DENON

Hi-Fi Component / Turntable

SERVICE MANUAL

SERVO-CONTROLLED DIRECT DRIVE TURNTABLE

MODEL DP- 3700F
MODEL DP- 3500F
MODEL DP- 3000

MODEL DP-3700F

NIPPON COLUMBIA CO.,LTD

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—— SPECIFICATIONS ——

Model DP-3000 Turntable Unit

Rotation Speed : 33-1/3 rpm, 45 rpm.
Platter : Aluminum diecast, dia.; 300mm, mass of inertia; 160kg-cm^2, weight; 1.1kg
Range of Speed Adjustment : ±3% of stipulated speed
Starting Characteristic : Less than 1/2 turn to reach nominal speed (at 33-1/3 rpm)
Wow and Flutter : Less than 0.03% (WRMS)
S/N : Over 60 dB
Power Supply : AC220, 230, 240V, 50/60 Hz changeable
Power Consumption : 14W

Model DA-305 Tone Arm

Type : Static Balance Type
Total Length : Within 347mm
Effective Length : 244mm (from fulcrum to stylus point)
Overhang : 14mm
Range of Height Adjustment : 35~70mm (from the arm board to the center of the arm pipe)
Offset Angle : 20.5°
Tracking Error : Less than ±2°
Adjustable Range of Stylus Pressure : 0~3gr., direct reading micrometer type (0.2gr. calibration)
Shell Weight : 8gr. (net exclusive of screws and nuts)
Weight of Acceptable Cartridge : 4~15gr.
Head Connector : EIA Standard, 4P connector
Lateral Balance : S-shaped balancing system
Bearing : High-precision pivot bearing, miniature bearing
Output Cord : Low-capacitance cord, connection through 5P connector
Dimensions : 530x440x180mm DP-3500F, DP-3700F
374x370x138mm DP-3000
Weight (overall) : 10.3kg DP-3500F
6.7kg DP-3000
15 kg DP-3700F

*Subject to change without notice

—— TO ASSEMBLE AND ADJUST THE MODEL DP-3700F ——

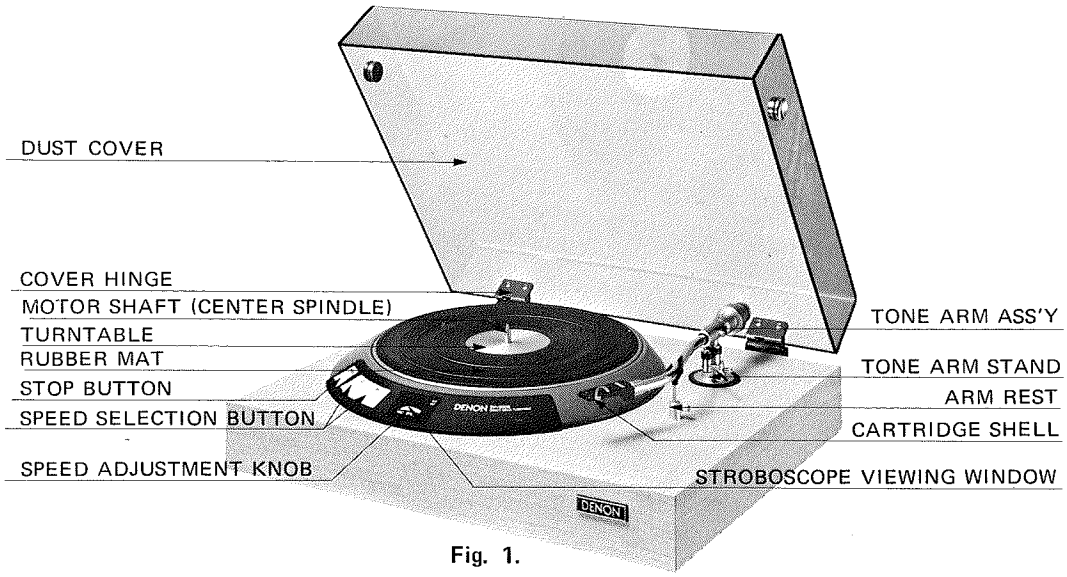


Fig. 1.

(A) TO ASSEMBLE THE TURNTABLE UNIT AND TONE ARM

The Model DP-3700F is composed of the model DP-3000 turntable unit, model DA-305 tone arm with arm lifter and specially designed cabinet.
Please assemble and adjust each part as following procedures.

1. After unpacking the carton, carefully take out the dust cover, turntable, rubber sheet, tone arm assembly, cartridge shell and accessories in the parts box, and then take out the cabinet.

2. Insert the main shaft of the tone arm into the arm stand fixed on the cabinet and hold the tone arm to the arm stand by hand, then insert and connect the 5P connector plug of the output cord into the connector socket on the bottom of the tone arm shaft deeply enough to fit the key and slot.

3. Then fix the inserted tone arm to the arm stand. First, temporarily adjust the auxiliary height-adjusting screw with screw driver and fix the tone arm loose so that it can rest by itself and is movable with a slight finger touch. (See figure 1)

4. The tone arm is able to horizontally turn within an angle of about 90 degrees. Adjust the tone arm direction so that it may cover the angle between the arm rest and the center spindle of the turntable. When the adjustment is over, fix the tone arm temporarily at a proper height by means of the main height-adjusting screw. (See figure 2)

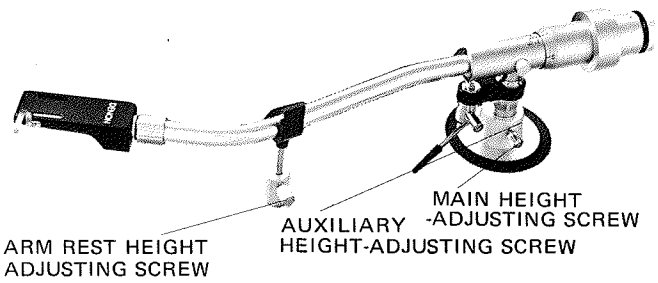


Fig. 2

5. Remove the red colored head screws (Fixing screws for transport) clamping the power transformer for transportation. (See figure 3)
   Note: These screws, if not removed, will cause noises, as vibration of the power transformer is conveyed to the turntable. Make sure to re-clamp the transformer with the screws when transporting the player as you change residences.

6. Fit the turntable to the tapered-part of the motor shaft (center spindle). Do it gently after making it sure that the tapered surface is clean without dust and that the detecting magnetic-head is retracted as shown in figure 4.

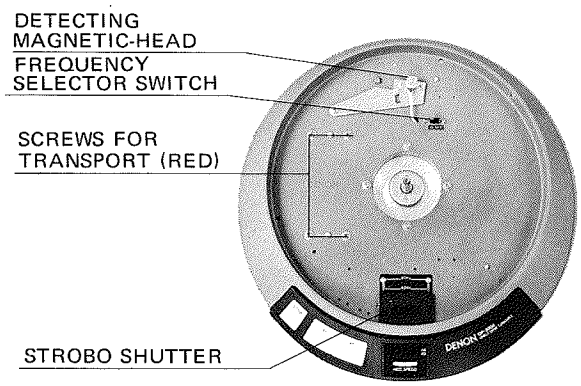


Fig. 3

7. Rotating the turntable slowly by hand, bring the adjustment hole of the turntable to the position right above the detecting magnetic-head.
   Once loosen the clamping screw, tighten it again after putting the magnetic-head fixing arm in a position pressing against the stopper as shown in figure 5.
   Pre-adjustment is provided at factory so that the distance between the magnetically-coated surface of the turntable inner rim and the detecting magnetic-head may come within a range of 0.2m/m – 0.25m/m.
   Manually rotate the turntable for a few turns and confirm that vibration or shock during the transportation has not disarranged the pre-adjustment. When the detecting magnetic-head comes in touch with the turntable, refer to "Adjusting the position of the detecting magnetic-head" on page8

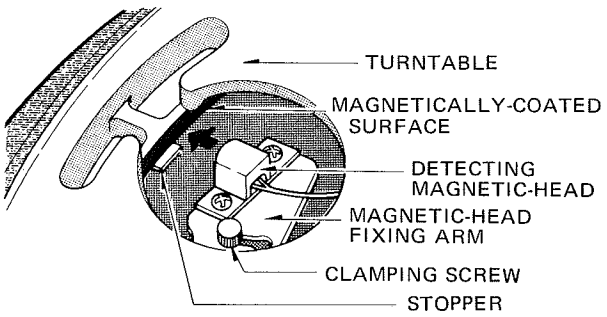


Fig. 4

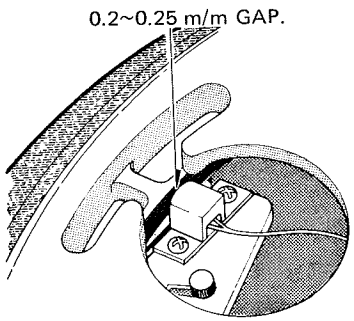


Fig. 5

8. Put the rubber sheet on the turntable.

9. To install the dust cover, fit it to the hinges as shown in figure 6 and 7. Before it is closed, make sure that the cover is first pushed into the hinges and then deeply to the left side, from front view. To take off the cover, first open it fully and next push it to the right, as seen from the front view, and then pull it out.

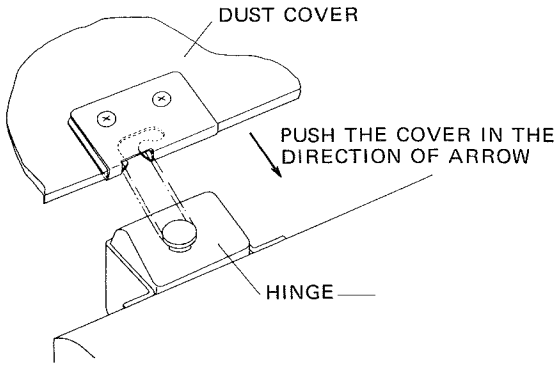


Fig. 6

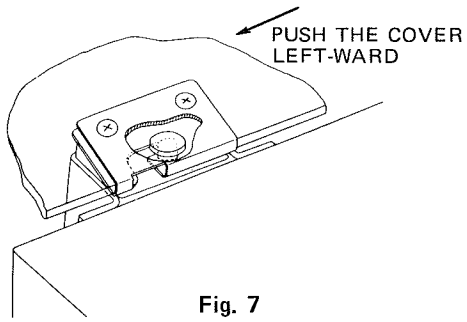


Fig. 7

(B) TO ASSEMBLE THE CARTRIDGE INTO THE CARTRIDGE SHELL

Prepare your desired cartridge and fix it to the cartridge shell as described below:

1. As two different length of cartridge fixing screw pairs are prepared as accessories, select one of them suitable for the cartridge you use. Determine the position of the fixing screw head either to face to upper side of the shell or to the body of the cartridge, so that the stylus protect cover can be suitably put on.
   Utilize the nylon washer attached not to injure the shell.
   Align the cartrdige and the shell in parallel, and in case of DENON PCL-1 cartridge shell adjust the position of cartrdige so that the stylus tip comes out about 7m/m off from the top-end of the shell. (See figure 8)

2. As shown in figure 8, the lead wires are color-coded; red for right channel (+), green for right ground (–), white for left channel (+) and blue for left ground (–). Carry out connections correctly, paying enough attention for the connection to the terminals on the cartridge side. A wrong connection may cause reversed-channels, abnormal sound image position or hum noise.

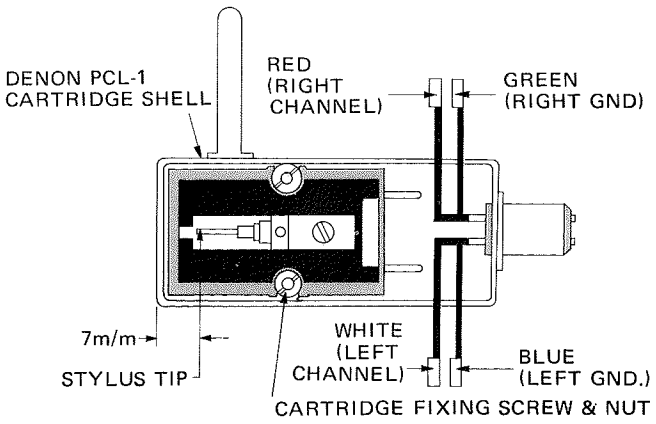


Fig. 8

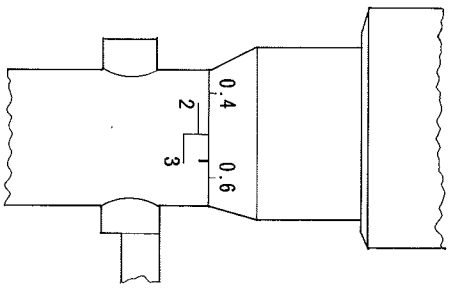


Fig. 9

(C) TO ADJUST THE TONE ARM

Fix the head shell mounted with cartridge to the tone arm with the locking nut, then confirm and adjust the tone arm as described below;

1. The overhang of the DA-305 tone arm is designed to be 14m/m. Minor deviation will affect the sound tone almost none. In case a large deviation has resulted from the installation, correct the cartridge position.
2. To adjust the stylus pressure.

2-1 Confirm the weight of the cartridge you use, as the stylus pressure is to be adjusted by the black-colored scale for the cartrdige weighing from 4 to 9.5 grams and by the orange-colored scale for the cartrdige weighing from 9.5 to 15 grams.

2-2 Align the 0 (zero) point of either one of the two scales with the "0" point of the sleeve scale (rotary), and while keeping the alignment, slide the weight ring to attain the horizontal balance.
In this case if the cartrdige has the stylus protection cover, remove it off from the cartridge or pull it up if it is fixed with hinge before attaining the horizontal balance. When the weight of the cartrdige is unknown, align the "0" point of the either one of the two scales with the 0 point of the sleeve scale and adjust the weight ring to attain the horizontal balance. The balance is attained only on the correct scale.

2-3 When the horizontal balance is attained, set the scale for a desired stylus pressure to complete stylus pressure adjustment.
One turn of the sleeve corresponds to a stylus pressure of 1 gram and the sleeve scale is provided with five calibrations each representing 0.2 grams. Finer adjustment of stylus pressure, if needed depending on the purpose, is possible to the order of 0.05 – 0.1 grams.
Figure 9, for instance, shows the setting of a stylus pressure at 1.5 grams.

3. To adjust the height of the tone arm.
Place a record on the turntable, and put the stylus tip on the surface of the record. Then, loosen the main height-adjusting screw, and watching horizontally from the side, adjust the height of the tone arm so that the tone arm pipe and the record surface are in parallel.
The adjustment can be performed easily with one hand, since the auxiliary height-adjusting screw is properly adjusted in the procedure in A-(3) to prevent the stylus tip from damage caused by dropping of the tone arm by its own weight.
When the horizontal alignment of the tone arm is obtained, fix it there by tightening the main height-adjusting screw.

(D) CONNECTIONS

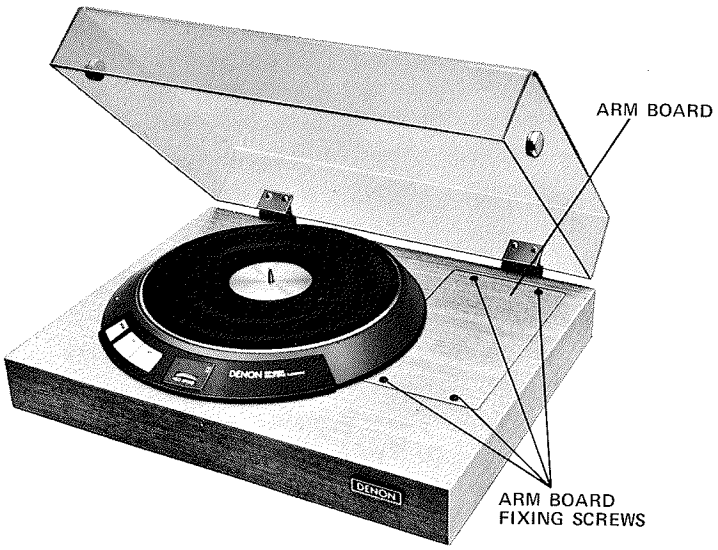
1. Connect the pick-up output cord to the amplifier: the red-colored pin plug of the output cord to the right channel phono input of the amplifier and the white-colored one to the left channel.
2. Connect the black lead wire of the arm body to the ground (GND) terminal on the amplifier (if the GND terminal is not provided, connect it to the amplifier chassis) separately from the negative line for the input signal so as to improve signal to noise ratio. Sufficient care must be taken to provide adequate grounding, as poor grounding may cause hum and noises, or occasional hum generated by a hand-touch to the tone arm body.
3. As the ground terminal on the back of the player cabinet is connected to the chassis frame of the turntable unit, when the hum and noises occur for grounding of the tone arm only, connect wire from this terminal to a ground terminal or chassis of the amplifier for more effective grounding.
4. Connect the AC power cord plug to a wall AC outlet. (Note:)
This model can be operated with either 220, 230 or 240 volts AC 50 or 60 Hz. power supply and is pre-set at the voltage and frequency to meet your power supply before shipment.
Check and confirm the voltage and frequency stamped on the carton case whether they will meet with the power supply of your usage, if it is different from yours, please contact your nearest DENON dealer for re-adjustment.

(E) TO OPERATE THE MODEL DP-3700F

1. Check and confirm that the pick-up output cords, ground wire(s) and AC power cord plug are properly connected.
2. Press the speed selection button, either 33 or 45 r.p.m. The pilot lamp inside the button and the neon lamp for the stroboscope window will light, then the turntable will start rotating.

3. Observe the running pattern of the stroboscope through the viewing window, and adjust with the speed adjustment knob in order to get a still pattern in the window. If the pattern is running rightward, turn the speed adjustment knob leftward (in the arrow direction) to quicken the turntable rotation.
   If the pattern is running leftward, turn the speed adjustment knob rightward to slow down the turntable rotation.
4. Once the speed is adjusted for either one of 33-1/3 r.p.m. or 45 r.p.m., readjustment for the other one will not be necessary. If, however, re-adjustment would be necessary with the alternation of the speed selection, follow to the procedure described in "Adjustment of rotations" on page 8.
5. To stop the turntable rotation, press the stop button.
6. This model is equipped with the tone arm lift lever so that both the record groove and the stylus tip may not be damaged. By moving it upward, the tone arm will lift up from the arm rest or from the record surface when playing the record. And by moving it downward, the tone arm will gently come down on the record surface or arm rest.

—— TO ASSEMBLE AND ADJUST THE MODEL DP-3500F ——



MODEL DP-3500F

Fig. 10

The model DP-3500F is composed of the model DP-3000 turntable unit and specially designed cabinet.

1. Unpack the carton case and carefully take out the dust cover, turntable and rubber sheet from the parts box and then take out the cabinet with the turntable frame.
2. Install your desired tone arm to the arm board of the cabinet according to an instruction and installation manual of the tone arm.
   To take off the arm board, remove four arm board fixing screws with a phillips (+) screwdriver and press down the left side (arrow 1) of the arm board and then the board inclines to be ready for pull-out in the direction (arrow 2) as shown in figure 10.
3. After installing the tone arm, proceed with assembling by following item 5 to 9 in "(A) TO ASSEMBLE THE TURNTABLE UNIT AND TONE ARM" of MODEL DP-3700F on page 3.
4. Please assemble and adjust the tone arm refering to the instruction manual of the tone arm.

—— TO ASSEMBLE AND ADJUST THE MODEL DP-3000 ——

1. Unpack the carton case and carefully take out the turntable, rubber sheet, turntable frame and accessories.
2. Determine the position of the turntable frame on the cabinet, utilizing the template packed with this instruction manual.
   Also determine the tone arm location and position based with the turntable center on the template.
3. Place the template on the cabinet. Draw the cutting line on the board by tracing the thick line on the template (carbon is applied on the back of the template), and also mark the tone arm fixing hole position on the board.
4. Cut out a hole as drawn on the cabinet with a fret-saw or the like. Next, drille a hole to install the tone arm.
5. Fix the turntable frame to the cabinet using the wood screws and washers supplied as accessories.
6. Install the tone arm and provide wiring.
7. For final assembly and adjustment of the turntable unit, proceed with item 5 to 8 in "(A) TO ASSEMBLE THE TURNTABLE UNIT AND TONE ARM" of MODEL DP-3700F on page 3.
8. For assembling and adjustment of the tone arm, please refer to the instruction manual of the tone arm.

—— CAUTIONS AND MAINTENANCE ——

1. **Loading and Unloading of the Turntable**
   Before loading the turntable on the motor shaft or unloading it from the motor shaft, loosen the magnetic-head fixing arm clamping screw and retract the detecting magnetic-head to a position apart from the magnetically-coated surface as shown in figure 4.
   Do this without fail, otherwise, the magnetically-coated surface may be injured or rated performance may fail to be fulfilled.

2. **Clearance between the Magnetically-coated Surface and the Detecting Magnetic-head.**
   If the motor is switched on while the magnetically-coated surface of the turntable inner rim and the detecting magnetic-head are placed more than 0.2 m/m – 0.25 m/m apart or while the turntable is removed, the motor may rotate at high speed or irregularly. In such a case, once press the stop button and stop the motor and correctly adjust the distance between the magnetically-coated surface and detecting magnetic-head.
   (Refer to "Adjusting the position of the Detecting Magnetic Head" on page 8)

3. **Lubrication**
   Lubricating is not required, as special preoiling is provided for the bearings of this player unit.

4. **Keep this player system in a level position.**
   The height of insulating legs are adjustable by turning up to 15m/m. Unless the level position is maintained, the tone arm may fail to regularly trace the record, resulting the stylus tip to skip the groove of the record.

5. **Never supply oil to the rotating part of the tone arm or elsewhere.**

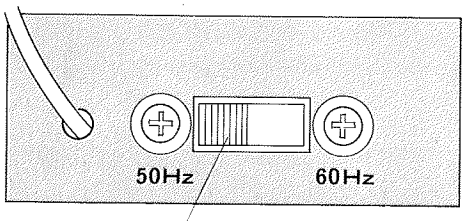
6. High precision double threads are provided for the rotation of the sleeve on the tone arm in order to attain an accurate stylus pressure at all times. Because of double-threading, the pressure indication of the scale may deviate by 0.5 grams when the sleeve is restored after once removed from its position.

   When such deviation is observed, take off the sleeve and refit it to have the deviation remedied.
   Avoid removing the sleeve, unless it is necessary. If silicon grease applied is wiped off or dust is allowed to rest on the sliding surface of the sleeve, the smooth movement of the sleeve is detracted.

—— ALTERATION OF SUPPLY FREQUENCY ——

Power frequency can be altered either for 50 Hz or 60 Hz with slight switching over adjustments as follows.

1. Move the detecting magnetic-head to a position apart from the magnetically-coated surface (refer to Item 1 of CAUTIONS AND MAINTENANCE on this page) and remove the turntable from the motor shaft, and you will find the frequency switch under the turntable. (See Fig. 3)
   Set the switch to the required frequency. (Fig. 11 shows the setting for 50 Hz.)



FREQUENCY SELECTOR SWITCH
(THIS DIAGRAM SHOWS THE SWITCH SET AT 50 Hz OPERATION).

Fig. 11

2. It is also required to change the strobo shutter according to the frequency. Fasten the screw for the strobo shutter on the required frequency. (See Fig. 12)

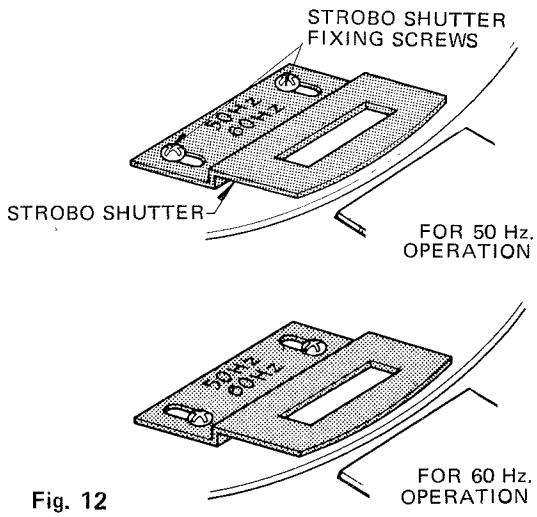


Fig. 12

3. After setting the frequency switch, restore the turntable, put back the detecting magnetic-head to its regular position. Then press the speed selection button "45," and adjust the speed adjustment knob to obtain a still strobo pattern. Next, press the speed selection button "33," and a running strobo pattern will be observed. To have still pattern, adjust the speed-adjustment VR with a small screwdriver through the hole with an indication of "33" as shown in Fig. 13.

—ADJUSTMENTS—

1) **Adjustment of Rotation**
This player set or turntable unit is preadjusted so that no readjustment is required, once speed is adjusted for either 33-1/3 rpm or 45 rpm. Should readjustment become necessary for any reason upon altering the speed selection, follow adjustment procedures as mentioned below:

1-1 First, press the speed-selection button for "45" and adjust the speed adjustment knob to have a still strobo pattern.

1-2 Then, change the speed selection to "33" and, leaving the speed adjustment knob untouched, adjust the speed-adjustment V.R. to have a still strobo pattern again using a small (–) screw driver through the hole which is provided at the bottom with an indication of "33". (See Fig. 13)
Note: Please do not touch the VR indicated as "45", the variable range of the speed-adjustment knob for 45 r.p.m. is pre-adjusted to be more than ±3%.

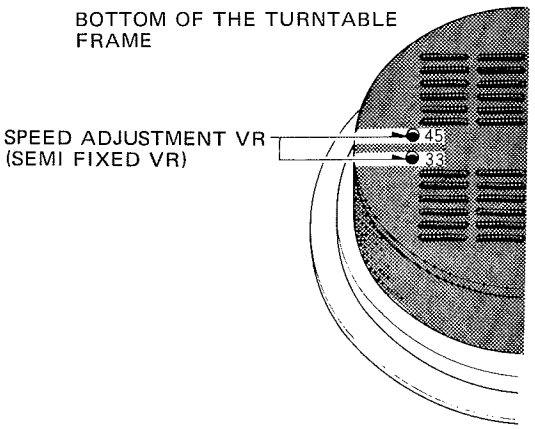


Fig. 13

2) **Adjusting the Position of the Detecting Magnetic-Head**
The position of the detecting magnetic-head is preadjusted correctly at the factory. In case the alignment is disarranged because of vibration during transportation or any other causes, re-adjust as follows:

2-1 Rotate the turntable with a hand until the hole of the turntable comes just above the magnetic head as shown in Fig. 14.

2-2 Next, loosen the magnetic-head fixing screws and make the magnetic-head movable for adjustment.

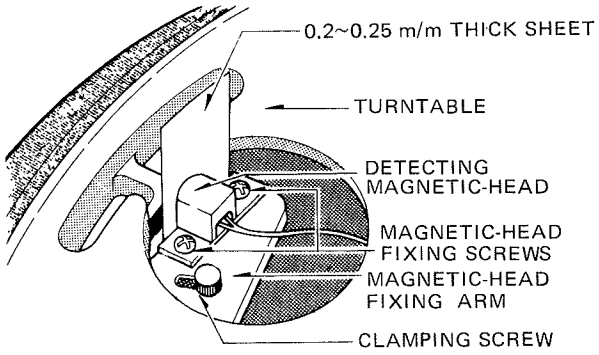


Fig. 14

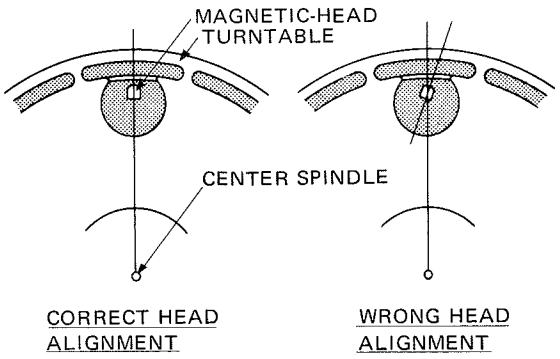


Fig. 15

2-3 Then, press the magnetic-head fixing arm against the stopper, and fix it with the calmping screw.

2-4 After the arm is fixed in that position, insert a 0.2~0.25mm thick sheet (for instance a postcard) between the magnetically-coated surface of the turntable and the detecting magnetic-head as shown in Fig. 14. Fix the magnetic-head fixing screws, pressing the magnetic head against the inserted sheet as shown in Fig. 15.

2-5 Take out the sheet and the adjustment is over.

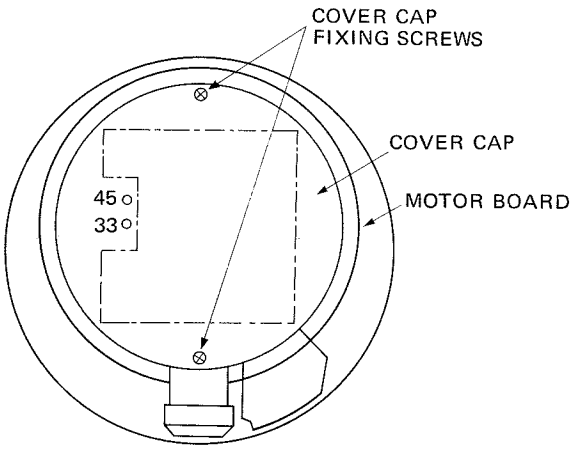
—— STROBO PATTERN STABILITY ——

In the case of a turntable driven by a conventional synchronous motor, both motor driving and neon-lamp lighting have a same power source.
Therefore, on such a turntable, the strobo pattern does not run even if the rotation of the turntable is fluctuated according to variation of power frequency.
In the case of this model DP-3000, though the servo circuit is designed to constantly maintain a stipulated speed once the strobo pattern is adjusted to remain still, the strobo pattern may rarely run due to frequency fluctuation of a power supply which lights the neon lamp only of this set. Actually the frequency fluctuation of power supply is about 0.2%. In adjusting the motor speed, observe the movement of strobo pattern for a few minutes and, taking the frequency fluctuation into consideration, adjust the strobo pattern speed at an average frequency.
When the strobo pattern runs 6 frames/min. for 50 Hz. and/or 7 frames/min. for 60 Hz., that corresponds to a 0.1% variation of the number of motor rotation.

—— TO CHANGE THE OPERATIONAL VOLTAGES ——

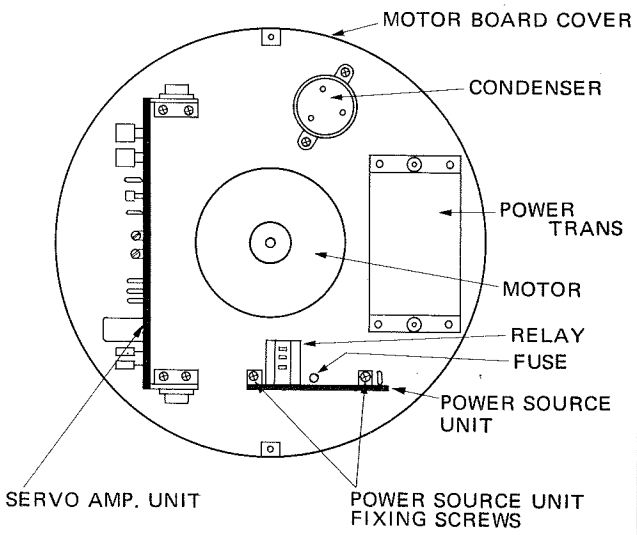
The model DP-3000 Turntable unit can be operated with either 220, 230 or 240 volts power supply.
If you bring the set to the other country or place for operation, check the power supply voltages first and if it is different from the pre-set voltage, please contact your nearest DENON dealer for re-adjustment.
FOLLOWING VOLTAGE CHANGE PROCEDURES ARE FOR AUTHORIZED DENON DEALER OR EXPERIENCED PERSONAL FOR ELECTRONICS ONLY.

1. Remove the two bottom cover cap fixing screws and take off the cover cap. (See figure 19)
2. Remove the power source unit fixing screws and carefully take out the circuit board from the turntable frame. (See figure 20)
3. Remove the power fuse using a soldering iron.
4. Then solder the fuse again at the required voltage position. (See figure 21, 22 and 23)



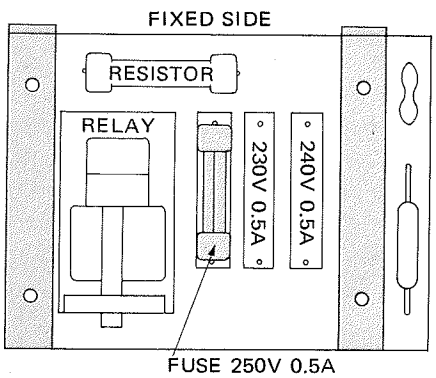
BOTTOM VIEW OF MOTOR BOARD

Fig. 19



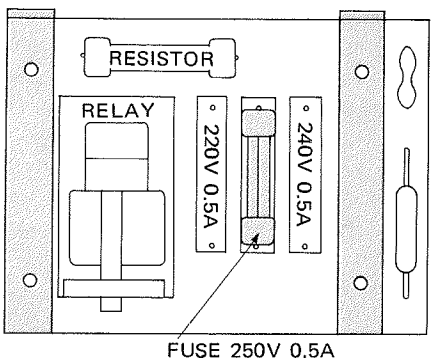
INSIDE VIEW OF MOTOR BOARD

Fig. 20



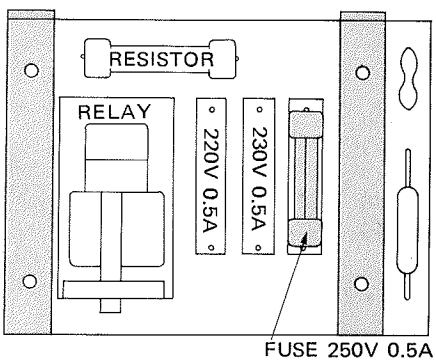
FOR 220V OPERATION

Fig. 21



FOR 230V OPERATION

Fig. 22



FOR 240V OPERATION

Fig. 23

CIRCUIT CONFIGURATION ON MODEL DP-3000

Fig. 1 is a block diagram of the DP-3000. Sine-wave signals sensed by the detector head are amplified, and the amplitude is limited by an IC (TA-7061P) to obtain pulse signals required for driving the servo-system. The pulse signals are waveform-shaped and converted into trigger pulses to drive the monostable multivibrator, through a differentiation and a gate circuit.

The waveform-shaped pulses are also branched to another differentiation circuit, through a phase invertor, before they are supplied to trigger input of the monostable multivibrator. Therefore, the monostable multivibrator is driven by trigger pulses whose frequency is twice the signal frequency sensed by the magnetic head. High-frequency triggering of the monostable multivibrator is necessary to reduce the time constant of the signal detection circuit; if the servo-system were driven by low-frequency trigger signals, a phase lag in the servo-system would affect stability of the system.

For example, fluctuations of turntable speed modify the duty cycle of multivibrator trigger signals, resulting in a delay in voltage fluctuations, because the time constant of the circuit is considerably large, even though FM detector output signals fluctuate. This causes a loss in tracking speed of the servo-system, which can increase fluctuations of the motor speed.

If the motor speed is increased for some reason, the servo-system attempts to recover normal motor speed; however, a lag in response time causes the system to lapse for a certain period before the rated motor speed is resumed. If load to the motor suddenly varies to lower the turntable speed, within the period in which the servo-system is still operating to reduce the motor speed (due to a time lag in the system), the motor speed can be lowered below the rated limit. The servo-system, which requires a negative feedback circuit, can operate as a positive feedback circuit in certain cases.

To minimize a chance of producing such positive feedback operation, the time constant of the detector circuit must be as small as possible. However, a simple reduction of the C.R component in the detector time constant circuit results in lowered detection efficiency; thus, the signal frequency to be detected must be set as high as possible. The number of signal pulses to be recorded on the turntable also presents a similar problem.

One thousand pulses are recorded around the DP-3000 turntable rim. The number of signal pulses recorded on the turntable presents problems in phase lag of the circuit and in designing the signal sensing mechanism which poses a problem in spacing the head surface from the side wall of the turntable rim.

When the wavelength of signals to be recorded around the turntable is short (signal frequency is high), the head must be positioned very close to the turntable side wall; but when the wavelength is long (signal frequency is low), the gap between the head surface and the turntable can be rendered sufficiently wide, making both design and handling of the turntable and head much easier.

Adjustment of the magnetic head can also be simplified. Considering these matters, the DP-3000 magnetic head is positioned 0.2 to 0.25 mm outward from the turntable side wall.

In addition, high-frequency control signals enable smooth detection and control of the motor speed, improving turntable performance.

High performance of the DP-3000 turntable is ensured by an increased number of signal pulses around the turntable and a doubled monostable multivibrator trigger frequency, although the servo-system must also remain sufficiently stable against other conditions. Particularly, variations in ambient temperature can induce a big problem.

Output signals of the monostable multivibrator are fed to a waveform shaper designed to minimize fluctuations of the zero-level because of the thermal factor. On the other hand, output signals of the FM detector are supplied to a comparator composed of a differential amplifier which is able to remain sufficiently stable against ambient temperature variations.

The reference voltage to be supplies to an input circuit of the differential amplifier is produced by dividing the regulated DC power voltage. The output signals of the comparator (error signals) are amplified by another differential amplifier circuit which ensures high thermal stability and high amplifier gain. The output signals of the differential amplifier are supplied to the amplitude modulation circuit.

The DP-3000 turntable motor is a solid-rotor torque motor with a phase advancing capacitor. The turntable motor is driven by commercial line voltage through a transformer, and motor speed is regulated by controlling the power voltage (current) to the motor with an amplitude modulation circuit, which controls voltage amplitude of the power output driven by error signal voltage from the comparator and the differential amplifier.

Certain manufacturers handle the error signal output as variations in the DC signal level, identifying their speed control system as "DC-AC control". The memory circuit (motor speed selecting 33-1/3 or 45 rpm), time constant switching circuit are detailed in subsequent sections herein.

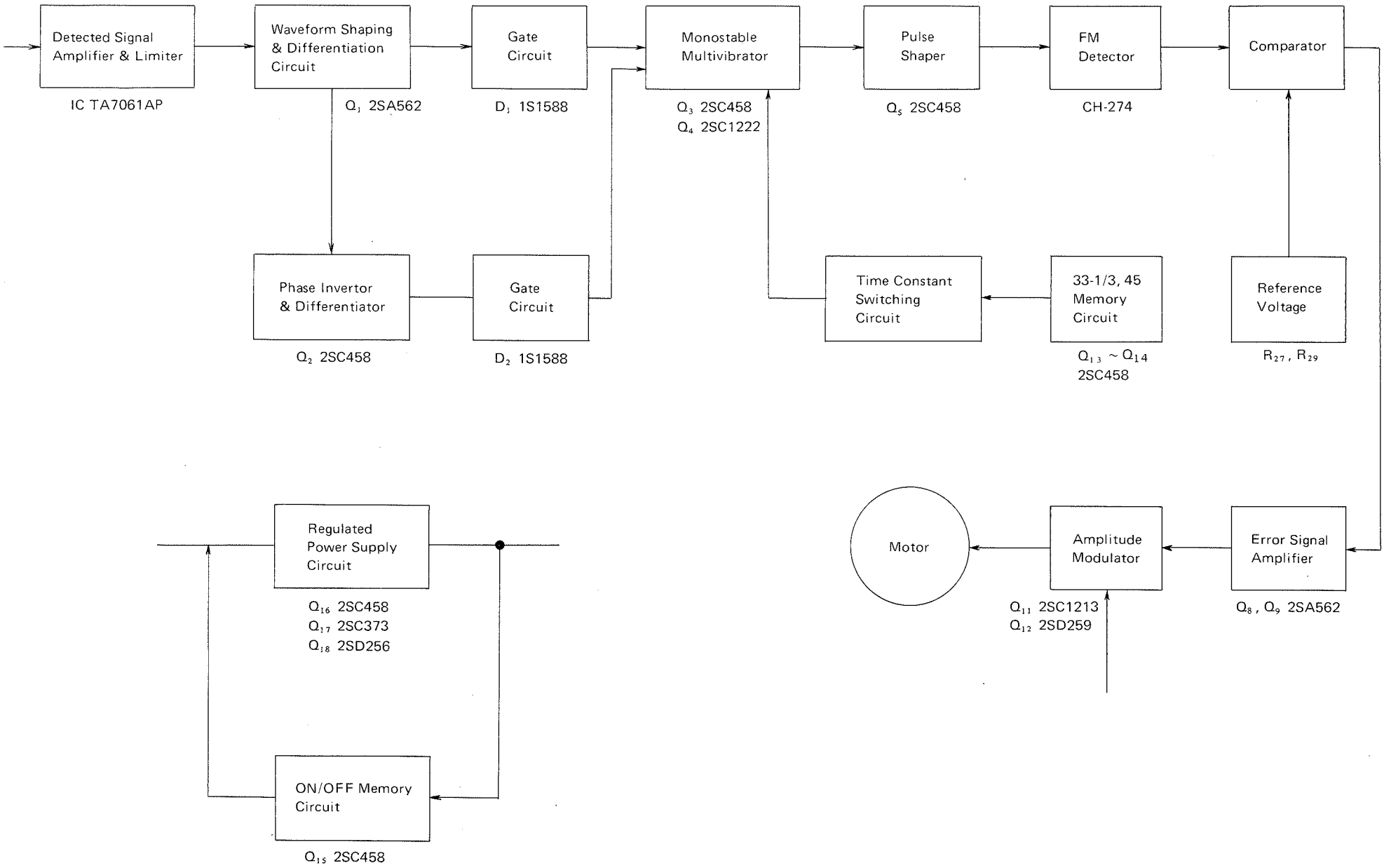


Fig. 1 BLOCK DIAGRAM: DP-3000

OPERATION OF DP-3000 TURNTABLE UNIT

(A) Signal sensing

The magnetic head senses 1,000 signal pulses recorded on the inner wall of the turntable rim per one turntable revolution. The signal frequency is approximately 550 Hz for 33-1/3 rpm and 750 Hz for 45 rpm. The period of one cycle is approximately 1.82 ms at 33-1/3 rpm and 1.33 ms at 45 rpm. When the head is correctly positioned, it outputs sine wave signals of approximately 3 mV rms amplitude.

Turntable manufacturers offer elaborate designs for sensing speed signals; however, DENON is the only manufacturer who employs the magnetic sensing of motor speed.

limiter must be sufficiently shorter than rise time of the turntable motor.

Fig. 1 shows an equivalent circuit of IC TA-7061AP used in the signal amplifier/limiter circuit. This circuit starts normal operation when the base voltage of transistor Q_2 is set to the rated voltage level. For this purpose, capacitor C_4 is quickly charged when power is supplied by diode D_{10} and capacitor C_{16}. When power is supplied, diode D_{10} conducts to charge C_4 until the base voltage of Q_2 reaches

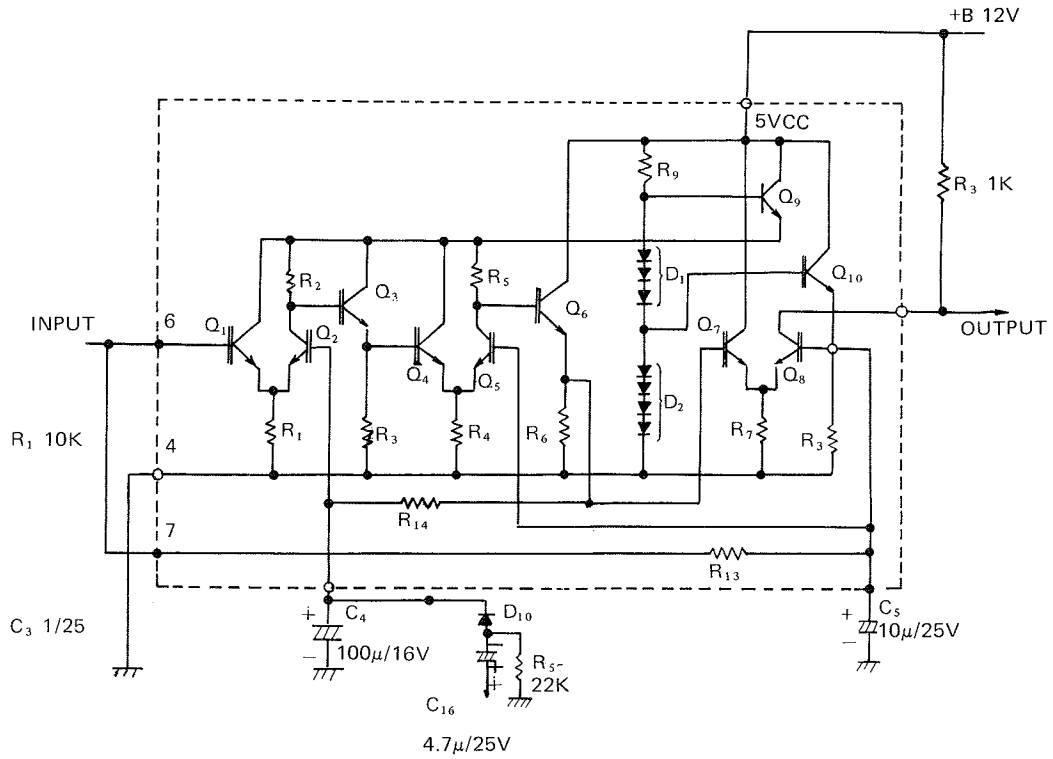


Fig. 1 Equivalent Circuit of TA7061AP

(B) Detected Signal amplifier/limiter

In the DP-3000, which operates on commercial line voltage, the turntable endeavors to revolve at high speed immediately upon a supply of power because the control IC module requires a certain rise time to operate. During the rise time, the control IC cannot function normally; thus, the amplitude modulation circuit outputs a signal to increase motor speed (no input signal or very slow motor speed signal).

If the turntable is driven at an excessively high speed immediately after power is supplied, the servo-system requires a considerable time to recover the rated motor speed; as a result, turntable rise time is increased. To avoid this phenomenon, rise time of the signal amplifier and the

the rated level; then the diode is biased in reverse direction (capacitor C_{16} is cut off) and the base voltage is retained at a level determined by the emitter voltage of Q_6 and resistors R_{14} and R_2. This quick charging of C_4 ensures fast rise time of the DP-3000 signal amplifier/limiter.

(C) Waveform shaper/phase invertor

The waveform shaper trims the waveform of output voltage from the amplifier/limiter IC and amplifies the wave-form-shaped signal to a rated amplitude. The collector output signal of Q_1 is 12Vp-p amplitude and approximately 0.9 ms pulsewidth at 33-1/3 rpm (approximately 0.65 ms at 45 rpm). The phase invertor and differentiator circuits are used to double the frequency of the trigger pulse for the monostable multivibrator.

(D) Comparator/reference voltage and error amplifier

To minimize thermal drift of the level and to obtain high amplifier gain, a balanced differential amplifier is used in the comparator circuit. Together with another differential amplifier circuit used in the error signal amplifier, the differential comparator greatly contributes to suppressing thermal drift of the level which becomes practically negligible. Fig. 2 is a configuration of the comparator and error signal amplifier circuits. Capacitor C_{15} (0.1μF) is used to supress the noise component in power supply and to ensure stability of this circuit.

collector current of Q_7 is reduced. In another case, where the collector current of Q_7 is increased by a temperature rise, it will reduce the collector current of Q_6. These transistors provide complementary action against variations in ambient temperature.

In a strict sense, the extent of variation of collector current may not be equal to these transistors, but owing to the differential voltage output from points (a) and (b), thermal variation cannot change the output signal level, provided that the thermal current increment and decrement

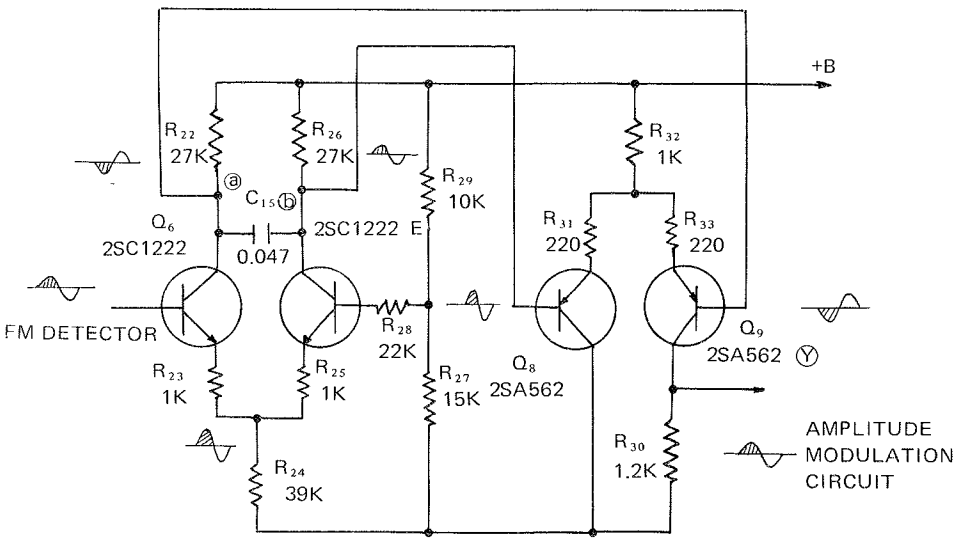


Fig. 2 Comparator and Error Signal Amplifier

When output voltage of the FM detector is increased (turntable speed is lowered), the base voltage of Q_6 increases, causing the collector current of Q_6 to increase and voltage at point (a) to lower. At the same time, the emitter current of Q_6 increases the voltage drop across R_{24}, resulting in increased emitter voltage to Q_7, a reduction in Q_7 collector current, and increased voltage at point (b). Since output voltage of the differential amplifier is obtained across points (a) and (b), the voltage amplification factor of the circuit can be doubled compared with the output voltage from an unbalanced amplifier. The regulated power voltage (22.5V) is divided by resistors R_{29} and R_{27}, and supplied to the base of Q_7 through R_{28} as reference voltage. Output voltage of the differential amplifier is directly supplied to the error signal amplifier, but when increase the base voltage of Q_8 that lowers the base voltage of Q_9 because the base voltages of Q_6 and Q_7 are opposite phase.

The increase of base voltage to Q_8 reduces the emitter current, causing the emitter voltage and the collector current of Q_9 to increase. Together with the decrease of Q_9 base voltage (by differential operation), a very large current flows to the collector of Q_9. The voltage drop across R_{30} is supplied to the amplitude modulator.

When the ambient temperature rises, the collector current of Q_6 may increase, and it increases the common emitter voltage of two transistors Q_6 and Q_7; thus, the of transistor currents are equal. Therefore, base voltages supplied to Q_8 and Q_9 can be maintained stable against variations in ambient temperature, rendering output signal level of the error signal amplifier free from thermal variations. To expect these effects from differential amplifiers, a couple of the transistors in the circuit (for example, Q_6 and Q_7) must be a balanced.

On servicing, resistors and/or transistors of the specified parts must be replaced if replacement of a resistor and/or a transistor is required. These specified parts are marked with an asterisk (*) in the circuit diagram. Be sure to replace these parts with specified ones.

(E) Amplitude modulation circuit

The amplitude modulation circuit controls turntable speed by adjusting AC voltage to be supplied to the motor in response to a given error signal voltage. Motor torque, and consequently turntable speed, is changed by controlling the collector current of transistor Q_{12} in the amplitude modulation circuit shown in Fig. 3. Transistor Q_{11} is a common collector (emitter follower) which drives the power transistor.

When the error signal voltage is increased, the base voltage of Q_{11} increases, causing the emitter current of Q_{11} and the base current of Q_{12} to increase. In a positive half-cycle of the base current, a current which is hfe times the base current flows through the collector as shown by

the solid lines in Fig. 3. Next, in the negative half-cycle, the current flows as shown by the hyphenated lines. Thus, AC current to be supplied to the motor can be controlled by Q_{12}. To obtain a smooth rotating field in any case, AC voltage supplied to the motor is switched to 68V (for 50 Hz operation) or 75V (for 60 Hz operation). At the same time, capacitance of the phase advancing capacitor is changed.

collector current waveform becomes similar to a square wave. This relation between the collector voltage and the current is shown in Fig. 4 in which the saturated region is shadowed.

The square wave current, because of nonlinearity of the transistor, affects induction of smooth rotating field, excessively increasing motor vibration; thus, the collector

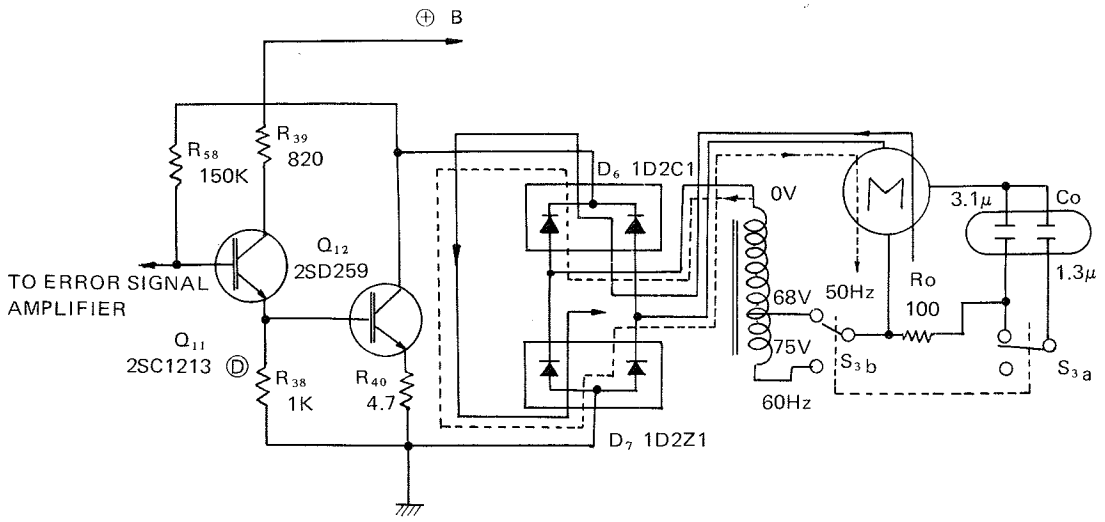


Fig. 3 Amplitude Modulation Circuit

Some manufacturers term this control circuit a "DC-AC control circuit" because the motor voltage is controlled by the DC base voltage. However, without resistor R_{58}, this circuit cannot produce a smooth rotating magnetic field for the following reason. The collector current of a transistor is determined by the base current and the collector voltage, but the base voltage in this circuit is varied by error signal output current, and the collector voltage fluctuates according to AC voltage supplied from the power transformer. When the collector is zero, the collector current becomes zero at any base current. The collector current increases with an increase in the collector voltage until the current reaches the saturation current for the transistor; thus, the current waveform must be shaped to reduce this effect. In the DP-3000, resistor R_{58} (150 kilohms) is used for this purpose. Without this resistor, the collector current of Q_{12} is limited as shown by the shadowed waveform in Fig. 5, but the collector voltage waveform is approximately a sine wave (supplied from the power transformer).

A portion of the collector voltage is branched through R_{58} and supplied to the base of Q_{11}. It increases the base current to Q_{11} in a sinusoidal form. The currents supplied to and output from Q_{12} are also varied similarly to a sine wave, allowing the modulator to supply a smooth rotating field to the motor. (Waveforms marked with an asterisk (*) in Fig. 5 illustrate the compensation current by R_{58}).

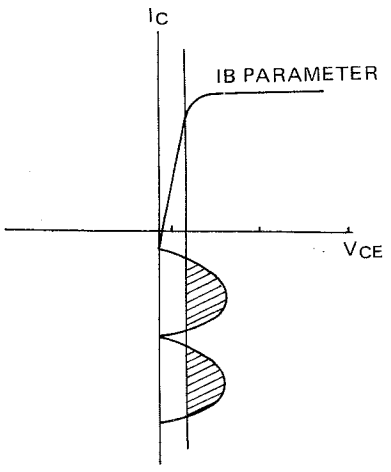


Fig. 4 Relation between VCE and Ic

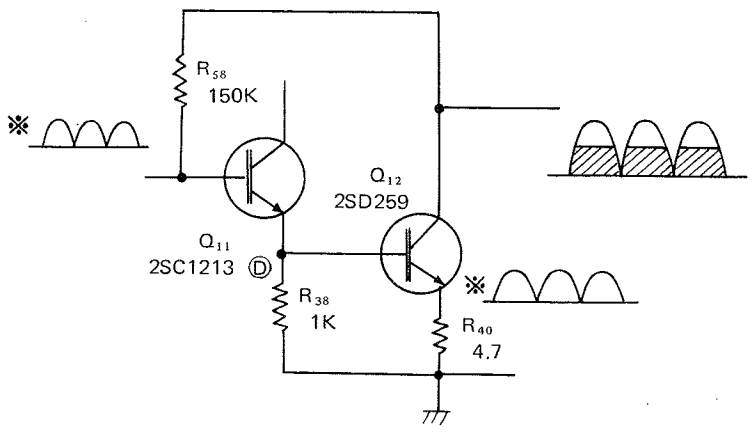


Fig. 5 Waveform Compensation Circuit

(F) 33/45 memory circuit

In the DP-3000, the 33-1/3 memory circuit is actuated when power is supplied to the circuit (the 45 memory is actuated later, even when 45 rpm is selected). When the 33-1/3 button is depressed, switch S_4 in the power supply circuit is actuated to supply power voltage to the voltage regulator circuit; however, switches S_2 and S_4 cannot always be closed at the same moment (in a strict sense) because of the tolerance of mechanical linkage. If S_4 is closed faster than S_2, the 33-1/3 may fail to start (the 45 memory may start faster; operation of bistable multivibrator, the side to be turned ON, depends on various conditions when power is supplied to the multivibrator). If the 45 memory is turned ON, the amplitude modulation circuit operates to increase turntable speed (up to 45 rpm); then, an unnecessary time must elapse before the motor is controlled to 33-1/3 rpm. This is a loss in rise time of a turntable. To prevent such trouble, the 33-1/3 memory is actuated faster than the 45 memory.

A configuration of the DP-3000 33-45 memory circuit is shown in Fig. 6 in which capacitor C_{17} accomplishes to aforesaid purpose.

When power is supplied (by turning S_4 ON), the base voltage to Q_{14} cannot rise until C_{14} is charged; while, transistor Q_{13}, to which no capacitor is connected to the base, is turned ON, causing Q_{14} to be shut OFF.

When the 45 rpm switch (S_1) is selected, the base of Q_{13} is grounded, causing Q_{13} to be shut OFF. The collector voltage of Q_{13} (and the base voltage of Q_{14}) increases, but base voltage is not supplied to Q_{14} before C_{17} is charged. Thus, the memory is set to 33 rpm momentarily until C_{17} is charged (duration of charging is determined by the time constant given by C_{17} and R_{43}). Then Q_{14} is turned ON, and Q_{10} in the time constant switching circuit is turned ON to drive the motor at 45 rpm. Turntable speed of the DP-3000 is adjustable within ±3% of the rated speed.

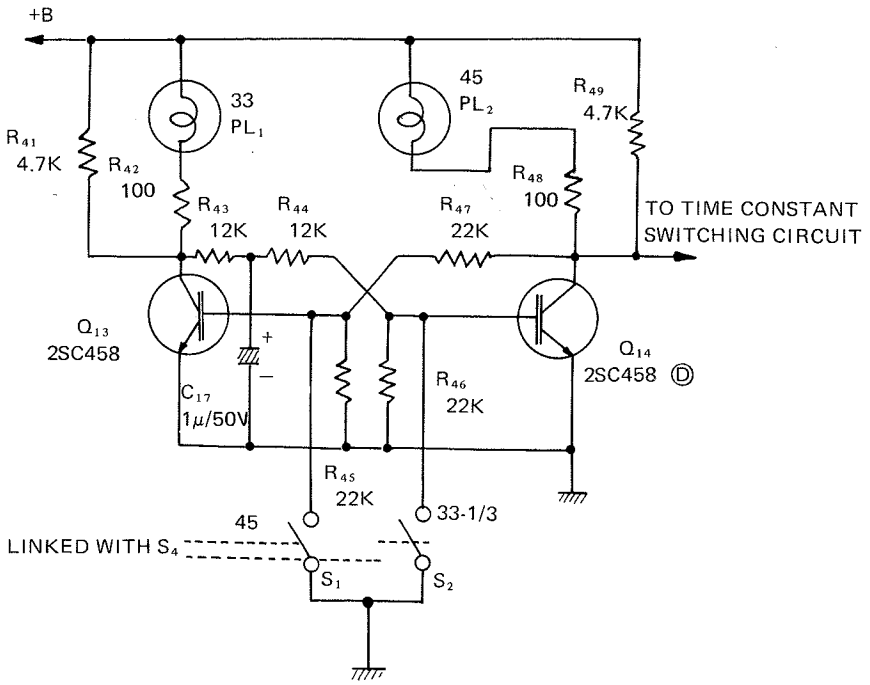


Fig. 6 33-45 Memory Circuit

(G) ON/OFF memory circuit

In the DP-3000, the ON/OFF memory is composed of only one transistor. The ON/OFF memory circuit is shown in Fig. 7.

When either of the 33 or 45 button is depressed, power switch S_4 is closed at the same time, and power voltage is supplied through relay RL to the collector of Q_{15} and through R_{50} to the base of Q_{15}. It turns Q_{15} ON and closes the relay contacts; thus, the relay is held and the power supply is continuously operated after the speed select button is released. When the STOP switch is pushed, the base voltage to Q_{15} is shorted, causing Q_{15} to be shut OFF and relay RL to be denergized; then the power circuit is opened.

Note that relay RL may fail to open the power circuit if the user depresses the STOP button and releases it very quickly (relay RL is kept energized until the power supply capacitors are fully discharged). Customers should be oriented to keep depressing the STOP button until the power supply is completely cut.

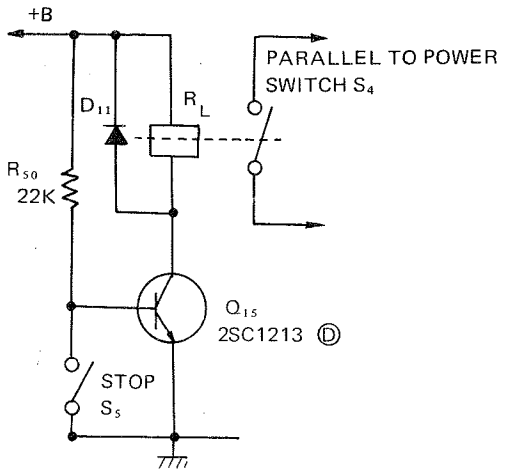


Fig. 7 ON/OFF Memory Circuit

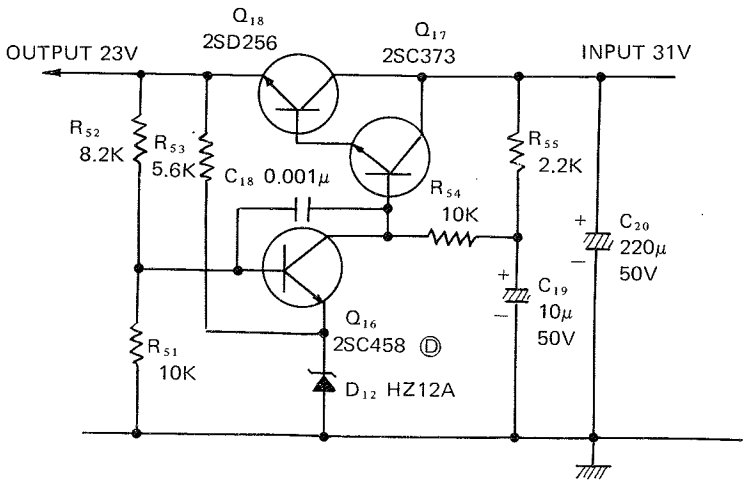


Fig. 8 Voltage Regulator Circuit

(H) Voltage regulator circuit

The DP-3000 voltage regulator circuit has the very common configuration shown in Fig. 8.

Transistor Q_{16} is an error detector/amplifier, Q_{18} is an output voltage limiter, and Q_{17} functions to drive the limiter. This circuit, designed to output 23V DC, requires no adjustment.

The emitter voltage of error voltage amplifier Q_{16} is fixed at a voltage determined by zener diode D_{12}, but the base voltage to Q_{16} is supplied from the output voltage through voltage divider R_{52} and R_{51}. When the output voltage is increased, the base-emitter forward current of Q_{16} increases, causing the collector current to increase. The voltage drop across R_{54} is also increased, lowering the base voltage to Q_{17} which is in a Darlington-type connection with voltage limiter Q_{18} (namely, these transistors correspond to an n-p-n transistor). The lowered base voltage to Q_{17} decreases the current through Q_{18}, thereby lowering the output voltage until the error voltage becomes constant. As a result, output voltage is regulated to the designed voltage.

When servicing, particular care must be excercised not to short-circuit the output voltage (the load) since this voltage regulator has no overload protection circuit.

TROUBLE-SHOOTING PROCEDURE CHART (I)

Turntable speed cannot be selected

1. Defective S_1, S_2 or circuit concerned.
2. Defective Q_{13}, Q_{14} or circuit concerned.
3. Defective Q_{10} or circuit concerned.

Power not cut off when STOP button depressed

1. Defective S_5 or circuit concerned.
2. Defective Q_{15}.
3. Defective S_4.
4. Defective RL (Relay).

Strobo indication fails to vary against SPEED adjustment

1. Defective VR_3.
2. VR_3 circuit short-circuited.
3. Slipping of VR_3 shaft and knob.

Excessive rumble

1. Setscrews (secured for transportation) not removed.
2. Incorrect setting of S_3.
3. Defective friction metal.
4. Defective vibration absorber rubber or defective rubber mounting.
5. Defective Co or circuit concerned.
6. Defective motor.
7. Defective S_3 or circuit concerned.
8. Defective D_6 or D_7.
9. Defective R_{58} or circuit concerned.

Excessive wow and flutter

1. Defective magnetic head position.
2. Turntable inner-rim rubbing strobo-shutter.
3. Defective motor.
4. Defective magnetic coating on turntable inner-rim.

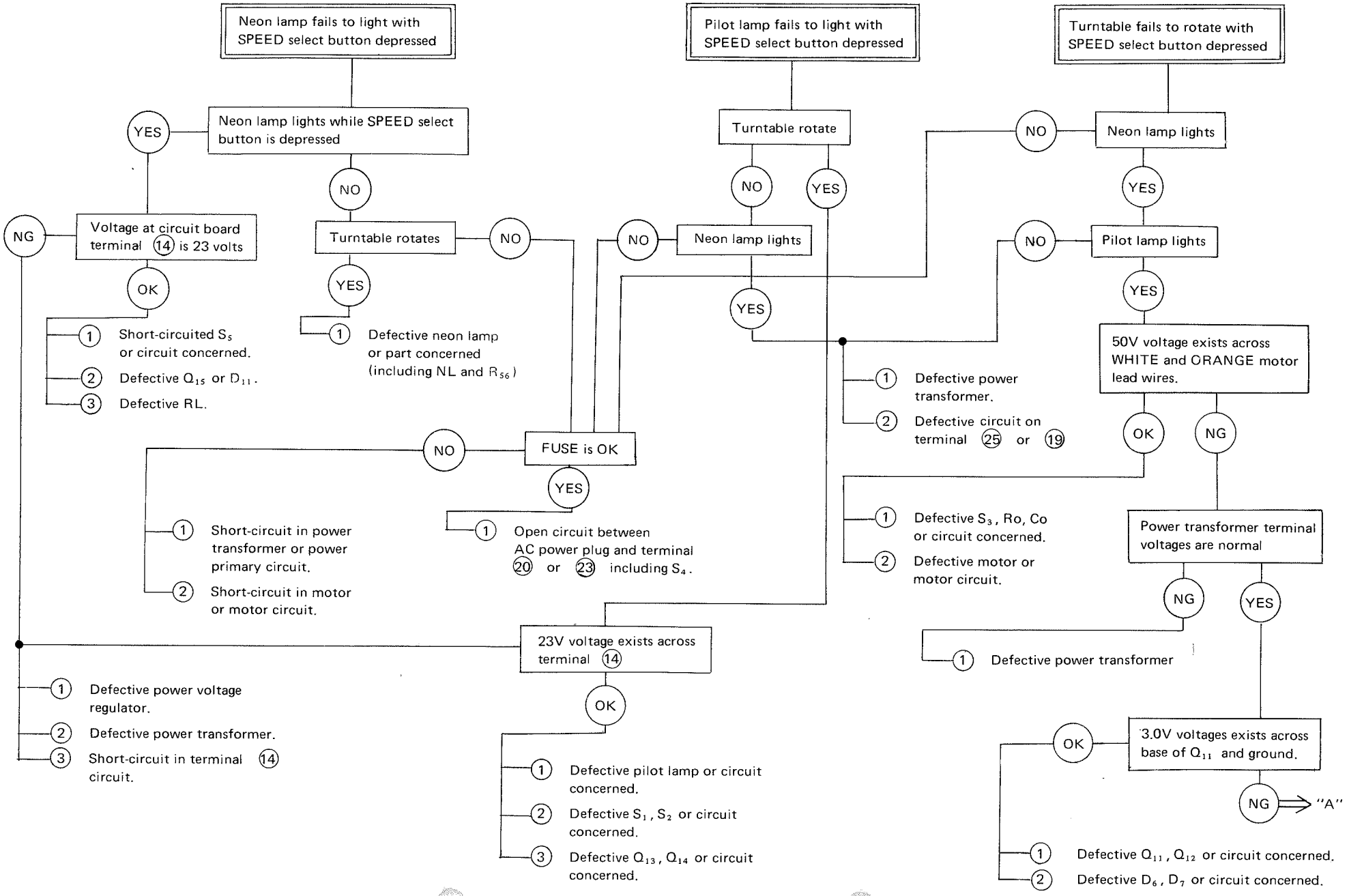
Mechanical noise

1. Magnetic head rubbing turntable.
2. Strobo-shutter rubbing turntable.
3. Defective motor.
4. Defective motor shaft or friction roller.

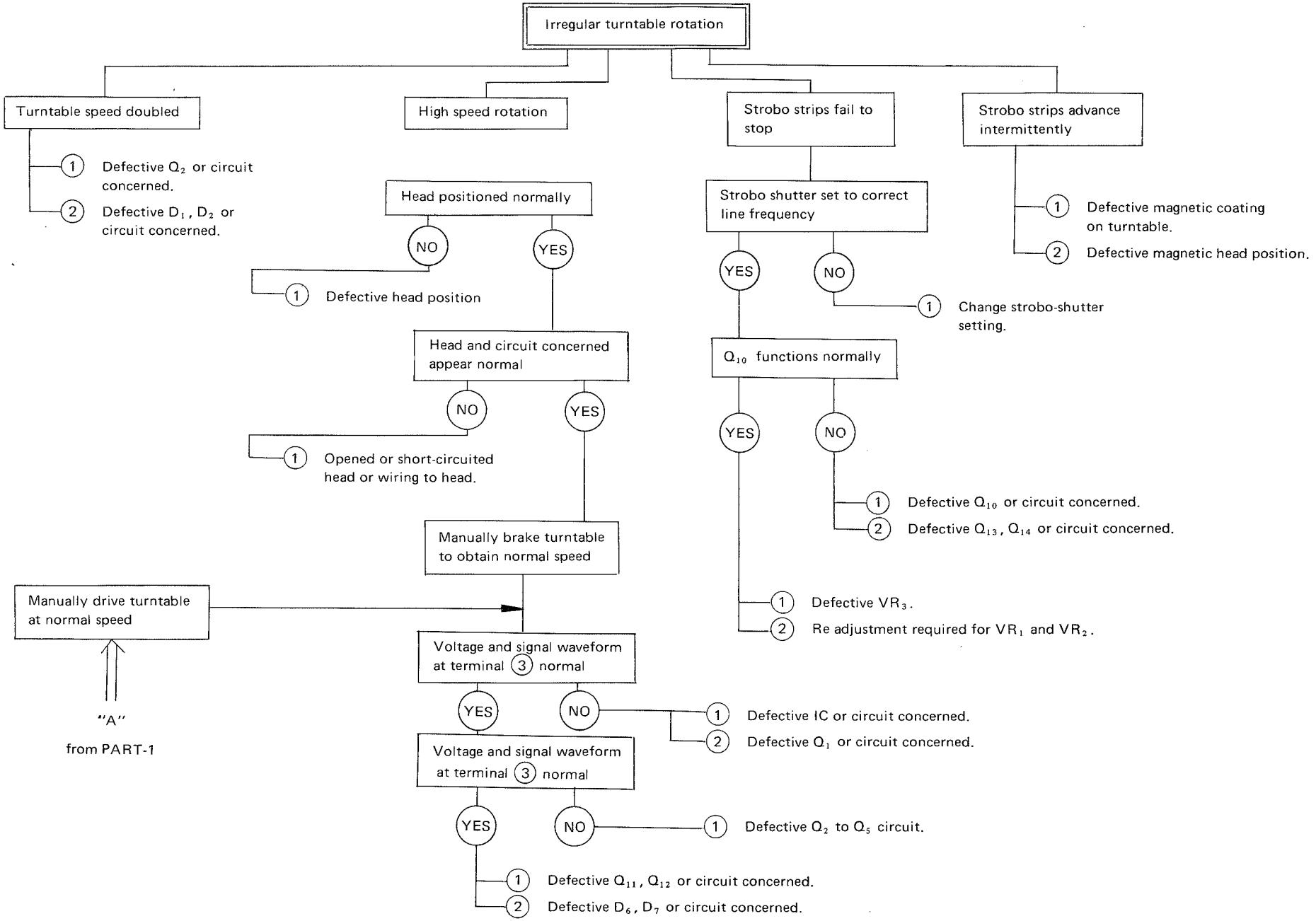
Speed adjustment range narrower than ±3%

1. Incorrect adjustment of VR_1 or VR_2.
2. Defective R_{36} or R_{37}.

TROUBLE-SHOOTING PROCEDURE CHART (II) PART-1



TROUBLE SHOOTING PROCEDURE CHART (II) PART-2



——TROUBLE-SHOOTING PROCEDURES REGARDING TURNTABLE ROTATION——

Although a variety of causes may exist in turntable problems and trouble-shooting, a few complicated ones are briefly described here.

Possible troubles may be classified into the following six categories:

(A) Motor fails to run
(B) Excessively high speed
(C) Motor speeds unswitcheable
(D) Motor speed doubled
(E) Motor speed halved
(F) Intermittent drift of motor speed

Check procedures for each trouble category:

(B) High-speed rotation

In this case, the trouble source—the pulse circuit including the demodulator or a subsequent drive circuit—must be examined. Normal functioning of the pulse circuit, including the demodulator, can be checked by manually turning the turntable to 33-1/3 or 45 rpm and checking the signal waveform at test points. (Be sure to set the SPEED selector to the manually rotated turntable speed).

1. If no signals are observed at any test points, check the magnetic head output voltage. If an approximate 3 mV signal is observed at the head output, proceed to step "1".
2. Check if voltage at the voltage divider R_{27} and R_{29} (nominally 14V) junction changes proportionately to motor speed (or speed fluctuation).

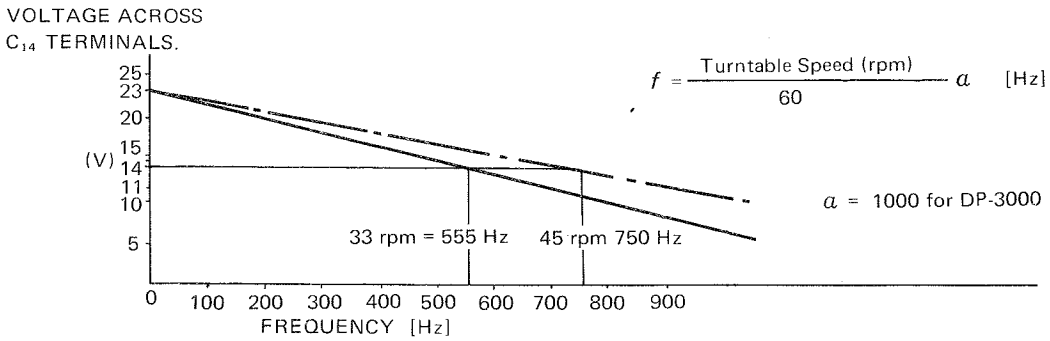


Fig. 1 Turntable speed and frequency – Voltage characteristics

(A) Motor fails to run

Functionally divide the circuit into the following three blocks and check the function of each block.

a. Motor and power transformer
b. From demodulator circuit to transistor Q_{12}
c. From pulse head to demodulator circuit

To drive the motor normally, transistor Q_{12} must be in its operating region. For this purpose, the base voltage to transistor Q_6 in the differential amplifier must be set to within the region shown in Fig. 1. (In the Fig. 1, motor speed is plotted as a function of voltage across the C_{14} terminals. When voltage is supplied to the base of Q_6, the voltage-turntable speed curve forms a reversed gradient).

Therefore, motor speed will increase when the demodulation circuit is disconnected from the differential amplifier and external voltage is supplied to the base of Q_6 (motor speed increases with an increase of external voltage).

Functioning of the demodulator and the differential amplifier or a subsequent circuit can be examined by disconnecting the demodulator from the differential amplifier and supplying positive DC voltage to the base of Q_6. Trouble-shooting of individual circuits will be explained later in detail.

$$\frac{\Delta Ex}{23-Ex} = \frac{\Delta fx}{fx}$$

When the voltage varies proportionately to the turntable speed, R_{27} or R_{29} is defective (resistance value varies).

If not, proceed to step "3".

3. Use an external signal generator to supply 555 Hz (33 rpm) or 750 Hz (45 rpm) external signals across terminals ① and ②. Monitor the signal waveform at terminal ④ to check if the pulses appear continuously (without intermittent blocking).
4. When the pulses appear at a constant rate, check the voltage waveform at terminal ④ and measure the DC voltage across C_{14} to examine if they are stable. The measuring instruments must be sufficiently warmed up before checking the turntable.

Adjust setting of the CRT oscilloscope trigger input circuit so that an astable period of the monostable multivibrator may be accurateiy observed.

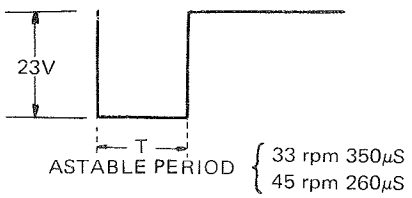


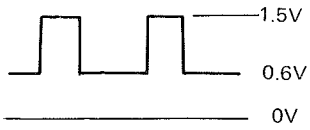
Fig. 2

If the monostable multivibrator astable period fluctuates at the same rate during 33 rpm and 45 rpm, check the waveform of the base voltage to Q_3 and Q_4 and the waveform of collector voltages. When fluctuation is observed only during the astable period (1.5V from base line) of the base voltage to Q_3, a deterioration of V_{BE} characteristics of Q_3 is the cause. If both the base and collector voltages (Q_3) fluctuate, diode D_4 is defective. When the collector voltage of Q_3 fluctuates while the base signal is stable, diode D_3 or transistor Q_3 (V_{CE} saturation characterics) is defective. When the peak of Q_3 collector voltage (23V) fluctuates, deterioration of Q_6 (I_{CBO} characteristics) or defective insulation of C_{11} is the cause.

Since capacitor C_{11} is an important circuit element which determines the pulse astable period, if C_{11} insulation is defective, duration "T" of the astable period will vary with collector voltage fluctuation.

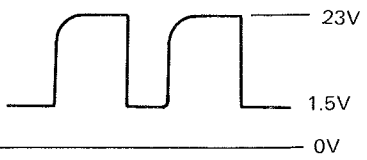
Check on a possible defective circuit element on the Q_4 side of the monostable multivibrator in the similar way.

If the base voltage waveform to Q_4 fluctuates (1.5V), the V_{BE} characteristics of Q_4 is defective. When both the Q_4 base voltage (1.5V) and Q_4 collector voltage (0.8V) fluctuate, the diode D_5 is defective. If only the collector voltage (0.8V) to Q_4 fluctuates, a deterioration of V_{CEO} (sat) characteristics of Q_4 is the cause. The reverse characteristics of diode D_5 are defective if only the base voltage waveform to Q_4 (20V) fluctuates. When both the base voltage waveform (20V) to Q_4 and its collector voltage waveform (20V) fluctuate, the I_{CBO} characteristics of Q_4 are defective. When voltage waveforms are normal but the rated turntable speed is unobtainable, the capacitance of C_{11} (4700pF) has varied.



Q_3 BASE VOLTAGE WAVEFORM

Fig. 3



Q_3 COLLECTOR VOLTAGE WAVEFORM
(at junction of R_{15} and D_3)

Fig. 4

Functioning of the monostable multivibrator circuit can be perfectly checked by following the aforementioned steps. Fluctuation of turntable speed substantially depends on the stability of astable pulse duration which is affected by the operating voltage and forward voltage characteristics of Q_3, D_4, D_3, Q_4, and D_5, as well as by the resistance value of resistors in the 33-45 time constant switching circuit.

In some cases, turntable fluctuation is sensed at a particular turntable speed (33 or 45). When the 33 rpm speed is unstable, the cause may be the VR_1, R_{37}, and I_{CBO} characteristics of Q_{10}. When a larger fluctuation is observed during 33 rpm operation than during 45 rpm operation, the I_{CBO} characteristics of Q_4 are defective. If 45 rpm speed fluctuates much more than 33-1/3 rpm speed, the cause is VR_2, VR_3, or R_{36}.

The modulator output voltage is determined by frequency, duty cycle, and amplitude of the multivibrator pulse (the term "frequency" in this section deals with frequency of the external oscillator signal or frequency of the pulse head output). When the signal frequency is stable and the monostable multivibrator astable period is maintained constant, the output signal duty cycle is held stable.

However, a fluctuation of the pulse output amplitude, which varies with detector output voltage, results in fluctuation turntable speed. Transistor Q_5 is used as a buffer to protect the turntable speed from fluctuating. Thus, if the astable period T is held stable but voltage fluctuates across the C_{14} terminals, R_{21}, CH-274 (intermittent opening of coil), or defective insulation of capacitor C_{14} or C_{13} may be the cause.

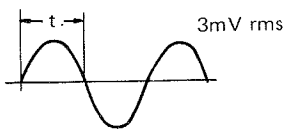
5. When both the astable period "T" and the voltage across C_{14} are stable, reconnect the base of Q_6 to the demodulator output and supply 555 Hz or 750 Hz external signals to terminals (1) and (2). Then, finely adjust the signal frequency until the emitter voltage waveform to Q_{12} is set to 0.6V amplitude, and check the voltage waveforms and fluctuation of signals in the circuit from Q_6 to Q_{12}.

   Before starting the measurement, the external signal generator must be sufficiently warmed up (at least 1 hour).

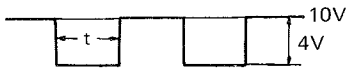
   When the Q_6 circuit is soldered, allow the circuit board to cool sufficiently before starting the next measurement.

   The aforementioned check steps can be applied to turntable speed fluctuations above 1%.

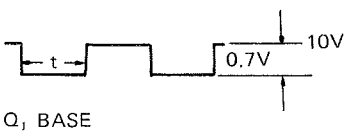
(C) VOLTAGE WAVEFORMS



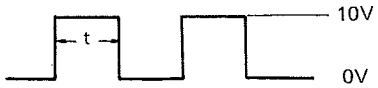
(1) CIRCUIT TERMINAL NO. 1



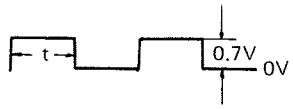
(2) Ic. TA7061AP PIN NO. 3



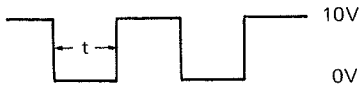
(3) Q_1 BASE



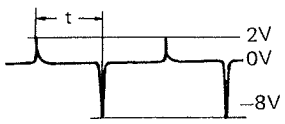
④ Q_1 COLLECTOR



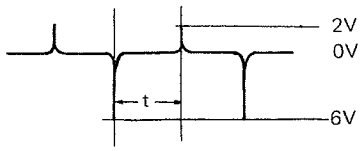
⑤ Q_2 BASE



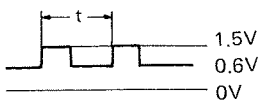
⑥ Q_2 COLLECTOR



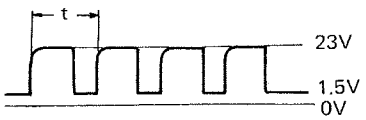
⑦ C_9-D_1 JUNCTION POINT



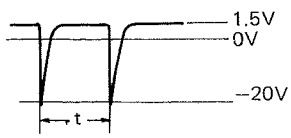
⑧ C_{10}-D_2 JUNCTION POINT



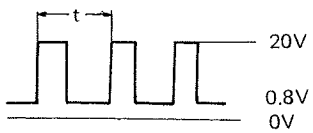
⑨ Q_3 BASE



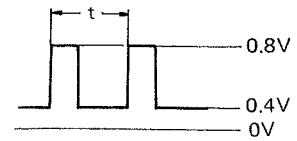
⑩ D_3-R_{15} JUNCTION POINT



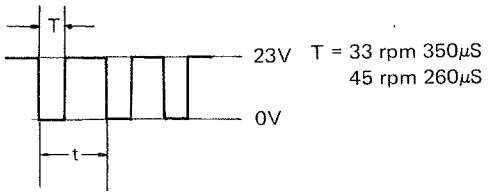
⑪ Q_4 BASE



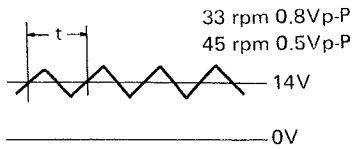
⑫ Q_4 COLLECTOR



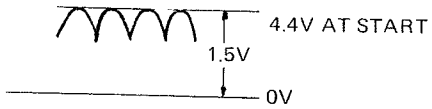
⑬ Q_5 BASE



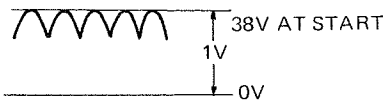
⑭ Q_5 COLLECTOR



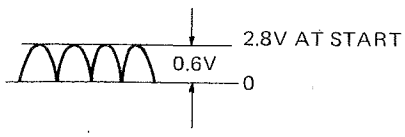
⑮ R_{21}-CH-274 JUNCTION POINT



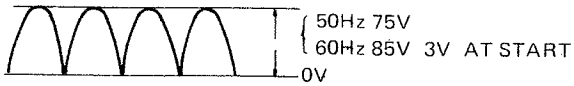
⑯ Q_{11} BASE



⑰ Q_{11} EMITTER

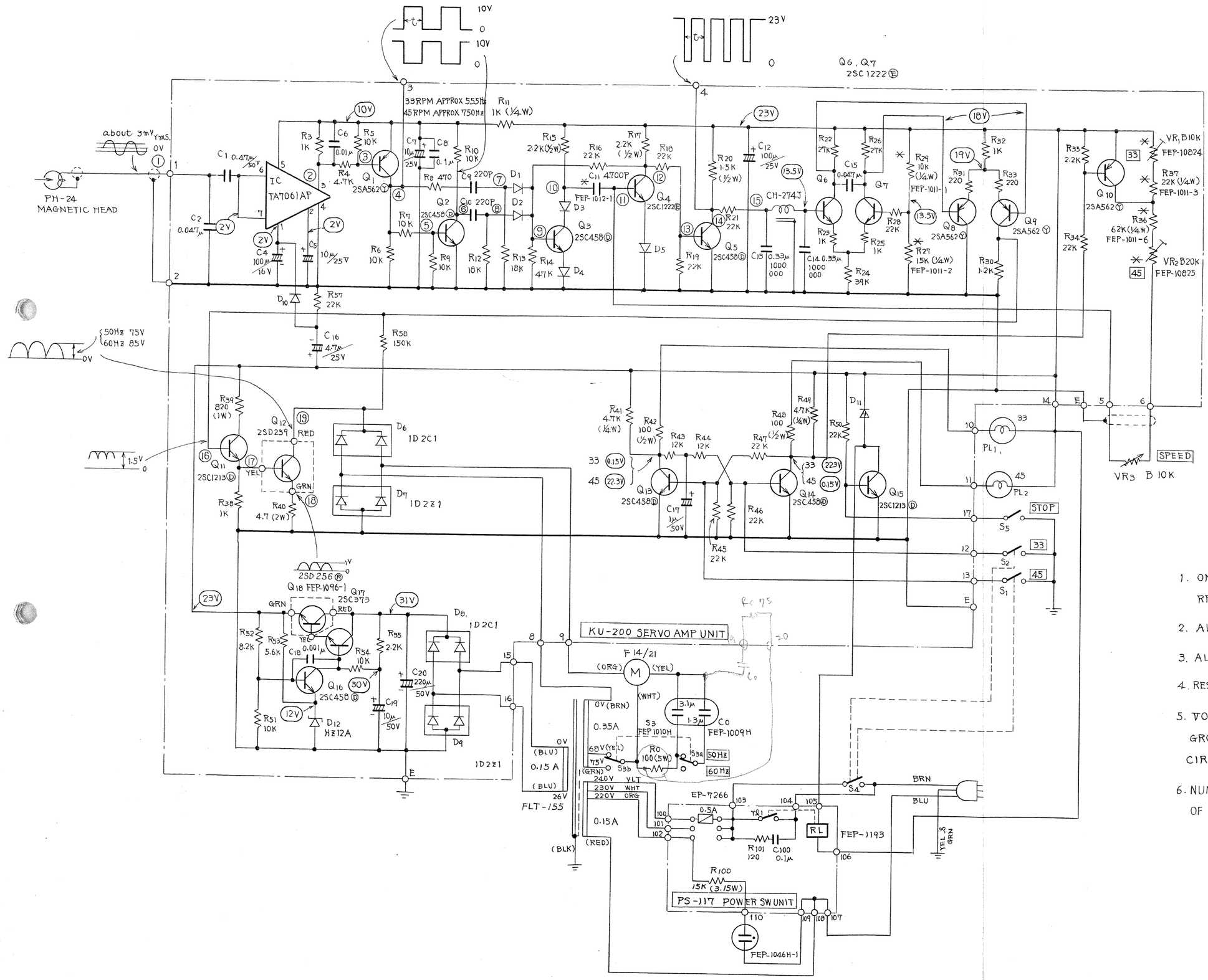


⑱ Q_{12} EMITTER



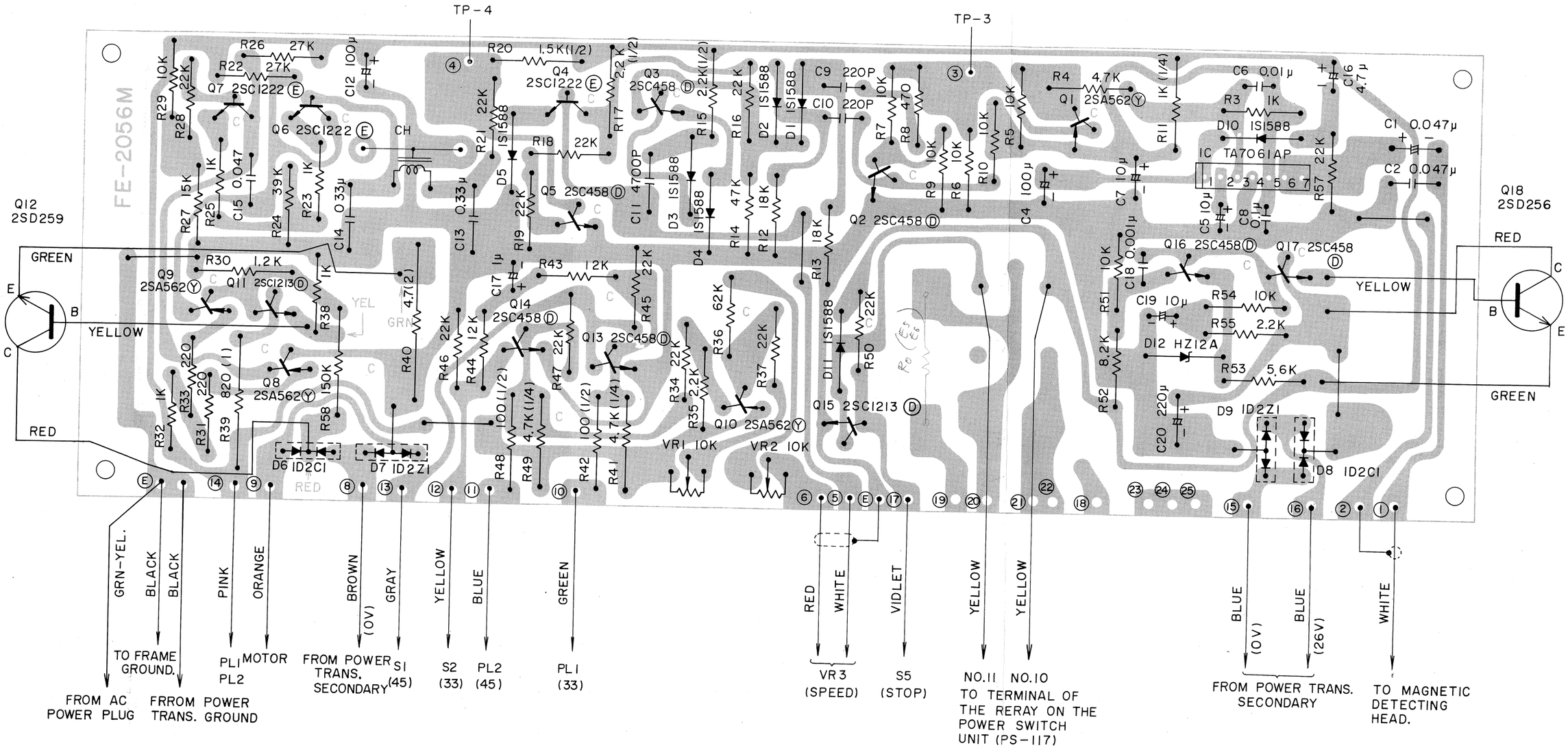
⑲ Q_{12} COLLECTOR

DP-3000EX CIRCUIT DIAGRAM

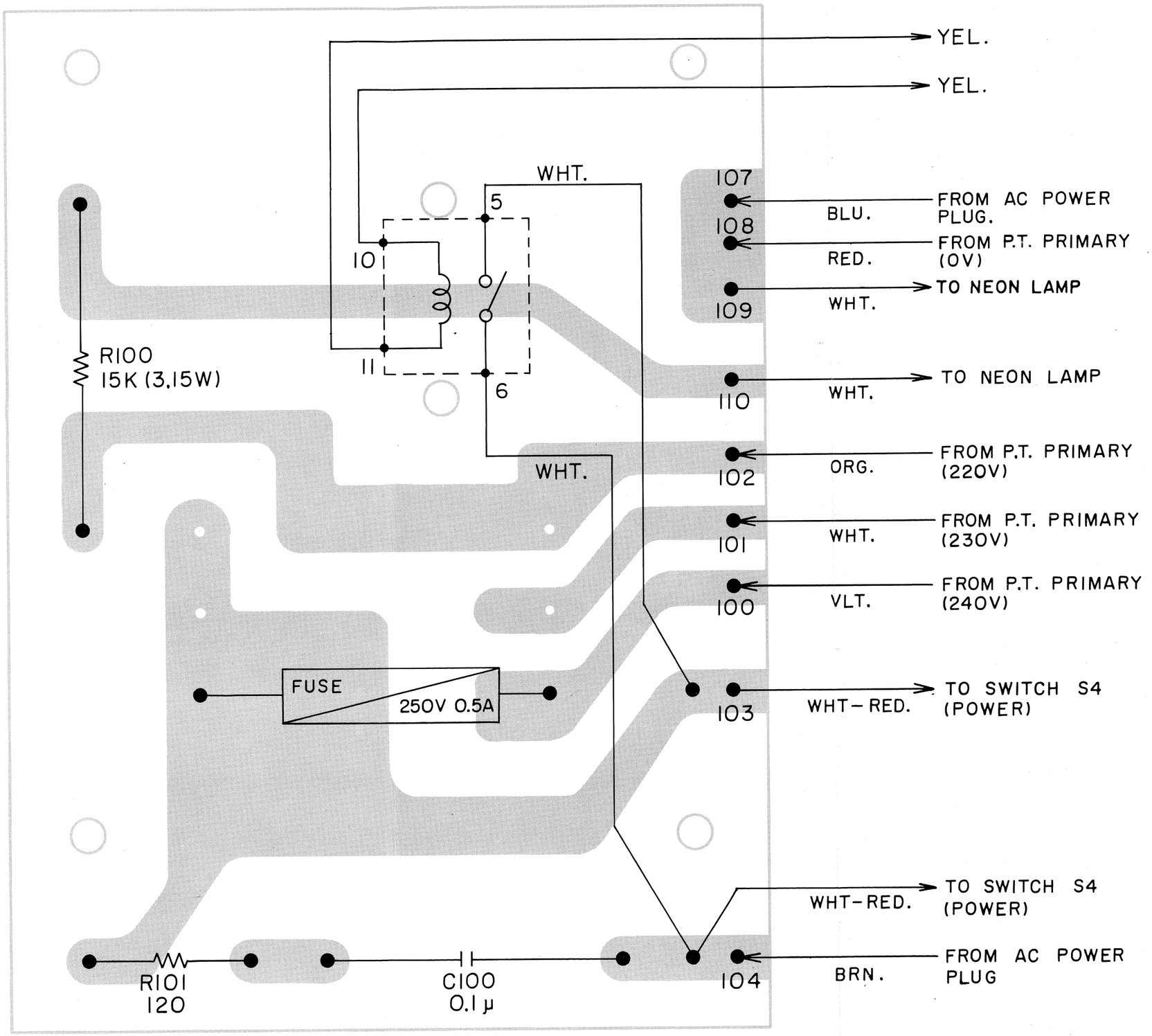


1. ONLY SPECIFIED RESISTORS AND CAPACITORS CAN REPLACE THE ONES WITH ASTERISKS (✳).
2. ALL THE DIODES WITHOUT REMARKS ARE 1S1588
3. ALL THE RESISTORS WITHOUT REMARKS ARE 1/8 WATT, ±5%.
4. RESISTORS AND CAPACITORS ARE IN Ω AND F RESPECTIVELY.
5. VOLTAGES ARE MEASURED WITH RESPECT TO THE GROUND DURING NO-LOAD ROTATION. THOSE IN CIRCLES (◯) ARE D.C. POTENTIAL.
6. NUMBER IN CIRCLES(○) ARE REFERENCE NUMBER OF WAVE FORM IN TROUBLE SHOOTING ON PAGE ___.

DP-3000 SERVO AMP. UNIT. KU-200



PS-117 POWER SWITCH UNIT



MODEL DP-3000 MECHANICAL PARTS LIST

Ref. No.	Part No.	Part Name	Descriptions
	FMD-380K	TURNTABLE	
	FMD-358R	MOTOR BOARD	
	FTS-600L	MOTOR BOARD COVER	
	EE-2323	MOTOR BOARD COVER CAP	
	EE-2347H-1	BUSH PLATE	
	FE-2343H	SWITCH PLATE ASSY	
	FMD-70-2	RUBBER BUSH	
	FE-2344	SWITCH SUPPORT	
	FMD-386H	BUTTON ASS'Y (B)	"STOP" INCLUDING HINGE, SHAFT AND SPRING
	FMD-385-1	BUTTON ASS'Y (A)	"38" INCLUDING HINGE, SHAFT AND SHEET
	FMD-385-2	BUTTON ASS'Y (A)	"45" INCLUDING HINGE, SHAFT AND SHEET
	FMD-324J	POWER SWITCH COVER	
	GM-8	CUSHION RUBBER	FOR POWER TRANSFORMER
	FPR-420	LABEL	
	FMD-361J	MIRROR CASE ASS'Y	INCLUDING MIRROR AND MIRROR CASE
	FMD-326K	V.R. MOUNTING PLATE	FOR VR3 MOUNTING
	FMD-322L	KNOB	FOR SPEED ADJUSTMENT (VR3)
	FMD-330H	STROBO CASE CAP	
	FMD-323K	ACRYLIC PLATE	FOR STROBO WINDOW
	FTS-597	STROBO SHUTTER	
	FWA-62H	WASHER	MOUNTING WASHER FORSTROBO SHUTTER
	F14/21M-1	MOTOR	
	FMD-357J	FRICTION ROLLER	
	FTS-589K	ROLLER SPRING	
	FTS-591J	FRICTION COVER	
	FTS-533N	HEAD PLATE ARM	
	FE-2341	HEAD SUPPORT	
	FTS-599J	STOPPER	
	FTS-535L	CLAMP SCREW	
	FTS-536K	COLLAR	FOR MOUNTING OF THE HEAD ARM
	FWA-72H	WASHER	
	FE-2348	CORD BUSH	
	FE-2261H	INSULATING SHEET	FOR MICRO SWITCH
	FMD-387J	RUBBER SHEET	FOR TURNTABLE MAT
	FTS-596K	45 ADAPTOR	45 rpm SPINDLE ADAPTOR

MODEL DP-3000 ELECTRONIC PARTS LIST

Ref. No.	Part No.	Part Name	Descriptions
S1, S2, S5	FEP-1199	LEAF SWITCH	
PL1	3930001118	LAMP	
PL2	3930001121	LAMP	
	FEP-1046H-1	NEON LAMP ASS'Y	FOR STROBO SCOPE
S4	FEP-1204	MICRO SWITCH	
	FEP-1049H	EARTH LEAD	
	FEP-1048H-2	EARTH WIRE	
	2006020008	AC CORD FOR EUROPE	
	2006019103	AC CORD FOR AUSTRALIA	
	FLT-155H	POWER TRANSFORMER	
Ro		RWST 100 OHMS K	100 ohms ±10% 5W WIRE WOUND RESISTOR
Co	FEP-1009H	CMPL (3.1μF + 1.3μF) J 250V	3.1μF + 1.3μF ±5% 250V CAPACITOR
S3	FEP-1010H	SLIDE SWITCH	FOR FREQUENCY (50/60) SELECTOR
	EP-4772	CORD HOLDER	
	PH-24	MAGNETIC HEAD	
	KU-200	SERVO AMP. UNIT	SEE SEPARATE LIST
	PS-117	POWER SUPPLY UNIT	SEE SEPARATE LIST

—— KU-200 SERVO AMP. UNIT——

Ref. No.	Part No.	Part Name	Descriptions	
CAPACITORS				
C1	2544043000	CE04W1HR47	0.47μF 50V	ELECTROLYTIC
C2	2551021002	CQ92M1H473K	0.047μF ±10% 50V	PLASTIC FILM
C3				
C4		CEMW 100μF 16V	100μF 16V	ELECTROLYTIC
C5		CEMW 10μF 25V	10μF 25V	ELECTROLYTIC
C6		CBS 0.01μF(K) 50V	0.01μF ±10% 50V	PLASTIC FILM
C7		CEMW 10μF 25V	10μF 25V	ELECTROLYTIC
C8		CBS 0.1μF(K) 50V	0.1μF ±10% 50V	PLASTIC FILM
C9		CKD 220pF(K) 500V	220pF ±10% 500V	CERAMIC
C10		CKD 220pF(K) 500V	220pF ±10% 500V	CERAMIC
C11	FEP10121	CM92C2A472J	4700pF ±5% 100V	MICA
C12		CEMW 100μF 25V	100μF 25V	ELECTROLYTIC
C13	2561000000	CF93B1H334K	0.33μF ±10% 50V	METALLIZED PLASTIC
C14	2561000000	CF93B1H334K	0.33μF ±10% 50V	METALLIZED PLASTIC
C15	2551021002	CQ92M1H473K	0.047μF ±10% 50V	PLASTIC FILM
C16		CEMW 4.7μF 25V	4.7μF 25V	ELECTROLYTIC
C17		CEMW 1μF 50V	1μF 50V	ELECTROLYTIC
C18		CBS 0.001μF(K) 50V	0.001μF ±10% 50V	PLASTIC FILM
C19		CEMW 10μF 50V	10μF 50V	ELECTROLYTIC
C20		CEMW 220μF 50V	220μF 50V	ELECTROLYTIC
RESISTORS				
R1			MISSING	
R2			MISSING	
R3		RD 1/8 PS 1 K-ohm J	1 Kohm ±5% 1/8W	CARBON FILM
R4		RD 1/8 PS 4.7 K-ohm J	4.7 Kohms ±5% 1/8W	CARBON FILM
R5		RD 1/8 PS 10 K-ohm J	10 Kohms ±5% 1/8W	CARBON FILM
R6		RD 1/8 PS 10 K-ohm J	10 Kohms ±5% 1/8W	CARBON FILM
R7		RD 1/8 PS 10 K-ohm J	10 Kohms ±5% 1/8W	CARBON FILM
R8		RD 1/8 PS 470 ohm J	470 ohms ±5% 1/8W	CARBON FILM
R9		RD 1/8 PS 10 K-ohm J	10 Kohms ±5% 1/8W	CARBON FILM
R10		RD 1/8 PS 10 K-ohm J	10 Kohms ±5% 1/8W	CARBON FILM
R11		RD 1/4 PS 1 K-ohm K	1 Kohms ±10% 1/4W	CARBON FILM
R12		RD 1/8 PS 18 K-ohm J	18 Kohms ±5% 1/8W	CARBON FILM
R13		RD 1/8 PS 18 K-ohm J	18 Kohms ±5% 1/8W	CARBON FILM
R14		RD 1/8 PS 47 K-ohm J	47 Kohms ±5% 1/8W	CARBON FILM
R15	2410193000	RD14B2H222J	2.2 Kohms ±5% 1/2W	CARBON FILM
R16		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W	CARBON FILM
R17	2410193000	RD14B2H222J	2.2 Kohms ±5% 1/2W	CARBON FILM
R18		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W	CARBON FILM
R19		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W	CARBON FILM
R20	2410189001	RD14B2H152J	1.5 Kohms ±5% 1/2W	CARBON FILM
R21		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W	CARBON FILM
R22		RD 1/8 PS 27 K-ohm J	27 Kohms ±5% 1/8W	CARBON FILM
R23		RD 1/8 PS 1 K-ohm J	1 Kohm ±5% 1/8W	CARBON FILM
R24		RD 1/8 PS 39 K-ohm J	39 Kohms ±5% 1/8W	CARBON FILM
R25		RD 1/8 PS 1 K-ohm J	1 Kohm ±5% 1/8W	CARBON FILM
R26		RD 1/8 PS 27 K-ohm J	27 Kohms ±5% 1/8W	CARBON FILM
R27	FEP-1011-2	RN 1/4 PS 15 K-ohm G	15 Kohms ±2% 1/4W	METAL FILM
R28		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W	CARBON FILM
R29	FEP-1011-1	RN 1/4 PS 10 K-ohm G	10 Kohms ±2% 1/4W	METAL FILM
R30		RD 1/8 PS 1.2 K-ohm J	1.2 Kohms ±5% 1/8W	CARBON FILM
R31		RD 1/8 PS 220 ohm J	220 ohms ±5% 1/8W	CARBON FILM
R32		RD 1/8 PS 1 K-ohm J	1 Kohm ±5% 1/8W	CARBON FILM
R33		RD 1/8 PS 220 ohm J	220 ohms ±5% 1/8W	CARBON FILM
R34		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W	CARBON FILM
R35		RD 1/8 PS 2.2 K-ohm J	2.2 Kohms ±5% 1/8W	CARBON FILM
R36	FEP-1011-6	RN 1/4 PS 62 K-ohm G	62 Kohms ±2% 1/4W	METAL FILM
R37	FEP-1011-3	RN 1/4 PS 22 K-ohm G	22 Kohms ±2% 1/4W	METAL FILM
R38		RD 1/8 PS 1 K-ohm J	1 Kohm ±5% 1/8W	CARBON FILM
R39	2440040000	RS14B3A821JNB	820 ohms ±5% 1W	METAL OXIDE FILM
R40	2440070009	RS14B3D4R7JNB	4.7 ohms ±5% 2W	METAL OXIDE FILM
R41		RD 1/4 PS 4.7 K-ohm J	4.7 Kohms ±5% 1/4W	CARBON FILM

Ref. No.	Part No.	Part Name	Descriptions
R42	2410161003	RD14B2H101J	100 ohms ±5% 1/2W CARBON FILM
R43		RD 1/8 PS 12 K-ohm J	12 Kohms ±5% 1/8W CARBON FILM
R44		RD 1/8 PS 12 K-ohm J	12 Kohms ±5% 1/8W CARBON FILM
R45		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W CARBON FILM
R46		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W CARBON FILM
R47		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W CARBON FILM
R48	2410161003	RD14B2H101J	100 ohms ±5% 1/2W CARBON FILM
R49		RD 1/4 PS 4.7 K-ohm J	4.7 Kohms ±5% 1/4W CARBON FILM
R50		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W CARBON FILM
R51		RD 1/8 PS 10 K-ohm J	10 Kohms ±5% 1/8W CARBON FILM
R52		RD 1/8 PS 8.2 K-ohm J	8.2 Kohms ±5% 1/8W CARBON FILM
R53		RD 1/8 PS 5.6 K-ohm J	5.6 Kohms ±5% 1/8W CARBON FILM
R54		RD 1/8 PS 10 K-ohm J	10 Kohms ±5% 1/8W CARBON FILM
R55		RD 1/8 PS 2.2 K-ohm J	2.2 Kohms ±5% 1/8W CARBON FILM
R56			
R57		RD 1/8 PS 22 K-ohm J	22 Kohms ±5% 1/8W CARBON FILM
R58		RD 1/8 PS 150 K-ohm J	150 Kohms ±5% 1/8W CARBON FILM
VR1	FEP-10824	K07QB103	B-10 Kohms METAL COMPOSITION V.R.
VR2	FEP-10825	K07QB203	B-20 Kos METAL COMPOSITION V.R.
SEMICONDUCTORS			
D1, 2, 3		1S1588 DIODE	
D4, 5		1S1588 DIODE	
D6, 8	2760151006	1D2C1 RECTIFIER	
D7, 9	2760152005	1D2Z1 RECTIFIER	
D10, 11		1S1588 DIODE	
D12		HZ-12A ZENNER DIODE	
Q1		2SA562 (Y) TRANSISTOR	
Q2, 3		2SC458 (D) TRANSISTOR	E
Q4	~~2730046015~~	2SC1222 (F) TRANSISTOR	
Q5		2SC458 (D) TRANSISTOR	
Q6, 7	~~2730046015~~	2SC1222 (E) TRANSISTOR	FEP-1221
Q8, 9, 10		2SA562 (Y) TRANSISTOR	
Q11		2SC1213 (D) TRANSISTOR	
Q12		2SD259 TRANSISTOR	
Q13, 14		2SC458 (D) TRANSISTOR	
Q15		2SC1213 (D) TRANSISTOR	
Q16		2SC458 (D) TRANSISTOR	
Q17		2SC373 TRANSISTOR	
Q18	FEP-1096-1	2SD256 (R) TRANSISTOR	
	FEP-1190	TA-7061AP	INTEGRATED CIRCUIT
OTHERS			
	CH-274HJ	CHOKE COIL	
	FEP-1081-2	TRANSISTOR SOCKET	TR. SOCKET FOR Q12 AND Q18

PS-117 POWER SUPPLY UNIT

Ref. No.	Part No.	Part Name	Descriptions
C100	EP-7376H6	CF93B2EAC 104M	0.1μF ±20% 250VAC METALLIZED PLASTIC FILM CAPACITOR
R100	2440167006	RS14B3F153JNB	15 Kohms ±5% 3W METAL OXIDE FILM RESISTOR
R101	2410292008	RD14B2E121J	120 ohms ±5% 1/4W CARBON FILM RESISTOR
FUSE	EP-7266	FUSE 0.5A 250V	
RL	FEP-119B	RELAY	

MODEL DP-3500F PARTS LIST

Ref. No.	Part No.	Part Name	Descriptions
	DP-3000	TURNTABLE SYSTEM	SEE SEPARATE LIST
	FCT-302	CABINET ASS'Y	
	FCT-276J	DUST COVER ASS'Y	
	FE-2050H	CORD CLAMPER	FOR AC CORD

MODEL DP-3700F PARTS LIST

Ref. No.	Part No.	Part Name	Descriptions
	DP-3000	TURNTABLE SYSTEM	SEE SEPARATE LIST
	FCT-296H	CABINET ASS'Y	
	FCT-276J	DUST COVER ASS'Y	
	EPU-300	TONE ARM UNIT	
	AL-1	ARM LIFTER ASS'Y	INCLUDING FOLLOWING PARTS FPU-385 ARM LIFTER FMD-408 LIFTER BASE EPU-387 LIFTER BASE UNIT 2 x 10 FFS MOUNTING SCREW
	PCL-3	HEAD SHELL ASS'Y	
	FPU-407	ARM STAND ASS'Y	ARM REST BASE WITH SCREW
	FMD-469H	STAND SHEET	
	FMD-470H	RUBBER WASHER	
	FPU-368J	ARM REST ASS'Y	
	FMD-379	OUTPUT CORD	PHONO OUTPUT CORD WITH PLUG