DENON Hi-Fi Component/Turntable

TECHNICAL BULLETIN

VOL. A2-53
NO. 003

TECHNICAL SERVICE MANUAL FOR
TURNTABLE MODELS
DP-6000 / DP-6700

NIPPON COLUMBIA CO., LTD.
NO.14-14, 4CHOME AKASAKA, MINATOKU, TOKYO, 107, JAPAN

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78. 3

DP-6000 is a direct drive record player equipped with quartz crystal control system. DP-6700 is a complete record player system consisting of the DP-6000 phono motor and a universal tonearm mounted on a special cabinet.

Theory of operation is explained in this manual.

DP-6000 has a time base oscillation of 33.75KHz by quartz crystal.
The frequency is divided to 187.5Hz through a divided-by-180 counter for 45rpm, and the counter is switched to a divided-by-243 counter to divide the frequency to 183.8Hz for 33-1/3rpm. These frequencies are the same as those obtained by detection of the pulse signal recorded on the platter and it is transferred to sampling hold circuit. On the other hand, the frequency signal is passed to the strobo lighting circuit through the binary counter.

BINARY AND TRINARY COUNTERS

Binary and trinary counters are switched by the voltage applied to the pin 6 of M53273P. Diagram2 shows internal equivalent circuit of M53273P. The voltage to the pin 6 is applied by 33/45 memory circuit, it turns to L level for 45rpm and to H level for 33rpm.

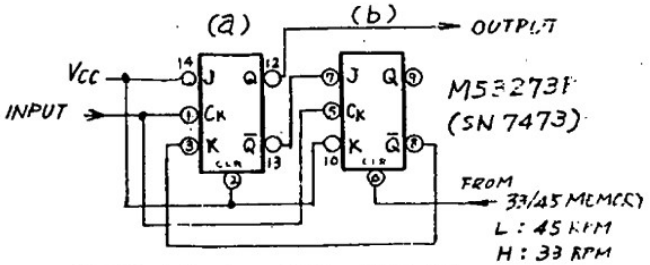


DIAGRAM 2 BINARY & TRINARY COUNTERS

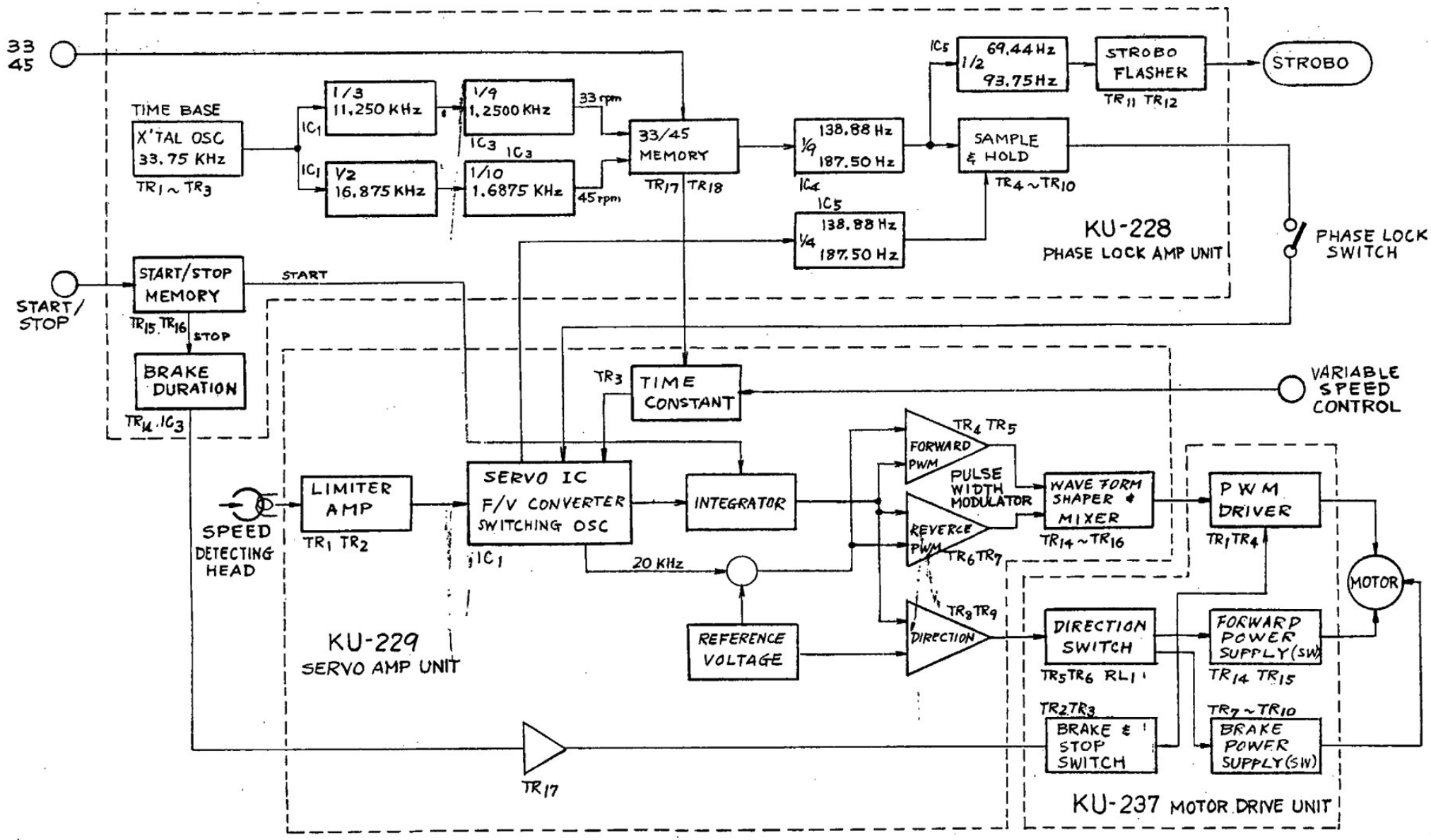
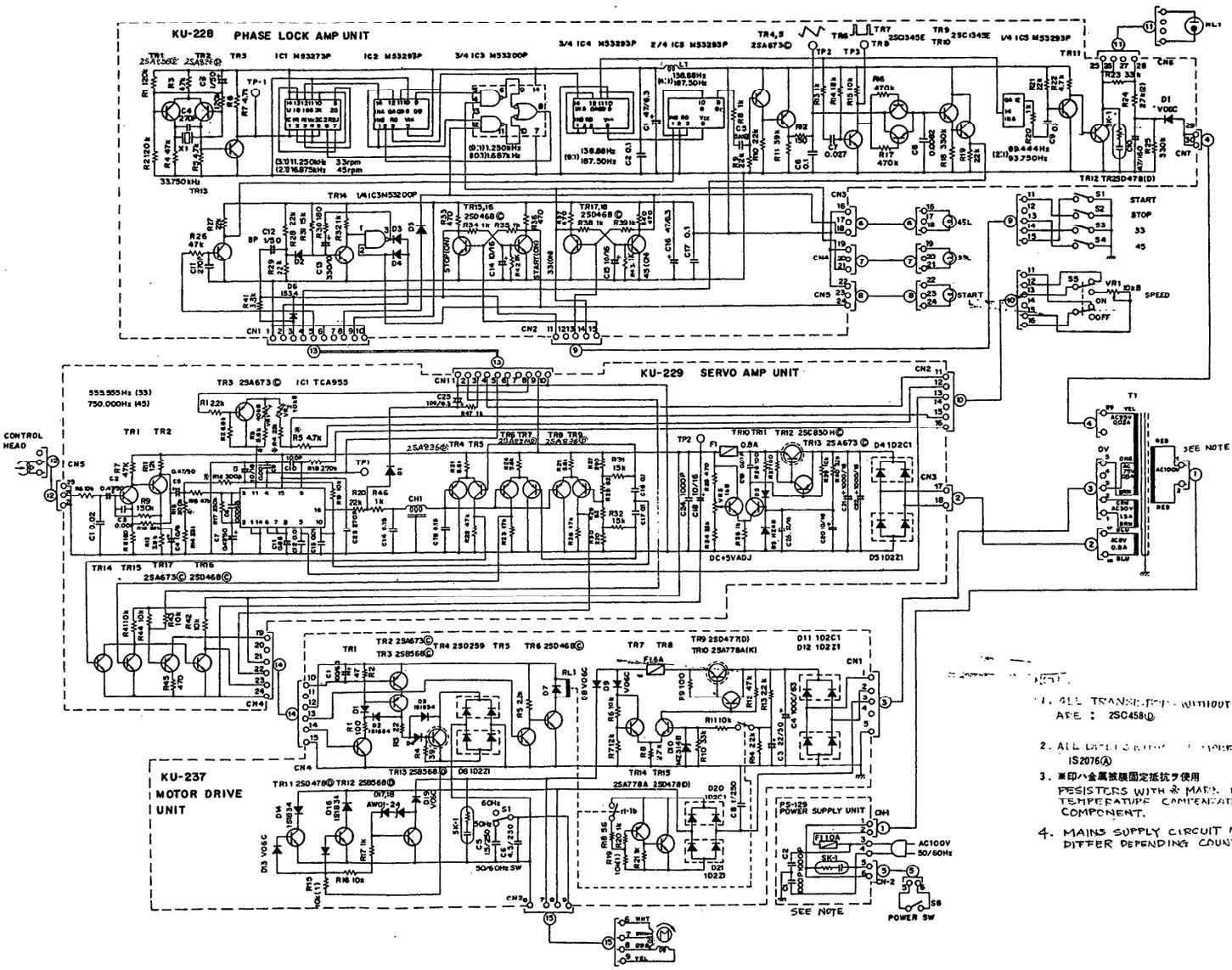


DIAGRAM 1 BLOCK DIAGRAM OF DP-6000/DP-6700

DP-6000 CIRCUIT DIAGRAM



1. ALL TRANSISTORS WITHOUT REMARKS ARE : 2SC458(D)
2. ALL DIODES WITHOUT REMARKS ARE : IS2076(A)
3. ※印ハ金属被膜固定抵抗ヲ使用
   RESISTORS WITH ※ MARK IS TEMPERATURE COMPENSATING COMPONENT.
4. MAINS SUPPLY CIRCUIT MAY DIFFER DEPENDING COUNTRIES.

Pin 6 becomes L level by the command from 33/45 memory circuit for 45rpm so that pin 8 turns to H level. Therefore J&K. terminals of filp-flop become H level so the flip-flop operates as binary counter. Pin 6 becomes H level for 33rpm so the flip-flop (b) operates.
Under this condition it operates as a divided-by-three counter.

The switching of either devided by 10 or by 9 is performed by the three NAND circuits contained in M53293P and M53200P.

The dotted part of diagram 3 consists of NAND circuit (3/4IC M53200P),it applies the output of either QA or QB to pin 2 by the instructions from 33/45 memory circuit.

It operates as devided by 9 counter when output QA is applied at pin 2 and it operates as decimal counter when output QB is applied.

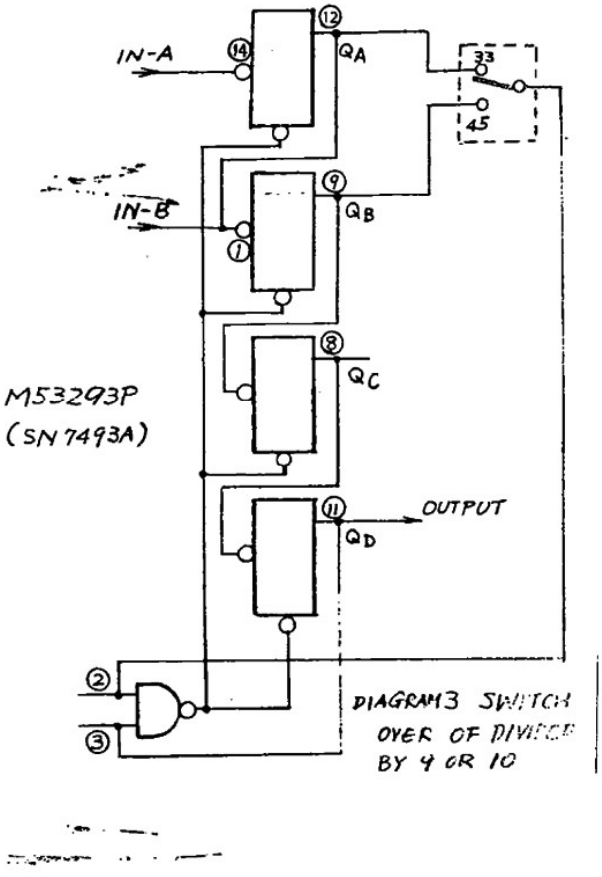


DIAGRAM 3 SWITCH OVER OF DIVIDE BY 9 OR 10

Pins 2 and 3 are reset terminals, the IC is reset when both these 2 terminals become H level.
M53293P is used as a devided-by-4 counter, the signal is introduced to IN-B, and QC is used as output. The reset terminal is connected to ground so that it operates as the devided-by-4 counter.
The output QC is supplied to IN-A and taken out from QA, therefore, the frequencies are 93.75Hz for 45rpm and 69.44Hz for 33rpm. So that these are used for lighting strobo.

STOP CONTROL CIRCUIT

Diagrm 4 shows the STOP control circuit. It operates electric brake when STOP button is operated in PLAY status.

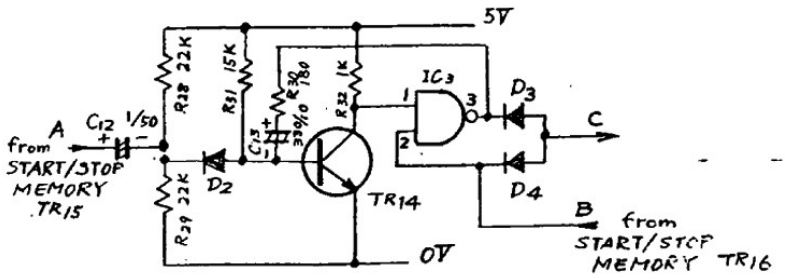


Diagram 4: STOP control circuit

It has function to give the brake operation time.
Point A is L level when STOP and is H level when the turntable is being operated. Point B is H level when STOP and L level when the turntable is being operated.
Brake operation time is determined by a mono-stable multi-vibrator consisting of Tr4 and IC3.
Point B becomes H level when STOP and turns to L level when the turntable is being operated. START/STOP memory circuit TR15 is OFF when the turntable is operated, so that C12 is charged at the polarity as shown in the diagram.

Point A is grounded by TR15 when STOP button is operated while the turntable is turning, so that TR14 base turns to negative and it turns OFF. Therefore point B becoms L leve. As the time goes, C12 is discharged to turn ON TR14 and point B turns to H level. The brake operation time means a period during which point B turns to H level after STOP button is operated, the time is set for 3-4 seconds.
The circuit sets only the brake time, in practical, signal at point B is relayed to brake power supply circuit and the brake is operated.

Forward and reverse PWM modulation circuit and servo direction switch circuit.

Diagram 6

The comparator composed of TR4 and TR5 is PWM modulation circuit which provides positive revolution, TR6 and TR7 provide PWM modulation circuit which generated negative revolution(brake). Comparator circuit composed of TR8 and TR9 is servo direction switching circuit to actuate RL1 through TR5 and TR6 on KU-237 by the output of TR9.

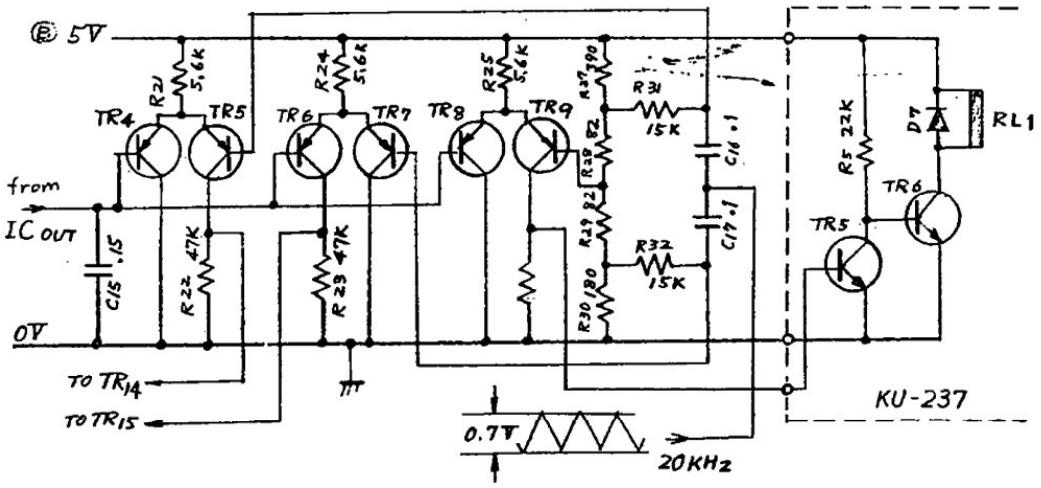


DIAGRAM 6 DIRECTION SWITCH & PULSE WIDTH MODULATOR

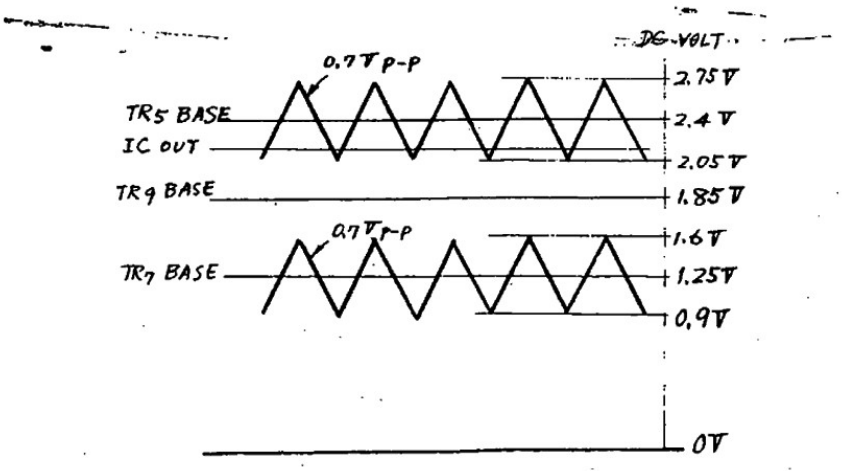


DIAGRAM 7 VOLTAGE DISTRIBUTION

Voltage distribution for each comparator is as per diagram 7. Servo IC output(TCA955) decreases as the revolution increases, so that high output voltage from IC comes out at the instance START switch is operated to actuate comparator TR5 to turn ON.

(Switching of TR5 is modulated by 20KHz triangle wave and its operation rage is between 2.75 and 2.05 V of IC-output. But if it deviates out of the operational range, the comparator will be in status either ON or OFF). As the revolution increases, TR5 performs PWM modulation with 20KHz carrier. IC output and each comparator voltage at nominal speed are as shown in diagram 7 and gives slight positive direction torque. The necessity of provision of slight positive torque is to compensate the losses caused by pivot resistance and friction of the stylus at the standard revolution. As the revolution increases, IC output decreases to 1.85V then the servo direction switch TR9 turns OFF. So that TR6 turns ON and TR5 of the motor drive unit KU-237 turns OFF to turn on RL1. Comparator TR5 and TR6 of PWM modulation circuit turn OFF when the above process is achieved (at IC output of 2.05 - 1.6V).

Diagram 8 shows the block diagram for motor drive unit. Servo direction switching circuit TR9 is ON during the period after START switch is ON until the standard revolution is obtained, therefore, TR5 of the motor drive unit is ON, TR6 is OFF so that RL1 is open.

Diagram 8 shows the circuit when RL1 is open, S1 is ON

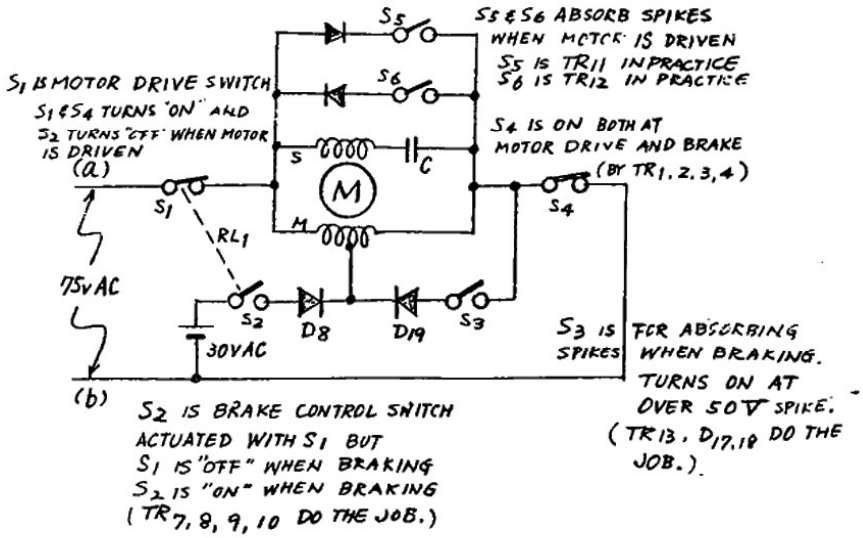


DIAGRAM 8

and S2 is OFF. TR5 in PWM modulation circuit for forward revolution is at status ON until standard revolution is obtained after START switch is ON, and alternative ON and OFF at standard revolution. It equals to S4 in the diagram 8 .

Therefore, motor current flows(a) $\longrightarrow$ S1 $\longrightarrow$ M $\longrightarrow$ S4(b).

PWM modulation circuit TR5 turns OFF when the motor revolution exceeds standard revolution(S4 OFF in diagram 10) and break the motor current. Though the motor current is a sine wave drawn from AC supply, the voltage applied is a sampled pulse wave with the carrier whose frequency is 20KHz for PWM modulation. Therefore, spikes take place during OFF period by inductance of the motor.

S5 and S6 shown in diagram 8 are used for absorbing the spike.

Electrical brake

There were some considerable duration for DP-3000 and DP-5000 to reach the standard revolution when switched to 33rpm from 45rpm. However DP-6000 takes shorter duration of time to reach the standard revolution with an aid of electric brake.

The electric brake is energized by a DC current flowing in the motor coil. Therefore, spike takes place when the electric brake is turned OFF. S3 shown in diagram 8 is for absorbing the spike along with D17, D18 and TR13 electronically, in practice.

Brief explanation on the action when the speed is switched to 33rpm from 45rpm, the servo system understands the speed is "exceeding" then negative revolution PWM modulation TR6 turns ON. Then the servo direction switching circuit TR9 turns OFF so that the relay RL1 (in KU-237) is energized. According to the block diagram of motor drive unit in the diagram 10, S1 turns OFF and S2 turns ON when RL1 is energized. S4 is in ON position since TR6 is ON, the current from DC power source (30V) flows S2 $\longrightarrow$ M $\longrightarrow$ S4. Therefore, brake torque is applied on the motor to decrease the speed to settle in the standard speed.

When the revolution comes near to the standard speed, (IC output voltage is increased to the base voltage of TR7) TR6 operates the PWM modulation with 20KHz carrier, then the modulation level decreases as the revolution gets

close to the standard speed. Therefore, the brake power decreases and is released since TR6 turns OFF when the IC output increases to 1.6V.

Then the revolution is almost at the standard speed, the servo direction switch TR9 turns ON so that the relay RL1 turns to brake circuit. Therefore, S1 in the diagram 8 turns ON and S2 turns OFF. After that the revolution is at the standard speed, so that the positive direction modulator TR5 operates switching to maintain the standard revolution.

In the STOP status, START/STOP memory circuit signal turns OFF TR2 in the motor drive unit so that S4 in the diagram 8 turns OFF to cut the current for the motor.

MIXING CIRCUIT

Mixing circuit consisting of TR14, TR15 and TR16 is to operate the switching circuit in the motor drive unit and at the sametime, it reshapes the output wave form from the PWM modulation circuit.

TR17 is necessary for switching TR2 in the motor drive unit. TR17 base voltage becomes L level only when the revolution and brake statuses, it maintains H level when stand-by.

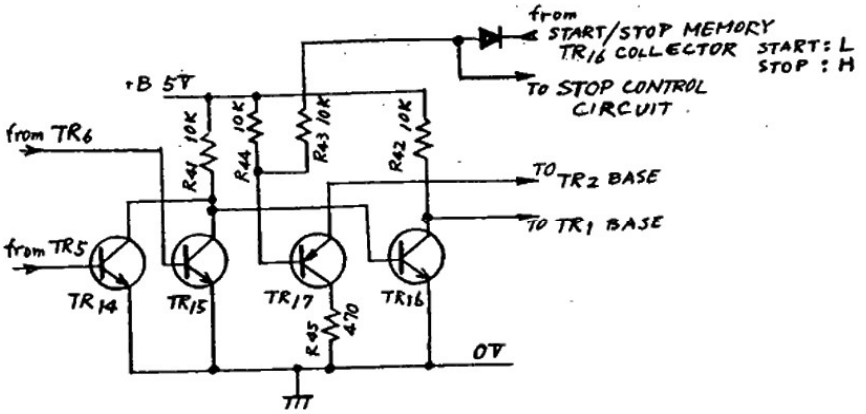


DIAGRAM 9 MIXING CIRCUIT

Diagram 8 shows the block diagram of the motor drive unit. S1 and S2 shown in the diagram is operated by RL1, S2 operates OFF when S1 is ON. Relay RL1 is released when TR9 turns ON. S1 turns ON and S2 turns OFF when the relay is released. Therefore, S1 turns ON when the revolution is at the standard speed, the motor revolves normally since S4 continues switching at 20KHz cycle to flow the current S1 ⟶ M ⟶ S4. S5 and S6 shown in the diagram are to absorb the spike at motor operation, S3 absorbs the spike that takes place when the motor is braked.

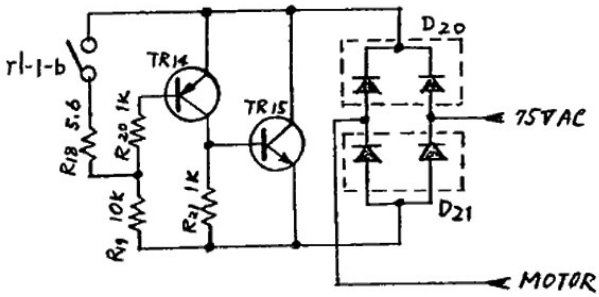


DIAGRAM 10 S1 ON ACTUAL APPLICATION

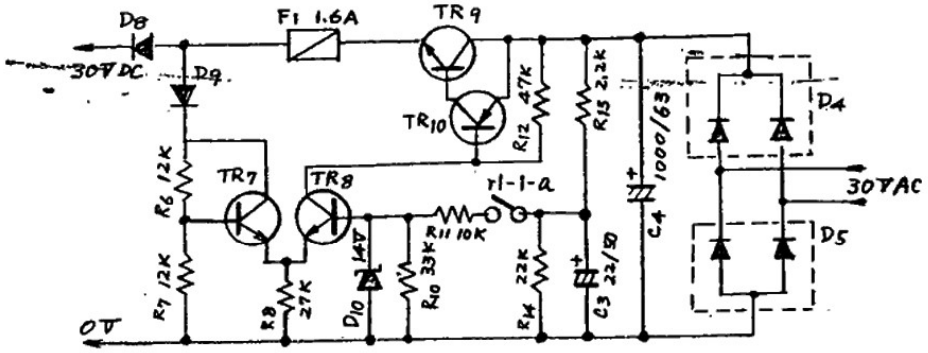


DIAGRAM 11 S2 ON ACTUAL APPLICATION

The actual circuits of S1 and S2 are as shown in diagrams 10 and 11. TR15 turns ON as well as TR14 when rl-1-b is

OFF (RL1 is released). Therefore S1 can be considered to be ON since the motor current flows through TR15. While TR14 turns OFF when rl-1-b turns ON since the divided voltage by R18(5.6ohms) and R19 (10K)does not reach V_{be} which is required for turning TR14 ON.

Diagram 14 shows 30V power source and S2 in actual schematic diagram, 30V power source is not generated since no voltage is applied to TR8 base when rl-1-a is OFF. S2 is considered ON when the voltage regulator operates as rl-1-a turns ON.

Diagram 12 shows the actual circuit of S4, the motor current flows when TR4 turns ON (S1 ON), TR2 and TR3 should turn on together to turn TR4 ON.

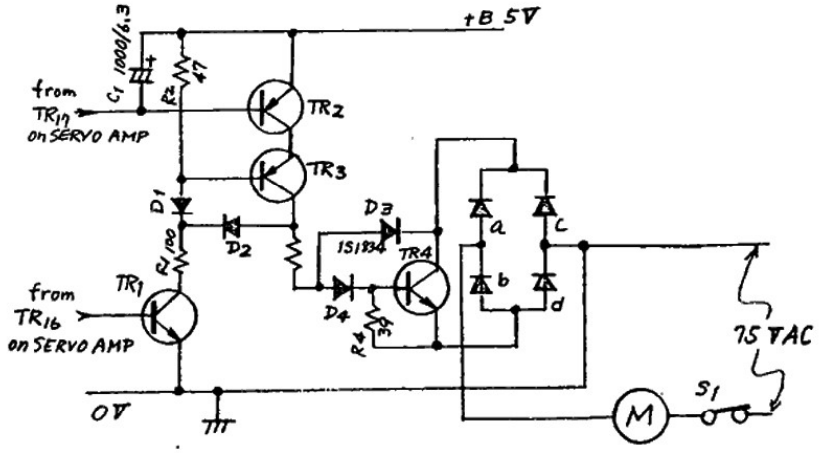


DIAGRAM 12 S4 ON ACTUAL APPLICATION

TR2 operates ON and OFF by the instructions from START/STOP memory and STOP control circuit. Therefore, TR2 turns ON when the START button is depressed and also when STOP control unit is operated by STOP button. Therefore, TR2 is ON whenever the platter is rotating. TR3 turns ON when TR1 is ON. TR1 operates switching by instruction

from PWM modulation unit. Thus, to bring TR4 ON in diagram 12, TR4 or TR6 in the PWM modulation unit should be of base voltage of more than 2.05V or less than 1.6V respectively.

When the output voltage of servo IC is in a range of 1.6V to 2.05V, motor drive current and control current do not flow since the TR1 is OFF.

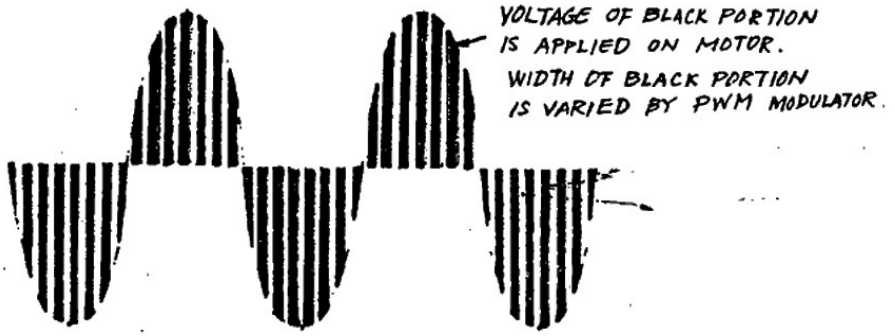


DIAGRAM 13 VOLTAGE FORM APPLIED ON MOTOR

Diagram 13 shows the voltage for motor drive, AC supply current is sampled by PWM modulated signal at 20KHz. The motor current becomes clean sine wave since the sampled current is integrated and smoothed by motor inductance. However, spikes take place since the voltage applied to the motor is a pulse train at 20KHz. S5 and S6 are therefore necessary to absorb the spikes and also S3 unit is for absorbing the spikes which take place when the brake voltage is cut off.

Voltage is applied only the period of the black portion. The width varies according to the instruction from the PWM modulation unit.

Diagram 14 shows the circuit to absorb the spikes that take place when the motor driving current is cut off.

TR11 and TR12 are for absorbing the spikes when the motor drive current is cut, TR11 equals to S5 shown in diagram 8 , TR12 equals to S6, TR13 is for absorbing the spikes that take place when the brake current is cut, this TR13 equals to S3 in diagram 8 .

Diagram 15 shows the principle of spike absorbing. As it has been explained, the AC supply current is added to the motor. The voltage at point (a) in diagram 14 alters at the cycle of the mains supply. Thus spikes either

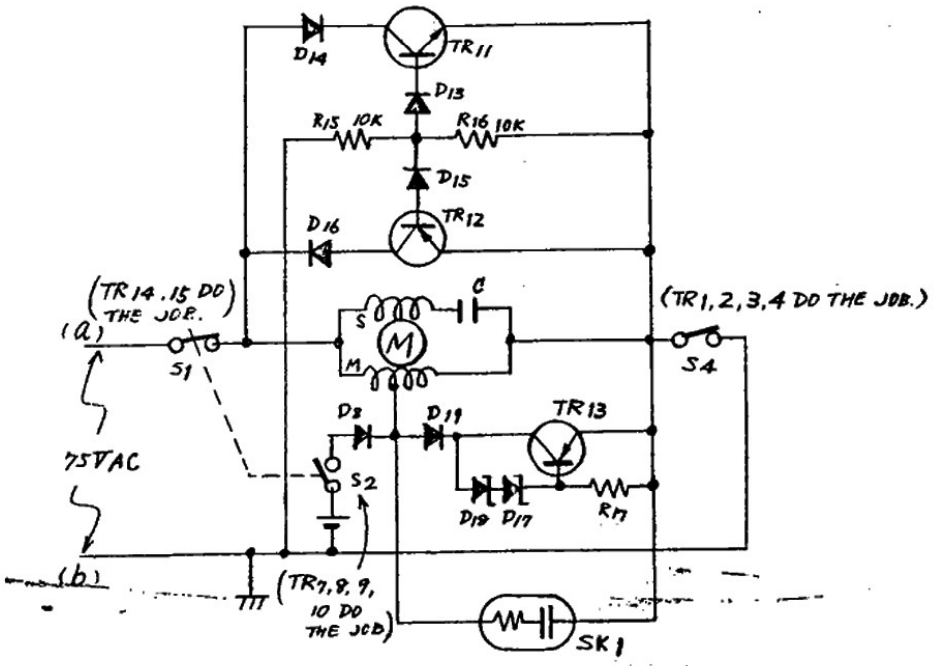


DIAGRAM 14 SPIKE SNUBBERS

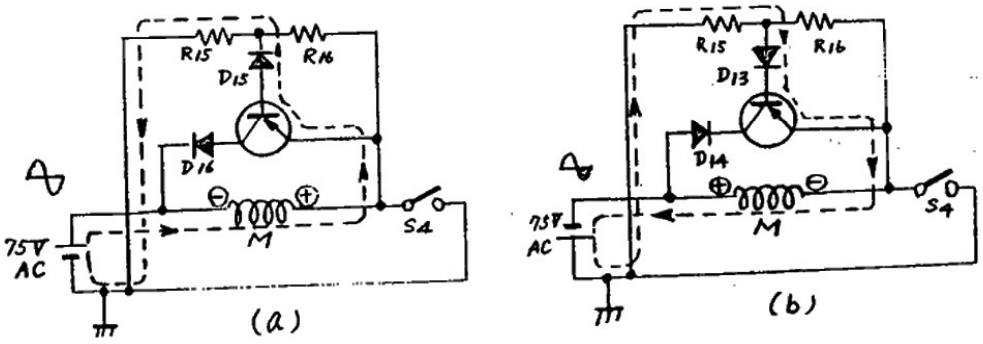


DIAGRAM 15 SPIKE SNUBBERS ON MOTOR CIRCUIT

when the current is negative or positive (diagram 15 (a) (b) must be absorbed. During motor-driving period, S1 is ON, and it is omitted in diagram 15.)

In explaining the operation when point(a) is in positive current, if S4 is in a state of ON, the motor current from AC supply current is ON.

When motor is in the normal rotation, S1 continues to be ON, and S4 is operating the switching at the cycle of 20KHz thus spikes are generated at the motor-coil on the moment of $OFF^{of}_{\wedge}$S4 as shown in diagram 15 (a). This spike added with the supply current flows as a base-current of TR12 as shown in the dotted line, and TR12 becomes in a state of ON. Thus the spikes are short circuited through TR12 D16, and the objective can be acheived. Also, when S4 is ON, the potential of the base-emittor of TR12 is earthed, thus TR12 is in OFF.

When point(a) is in negative current, the base current flows as illustrated in diagram 15 (b), achieving the objective.

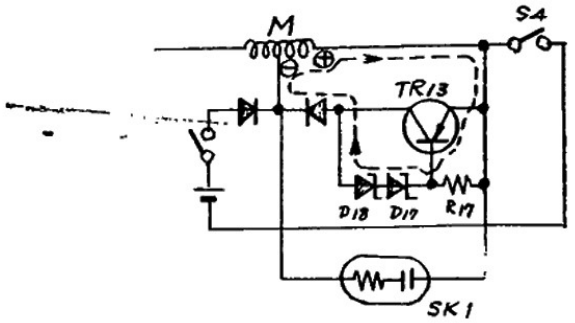


DIAGRAM 16 SPIKE SNUBBER ON BRAKE CIRCUIT

Diagram 16 is a circuit for absorbing the spike in the event of braking current is off.

In the equivalent circuit of diagram 16, the brake current flows in the route, S2 ⟶ D8 ⟶ Coil ⟶ S4 at the

brake-operating period.

Thus at the time of breaking the DC current (Moment of OFF of S4), the spike is generated at motor coil with the polarity shown in the diagram. This spike becomes the base-Current of TR13 through TR13 ⟶ D17 ⟶ D18 ⟶ D19, whereas, Zener voltage of D17 and D18 is about 25V each, thus the TR13 is ON when the amplitude of the spike is about more than 50V, and TR13 becomes ON, and the spike is limited.

The operation with spike voltage over 50V is intended for preventing the mis-operation of TR13 by normal motor voltage.

ADJUSTMENT

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1. HEAD SPACING

Correct spacing between the detecting head and the magnetic coating on the inside circumference of platter is between 0.2mm and 0.25mm.

2. TIME BASE CRYSTAL OSCILLATOR FREQUENCY (KU-228 PHASE LOCK AMP. UNIT)

The high precision of the DP-6000 is derived from the highly accurate and stable crystal oscillation. The oscillation frequency is very accurate with an error of less than 0.002% (1/50,000). This frequency is highly stable against changes of temprature and humidity. No readjustment is needed.

3. PLATTER SPEED (KU-229 SERVO AMP UNIT)

Adjust speed of 45rpm and then 33-1/3rpm.

3-1. Select speed of 45rpm with the phase lock switch at locked NORMAL condition. Adjust VR2 so that the strobo scope becomes still. (Check at the same time with an oscilloscope at T2 and T3. Apply signal at T2 to horizontal deflection input of the oscilloscope and signal at T3 to vertical deflection input. Adjust VR2 again so that the vertical deflection rises at around center of horizontal deflection.)

3-2. Keeping the same speed (45rpm) selection, push out the phase lock switch to unlocked VARIABLE

position and adjust the SPEED control knob at operation surface to have a still strobo pattern.

3-3. Change speed selector to 33 and without touching other controls at surface, adjust VR1 to have a still strobo pattern.

Manually variable range by the SPEED control knob is more than ±6% of nominal speeds at both 33rpm and 45rpm. Preset adjustable ranges by VR1 and VR2 are approx. ±20% of nominal speeds.

4. REGULATED SUPPLY VOLTAGE
(KU-229 SERVO AMP. UNIT)

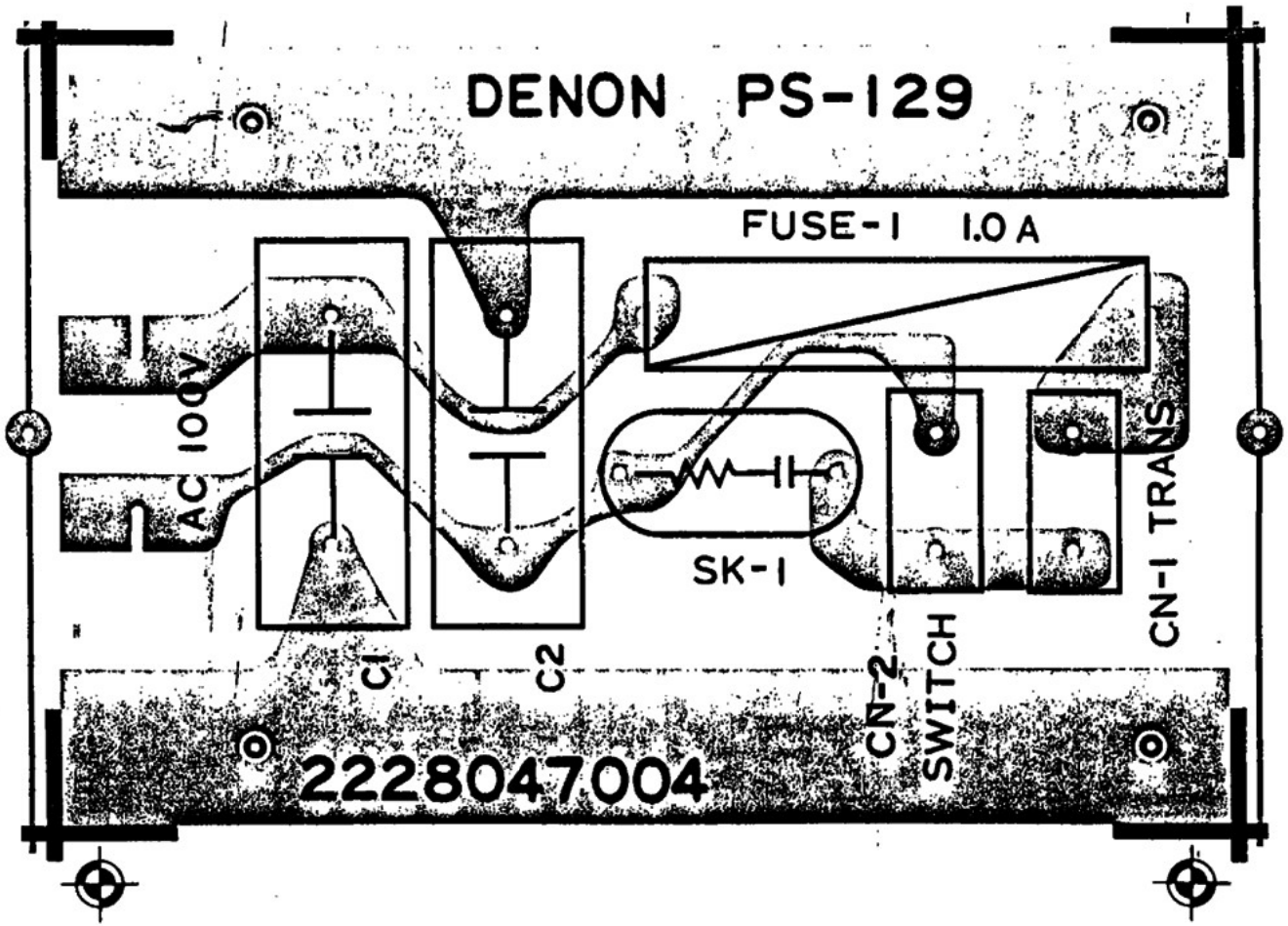
Precisely adjust the DC supply voltage since the control circuit involves TTL ICs and analog servo IC.

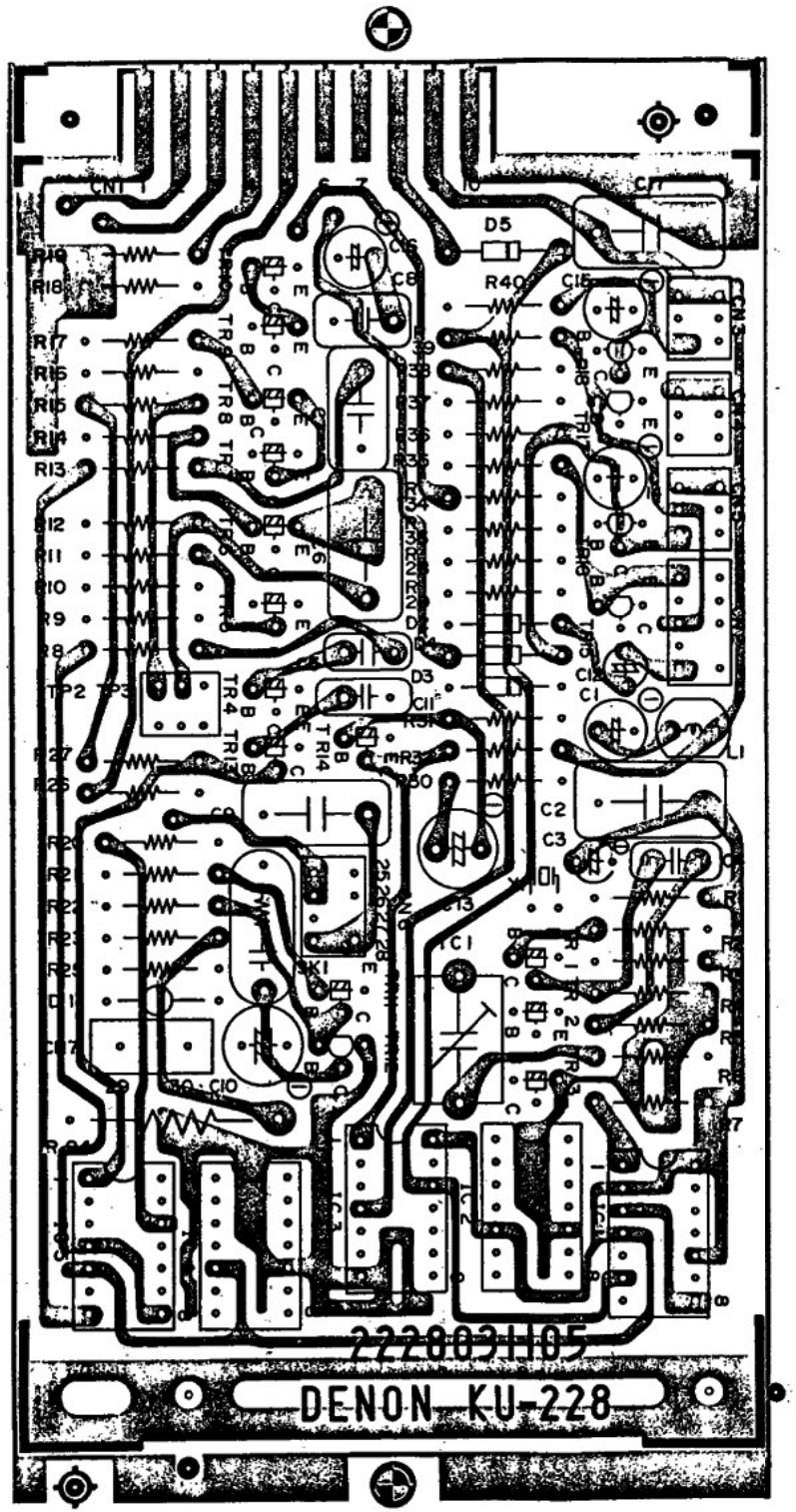
4-1. Connect a DC volt meter to TP2 and to earth ground (or frame). Adjust VR3 to have voltage reading between 5V to 5.2V on the meter.

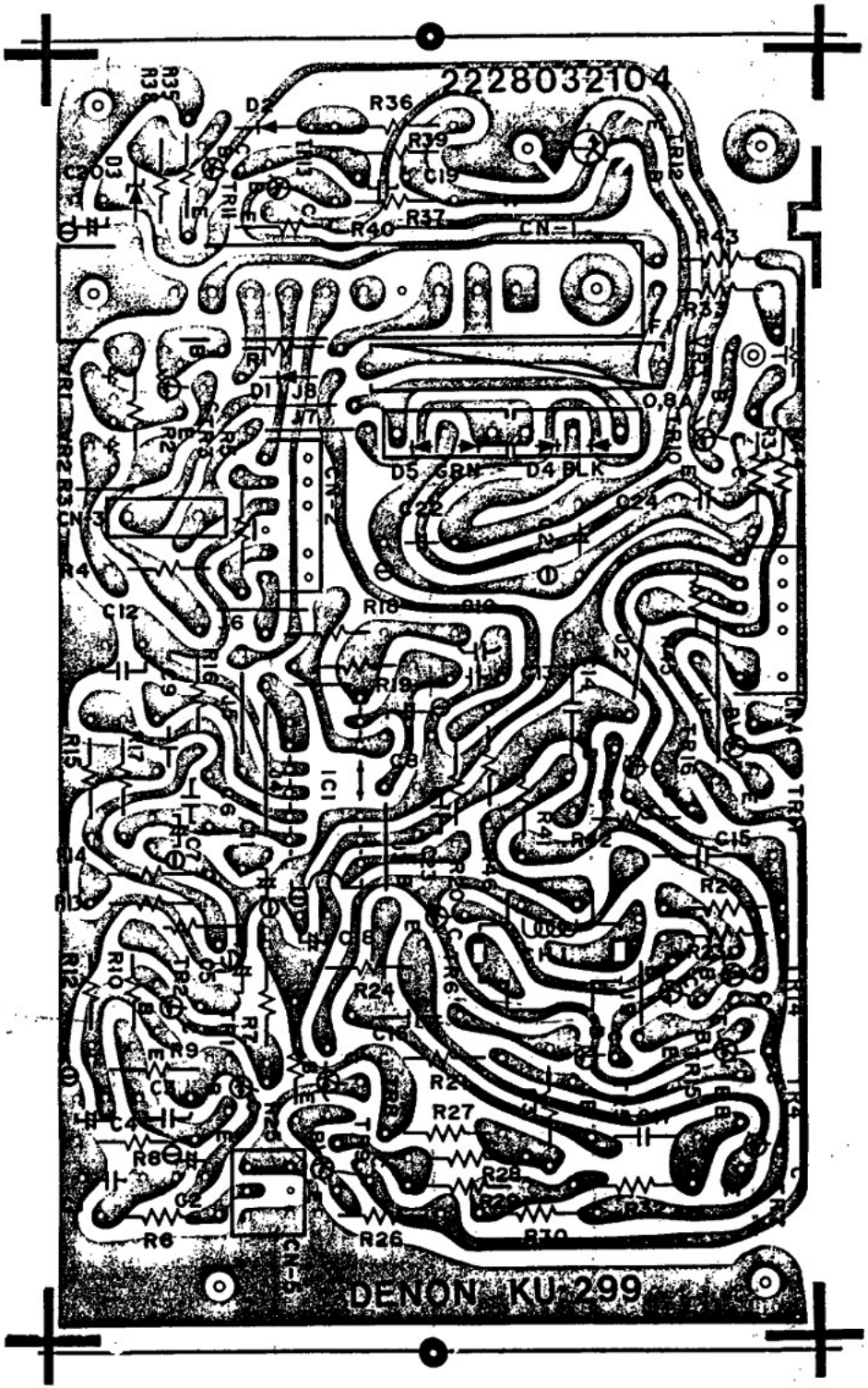
The adjustable range by VR3 is approx. ±1V of 5V.

5. MAINS FREQUENCY

Optimum capacitance of the motor capacitor should be selected by SI under platter for different mains frequencies.


DENON PS-129
FUSE-1 1.0A
AC 100V
SK-1
CN-1 TRANS
C1
C2
CN-2
SWITCH
2228047004


222803110S
DENON KU-228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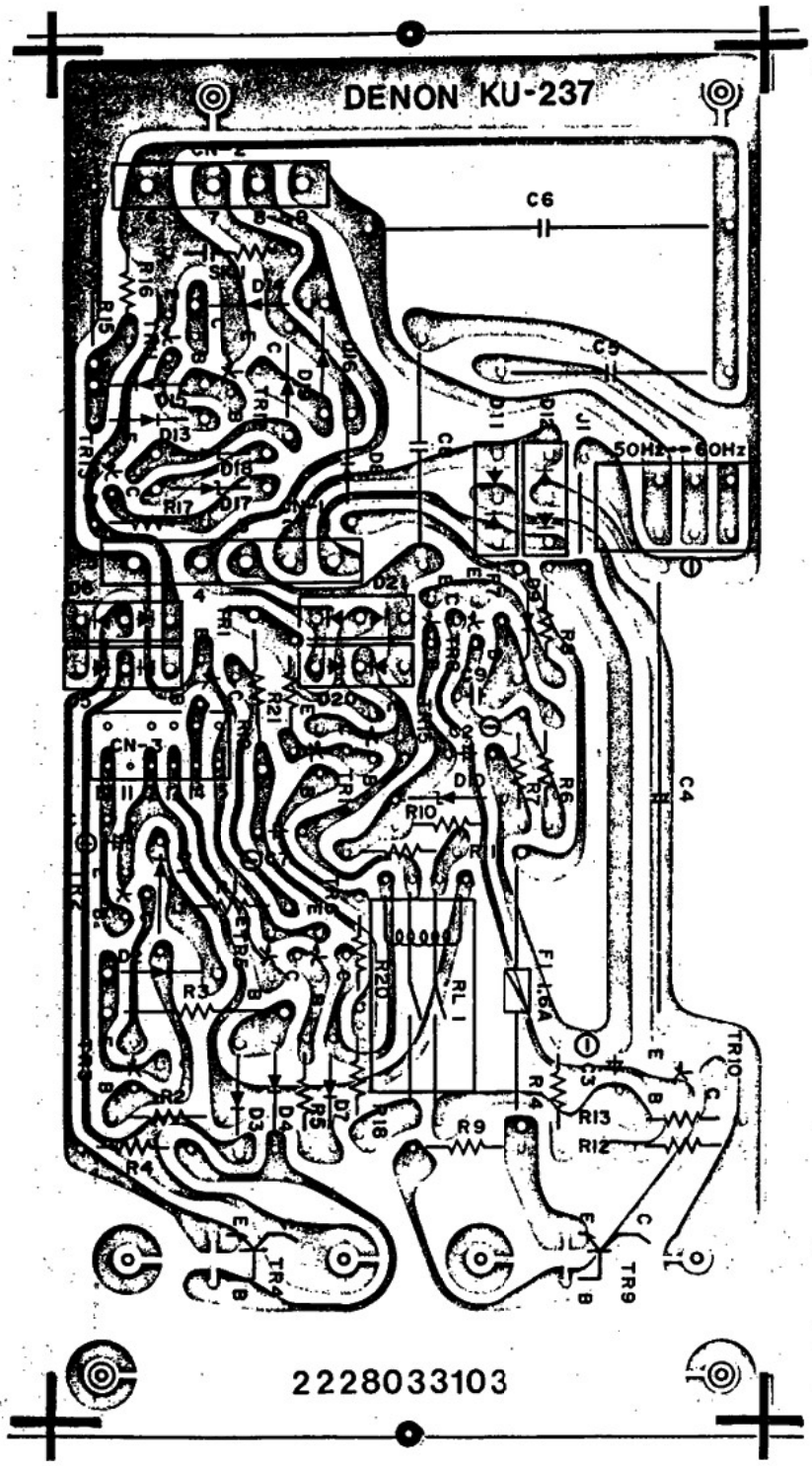
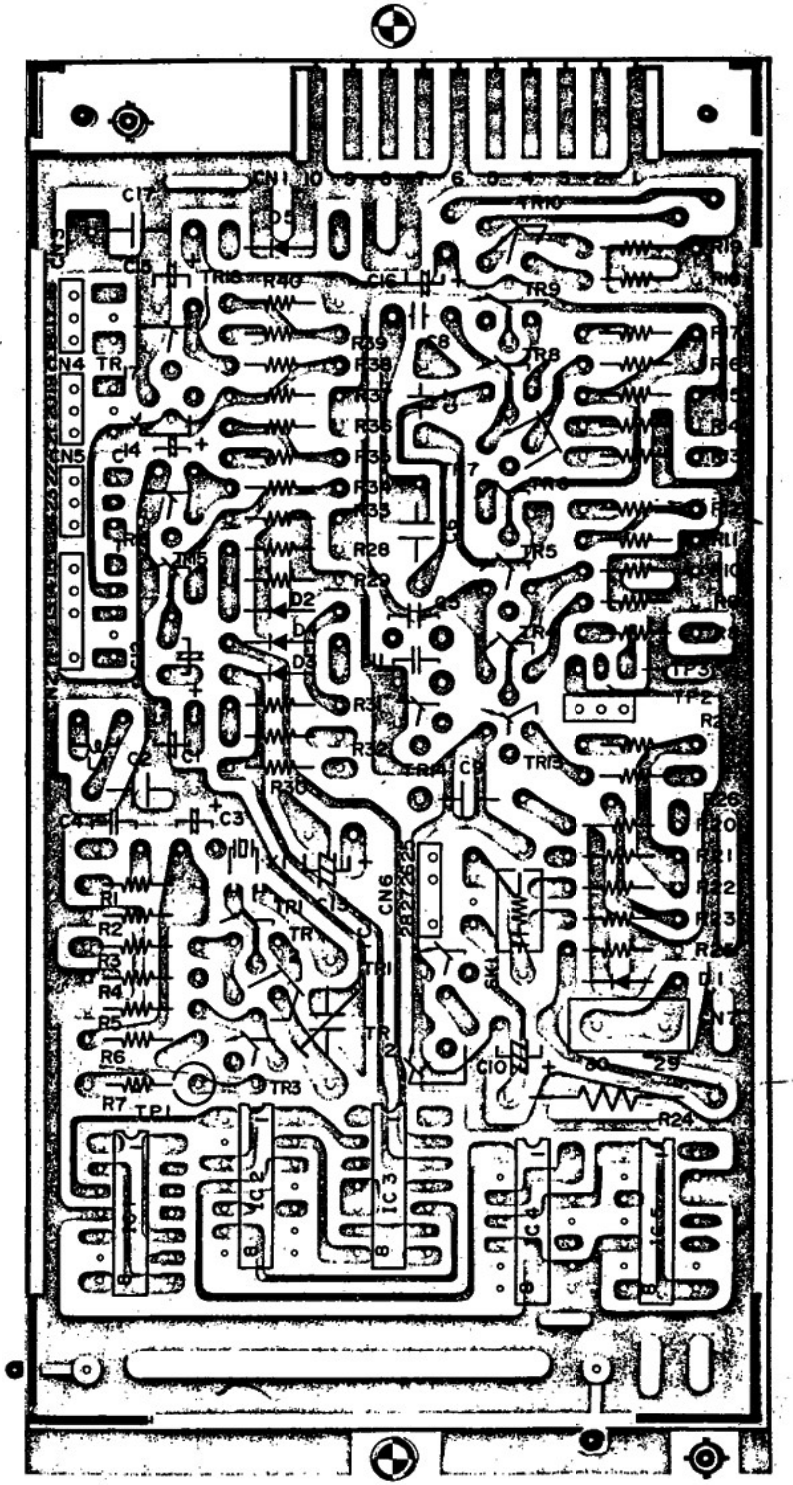

DENON KU-237
50Hz 60Hz
2228033103



PARTS LIST FOR MODEL DP-6700

Part No.	Part Name
1018042101	CABINET ASS
FCT0276K	DUST COVER ASS
1048002506	INSULATOR LEG ASS
FPU-700	TONE ARM UNIT (DA-307)
FPU-491M	HOUSING ASS (LIFTER / ANTI-SKATE)
FPU-484H	HEAD SHELL ASS
FEP-1272J	OUTPUT CORD
4438061109	45 ADAPTER ASS
4218023309	INSULATE MAT

(DP-6000 PHONO MOTOR UNIT)

Ref.No.		
1	KU-228**	PHASE LOCK AMP UNIT
2	KU-229**	SERVO AMP UNIT
3	KU-237**	MOTOR DRIVE AMP UNIT
4	PS-129**	POWER SUPPLY UNIT

** SEPARATE LIST

	4218025006	RECORDED TURNTABLE
5	4468007007	MOTOR BOARD ASS
	1438001007	ACRYL PLATE (STROBO WINDOW)
	4148007204	WINDOW SHEET
6	2178007108	MOTOR ASS
7	4618028001	PAD (MOTOR BOTTOM)
	4338042008	FRICTION ROLLER
	4638056008	ROLLER SPRING
	1468023000	ROLLER COVER
8	2339007002	POWER TRANSFORMER
	4438057100	SPACER (X'FORMER FIXING)
	1298005007	CUSHION RUBBER (same)
9	4498008306	BOARD COVER
10	4498003408	SWITCH COVER
	PH-0024	MAGNETIC HEAD

(MIRROR CASE GROUP)

Ref. No.		
11	1468024106	MIRROR CASE ASS
12	3933005014	NEON LAMP ASS
13	FMD0439	STROBO CAP
14	1468026104	SHUTTER
	1468029004	COVER

(SWITCH GROUP)

15	4418046209	SWITCH PLATE ASS
16	FEP1199	LEAF SWITCH
17	3930030008	PILOT LAMP
18	FMD0070	RUBBER BUSH (LAMP SUPPORT)
19	4338040000	BUTTON ASS (Z) (START)
20	4338030010	BUTTON ASS (X) (STOP)
21	4338033208	BUTTON ASS (Y) (33)
22	4338033211	BUTTON ASS (Y) (45)
23	4418139006	POWER SW SUPPORT
24	2129028204	POWER SWITCH
	1138038008	POWER SW KNOB
25	4418049002	LOCK SW SUPPORT
26	1138030006	LOCK SW ASS
27	1128019000	VOLUME ASS (SPEED CONTROL)

(KU-228 PHASE LOCK AMP UNIT)

$TR_{1,2}$	2710063005	2SA836(D)	
$TR_{3,6,11\ 13,14}$	2730021043	2SC458(D)	
$TR_{4,5}$	2710040028	2SA673(C)	
$TR_{7,8,9\ 10}$	2730116013	2SC1345(E)	
$TR_{15,16\ 17,18}$	2740036002	2SD468(C)	
TR_{12}	2740053001	2SD669A(C)	
D_1	2760057016	V06C	
$D_{2,3,4,5}$	2760049011	1S2076A	
D_6	2760010008	1S34	
IC_1	2628006002	M53273P	or SN7473N
$IC_{2,5}$	2620047001	M53293P	or SN7493N
IC_3	2628004004	M53200P	or SN7400N
IC_4	2628005003	M53290P	or SN7490N

$R_{1,2,6}$	2410364004	RD14B2E104J	100K	¼W 5% Carbon
$R_{3,4,5\ 7,22}$	2410330009	RD14B2E472J	4.7K	same
$R_{8,13,20\ 32,34,35\ 38,39,42\ 43}$	2410314009	RD14B2E102J	1K	same
$R_{9,10,19\ 21,27,28\ 29}$	2410346006	RD14B2E223J	2.2K	same
R_{11}	2410352003	RD14B2E393J	39K	same
R_{12}	2410294006	RD14B2E151J	150	same
R_{14}	2410344008	RD14B2E183J	18K	same
R_{15}	2410338001	RD14B2E103J	10K	same

$R_{16,17}$	2410378003	RD14B2E474J	470K	¼W	5% Carbon
$R_{18,25}$	2410374007	RD14B2E334J	330K		same
R_{30}	2410296004	RD14B2E181J	180		same
$R_{33,36,37,40}$	2410306004	RD14B2E471J	470		same
R_{31}	2410342000	RD14B2E153J	15K		same
R_{26}	2410354001	RD14B2E473J	47K		same
R_{41}	2410346006	RD14B2E332J	3.3K		same
*R_{24}	2440100005	RS14B3D152JNB	1.5K	2W	5% Metal
$C_{1,16}$	2544009002	CE04W1A470	47uF	10V	Electro-litic
C_3	2544044009	CE04W1H010	1uF	50V	same
C_{10}	2544070002	CE04W2C4R7	4.7uF	160V	same
C_{13}	2544012002	CE04W1A331	330uF	10V	same
$C_{14,15}$	2544015009	CE04W1C100	10uF	16V	same
C_5	2551070008	CQ93M1H682K	.0068uF	50V 10%	Film
C_8	2551071007	CQ93M1H822K	.0082uF	50V 10%	Film
C_7	2551077001	CQ93M1H273K	.027uF	50V 10%	Film
$C_{2,6,9,17}$	2551084007	CQ93M1H104K	.1uF	50V 10%	Film
$C_{4,11}$	2533662007	CC45SL1H271K	270pF	50V 10%	Ceramic
C_{12}	2543016009	CE04D1HoloMBP	1uF	50V 20%	Bipoler
	2228031105	P. CIRCUIT BOARD (A)			
X_1	2618003206	CRYSTAL (33.75KHz)			
SK_1	FEP0429K	SPARK KILLER			
L_1	2328008106	INDUCTOR	1mH		

(KU-229 SERVO AMP UNIT)

$TR_{1,2,10\ 11,14,15\ 16}$	2730021043	2SC458(D)		
TR_{12}	2730083007	2SC830H(C)		
$TR_{4,5,6\ 7,8,9}$	2710063005	2SA836(D)		
$TR_{3,13,17}$	2710040028	2SA673(C)		
IC_{1}	2688002004	TCA955		
$D_{1,2}$	2760049011	1S2076A		
D_{3}	2760185001	HZ4B	4V Zener	
D_{4}	2760151006	1D2C1		
D_{5}	2760152005	1D2Z1		
R_{1}	2410322004	RD14B2E222J	2.2K	$\frac{1}{4}$W 5% Carbon
R_{2}	2410334005	RD14B2E682J	6.8K	same
$R_{6,19,39\ 41,42,43\ 44}$	2410338001	RD14B2E103J	10K	same
$R_{7,15,22\ 23,26}$	2410354001	RD14B2E473J	47K	same
R_{8}	2410296004	RD14B2E181J	180	same
$R_{9,18}$	2410366002	RD14B2E154J	150K	same
R_{10}	2410352003	RD14B2E393J	39K	same
R_{11}	2410340002	RD14B2E123J	12K	same
R_{12}	2410328008	RD14B2E392J	3.9K	same
R_{14}	2410350005	RD14B2E333J	33K	same
R_{17}	2410374007	RD14B2E334J	330K	same
$R_{20,40}$	2410346006	RD14B2E223J	22K	same
$R_{21,24,25}$	2410332007	RD14B2E562J	5.6K	same
R_{27}	2410304006	RD14B2E391J	390	same

(KU-229)

$R_{28,29}$	2410288009	RD14B2E820J	82	¼W	5% Carbon
R_{30}	2410298002	RD14B2E221J	220	same	
$R_{31,32}$	2410342000	RD14B2E153J	15K	same	
$R_{33,45}$	2410306004	RD14B2E471J	470	same	
R_{34}	2410326000	RD14B2E332J	3.3K	same	
$R_{35,46,47}$	2410314009	RD14B2E102J	1K	same	
$R_{36,37}$	2410290000	RD14B2E101J	100	same	
*R_3	FEP101126	RN1/4PS7.5K G	7.5K	¼W	2% Metal
*R_4	FEP101127	RN1/4PS24K G	24K	¼W	2% Metal
*R_5	FEP101119	RN1/4PS4.7K G	4.7K	¼W	2% Metal
*$R_{13,16}$	FEP101124	RN1/4PS300K G	300K	¼W	2% Metal
$VR_{1,2}$	FEP10823	K07QB502	5K	Preset VR	
VR_3	EP-5462H7	SOLID VOLUME 1K	1K	Preset VR	

$C_{2,5,7}$	2544043000	CE04W1HR47	.47uF	50V	Electrolitic
$C_{4,8,18}$	2544015009	CE04W1C100	10uF	16V	same
$C_{21,22}$	2544022005	CE04W1C102	1000uF	16V	same
C_{25}	2544003008	CE04W0J101	100uF	6.3V	same
C_{20}	2544054002	CE04W1C220	22uF	16V	same
$C_{3,9}$	2551060005	CQ93M1H102K	.001uF	50V 10%	Film
C_1	2551076002	CQ93M1H223K	.022uF	50V 10%	Film
$C_{16,17}$	2551084007	CQ93M1H104K	.1 uF	50V 10%	Film
$C_{13,19}$	2551072006	CQ93M1H103K	.01uF	50V 10%	Film
$C_{14,15}$	2551086005	CQ93M1H154K	.15uF	50V 10%	Film
C_6	2551070008	CQ93M1H682K	.0068uF	50V 10%	Film
C_{12}	2556123002	CQ09S1H103J	.01uF	50V 5%	Film

*Parts with * mark are temperature compensation device.

C_{11}	2541028002	CS45E1VR68M	.68uF 35V 20% Tantal
C_{10}	2533657009	CC45SL1H101K	100pH 50V 10% Ceramic
C_{23}	2533662007	CC45SL1H271K	270pH 50V 10% Ceramic
C_{24}	2531004007	CK45B1H102K	1000pF 50V 10% Ceramic
	2228032201	P. CIRCUIT BOARD	
	4178001209	HEAT SINK (A)	
F_1	2061018000	FUSE (0.8A)	
CN_1	2045310009	P. C. B. CONNECTOR	
CH_1	CH-0274J	CHOKE COIL	5H

(KU-237 MOTOR DRIVE UNIT)

$TR_{1,5,7}$	2730021043	2SC458(D)	
TR_{2}	2710040028	2SA673(C)	
$TR_{3,12,13}$	2720031001	2SB568(D)	
TR_{4}	2740026009	2SD259	
TR_{6}	2740036002	2SD468(C)	
TR_{8}	2730116013	2SC1345(E)	
TR_{9}	2740050017	2SD477(D)	
$TR_{10,14}$	2710086008	2SA778A(K)	
$TR_{11,15}$	2740044007	2SD478(D)	
$D_{1,4,7}$	2760049011	1S2076A	
$D_{2,3,14,16}$	2760184002	1S1834	
$D_{5,11}$	2760151006	1D2C1	
$D_{6,12}$	2760152005	1D2Z1	
$D_{8,9,13,15,19}$	2760057016	V06C	
D_{10}	2760174012	MZ-314B	14V Zener
$D_{17,18}$	2760071018	AW01-24	24V Zener

$R_{1,9}$	2410290000	RD14B2E101J	100	¼W 5% Carbon
R_{2}	2410282005	RD14B2E470J	47	same
R_{4}	2410280007	RD14B2E390J	39	same
$R_{5,13}$	2410322004	RD14B2E222J	2.2K	same
$R_{6,11,16}$	2410338001	RD14B2E103J	10K	same
R_{7}	2410340002	RD14B2E123J	12K	same
R_{8}	2410324002	RD14B2E272J	2.7K	same
R_{10}	2410350005	RD14B2E333J	33K	same
R_{12}	2410354001	RD14B2E473J	47K	same

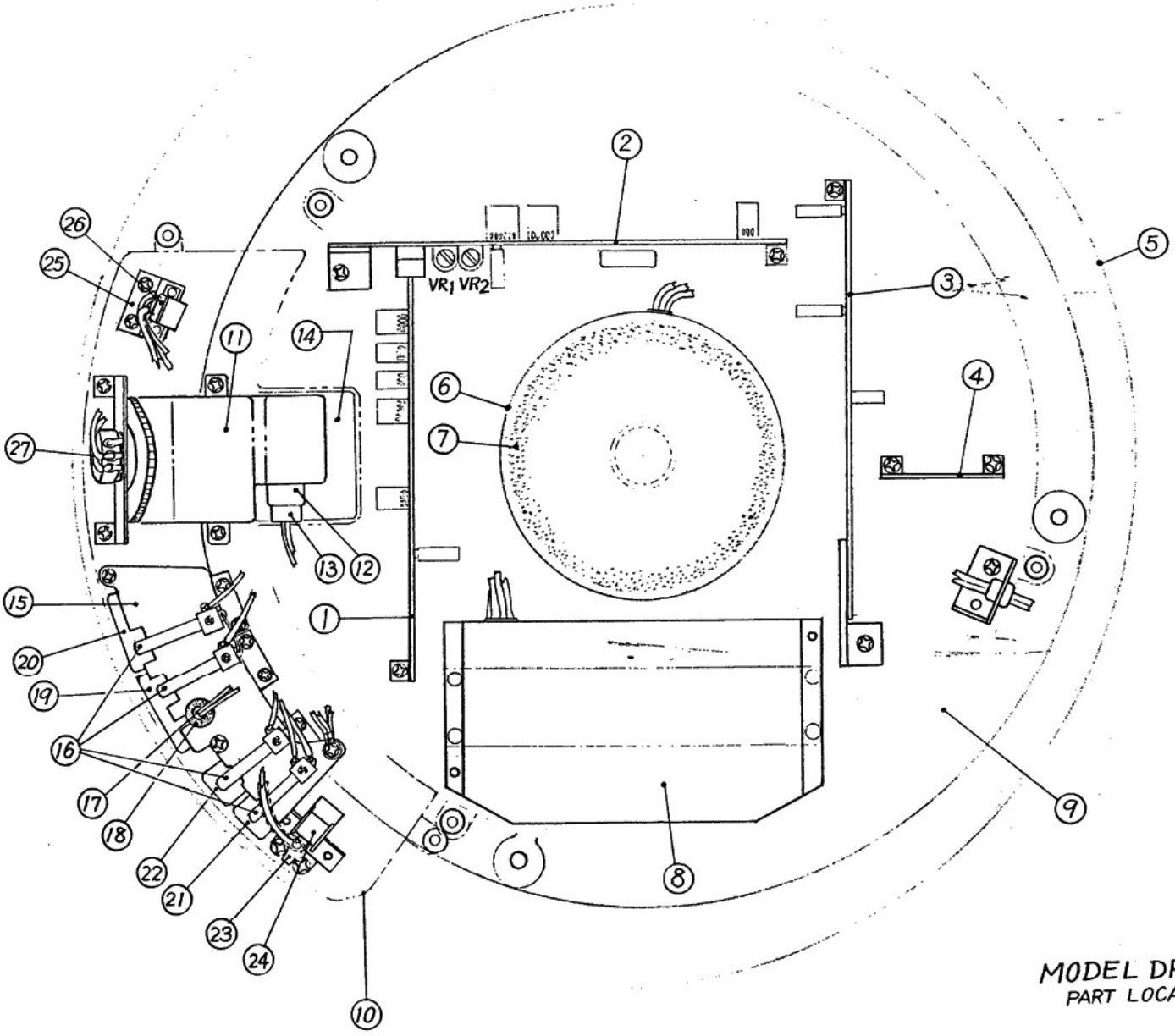
R_{14}	2410346000	RD14B2E223J	22K	¼W	5%	Carbon
$R_{17,20,21}$	2410314009	RD14B2E102J	1K	same		
R_{18}	2410260001	RD14B2E5R6J	5.6	same		
R_3	2440021003	RS14B3A220JNB	22	1W	5%	Metal
$R_{15,19}$	2440053000	RS14B3A103JNB	10K	1W	5%	Metal

C_1	2544003008	CE04W0J101	100uF	6.3V	Electrolitic
C_3	2544066016	CE04W1H220	22uF	50V	same
C_4	2542063008	CE02W1J102	1000uF	63V	same
C_5	2568007048	CF99=2EAC155J	1.5uF	250VAC 5%	Metalized
C_6	2568007051	CF99=2EAC455J	4.5uF	250VAC 5%	same
C_8	2568007019	CF99=2EAC105J	1uF	250VAC 5%	same
C_9	2531004007	CK45B1H102K	1000pF	50V 10%	Ceramic

	2228033103	P. CIRCUIT BOARD
SW_1	2129015000	PUSH SWITCH
F	2061018039	FUSE (1.6A)
RL_1	2148004005	REED RELAY
SK_1	FEP0429K	SPARK KILLER
	4178010106	HEAT SINK (Y)

(PS-129 POWER SUPPLY UNIT)

$C_{1,2}$	2538004000	CK45-2BAC102P-	1000pF 125VAC
SK_1	FEP0429K	SPARK KILLER	
F_1	2061018039	FUSE (1.6A)	
	2228047102	P. CIRCUIT BAORD (D)	



MODEL DP-6000
PART LOCATION

OPERATION OF SERVO IC

TCA-955 of Seamens is used for the servo system. Switching frequency oscillator in the IC is used to obtain 20KHz triangle wave. The frequency is set by R2 and C4 connected to IC outlet. Oscillation frequency becomes $f = \frac{1}{0.4R2C4}$. The oscillation voltage is generated at terminal 10, so that the voltage is applied to the circuit.

The amplitude of oscillation is approx. 0.7Vp-p.

D1 and D6 connected to output terminal of the IC are necessary for smooth switching operation of the motor driving system at start or stop. Refer to motor drive system block for detail.

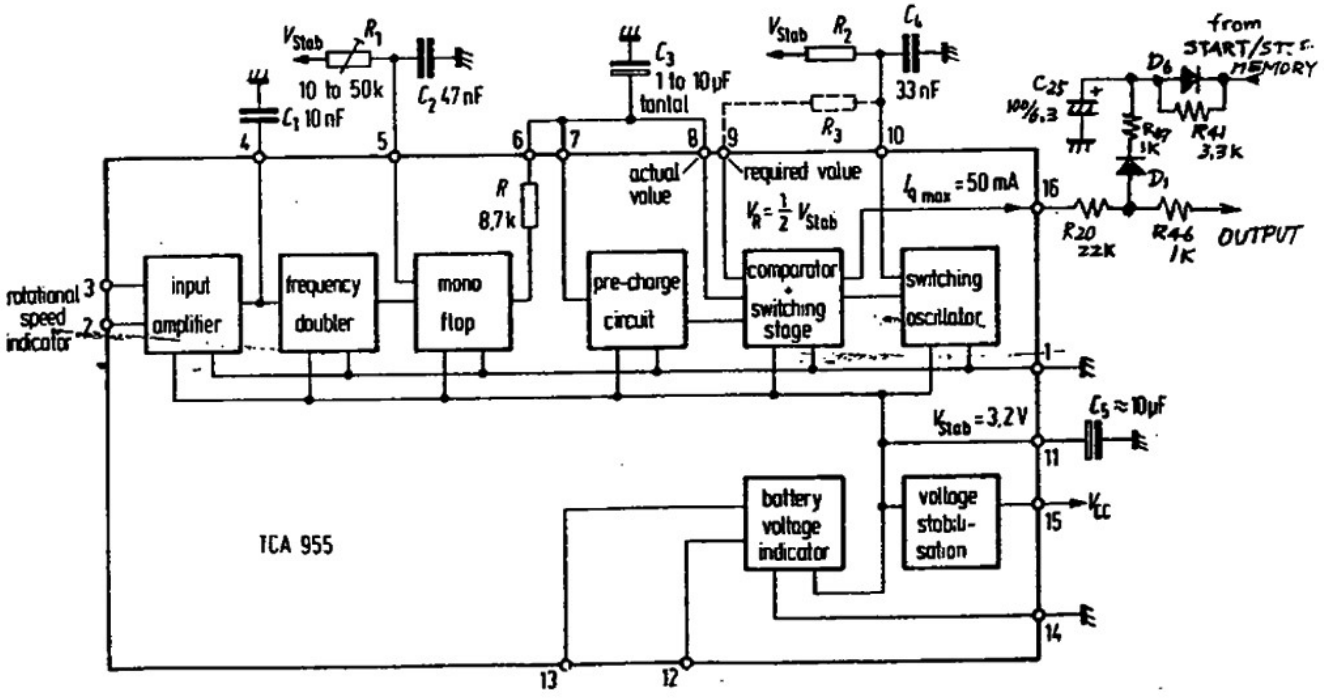


Diagram 5: Internal structure of TCA-955