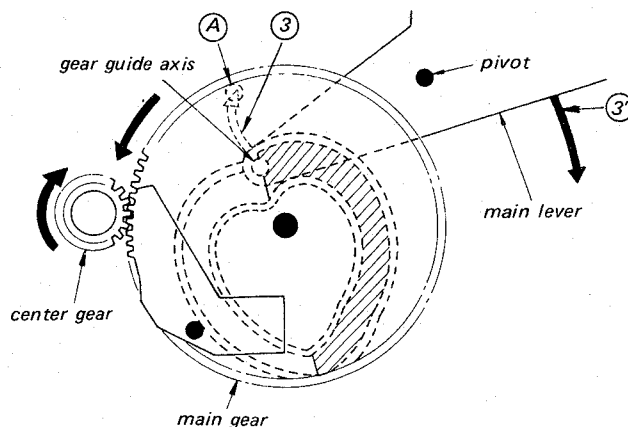


Fig. 1-3.

5. At this time, the lead-in lever moves in the direction of arrow ④, guided by the lead-in cam which moves together with the main lever. The tip ④ of the lead-in lever moves to position ⑤, pushing against a pin on the brake drum in the direction of arrow ⑥. And since this brake drum moves in unison with the tonearm, the tonearm will move across (horizontal movement) in the direction of arrow ⑤. (See Fig. 1-4.)

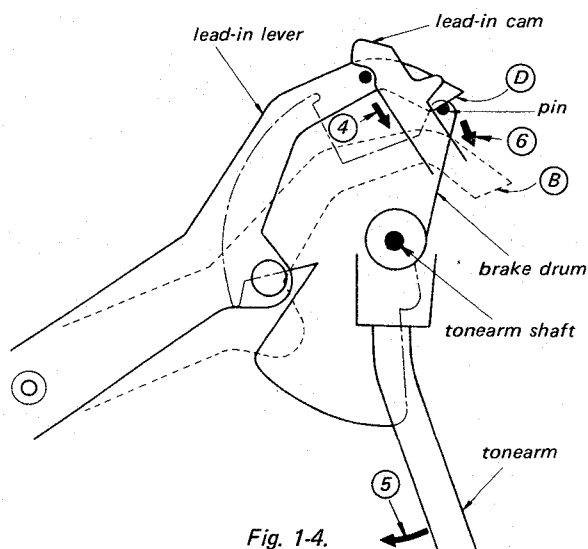


Fig. 1-4.

Lowering of tonearm onto record

The central axis of the push rod resting against the tonearm lifter is on the position ③ in STOP mode. (See Fig. 1-5.)

During lead-in, the main lever moves across in the direction of arrow ③' (See Fig. 1-3), resulting in the position of the central axis of the push rod moving across as shown by arrow ⑦. (Fig. 1-5.)

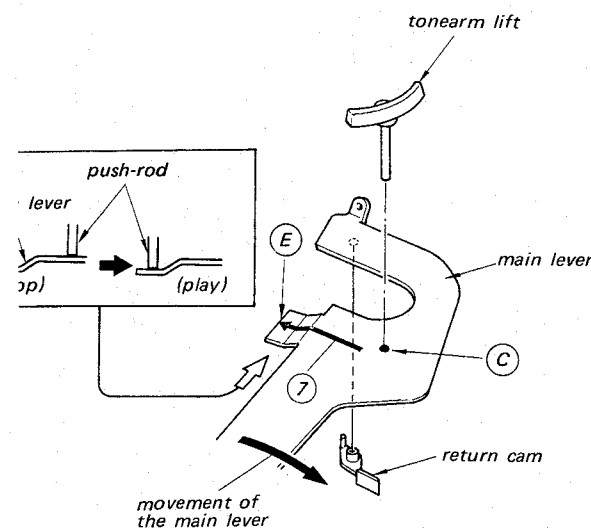


Fig. 1-5.

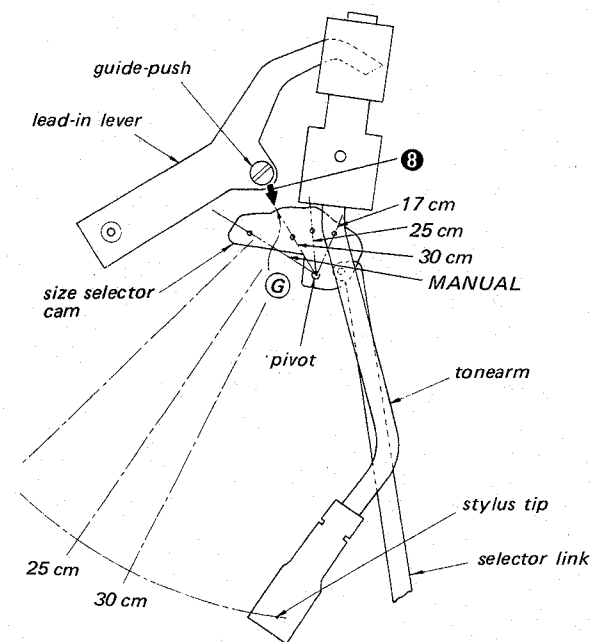


Fig. 1-6.

3. The guide-push stops at the position determined by the surface ⑥ (Fig. 1-6) of the record size selector cam. The push rod consequently descends to the lower position ⑤ of the main lever (Fig. 1-5), resulting in the tonearm lowering onto the surface of the record for the commencement of play.
4. The position where the tonearm lowers (30 cm, 25 cm, 17 cm) is determined by the position of the record size selector cam shown in Fig. 1-6. The guide-push of the lead-in lever moves across in direction of arrow ⑧ during lead-in, and meets the size selector cam at surface ⑥ (for the 30 cm example shown), thus determining the drop point at the outer edge of a 30 cm record. That is, this position determines the distance moved by the lead-in lever, which consequently determines the rotational angle of the brake drum (and of the tonearm as well). With the record size selector knob set to the MANUAL position, the lead-in lever moves a little and the tonearm does not move.
5. The attaching shaft of the guide-push is not positioned at a center of the guide-push and the edge of the record size selector cam is formed a curve, so the fine adjustment of the stylus drop-point can be performed by turning the guide-push.

Operation During Return of Tonearm

Although the return operation can be activated in 2 different ways, the operation itself is the same.

- Tonearm made to return during playing of a record by touching the START/STOP button.
- Automatic return as a result of the tonearm activating the record end detector mechanism (luminous sensor record end detector).

1. While the record is being played, the main gear and main lever are in the positions as shown in Fig. 1-7.
2. If the START/STOP button is touched during play, or if the record finishes playing, the systems control circuit is activated. A current flows through the solenoid (PM), and the kick lever moves in the same way as at the beginning of record play (see Fig. 1-2). This time, however, the sub-gear (R) is pushed back and engaged with the center gear, thus rotating the main gear again in the counterclockwise direction.
3. The gear guide axis at the tip of the main lever is moved across to position ⑤ by following the curved path ⑨ due to the guiding action

of the shaded portion of the groove in the heart-shaped cam positioned on the main gear. The main lever consequently moves across in the direction of the arrow ⑨ (see Fig. 1-7).

4. At this time, the push rod is forced back up onto the main lever, resulting in the tonearm lifting up from the record surface.

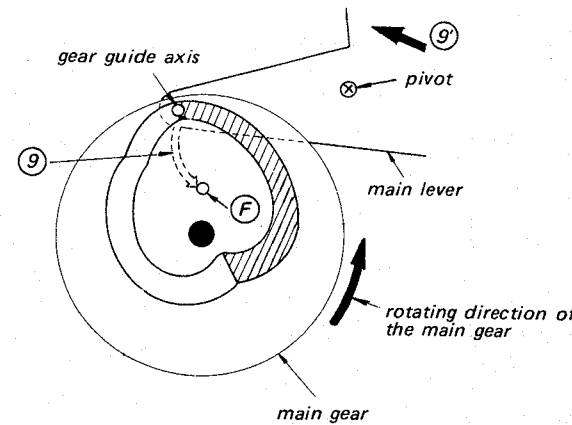


Fig. 1-7.

5. The return cam attached to the main lever (see Fig. 1-5) pushes against the pin of the brake drum, forcing the tonearm to move back (horizontally) towards the arm rest.
6. The return operation is completed when the tonearm arrives back at the arm rest. The main gear comes to a stop in the position shown in Fig. 1-3.

Brake Mechanism (Operation of brake lever)

A fixed amount of braking is applied to the brake drum in order to assure smooth travel of the tonearm during both lead-in and return.

Furthermore, a spring is also employed to exert pressure upon the main lever in the direction of arrow ⑩ (see Fig. 1-8), thus keeping the main gear in the stop position. (See Fig. 1-3.)

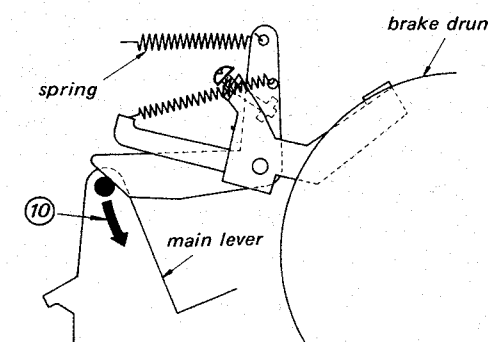


Fig. 1-8.

Record End Detector Mechanism (Luminous Sensor Record End Detector Mechanism)

(see Figs. 1-9 and 1-10)

This record end detector mechanism consists of a lamp, a photo-conductor (CdS), and a shutter connected to the shaft of the tonearm. Changes in position of the shutter (due to the gradual inward movement of the tonearm) results in changes in the amount of light received by the photosensitive element. When the stylus runs in the lead-out groove of the record, the tonearm suddenly moves across by a relatively larger amount, resulting in a sudden increase in the amount of light striking the photo-sensitive element, exceeding a preset value. An electronic circuit is consequently activated, resulting in current flowing through the solenoid.

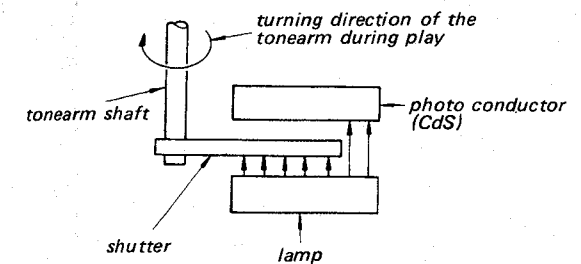


Fig. 1-9.

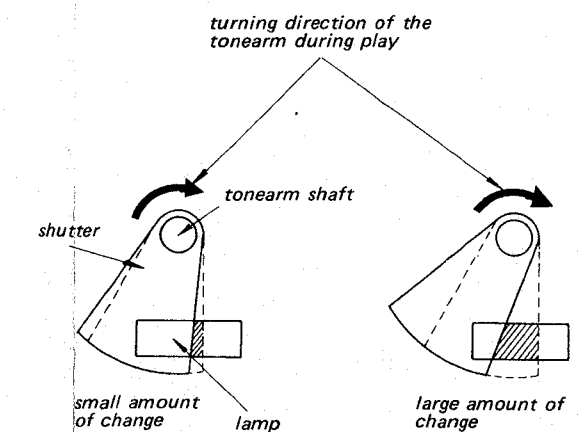
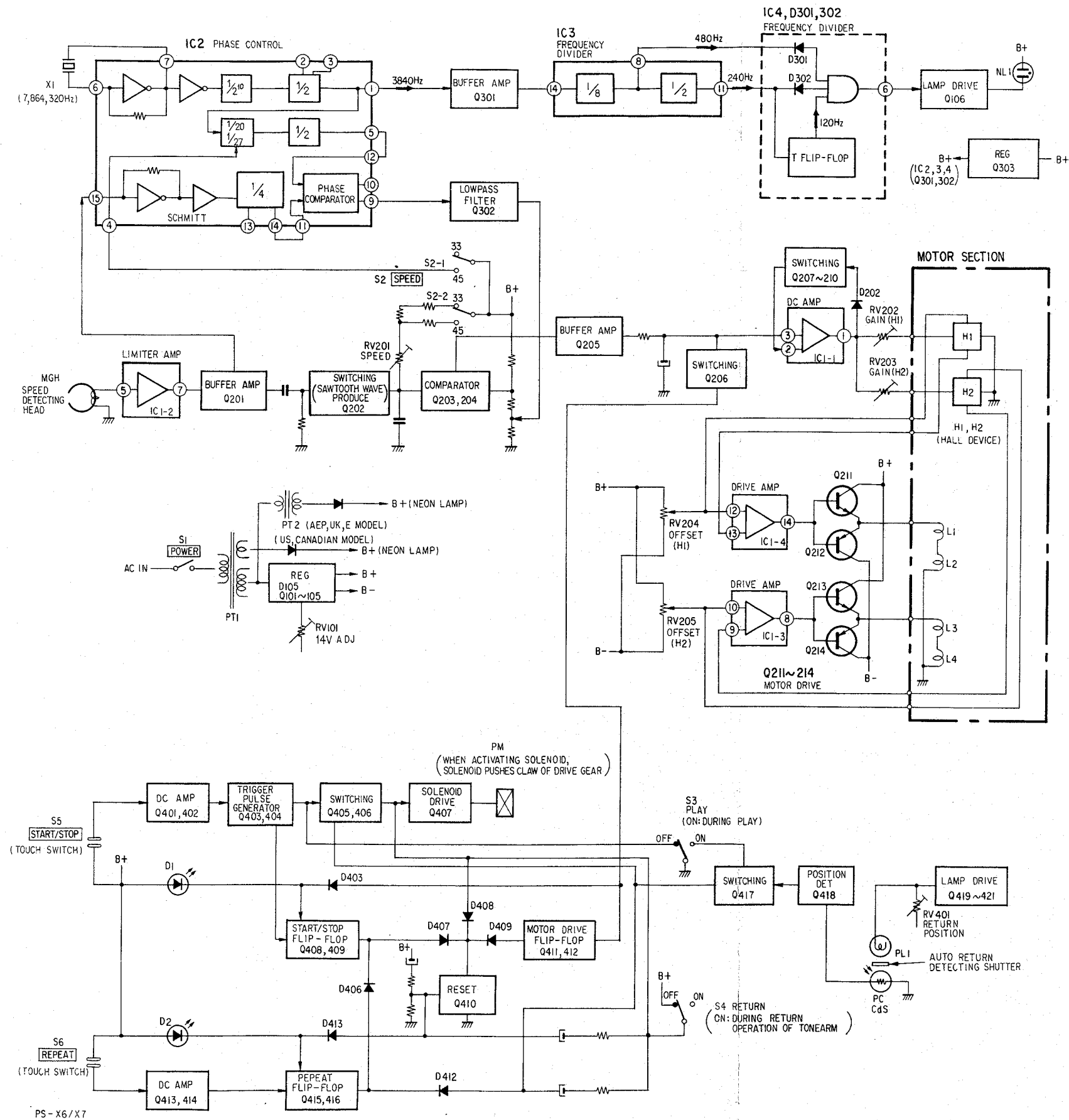


Fig. 1-10.

PS-X6/X7 PS-X6/X7

DIAGRAM

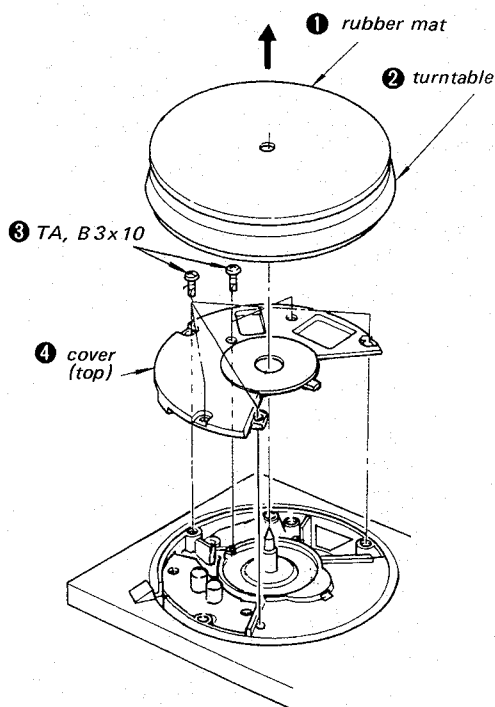


SECTION 2 DISASSEMBLY AND REPLACEMENT

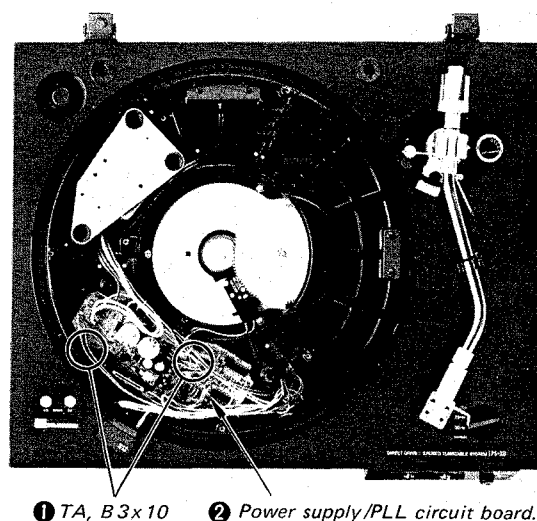
2-1. REMOVAL

Remove the parts in the numerical order.

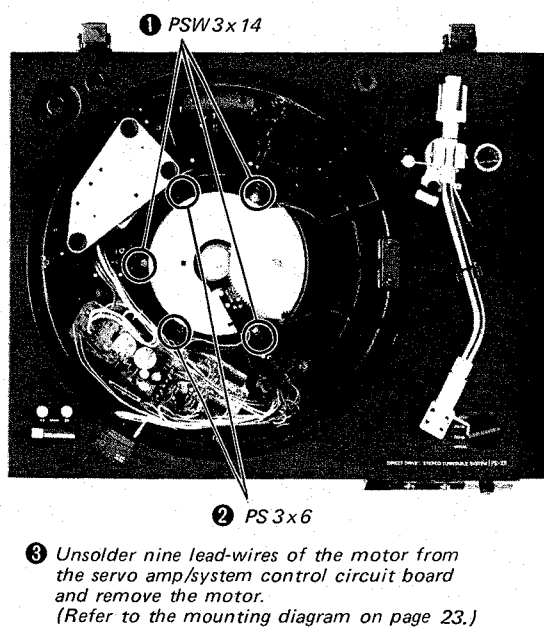
Cover (top) Removal



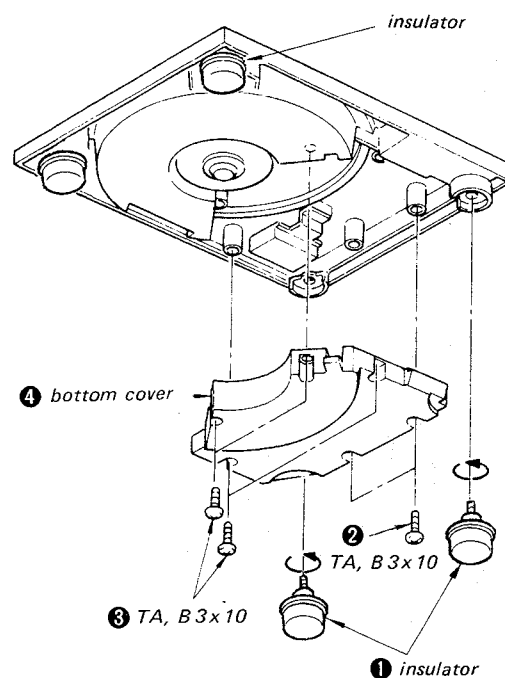
Power Supply/PLL Circuit Board Removal



Motor Removal

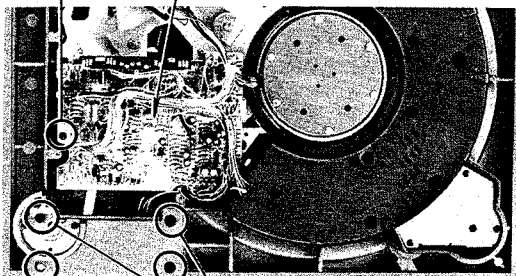


Bottom Cover Removal



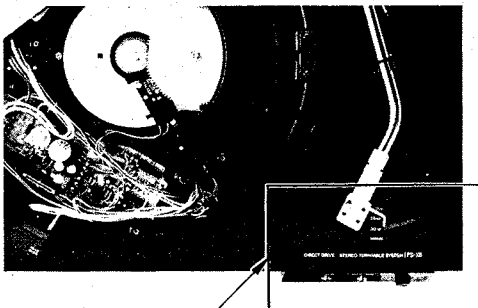
Servo Amp/System Control Circuit Board Removal

- ① TA, B 3x10 ② servo amp/system control circuit board



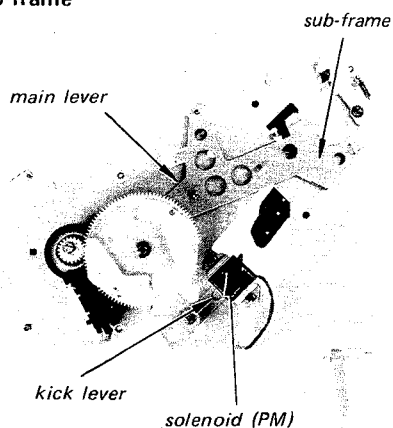
- ③ TA, P 3x30 W4 ④ TA, B 3x10

Control Panel Removal



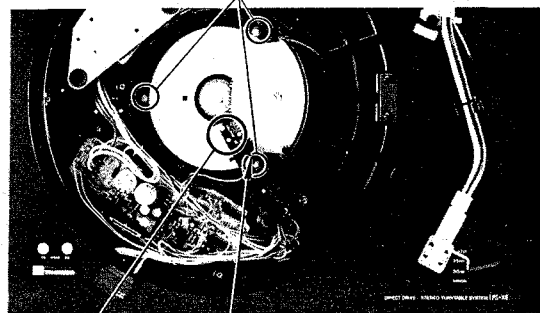
- ⑤ Control panel, touch switch circuit board, power switch, record size selector lever can be removed.

Sub-frame

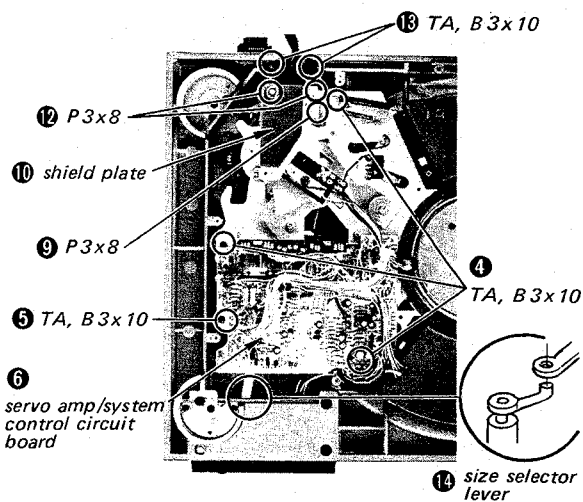


Sub-flame Removal

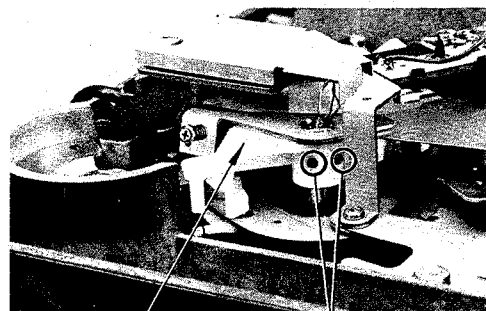
- ① PSW 3x14



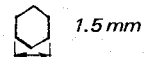
- ② PS 3x14 ③ return switch (S4)



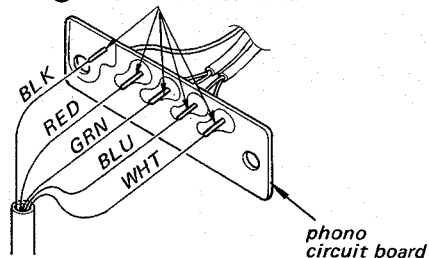
- ⑥ servo amp/system control circuit board



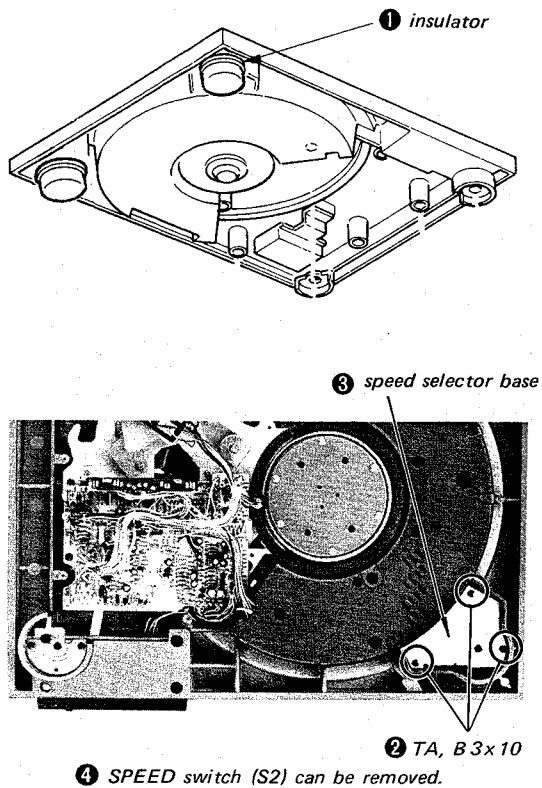
- ⑧ brake drum ⑦ SC M 3x6, hexagon socket



- ⑪ Unsolder five lead-wires.

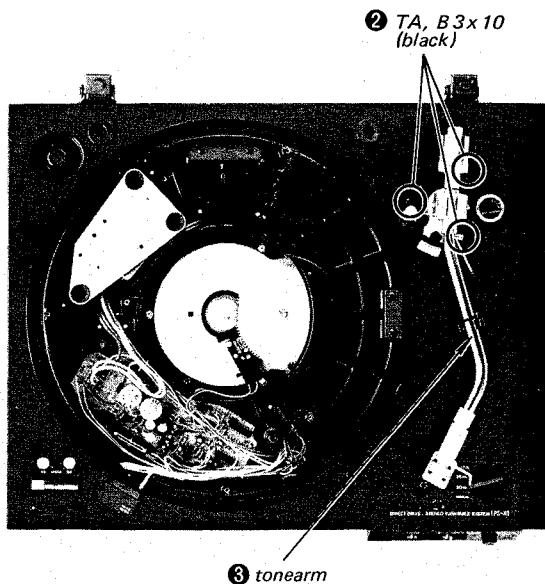


SPEED Switch (S2) Removal

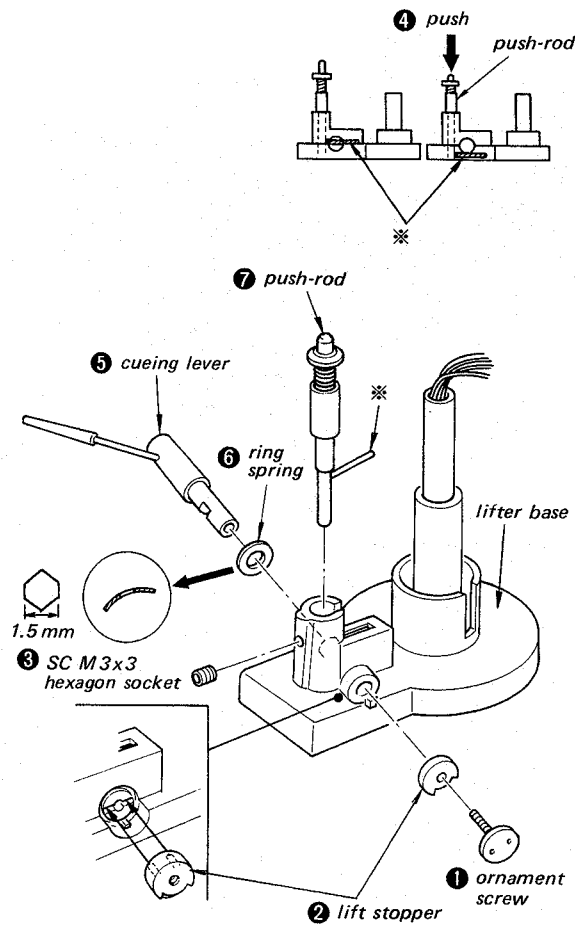


Tonearm Removal

- 1 Remove the brake drum and five lead wires.
(Refer to Sub-frame Removal - 8 and 11.)

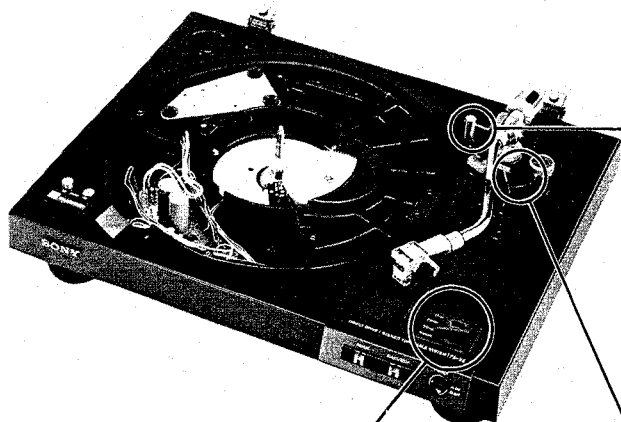


Arm Lifter Shaft Removal



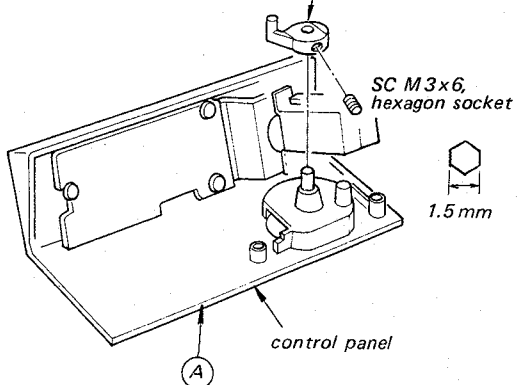
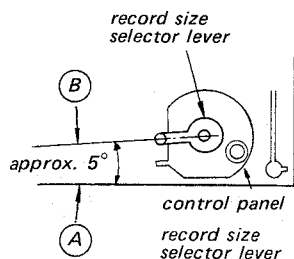
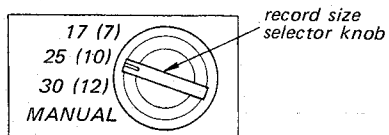
- Note:
- When installing the cueing lever, take care to the direction of the ring spring 6.
 - After installing the cueing lever, make sure that the push-rod is smoothly moved up and down by the cueing lever.

2-2. CAUTION FOR INSTALLATION



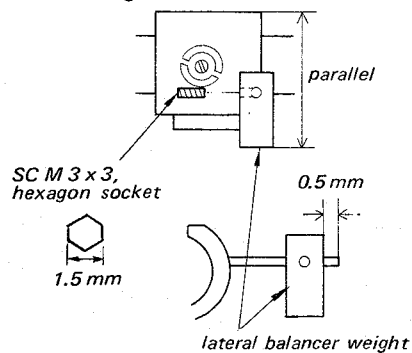
Record Size Selector Lever Installation

- ① Set the record size selector knob to the 25 (10) position.
- ② Install and set the record size selector lever as shown below.



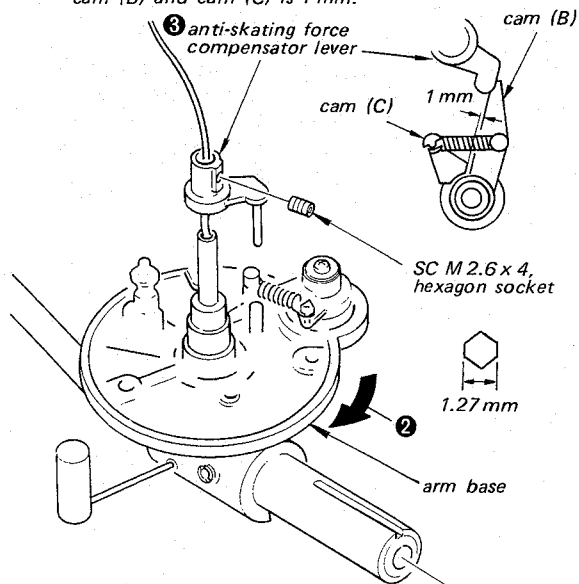
- ③ Set the record size selector knob to the MANUAL position and, when touching the start/stop switch, make sure that the tonearm does not move.

Lateral Balancer Weight Installation



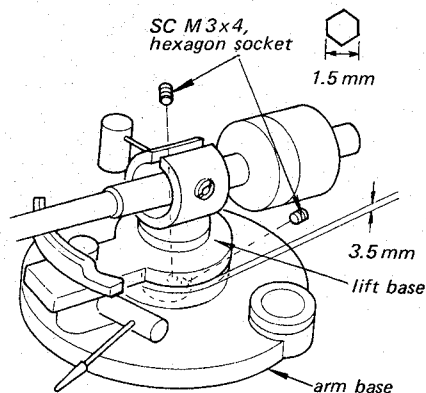
Anti-skating Compensator Lever Installation

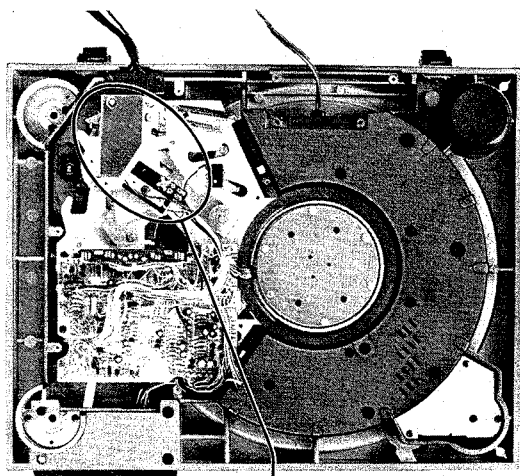
- ① Set the anti-skating force compensator knob to 0.
- ② Turn the arm base fully clockwise.
- ③ Install the anti-skating force compensator lever so that the clearance between the cam (B) and cam (C) is 1 mm.



Lift Base Installation

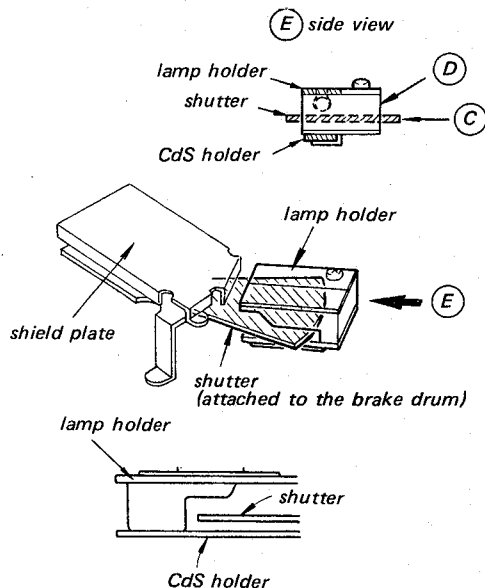
Install the lift base so that the clearance between the arm base and lift base is 3.5 mm.





Brake Drum Installation

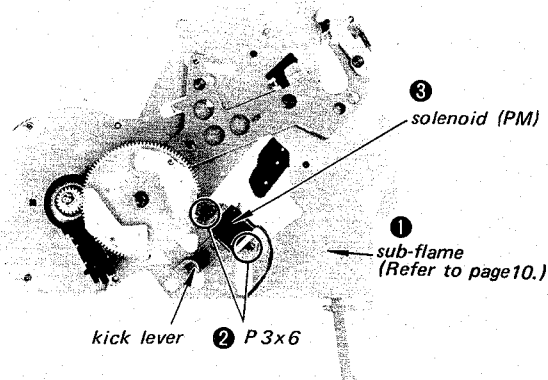
1. Install the brake drum at the tonearm shaft and set the tonearm on the tonearm rest.
2. Move the shutter to align the face (C) of the shutter and the face (D) of the lamp holder as shown below.



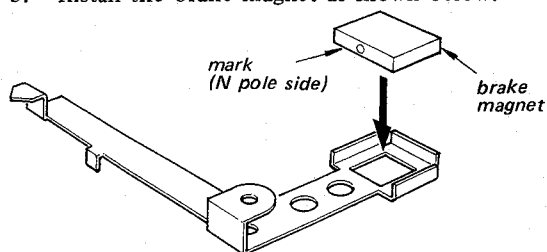
Note: Make sure that the shutter does not touch the lamp holder and the CdS holder.

Brake Magnet Installation

1. Remove the solenoid as shown below.

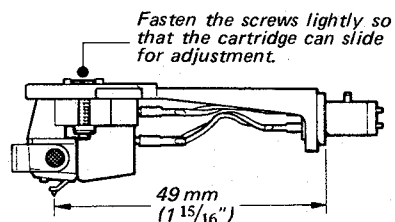


2. Apply the Sony bond master G580 to the brake magnet.
3. Install the brake magnet as shown below.

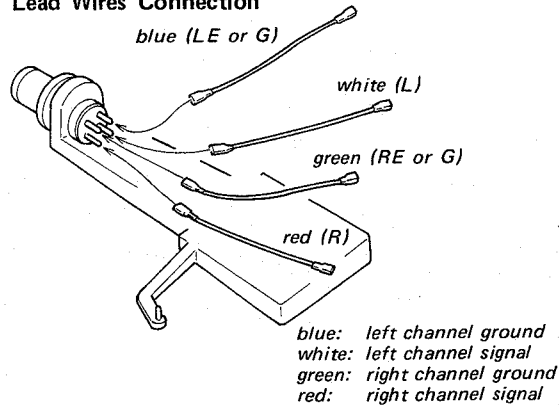


Cartridge Installation

Install the cartridge into the shell with the mounting screws so that the distance between the shell end and the stylus tip is 49 mm (1 15/16 inches).

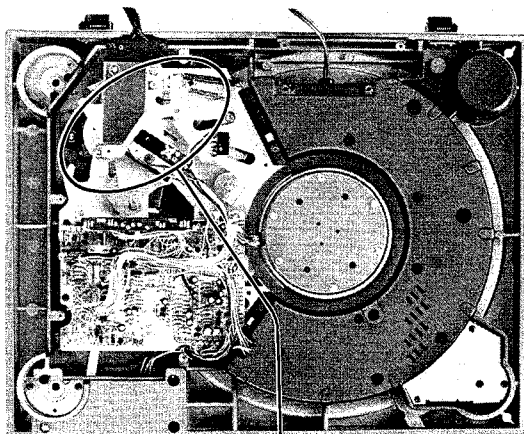


Lead Wires Connection



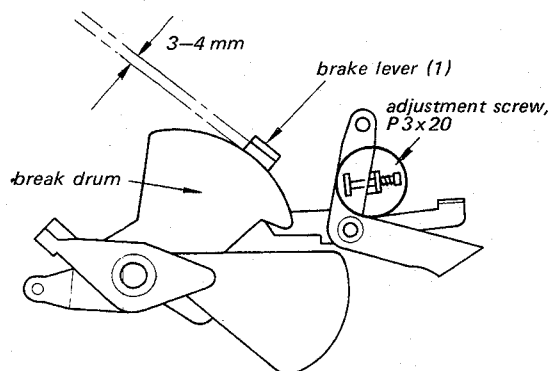
SECTION 3 ADJUSTMENTS

3-1. MECHANICAL ADJUSTMENTS

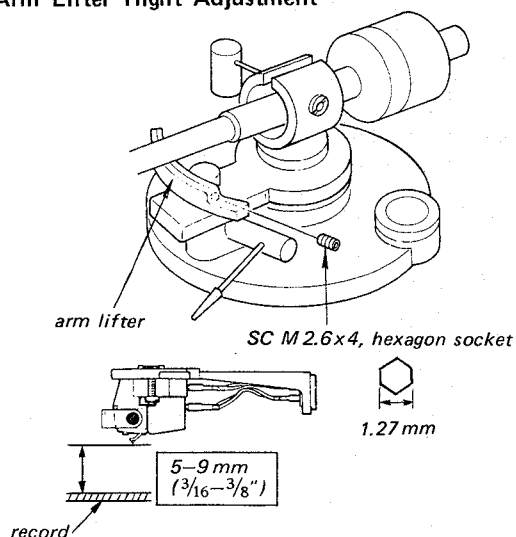


Brake Lever (1) Position Adjustment

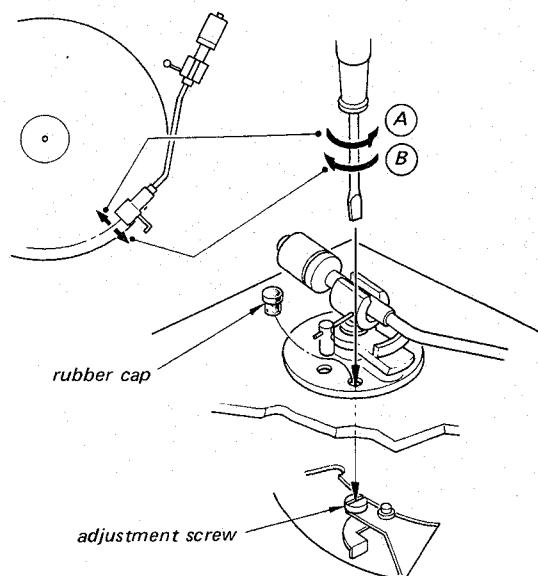
1. Set the tonearm on the tonearm rest and turn the adjustment screw as shown below.
2. Make sure that the tonearm moves smoothly.



Arm Lifter Height Adjustment



Stylus Drop-point Adjustment



1. Set the record size selector lever to the 30 (12") position and make sure that the stylus gets down on the specified point of the test record.

test record: YFSC-16

Record size selector lever position	Count of drop-point
30 (12")	4 to 16
25 (10")	6 to 24
17 (7")	7 to 25

2. If necessary, insert the screw-driver into the hole and adjust the drop-point by turning the adjustment screw.

To change the drop-point inward:

Turn the adjustment screw slightly counterclockwise (A)

To change the drop-point outward:

Turn the adjustment screw slightly clockwise (B)

3. Once it is properly adjusted with a 30 cm (12") record, the drop-point will be correct for 17 cm (7") and 25 cm (10") records as well.

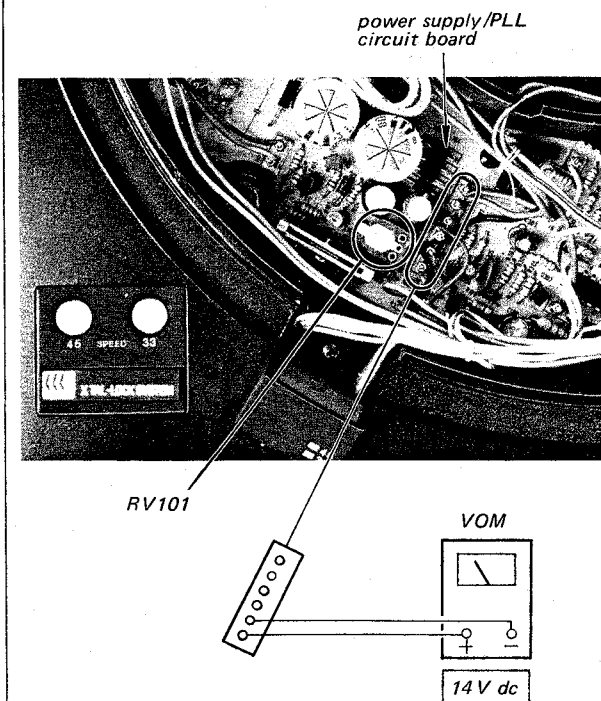
Note: The stylus drop-point is changed to about 12 mm ($\frac{1}{2}$ ") by one turn of the adjustment screw.

3-2. ELECTRICAL ADJUSTMENTS

Note: Wait a few seconds for warm-up after the power switch is turned on.

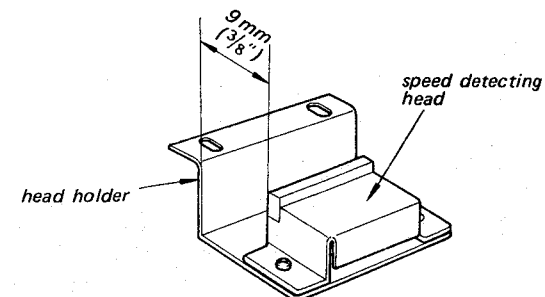
B+ (14 V) Adjustment

Adjust RV101 for 14V reading on VOM.

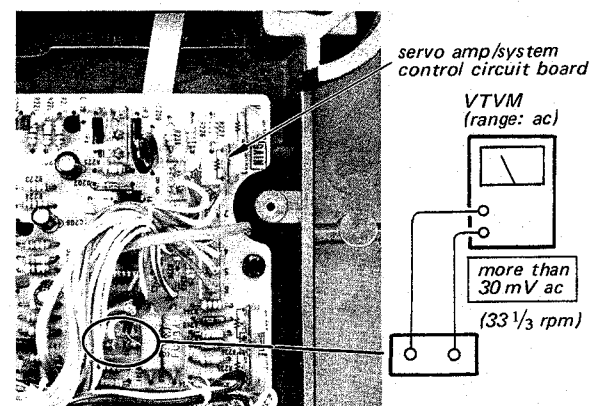


Speed Detecting Head Output Level Adjustment

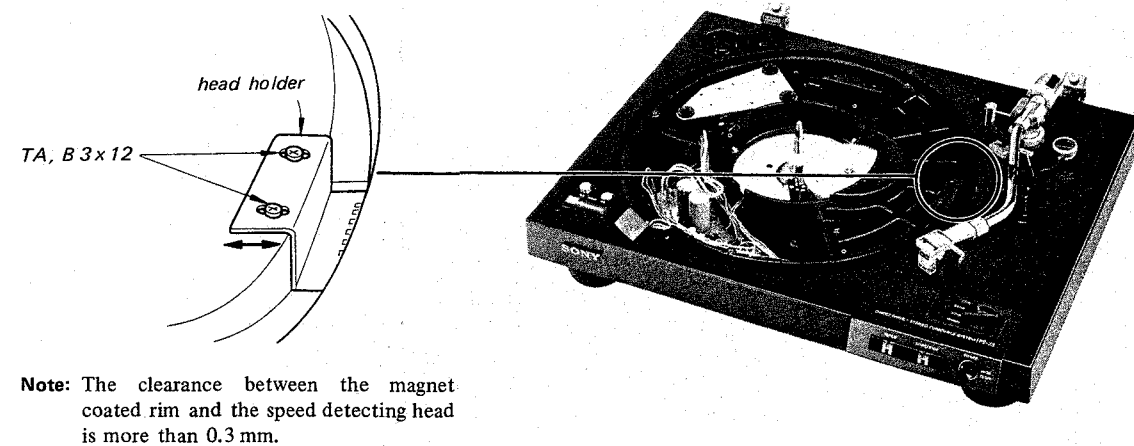
Before this adjustment, set the speed detecting head on the head holder as shown below.



1. Adjust the position of the head holder so that the VTVM reading is more than 30 mV ac at 33 1/3 rpm.
2. Make sure that the head does not touch the turntable and tighten the screws securely.

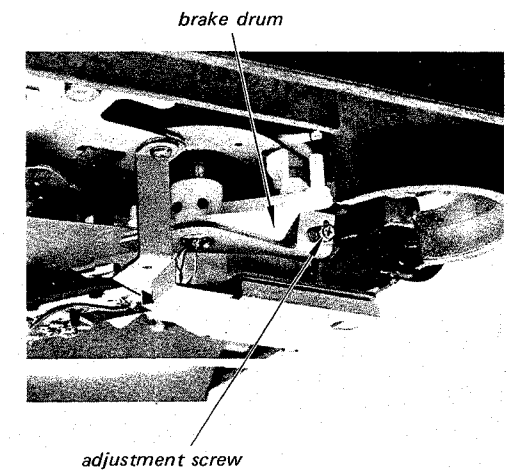
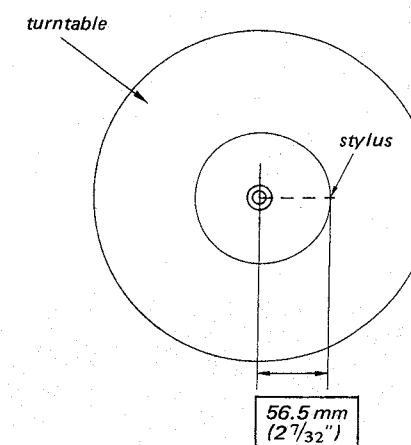


Adjustment Location:



Automatic Return Adjustment

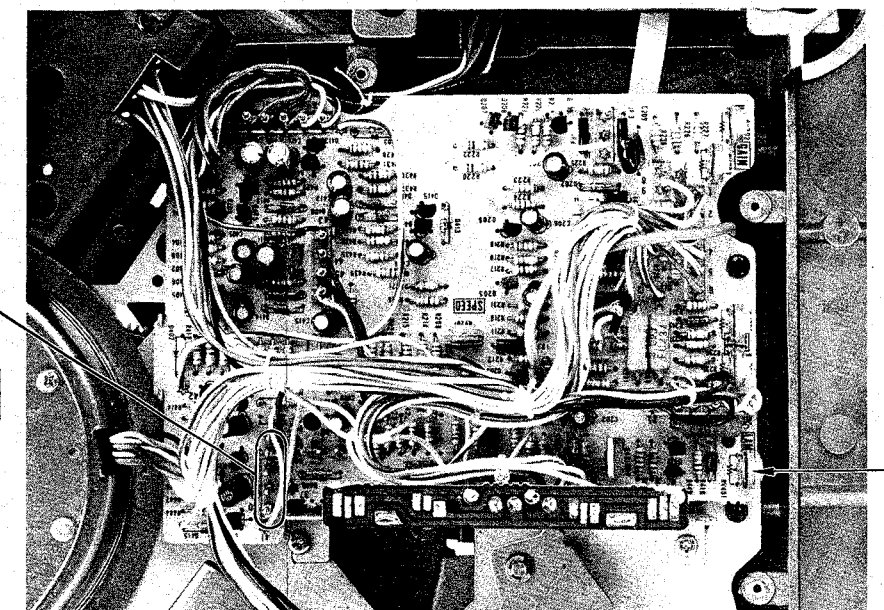
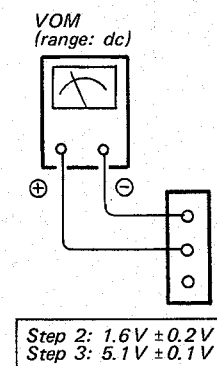
1. Move the tonearm into the turntable center by hand so that the shutter keeps apart from the CdS and lamp holder.
2. With the play switch (S3) pushed, adjust RV401 for 1.6V ± 0.2V reading on VOM.
3. Set the position of the stylus as shown below and turn the adjustment screw for 5.1V ± 0.1V reading on VOM with the play switch (S3) pushed.
4. When playing the band 2 of the test record, make sure that the tonearm returns from the count 14 to 18 of the test record. If necessary, readjust the adjustment screw.
5. When playing the band 3 of the test record, make sure that the tonearm returns from the position of 1 kHz signal. If necessary, readjust RV401 and repeat above steps 4 and 5.



Adjustment Location:

— servo amp/system control board —

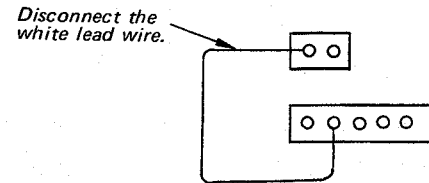
control panel side



Note: When replacing the pilot lamp (PL1), this adjustment should be performed.

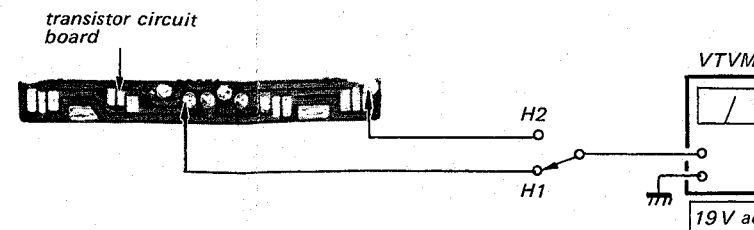
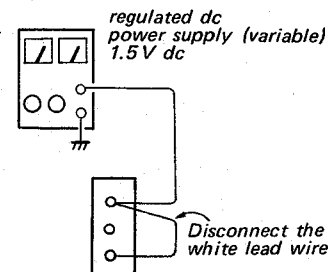
Turntable Speed Adjustment

1. Disconnect the white lead wire and adjust RV201 so that the stroboscope pattern appears stationary.
2. Connect the white lead wire and make sure that the stroboscope pattern appears stationary after changing the turntable speed by hand.

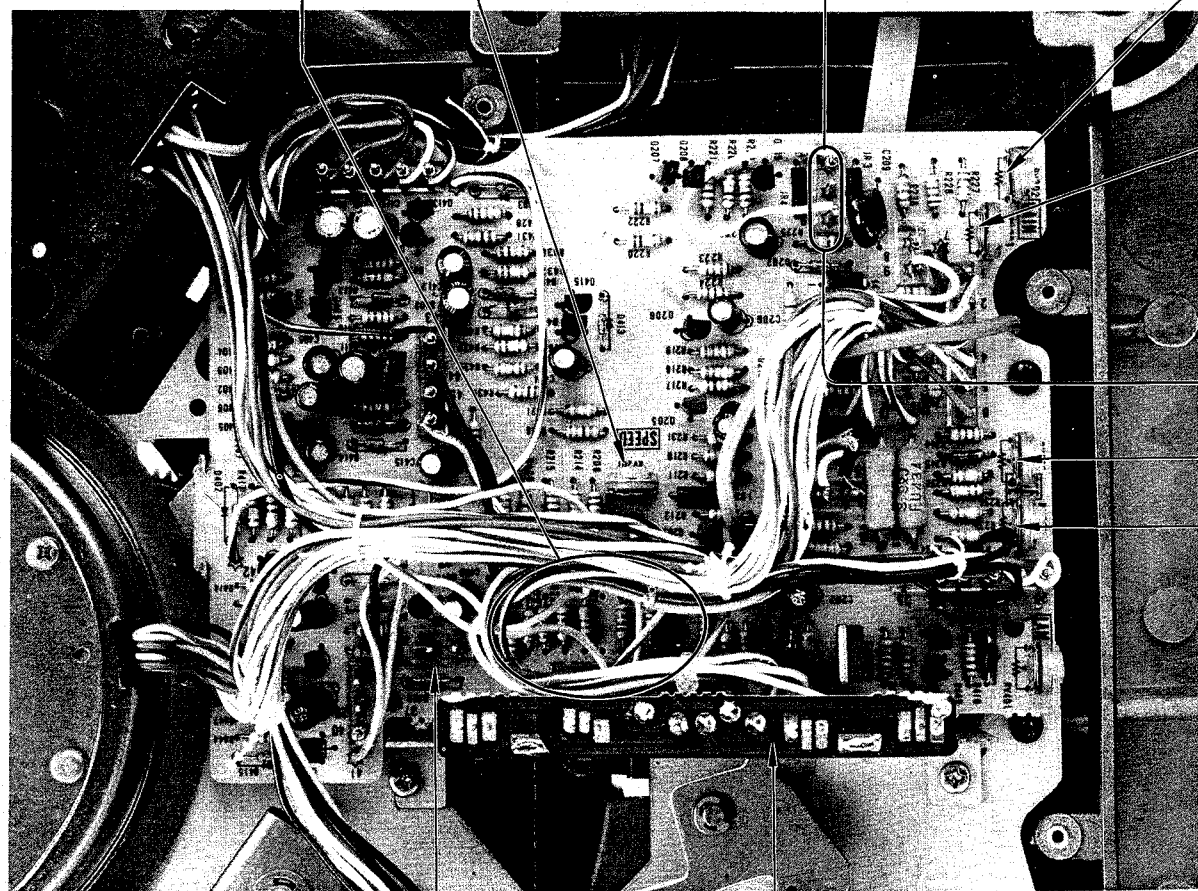
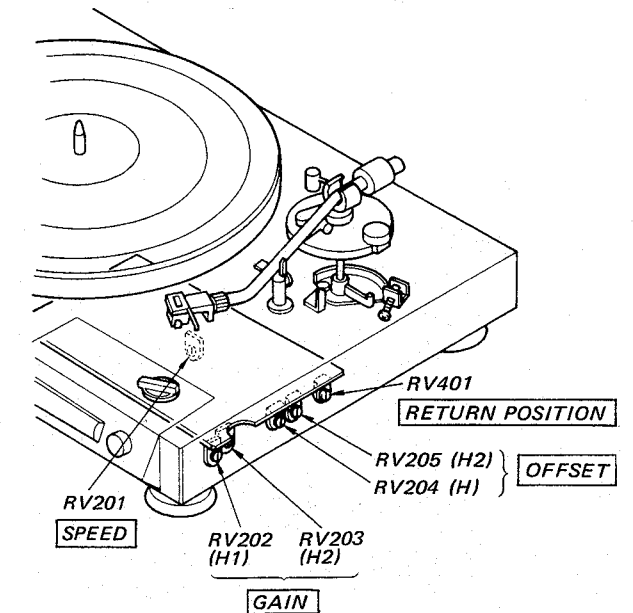


Hall Device Gain Adjustment (33 1/3 rpm)

1. Disconnect the white lead wire and connect the regulated power supply as shown below.



ADJUSTMENT LOCATION

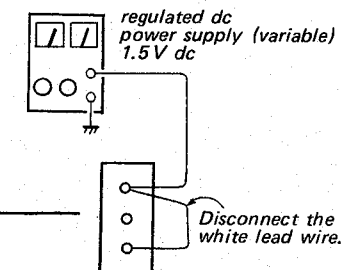


servo amp/system control circuit board

transistor circuit board

Motor Amp Offset Adjustment (33 1/3 rpm)

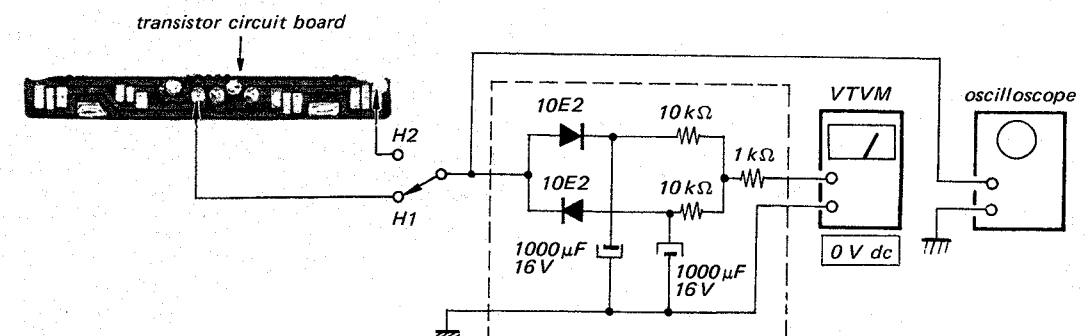
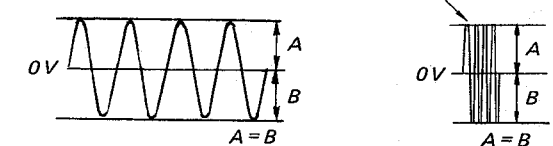
1. Disconnect the white lead wire and connect the regulated power supply as shown below.



2. Connect VTVM or oscilloscope to H1 and adjust RV204 for 0V dc VTVM reading or the waveform on oscilloscope as shown below.
3. Connect VTVM or oscilloscope to H2 and adjust RV205 for 0V dc VTVM reading or the waveform on oscilloscope as shown below.

Waveform on Oscilloscope:

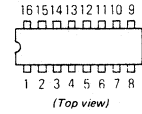
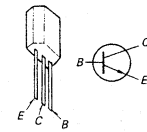
Note: Set the sweep time to longer for easy checking the waveform.



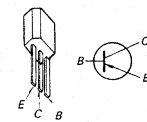
Replacement Semiconductors

For replacement, use semiconductors except in ().

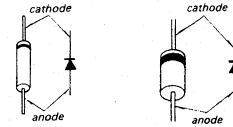
Q106: 2SC926A
Q102, 103 } 2SC634A
Q301-303 } (2SC633A) IC2: MSM5811



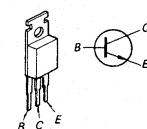
Q104: 2SA678
(2SA677)



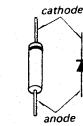
D101-104: 10E2 (GP08-D)



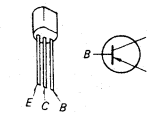
Q101: 2SC1061
(2SC1419)



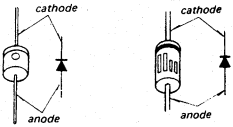
D301, 302: 1S1555
(1T40)



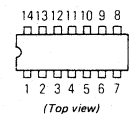
Q105: 2SA684
(2SA773)



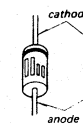
D106: 10D6 (SIB01-06)



IC3: M53293P (SN7493AN)
IC4: M53200P (SN7400N)



D105: EQB01-06
(EQA01-06)

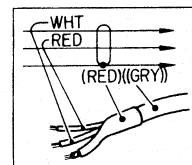


Note:

- — : parts extracted from the component side.
- — : parts extracted from the conductor side.

- : nonflammable resistor.
- : fusible resistor.

- Color code of sleeving over the end of the jacket.



4-1. MOUNTING DIAGRAM — Power Supply/PLL Board —

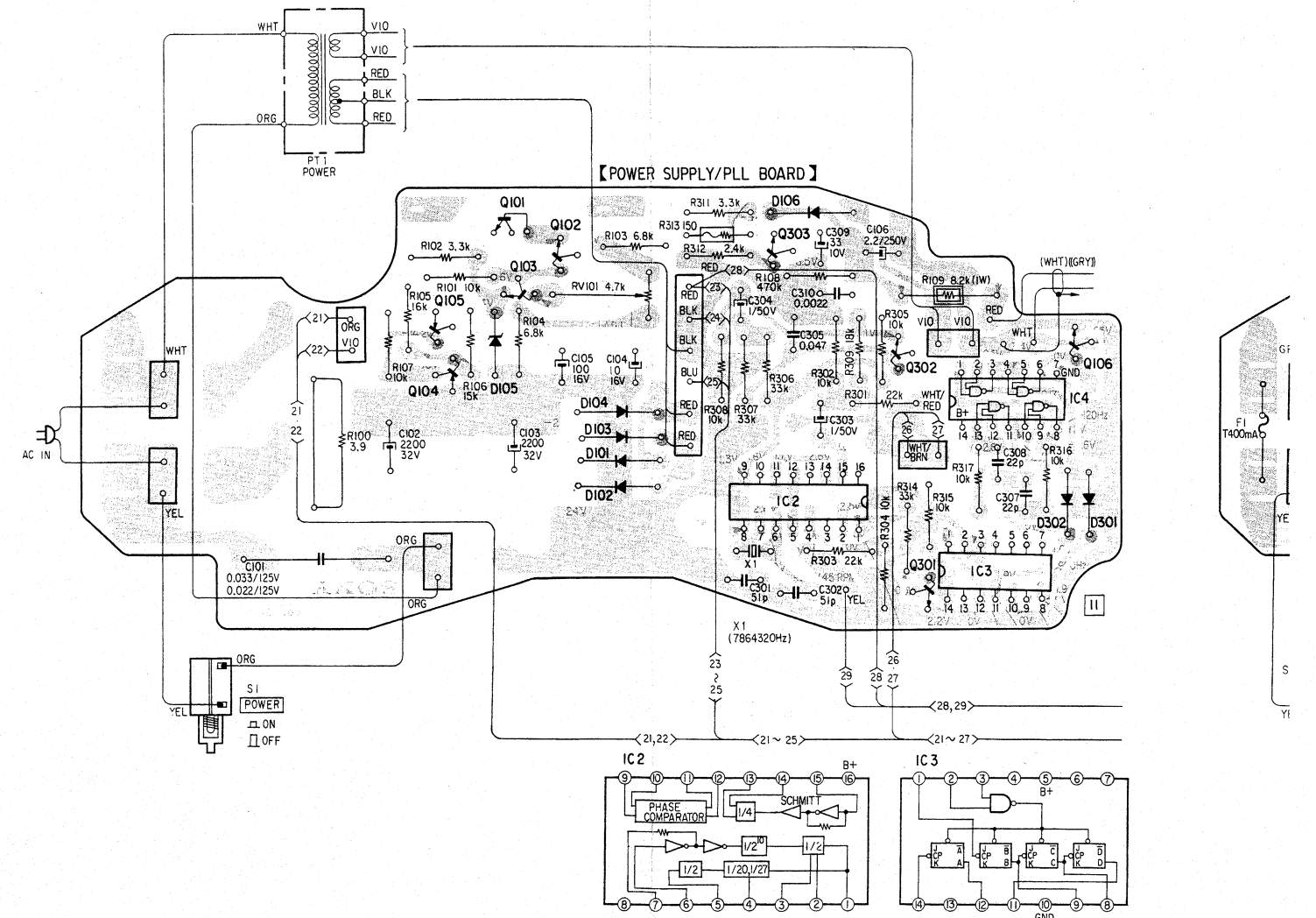
— Conductor Side —

US, Canadian model

Q	IC	D
	I05 I04	I01 I03
	I02	I04 I03 I01 I02
	303 IC2	302 301
	IC4 IC3	I06
		302,301

AEP,

Q	IC	D

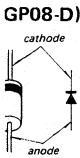


4-1. MOUNTING DIAGRAM – Power Supply/PLL Board –

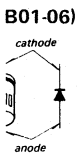
– Conductor Side –

US, Canadian model

Q		I05	I01	I02		303	302	IC4	I06
IC		I04	I03			IC2	301	IC3	
D		I05	I03	I04	I06				302,301
			I01	I02					



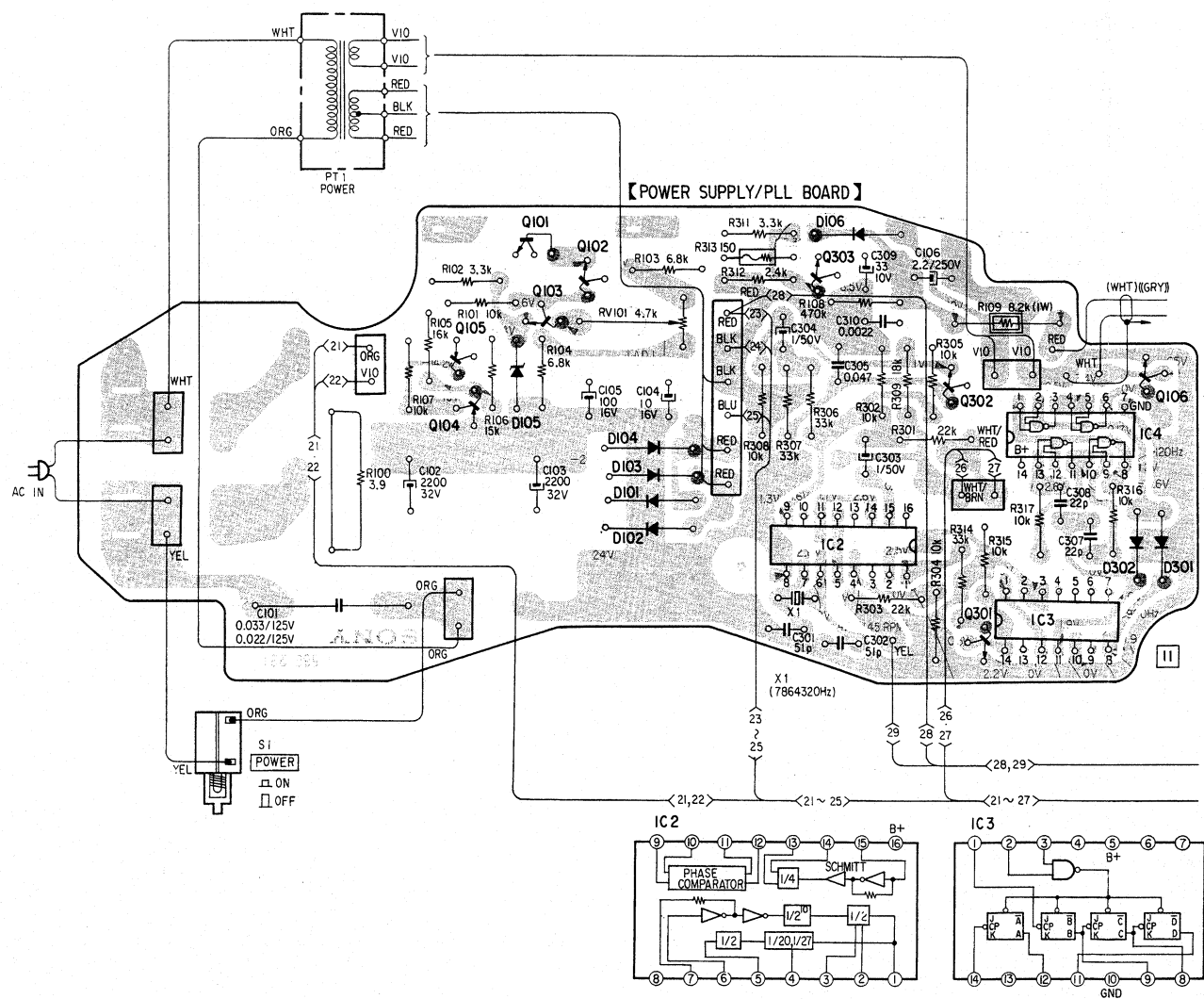
5)



6)

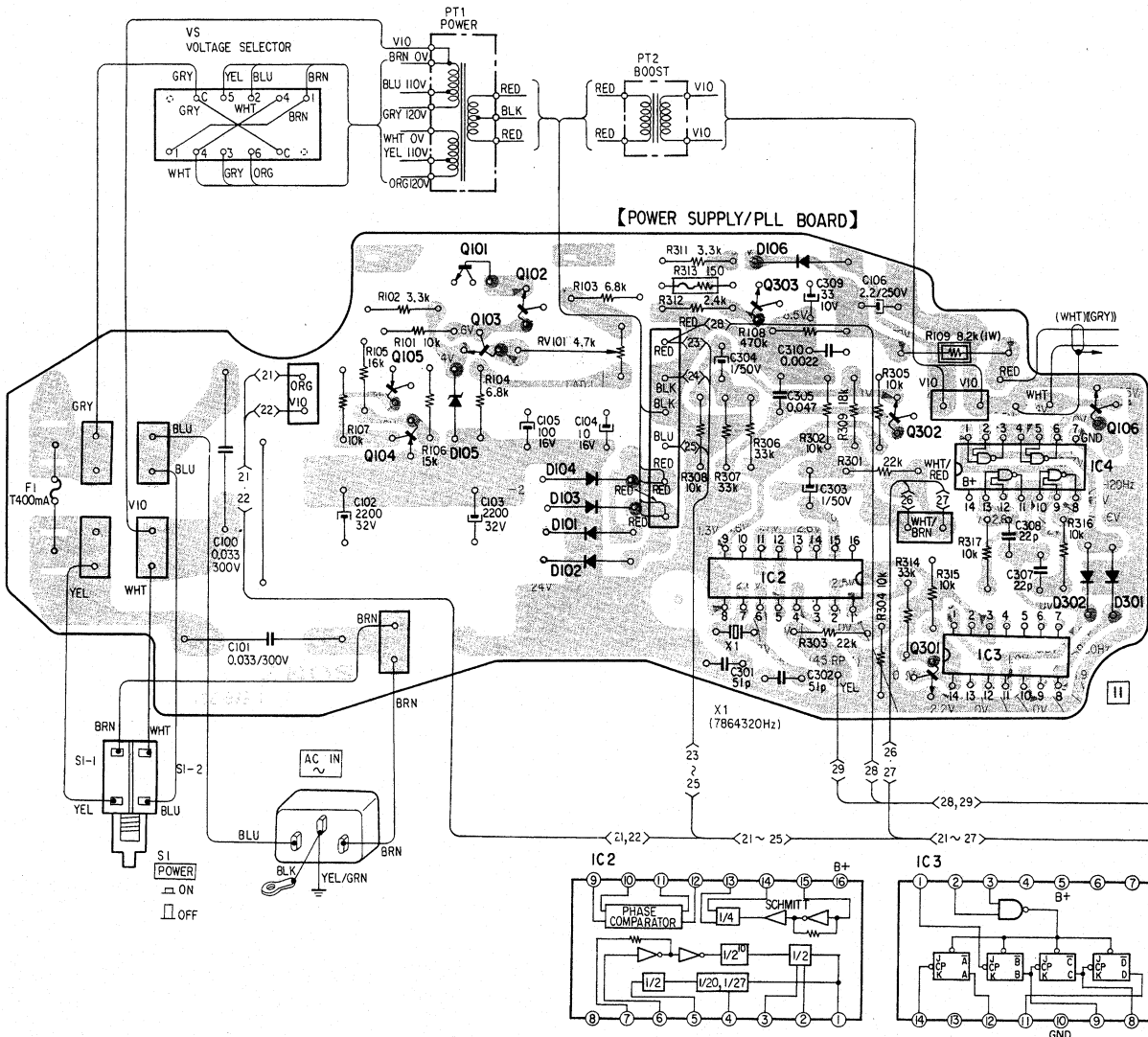
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le.

cket.

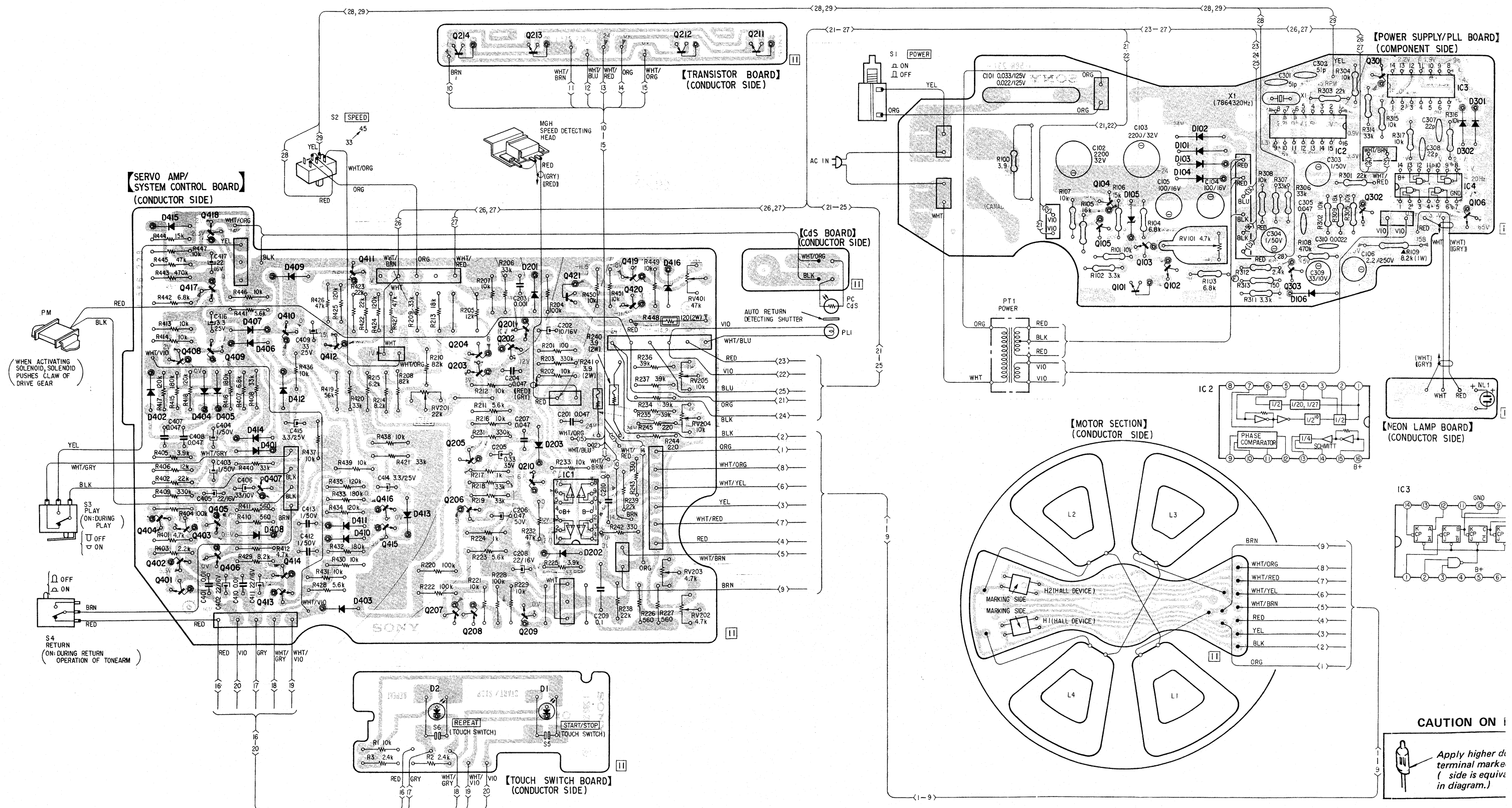


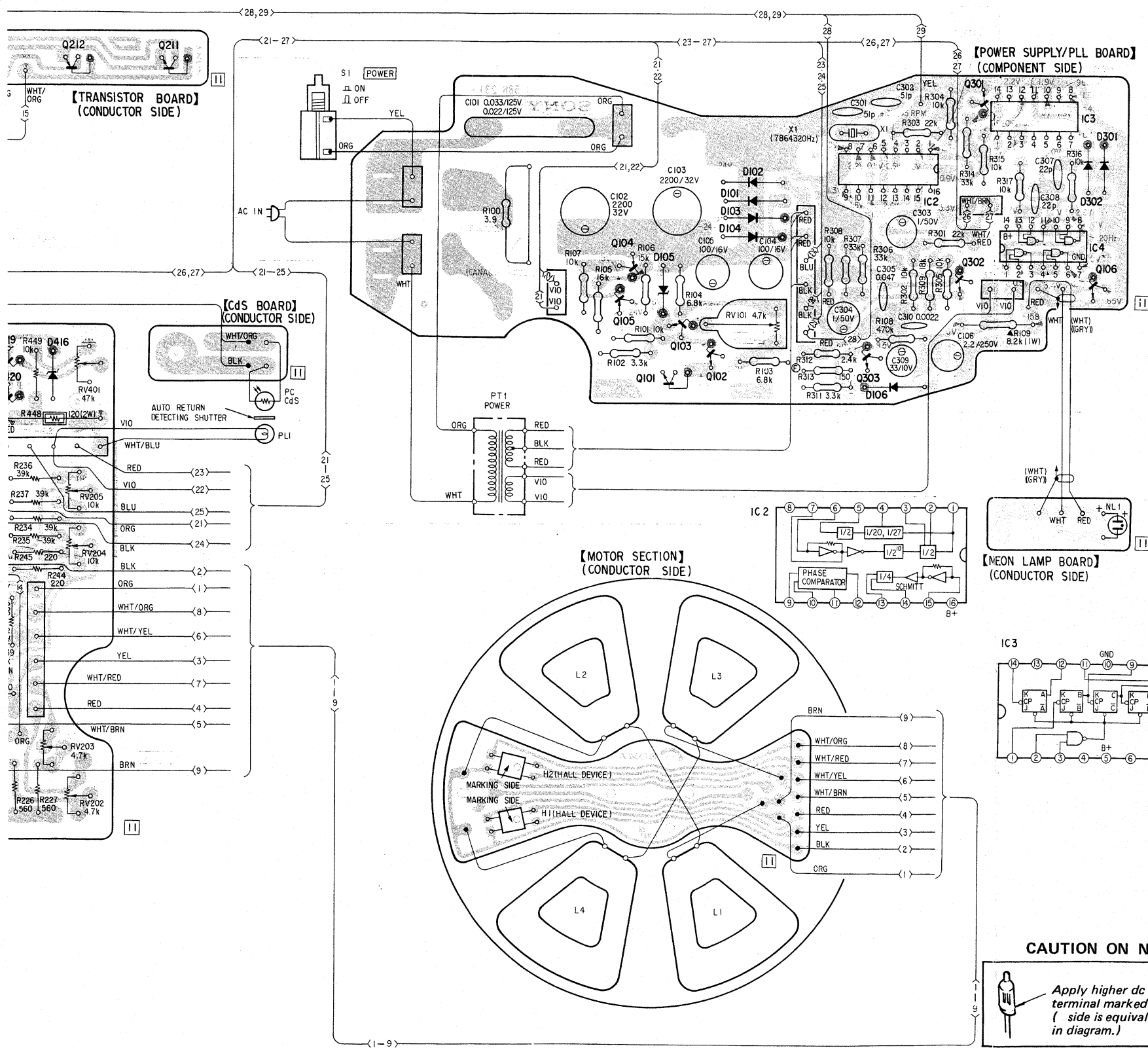
AEP, UK, E model

Q		I05	I01	I02		303	302	IC4	I06
IC		I04	I03			IC2	301	IC3	
D		I05	I03	I04	I06				302,301
			I01	I02					

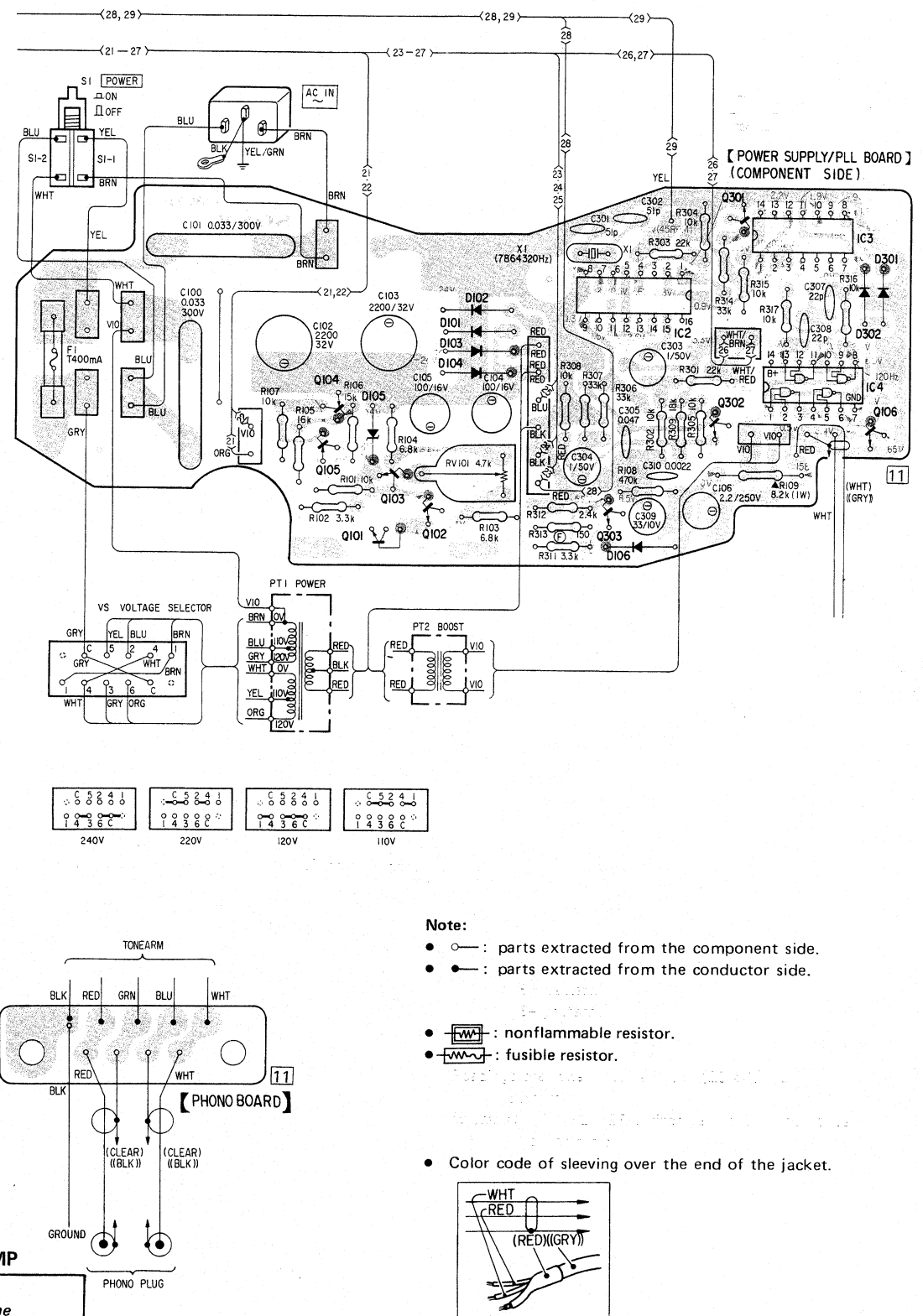


D	402	415	404,405	407 406	409 412	411 410	413	2	201 203	202	416	105	102 101 103 104	302,301						
Q, IC	404	408 403 402 401	418 417 409 405 406	407	410 414 413	412 411 416 415	214 204 203	205 206 208	201 202	213 421 210 IC1	419 420	212	211	104 105	103 102	IC2 303	301 302	IC3 IC4	106	Q

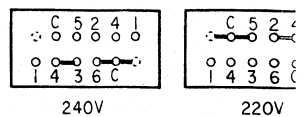
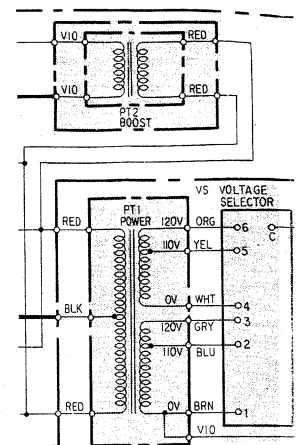
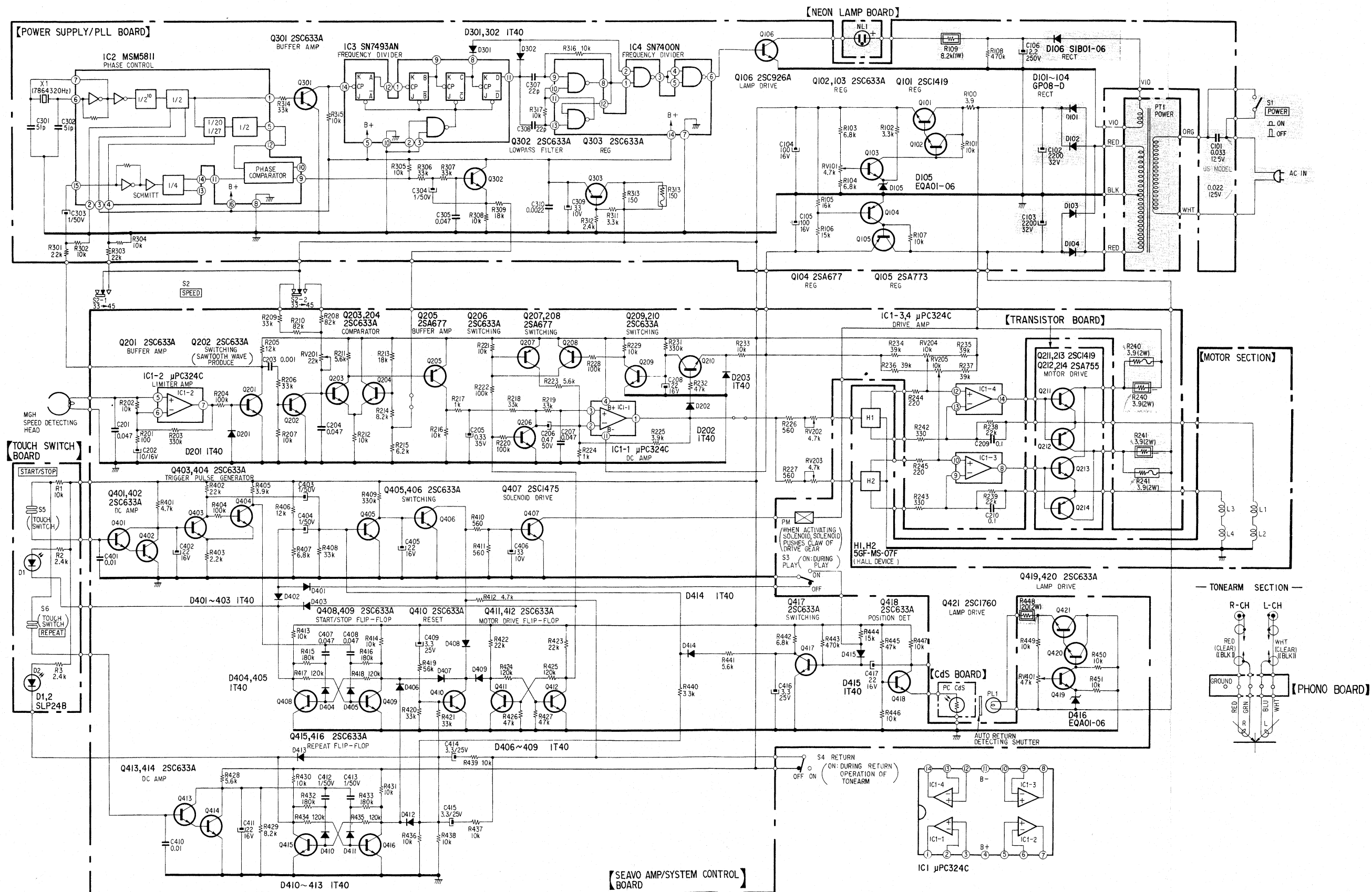


[illegible]

D	105	102 101 103 104	106	302,301			
Q, IC	104 105	103 101	102 303	IC2 302	301 302	IC3 IC4	106



4-3. SCHEMATIC DIAGRAM



Note:

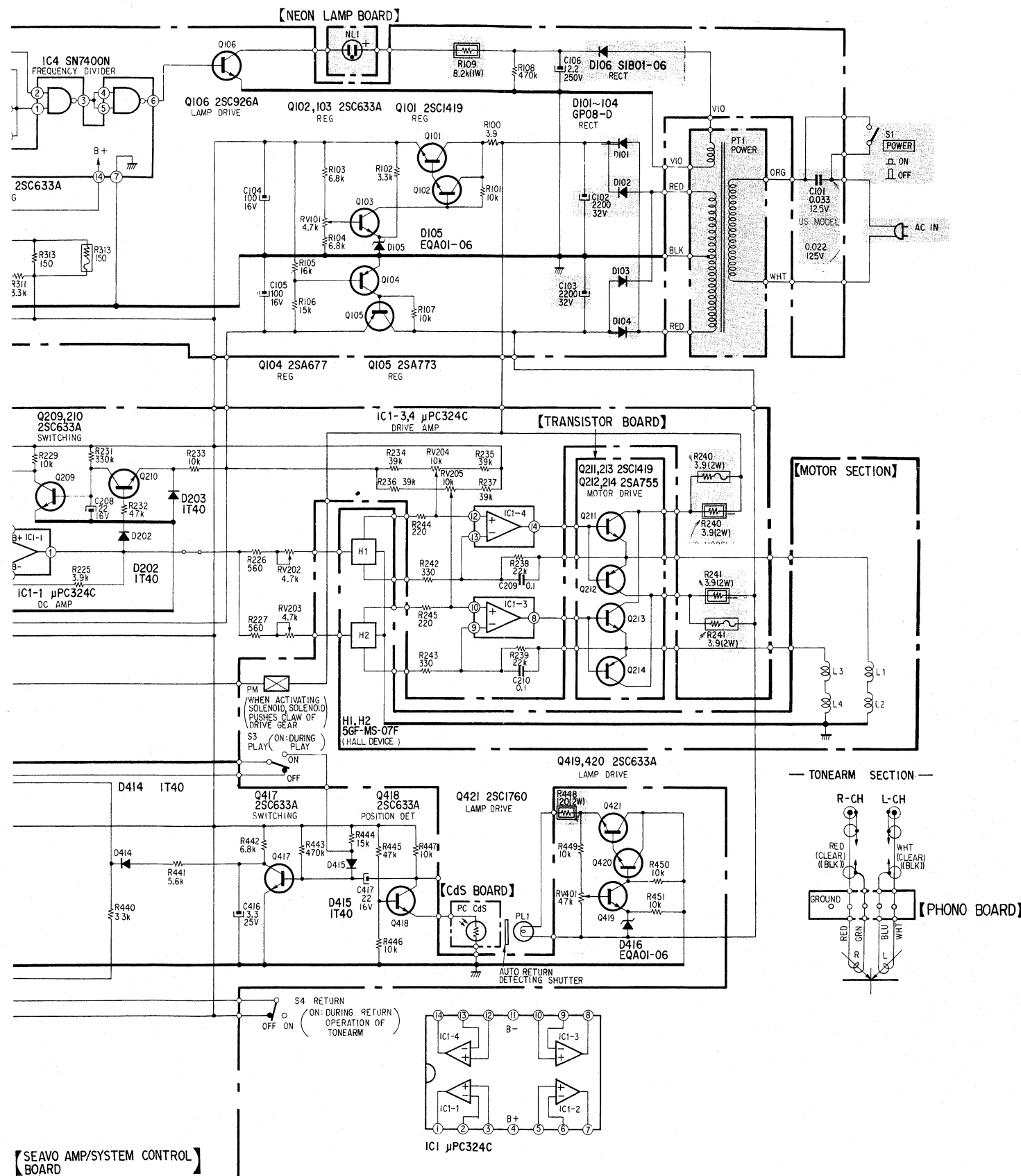
- All capacitors are in μF unless 50WV or less are not indicate
- All resistors are in ohms, $\frac{1}{4}\text{W}$ $\text{k}\Omega = 1000\Omega$, $\text{M}\Omega = 1000\text{k}\Omega$
- All adjustable resistors have c otherwise noted.
- $\square$: nonflammable resist
- $\square$: fusible resistor.

• $\square$: panel designation.

• Switch

Ref. No.	Switch
S1	POWER
S2	SPEED
S3	PLAY
S4	RETURN
S5	START
S6	REPEAT

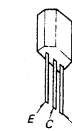
Note: The components id safety. Replace c



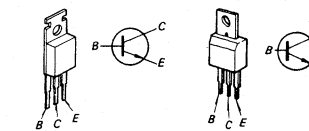
Replacement Semiconductors

For replacement, use semiconductors except in ().

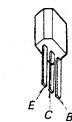
Q106: 2SC926A
Q102, 103, 201-204 } 2SC634A
Q206, 209, 210 } (2SC633A)
Q301-303, 401-406 }
Q408-420 }



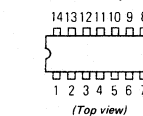
Q421: 2SC1173 (2SC1760)



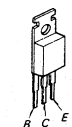
Q104, 205 } 2SA678
Q207, 208 } (2SA677)



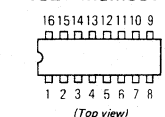
IC1: μ PC324C
IC3: M53293P (SN7493AN)
IC4: M53200P (SN7400N)



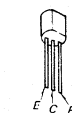
Q101, 211, 213: 2SC1061 (2SC1419)



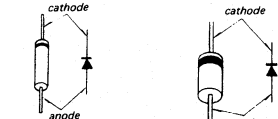
IC2: MSM5811



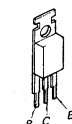
Q105: 2SA684 (2SA773)



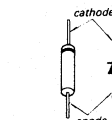
D101-104: 10E2 (GP08-D)



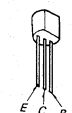
Q212, 214: 2SA671 (2SA755)



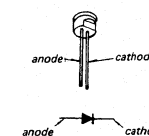
D201-203 } 1S1555
D301, 302 } (1T40)
D401-415 }



Q407: 2SC1475



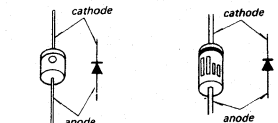
D1, 2: SLP24B



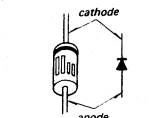
H1, 2: 5GF-MS-07F



D106: 10D6 (SIB01-06)



D105, 416: EQB01-06 (EQA01-06)



Note:

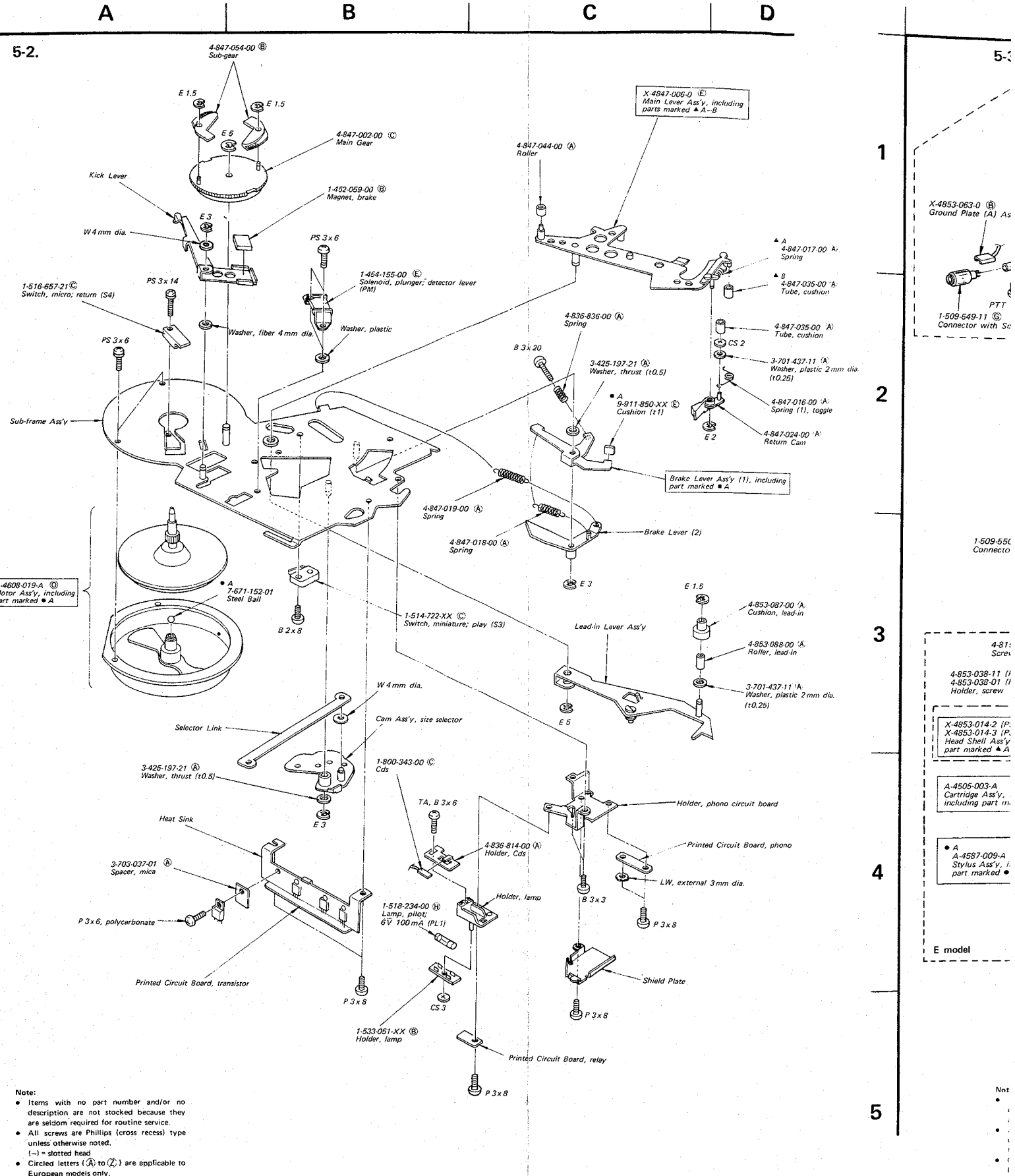
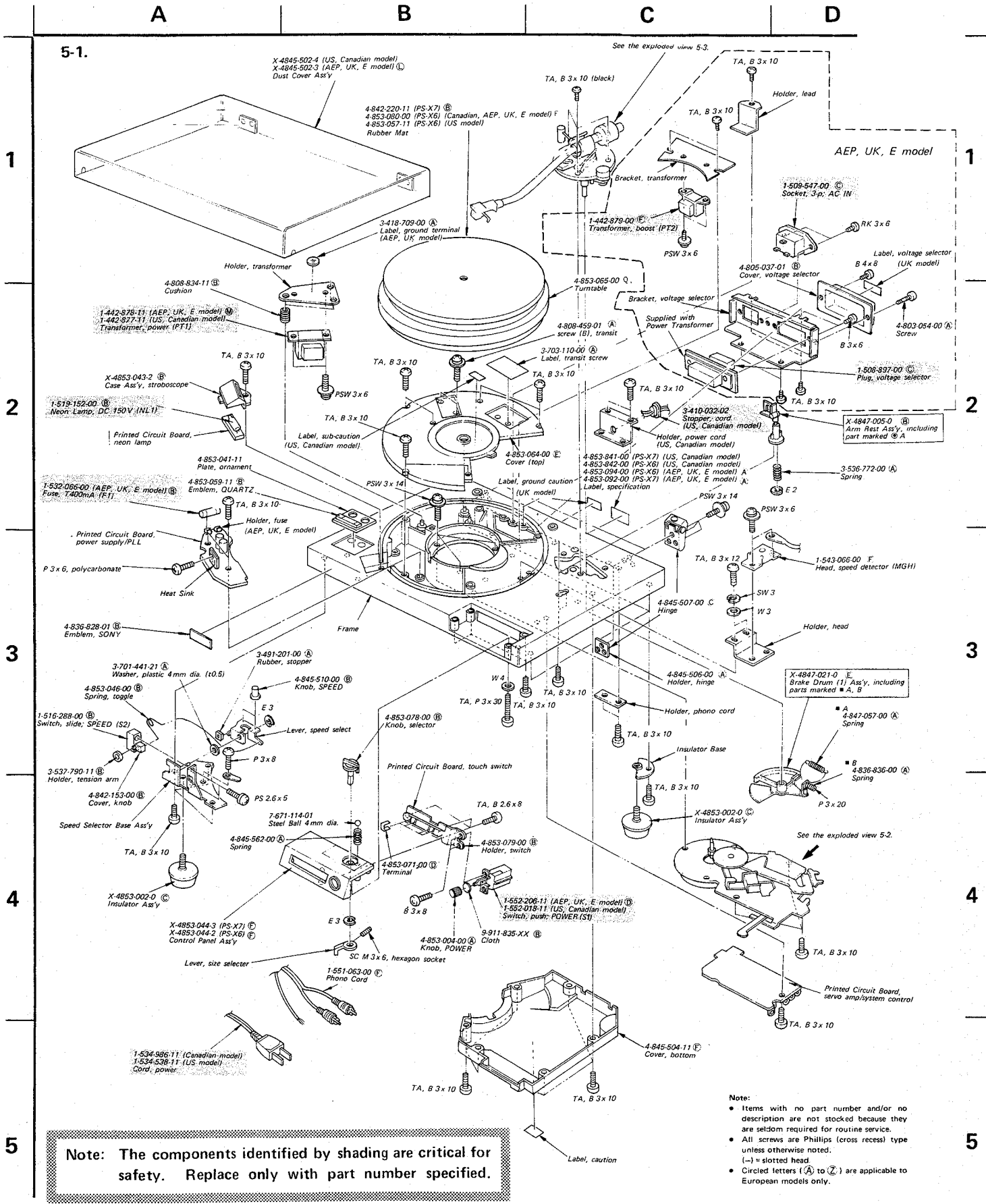
- All capacitors are in μ F unless otherwise noted. $pF = \mu\mu F$
- 50WV or less are not indicated except for electrolytics.
- All resistors are in ohms, $\frac{1}{4}W$ unless otherwise noted.
- $k\Omega = 1000\Omega$, $M\Omega = 1000k\Omega$
- All adjustable resistors have characteristic curve B, unless otherwise noted.
- : nonflammable resistor.
- : fusible resistor.

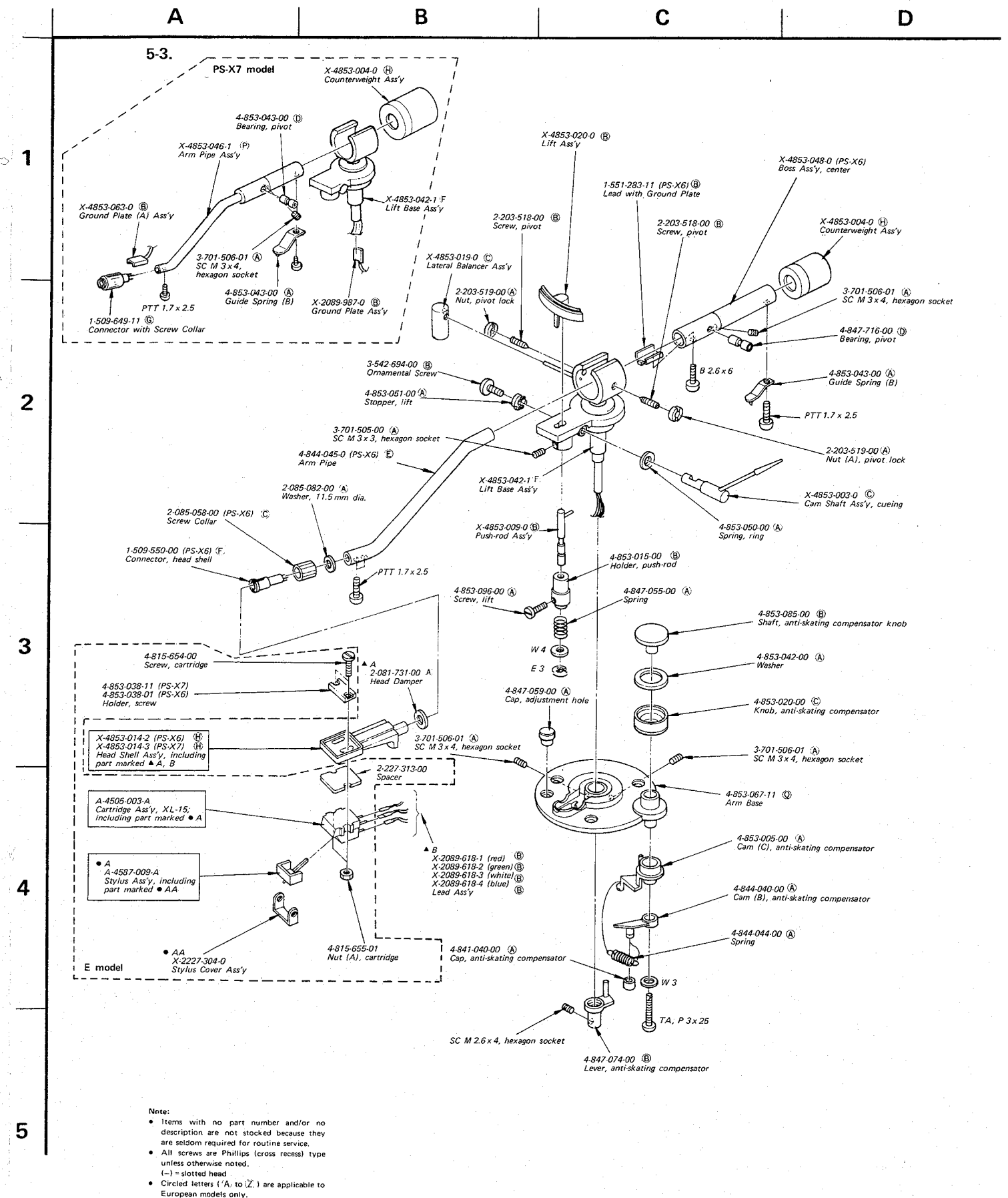
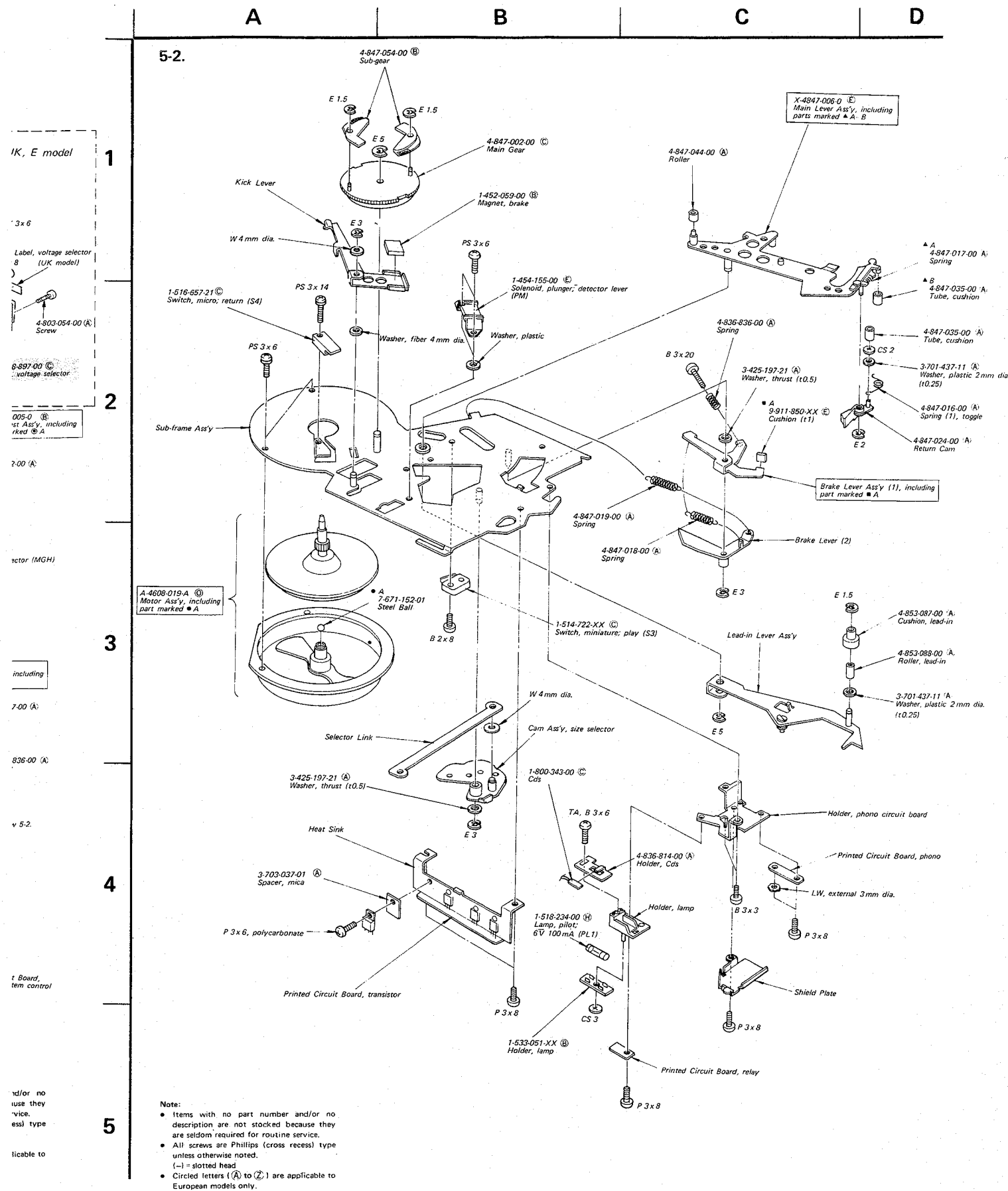
- : panel designation.

Switch

Ref. No.	Switch	Position
S1	POWER	OFF
S2	SPEED	33
S3	PLAY	OFF
S4	RETURN	OFF
S5	START	OFF
S6	REPEAT	OFF

Note: The components identified by shading are critical for safety. Replace only with part number specified.





SECTION 6 ELECTRICAL PARTS LIST

Note: Circled letters (A to Z) are applicable to European models only.

Ref. No. Part No. Description

SEMICONDUCTORS

Transistors

⇒ Q101	(D)	2SC1061
⇒ Q102,103	(B)	2SC634A
⇒ Q104	(C)	2SA678
⇒ Q105	(C)	2SA684
Q106	(D)	2SC926A
⇒ Q201-204	(B)	2SC634A
⇒ Q205	(C)	2SA678
⇒ Q206	(B)	2SC634A
⇒ Q207,208	(C)	2SA678
⇒ Q209,210	(B)	2SC634A
⇒ Q211	(D)	2SC1061
⇒ Q212	(E)	2SA671
⇒ Q213	(D)	2SC1061
⇒ Q214	(E)	2SA671
⇒ Q301-303	(B)	2SC634A
⇒ Q401-406	(B)	2SC634A
Q407	(C)	2SC1475
⇒ Q408-420	(B)	2SC634A
⇒ Q421	(C)	2SC1173

ICs

IC1	(G)	μPC324C
IC2	(L)	MSM5811
⇒ IC3	(K)	M53293P
⇒ IC4	(E)	M53200P

Diodes

D1,2	(C)	SLP-24B
⇒ D101-104	(B)	10E2
⇒ D105	(B)	EQB01-06
⇒ D106	(B)	10D6
⇒ D201-203	(B)	1S1555
⇒ D301,302	(B)	1S1555

⇒: Due to standardization, interchangeable replacements may be substituted for parts specified in the diagrams.

Ref. No. Part No. Description

⇒ D401-415	(B)	1S1555
⇒ D416	(B)	EQB01-06
H1,2	(D)	5GF-MS-07F

TRANSFORMERS

PT1	1-442-877-11	Power (US, Canadian model)
PT1	1-442-878-11	(M) Power (AEP, UK, E model)
PT2	1-442-879-11	(F) Boost (AEP, UK, E model)

CAPACITORS

All capacitors are in μF and ceramic unless otherwise noted.
50WV or less are not indicated except for electrolytics. pF = μμF, elect = electrolytic

C100,101	1-108-750-11	(B) 0.033	300V	mylar
				(AEP, UK, E model)
C101	1-108-750-11	0.033	125V	mylar
				(US model)
C101	1-130-098-11	(C) 0.022	125V	polystyrol
				(Canadian model)
C102,103	1-123-047-11	(C) 2200	32V	elect
C104,105	1-123-193-11	(B) 100	16V	elect
C106	1-123-027-11	(B) 2.2	250V	elect
C201	1-101-925-11	(A) 0.047		
C202	1-121-651-11	(A) 10	16V	elect
C203	1-102-074-11	(A) 0.001		
C204	1-108-246-12	(A) 0.047		mylar
C205	1-131-212-11	(B) 0.33	35V	
C206	1-121-951-11	(A) 0.47	50V	
C207	1-101-925-11	(A) 0.047		
C208	1-123-191-11	(A) 22	16V	elect
C209,210	1-108-251-12	(A) 0.1		mylar
C301,302	1-102-491-11	(A) 51p		
C303	1-121-391-11	(A) 1	50V	elect
C304	1-121-952-11	(A) 1	50V	elect
C305	1-101-925-11	(A) 0.047		
C307,308	1-102-959-11	(A) 22p		

Note: The components identified by shading are critical for safety. Replace only with part number specified.

Note: Circled letters (A to Z) are applicable to European models only.

Ref. No.	Part No.	Description
C309	1-123-194-11 (A) 33	10V elect
C310	1-101-919-11 (A) 0.0022	
C401	1-101-923-11 (A) 0.01	
C402	1-123-191-11 (A) 22	16V elect
C403,404	1-121-391-11 (A) 1	50V elect
C405	1-123-191-11 (A) 22	16V elect
C406	1-123-194-11 (A) 33	10V elect
C407,408	1-101-925-11 (A) 0.047	
C409	1-121-392-11 (A) 3.3	25V elect
C410	1-101-923-11 (A) 0.01	
C411	1-123-191-11 (A) 22	16V elect
C412,413	1-123-228-11 (B) 1	50V elect
C414-416	1-121-392-11 (A) 3.3	25V elect
C417	1-131-201-11 (C) 22	16V tantalum

RESISTORS

All resistors are in ohms. Common 1/4W carbon resistors are omitted.
Check schematic diagram for values.

R109	1-213-154-11 (A) 8.2k	1W metal oxide
R240,241	1-206-453-11 3.9	2W metal oxide (US model)
R240,241	1-217-429-11 (B) 3.9	2W fusible (E, AEP, UK, Canadian model)
R313	1-217-401-11 (B) 150	1/4W fusible (E, AEP, UK, Canadian model)
R448	1-206-642-11 (A) 120	2W metal oxide
RV101	1-224-644-XX (B) 4.7k	adjustable
RV201	1-224-635-00 (B) 22k	adjustable
RV202,203	1-224-644-XX (B) 4.7k	adjustable
RV204,205	1-224-645-XX (B) 10k	adjustable
RV401	1-224-636-00 (B) 47k	adjustable

Ref. No.	Part No.	Description
----------	----------	-------------

SWITCHES

S1	1-552-018-11	Push, POWER (US, Canadian model)
S1	1-552-206-00 (D)	Push, POWER (AEP, UK, E model)
S2	1-516-288-00 (B)	Slide, SPEED
S3	1-514-722-XX (C)	Miniaature, play
S4	1-516-657-21 (C)	Micro, return

MISCELLANEOUS

F1	1-532-066-11 (B)	Fuse, T400 mA (AEP, UK, E model)
MGH	1-543-066-00 (F)	Head, speed detector
NL1	1-519-152-00 (B)	Neon Lamp, DC 150V 10mA
PL1	1-518-234-00 (B)	Lamp, pilot; 6V 100mA
PM	1-454-155-00 (E)	Solenoid, plunger; detector lever
	1-452-059-00 (B)	Magnet, brake
	1-508-897-00 (C)	Plug, voltage selector (AEP, UK, E model)
	1-509-547-11 (C)	Socket, 3-p; AC IN (AEP, UK, E model)
	1-509-550-00 (F)	Connector, head shell (PS-X6)
	1-509-649-11 (G)	Connector with screw collar (PS-X7)
	1-527-304-00 (F)	Crystal 7.864320 MHz
	1-533-051-XX (B)	Holder, lamp
	1-534-538-XX	Cord, power (US model)
	1-534-986-XX	Cord, power (Canadian model)
	1-551-063-00 (F)	Phono Cord
	1-551-283-11 (B)	Lead with Ground Plate (PS-X6)
	1-800-343-00 (C)	CdS
	A-4608-019-A (C)	Motor Ass'y
	X-2089-618-1 (B)	(red)
	X-2089-618-2 (B)	(green) Lead Ass'y,
	X-2089-618-3 (B)	(white) cartridge
	X-2089-618-4 (B)	(blue)

Note: The components identified by shading are critical for safety. Replace only with part number specified.

Note: Circled letters (A to Z) are applicable to European models only.

ACCESSORIES & PACKING MATERIALS

<i>Part No.</i>	<i>Description</i>	<i>Part No.</i>	<i>Description</i>
A-4504-003-A	Cartridge Ass'y, XL-15 (E model)	3-701-616-00	(A) Bag, plastic; shell
including;		3-701-630-00	(A) Bag, plastic; printed matters
A-4587-009-A	Stylus Ass'y	3-701-806-01	(A) Adaptor, 45 rpm
A-4587-009-A	Stylus Ass'y (E model)	3-770-314-11	(E) Manual, instruction (AEP, UK model)
including;		3-770-314-11	Manual, instruction (E model)
X-2227-304-0	Stylus Cover Ass'y	3-794-124-11	
X-4853-006- ² ₃	(E) Screw Ass'y, cartridge (2: PS-X7 3: PS-X6) (AEP, UK, US, Canadian model)	3-770-314-21	Manual, instruction (US model)
including;		3-770-314-21	Manual, instruction (Canadian model)
3-701-614-00	(A) Bag, plastic	3-794-103-31	
2-054-625-00	(A) Screw (C), cartridge	3-793-395-11	(B) Gauge, tracking error check
2-056-532-00	(B) Screw (A), cartridge	3-793-867-11	(A) Leaflet, caution; power cord
2-224-081- ⁰¹ ₁₁	(A) Screw (E), cartridge	3-793-867-11	(A) Leaflet, caution; rubber sheet (PS-X7)
2-227-313-00	(A) Spacer	4-847-092-00	(C) Screwdriver
4-815-655-01	(A) Nut (A), cartridge	4-847-314-00	(C) Bag, plastic
4-853-038- ⁰¹ ₁₁	(C) Holder, screw (01: PS-X6 11: PS-X7)	4-848-002-00	(A) Cushion, arm-pipe
X-4853-018-0	(C) Sub-counterweight Ass'y	4-848-005-00	(C) Box, accessories
1-534-754-00	Cord, power; parallel-blade plug (E model)	4-848-006-00	(B) Bag, accessories
1-534-819-00	(G) Cord, power (UK model)	4-848-012-00	(A) Board, protection
1-551-216-00	Cord, power; euro-plug (E model)	4-849-790-00	(A) Bag, protection
2-227-313-00	Spacer (E model)	4-853-065-00	(Q) Sheet, protection (PS-X7)
3-550-734-00	Cord, Holder, euro-plug (E model)	4-853-838-00	(F) Carton (PS-X6)
3-701-613-00	(A) Bag, plastic; sub-counterweight	4-853-839-00	(C) Frame
		4-853-840-00	(F) Carton (PS-X7)
		4-853-847-00	(B) Board, protection (PS-X7)
		4-853-836-00	(C) Cushion

Note: The components identified by shading are critical for safety. Replace only with part number specified.

HARDWARE NOMENCLATURE

Screw:

P 3 x 10

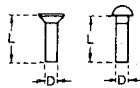
L: Length in mm

D: Diameter in mm

Type of head

Indicated slotted-head only.

Unless otherwise indicated, it means cross-recessed head (Phillips type).



Nut, Washer, Retaining ring:

N 3

Diameter of usable screw or shaft

Reference designation

Reference Designation	Shape	Description	Remarks
SCREWS			
P		pan-head screw	binding-head (B) screw for replacement
PWH		pan-head screw with washer face	binding-head (B) screw and flat washer for replacement
PS PSP		pan-head screw with spring washer	binding-head (B) screw and spring washer for replacement
PSW PSPW		pan-head screw with spring and flat washers	binding-head (B) screw and spring and flat washers for replacement
R		round-head screw	binding-head (B) screw for replacement
K		flat-countersunk-head screw	
RK		oval-countersunk-head screw	
B		binding-head screw	
T		truss-head screw	binding-head (B) screw for replacement
F		flat-fillister-head screw	
RF		fillister-head screw	
BV		brazer-head screw	

Reference Designation	Shape	Description	Remarks
SELF-TAPPING SCREWS			
TA		self-tapping screw	ex: TA, P 3 x 10
PTP		pan-head self-tapping screw	binding-head self-tapping (TA, B) screw for replacement
PTPWH		pan-head self-tapping screw with washer face	binding-head self-tapping (TA, B) screw and flat washer for replacement
PTTWH		pan-head thread-rolling screw with washer face	binding-head (B) screw and flat washer for replacement
SET SCREWS			
SC		set screw	
SC		hexagon-socket set screw	ex: SC 2.6 x 4, hexagon socket
NUT			
N		nut	
WASHERS			
W		flat washer	
SW		spring washer	
LW		internal-tooth lock washer	ex: LW3, internal
LW		external-tooth lock washer	ex: LW3, external
RETAINING RINGS			
E		retaining ring	
G		grip-type retaining ring	

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— 34 —

FULL AUTOMATIC STEREO TURNTABLE SYSTEM

PS-X6/X7

US Model
Canadian Model
AEP Model
UK Model
E Model

SUPPLEMENT

File this supplement with the service manual.

No. 2
May, 1978

CIRCUIT DESCRIPTION

TABLE OF CONTENTS

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3-3. Operation if START/STOP Switch (S5) is touched during Play	9
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3-5. Repeat Operation	13
3-6. Operation if START/STOP Switch is touched during Lead-in	15
4. Hall Motor	17

SONY[®]
SERVICE MANUAL

1. Operation of Servo Amplifier Circuit (See Fig. 1-1)

During Motor Start

1. When the power switch is turned on, Q202 is still turned off since an output signal from the MG head is not applied to IC1-2. C204 will thus charge up through R210, R209 and RV201 (or R208 and RV201 for 45 rpm).
2. Once the emitter voltage of Q203 (charging voltage applied to the base of Q203) exceeds $+V_{BE}$, this transistor turns on.
3. Q205 is thus turned on, thereby applying a voltage to IC1-1.

Limiter Circuit

1. Once the turntable starts to rotate, an output signal is produced by the MG head.
2. Although the MG head output signal is a sine wave, there is some fluctuation in amplitude. Therefore, above a certain level, this sine wave is changed into a constant-amplitude square wave.

Waveform Rectification

1. The IC1-2 output signal is amplified by Q201 to obtain a complete square wave signal. The D201 is employed to maintain the base voltage of Q201 at $\pm 0.6V_{p-p}$.

2. This limiter circuit (IC1-2, Q201) serves to prevent incorrect detection of amplitude fluctuations as frequency changes.

3. The square wave signal on the collector of Q201 is then applied to the phase control circuit.

Differential Circuit

The square wave signal on the collector of Q201 is changed to a triangular wave by C203, R206 and R207. The differentiated (triangular) pulse triggers the sawtooth wave generator transistor (Q202).

Sawtooth Wave Generator Circuit

1. While Q202 is turned off, C204 is charged up through R210, R209 and RV201 (or R208 and RV201 for 45 rpm). But when the positive part of the differentiated wave turns Q202 on, C204 discharges immediately, resulting in the collector voltage of Q202 dropping to 0V.
2. After the $\oplus$ portion of this differentiated wave has passed on, Q202 is again turned off, and C204 is charged up, resulting in the Q203 base voltage forming a sawtooth wave signal.

Comparator

1. The sawtooth wave signal is applied to the comparator circuit formed by Q203 and Q204. The base of Q204 is biased by the reference voltage produced by voltage division of B+ by the output from R213, R214, R215 and the phase control circuit.

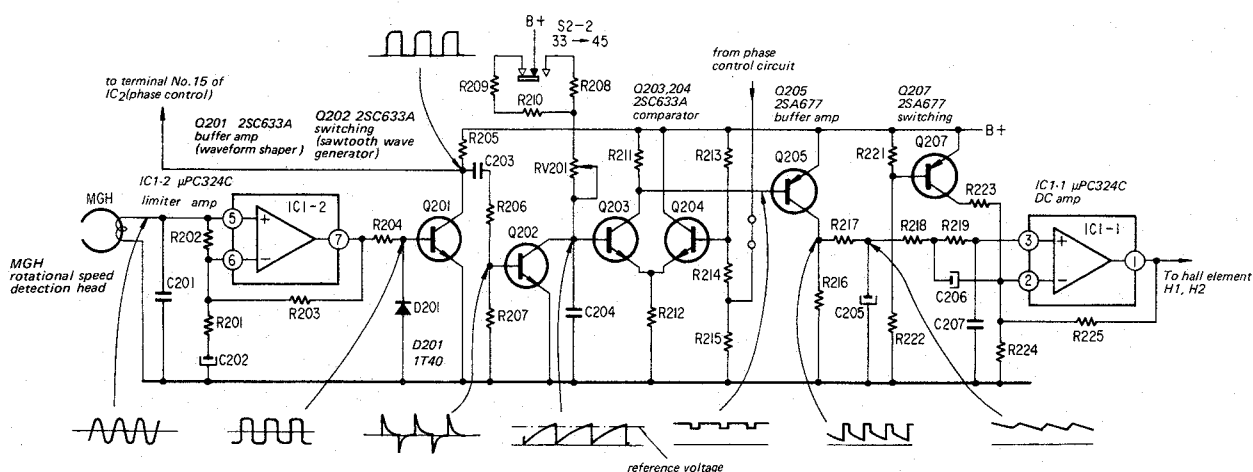


Fig. 1-1.

Since the emitter voltage of Q203 is determined at this time by the reference voltage, Q203 turns on when its base voltage (sawtooth wave) exceeds the total voltage (emitter voltage plus $+V_{BE}$). So a negative pulse will appear on the collector of Q203.

2. If the rotational speed slows down, the frequency of the sawtooth wave will be low. Also, the output pulse width increases, because the on-time of Q203 becomes long. On the other hand, if the rotational speed increases, the frequency of the sawtooth wave will be high. Also, the output pulse width becomes narrow, because the on-period of Q203 becomes short.

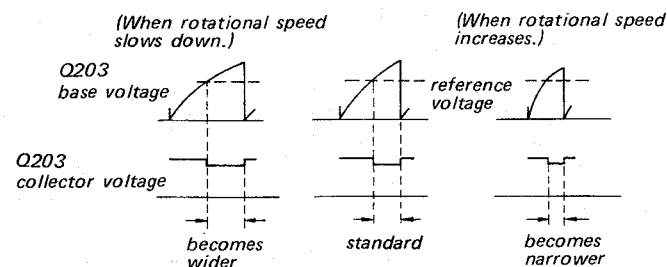


Fig. 1-2.

Pulse Signal Amplifier

Besides amplifying pulse signals, Q205 also serves as a phase inverter which feeds positive pulse signals to the next stage.

Smoothing Circuit (low-pass filter)

This smoothing circuit has two filters (one is made up of R217 and C205, and the other is IC1-1, R218, R219, C206 and C207). These filters operate as an integrating circuit which converts the pulse signals into dc signals (the voltage level being in proportion to pulse width).

DC Amplifier Circuit

The dc amplifier (that also serves as a low-pass filter), uses IC1-1, and amplifies the dc output signals from the previous stage.

Speed Selector Switch (S2)

1. The circuit time constant is changed by simply changing the resistance connected to the base of Q203.

2. The time constant for 45 rpm is designed to be faster than that for 33 rpm.
3. Consequently, when switching the speed selector switch from 33 to 45 rpm, the collector output pulse width of Q205 is widened, thereby increasing the level of the low-pass filter DC output signal. Motor speed is thus increased, followed by re-application of the servo control mechanism.
4. When switching back to 33 rpm, the reverse sequence of events takes place.

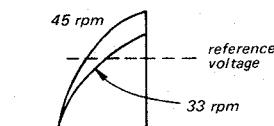


Fig. 1-3.

Servo Control

If for any reason, motor speed decreases or increases, even by the slightest degree, the servo control mechanism is activated to correct for the deviation, and returns the speed to the reference standard value.

1. If the motor speed is decreased slightly, the frequency of the MG head output signal decreases. This signal is applied to the phase control circuit (IC2) for phase comparison. The resultant output, of decreased voltage level, is then sent to the servo control. And since the base voltage of Q204 is reduced, the emitter voltage (reference voltage) of Q203 also decreases, resulting in the width of the Q203 collector output pulse being widened.
2. The dc output voltage from the low-pass filter consequently decreases, thereby increasing motor speed back to the original standard value.
3. If, on the other hand, motor speed is increased by some external influence, the servo control mechanism reduces speed in the reverse manner of that described above.

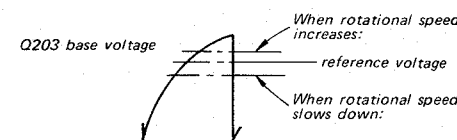


Fig. 1-4.

2. Maintaining Forward Rotation (See Fig. 2-3)

1. When a $\oplus$ signal is applied to the input terminal of the Hall elements, the motor is turned in the forward direction, but when a $\ominus$ signal is applied, the motor is turned in the reverse direction. Therefore, the reverse rotation that is caused by applying $\ominus$ input serves as a brake for rapid stopping of the turntable. (Conventional speed reduction systems use the phenomenon of hysteresis loss or mechanical loss.)

2. F-V converter circuit
This circuit converts the frequency of the MG head output signal into a voltage signal in accordance with the curve as shown in Fig. 2-1.

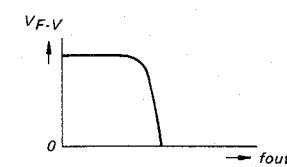


Fig. 2-1.

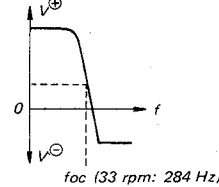


Fig. 2-2.

This curve shows "frequency against output voltage" for both forward and reverse rotations.

3. DC amplifier (IC1-1) operation
The output level of IC1-1 is determined by the relationship:
$$V_{OUT} = (V_{IN}^{\oplus} - V_{IN}^{\ominus}) \times \text{Gain},$$

or $V_{OUT} = V_{IN}^{\oplus} \times \text{Gain}$ when $V_{IN}^{\ominus}$ is 0V.
In this equipment, output levels of approx. -1.5V to +13V are possible by applying $\oplus$ voltage to $V_{IN}^{\oplus}$ through Q207 and R223. When the speed selector is instantly switched from 45 rpm to 33 rpm, $V_{IN}^{\oplus}$ becomes 0V, $V_{IN}^{\ominus}$ becomes positive, and V_{OUT} minus, thereby activating the brake operation.
4. If the frequency of the MG head exceeds f_{0c} during forward rotation, V_{OUT} becomes 0 or minus, thereby slowing down rotational speed. But during reverse rotation, the result is an acceleration of the reverse rotational action.
5. In order to prevent such "run-away" acceleration, a switching circuit consisting of Q210, Q209, and Q208 is employed, thus maintaining forward rotation.

Normal Operation

1. For normal operation, the emitter of Q210 is fixed to a level of -0.5V by D203.

2. Since the base potential of Q210 is normally kept at about 1.5V, Q210 turns on.
3. Since the base of Q209 is -0.5V, Q209 turns off. Q208 also turns off, and then Q207 turns on.
4. A $\oplus$ signal is thereby applied to the $\ominus$ input terminal of IC1-1 through R223.

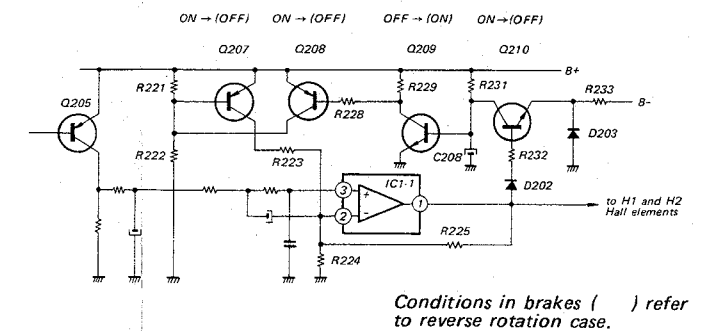


Fig. 2-3.

Reverse Rotation

1. When operating too fast during reverse rotation (when the frequency of the MG head output signal exceeds f_{0c}), Q205 is turned off and no signal is obtained on the $\oplus$ input terminal of IC1-1. The output level of IC1-1 then drops from the normal 1.5V (relative to ground) to less than +0.5V, resulting in Q210 being turned off.
2. Consequently, the base voltage of Q209 rises in accordance with the R231/C208 time constant, finally turning Q209 on once the base potential exceeds +0.5V.
3. Q208 then turns on, and Q207 turns off.
4. Consequently, no voltage is applied to the $\ominus$ input terminal of IC1-1.
5. That is, the operation of IC1-1 will be stopped, resulting in the output level reducing to 0V, and the slowing down of rotational speed.
6. The MG head output frequency consequently drops below f_{0c} , resulting in a positive output signal from the F-V converter, and forward motor rotation. Once the IC1-1 output level exceeds +0.5V, the reverse-rotation prevention circuit is put into standby status.
7. This reverse rotation prevention circuit can be switched off again extremely rapidly. When Q210 is turned on, C208 discharges through R233 to the B- bus.

2. Maintaining Forward Rotation (See Fig. 2-3)

- When a $\oplus$ signal is applied to the input terminal of the Hall elements, the motor is turned in the forward direction, but when a $\ominus$ signal is applied, the motor is turned in the reverse direction. Therefore, the reverse rotation that is caused by applying $\ominus$ input serves as a brake for rapid stopping of the turntable.
(Conventional speed reduction systems use the phenomenon of hysteresis loss or mechanical loss.)
- F-V converter circuit
This circuit converts the frequency of the MG head output signal into a voltage signal in accordance with the curve as shown in Fig. 2-1.

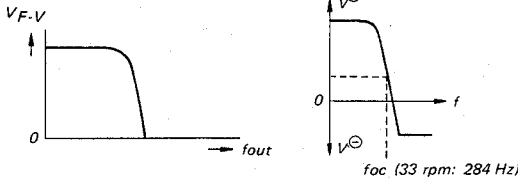


Fig. 2-1.

Fig. 2-2.

- This curve shows "frequency against output voltage" for both forward and reverse rotations.
- DC amplifier (IC1-1) operation
The output level of IC1-1 is determined by the relationship:
 $V_{OUT} = (V_{IN}^{\oplus} - V_{IN}^{\ominus}) \times \text{Gain}$,
or $V_{OUT} = V_{IN}^{\oplus} \times \text{Gain}$ when $V_{IN}^{\ominus}$ is 0V.
In this equipment, output levels of approx. -1.5V to +13V are possible by applying $\oplus$ voltage to $V_{IN}^{\oplus}$ through Q207 and R223.
When the speed selector is instantly switched from 45 rpm to 33 rpm, $V_{IN}^{\oplus}$ becomes 0V, $V_{IN}^{\ominus}$ becomes positive, and V_{OUT} minus, thereby activating the brake operation.
 - If the frequency of the MG head exceeds f_{oc} during forward rotation, V_{OUT} becomes 0 or minus, thereby slowing down rotational speed. But during reverse rotation, the result is an acceleration of the reverse rotational action.
 - In order to prevent such "run-away" acceleration, a switching circuit consisting of Q210, Q209, and Q208 is employed, thus maintaining forward rotation.

Normal Operation

- For normal operation, the emitter of Q210 is fixed to a level of -0.5V by D203.

- Since the base potential of Q210 is normally kept at about 1.5V, Q210 turns on.
- Since the base of Q209 is -0.5V, Q209 turns off. Q208 also turns off, and then Q207 turns on.
- A $\oplus$ signal is thereby applied to the $\ominus$ input terminal of IC1-1 through R223.

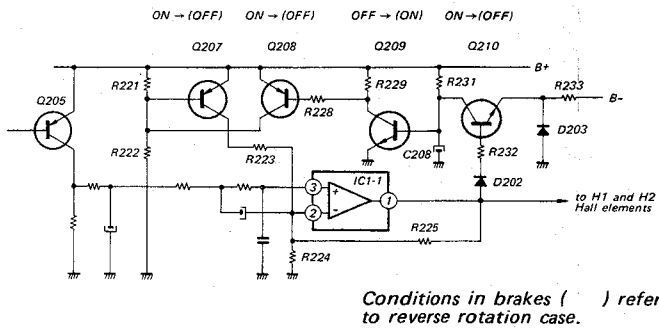


Fig. 2-3.

Reverse Rotation

- When operating too fast during reverse rotation (when the frequency of the MG head output signal exceeds f_{oc}), Q205 is turned off and no signal is obtained on the $\oplus$ input terminal of IC1-1. The output level of IC1-1 then drops from the normal 1.5V (relative to ground) to less than +0.5V, resulting in Q210 being turned off.
- Consequently, the base voltage of Q209 rises in accordance with the R231/C208 time constant, finally turning Q209 on once the base potential exceeds +0.5V.
- Q208 then turns on, and Q207 turns off.
- Consequently, no voltage is applied to the $\ominus$ input terminal of IC1-1.
- That is, the operation of IC1-1 will be stopped, resulting in the output level reducing to 0V, and the slowing down of rotational speed.
- The MG head output frequency consequently drops below f_{oc} , resulting in a positive output signal from the F-V converter, and forward motor rotation. Once the IC1-1 output level exceeds +0.5V, the reverse-rotation prevention circuit is put into standby status.
- This reverse rotation prevention circuit can be switched off again extremely rapidly. When Q210 is turned on, C208 discharges through R233 to the B- bus.

Stroboscope

The stroboscope system employed in this equipment consists of stroboscope stripes marked on the outer rim of the turntable platter, plus a neon lamp directed onto the outer rim stripes. The number of stroboscope stripes for 33 1/3 rpm and 45 rpm are determined by the following equation:

$$n = \frac{60(m + 2f)}{N}$$

where n = number of stripes,
 m = the number of stripes to pass any one point during 1 second,
 f = power supply frequency (Hz),
and N = turntable speed (rpm).

RPM	Number of stroboscope stripes	
	50 Hz	60 Hz
33 1/3	180	216
45	133 1/3	160

As can be seen from this table, the above equation does not give an integral number of stripes for the 45 rpm speed at 50 Hz.

Therefore, the strips of the stroboscope are difficult to judge at 50 Hz, 45 rpm. However, this speed error can be ignored while a record is being played. To eliminate this error, a 120 Hz signal corresponding to a 60 Hz power line is generated to light the neon lamp.

Stroboscope Operation (See Fig. 2-5 and Fig. 2-6)

- A signal of approximately 7.9 MHz is generated by IC2 and the crystal oscillator, and then divided within IC2. The output signal appearing at terminal No. 1 of IC2 has a frequency of 3840 Hz.

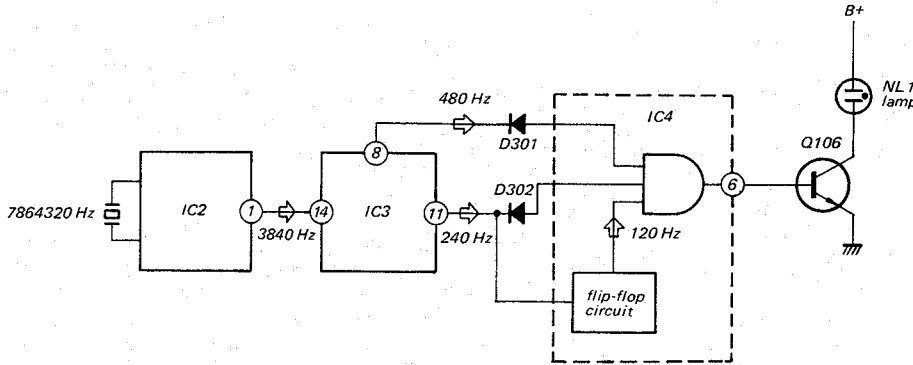


Fig. 2-6.

- This frequency is then fed into IC3 where it is further divided. A 480 Hz signal appears at terminal No. 8, and a 240 Hz signal at terminal No. 11.
- The 240 Hz signal is divided again into a 120 Hz signal by the flip-flop of IC4.
- Although stroboscope stripes designed with smaller t/T ratios appear to be sharper to the eye, they do require stronger illumination than is normally available. The stripes marked on the turntable platter of this equipment have a t/T ratio corresponding to 13%.

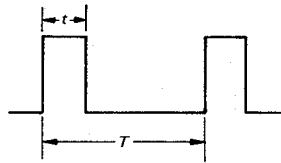


Fig. 2-4.

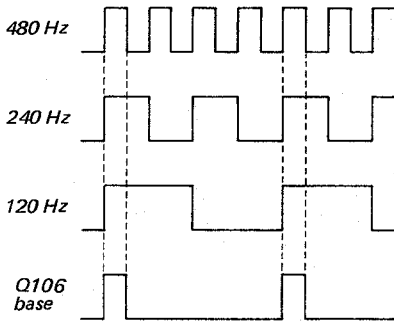


Fig. 2-5.

3. System Control Circuit

The system control circuit is composed of the following four sections:-

1. Flip-flop for start/stop operation (Q408, Q409)
2. Flip-flop for motor operation (Q411, Q412)
3. Flip-flop repeat operation (Q415, Q416)
4. Return-position detector circuit

The control circuit is thus responsible for turning the motor and solenoid (PM) on and off to drive the mechanical system, and activates the automatic lead-in, return, and repeat operations.

3-1. Operation when POWER Switch is turned on.
(See Fig. 3-1)

1. When the power switch (S1) is turned on, C409 charges up, and Q410 is turned on (routes &).
2. Once Q410 is turned on, all three flip-flops are reset by D407, D406, and D409 to the following stable states (routes , &).
 1. Q408 off, Q409 on
 2. Q411 on, Q412 off
 3. Q415 off, Q416 on

3. Q206 is turned on, so a voltage is not applied to the ⊕ input terminal of IC1-1 (route).
4. Q207 is turned off, so a voltage is not applied to the ⊖ input terminal of IC1-1 (route).
5. IC1-1 does not operate, and the motor does not turn.
6. Since Q406 is turned on (by the charge voltage in C405), Q407 will turn off, thereby preventing the solenoid (PM) from being energized.

3-2. (W (S5) is 1. 1. 1. 1. 1. 2. 3. (

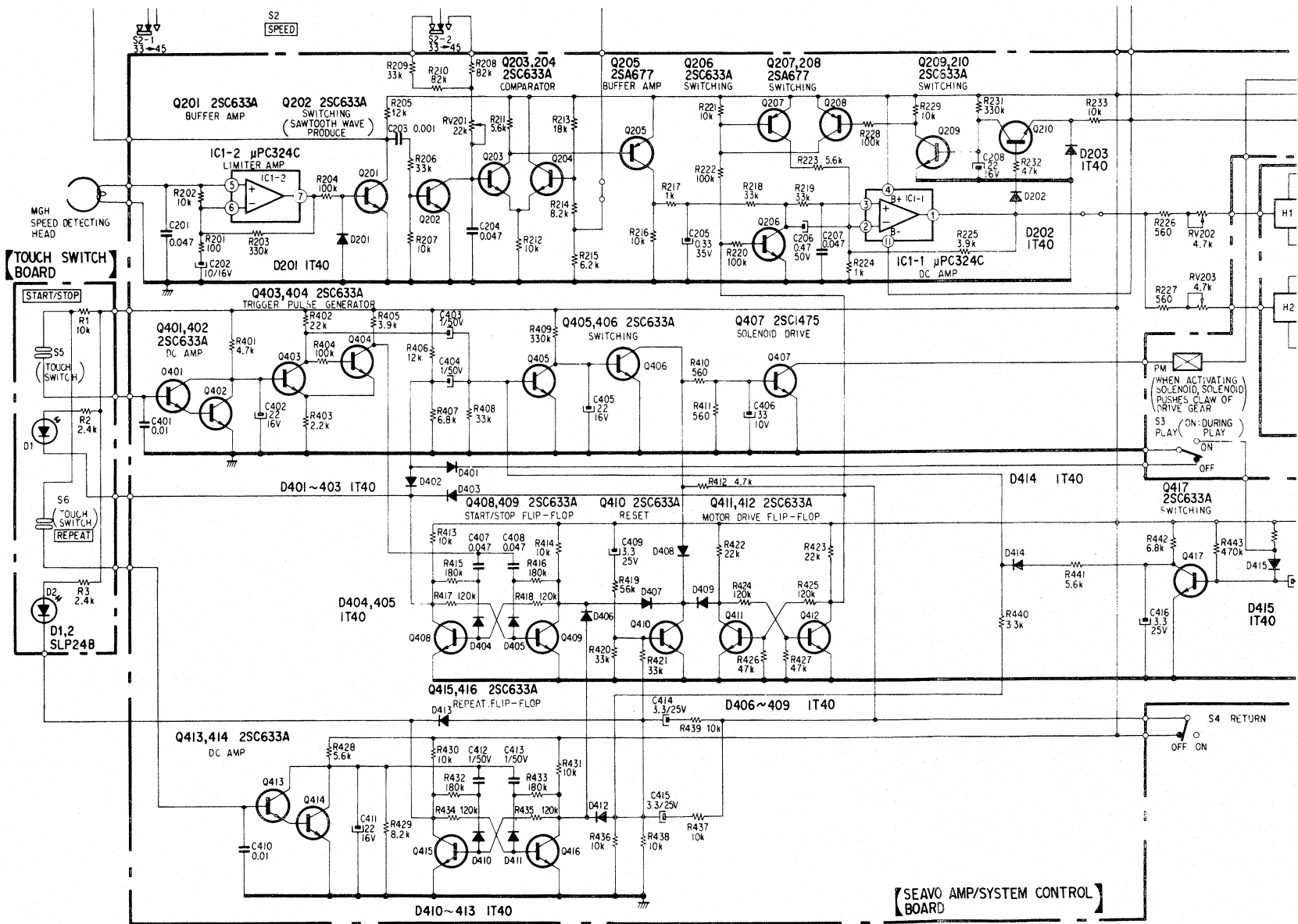
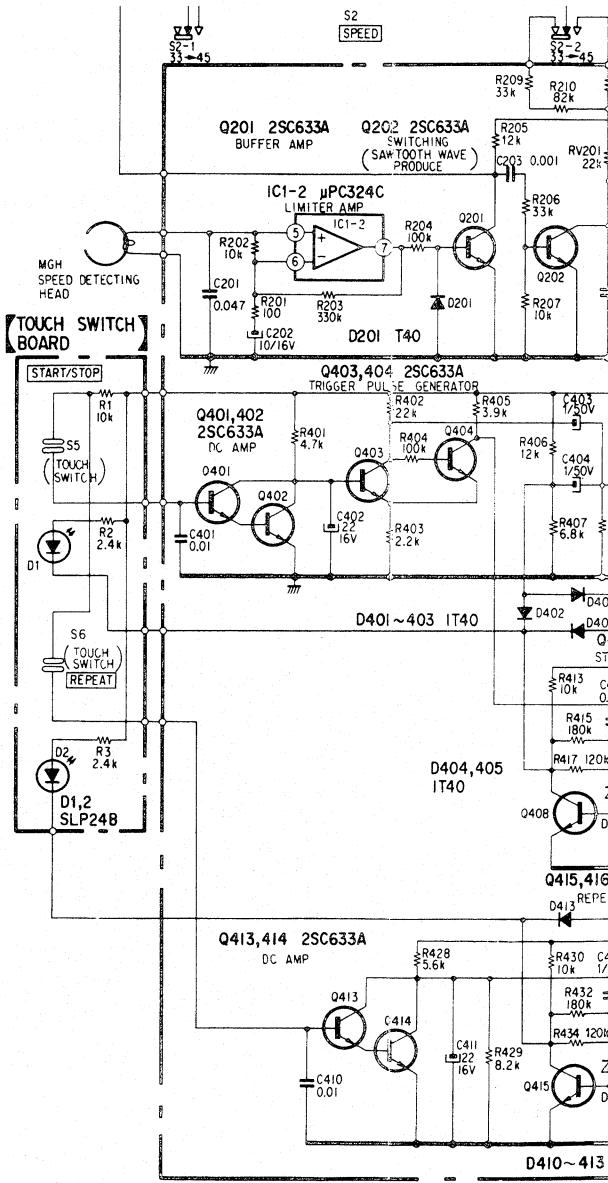


Fig. 3-1.



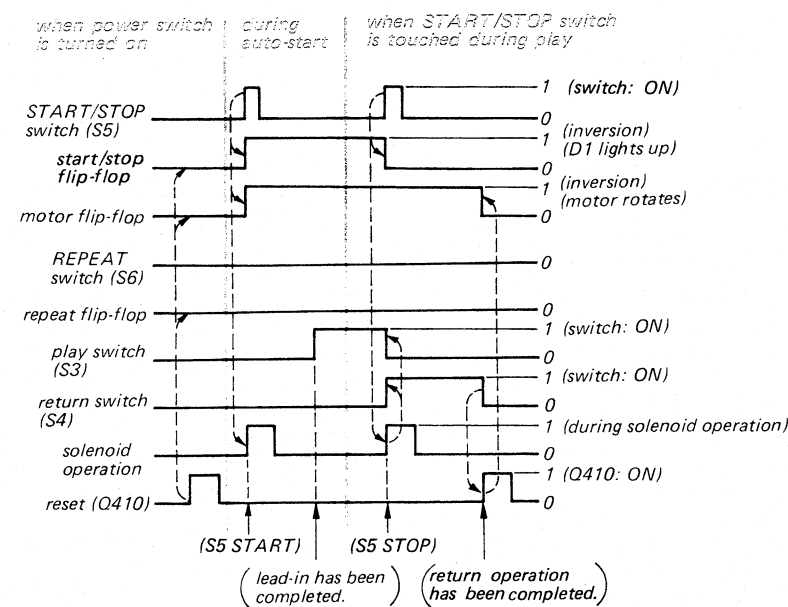


Fig. 3-3.

Fig. 3-1. Operation when the POWER switch is turned on

Fig. 3-2. Operation during auto-start

Fig. 3-3. Operation if START/STOP switch is touched during play

3-3. Operation if START/STOP Switch (S5) is touched during Play (See Fig. 3-4)

1. If S5 is touched during play, a negative pulse will be generated on the collector of Q404. This pulse inverts the operation of the Q408/Q409 flip-flop circuit. Namely, Q408 is turned off, and Q409 is turned on.
2. Once Q408 is turned off, the start indicator (LED) D1 is turned off.
3. On the other hand, a positive pulse is generated on the collector of Q403, turning Q407 on, and thereby passing a current through the solenoid (PM). The auto-return mechanism is thus activated, and the tonearm is returned to the arm rest.

4. Due to the operation of the auto-return mechanism, the return switch (S4) is turned on mechanically, thereby discharging C414.
5. When the tonearm returns to the arm rest, this switch again turns off.
6. While C414 is recharging, Q410 is turned on.
7. Consequently, all flip-flops are reset, and the motor stops rotating.
8. The circuitry is thus restored to its original status.

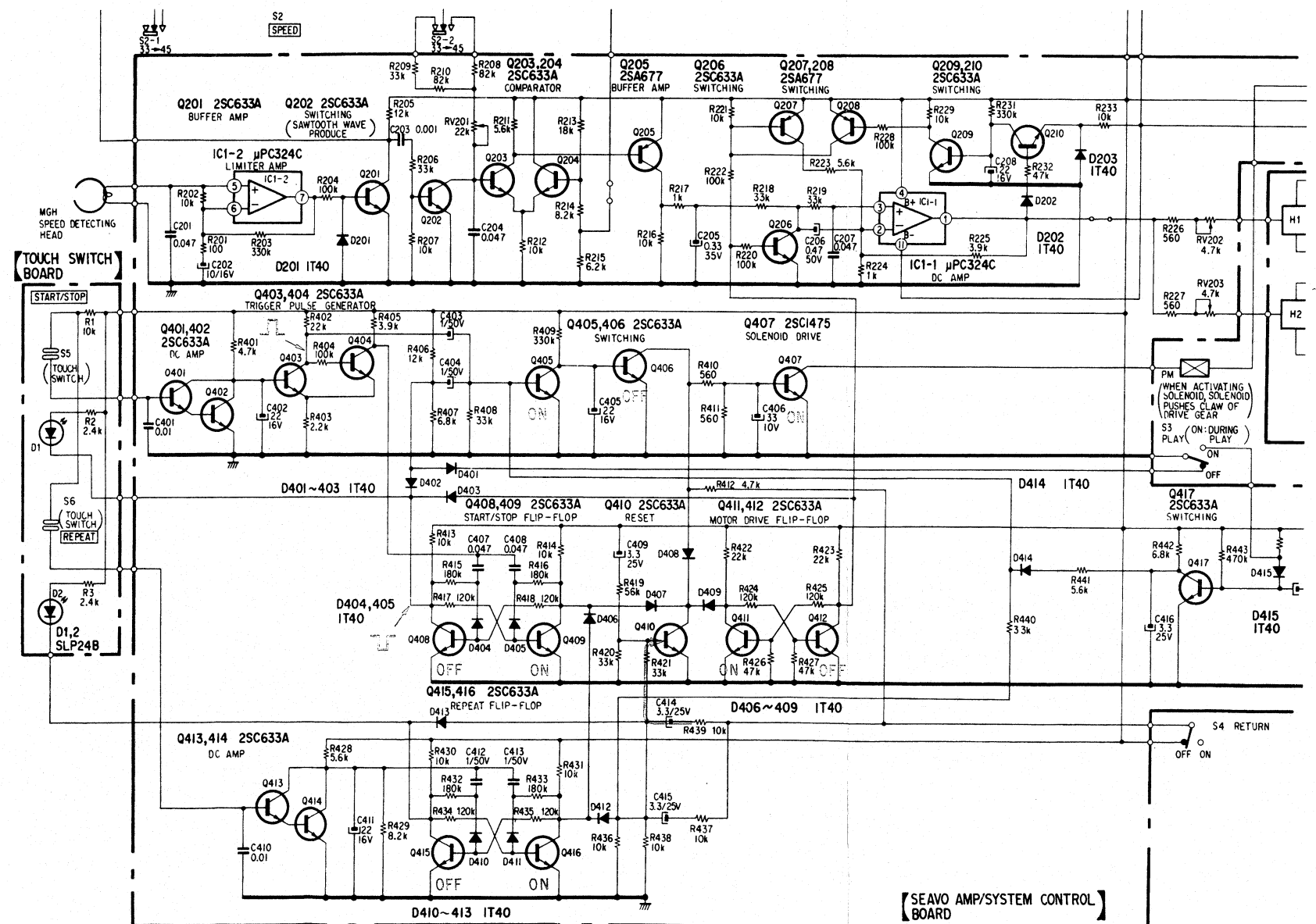


Fig. 3-4.



S3 (play switch)

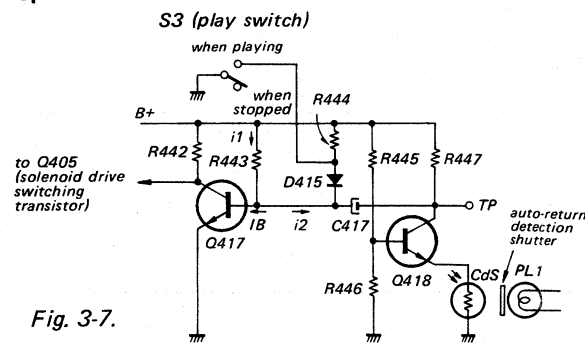


Fig. 3-7.

$$i_2 = \frac{V_{TP}}{dt} \cdot C417$$

In the circuit diagram shown above, D415 and R444 are employed to prevent misoperation when the tonearm is moved rapidly across by hand during the lead-in operation. (i₁ is increased, thereby reducing the sensitivity.)

1. When the power switch (S1) is turned on, Q419, Q420 and Q421 are all turned on. The auto-return operation detector lamp PL1 lights up.
2. The tonearm gradually moves across to, and then enters the auto-return position detection range (within 56.5 mm from the center spindle).
3. Once within the detection range, the pitch of the phonograph record groove changes rapidly (i.e. at the lead-out groove), the speed detection circuit (described later) is activated, turning Q417 off, and Q405 on (route ⑬).
4. Q407 is also consequently turned on, passing a current through to the solenoid (PM) (route ⑭).

5. Activation of the solenoid (PM) operates the auto-return mechanism, thereby bringing the tonearm back to rest automatically.
6. When operating the auto-return mechanism, the return switch (S4) is turned on mechanically, and C414 discharges.
7. Once the tonearm returns to the arm rest, this return switch is turned off again.
8. While C414 is recharging, Q410 is turned on (route ⑮).
9. As a result, all flip-flops are reset, the start indicator (LED) D1 turns off, and the motor stops rotating.
10. The circuitry is thus restored to the original status.

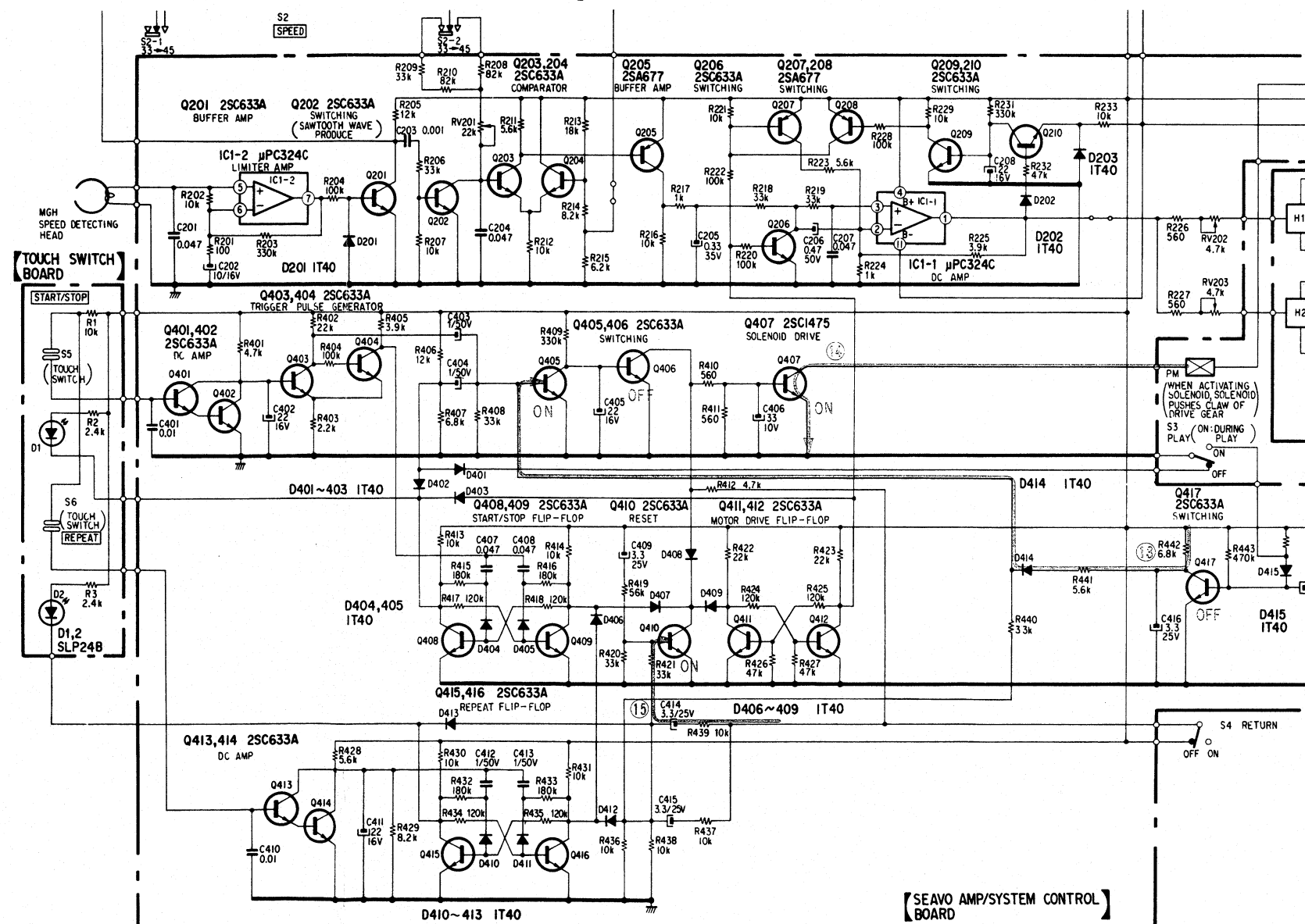


Fig. 3-6.

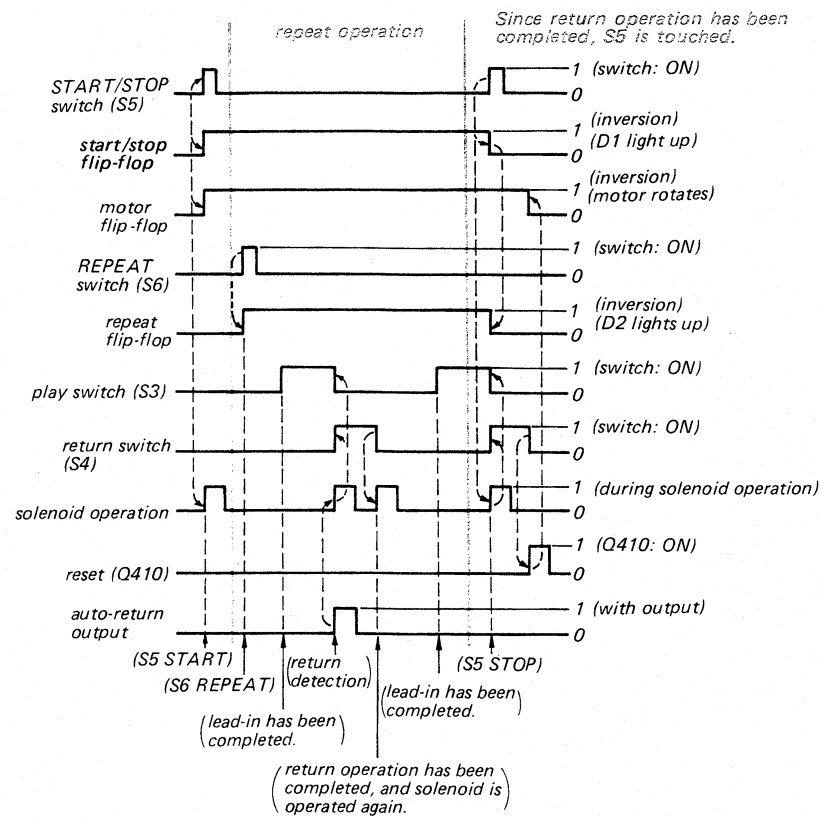


Fig. 3-8. Repeat operation

3-5. Repeat Operation (See Fig. 3-9)

When the feather-touch repeat switch (S6) is touched during play, the repeat indicator (LED) D2 lights up, and the same record is played over and over again.

1. When S6 is touched, a negative pulse is generated on the collector of Q414. This pulse inverts the state of the repeat flip-flop circuit, Q415/Q416. That is, Q416 is turned off, and Q415 is turned on.
When Q415 is turned on, the repeat indicator D2 lights up (route ③).
2. When the tonearm reaches the return position, the auto-return mechanism is activated, and the return switch (S4) turned on mechanically.

The tonearm then returns to the arm rest, and S4 then turns off again. But since Q415 is on in this case, D413 is biased in the forward direction. Therefore, unlike the operation for auto-return, Q410 is not turned on (route ⑰).

3. Consequently, neither the start/stop flip-flop circuit, Q408/Q409 nor the motor flip-flop Q411/Q412 circuits are inverted in this case.
4. Q405 is thus forward biased (i.e. turned on) by the charged voltage in C415 (route 18).
5. As a result, a current flows through the solenoid (PM), the lead-in mechanism is activated, and the tonearm is again moved across for the start of play.

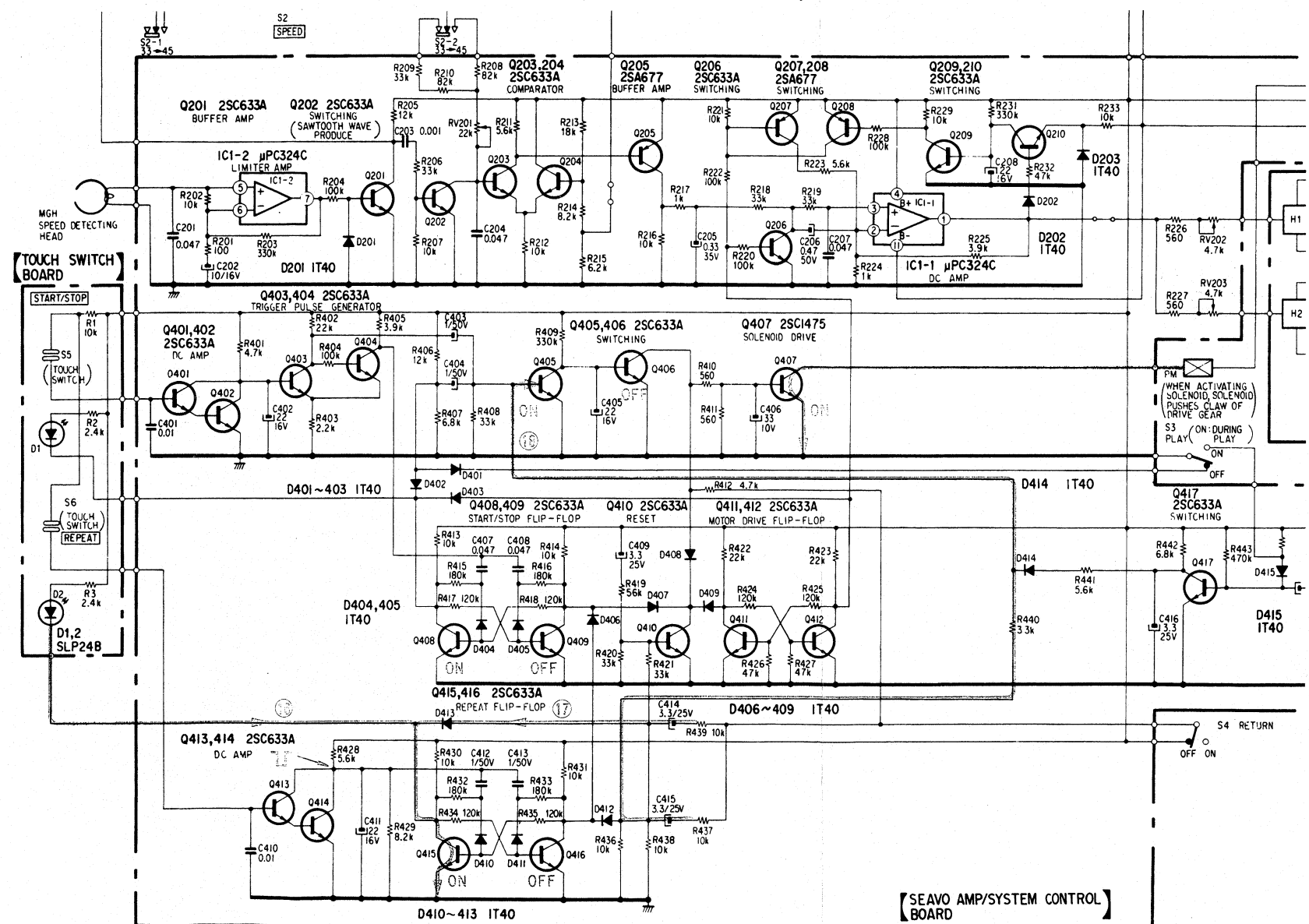


Fig. 3-9.

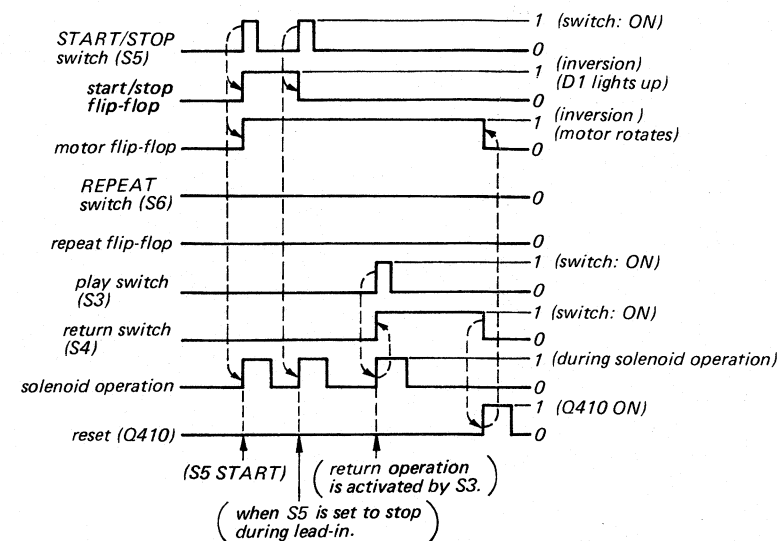
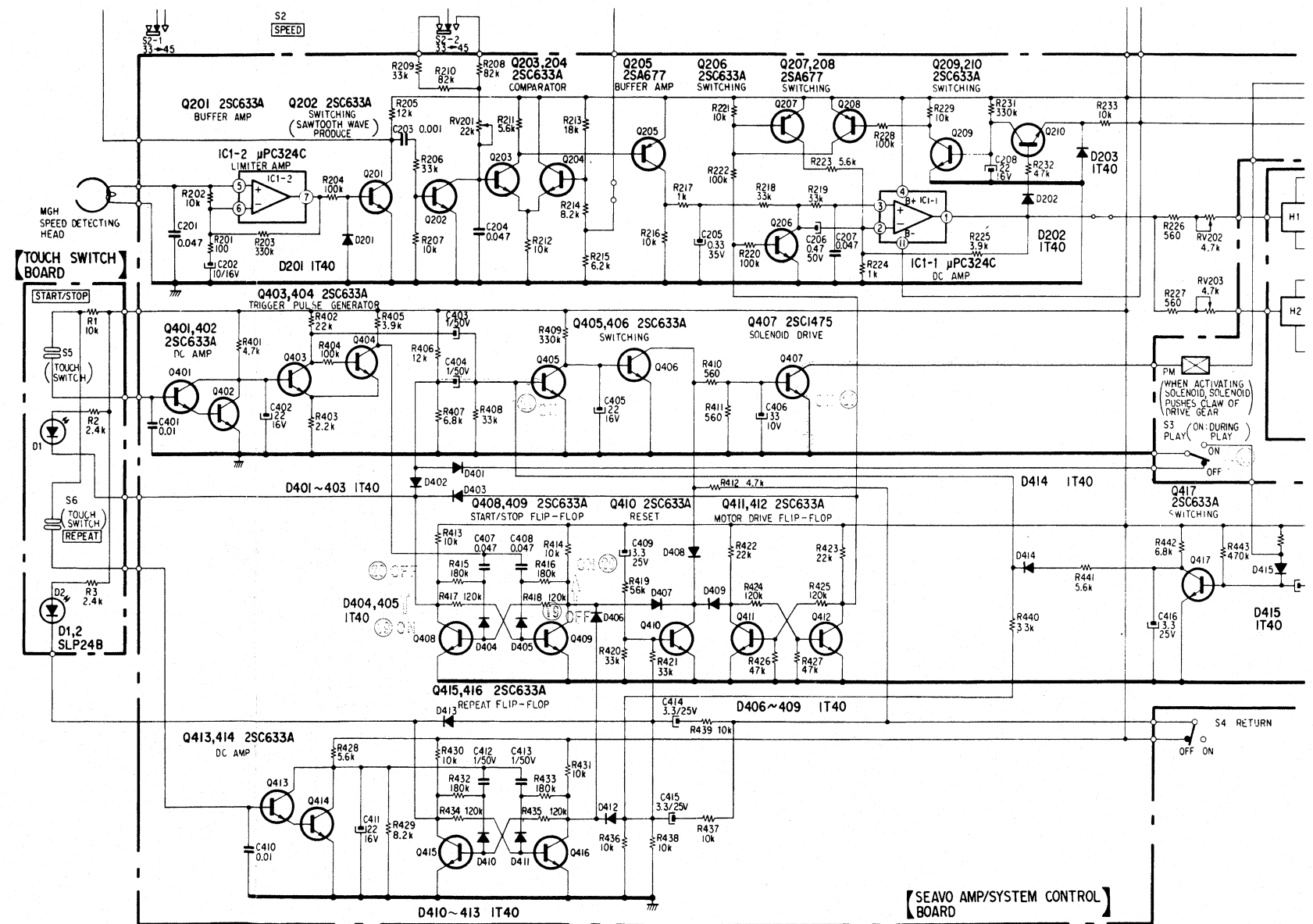


Fig. 3-10. Operation if START/STOP switch is touched during lead-in

3-6. Operation if the START/STOP Switch touched during Lead-in (See Fig. 3-11)

1. At the commencement of the auto-start operation, Q408 of the start/stop flip-flop circuit is turned on, and Q409 turned off. Since Q408 is turned on, the start indicator D1 is turned on. Q411 of the motor flip-flop circuit is turned off, and Q412 is turned on, thereby starting up the motor. Activation of the mechanical systems results in lead-in motion of the tonearm.
2. If S5 is then touched during this lead-in operation, the start/stop flip-flop circuit is inverted. That is, Q408 is turned off, and Q409 is turned on.

3. The starting indicator D1 will thus turn off as a result of Q408 turning off.
4. When S3 is then turned on mechanically, Q405 is turned on by the D402/D402 AND gate, thereby passing a current through the solenoid, and activating the auto-return operation (route ③).
5. The circuitry is thus restored to the original status.



4. Hall Motor

The PS-X6/X7 is equipped with the newly developed BSL (brush and slotless) dc servo motor, which has the following major advantages.—

1. Extremely uniform torque.
2. All-electronic switching (no mechanical contacts used at all), resulting in very little noise.
3. Extremely stable performance, and long operational life.

Magnetic Pole Arrangement (See Fig. 4-1)

- The motor coils L1 and L2 (plus L3 and L4) form a pair, connected in series.
- The reason for positioning two Hall elements H1 and H2 at an angle of $22^{\circ}30'$ from each other is to displace the electrical phase angle by 90° , thereby rotating the rotor in a 2-phase action.
- For the same reason, the positions of the coil pairs are set at an angle of $67^{\circ}30'$.
- The coil windings are wound in a partial cone shape to match the similarly shaped magnets, 8 of which are arranged in a circle underneath the rotor.

Motor Internal View (top view)

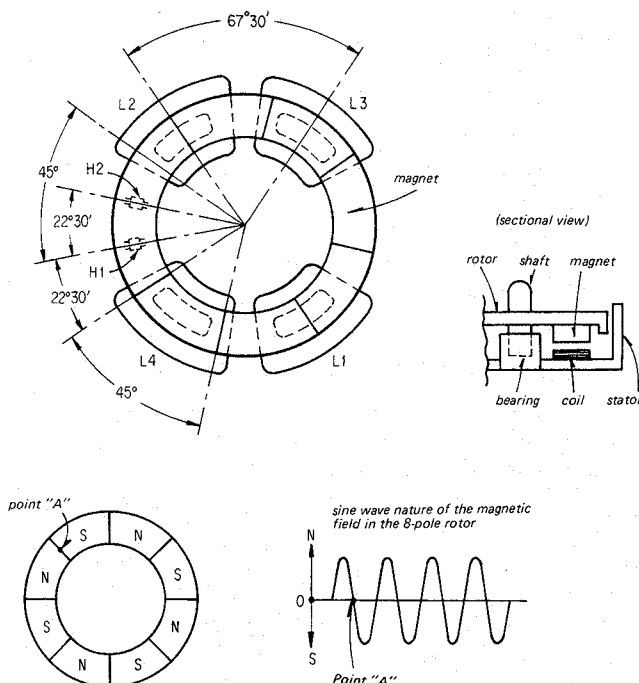
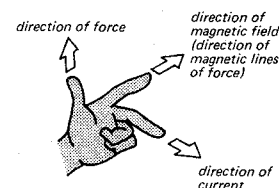


Fig. 4-1.

- Hall elements and motor coils have been set apart at an angle of $22^{\circ}30'$ so that the peak of an N or S pole magnetic field will cut across the center of a motor coil at the same time that the magnetic field peak of the preceeding or following S or N pole cuts across a Hall element.

Generation of Rotational Force (See Fig. 4-2)

According to Fleming's left hand rule, the force generated in the motor coils will be in the counter-clockwise direction, but since the coils are fixed, the magnets (attached to the rotor) will rotate in the clockwise direction. (Refer to Figs. 3-3 and 3-4.)



Fleming's left hand rule

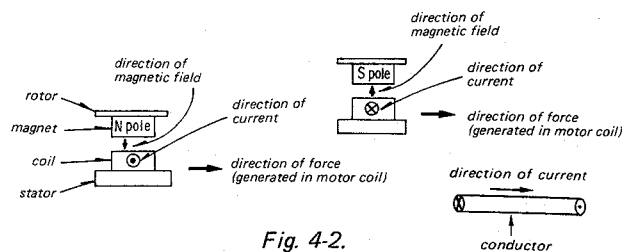


Fig. 4-2.

When an N pole corresponds to the Hall element H1 (shown in the Fig. 4-3), a positive voltage is generated in H1. This voltage is then amplified by IC1-4, and applied to Q211.

When Q211 is turned on, B+ voltage is applied to L1 and L2. The current flowing through L1 and L2, and the magnetic field produce an electro-magnetic force which spins the rotor in the direction of the arrow as shown in Fig. 4-3.

When an N pole corresponds to the Hall element H2 as shown in Fig. 4-3, current flows through L3 and L4, thereby generating the same electro-magnetic force to continue spinning the rotor.

When an S pole corresponds to the Hall element H1 (shown in Fig. 4-4), a negative voltage is generated in H1. This voltage is then amplified by IC1-4, and applied to Q212.

When Q212 is turned on, B- voltage is applied to L1 and L2. The current flowing through L1 and L2, and the magnetic field produce an electro-magnetic force which spins the rotor in the direction of the arrow as shown in Fig. 4-4.

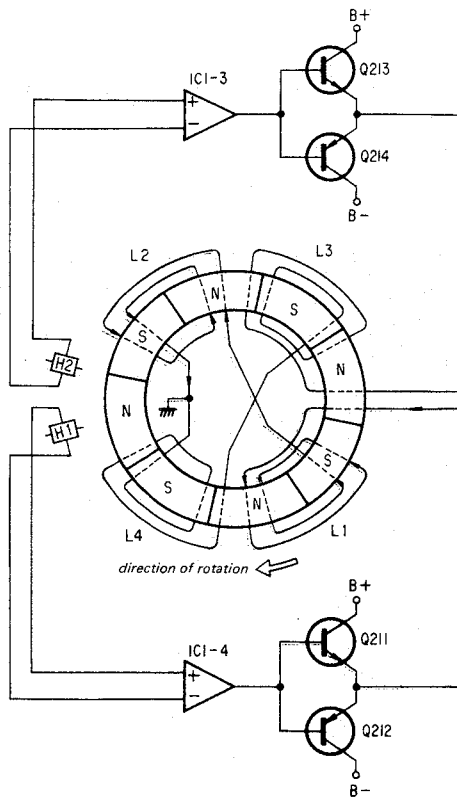


Fig. 4-3.

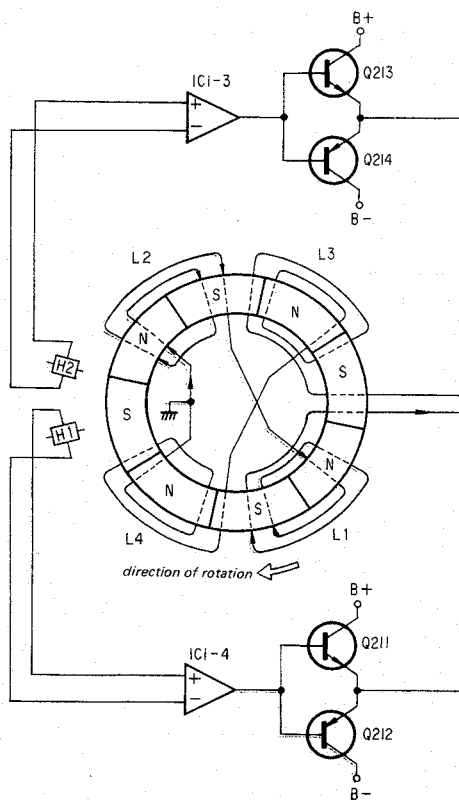


Fig. 4-4.

When an S pole corresponds to the Hall element H2, current flows through L3 and L4, thereby generating the same electro-magnetic force to continue spinning the rotor.

Hence, N and S poles are repeatedly positioned oppositely to the Hall elements H1 and H2 every $22^{\circ}30'$ of a rotation thereby generating the voltages in these elements, resulting in the production of a current in the motor coils, and subsequent rotation of the motor.

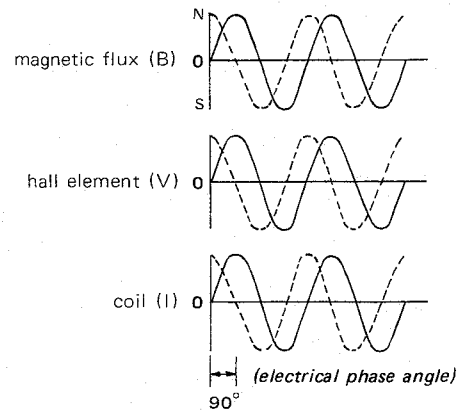


Fig. 4-5.

Rotational Force

The rotational force (torque F) varies directly with the strength of the magnetic field (B) cutting across the coils, and the amount of current (I) flowing through the coils.

That is, $F = B \cdot I$

But since the magnetic field produced by the magnets of the rotor varies in accordance with a sine wave relation with the angle of rotation, and the pairs of motor coils are arranged 90° out of phase each other, the combined torque will be constant.

Constant Speed Rotation (See Figs. 4-6 and 4-7)

In order to maintain constant turntable speed, this model features a magnetic-disc detection system in the speed-detector stage, and a crystal oscillator in the phase control stage of a crystal-locked servo system.

Changes in rotational speed of the turntable are detected by the speed-detection head fixed on the frame. (S and N magnets are mounted around the outer rim of the turntable platter with a very high degree of precision.) The reference standard frequencies detected by this head are 284 Hz at 33 rpm, and 384 Hz at 45 rpm. Any changes in frequency detected by this head are converted into voltage signals, and fed to the servo amplifier.

In addition, the phase of the frequency signal from the speed detection head is compared with the reference phase of the crystal oscillator frequency. Any difference in phase is also converted into a voltage signal, and fed to the servo amplifier, thereby ensuring accurate turntable rotational speed.

Since motor speed is determined by the amount of current flowing through the motor (that is, through the motor coils), motor speed may be conveniently changed by simply changing the flow of current through the Hall elements. In other words, if motor speed tends to deviate from the reference standard value due to external influences, the constant speed value may be maintained by simply varying the amount of current flowing through the Hall elements in proportion to the amount of deviation in turntable speed.

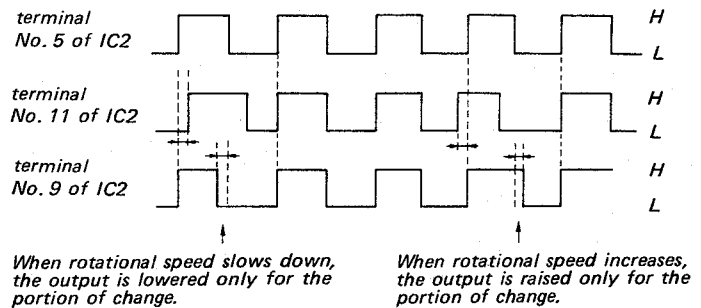


Fig. 4-7.

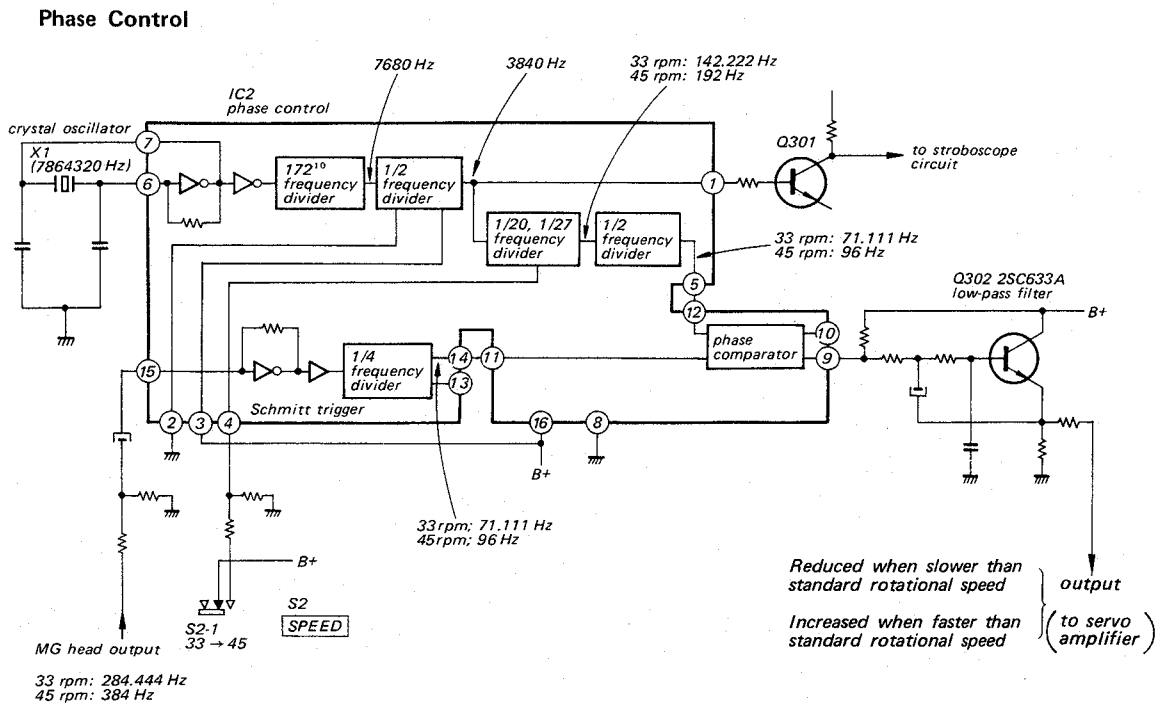


Fig. 4-6.

FULL AUTOMATIC STEREO TURNTABLE SYSTEM

PS-X6/X7

US Model
Canadian Model
AEP Model
UK Model
E Model

SUPPLEMENT

File this supplement with the service manual.

No. 2
May, 1978

CIRCUIT DESCRIPTION

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SONY®
SERVICE MANUAL

1. Operation of Servo Amplifier Circuit (See Fig. 1-1)

During Motor Start

1. When the power switch is turned on, Q202 is still turned off since an output signal from the MG head is not applied to IC1-2. C204 will thus charge up through R210, R209 and RV201 (or R208 and RV201 for 45 rpm).
2. Once the emitter voltage of Q203 (charging voltage applied to the base of Q203) exceeds $+V_{BE}$, this transistor turns on.
3. Q205 is thus turned on, thereby applying a voltage to IC1-1.

Limiter Circuit

1. Once the turntable starts to rotate, an output signal is produced by the MG head.
2. Although the MG head output signal is a sine wave, there is some fluctuation in amplitude. Therefore, above a certain level, this sine wave is changed into a constant-amplitude square wave.

Waveform Rectification

1. The IC1-2 output signal is amplified by Q201 to obtain a complete square wave signal. The D201 is employed to maintain the base voltage of Q201 at $\pm 0.6V_{p-p}$.

2. This limiter circuit (IC1-2, Q201) serves to prevent incorrect detection of amplitude fluctuations as frequency changes.
3. The square wave signal on the collector of Q201 is then applied to the phase control circuit.

Differential Circuit

The square wave signal on the collector of Q201 is changed to a triangular wave by C203, R206 and R207. The differentiated (triangular) pulse triggers the sawtooth wave generator transistor (Q202).

Sawtooth Wave Generator Circuit

1. While Q202 is turned off, C204 is charged up through R210, R209 and RV201 (or R208 and RV201 for 45 rpm). But when the positive part of the differentiated wave turns Q202 on, C204 discharges immediately, resulting in the collector voltage of Q202 dropping to 0V.
2. After the $\oplus$ portion of this differentiated wave has passed on, Q202 is again turned off, and C204 is charged up, resulting in the Q203 base voltage forming a sawtooth wave signal.

Comparator

1. The sawtooth wave signal is applied to the comparator circuit formed by Q203 and Q204. The base of Q204 is biased by the reference voltage produced by voltage division of B+ by the output from R213, R214, R215 and the phase control circuit.

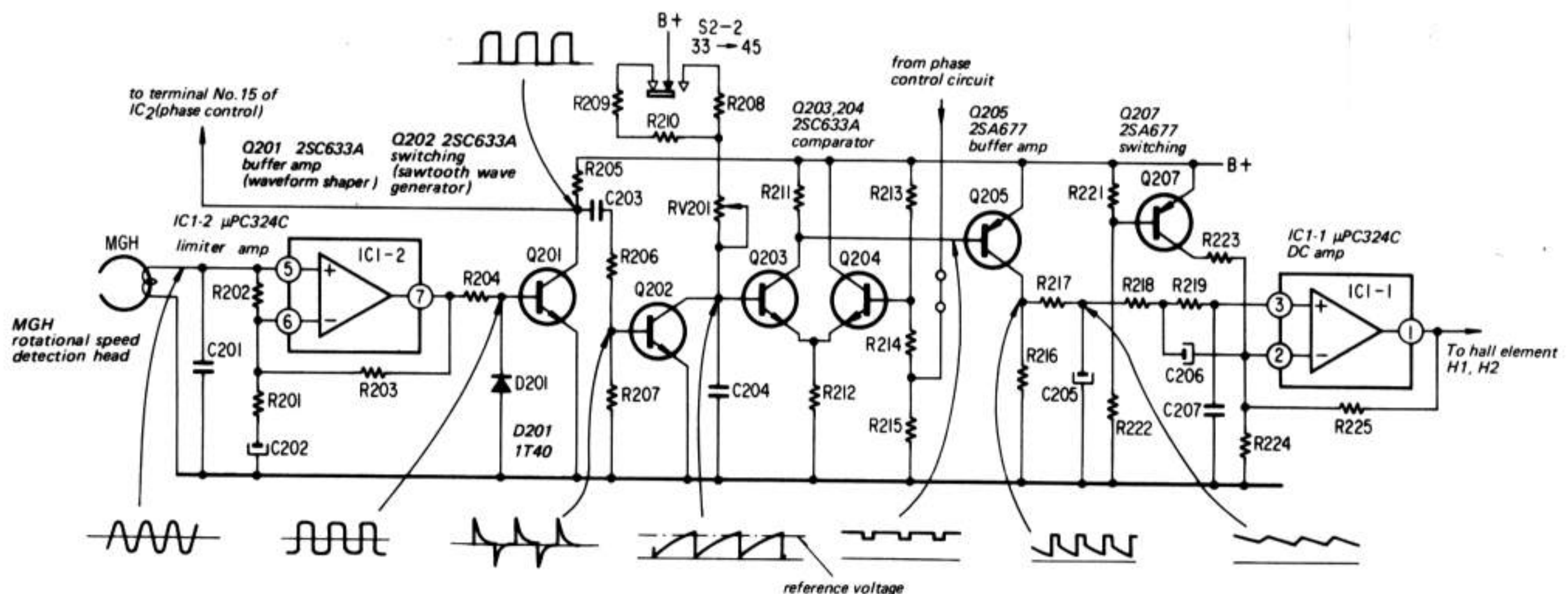


Fig. 1-1.

Since the emitter voltage of Q203 is determined at this time by the reference voltage, Q203 turns on when its base voltage (sawtooth wave) exceeds the total voltage (emitter voltage plus $+V_{BE}$). So a negative pulse will appear on the collector of Q203.

2. If the rotational speed slows down, the frequency of the sawtooth wave will be low. Also, the output pulse width increases, because the on-time of Q203 becomes long. On the other hand, if the rotational speed increases, the frequency of the sawtooth wave will be high. Also, the output pulse width becomes narrow, because the on-period of Q203 becomes short.

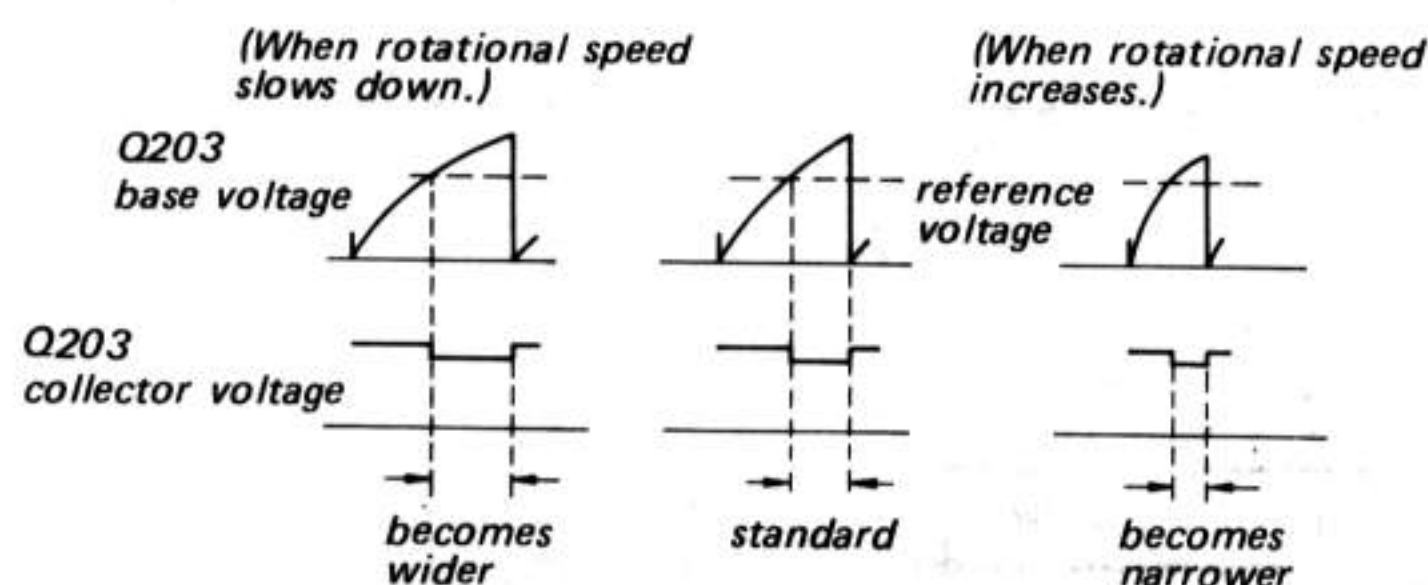


Fig. 1-2.

Pulse Signal Amplifier

Besides amplifying pulse signals, Q205 also serves as a phase inverter which feeds positive pulse signals to the next stage.

Smoothing Circuit (low-pass filter)

This smoothing circuit has two filters (one is made up of R217 and C205, and the other is IC1-1, R218, R219, C206 and C207). These filters operate as an integrating circuit which converts the pulse signals into dc signals (the voltage level being in proportion to pulse width).

DC Amplifier Circuit

The dc amplifier (that also serves as a low-pass filter), uses IC1-1, and amplifies the dc output signals from the previous stage.

Speed Selector Switch (S2)

1. The circuit time constant is changed by simply changing the resistance connected to the base of Q203.

2. The time constant for 45 rpm is designed to be faster than that for 33 rpm.
3. Consequently, when switching the speed selector switch from 33 to 45 rpm, the collector output pulse width of Q205 is widened, thereby increasing the level of the low-pass filter DC output signal. Motor speed is thus increased, followed by re-application of the servo control mechanism.
4. When switching back to 33 rpm, the reverse sequence of events takes place.

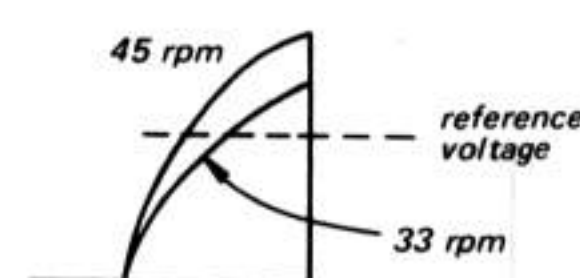


Fig. 1-3.

Servo Control

If for any reason, motor speed decreases or increases, even by the slightest degree, the servo control mechanism is activated to correct for the deviation, and returns the speed to the reference standard value.

1. If the motor speed is decreased slightly, the frequency of the MG head output signal decreases. This signal is applied to the phase control circuit (IC2) for phase comparison. The resultant output, of decreased voltage level, is then sent to the servo control. And since the base voltage of Q204 is reduced, the emitter voltage (reference voltage) of Q203 also decreases, resulting in the width of the Q203 collector output pulse being widened.
2. The dc output voltage from the low-pass filter consequently decreases, thereby increasing motor speed back to the original standard value.
3. If, on the other hand, motor speed is increased by some external influence, the servo control mechanism reduces speed in the reverse manner of that described above.

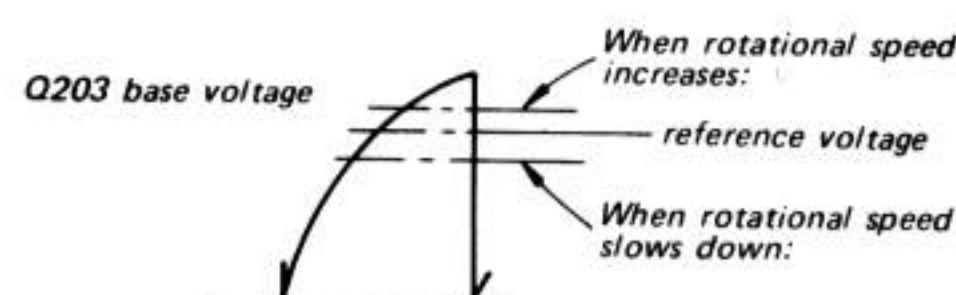


Fig. 1-4.

2. Maintaining Forward Rotation (See Fig. 2-3)

1. When a $\oplus$ signal is applied to the input terminal of the Hall elements, the motor is turned in the forward direction, but when a $\ominus$ signal is applied, the motor is turned in the reverse direction. Therefore, the reverse rotation that is caused by applying $\ominus$ input serves as a brake for rapid stopping of the turntable.
(Conventional speed reduction systems use the phenomenon of hysteresis loss or mechanical loss.)

2. F-V converter circuit

This circuit converts the frequency of the MG head output signal into a voltage signal in accordance with the curve as shown in Fig. 2-1.

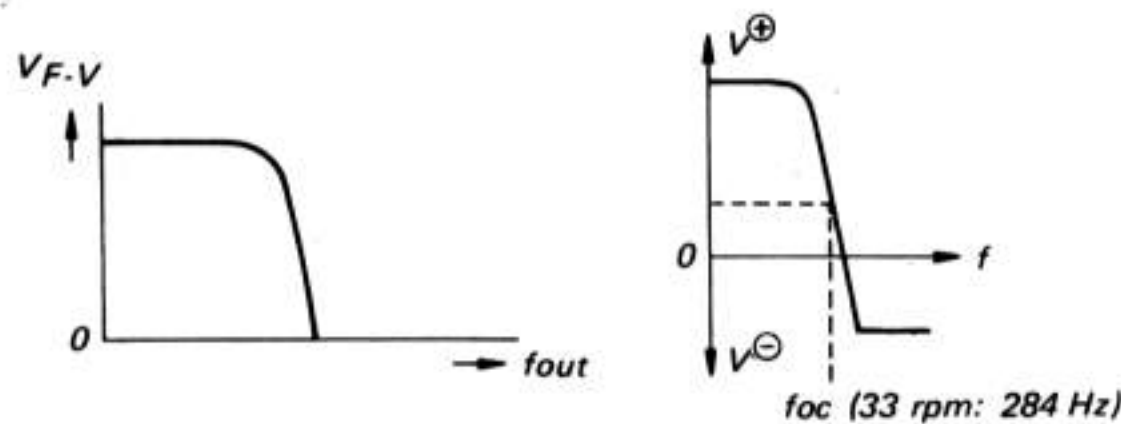


Fig. 2-1.

Fig. 2-2.

This curve shows "frequency against output voltage" for both forward and reverse rotations.

3. DC amplifier (IC1-1) operation

The output level of IC1-1 is determined by the relationship:

$$V_{OUT} = (V^{\oplus}_{IN} - V^{\ominus}_{IN}) \times \text{Gain},$$

or $V_{OUT} = V^{\oplus}_{IN} \times \text{Gain}$ when $V^{\ominus}_{IN}$ is 0V.

In this equipment, output levels of approx. -1.5V to +13V are possible by applying $\oplus$ voltage to $V^{\ominus}_{IN}$ through Q207 and R223.

When the speed selector is instantly switched from 45 rpm to 33 rpm, $V^{\oplus}_{IN}$ becomes 0V, $V^{\ominus}_{IN}$ becomes positive, and V_{OUT} minus, thereby activating the brake operation.

4. If the frequency of the MG head exceeds f_{oc} during forward rotation, V_{OUT} becomes 0 or minus, thereby slowing down rotational speed. But during reverse rotation, the result is an acceleration of the reverse rotational action.
5. In order to prevent such "run-away" acceleration, a switching circuit consisting of Q210, Q209, and Q208 is employed, thus maintaining forward rotation.

Normal Operation

1. For normal operation, the emitter of Q210 is fixed to a level of -0.5V by D203.

2. Since the base potential of Q210 is normally kept at about 1.5V, Q210 turns on.
3. Since the base of Q209 is -0.5V, Q209 turns off. Q208 also turns off, and then Q207 turns on.
4. A $\oplus$ signal is thereby applied to the $\ominus$ input terminal of IC1-1 through R223.

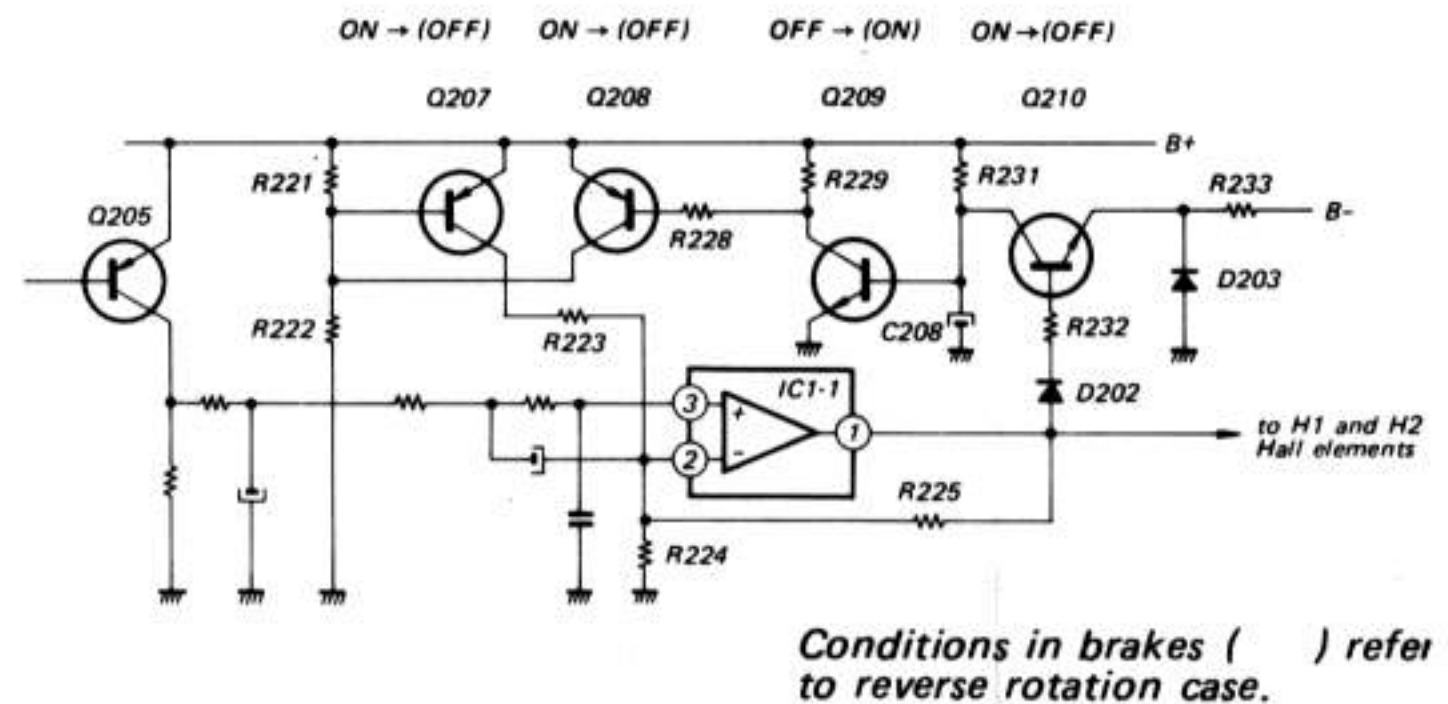


Fig. 2-3.

Reverse Rotation

1. When operating too fast during reverse rotation (when the frequency of the MG head output signal exceeds f_{oc}), Q205 is turned off and no signal is obtained on the $\oplus$ input terminal of IC1-1. The output level of IC1-1 then drops from the normal 1.5V (relative to ground) to less than +0.5V, resulting in Q210 being turned off.
2. Consequently, the base voltage of Q209 rises in accordance with the R231/C208 time constant, finally turning Q209 on once the base potential exceeds +0.5V.
3. Q208 then turns on, and Q207 turns off.
4. Consequently, no voltage is applied to the $\ominus$ input terminal of IC1-1.
5. That is, the operation of IC1-1 will be stopped, resulting in the output level reducing to 0V, and the slowing down of rotational speed.
6. The MG head output frequency consequently drops below f_{oc} , resulting in a positive output signal from the F-V converter, and forward motor rotation. Once the IC1-1 output level exceeds +0.5V, the reverse-rotation prevention circuit is put into standby status.
7. This reverse rotation prevention circuit can be switched off again extremely rapidly. When Q210 is turned on, C208 discharges through R233 to the B- bus.

Stroboscope

The stroboscope system employed in this equipment consists of stroboscope stripes marked on the outer rim of the turntable platter, plus a neon lamp directed onto the outer rim stripes. The number of stroboscope stripes for 33 1/3 rpm and 45 rpm are determined by the following equation:

$$n = \frac{60 (m + 2f)}{N}$$

where n = number of stripes,

m = the number of stripes to pass any one point during 1 second,

f = power supply frequency (Hz),

and N = turntable speed (rpm).

Table 1

RPM	Number of stroboscope stripes	
	50 Hz	60 Hz
33 1/3	180	216
45	133 1/3	160

As can be seen from this table, the above equation does not give an integral number of stripes for the 45 rpm speed at 50 Hz.

Therefore, the strips of the stroboscope are difficult to judge at 50 Hz, 45 rpm. However, this speed error can be ignored while a record is being played. To eliminate this error, a 120 Hz signal corresponding to a 60 Hz power line is generated to light the neon lamp.

Stroboscope Operation (See Fig. 2-5 and Fig. 2-6)

1. A signal of approximately 7.9 MHz is generated by IC2 and the crystal oscillator, and then divided within IC2. The output signal appearing at terminal No. 1 of IC2 has a frequency of 3840 Hz.

2. This frequency is then fed into IC3 where it is further divided. A 480 Hz signal appears at terminal No. 8, and a 240 Hz signal at terminal No. 11.
3. The 240 Hz signal is divided again into a 120 Hz signal by the flip-flop of IC4.
4. Although stroboscope stripes designed with smaller t/T ratios appear to be sharper to the eye, they do require stronger illumination than is normally available. The stripes marked on the turntable platter of this equipment have a t/T ratio corresponding to 13%.

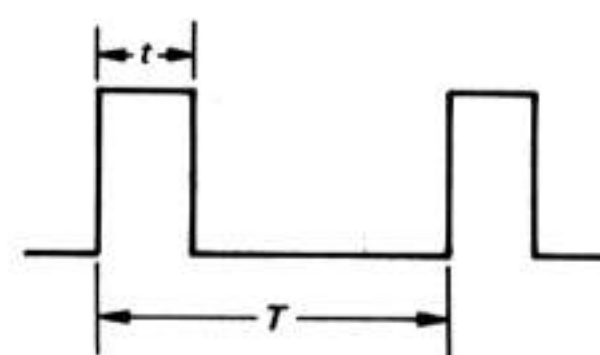


Fig. 2-4.

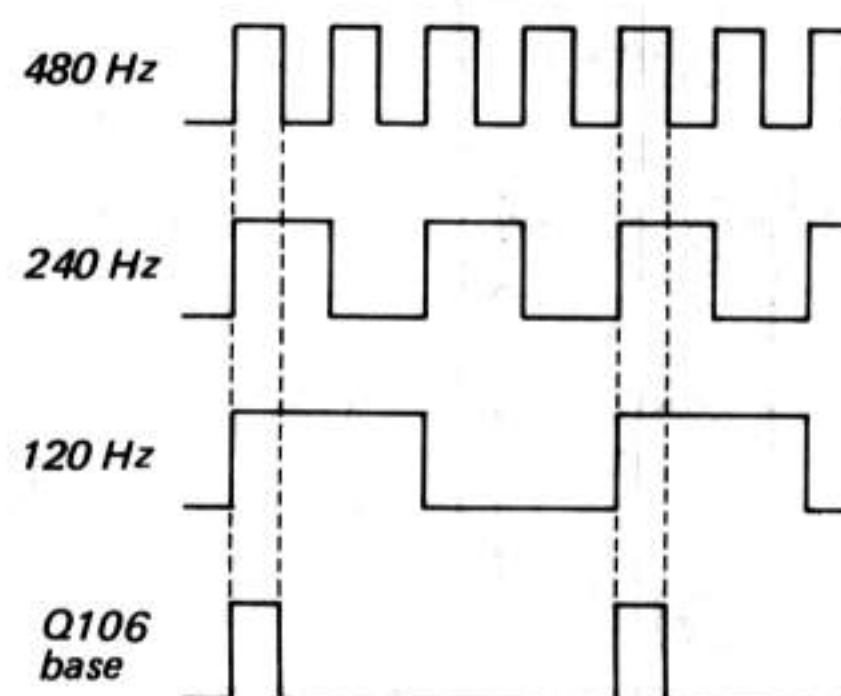


Fig. 2-5.

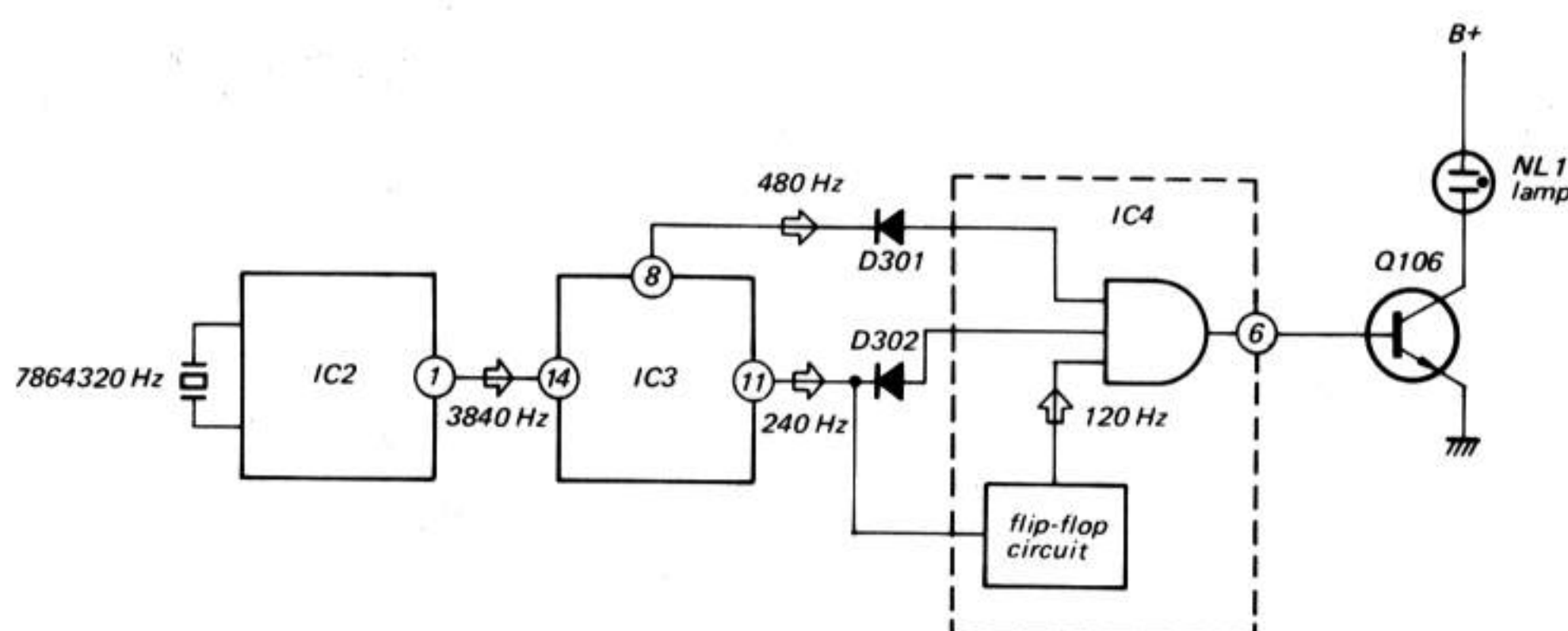


Fig. 2-6.

3. System Control Circuit

The system control circuit is composed of the following four sections:—

1. Flip-flop for start/stop operation (Q408, Q409)
2. Flip-flop for motor operation (Q411, Q412)
3. Flip-flop repeat operation (Q415, Q416)
4. Return-position detector circuit

The control circuit is thus responsible for turning the motor and solenoid (PM) on and off to drive the mechanical system, and activates the automatic lead-in, return, and repeat operations.

3-1. Operation when POWER Switch is turned on. (See Fig. 3-1)

1. When the power switch (S1) is turned on, C409 charges up, and Q410 is turned on (routes ① & ②).
2. Once Q410 is turned on, all three flip-flops are reset by D407, D406, and D409 to the following stable states (routes ③, ④ & ⑤).
 1. Q408 off, Q409 on
 2. Q411 on, Q412 off
 3. Q415 off, Q416 on

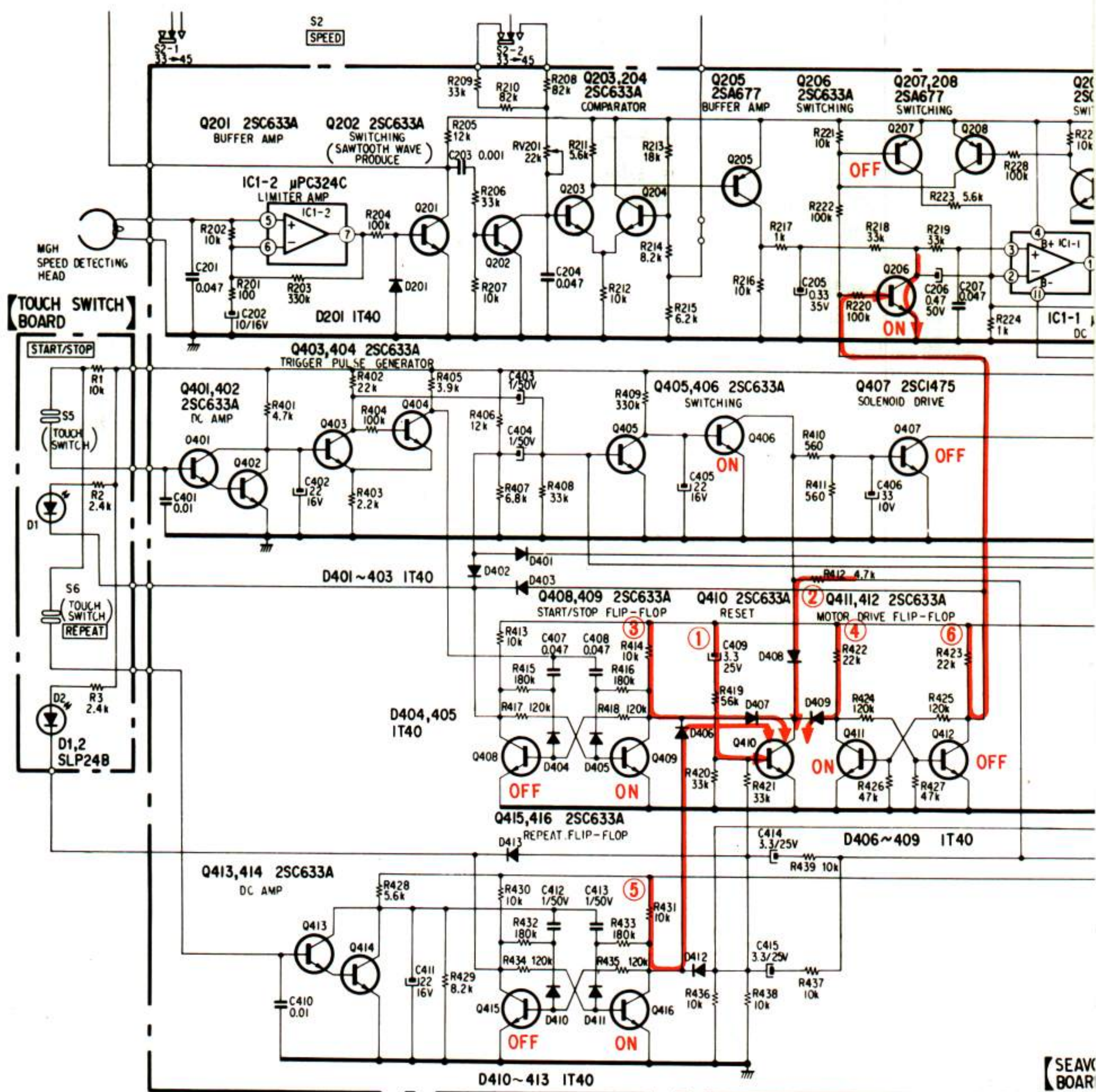
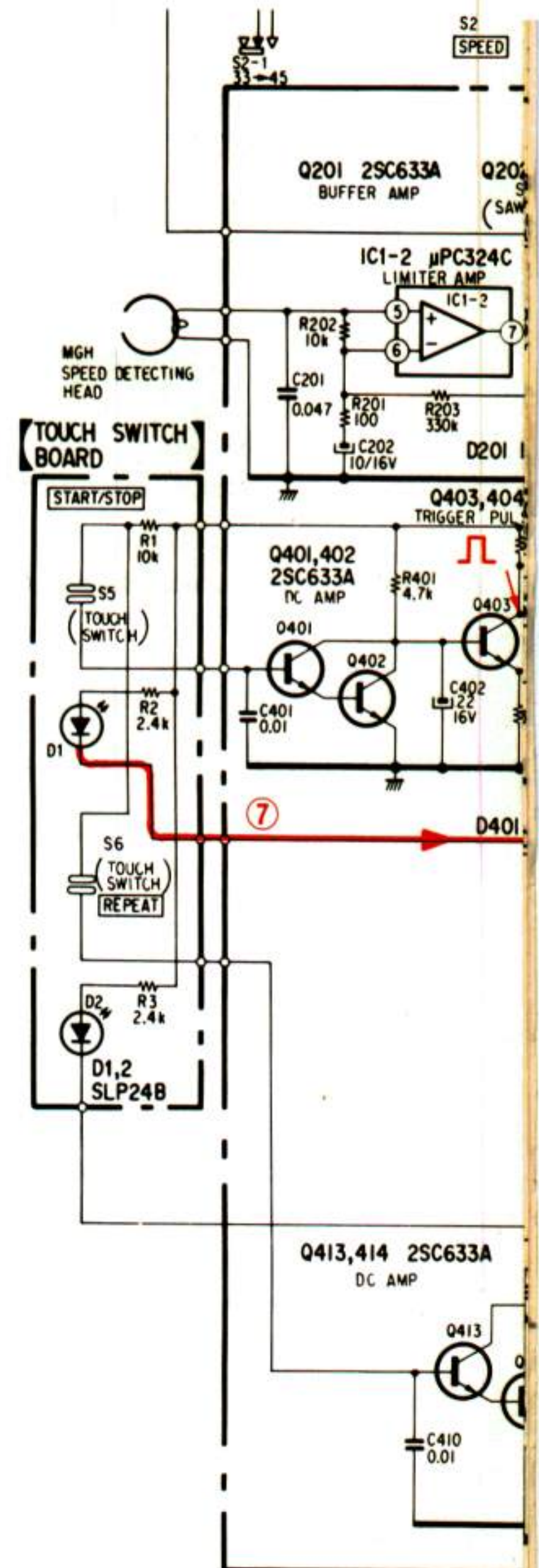
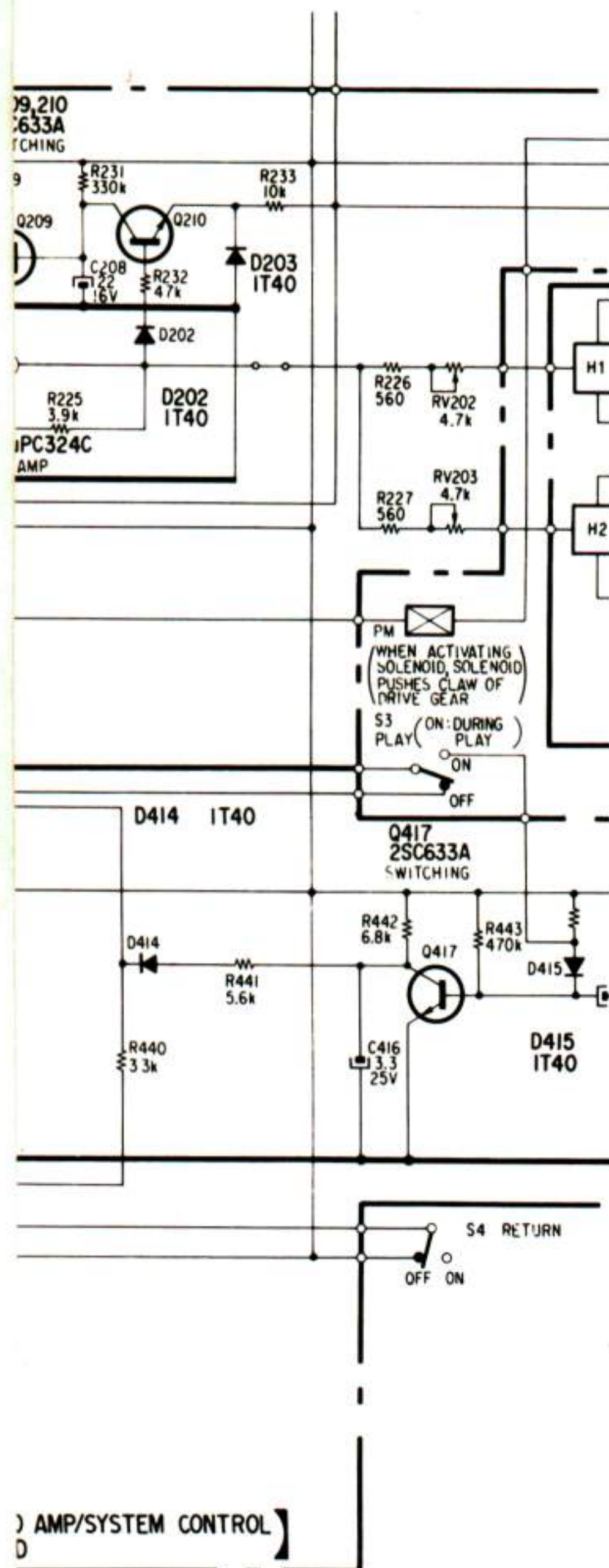


Fig. 3-1.

3. Q206 is turned on, so a voltage is not applied to the $\oplus$ input terminal of IC1-1 (route ⑥).
4. Q207 is turned off, so a voltage is not applied to the $\ominus$ input terminal of IC1-1 (route ⑥).
5. IC1-1 does not operate, and the motor does not turn.
6. Since Q406 is turned on (by the charge voltage in C405), Q407 will turn off, thereby preventing the solenoid (PM) from being energized.



3-2. Operation during Auto-start (See Fig. 3-2)

When the START/STOP feather-touch switch (S5) is touched:

1. A negative pulse signal is generated on the collector of Q404 (which forms a Schmitt trigger circuit with Q403). This pulse signal reverses the state of the start/stop flip-flop circuit Q408/Q409, thereby turning Q408 on, and Q409 off.
2. The start indicator (LED) D1 lights up (route ⑦).
3. Current then flows along route ⑧, so the collector potential of Q412 inverts the state of the motor flip-flop circuit Q411/Q412. Namely, Q411 turns off, and Q412 on.

4. Consequently, Q206 is turned off, and a voltage is applied to the $\oplus$ input terminal of IC1-1. And since Q207 is turned on, a voltage is applied to the $\ominus$ input terminal of this IC.
5. Therefore, IC1-1 operates, starting up the motor.
6. On the other hand, a positive trigger pulse signal is generated on the collector of Q403, and is applied to the base of Q405 to turn Q405 on (route ⑪).
7. Once Q405 is turned on, C405 is discharged, Q406 is turned off and Q407 turned on. As a result, the solenoid (PM) is energized, thereby activating the mechanical system for automatic lead-in of the tonearm (route ⑫).

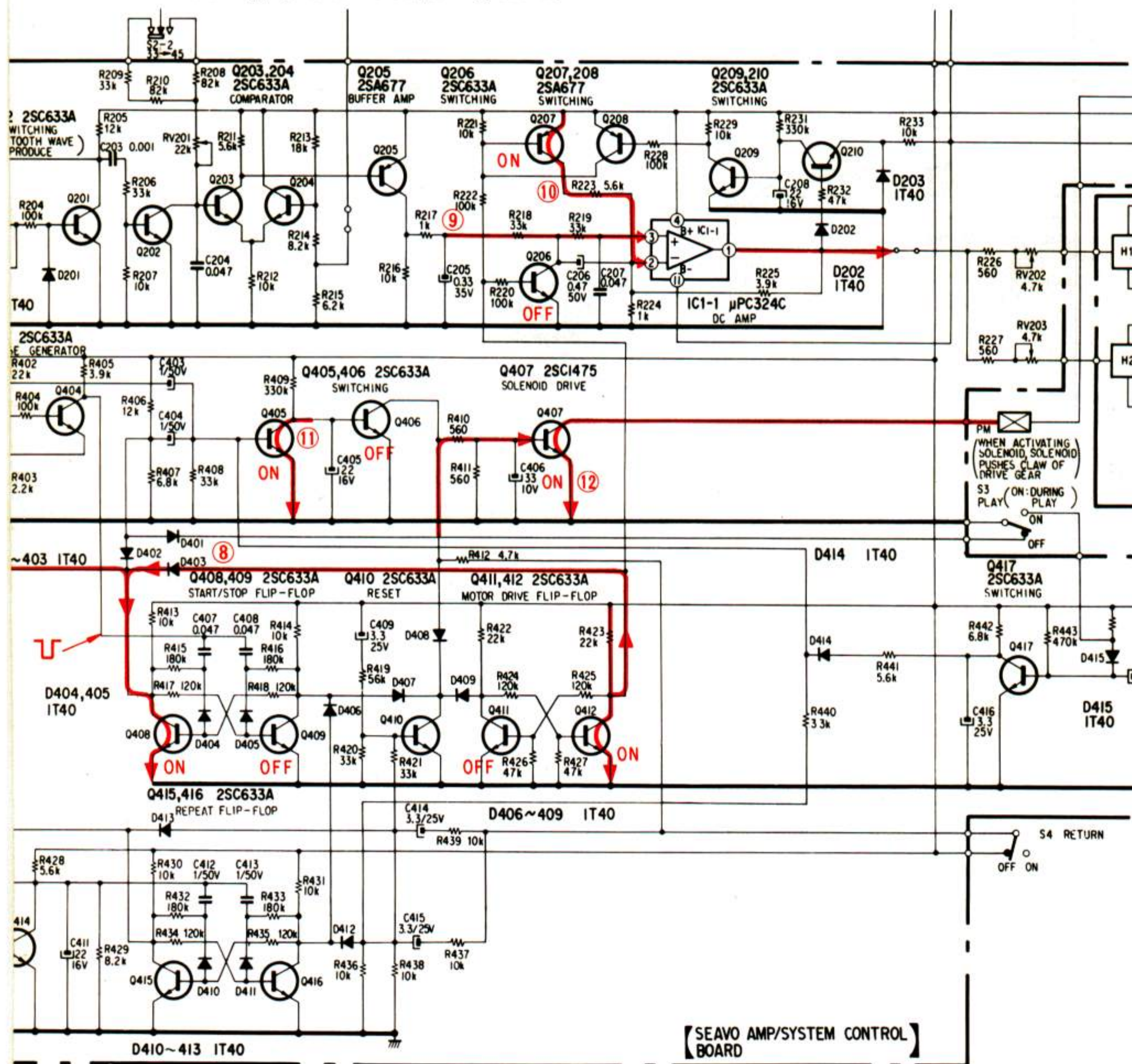


Fig. 3-2.

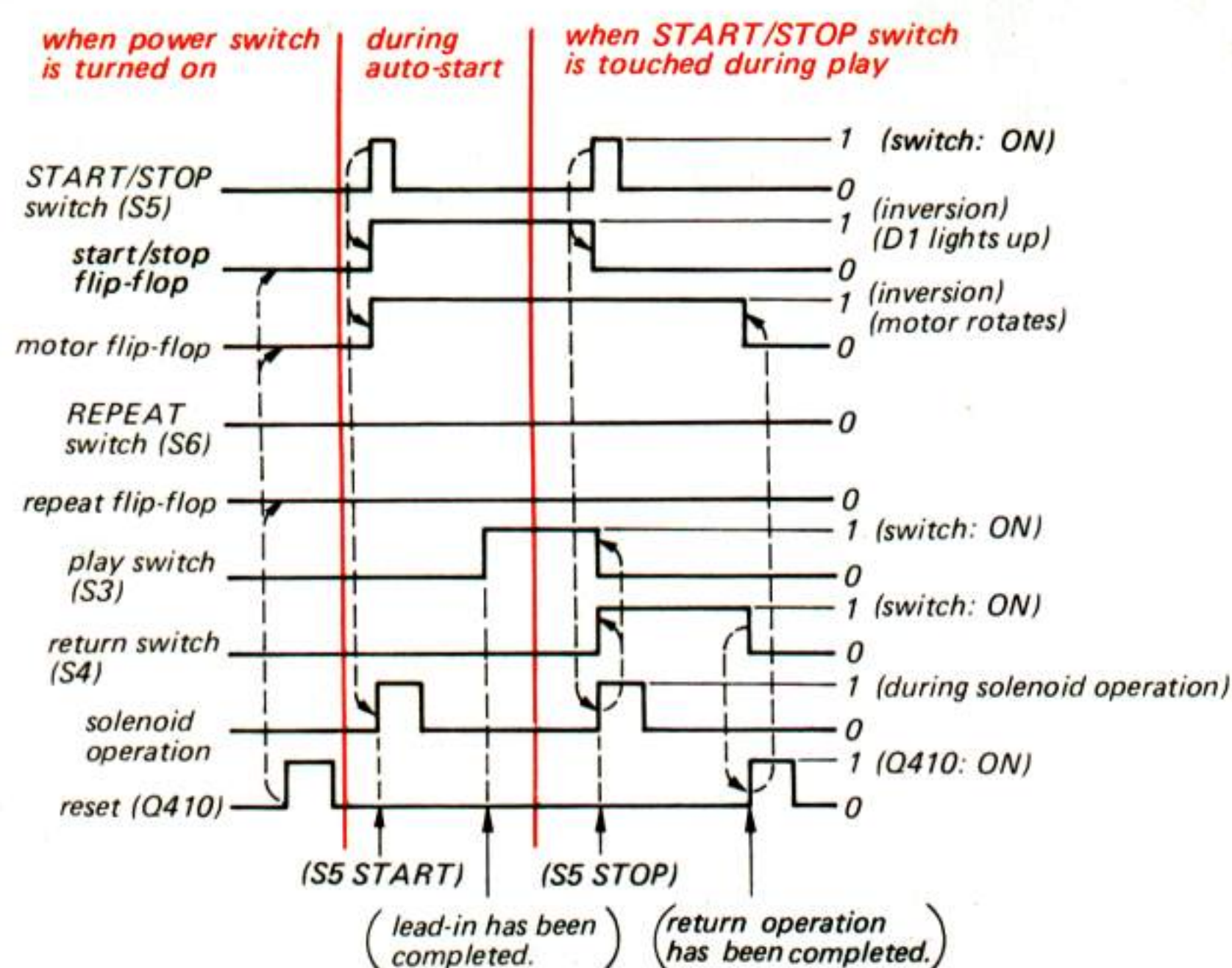
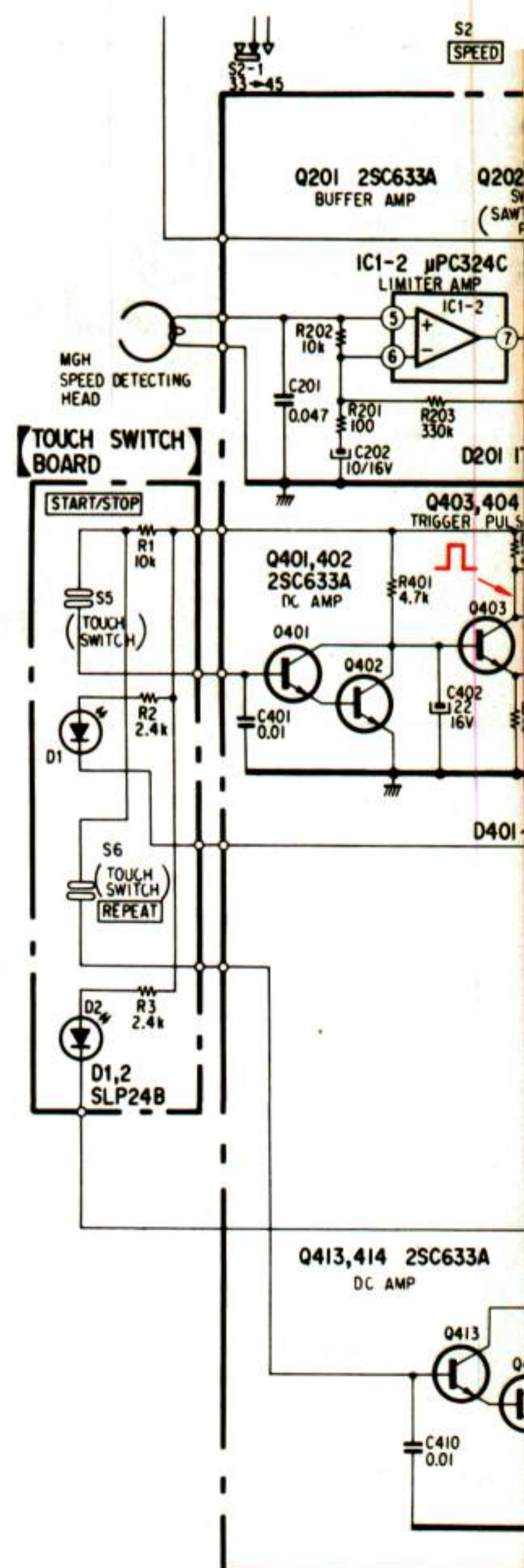


Fig. 3-3.

Fig. 3-1. Operation when the POWER switch is turned on

Fig. 3-2. Operation during auto-start

Fig. 3-3. Operation if START/STOP switch is touched during play



3-3. Operation if START/STOP Switch (S5) is touched during Play (See Fig. 3-4)

1. If S5 is touched during play, a negative pulse will be generated on the collector of Q404. This pulse inverts the operation of the Q408/Q409 flip-flop circuit. Namely, Q408 is turned off, and Q409 is turned on.
2. Once Q408 is turned off, the start indicator (LED) D1 is turned off.
3. On the other hand, a positive pulse is generated on the collector of Q403, turning Q407 on, and thereby passing a current through the solenoid (PM). The auto-return mechanism is thus activated, and the tonearm is returned to the arm rest.

4. Due to the operation of the auto-return mechanism, the return switch (S4) is turned on mechanically, thereby discharging C414.
5. When the tonearm returns to the arm rest, this switch again turns off.
6. While C414 is recharging, Q410 is turned on.
7. Consequently, all flip-flops are reset, and the motor stops rotating.
8. The circuitry is thus restored to its original status.

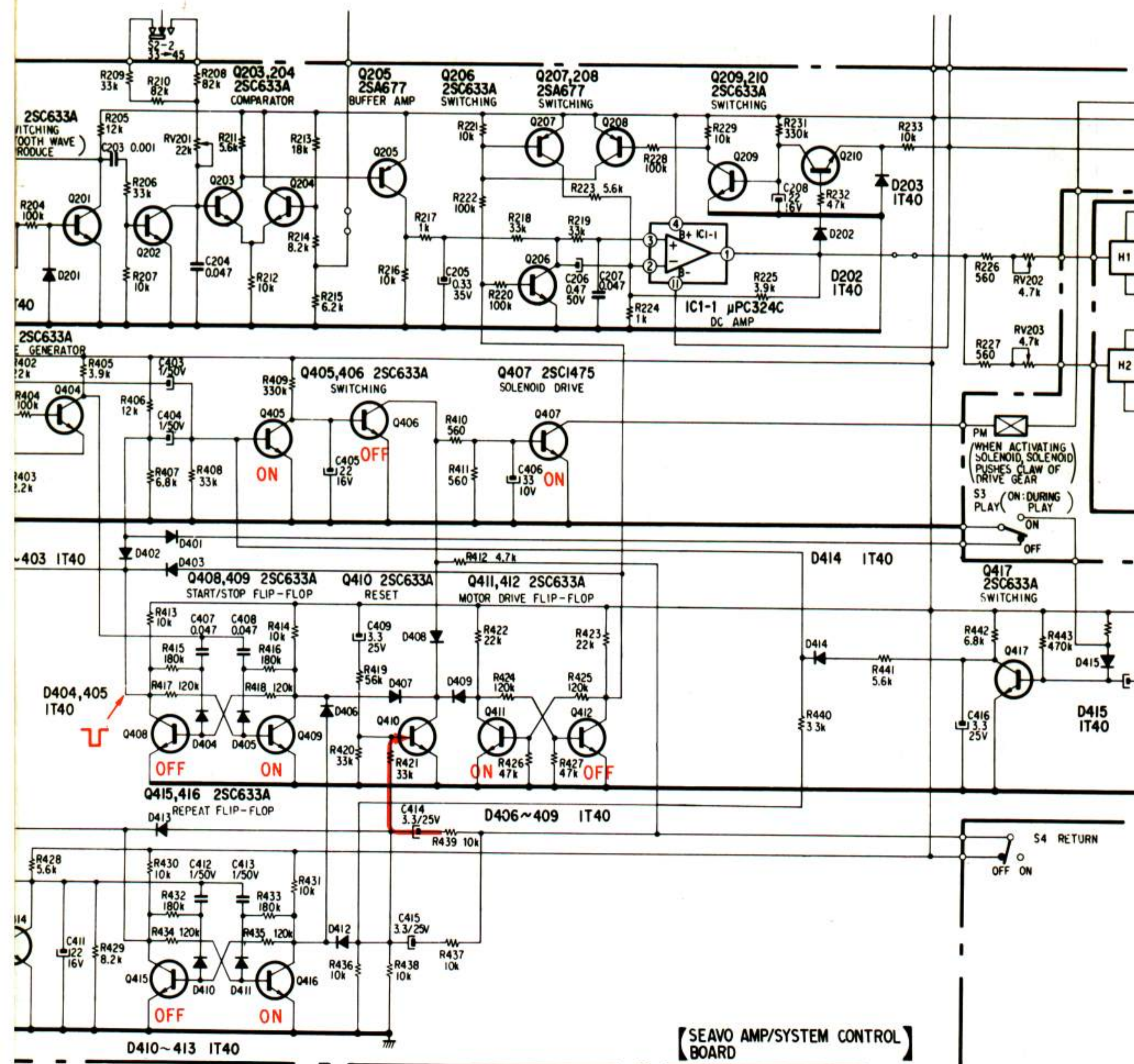


Fig. 3-4.

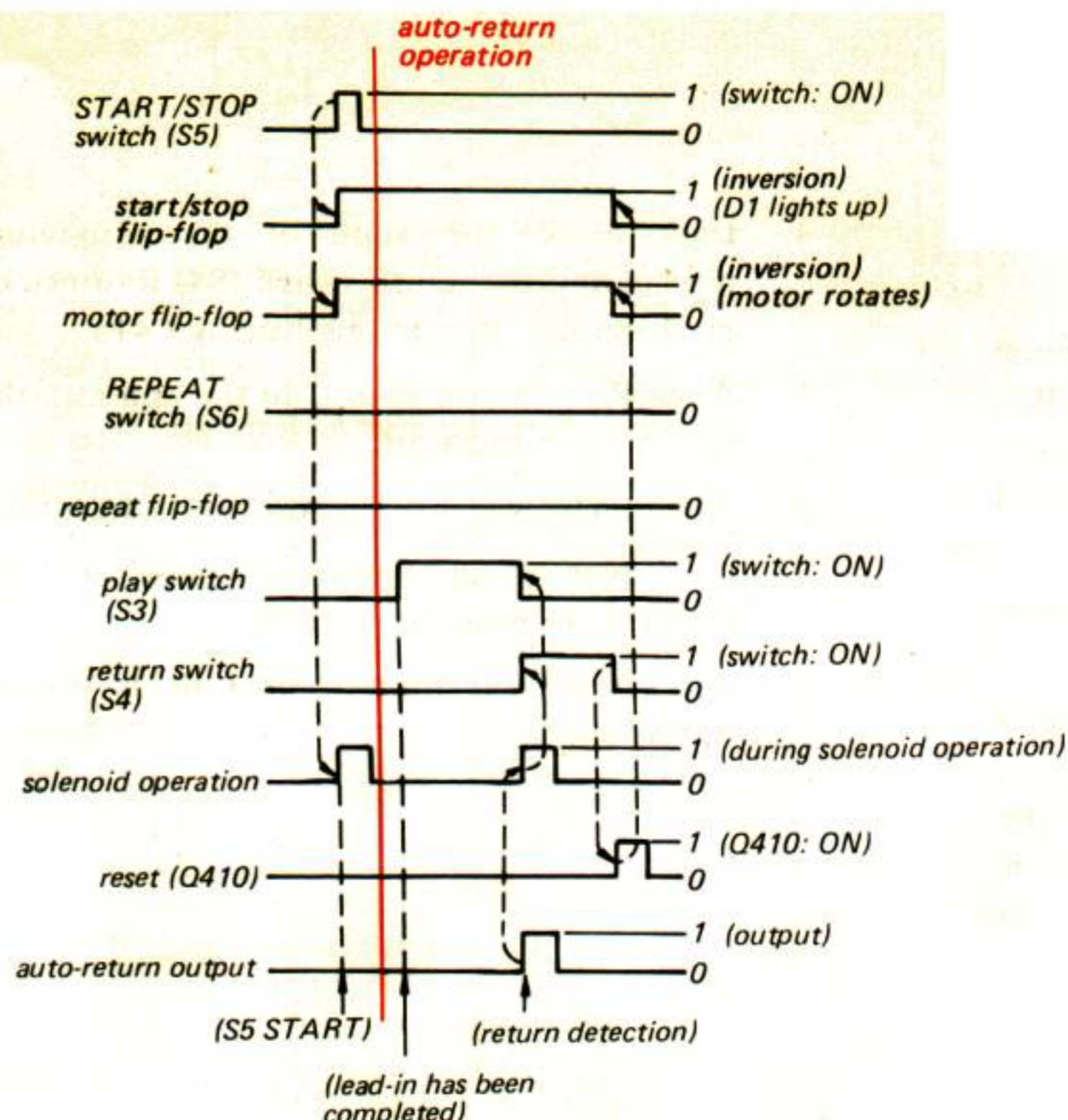


Fig. 3-5. Operation during auto-return

Speed Detection Circuit

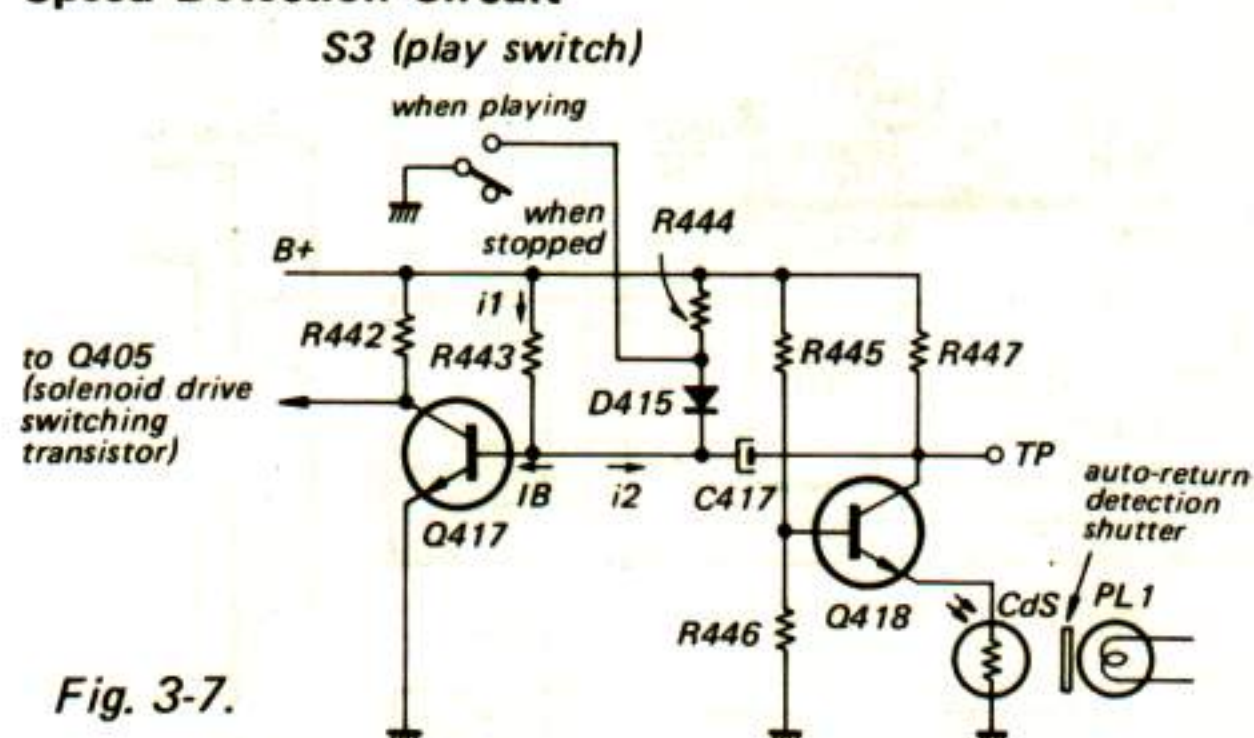


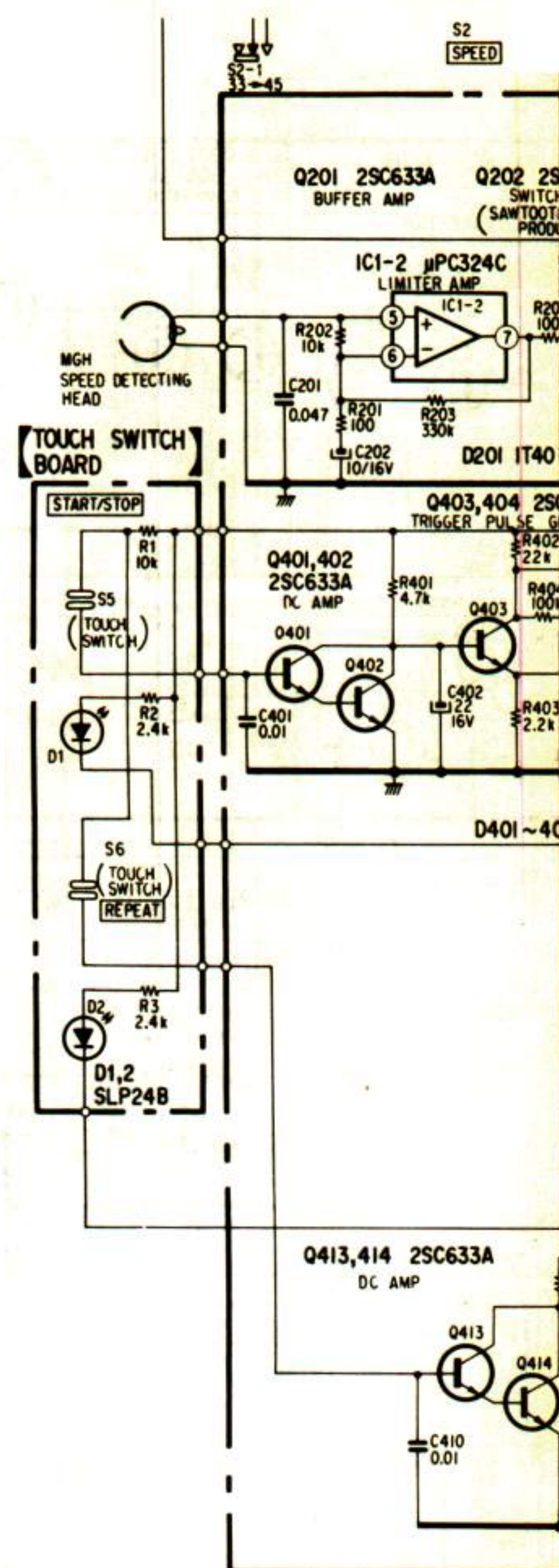
Fig. 3-7.

This circuit, a form of speed detection circuit, is designed to detect sudden changes in i_2 due to the changes in the collector voltage (V_{TP}) of Q418. i_2 is given by the following expression:-

$$i_2 = \frac{V_{TP}}{dt} \cdot C417$$

Gradual changes in the position of the detection shutter (due to changes in position of the tonearm as it traces the record groove) result in a change of the amount of light received by the CdS element, thereby reducing its resistance. Then when the amount of change in the detection shutter becomes large, i_2 approaches i_1 , and Q417 is consequently turned off. Therefore, B+ voltage is supplied to the solenoid drive circuit through R442, thereby activating the auto-return mechanism.

In the circuit diagram shown above, D415 and R444 are employed to prevent misoperation when the tonearm is moved rapidly across by hand during the lead-in operation. (i_1 is increased, thereby reducing the sensitivity.)



3-4. Operation during Auto-return (See Fig. 3-6)

1. When the power switch (S1) is turned on, Q419, Q420 and Q421 are all turned on. The auto-return operation detector lamp PL1 lights up.
2. The tonearm gradually moves across to, and then enters the auto-return position detection range (within 56.5 mm from the center spindle).
3. Once within the detection range, the pitch of the phonograph record groove changes rapidly (i.e. at the lead-out groove), the speed detection circuit (described later) is activated, turning Q417 off, and Q405 on (route 13).
4. Q407 is also consequently turned on, passing a current through to the solenoid (PM) (route 14).

5. Activation of the solenoid (PM) operates the auto-return mechanism, thereby bringing the tonearm back to rest automatically.
6. When operating the auto-return mechanism, the return switch (S4) is turned on mechanically, and C414 discharges.
7. Once the tonearm returns to the arm rest, this return switch is turned off again.
8. While C414 is recharging, Q410 is turned on (route 15).
9. As a result, all flip-flops are reset, the start indicator (LED) D1 turns off, and the motor stops rotating.
10. The circuitry is thus restored to the original status.

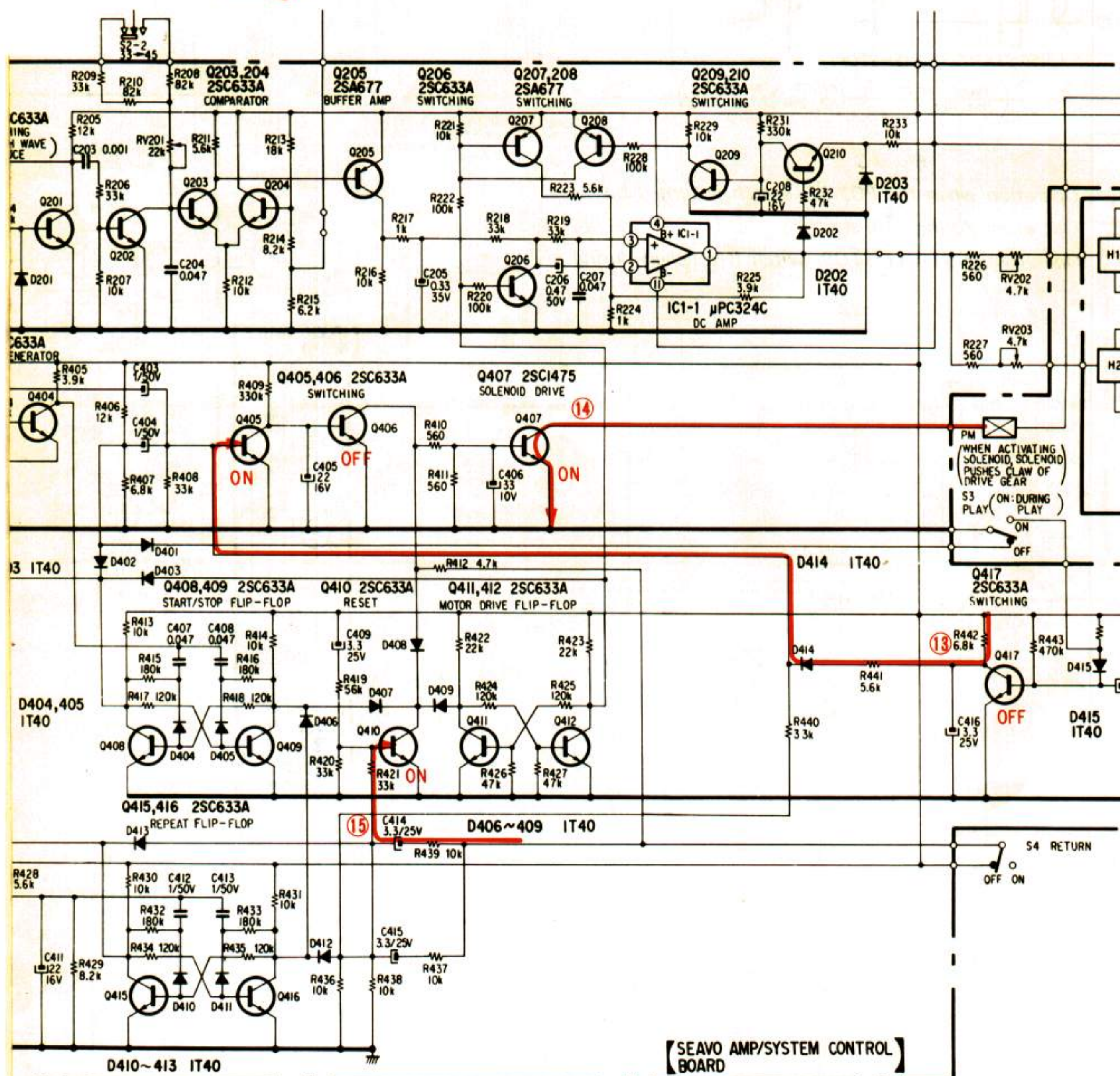


Fig. 3-6.

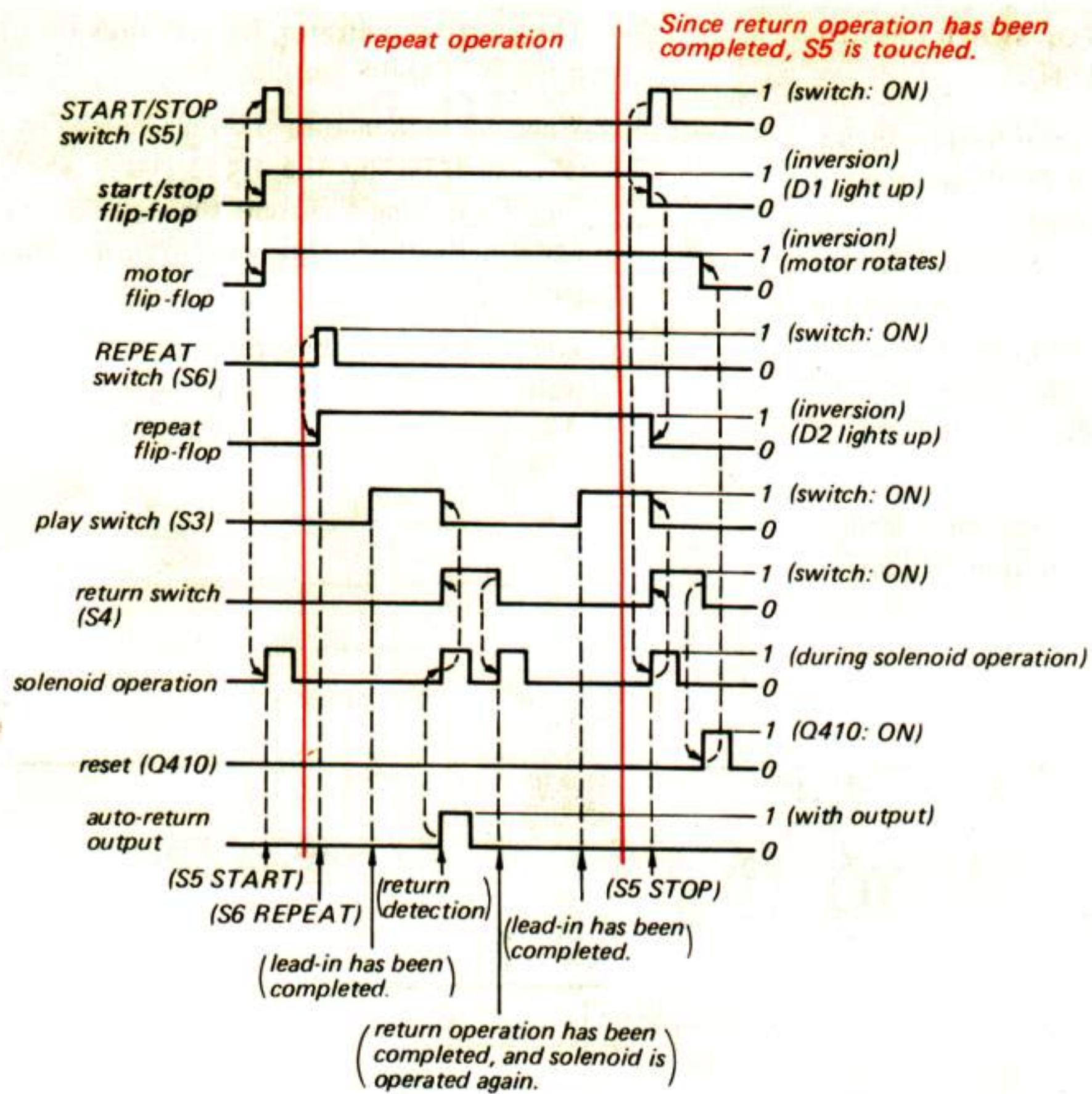
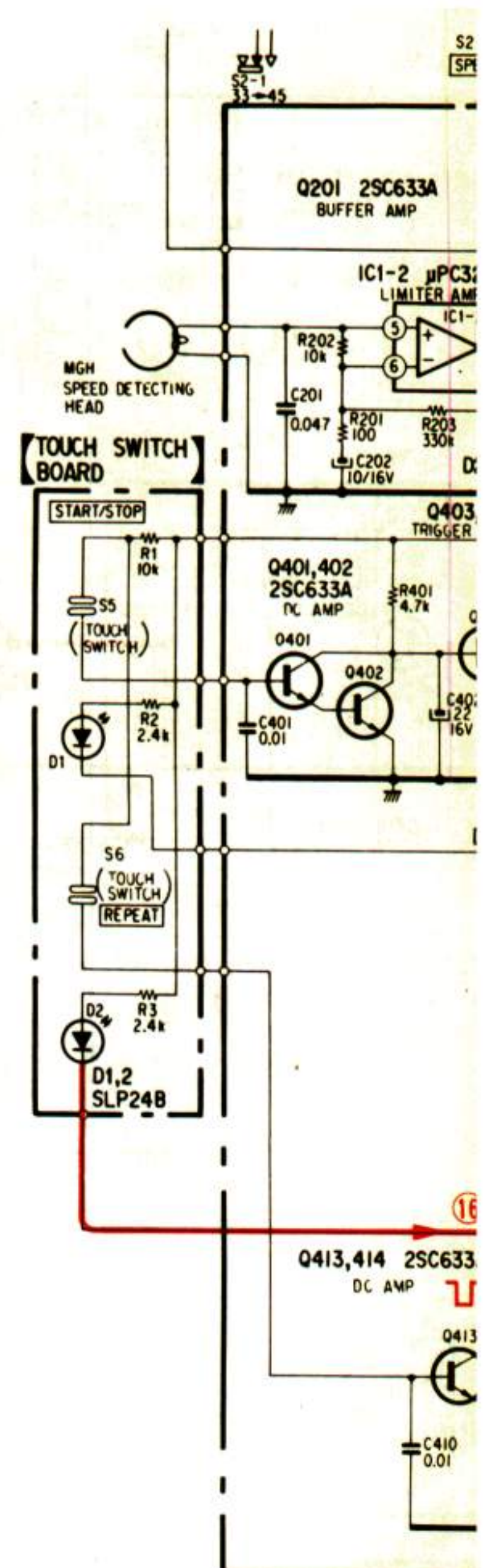


Fig. 3-8. Repeat operation



3-5. Repeat Operation (See Fig. 3-9)

When the feather-touch repeat switch (S6) is touched during play, the repeat indicator (LED) D2 lights up, and the same record is played over and over again.

1. When S6 is touched, a negative pulse is generated on the collector of Q414. This pulse inverts the state of the repeat flip-flop circuit, Q415/Q416. That is, Q416 is turned off, and Q415 is turned on.

When Q415 is turned on, the repeat indicator D2 lights up (route 16).

2. When the tonearm reaches the return position, the auto-return mechanism is activated, and the return switch (S4) turned on mechanically.

The tonearm then returns to the arm rest, and S4 then turns off again. But since Q415 is on in this case, D413 is biased in the forward direction. Therefore, unlike the operation for auto-return, Q410 is not turned on (route 17).

3. Consequently, neither the start/stop flip-flop circuit, Q408/Q409 nor the motor flip-flop Q411/Q412 circuits are inverted in this case.
4. Q405 is thus forward biased (i.e. turned on) by the charged voltage in C415 (route 18).
5. As a result, a current flows through the solenoid (PM), the lead-in mechanism is activated, and the tonearm is again moved across for the start of play.

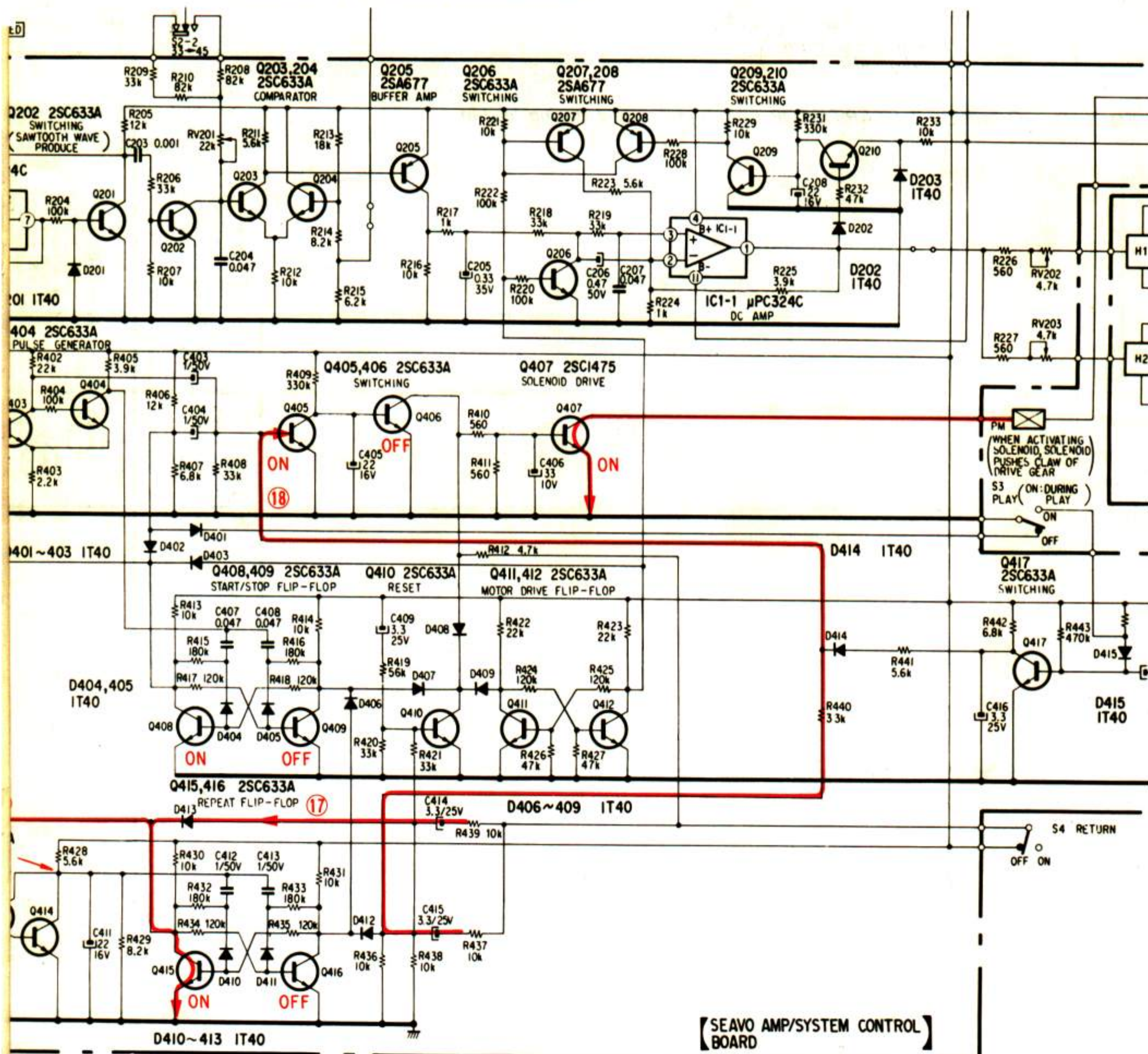


Fig. 3-9.

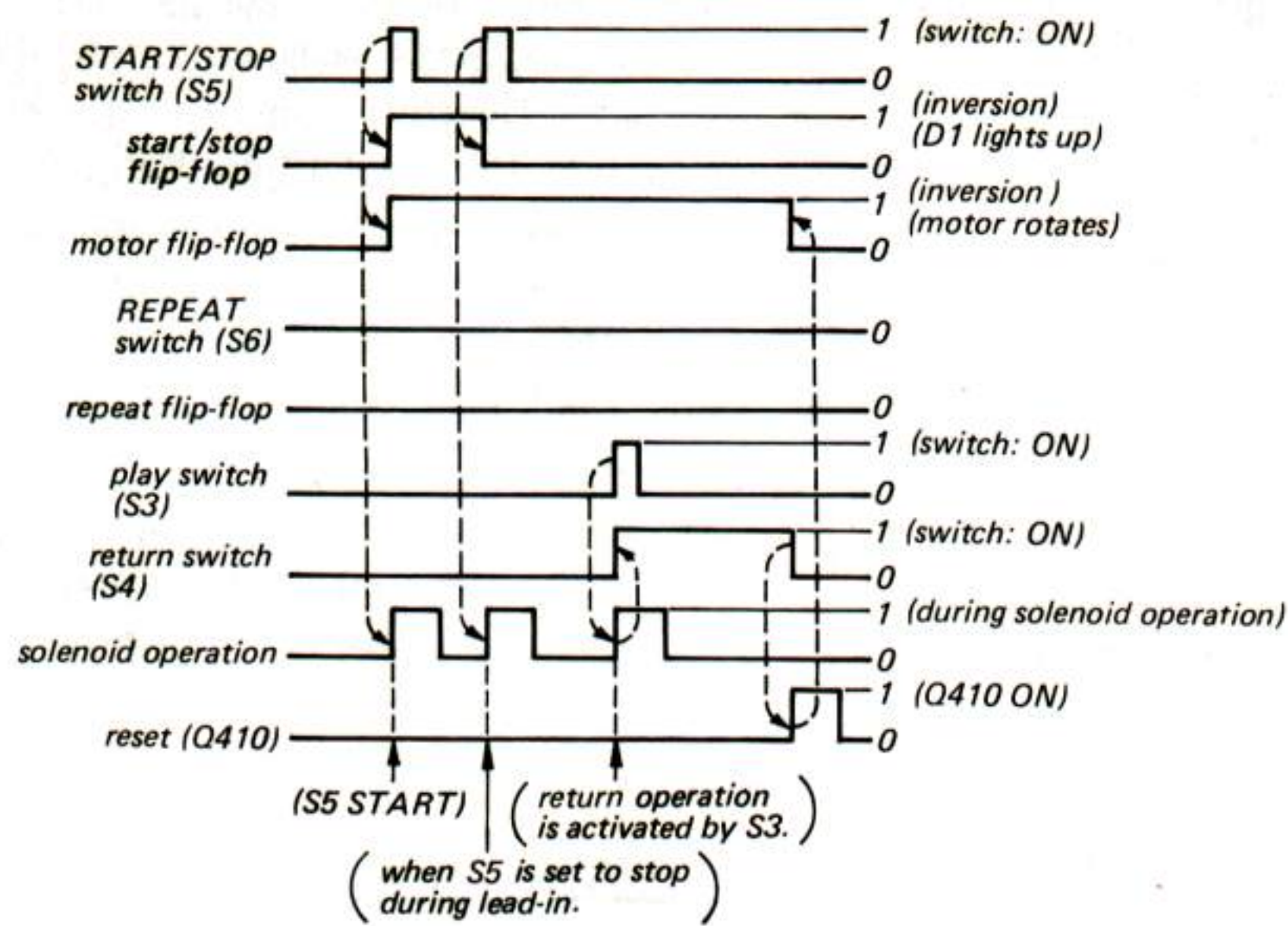
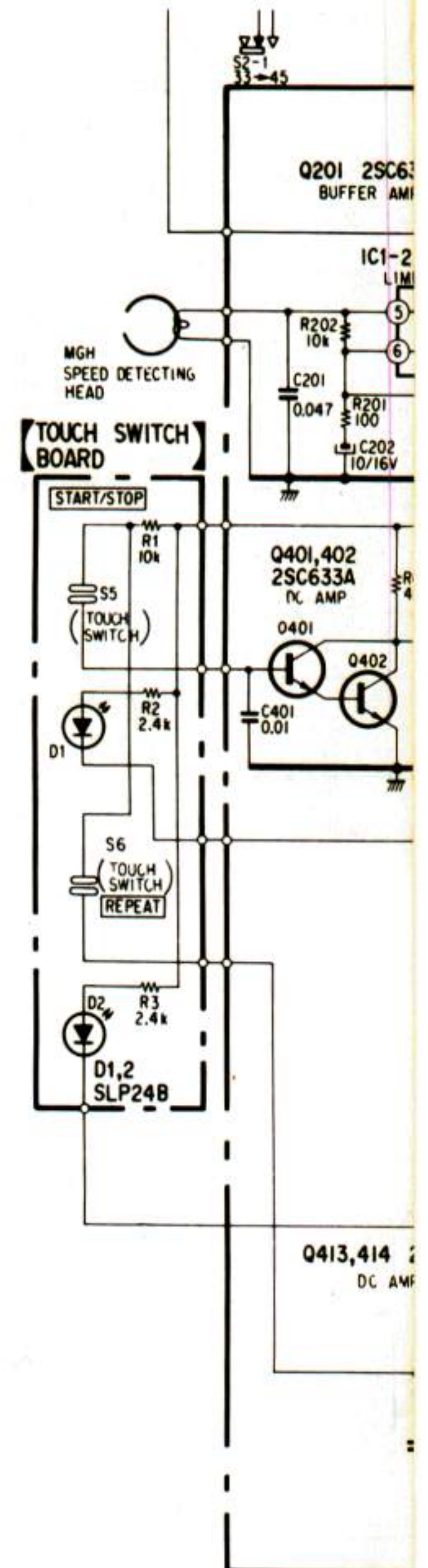


Fig. 3-10. Operation if START/STOP switch is touched during lead-in



3-6. Operation if the START/STOP Switch touched during Lead-in (See Fig. 3-11)

1. At the commencement of the auto-start operation, Q408 of the start/stop flip-flop circuit is turned on, and Q409 turned off. Since Q408 is turned on, the start indicator D1 is turned on. Q411 of the motor flip-flop circuit is turned off, and Q412 is turned on, thereby starting up the motor. Activation of the mechanical systems results in lead-in motion of the tonearm.
2. If S5 is then touched during this lead-in operation, the start/stop flip-flop circuit is inverted. That is, Q408 is turned off, and Q409 is turned on.

3. The starting indicator D1 will thus turn off as a result of Q408 turning off.
4. When S3 is then turned on mechanically, Q405 is turned on by the D402/D402 AND gate, thereby passing a current through the solenoid, and activating the auto-return operation (route 21).
5. The circuitry is thus restored to the original status.

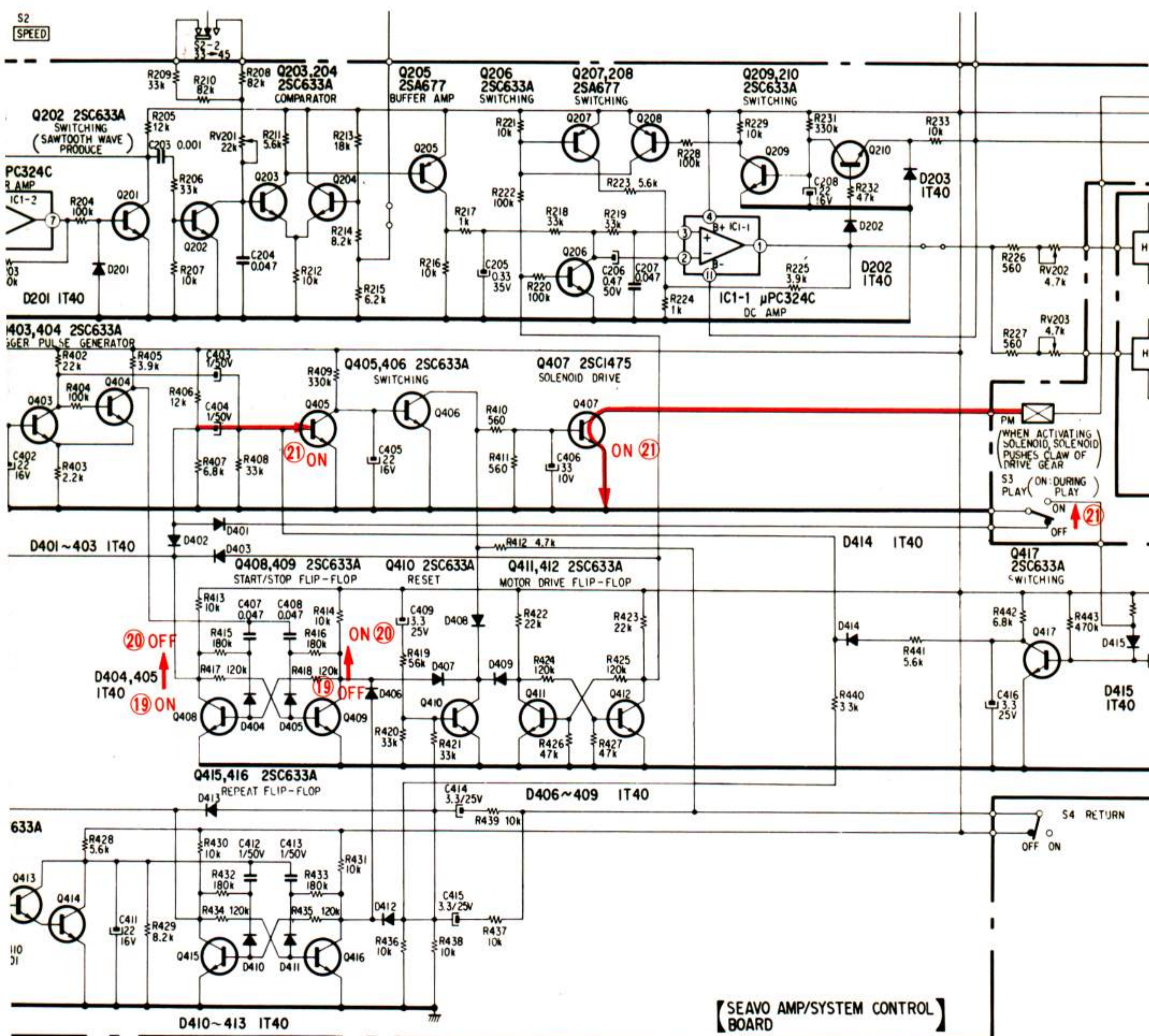


Fig. 3-11.

4. Hall Motor

The PS-X6/X7 is equipped with the newly developed BSL (brush and slotless) dc servo motor, which has the following major advantages.—

1. Extremely uniform torque.
2. All-electronic switching (no mechanical contacts used at all), resulting in very little noise.
3. Extremely stable performance, and long operational life.

Magnetic Pole Arrangement (See Fig. 4-1)

- The motor coils L1 and L2 (plus L3 and L4) form a pair, connected in series.
- The reason for positioning two Hall elements H1 and H2 at an angle of $22^{\circ}30'$ from each other is to displace the electrical phase angle by 90° , thereby rotating the rotor in a 2-phase action.
- For the same reason, the positions of the coil pairs are set at an angle of $67^{\circ}30'$.
- The coil windings are wound in a partial cone shape to match the similarly shaped magnets, 8 of which are arranged in a circle underneath the rotor.

Motor Internal View (top view)

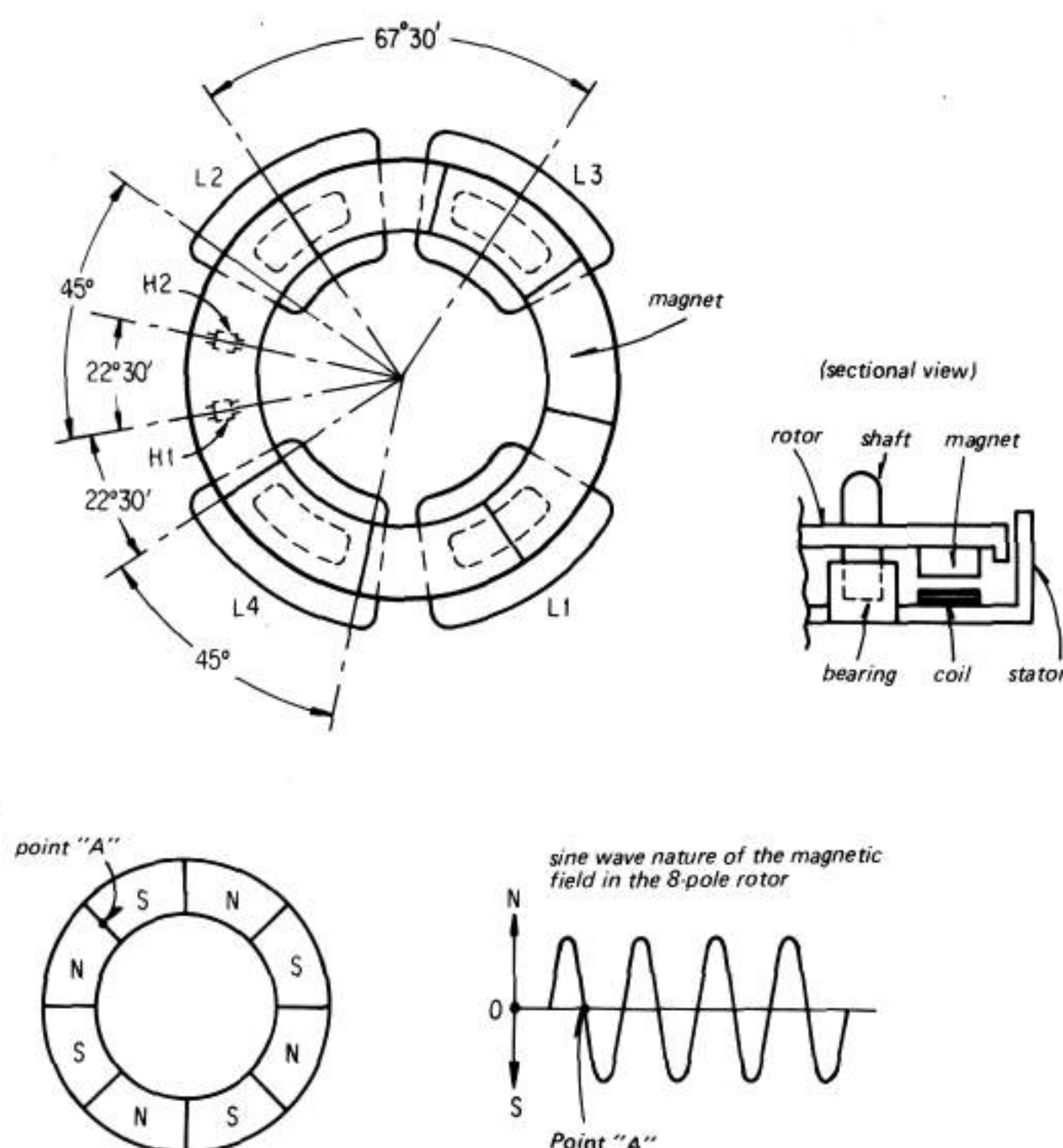


Fig. 4-1.

- Hall elements and motor coils have been set apart at an angle of $22^{\circ}30'$ so that the peak of an N or S pole magnetic field will cut across the center of a motor coil at the same time that the magnetic field peak of the preceding or following S or N pole cuts across a Hall element.

Generation of Rotational Force (See Fig. 4-2)

According to Fleming's left hand rule, the force generated in the motor coils will be in the counter-clockwise direction, but since the coils are fixed, the magnets (attached to the rotor) will rotate in the clockwise direction. (Refer to Figs. 3-3 and 3-4.)

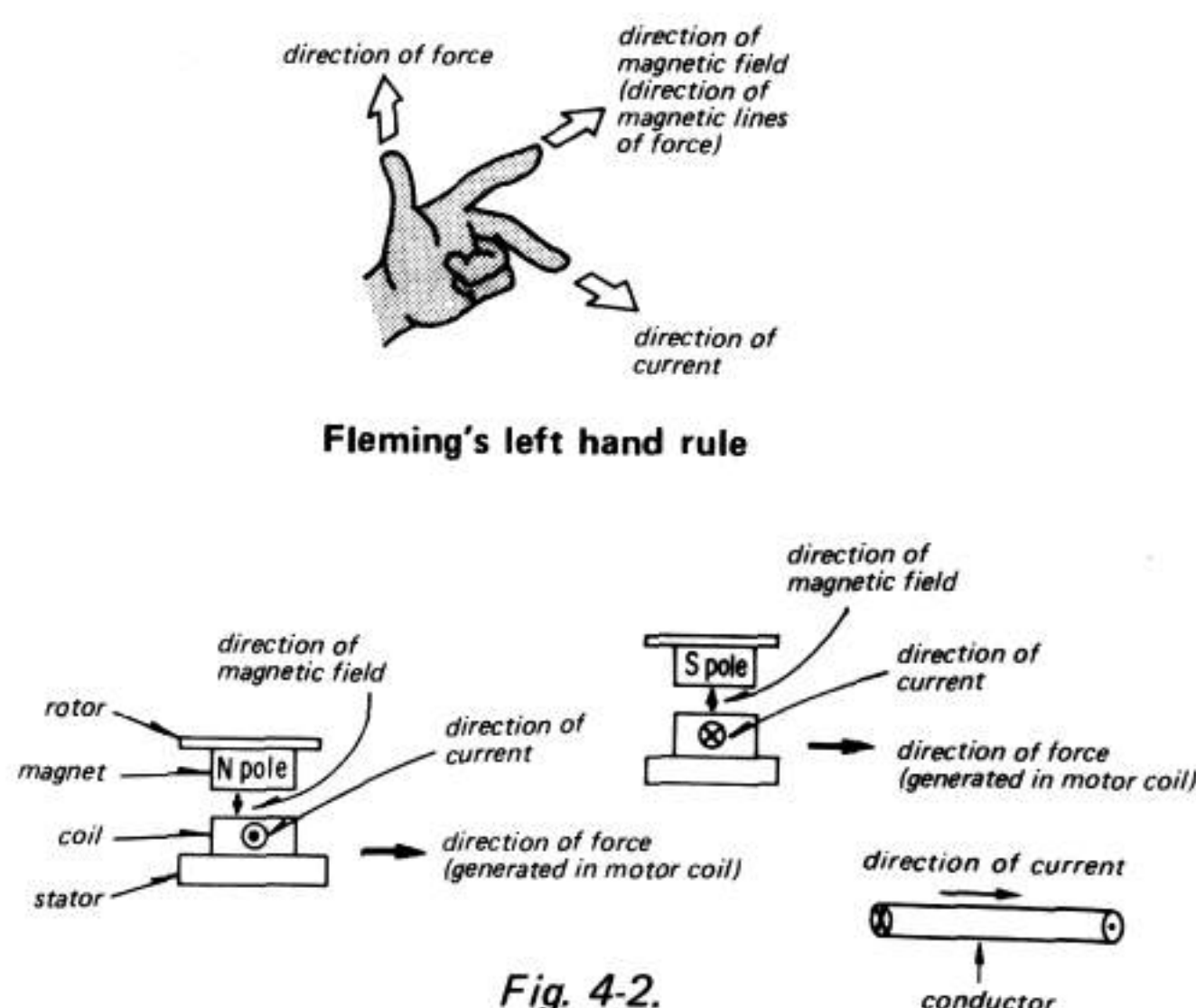


Fig. 4-2.

When an N pole corresponds to the Hall element H1 (shown in the Fig. 4-3), a positive voltage is generated in H1. This voltage is then amplified by IC1-4, and applied to Q211.

When Q211 is turned on, B+ voltage is applied to L1 and L2. The current flowing through L1 and L2, and the magnetic field produce an electro-magnetic force which spins the rotor in the direction of the arrow as shown in Fig. 4-3.

When an N pole corresponds to the Hall element H2 as shown in Fig. 4-3, current flows through L3 and L4, thereby generating the same electro-magnetic force to continue spinning the rotor.

When an S pole corresponds to the Hall element H1 (shown in Fig. 4-4), a negative voltage is generated in H1. This voltage is then amplified by IC1-4, and applied to Q212.

When Q212 is turned on, B- voltage is applied to L1 and L2. The current flowing through L1 and L2, and the magnetic field produce an electro-magnetic force which spins the rotor in the direction of the arrow as shown in Fig. 4-4.

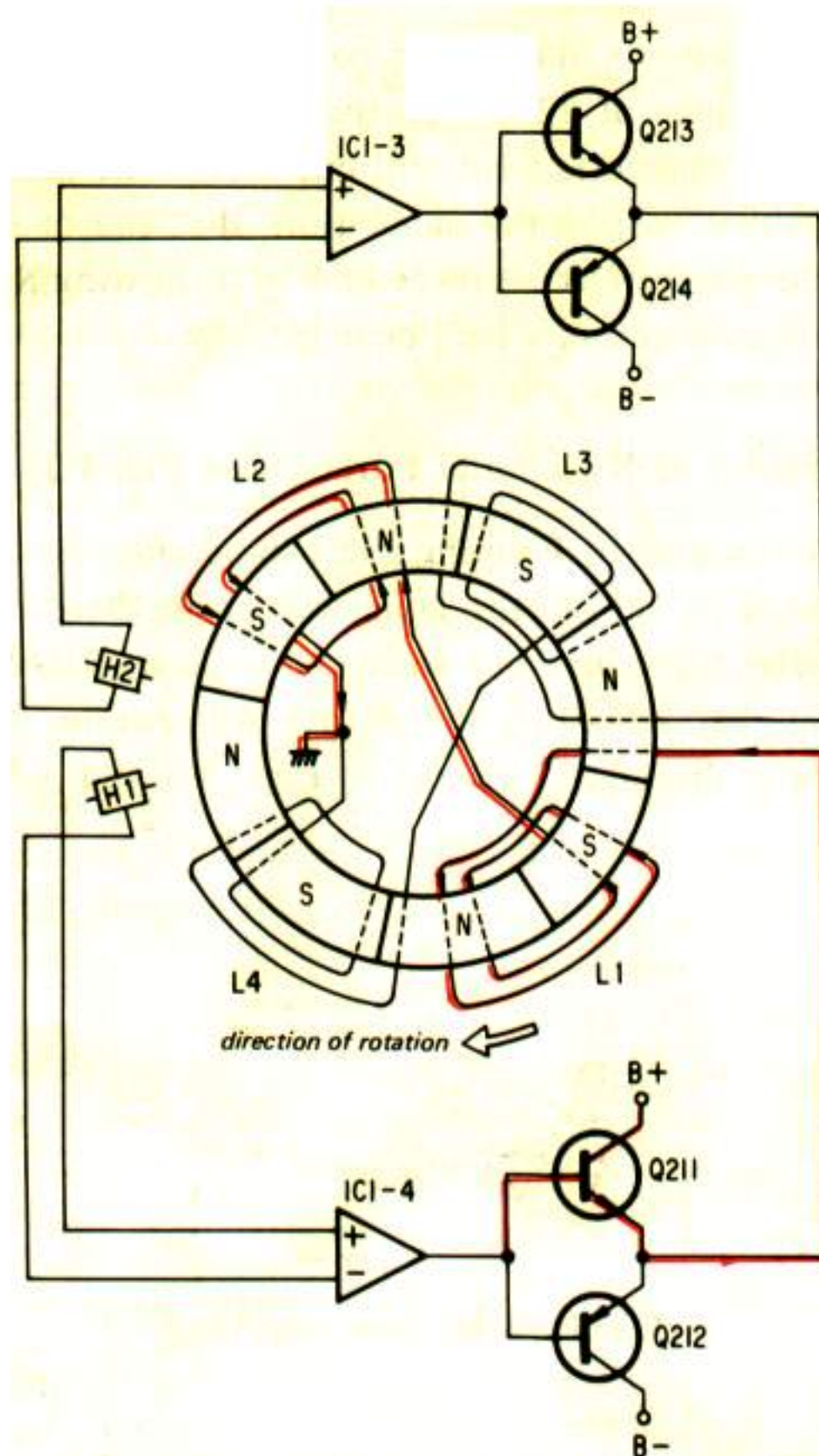


Fig. 4-3.

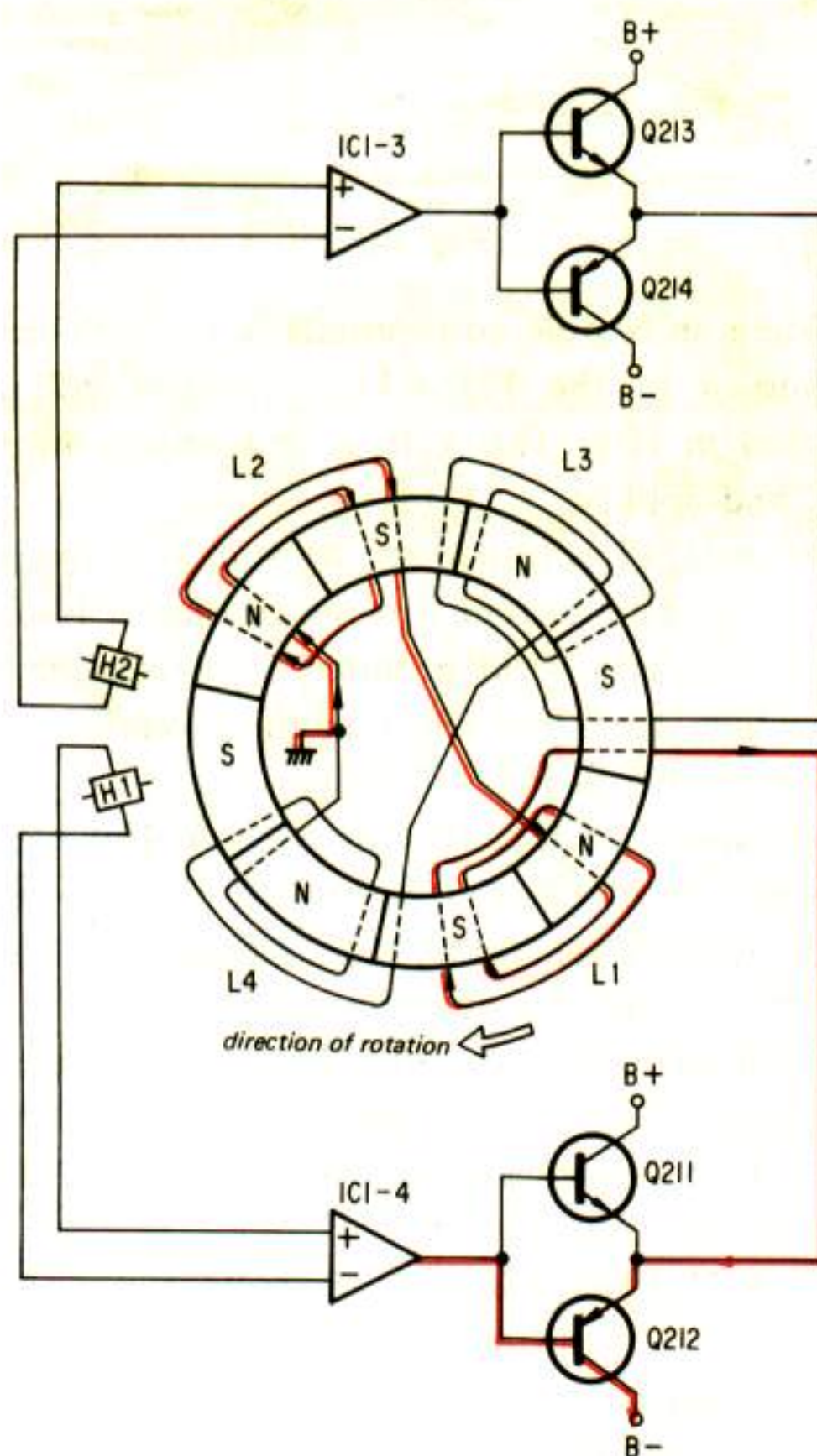


Fig. 4-4.

When an S pole corresponds to the Hall element H2, current flows through L3 and L4, thereby generating the same electro-magnetic force to continue spinning the rotor.

Hence, N and S poles are repeatedly positioned oppositely to the Hall elements H1 and H2 every $22^{\circ}30'$ of a rotation thereby generating the voltages in these elements, resulting in the production of a current in the motor coils, and subsequent rotation of the motor.

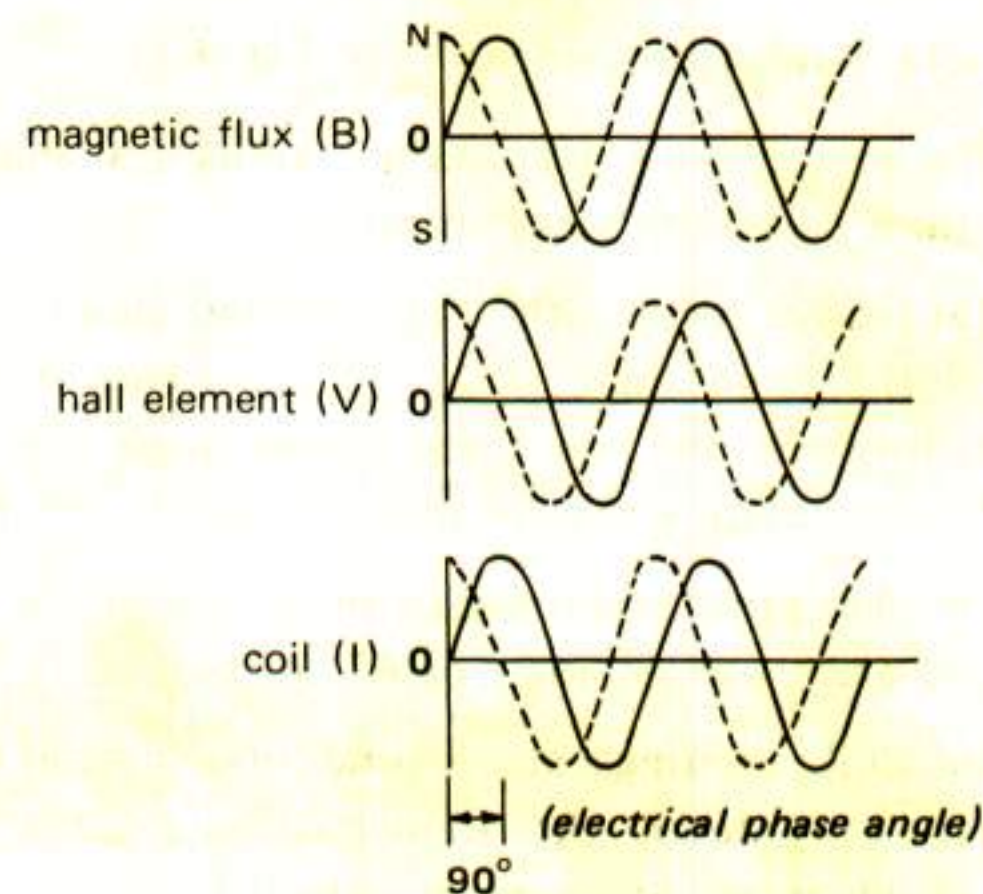


Fig. 4-5.

Rotational Force

The rotational force (torque F) varies directly with the strength of the magnetic field (B) cutting across the coils, and the amount of current (I) flowing through the coils.

That is, $F = B \cdot I$

But since the magnetic field produced by the magnets of the rotor varies in accordance with a sine wave relation with the angle of rotation, and the pairs of motor coils are arranged 90° out of phase each other, the combined torque will be constant.

Constant Speed Rotation (See Figs. 4-6 and 4-7)

In order to maintain constant turntable speed, this model features a magnetic-disc detection system in the speed-detector stage, and a crystal oscillator in the phase control stage of a crystal-locked servo system.

Changes in rotational speed of the turntable are detected by the speed-detection head fixed on the frame. (S and N magnets are mounted around the outer rim of the turntable platter with a very high degree of precision.) The reference standard frequencies detected by this head are 284 Hz at 33 rpm, and 384 Hz at 45 rpm. Any changes in frequency detected by this head are converted into voltage signals, and fed to the servo amplifier.

In addition, the phase of the frequency signal from the speed detection head is compared with the reference phase of the crystal oscillator frequency. Any difference in phase is also converted into a voltage signal, and fed to the servo amplifier, thereby ensuring accurate turntable rotational speed.

Since motor speed is determined by the amount of current flowing through the motor (that is, through the motor coils), motor speed may be conveniently changed by simply changing the flow of current through the Hall elements. In other words, if motor speed tends to deviate from the reference standard value due to external influences, the constant speed value may be maintained by simply varying the amount of current flowing through the Hall elements in proportion to the amount of deviation in turntable speed.

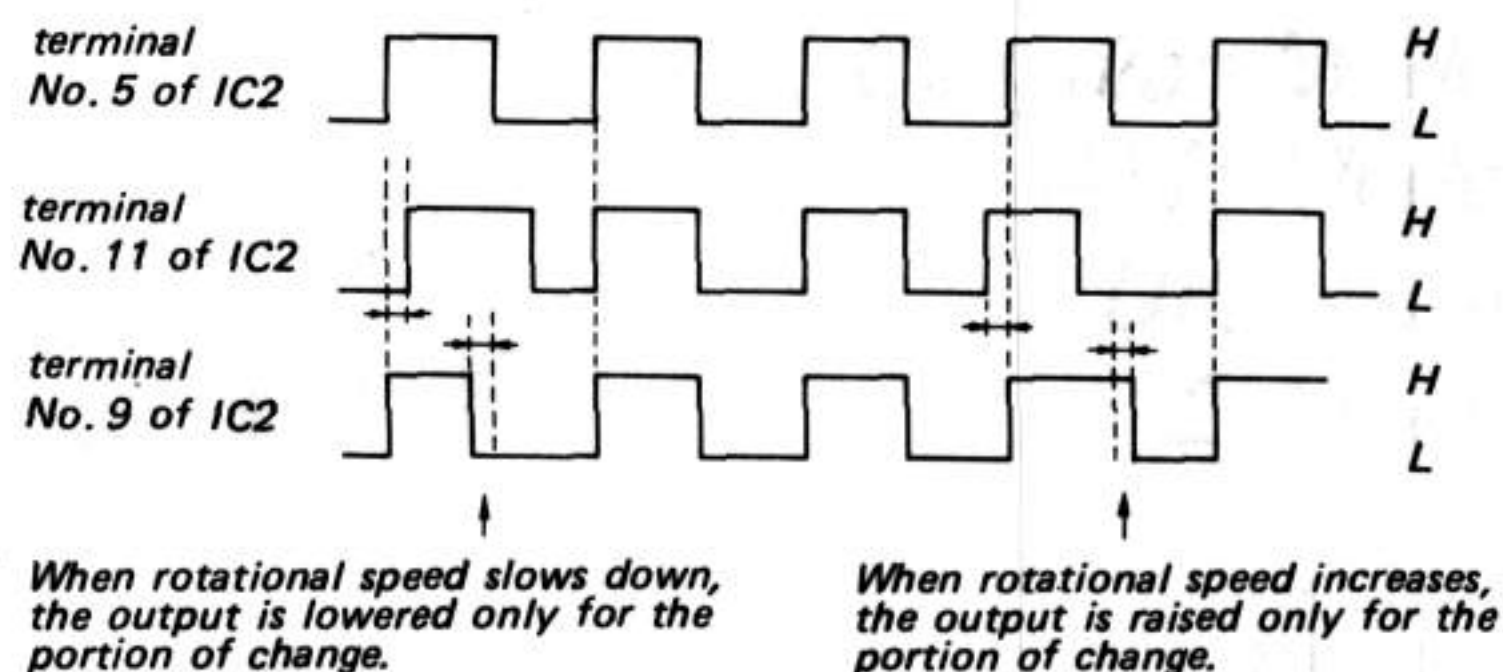


Fig. 4-7.

Phase Control

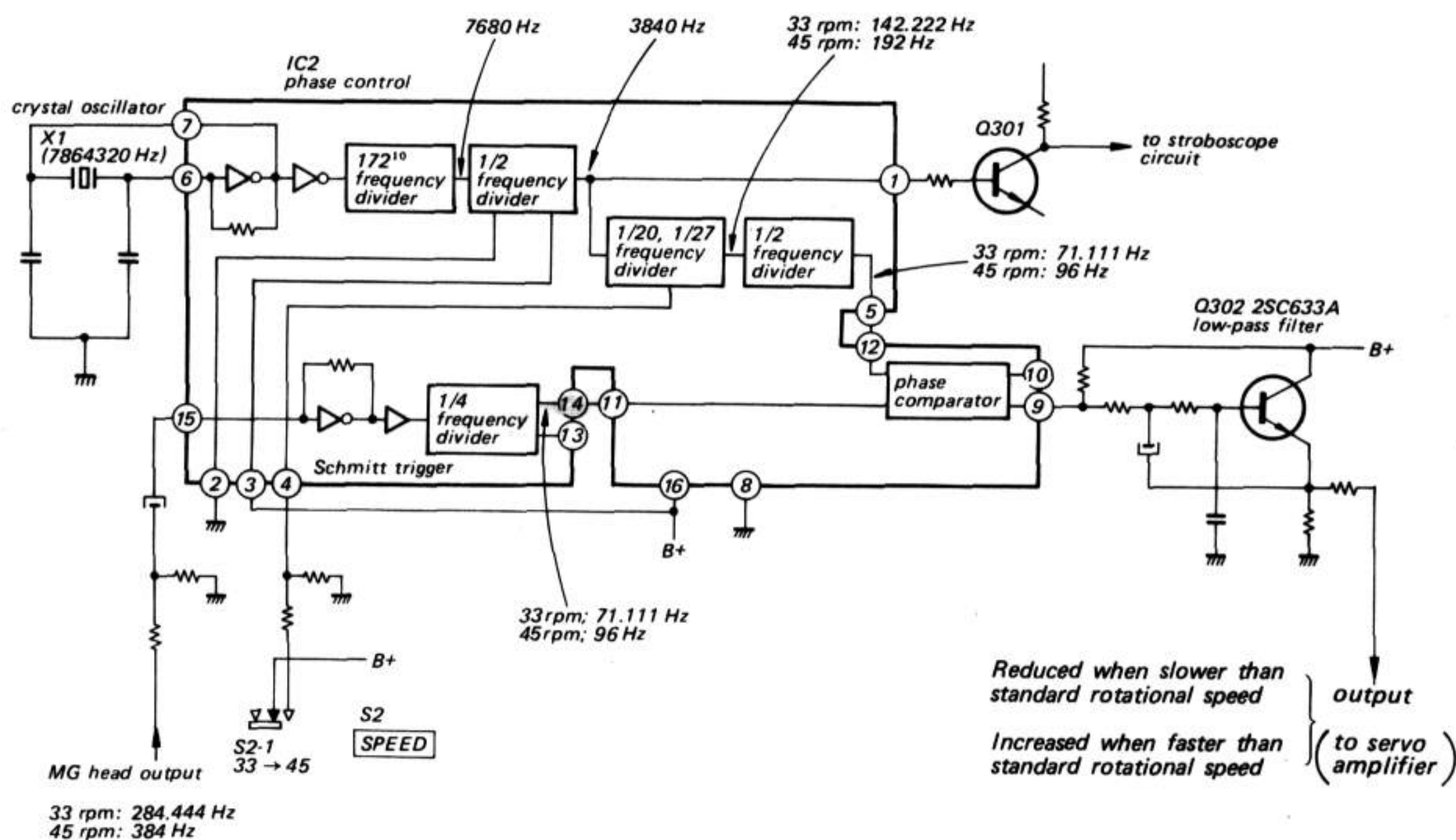


Fig. 4-6.

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