

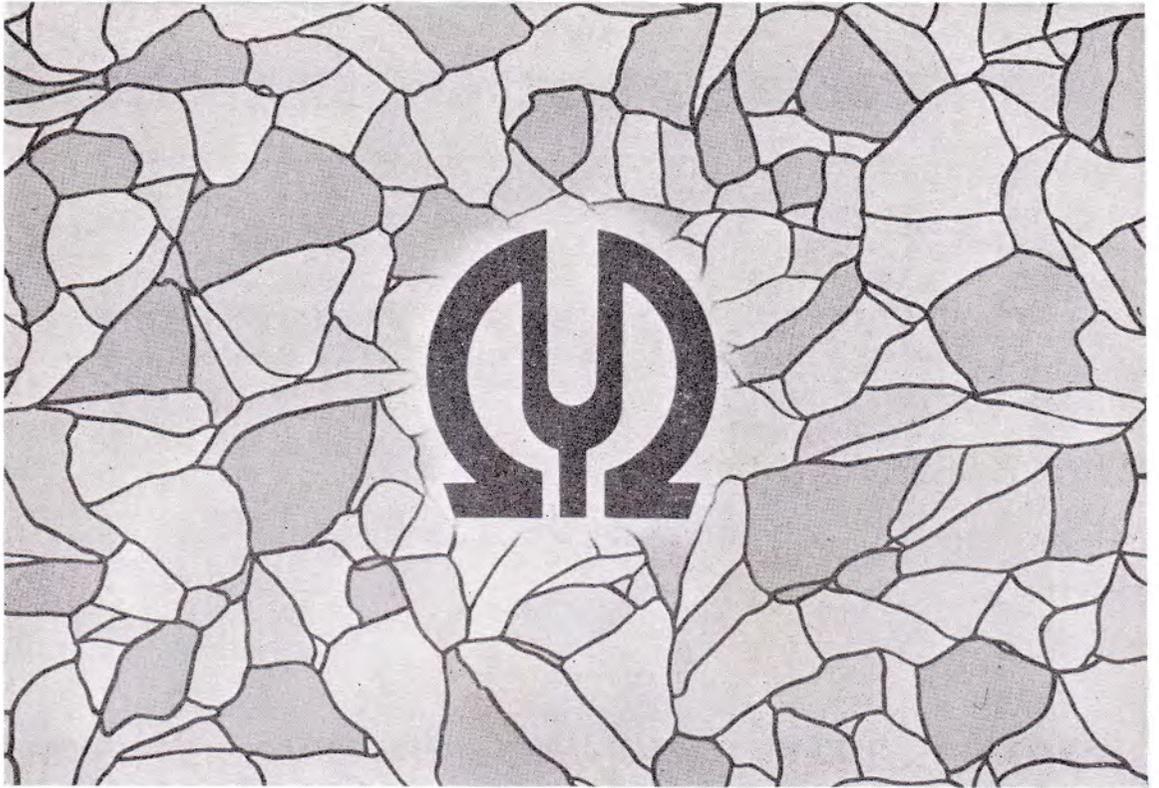
TECHNICAL GUIDE FOR SERVICE

TROUBLE SHOOTING

PROTECTION CIRCUITS

PIONEER®

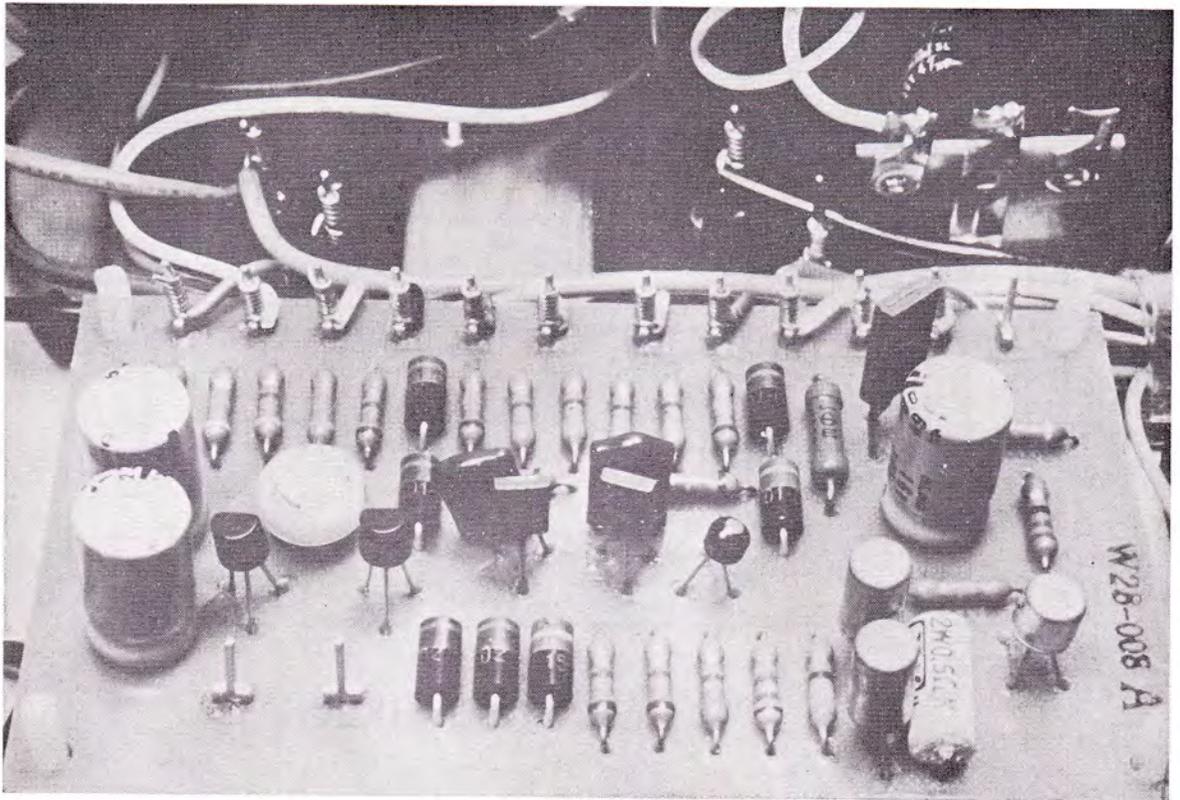
SERVICE DEPARTMENT INTERNATIONAL DIVISION



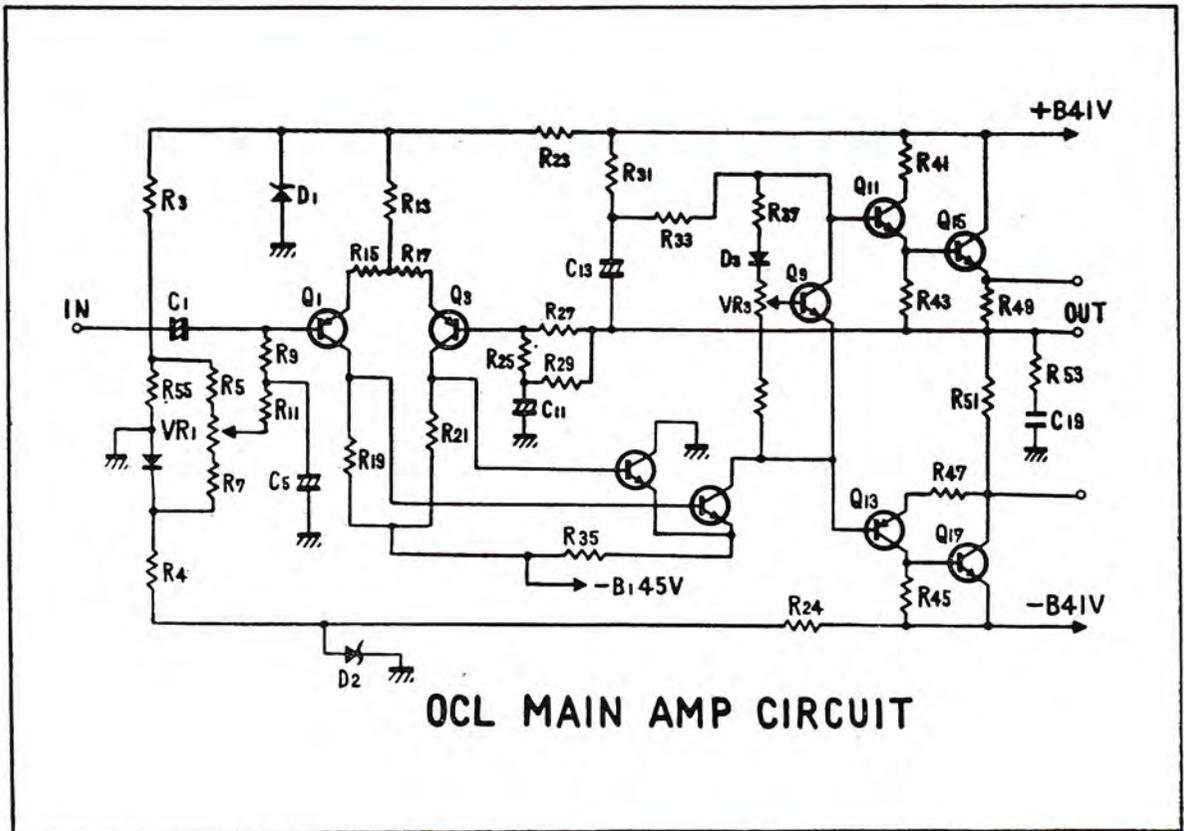
TROUBLE SHOOTING METHODS
FOR
PROTECTION CIRCUIT

PIONEER®

SERVICE DEPARTMENT INTERNATIONAL DIVISION

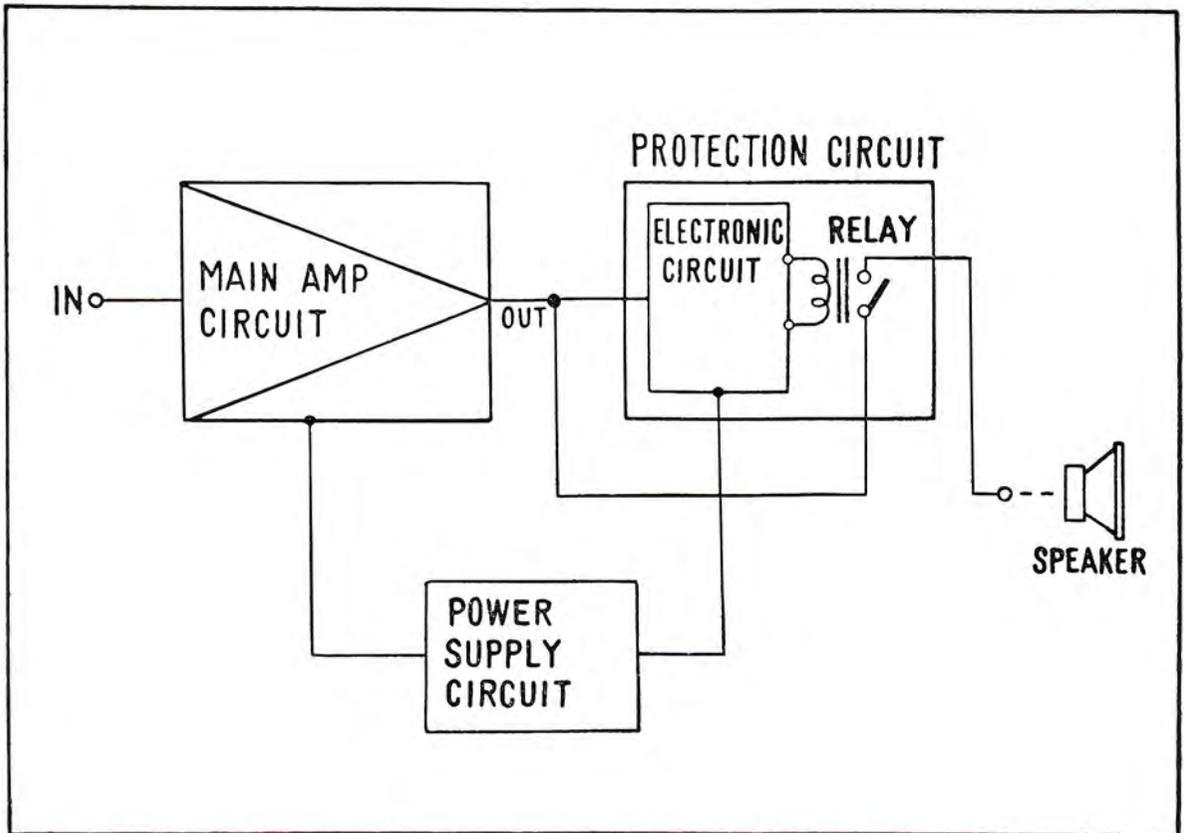


3. THE MAIN PURPOSE OF HAVING PROTECTION CIRCUITS IN AUDIO EQUIPMENT IS TO PROTECT THE POWER TRANSISTORS IN THE MAIN AMPLIFIER. HOWEVER, IN THE CASE OF OUTPUT CAPACITOR LESS (O.C.L.) MAIN AMPLIFIER CIRCUITS, LOUDSPEAKERS ARE DIRECTLY COUPLED TO THE AMPLIFIER. FOR THIS REASON WE MUST ALSO PROTECT THE SPEAKERS.



4. IN ORDER TO MEET THESE REQUIREMENTS, WE DESIGNED A CIRCUIT THAT WOULD DETECT A DEFECTIVE MAIN AMPLIFIER BY SENSING IF THERE IS A D.C. VOLTAGE PRESENT AT THE SPEAKER TERMINALS. THIS ALSO SENSES EXCESSIVE CURRENT IN THE OUTPUT STAGE.

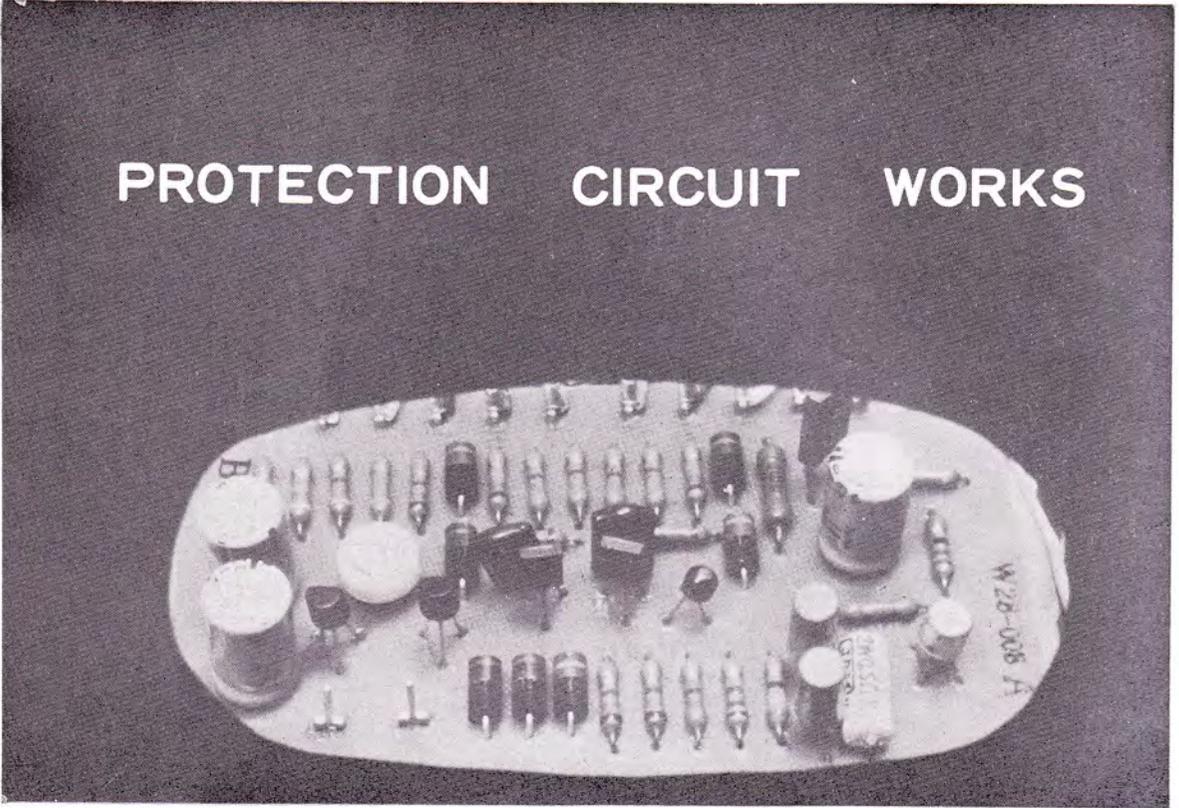
(5 THROUGH 9 NOT USED)



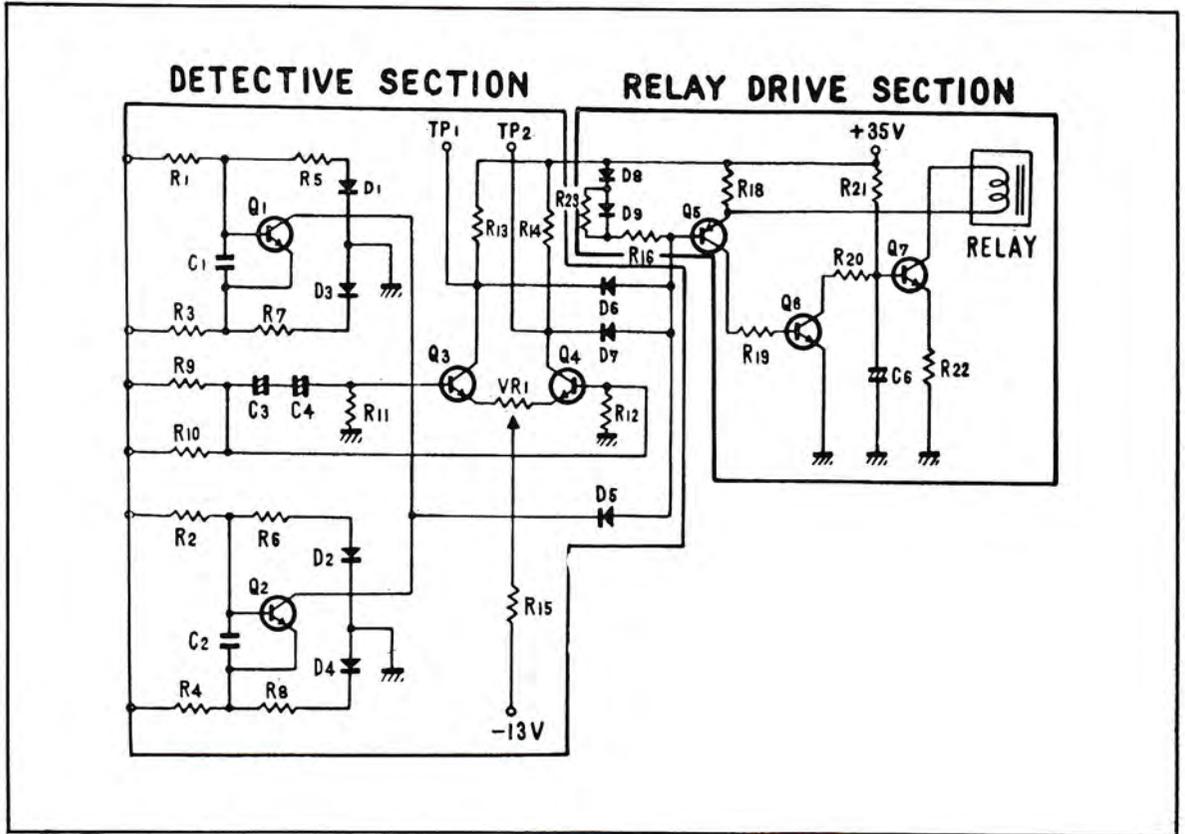
5. IN PIONEER O.C.L. MAIN AMP'S A "CUT OFF LOAD SYSTEM" IS EMPLOYED. THIS IS AN ELECTRIC SENSING CIRCUIT AND RELAY WHICH DISCONNECTS THE SPEAKERS FROM THE AMP WHENEVER THE AMPLIFIER OR SPEAKER MAY BE DEFECTIVE.

THE PROTECTION CIRCUIT OF THIS TYPE WORKS EFFECTIVELY ON OCL MAIN AMPLIFIER AND, AT THE SAME TIME, THE ACTION IS VERY STABILIZED.

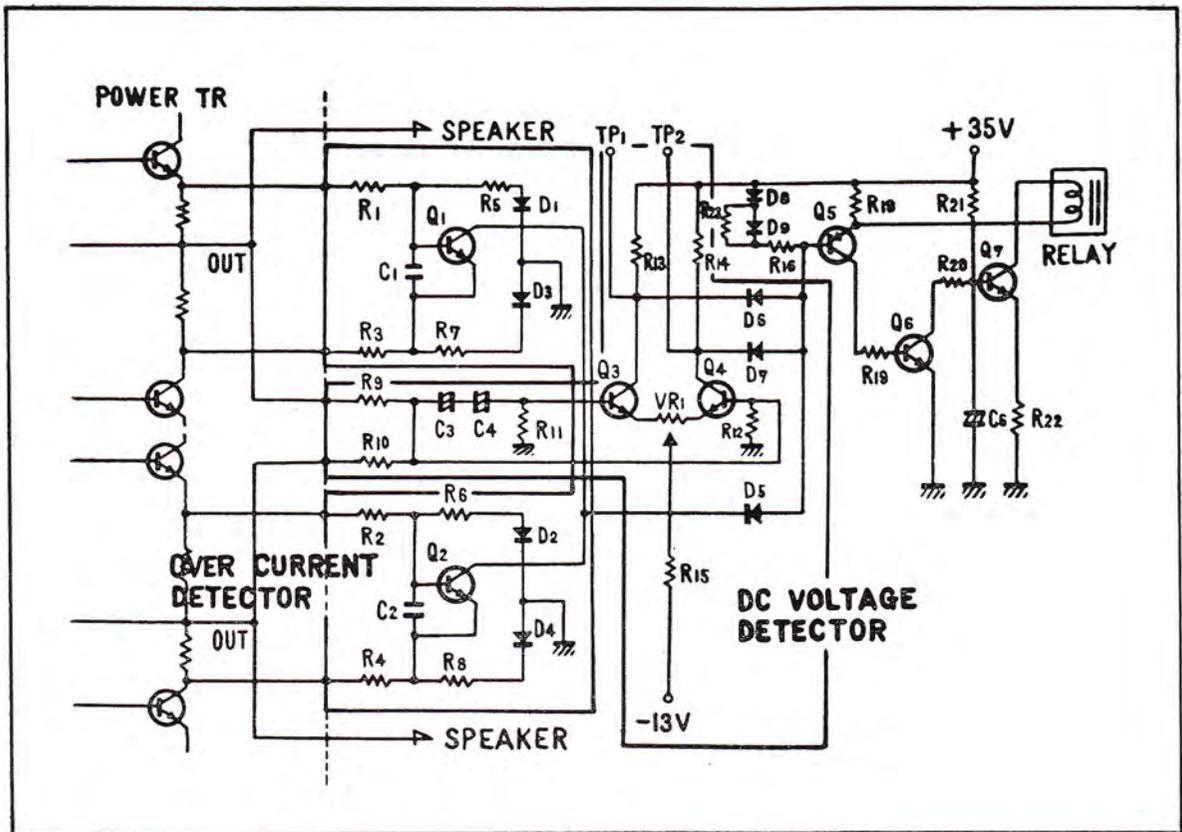
PROTECTION CIRCUIT WORKS



6. IN THESE NEXT SLIDES WE WILL LEARN HOW THE PROTECTION CIRCUITS OPERATE. AS AN EXAMPLE WE WILL USE THE PROTECTION UNIT FROM A SA-1000 AMPLIFIER.



7. THE PROTECTION UNIT IS COMPOSED OF THREE DIFFERENT CIRCUITS DESIGNED TO DETECT ANY ABNORMAL OPERATION IN THE AMPLIFIER, SUCH AS EXCESSIVE CURRENT OR D.C. VOLTAGE AT SPEAKER TERMINALS. THERE IS ALSO A SECTION TO DRIVE THE PROTECTION RELAY.



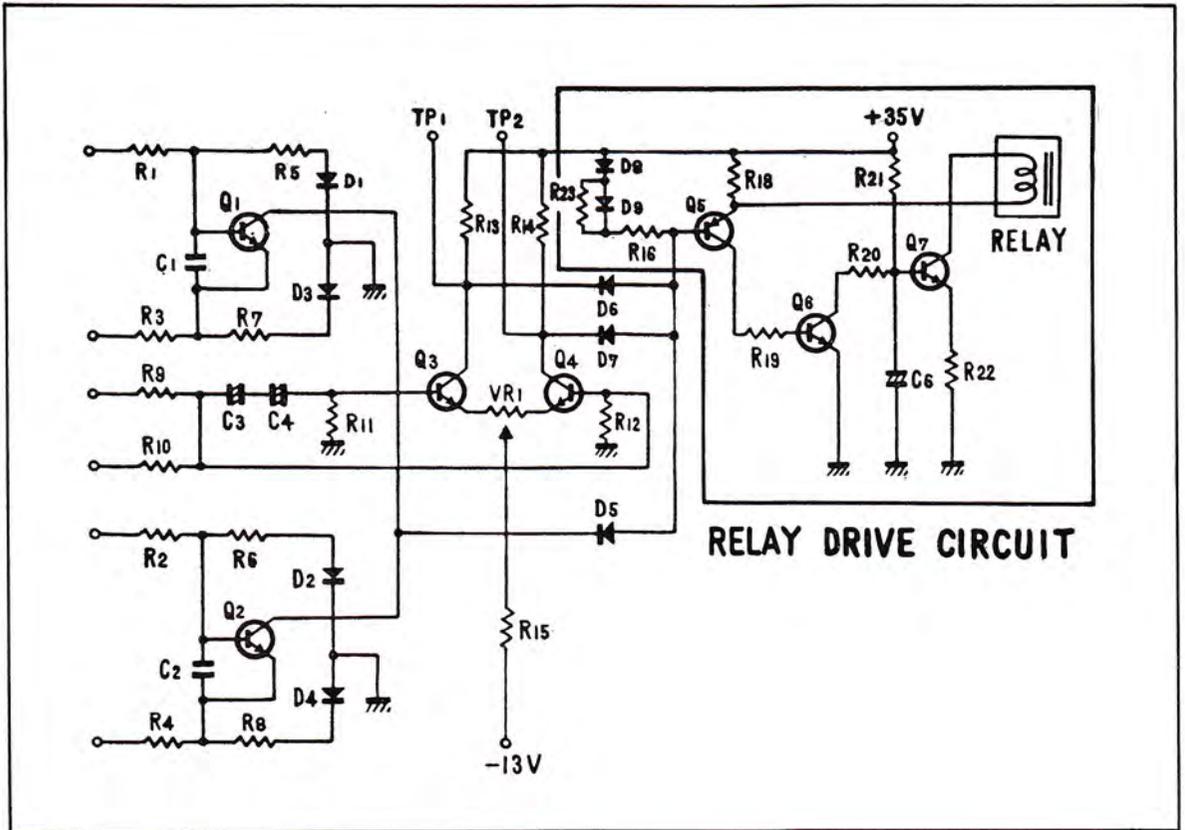
8. WE CAN DIVIDE THE PROTECTION UNIT INTO THREE SECTIONS, CONSISTING OF TRANSISTORS Q-1 AND Q-2, Q-3 AND Q-4 AND Q-5, Q-6, Q-7.

Q-1 AND Q-2 DETECT EXCESSIVE CURRENT DRAWN THRU THE POWER TRANSISTORS OF THE MAIN AMP. ONE TRANSISTOR IS FOR THE RIGHT CHANNEL AND THE OTHER IS FOR THE LEFT. Q-3 AND Q-4 DETECT ANY D.C. VOLTAGE PRESENT AT THE OUTPUT TERMINALS. EITHER OF THESE CONDITIONS WILL PRODUCE A SIGNAL TO ACTUATE THE PROTECTION RELAY.

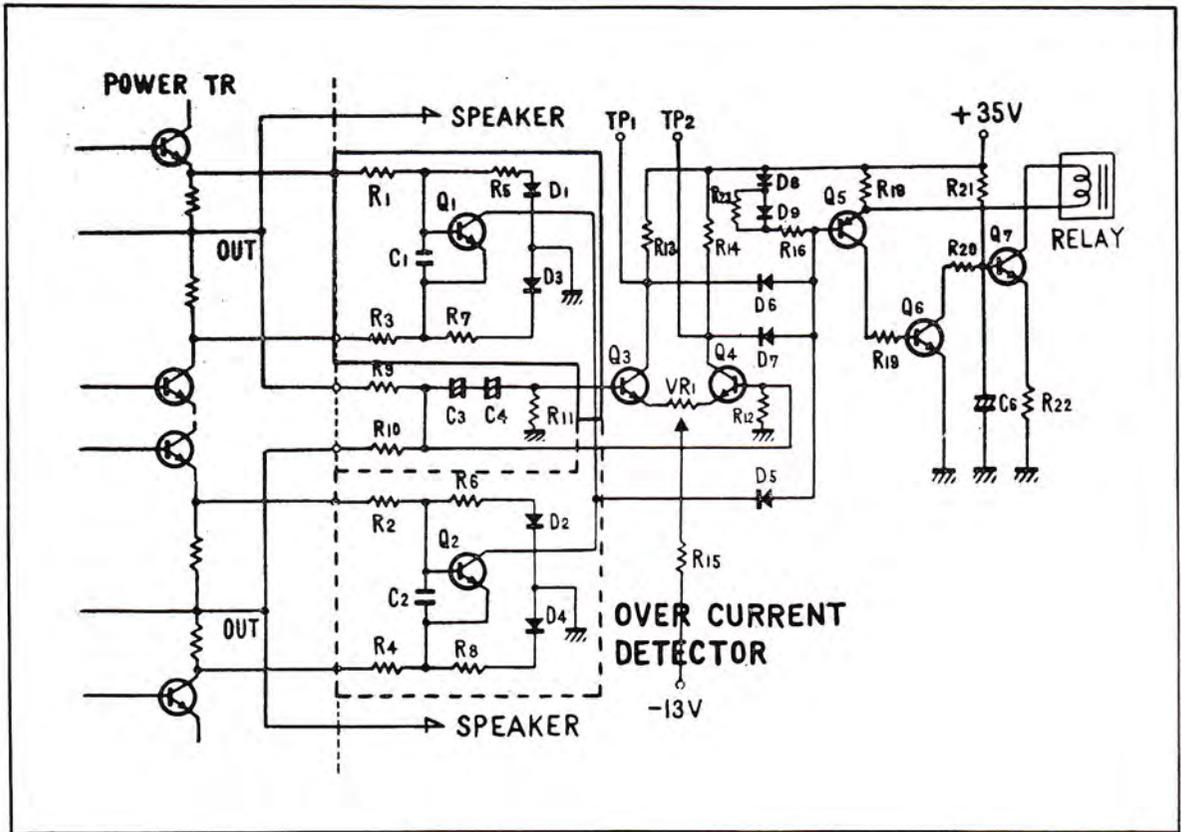
THE EXCESSIVE CURRENT

THE EXCESSIVE CURRENT SIGNAL CAN BE DETECTED AT Q-1 CIRCUIT FOR L-CHANNEL AND Q-2 FOR R-CHANNEL.

IN CASE OF LOWER SIDE POWER TRANSISTOR, THE RESISTOR IS CONNECTED TO THE COLLECTOR, SUCH A CIRCUIT AS THAT IS CONSISTING FOR THE PURPOSE OF GETTING THE SIGNAL FOR DETECTING EXCESSIVE CURRENT.

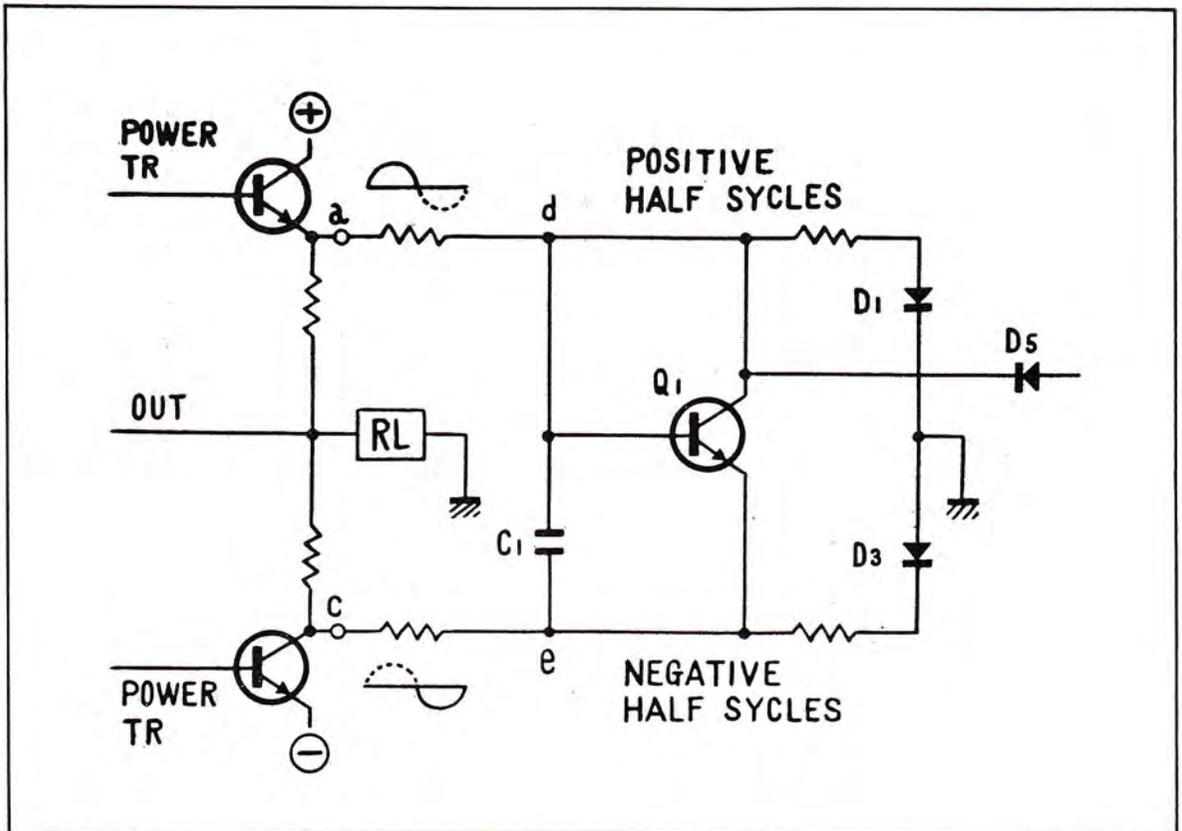


9. THE PROTECTION RELAY IS DRIVEN BY A SCHMIT TRIGGER CIRCUIT CONSISTING OF Q-5, Q-6 AND Q-7.

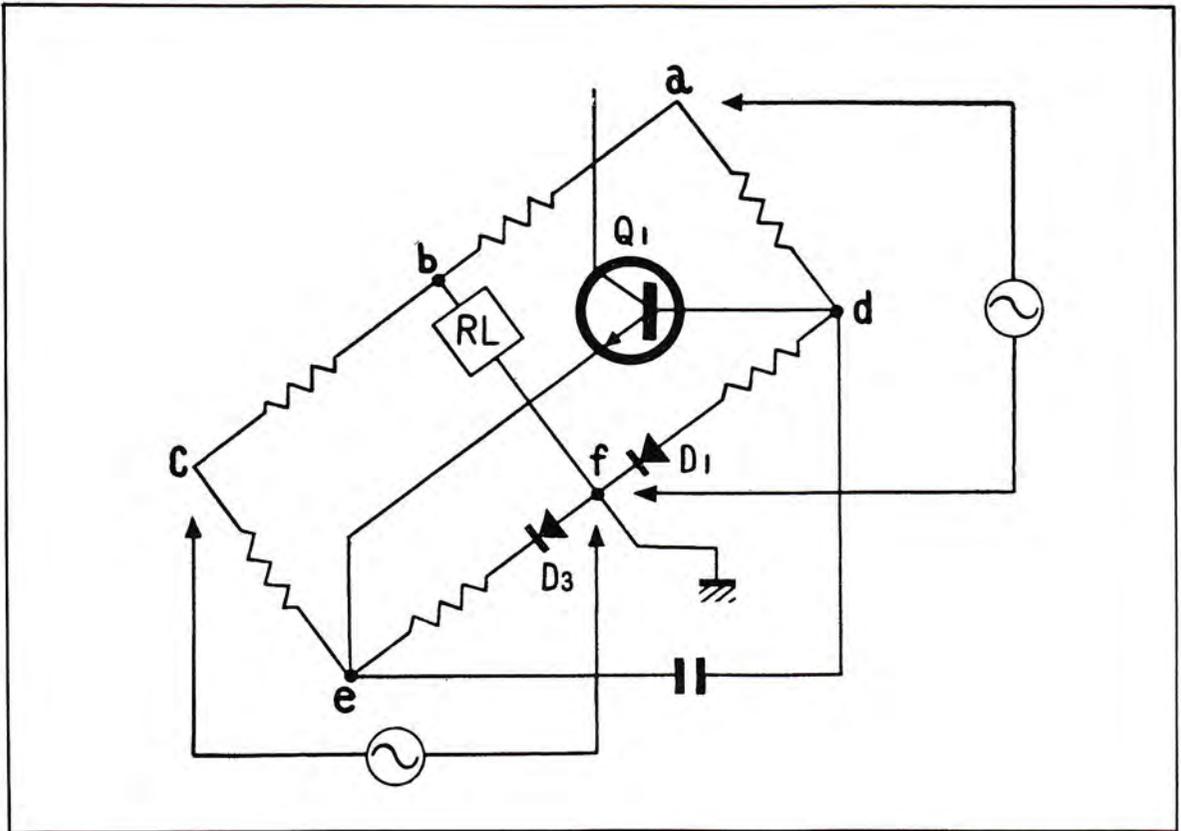


10.

HERE WE WILL EXPLAIN IN DETAIL HOW EACH OF THE CIRCUITS WORK. WE WILL START WITH THE CURRENT OVERLOAD SENSING CIRCUIT. AS YOU CAN SEE Q-1 AND Q-2 ARE THE SAME. ONE FOR EACH CHANNEL, SO WE WILL EXPLAIN ONLY ONE SIDE.

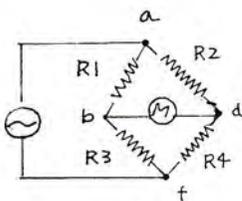


11. THE OUTPUT SIGNAL TO THE SPEAKER IS DEVELOPED ACROSS THE TWO EMITTER RESISTORS CONNECTED AT POINTS "a" "b" AND "c". SINCE WE ARE USING A CLASS "b" PUSH-PULL AMPLIFIER, THE "a" SIDE OF THE AMP HANDLES THE POSITIVE COMPONENTS OF THE SIGNAL BEING AMPLIFIED AND THE "c" SIDE HANDLES THE NEGATIVE.

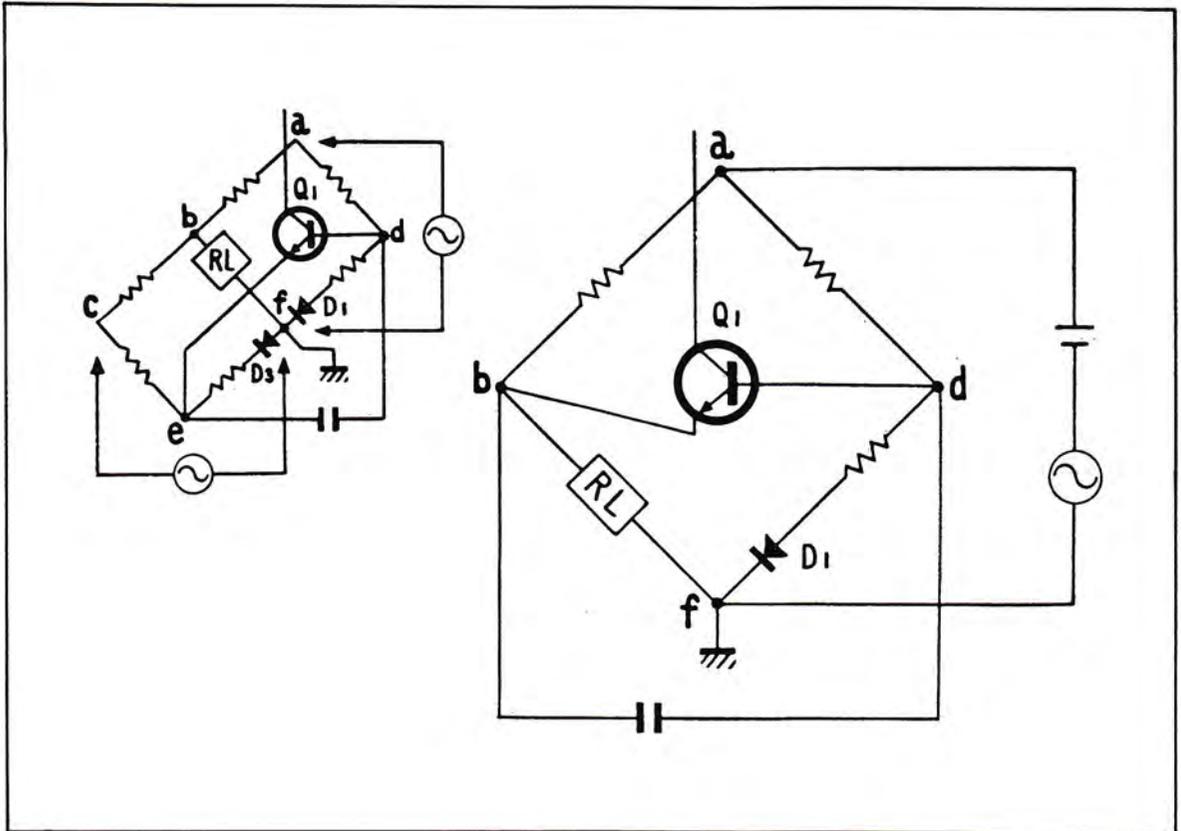


12.

Q1'S CIRCUIT MAY BE RE-DRAWN AS TWO COMBINED BRIDGE CIRCUITS. WHEN ONE BRIDGE CONSISTING OF POINTS "a", "b", "f" AND "d" AND THE OTHER OF "b", "c", "e" AND "f" ARE BALANCED THEN THE POTENTIALS AT POINT "b", "d", AND "e" ARE EQUAL. WHEN THE BRIDGE IS BALANCED IN THIS MANNER, NO POTENTIAL DIFFERENCE IS PRESENT BETWEEN THE EMITTER AND BASE OF Q-1. THEREFORE, THERE IS NO COLLECTOR CURRENT THRU Q-1 AND NO SIGNAL TO OPERATE THE PROTECTION RELAY.



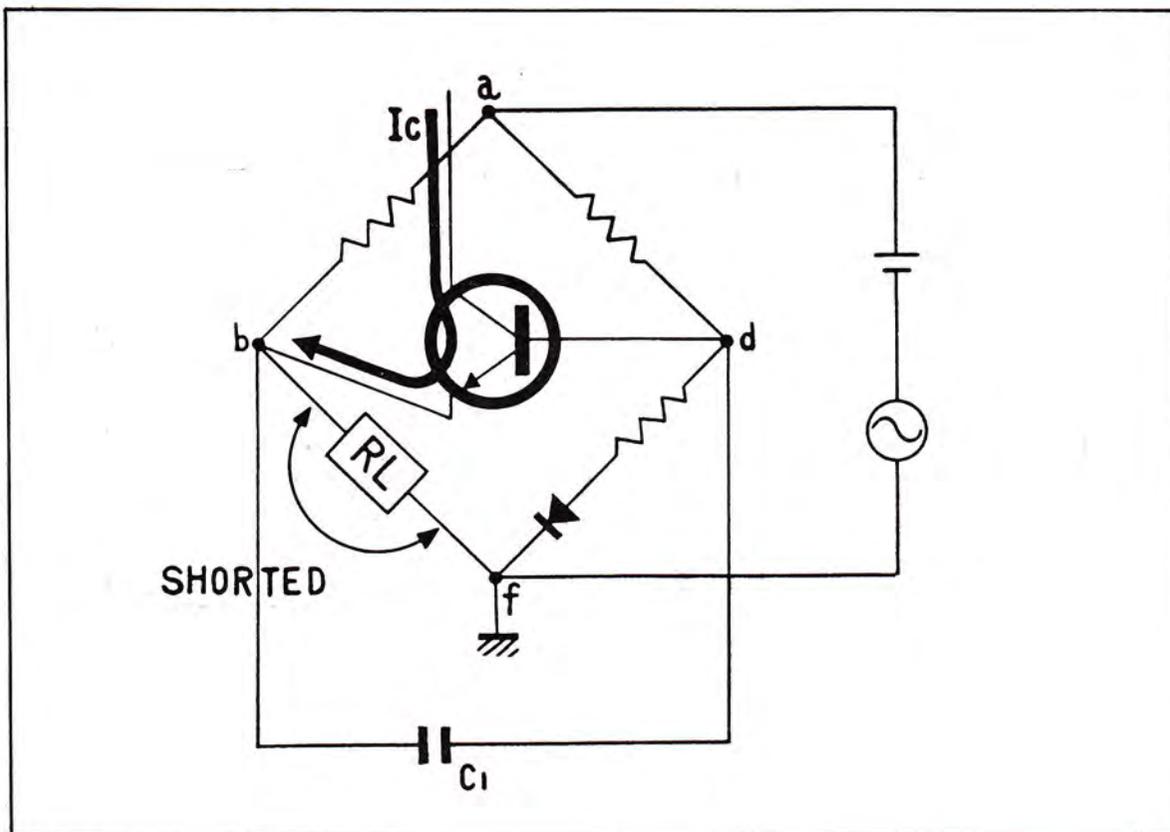
THE BRIDGE CIRCUIT IS BALANCED IN CASE OF $R_1 \times R_4 = R_2 \times R_3$ AND THE CURRENT DOES NOT FLOW BETWEEN (b) AND (d) SO THAT THE METER (M) CONNECTED BETWEEN (b) AND (d) DOES NOT MOVE. AS A RESULT, POINT (b) AND POINT (d) ARE AT THE SAME POTENTIAL AND THE VOLTAGE DOES NOT APPEAR BETWEEN (b) AND (d).



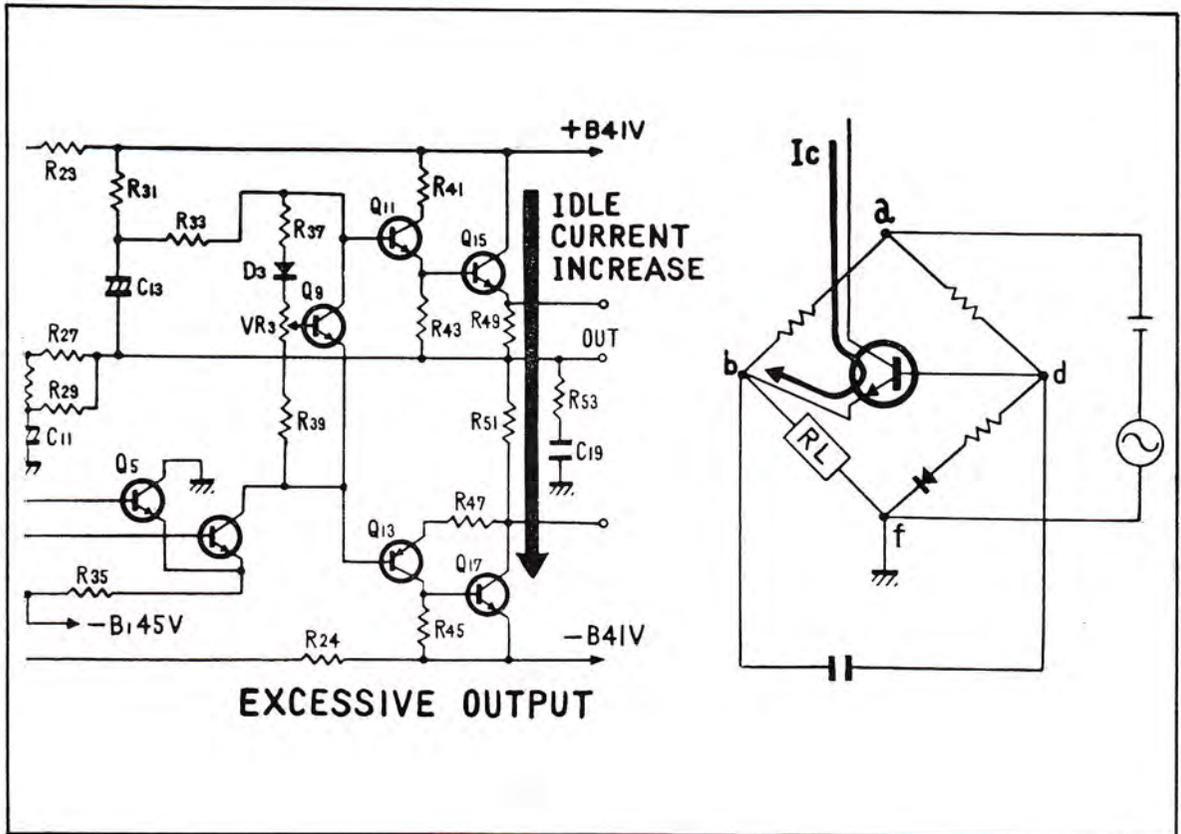
13.

TO SIMPLIFY THE EXPLANATION OF OPERATION WE HAVE RE-DRAWN THE CIRCUIT AS SHOWN. IN THIS SCHEMATIC, THE EMITTER OF Q-1 IS CONNECTED TO POINT "b" BECAUSE THE CIRCUIT IS CONSIDERED TO BE BALANCED WHEN THE AMPLIFIER IS OPERATING NORMALLY. THEREFORE, POINTS "b" AND "e" ARE ELECTRICALLY THE SAME. Q-1 WILL STILL DETECT ANY CURRENT VARIATION.

IF THE BRIDGE CIRCUIT (b), (c), (e) AND (f) ARE BALANCED, POINT (e) AND POINT (b) ARE AT THE SAME POTENTIAL AND IT CAN BE CONFIRMED THAT THEY ARE CONNECTED.

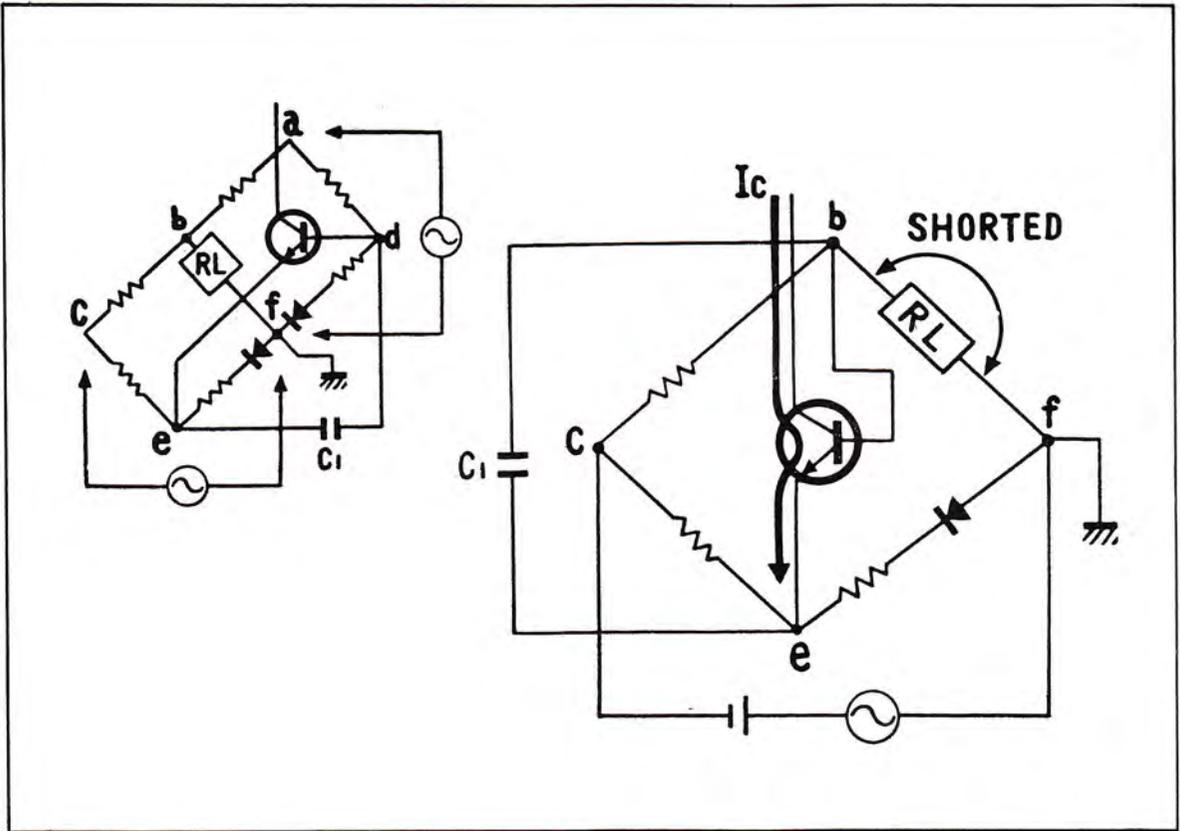


14. LET'S ASSUME A CASE WHERE R.L. HAS SHORT CIRCUITED OR R.L. IS A VERY LOW IMPEDANCE. IN THIS CASE, THE CIRCUIT WILL BECOME IMBALANCED, POTENTIAL AT THE BASE OF Q-1 INCREASES WITH RESPECT TO THE EMITTER, AND COLLECTOR CURRENT WILL FLOW THRU Q-1 OPERATING THE RELAY.

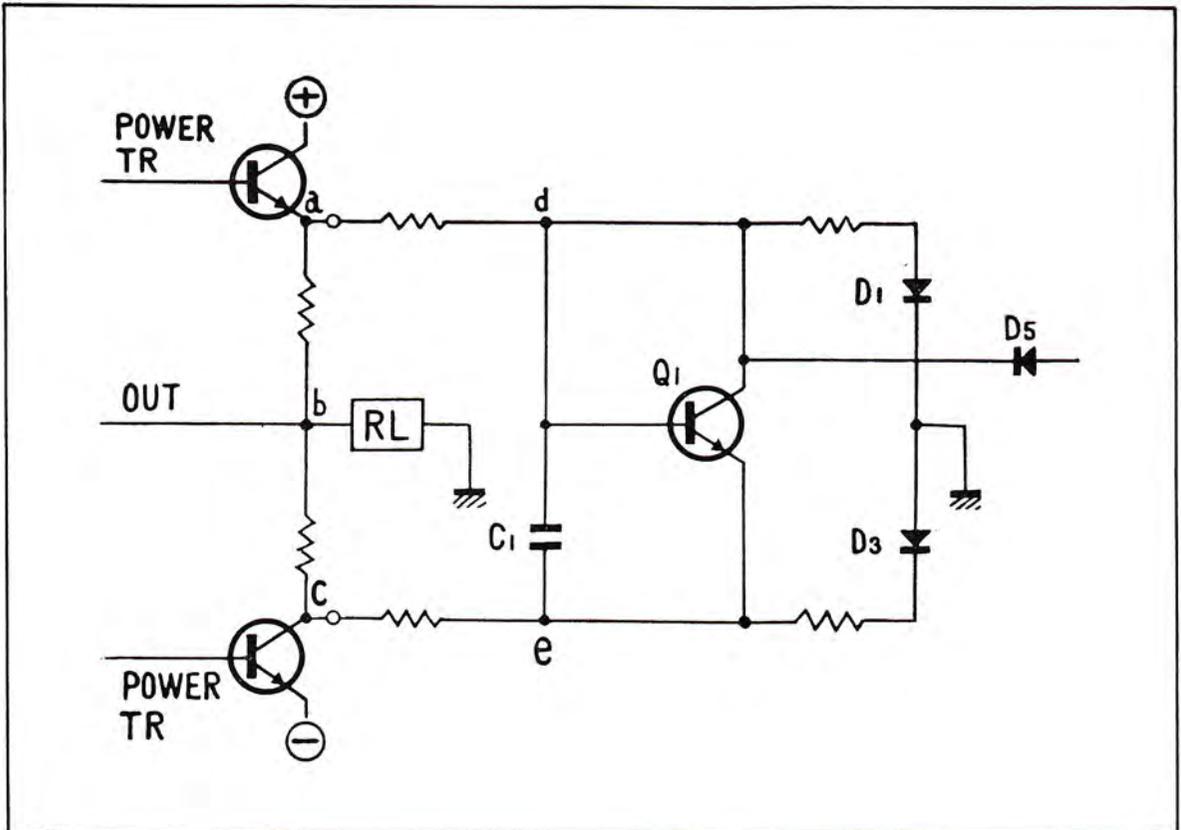


15.

IF THE POTENTIAL OF POINT "a" INCREASES BECAUSE OF EXCESSIVE OUTPUT OR HIGH IDLE CURRENT OR IMPROPER BIAS, EXCESSIVE CURRENT WILL FLOW THRU THE POWER TRANSISTORS CAUSING A LARGER VOLTAGE DROP ACROSS THE EMITTER RESISTORS. BECAUSE OF THIS, THE POTENTIAL AT POINT "b" WILL INCREASE CAUSING AN IMBALANCE OF THE BRIDGE CIRCUIT, WHICH WILL ACUATE THE PROTECTION RELAY.

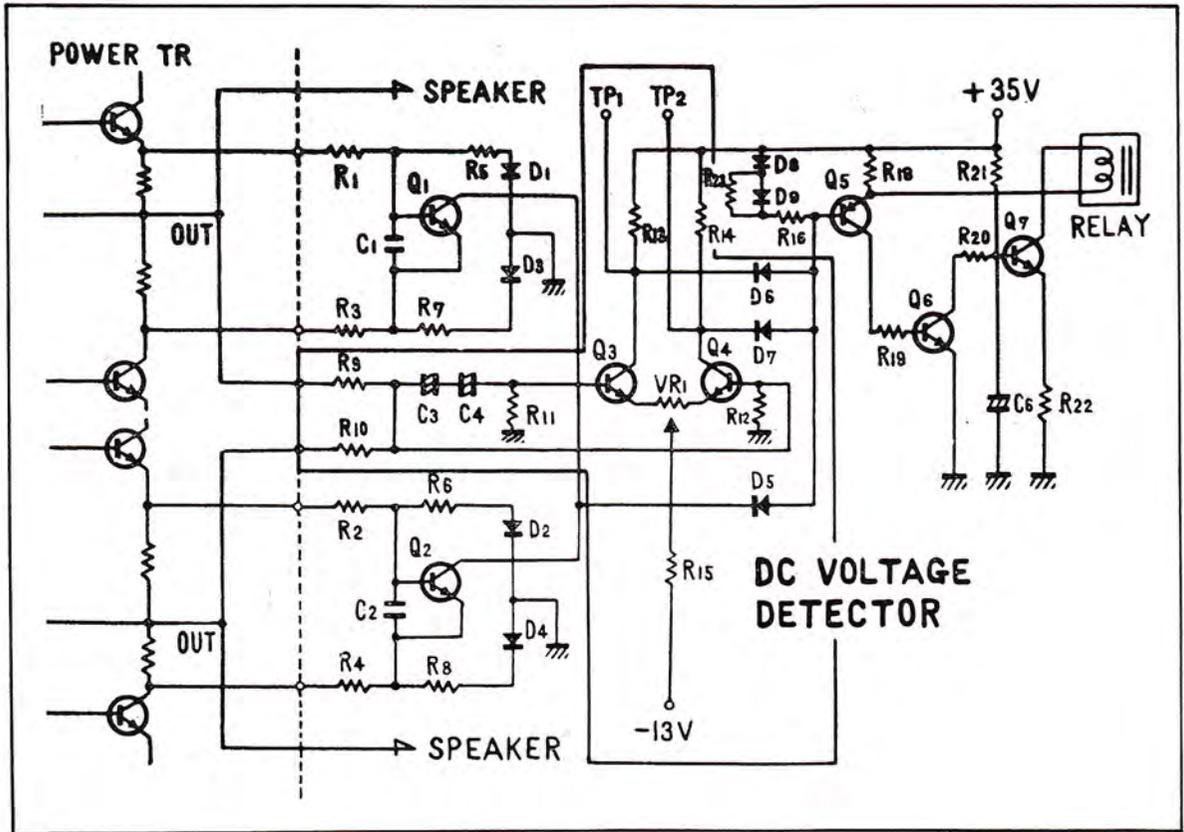


16. NOW WE WILL LOOK AT THE PORTION OF THE CIRCUIT MADE UP OF "c", "b", "e" AND "f". REMEMBER IN THE SA-1000 PROTECTION UNIT, THE BASE OF Q-1 IS CONNECTED TO POINT "b" IN THE SCHEMATIC. THIS IS BECAUSE WHEN THE BRIDGE IS IN A BALANCED CONDITION, POINTS "b" AND "d" ARE AT THE SAME POTENTIAL AND MAY BE CONSIDERED TO BE CONNECTED TOGETHER. NOW IF THE R.L. IS SHORTED, POTENTIAL AT THE BASE OF Q-1 BECOMES THE SAME AS GROUND. SINCE THE EMITTER IS NEGATIVELY CHARGED, COLLECTOR CURRENT WILL FLOW THRU Q-1 ACTIVATING THE RELAY.



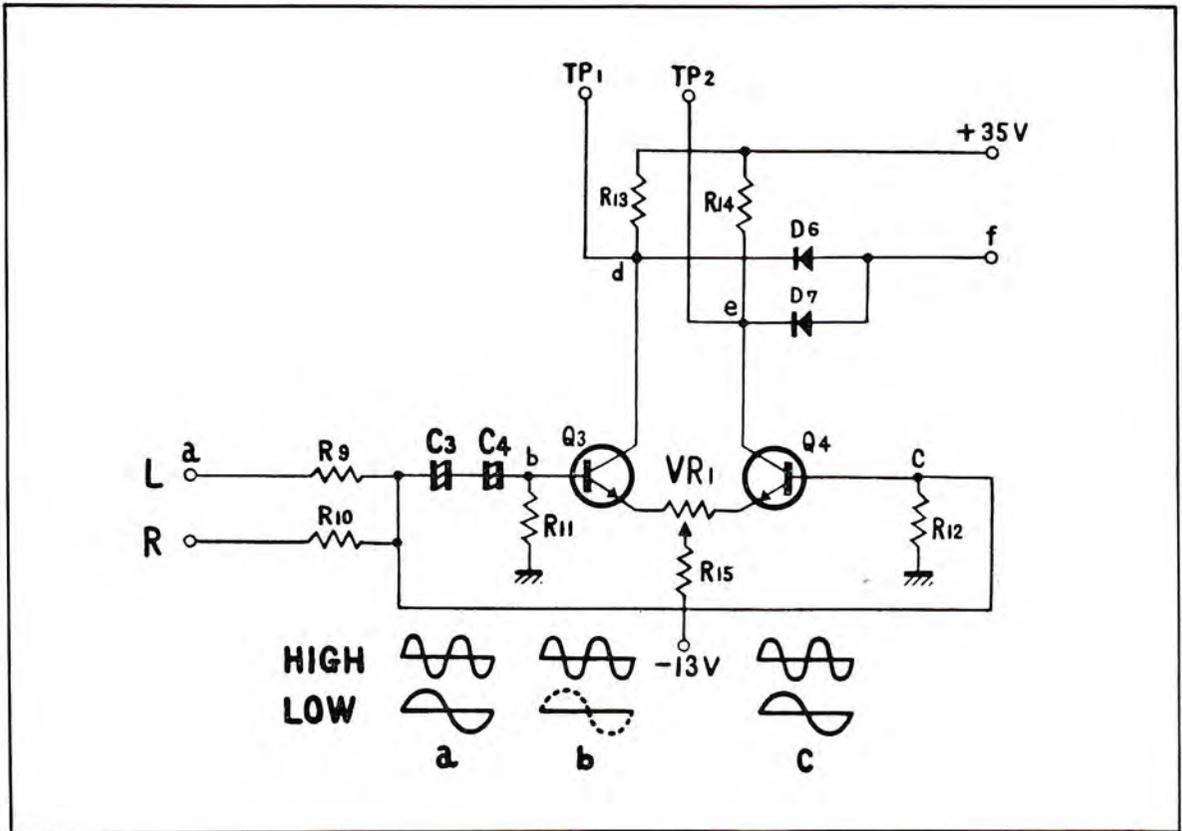
17.

THE DIODES, D-1 AND D-3 ARE USED FOR TEMPERATURE COMPENSATION AND MORE STABLE OPERATION WITHOUT BEING SENSITIVE TO TEMPERATURE. CAPACITOR C-1 CONNECTED BETWEEN THE BASE AND EMITTER OF Q-1 IS TO DECREASE SENSITIVITY OF THE PROTECTION UNIT AT HIGH FREQUENCIES. THIS IS TO PREVENT IMPROPER OPERATION DUE TO HIGH FREQUENCY NOISES OR POPS.



18.

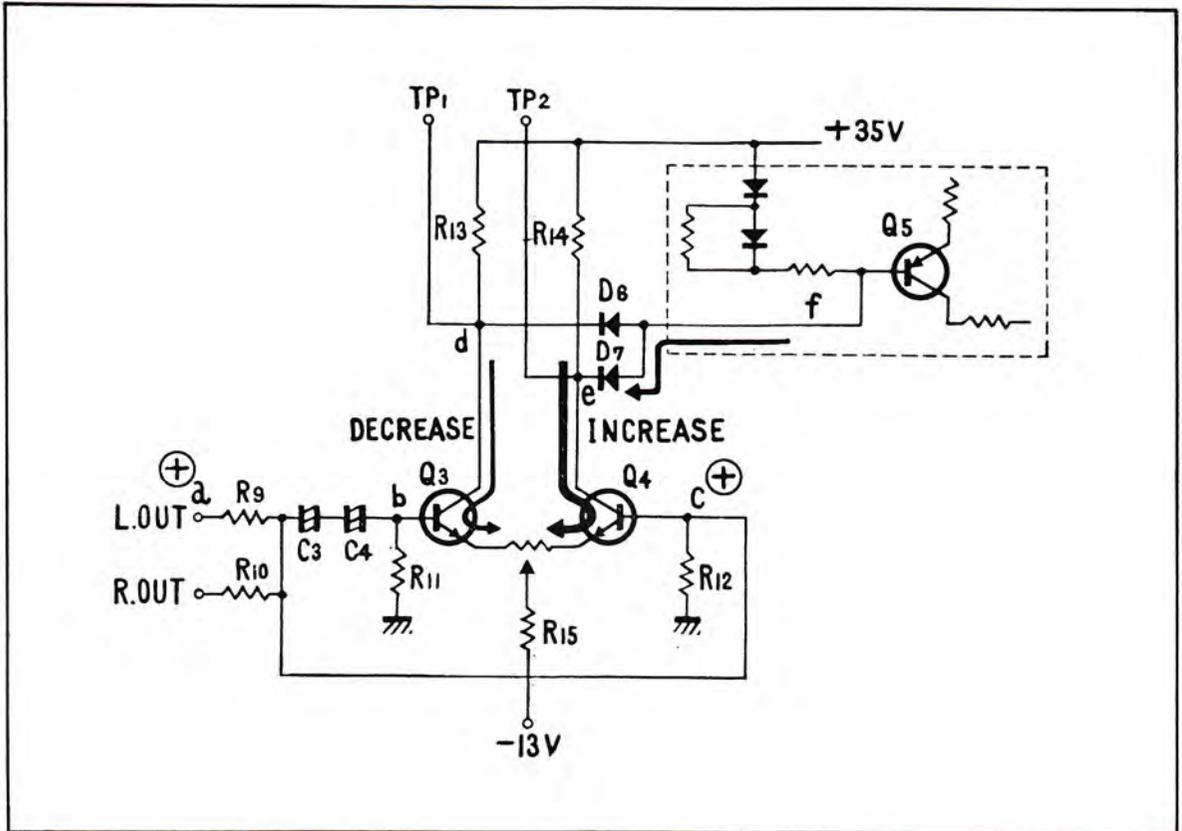
NOW WE WILL CONSIDER THE OPERATION OF THE D.C. VOLTAGE DETECTION CIRCUIT. THIS CIRCUIT IS COMPOSED OF TRANSISTORS Q-3 AND Q-4. IT IS DESIGNED TO OPERATE THE PROTECTION RELAY WHENEVER THERE IS D.C. VOLTAGE PRESENT AT THE SPEAKER TERMINALS. Q-3 AND Q-4 ARE A MATCHED PAIR FORMING A DIFFERENTIAL AMPLIFIER. A BIAS ADJUSTING CIRCUIT IS PROVIDED TO COMPENSATE FOR MINOR CIRCUIT VARIATIONS AND TO BALANCE THE DIFFERENTIAL AMP.



20.

THE REACTANCE OF C-3 AND C-4 MAY BE DISREGARDED AT ANY FREQUENCY OVER A FEW HERTZ. SINCE THE BASES OF Q-3 AND Q-4 ARE FED THE SAME SIGNAL, THERE IS NO DIFFERENCE SIGNAL PRESENT AND NO OUTPUT. HOWEVER, FOR SIGNALS BELOW A FEW HERTZ OR DIRECT CURRENT THE REACTANCE OF C-3 AND C-4 CANNOT BE DISREGARDED. THEREFORE, A DIFFERENCE SIGNAL WILL BE PRESENT BETWEEN THE BASES OF Q-3 AND Q-4. THIS WILL CAUSE OPERATION OF THE RELAY.

THE REACTANCE X_c OF CAPACITOR CAN BE SHOWN AS $X_c = \frac{1}{2\pi f c}$. AS THE FORMULA SHOWS, IF THE FREQUENCY (f) BECOMES HIGHER, THE VALUE OF X_c WILL BECOME SMALLER; IF THE FREQUENCY BECOMES LOWER, THE VALUE OF X_c WILL BECOME LARGER. IN CASE OF DIRECT CURRENT, THE VALUE OF X_c BECOMES INFINITE SINCE THE FREQUENCY IS ZERO IN THAT CASE.

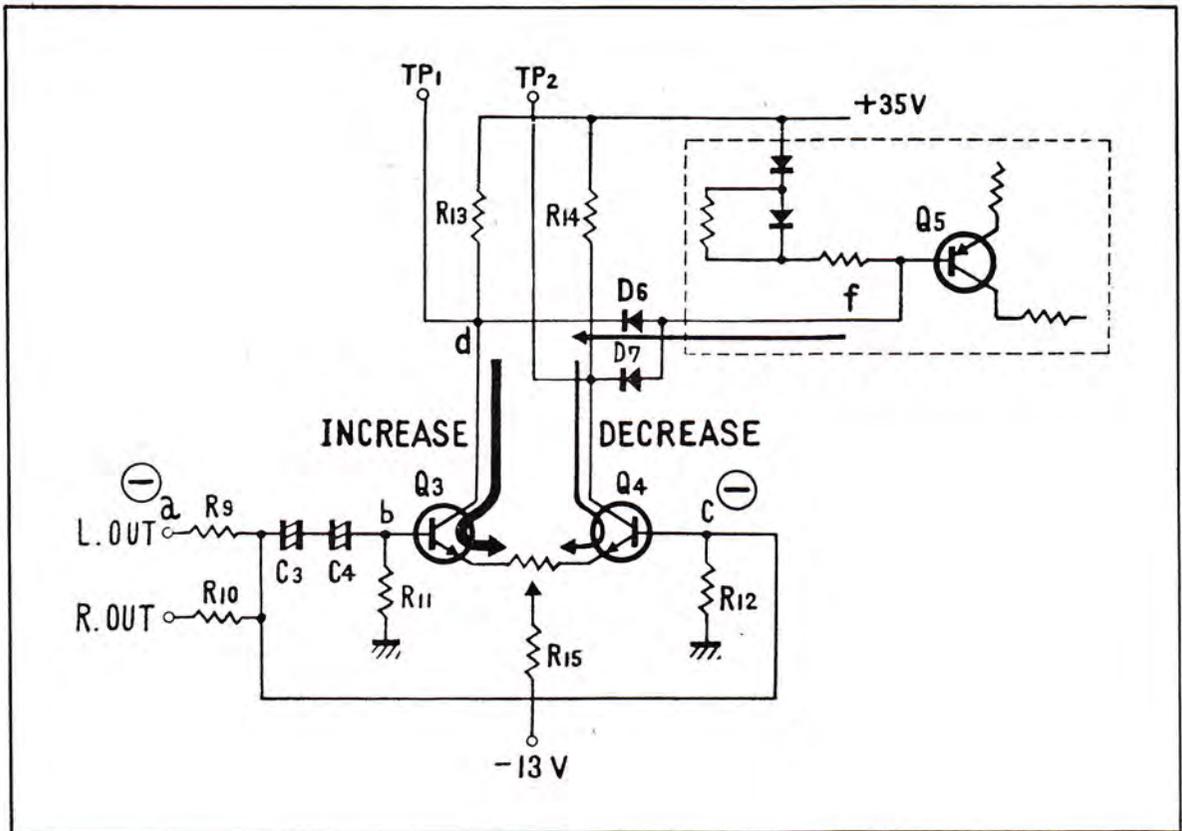


21.

NOW WE WILL DISCUSS WHAT TAKES PLACE WHEN A POSITIVE D.C. VOLTAGE IS PRESENT AT POINT "a". SINCE A CAPACITOR IS CONNECTED TO POINT "b", THE VOLTAGE AT POINT "a" WILL NOT AFFECT POINT "b". THE SAME SIGNAL AT POINT "a" IS ALSO PRESENT AT POINT "c". SINCE THE POTENTIAL POINTS "b" AND "c" ARE NO LONGER EQUAL, THE DIFFERENCE SIGNAL PRESENT AT POINT "c" WILL AFFECT THE COLLECTOR CURRENT OF Q-4. THE POTENTIAL AT POINT "e" WILL DECREASE IN PROPORTION TO THE INCREASE OF COLLECTOR CURRENT OF Q-4. THE DECREASE AT POINT "e" WILL FORWARD BIAS DIODE D-7. THIS WILL DECREASE POTENTIAL AT POINT "f", WHICH WILL TURN Q-5 ON, OPERATING THE PROTECTION RELAY.

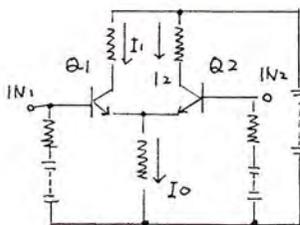


IF POINT (a) BECOMES PLUS VOLTAGE AGAINST POINT (b), DIODE BECOMES 'ON' AND THE ELECTRIC CURRENT FLOWS. IN THIS CASE, DIODE IS "BIASED IN FORWARD DIRECTION." IN CASE OF ABOVE PHOTOGRAPH, POINT (f) BECOMES 'PLUS' COMPARED WITH POINT (e) SINCE THE VOLTAGE AT POINT (e) DECLINES.

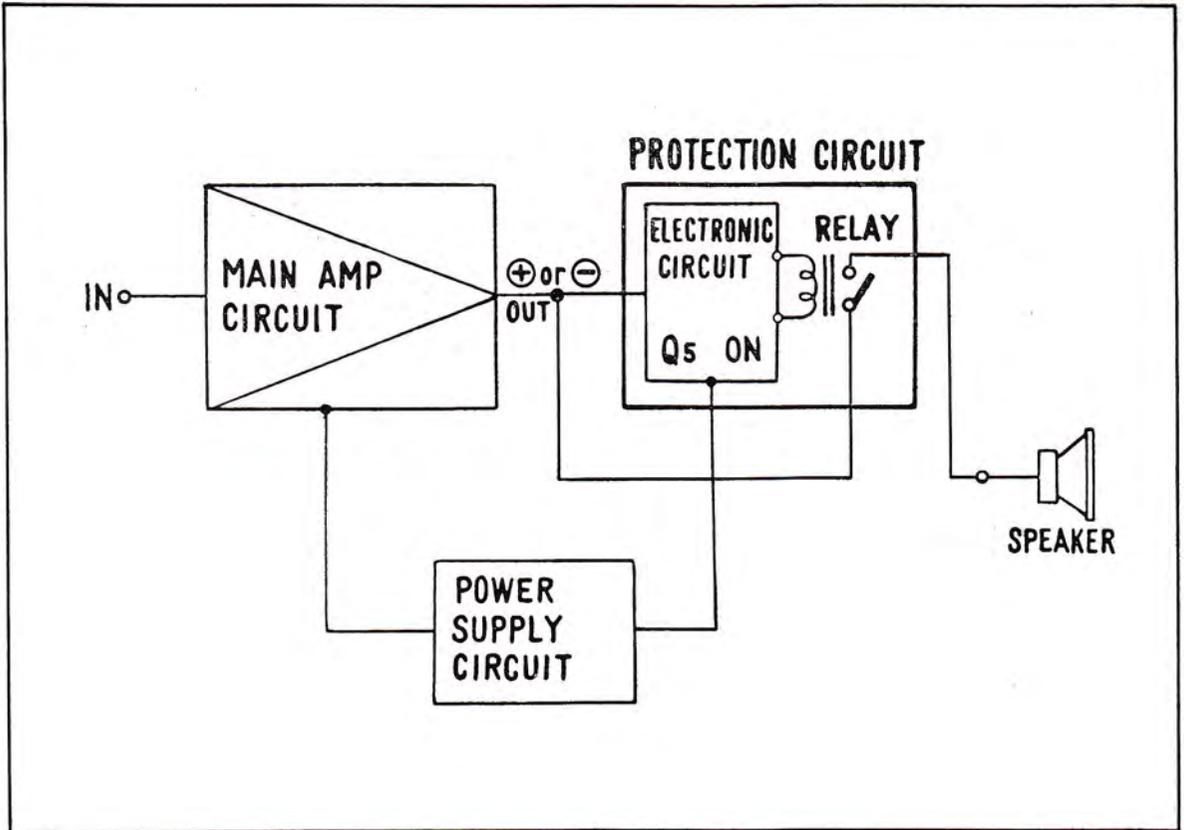


22.

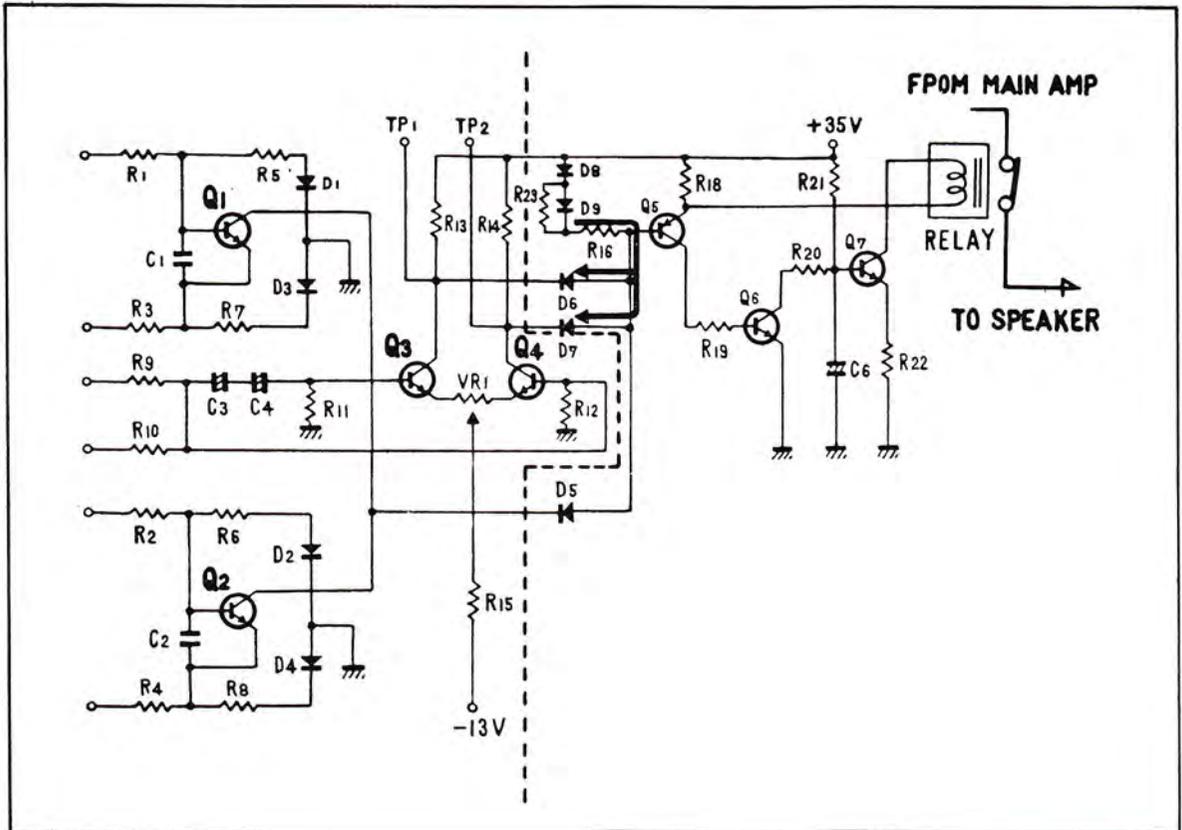
IF NEGATIVE VOLTAGE IS APPLIED TO POINT "a", THE COLLECTOR CURRENT OF Q-4 WILL DECREASE IN PROPORTION TO THE VOLTAGE AT THE BASE, WHILE THE COLLECTOR CURRENT OF Q-3 WILL INCREASE. THIS INCREASE WILL CAUSE THE POTENTIAL AT POINT "d" TO DECREASE IN INVERSE PROPORTION TO THE COLLECTOR CURRENT AT Q-3. AGAIN THIS WILL FORWARD BIAS THE DIODE D-6 WHICH WILL REDUCE POTENTIAL AT POINT "f", TURNING Q-5 ON AND OPERATING THE RELAY.



AS A CHARACTERISTIC OF THE DIFFERENTIAL AMPLIFIER CIRCUIT, I_o IS ALWAYS CONSTANT. ACCORDINGLY, THERE IS THE RELATION OF " $I_o = I_1 + I_2$." HERE, IF SIGNAL IS ADDED TO IN_1 TO INCREASE I_1 , I_2 WILL DECREASE IN ACCORDANCE WITH I_1 SINCE I_o IS CONSTANT. ALSO, IN CASE THE SIGNAL IS ADDED TO IN_2 , I_1 CHANGES IN ACCORDANCE WITH I_2 . IN CASE THE SAME SIGNAL IS ADDED TO IN_1 AND IN_2 , NO CHANGE WILL HAPPEN ON I_1 AND I_2 .



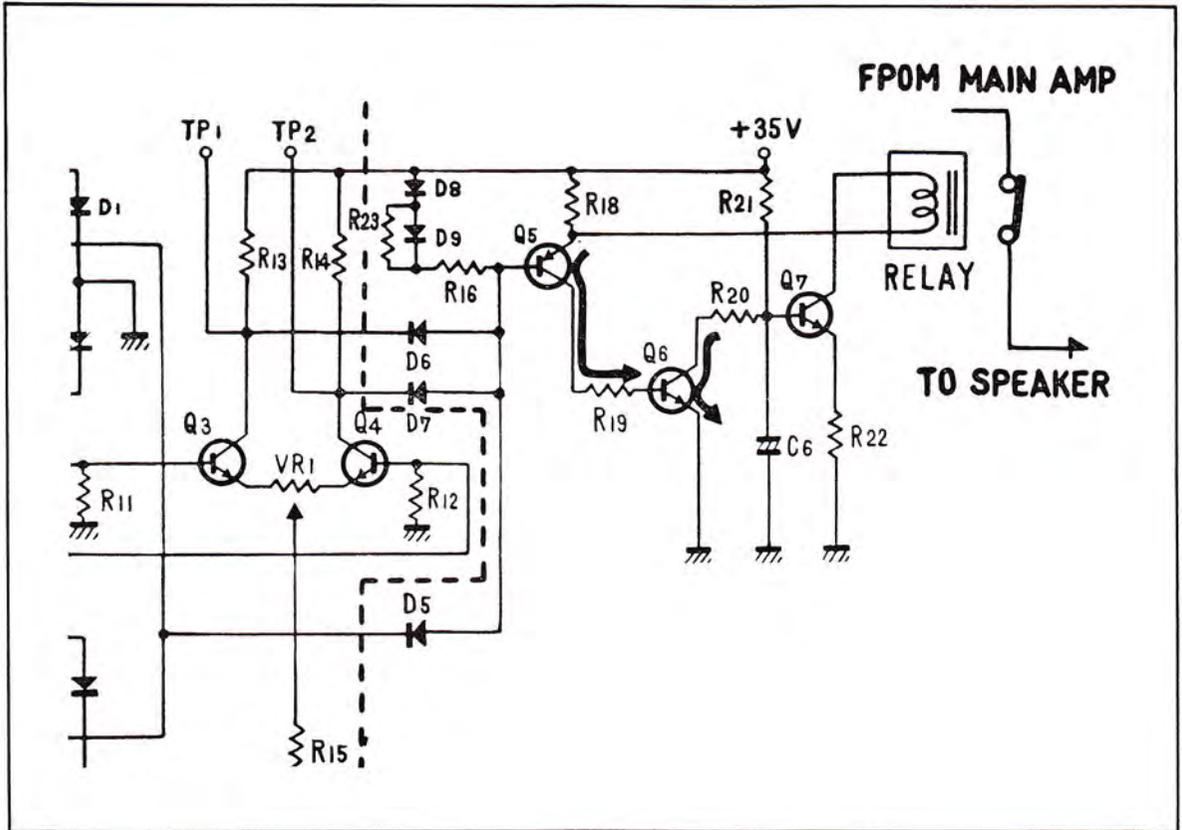
23. IN THIS MANNER, WHENEVER A POSITIVE OR NEGATIVE VOLTAGE IS PRESENT AT THE OUTPUT TERMINALS, Q-5 WILL CONDUCT, ACTUATING THE RELAY TO DISCONNECT THE SPEAKERS.



24.

NEXT WE'LL SEE HOW THE RELAY DRIVE CIRCUIT OPERATES. IF COLLECTOR CURRENT FLOWS IN Q-1, Q-2, Q-3, OR Q-4 THE DIODE CONNECTED TO THEIR COLLECTOR IS FORWARD BIASED AND THIS CAUSES A VOLTAGE DROP ACROSS R-16. THIS VOLTAGE DROP WILL DECREASE THE POTENTIAL AT THE BASE OF Q-5 BY AN AMOUNT EQUAL TO THE DROP ACROSS R-16.

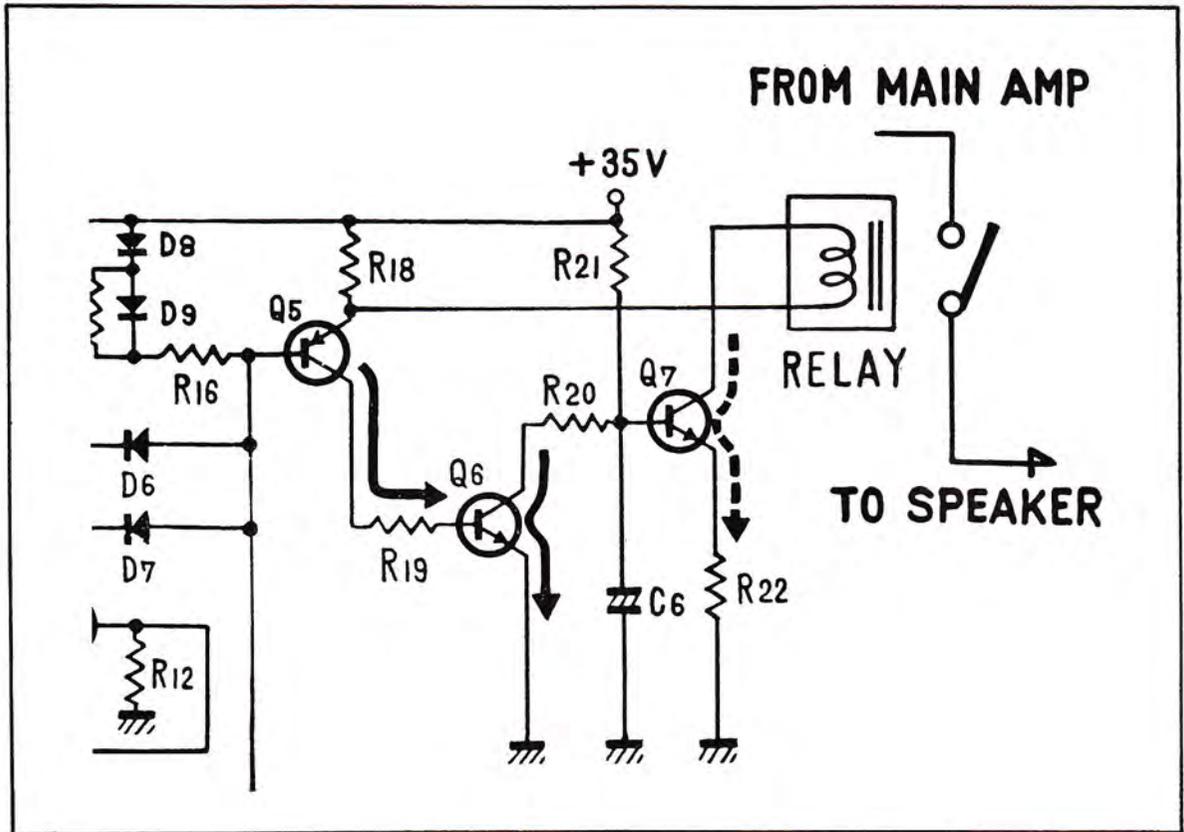
THE PROTECTION IS CARRIED OUT BY CUTTING THE RELAY WHICH CONNECT FOR OUT TERMINAL OF MAIN AMPLIFIER AND THE SPEAKER TERMINAL.



25.

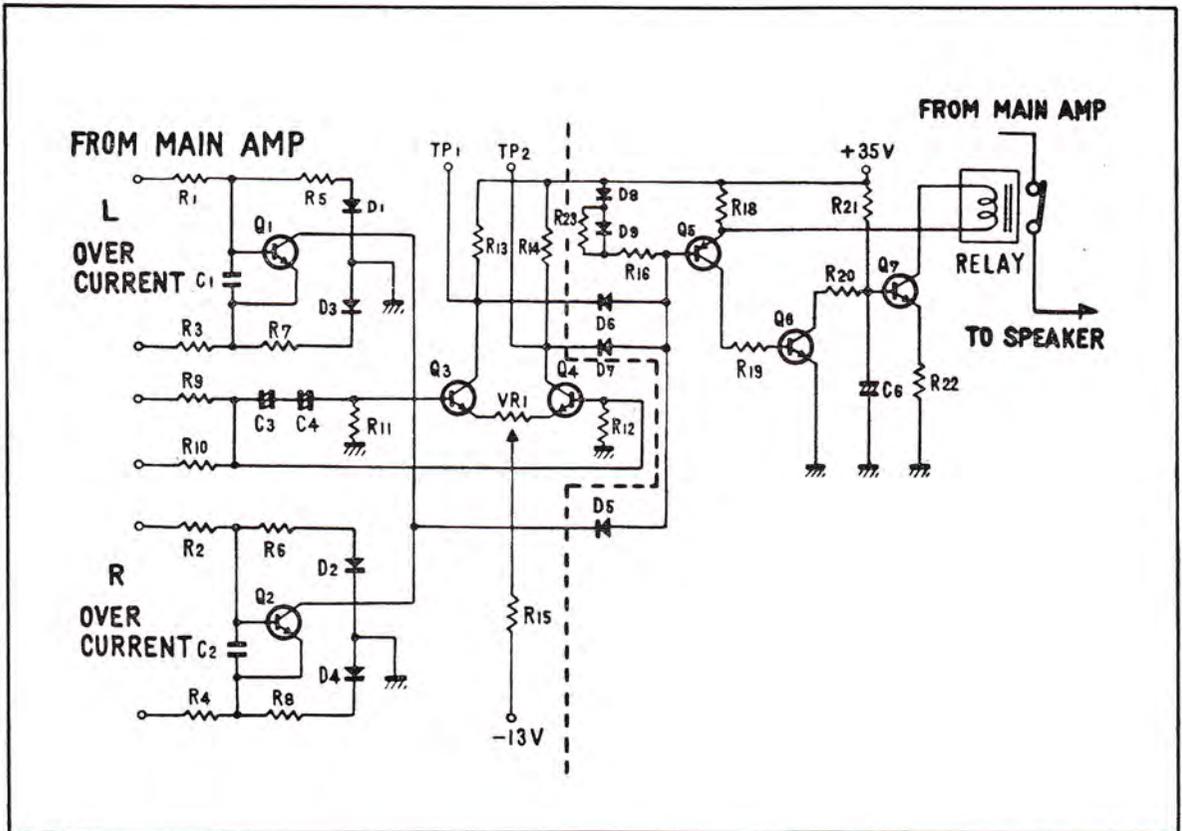
SINCE Q-5 IS A P.N.P. TRANSISTOR, IT WILL TURN ON WHENEVER ITS BASE VOLTAGE DECREASES. WHENEVER Q-5 IS ON, BASE CURRENT WILL FLOW IN Q-6 CAUSING COLLECTOR CURRENT TO FLOW.

IN CASE OF PNP TYPE TRANSISTOR, IF THE BASE VOLTAGE BECOMES MINUS K LESS THAN EMITTER VOLTAGE, THE TRANSISTOR BECOMES 'ON' AND THE COLLECTOR CURRENT FLOWS.



26.

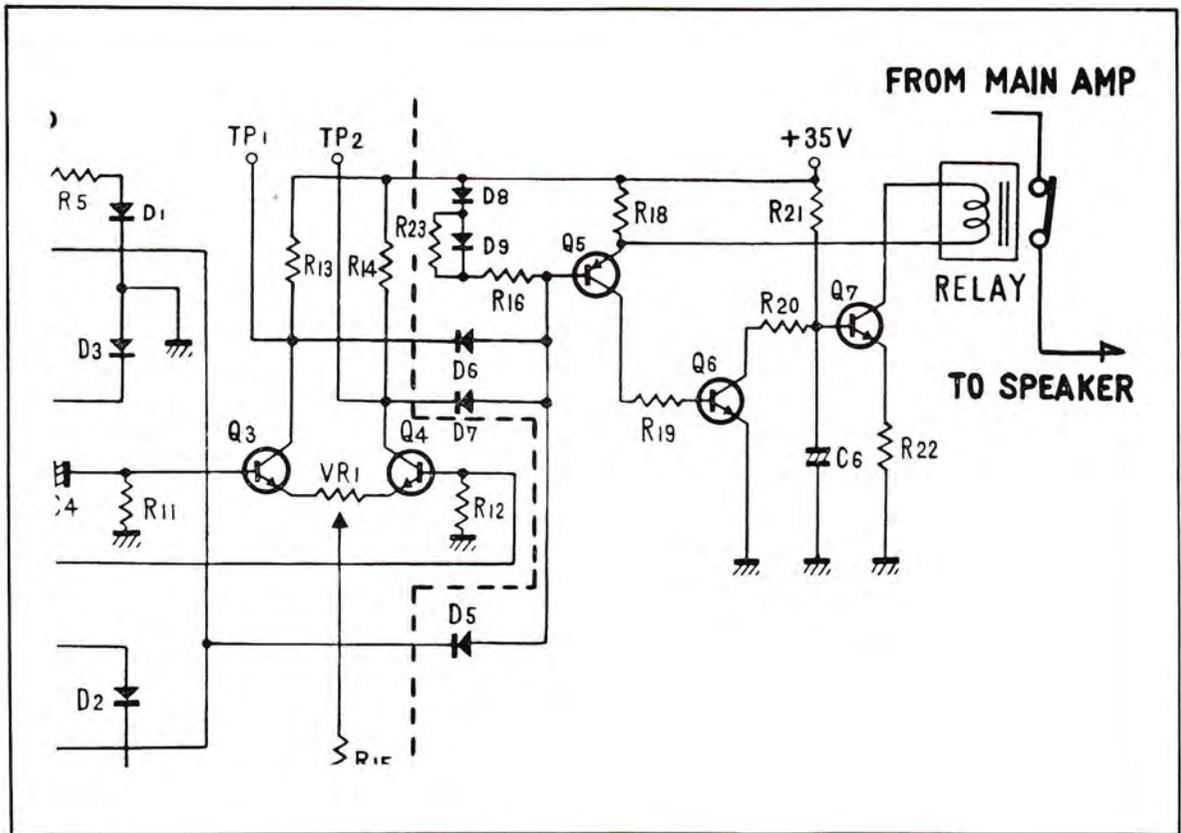
WHEN COLLECTOR CURRENT FLOWS THRU Q-6 A LARGE VOLTAGE DROP WILL APPEAR ACROSS R-21, CAUSING A BASE VOLTAGE DROP AT Q-7. THIS WILL CUT-OFF COLLECTOR CURRENT WHICH WILL DISCONNECT THE AMPLIFIER FROM THE SPEAKERS.



27.

WHENEVER THE RELAY IS NOT ENERGIZED, THE CURRENT DETECTION CIRCUIT, CONSISTING OF Q-1 AND Q-2 WILL TURN OFF WHICH INCREASE THE BASE POTENTIAL AT Q-5. THIS TURNS OFF Q-5 AND Q-6. Q-7 WILL TURN ON, ENERGIZING THE RELAY WHICH CONNECTS THE SPEAKERS AND AMP. IF THE ORIGINAL PROBLEM WHICH CAUSED THE RELAY TO OPEN IN THE FIRST PLACE STILL EXISTS THEN THE CIRCUIT WILL CYCLE ON AND OFF UNTIL THE PROBLEM IS CORRECTED.

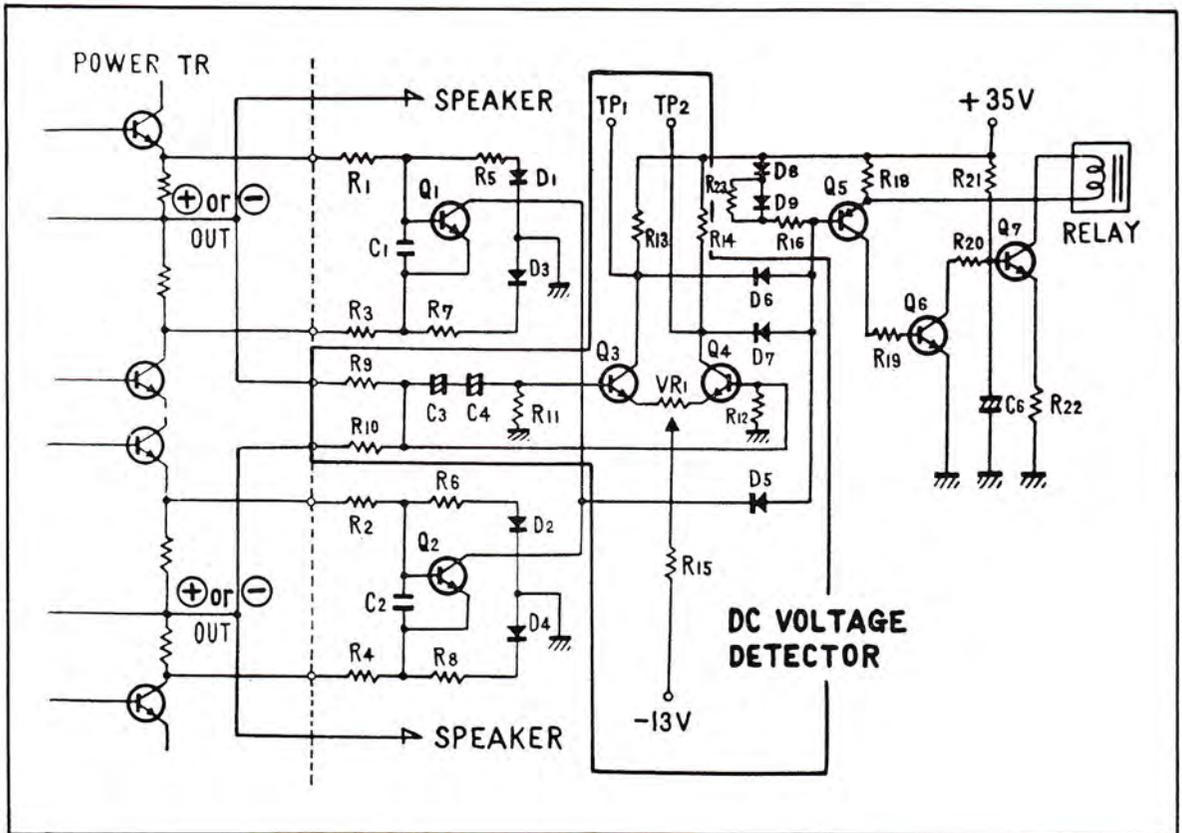
IN THE RELAY IS CUT, THE AMPLIFIER SECTION AND LOAD ARE CUT OFF, EMITTER VOLTAGE OF Q-1 BECOMES HIGHER THAN BASE VOLTAGE AND Q-1 BECOMES 'OFF.' AS A RESULT, THE ELECTRIC CURRENT DOES NOT FLOW THROUGH D₅ AND THE BASE VOLTAGE AND Q-5 RISES.



28.

TO SERVE AS A TURN-ON PULSE NOISE ELIMINATOR R-21 AND C-6 ARE CONNECTED TO THE BASE OF Q-7. THEY HAVE A TIME CONSTANT OF APPROXIMATELY FIVE SECONDS. Q-7 CANNOT TURN ON DURING THIS TIME AND THE DELAY SERVES AS A MUTING CIRCUIT AT THE TIME THE POWER IS TURNED ON.

KEEP RELEASING THE RELAY FOR A WHILE EVEN AFTER THE POWER SWITCH IS TURNED 'ON'. ACTIVE RELAY AFTER THE MAIN AMPLIFIER CIRCUIT IS STABILIZED. BY DOING SO, THE UNNECESSARY NOISE CAN BE PREVENTED FROM THE SPEAKER SYSTEM.

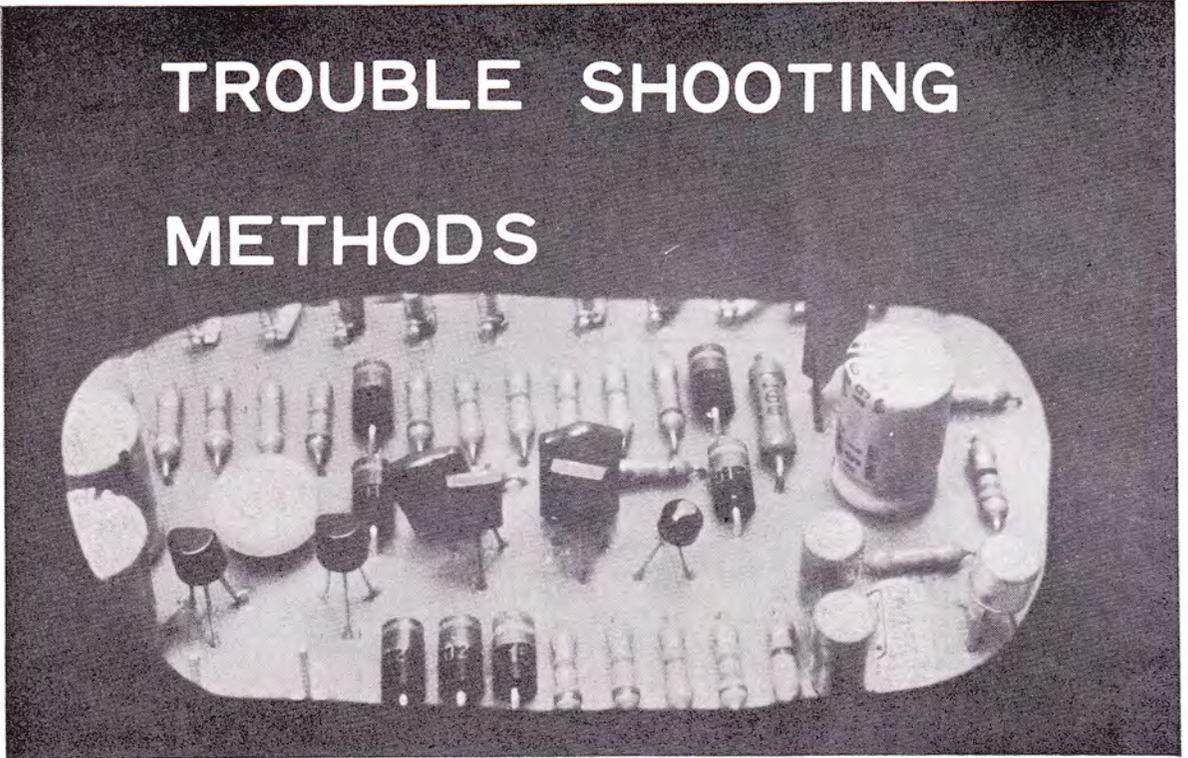


29.

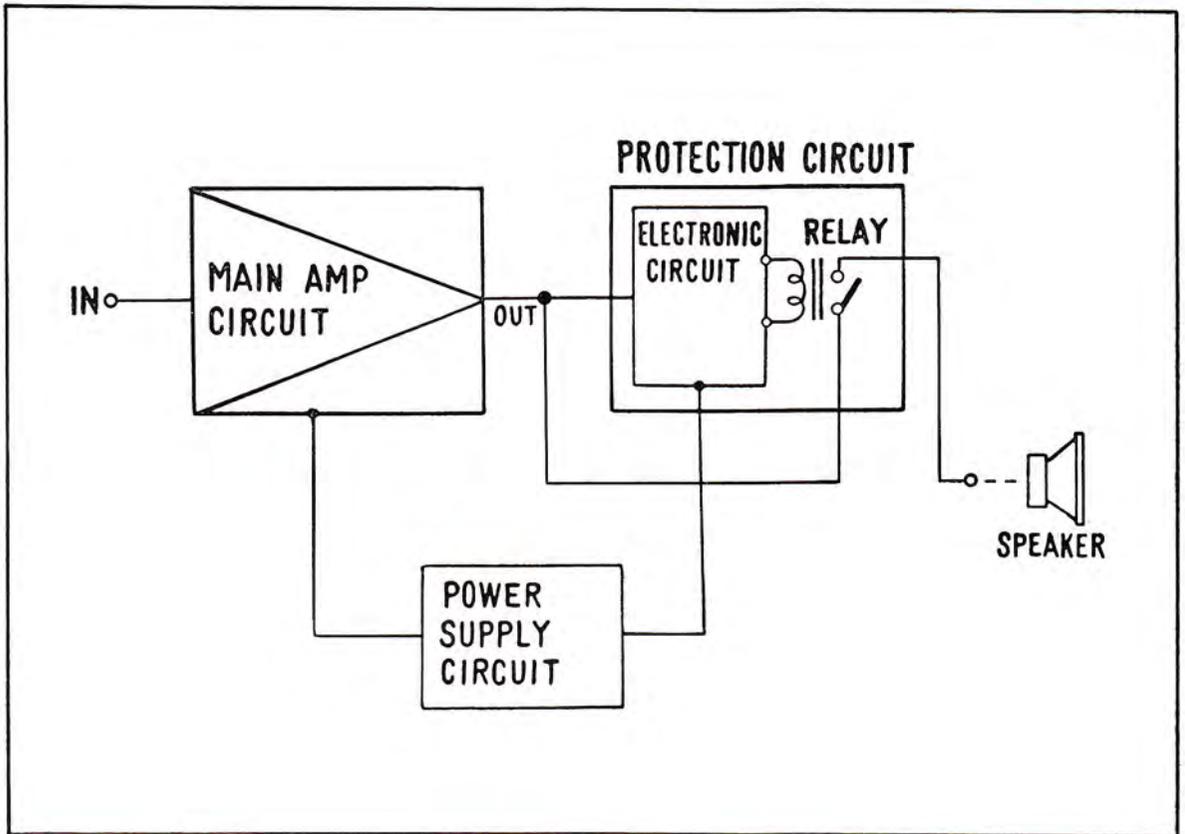
IF ANY D.C. VOLTAGE IS PRESENT AT THE OUTPUT TERMINALS OF THE AMPLIFIER, THE RELAY WILL REMAIN OPEN. UNTIL THE PROBLEM IS CORRECTED, SPEAKERS REMAIN DISCONNECTED SO NO DAMAGE IS POSSIBLE.

IN CASE THE BALANCE OF DIRECT CURRENT OF MAIN AMPLIFIER IS BROKEN, THE DIRECT CURRENT VOLTAGE APPEARS.

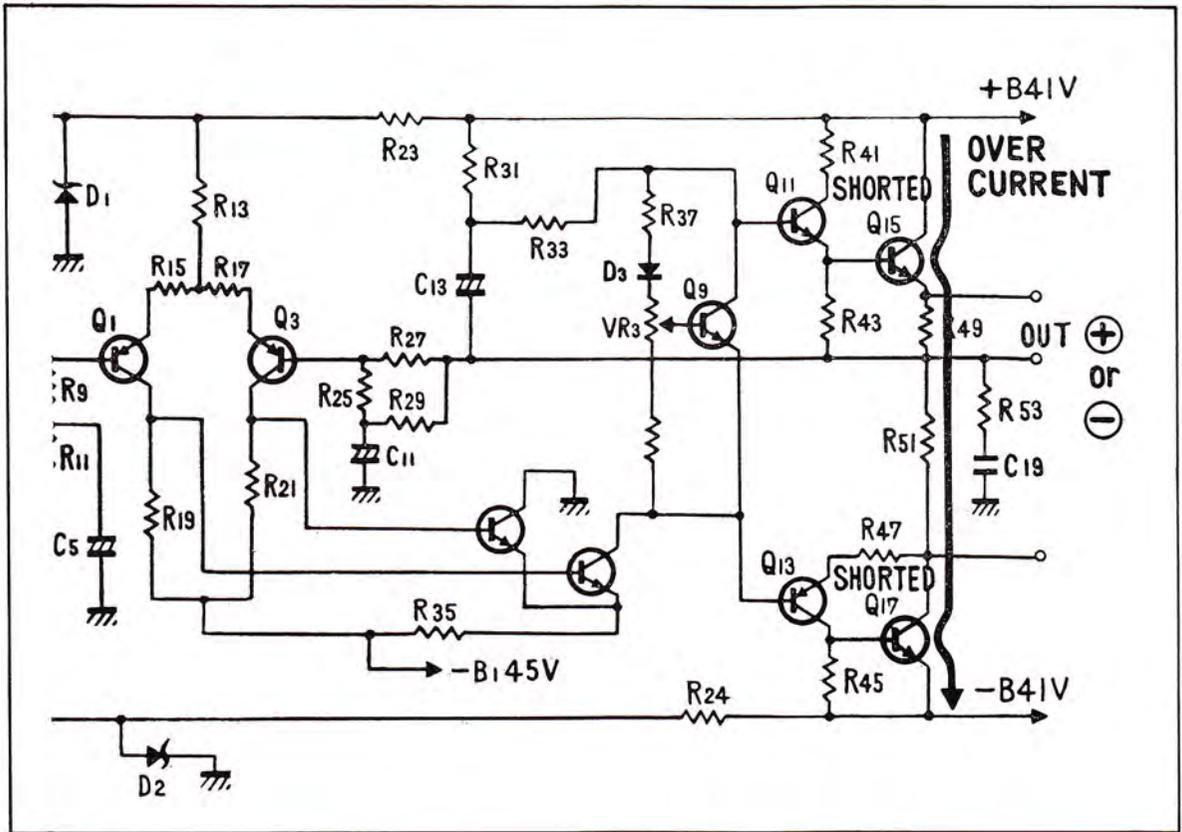
TROUBLE SHOOTING METHODS



30. NOW WE WILL CONSIDER THE TROUBLE SHOOTING PROCEDURE FOR PROTECTION CIRCUITS. YOU MUST, OF COURSE, CAREFULLY OBSERVE ALL SYMPTOMS OF FAILURE AND FOLLOW A LOGICAL PROCEDURE TO A REPAIR.

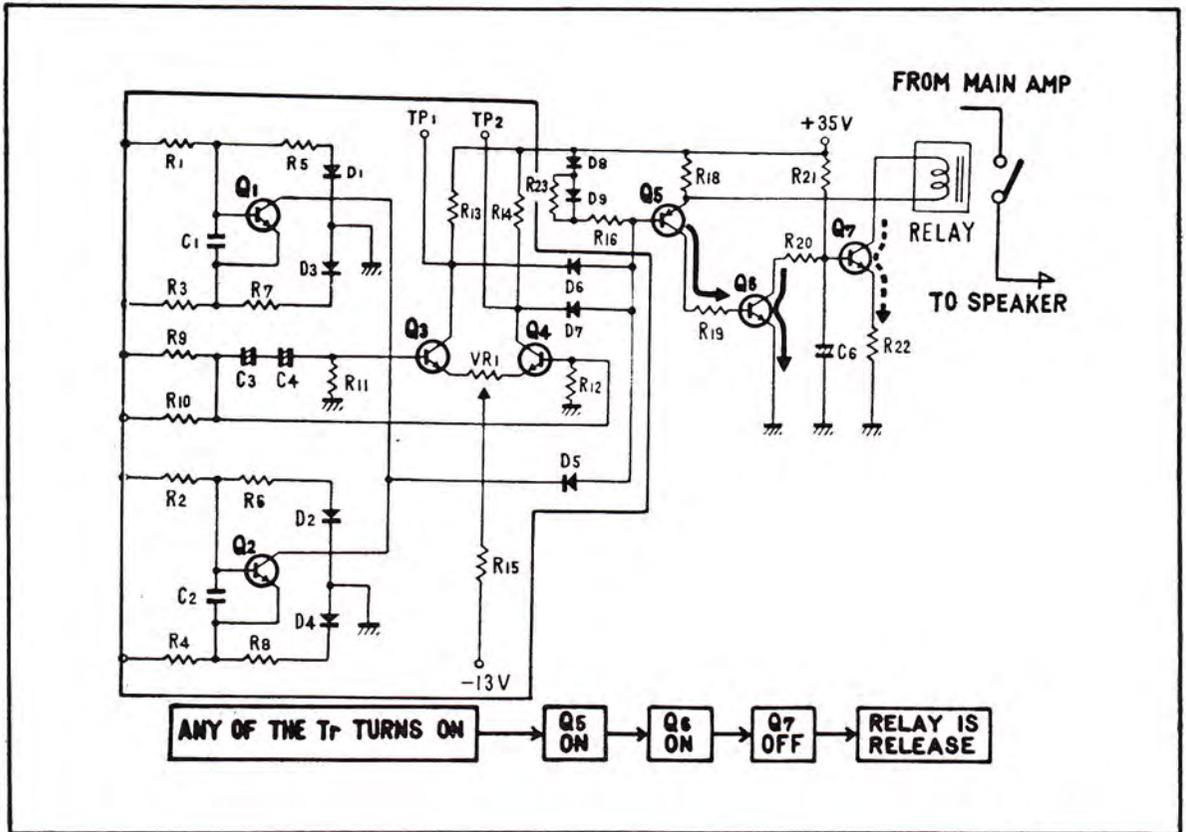


31. THE PROTECTION CIRCUIT MAY OPERATE DUE TO FAILURES EITHER IN THE MAIN AMP OR IN THE PROTECTION CIRCUIT ITSELF. TO COMMENCE TROUBLE SHOOTING, IT IS NECESSARY TO DECIDE IN WHICH CIRCUIT THE PROBLEM EXISTS.



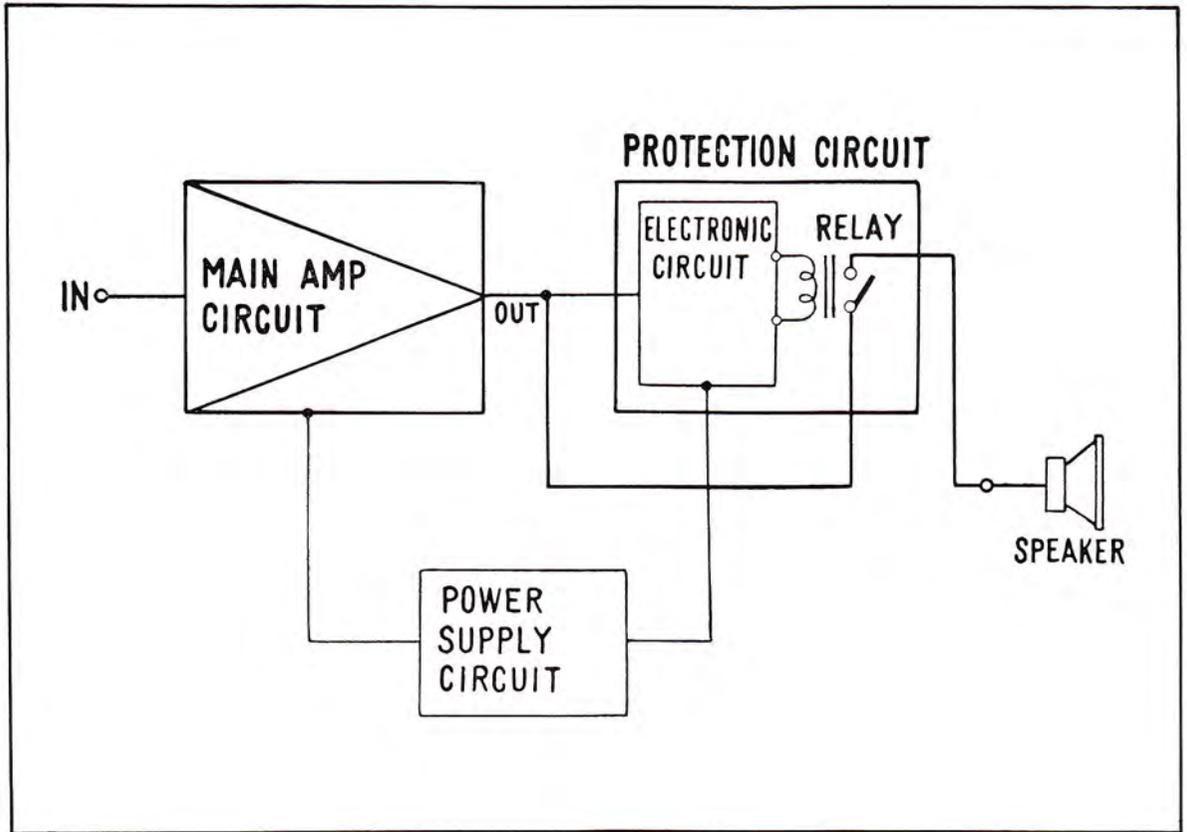
32.

FIRST WE WILL CONSIDER THE AMPLIFIER AS HAVING THE DEFECT. TWO CAUSES OF PROTECTION CIRCUIT OPERATION ARE POSSIBLE. (1) D.C. VOLTAGE IS PRESENT AT AMPLIFIER OUTPUT. (2) EXCESSIVE CURRENT IS FLOWING THRU THE OUTPUT TRANSISTORS.



33.

NOW WE WILL CONSIDER THE PROTECTION UNIT ITSELF. IF FOR ANY REASON, Q-1, Q-2, Q-3, OR Q-4 TURNS ON. THEN THIS WILL LOWER THE BASE POTENTIAL OF Q-5 WHICH WILL TURN OFF THE RELAY BY TURNING ON Q-5 AND Q-6 AND TURNING OFF Q-7.



34. GENERALLY SPEAKING, YOU CAN DECIDE IF THE PROBLEM EXISTS IN THE AMPLIFIER OR THE PROTECTION CIRCUIT, BY SEEING IF THE RELAY OPERATES OR NOT.

PROTECTION CIRCUIT DOES NOT WORK AT ALL

RELAY CLOSES IMMEDIATELY AFTER TURNING THE AMP ON

IT REMAINS IN ACTUATED STATE

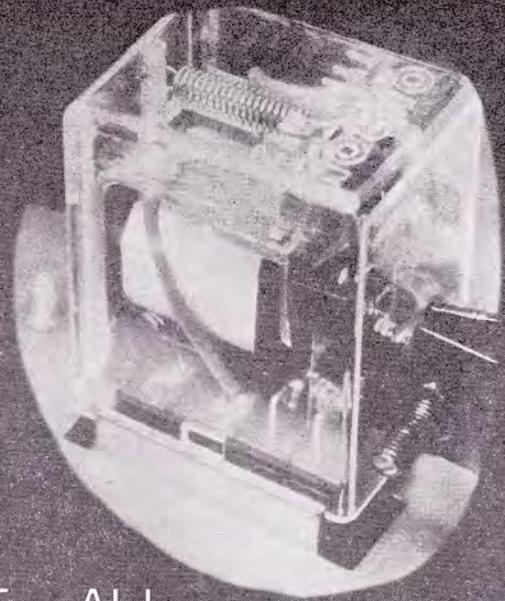
IT REPEATS PROTECTIVE OPERATIONS
AT INTERVALS OF ABOUT 5 SECONDS

IT IS IN CRITICAL STATE

IT WORKS WITH THE LAPSE OF TIME

35.

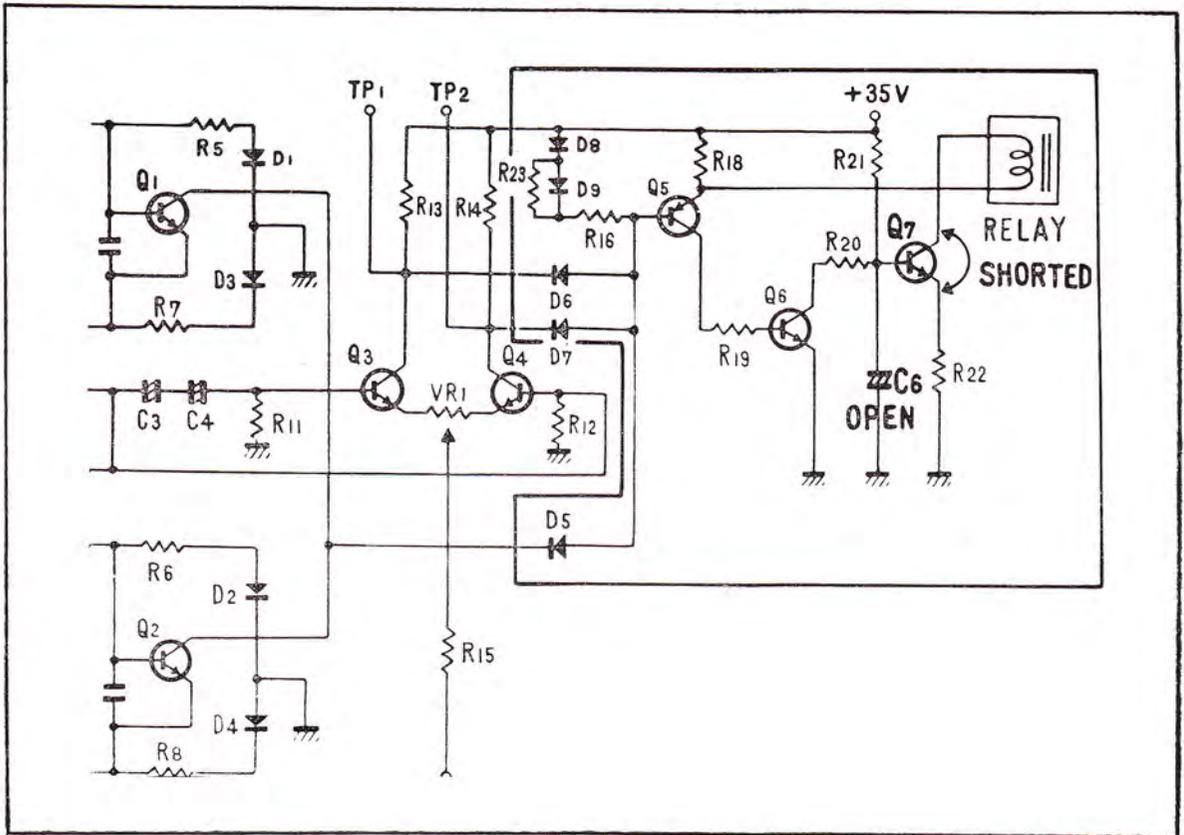
THERE ARE 6 MAIN SYMPTOMS THAT ARE CLUES TO THE PROBLEM IN A PROTECTION CIRCUIT. THESE ARE: 1. PROTECTION CIRCUIT DOES NOT OPERATE AT ALL (RELAY WILL NOT ENERGIZE). 2. RELAY CLOSES IMMEDIATELY AFTER TURNING THE AMP ON. 3. (OF No.38) PROTECTION CIRCUIT REMAINS ON AT ALL TIMES (RELAY WILL NOT DROP OUT WHEN IT IS SUPPOSED TO). 4. THE PROTECTION CIRCUIT CYCLES ON AND OFF AT INTERVALS OF APPROXIMATELY (5) FIVE SECONDS. 5. THE PROTECTION CIRCUIT IS TOO SENSITIVE AND OPERATES TOO EASILY. 6. THE PROTECTION CIRCUIT OPERATES AFTER THE AMPLIFIER HAS BEEN ON FOR THE SOME TIME AND APPEARS TO HAVE BEEN WORKING NORMALLY. (TEMPERATURE SENSITIVE).



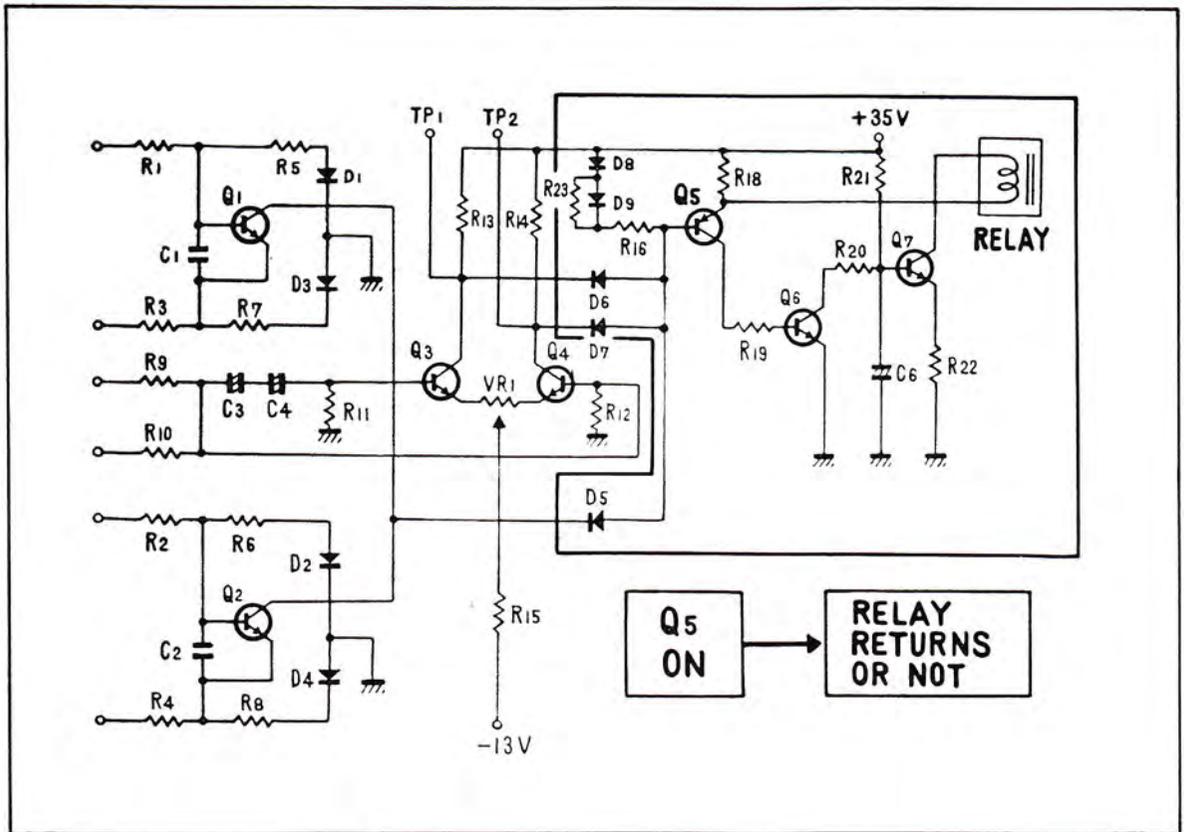
PROTECTION CIRCUIT
DOES NOT WORK AT ALL

36. IF THE PROTECTION CIRCUIT DOES NOT OPERATE AT ALL, THEN CHECK TO SEE IF IT IS RECEIVING POWER FROM THE POWER SUPPLY.

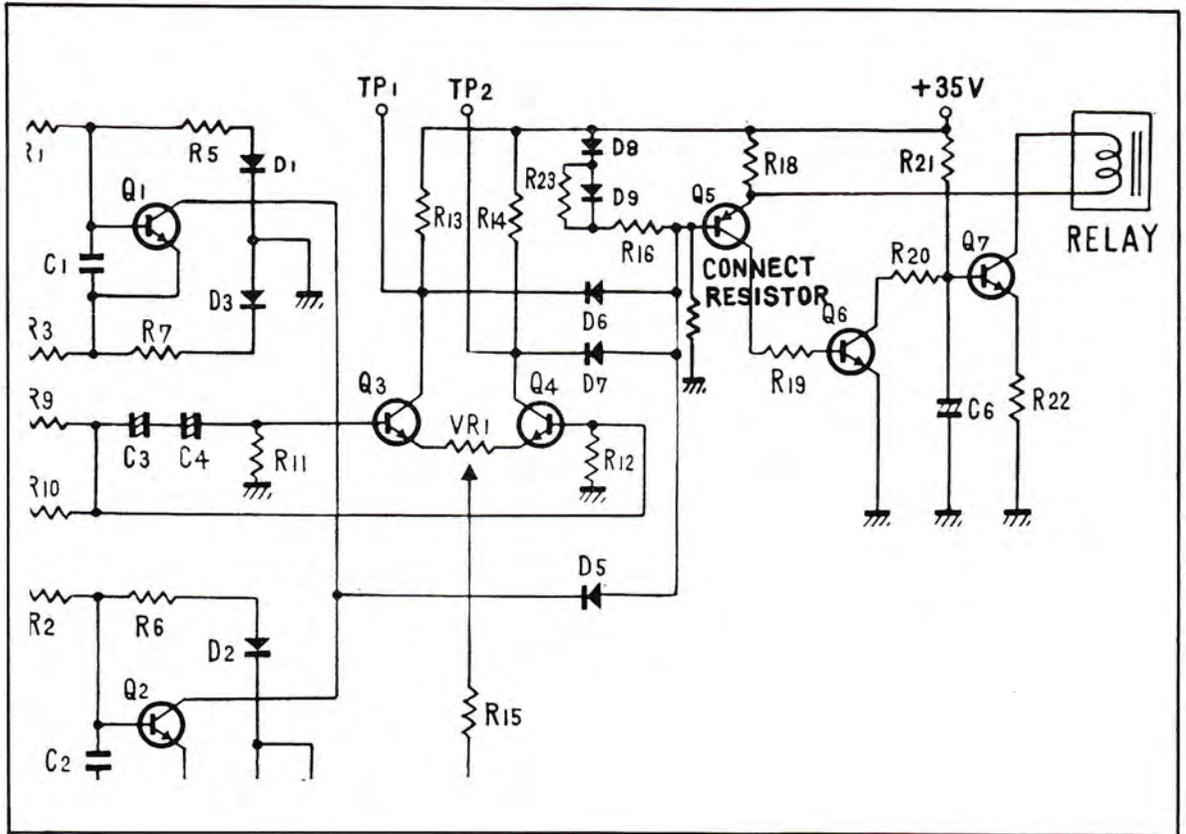
SEE CUT 28 AS TO THE EXPLANATION OF MUTING ACTION.



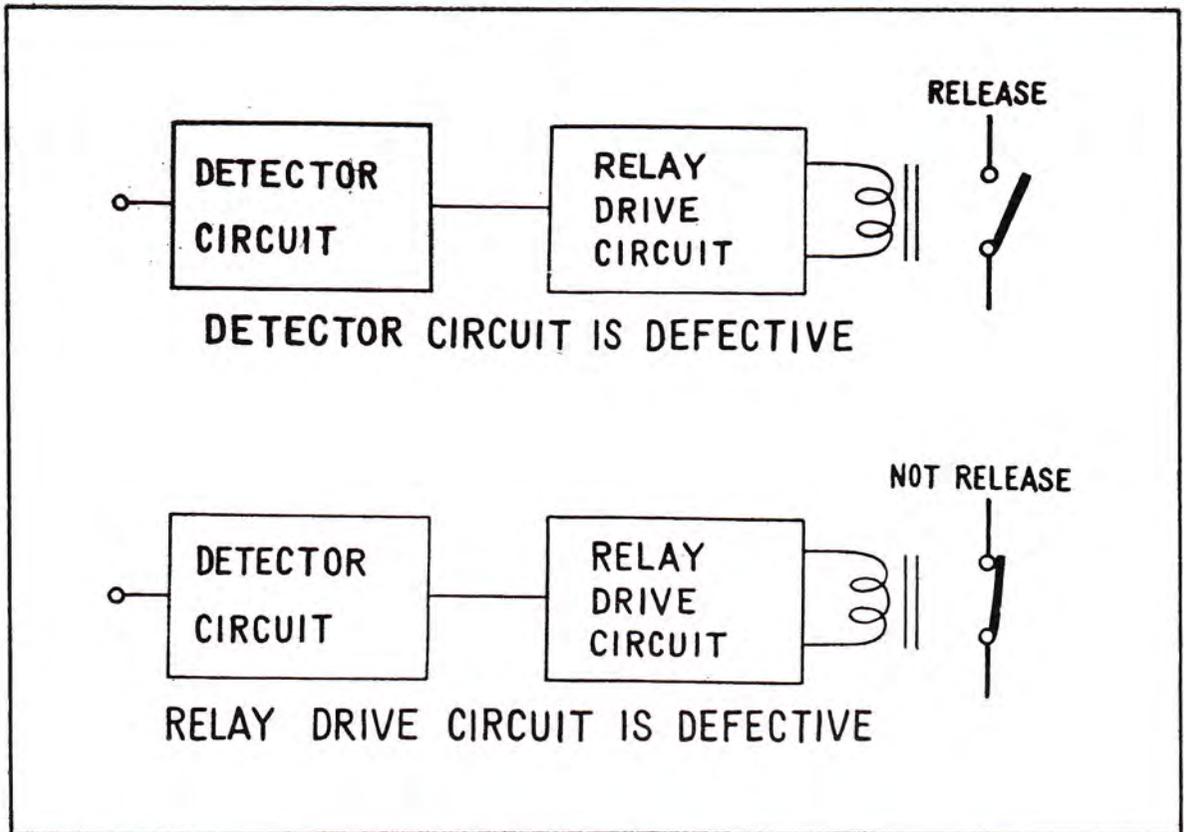
37. IF THE RELAY OPERATES AS SOON AS THE AMP IS TURNED ON, THEN THERE MAY BE A COLLECTOR-EMITTER SHORT IN Q-7, OR C-6 IS OPEN.



38. HOWEVER, IF THE MUTING ACTION IS NORMAL, THAT IS IF THE RELAY OPERATES APPROXIMATELY FIVE SECONDS AFTER TURN ON, WE CAN VERIFY NORMAL OPERATION OF Q-5, Q-6 AND Q-7 AND POSSIBLE FAILURE IN THE DETECTION SIDE Q-1 THRU Q-4.

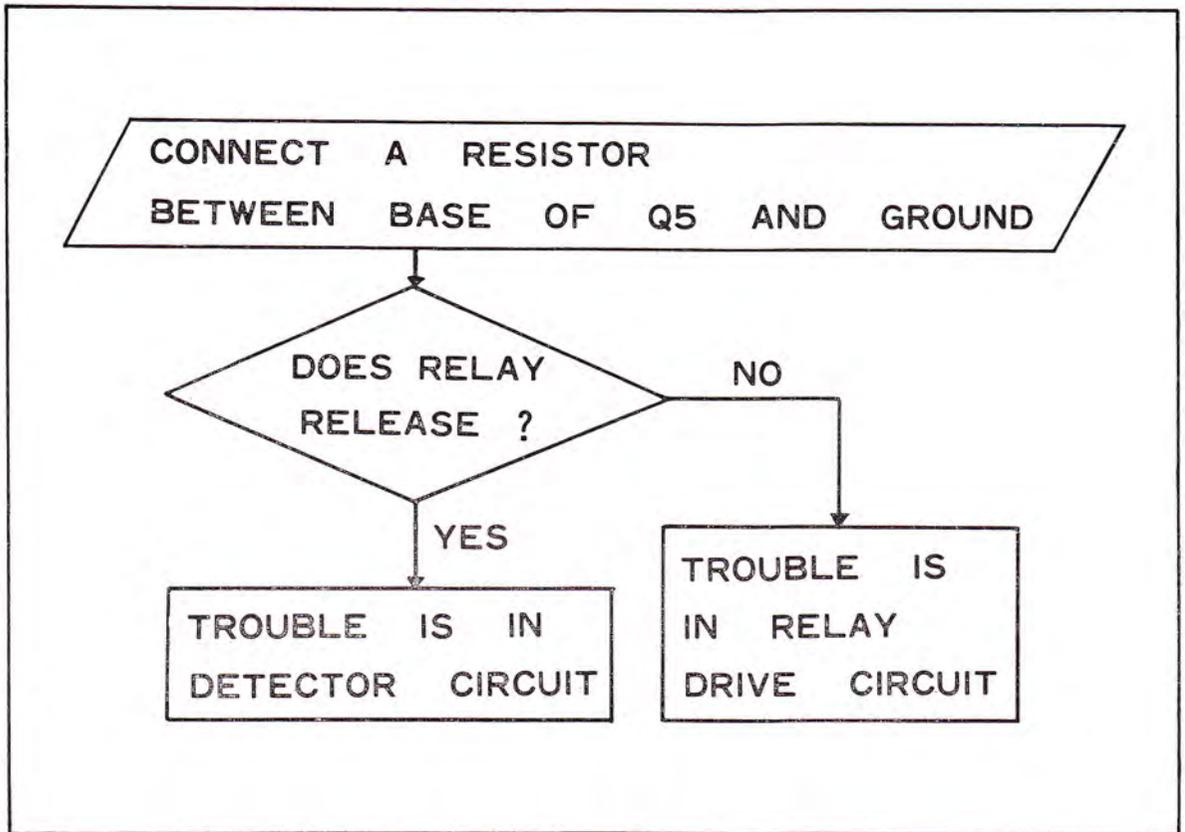


39. TO CHECK THE RELAY OPERATION WE CAN TURN Q-5 ON BY CONNECTING A 50KΩ 1/2W RESISTOR FROM THE BASE OF Q-5 TO GROUND.



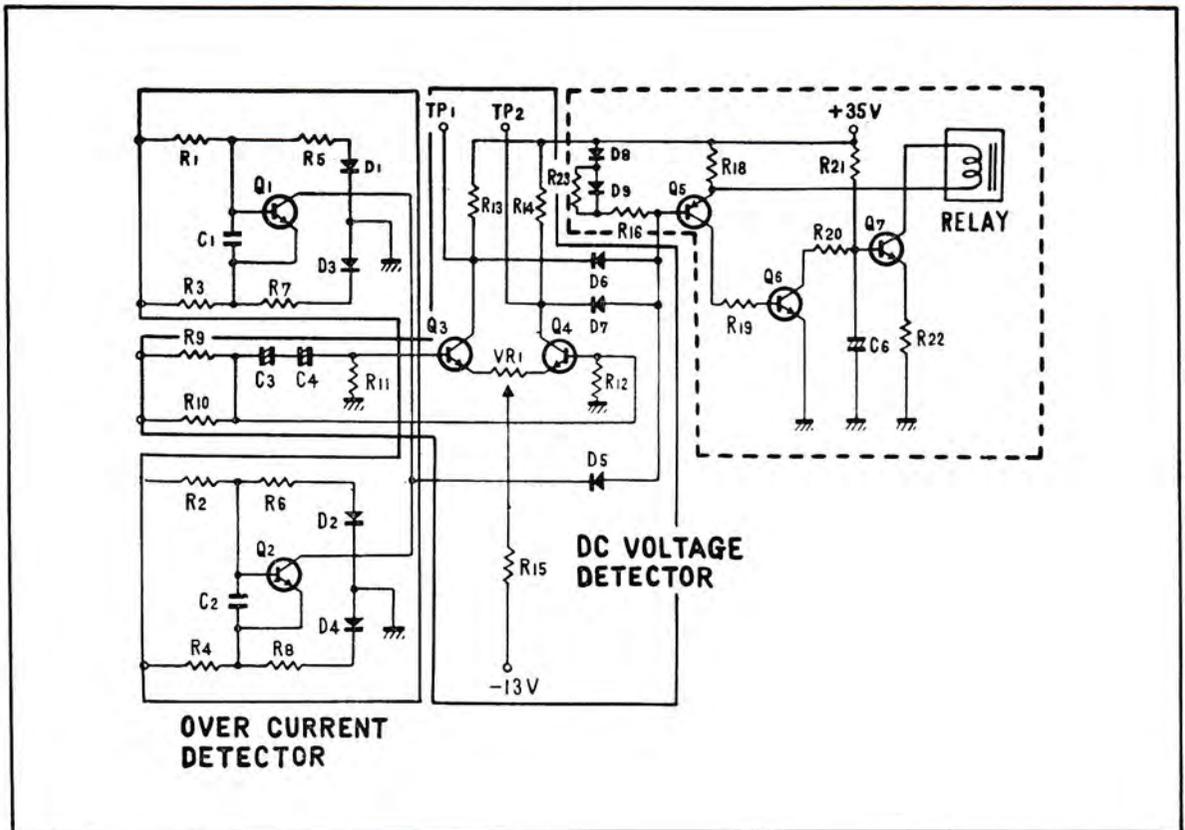
40.

IF THE RELAY OPENS AND DISCONNECTS THE SPEAKERS, THEN THE RELAY DRIVE CIRCUIT IS O.K. THE FAILURE MUST BE IN THE DETECTION CIRCUITS.



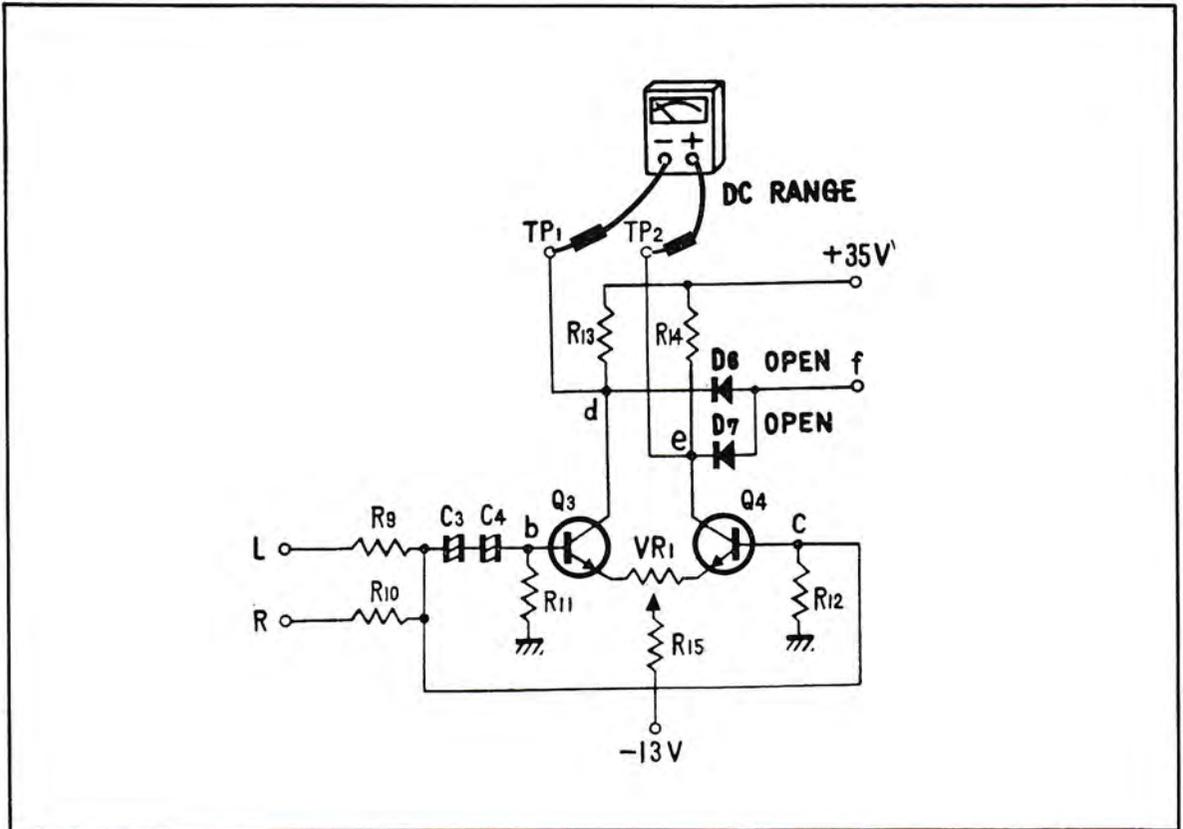
41.

CONNECT A $50K\Omega$ RESISTOR BETWEEN THE BASE OF Q-5 AND GROUND. IF THE RELAY OPENS AND DISCONNECTS THE SPEAKERS, THEN THE FAILURE IS IN THE DETECTIVE CIRCUITS. IF THE RELAY DOES NOT OPEN, THEN THE RELAY DRIVE CIRCUIT IS DEFECTIVE.

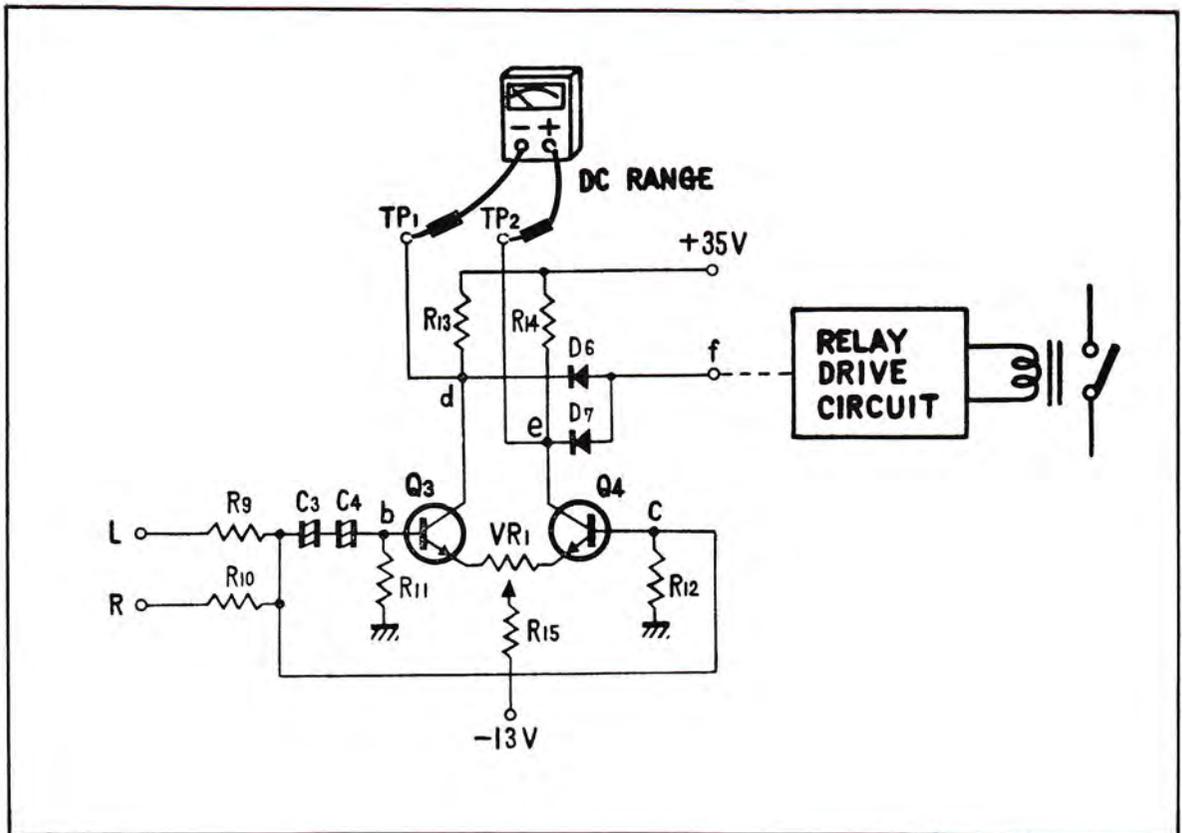


42.

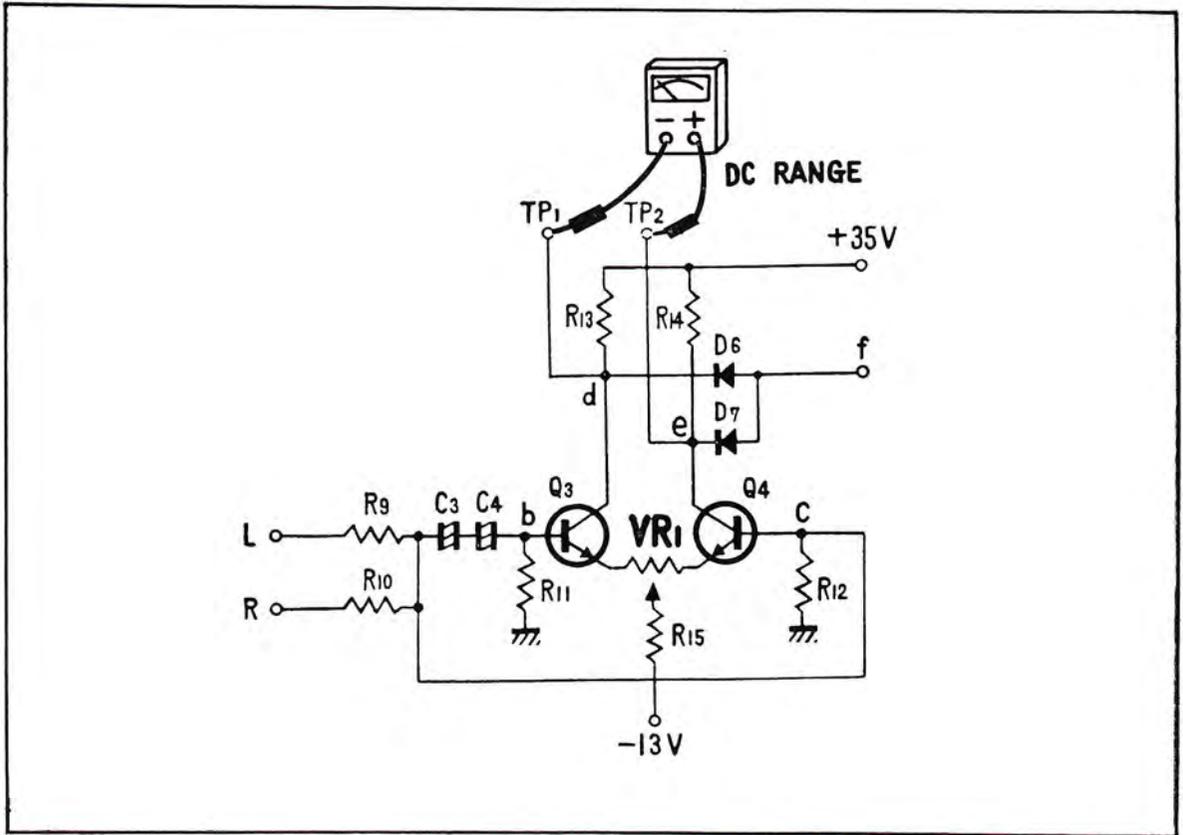
IF YOU DETERMINE THE DETECTION CIRCUITS ARE AT FAULT, WE WILL SHOW YOU HOW TO JUDGE IF IT IS THE VOLTAGE OR CURRENT CIRCUITS.



43. TO CHECK THE D.C. VOLTAGE DETECTION CIRCUIT, CONNECT A MULTIMETER SET FOR D.C. VOLTS BETWEEN TP-1 AND TP-2. TURN VR-1 IN BOTH DIRECTIONS.



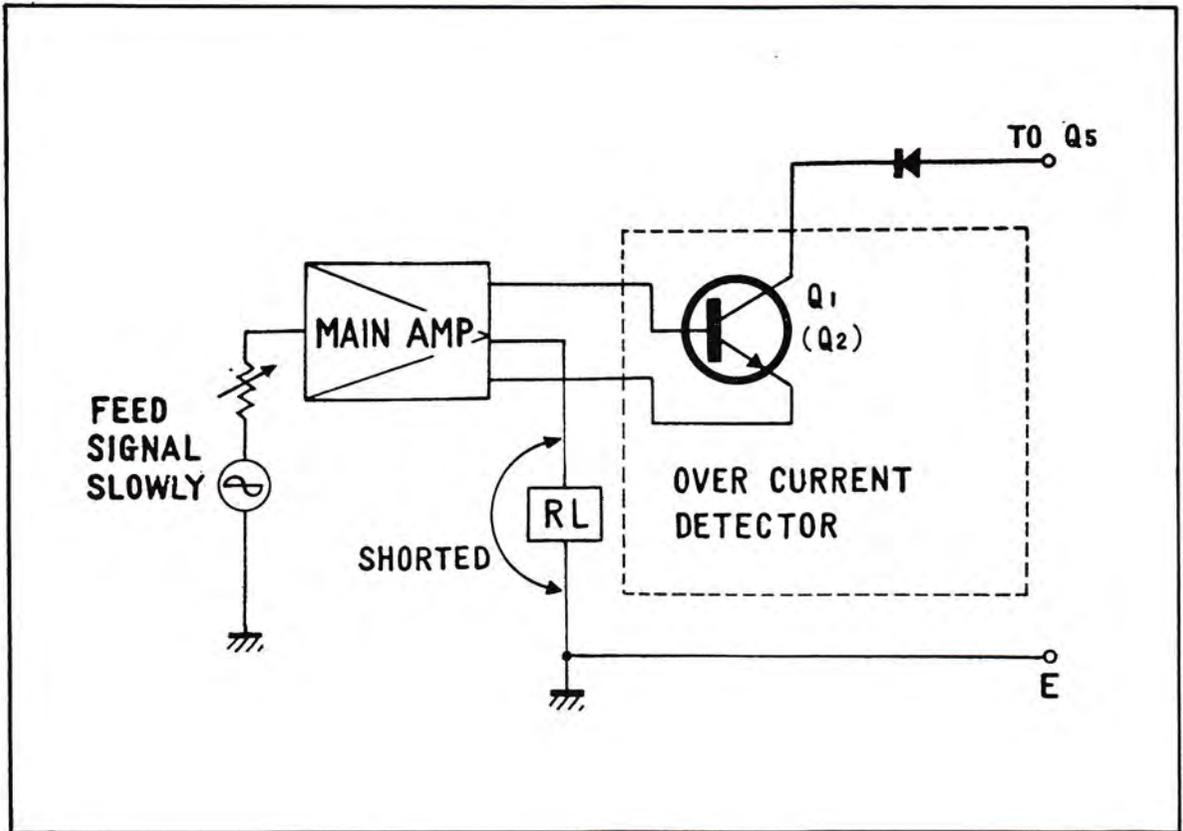
44. WHEN YOU TURN VR-1 CLOCKWISE AND COUNTER-CLOCKWISE, IF THE CIRCUIT IS NORMAL, AT SOME POINT, IN THE ROTATION, YOU WILL GET A VOLTAGE READING BETWEEN TP-1 AND TP-2. ALSO, THE RELAY SHOULD OPEN. IF WHEN YOU FIRST CHECK THE VOLTAGE READING AND ROTATING VR-1 HAS NO AFFECT, THEN Q-3 OR Q-4 MAY BE DEFECTIVE.



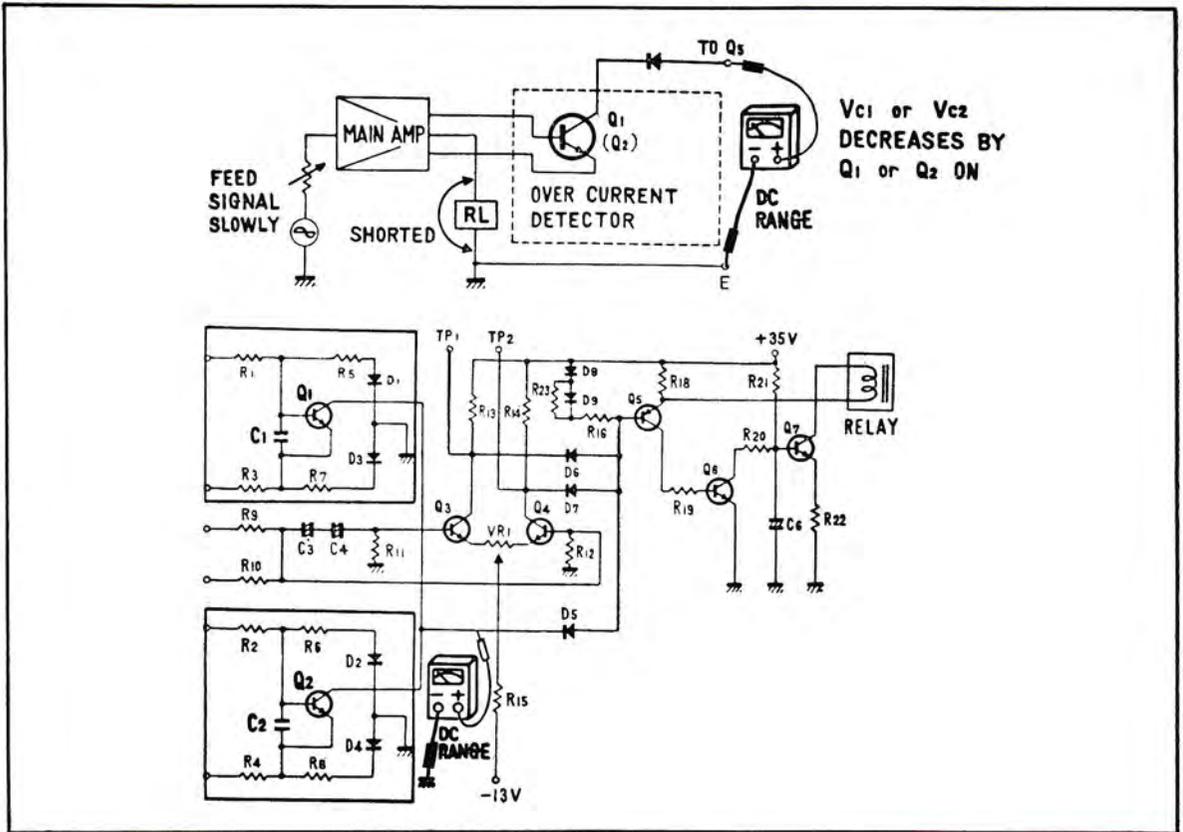
45.

IF ROTATING VR-1 AFFECTS YOUR METER READING BUT THE RELAY STILL DOES NOT OPERATE THEN THE DIODE D-6 OR D-7 MAY BE DEFECTIVE.

AFTER MAKING THE CHECK, BE SURE TO ADJUST THE VR-1 SO THAT THE POTENTIAL BETWEEN TP-1 AND TP-2 BECOMES ZERO.

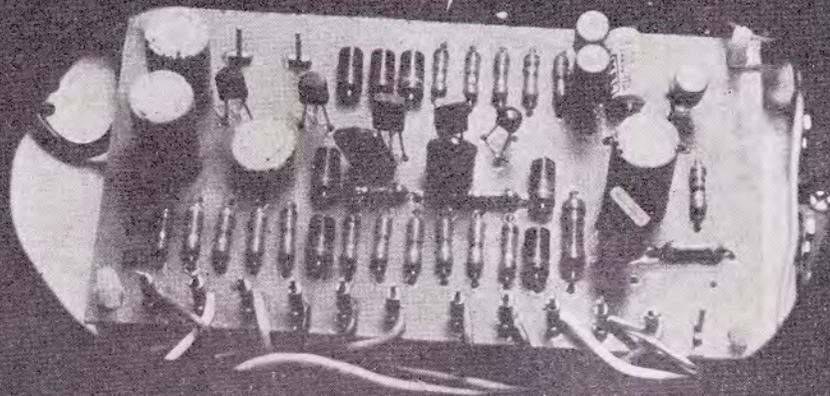


46. TO CHECK THE EXCESSIVE CURRENT DETECTION CIRCUIT INSURE THAT NO SIGNAL IS FED INTO THE AMPLIFIER. SHORT CIRCUIT BOTH OUTPUT TERMINALS AND VERY SLOWLY FEED A SIGNAL TO THE INPUT. YOU SHOULD BE CHECKING WITH YOUR MULTIMETER THAT THE COLLECTOR VOLTAGE OF Q-1 AND Q-2 DECREASES QUICKLY AS THEY TURN ON.



47.

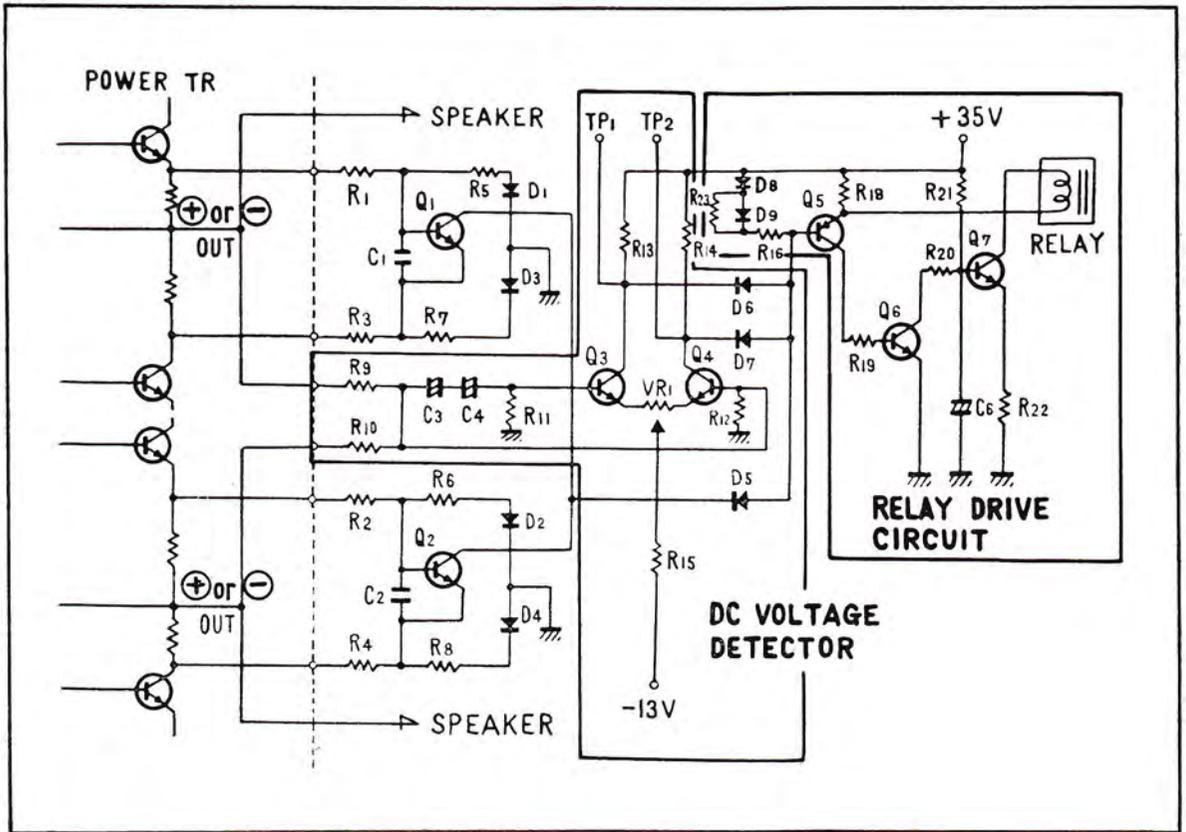
IF THE COLLECTOR VOLTAGE DECREASES, THEN THE CIRCUIT IS O.K. IF NOT THEN Q-1 OR Q-2 MAY BE DEFECTIVE, OR C-1 OR C-2 MAY BE SHORTED. BE SURE NOT TO INCREASE THE INPUT SIGNAL RAPIDLY AS YOU MAY DAMAGE THE POWER TRANSISTORS.



DETECTOR CIRCUIT REMAINS
ACTUATED ALL THE TIME

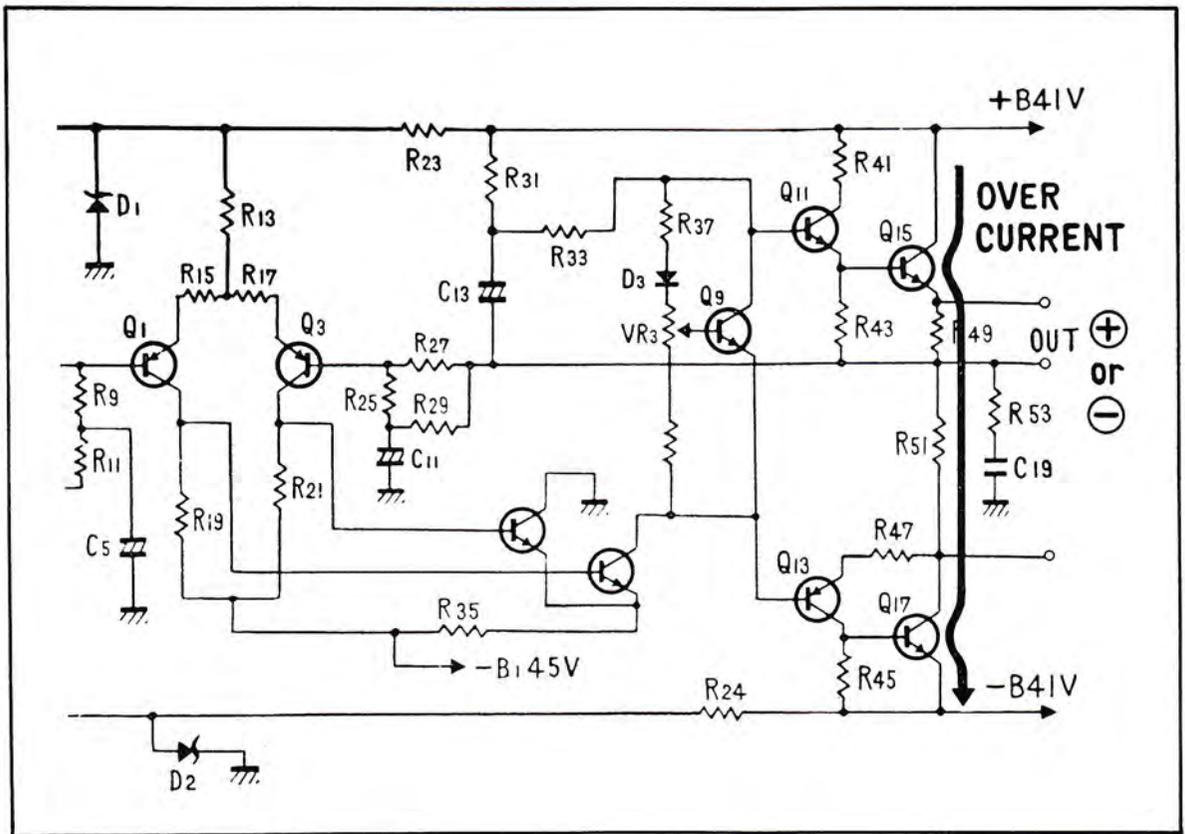
48. NOW WE WILL CONSIDER THE PROBLEM OF THE PROTECTION CIRCUIT REMAINING ACTUATED ALL THE TIME. THIS IS PROBABLY CAUSED BY D.C. VOLTAGE AT THE OUTPUT TERMINALS.

SEE CUT 24 THRU 33 AS TO THE DETAILS.



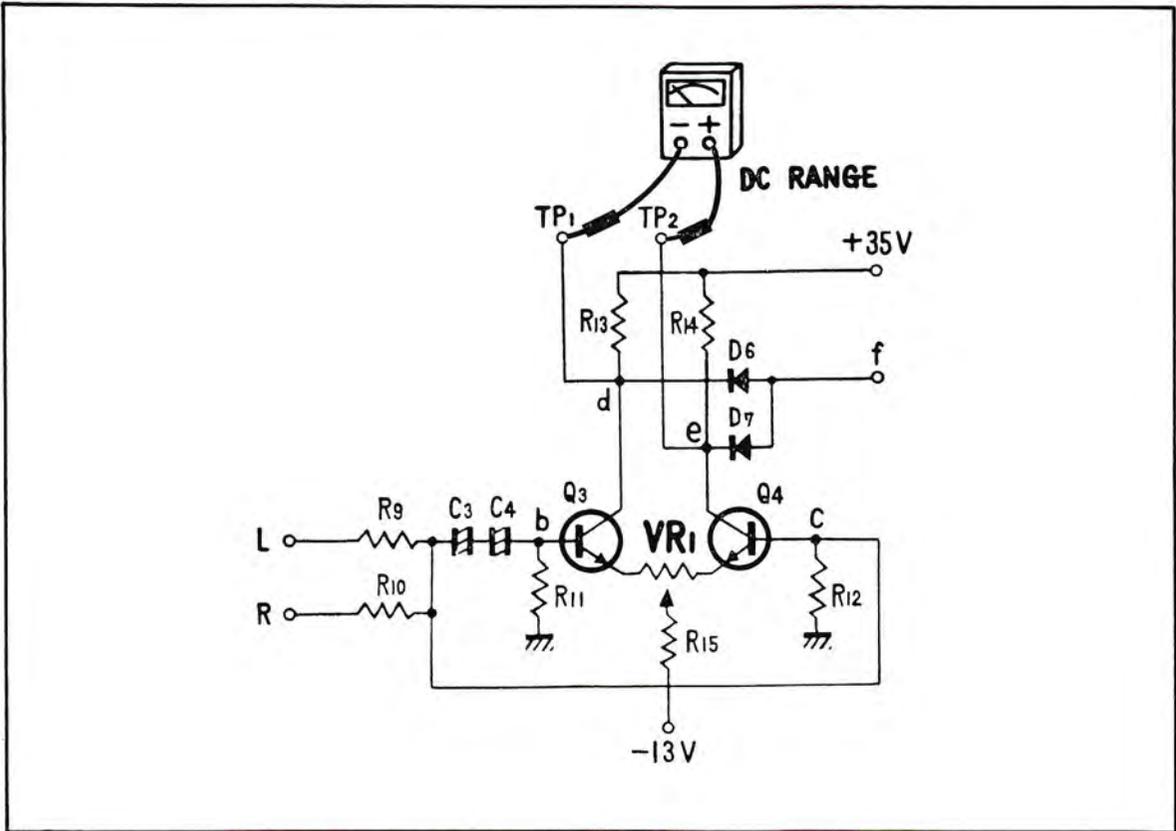
49.

OTHER POSSIBLE CAUSES FOR NON-OPERATION OF THE RELAY MAY ALSO BE A FAILURE OF THE RELAY DRIVE CIRCUIT OR THE D.C. VOLTAGE DETECTION CIRCUIT.

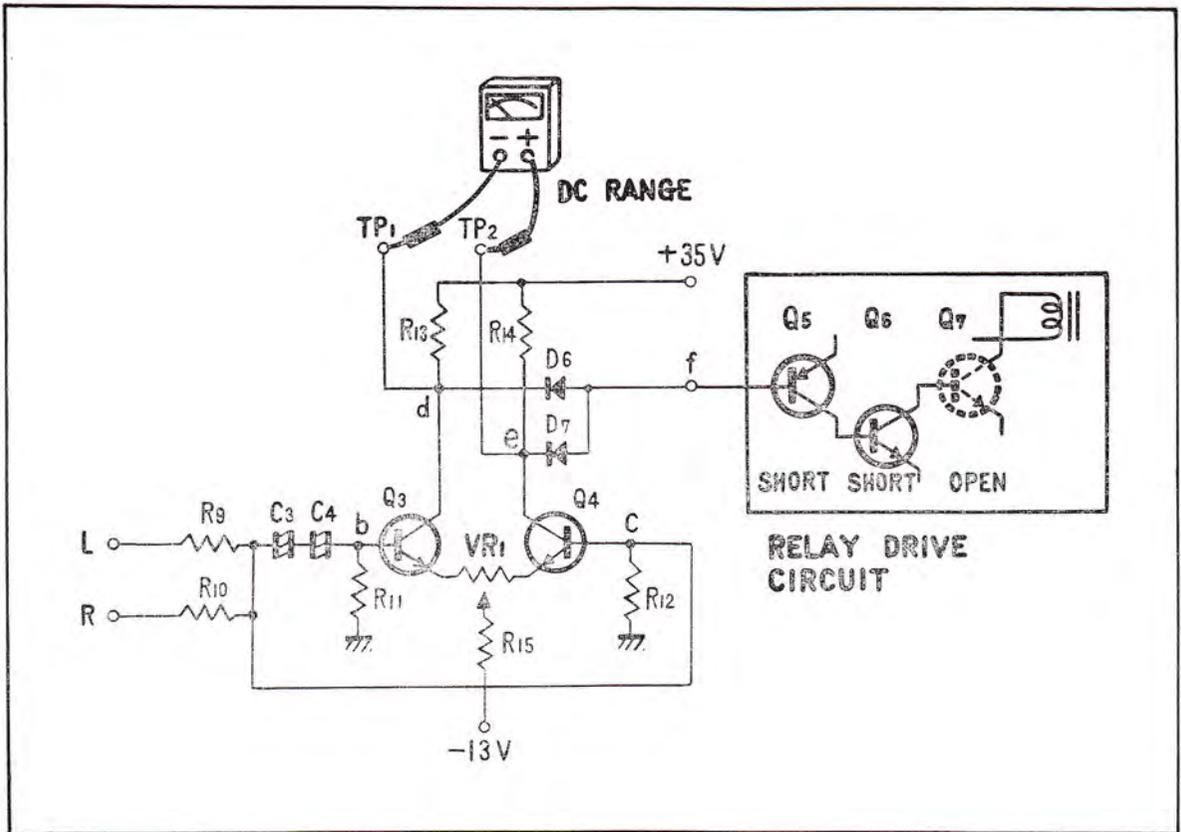


50.

IF A POWER TRANSISTOR SHORTS IN THE MAIN AMP IT WILL UNBALANCE THE AMPLIFIER AND A D.C. VOLTAGE WILL APPEAR ACROSS THE OUTPUT TERMINALS. ALSO, EXCESSIVE CURRENT WILL FLOW THRU THE TRANSISTORS TO GROUND.



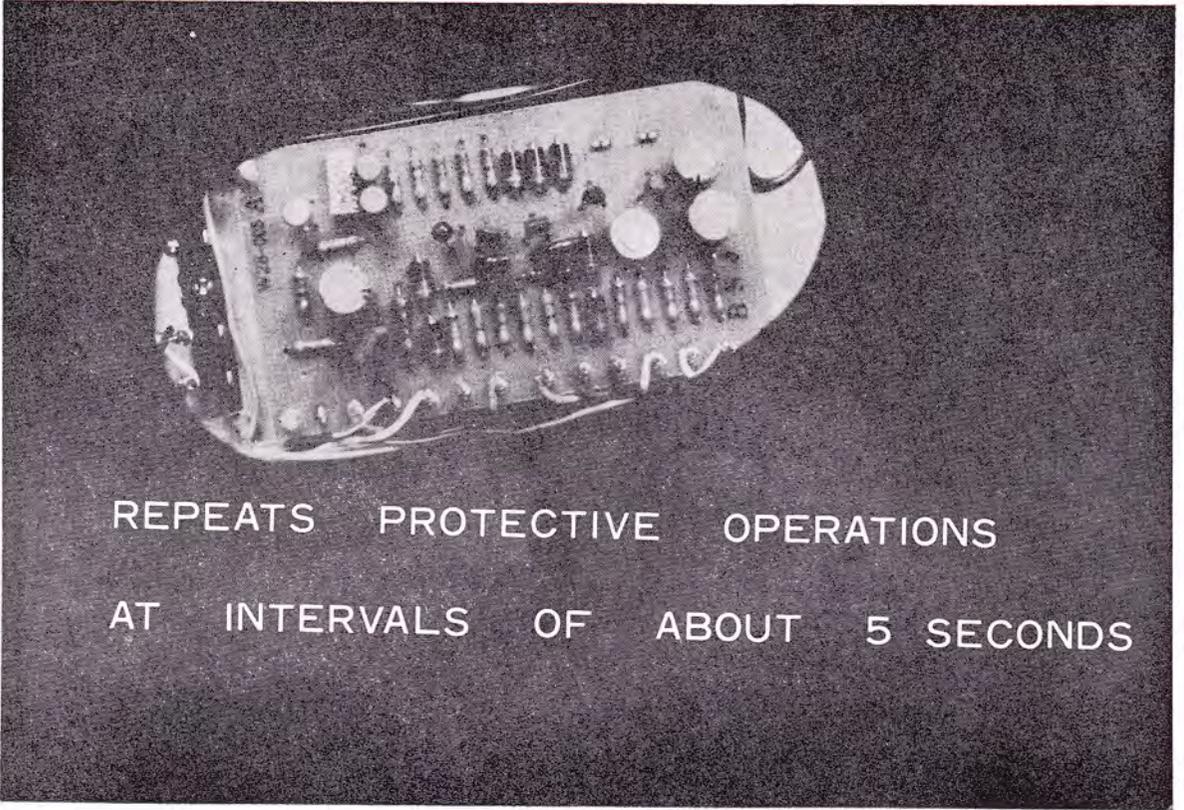
51. NOW WE WILL CONSIDER TROUBLE-SHOOTING THE PROTECTION CIRCUIT WHEN THE MAIN AMP UNIT IS O.K. CONNECT A MULTIMETER BETWEEN TP-1 AND TP-2 OF THE VOLTAGE DETECTION CIRCUIT Q-3 AND Q-4, AND BALANCE THE CIRCUIT BY ADJUSTING VR-1 UNTIL YOU GET A ZERO VOLTAGE READING ON YOUR METER. IF THE RELAY NOW WORKS, THEN THE PROBLEM WAS MISADJUSTMENT OF VR-1..



52.

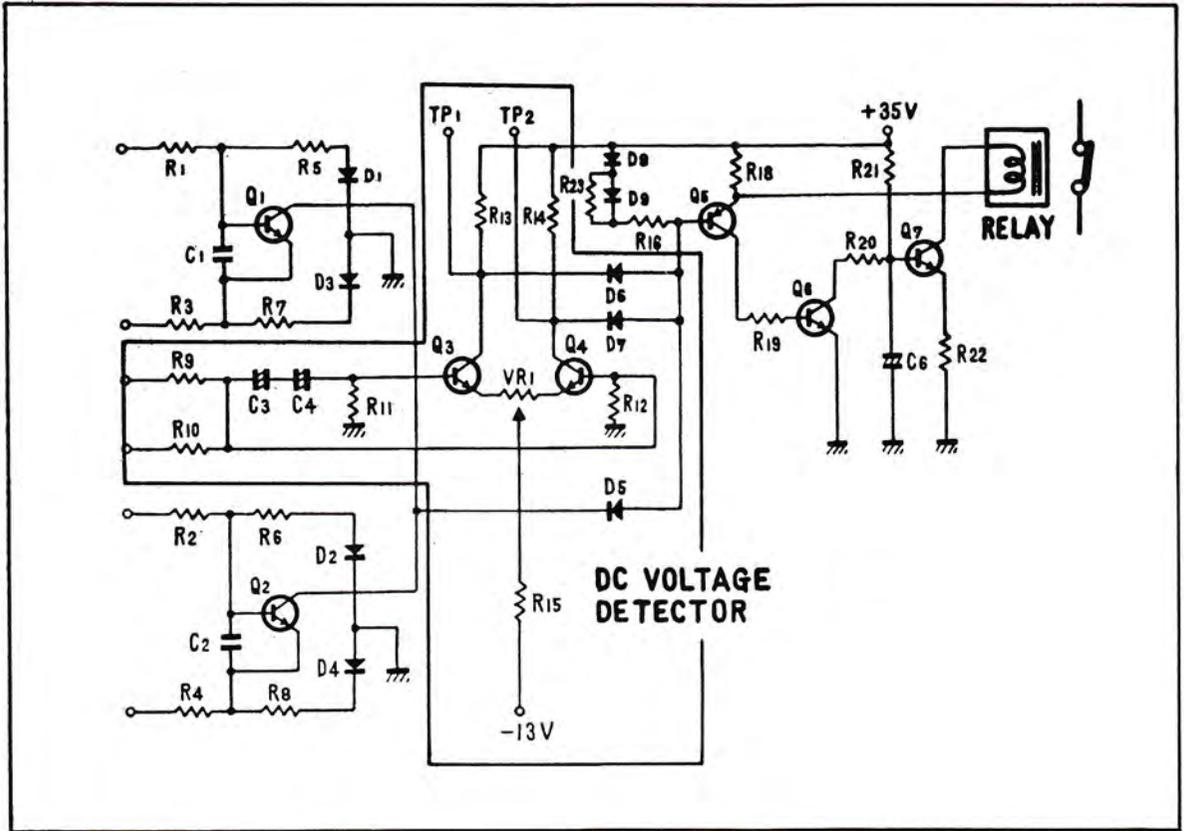
IF BALANCE CANNOT BE OBTAINED BY ADJUSTING VR-1, THEN THE D.C. VOLTAGE DETECTION CIRCUIT MUST BE DEFECTIVE. ALSO, IF THE RELAY DOES NOT WORK EVEN THOUGH THE CIRCUIT IS BALANCED, THEN THE RELAY DRIVE CIRCUIT MAY BE DEFECTIVE. POSSIBLE CAUSES MAY BE A SHORT IN Q-5 OR Q-6 OR AN OPEN IN Q-7.

IF THE SHORT CIRCUIT HAPPENS ON Q-5 OR Q-6, THE ELECTRIC CURRENT FLOWS THROUGH THE COLLECTOR OF Q-6, THE BASE VOLTAGE OF Q-7 DECLINES AND Q-7 IS CUT OFF, THE ELECTRIC CURRENT DOES NOT FLOW THROUGH THE RELAY AND NO ACTION TAKES PLACE. LIKEWISE, IN CASE Q-7 IS OPEN, THE ELECTRIC CURRENT DOES NOT FLOW THROUGH THE RELAY AND NO ACTION TAKES PLACE.



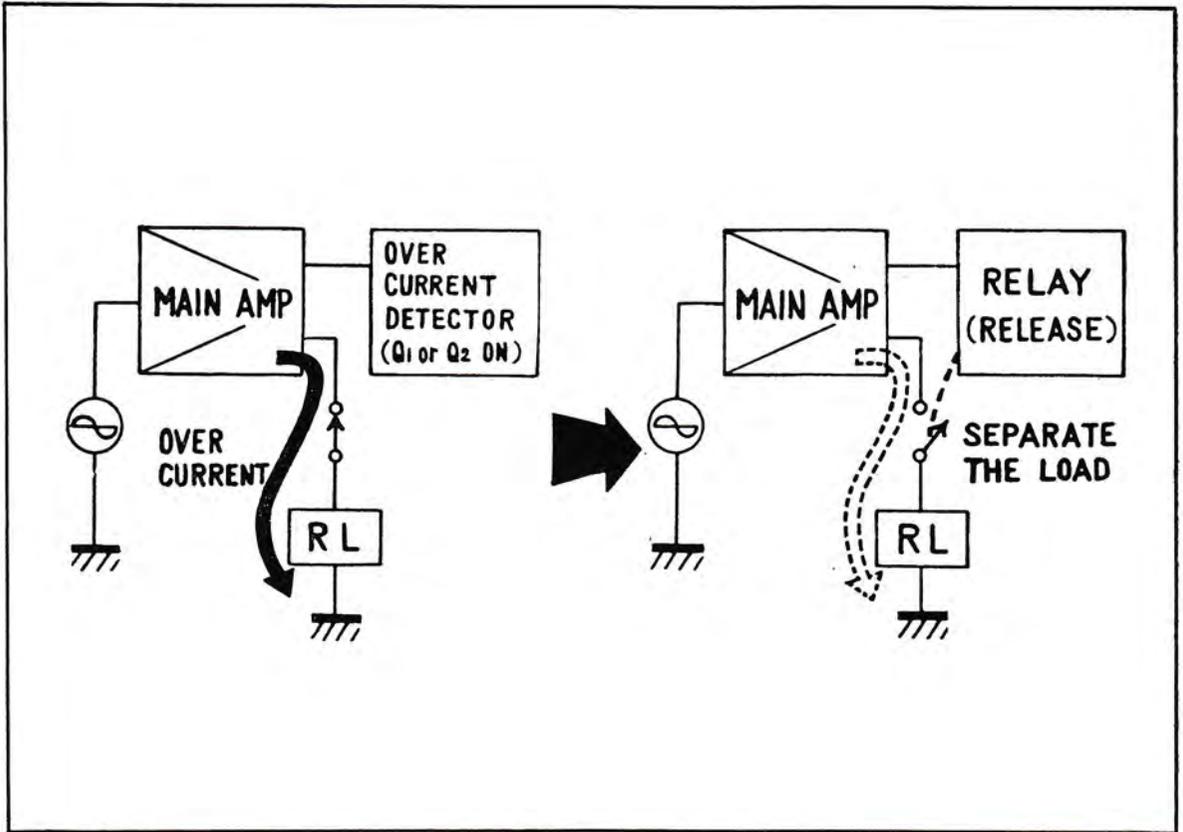
53.

NEXT, LET'S CONSIDER THE CASE IN WHICH THE RELAY REPEATS ACTIONS AT INTERVALS OF ABOUT 5 SECONDS. SINCE THE RELAY WORKS IN THIS CASE, THE RELAY DRIVE CIRCUIT IS NORMAL.



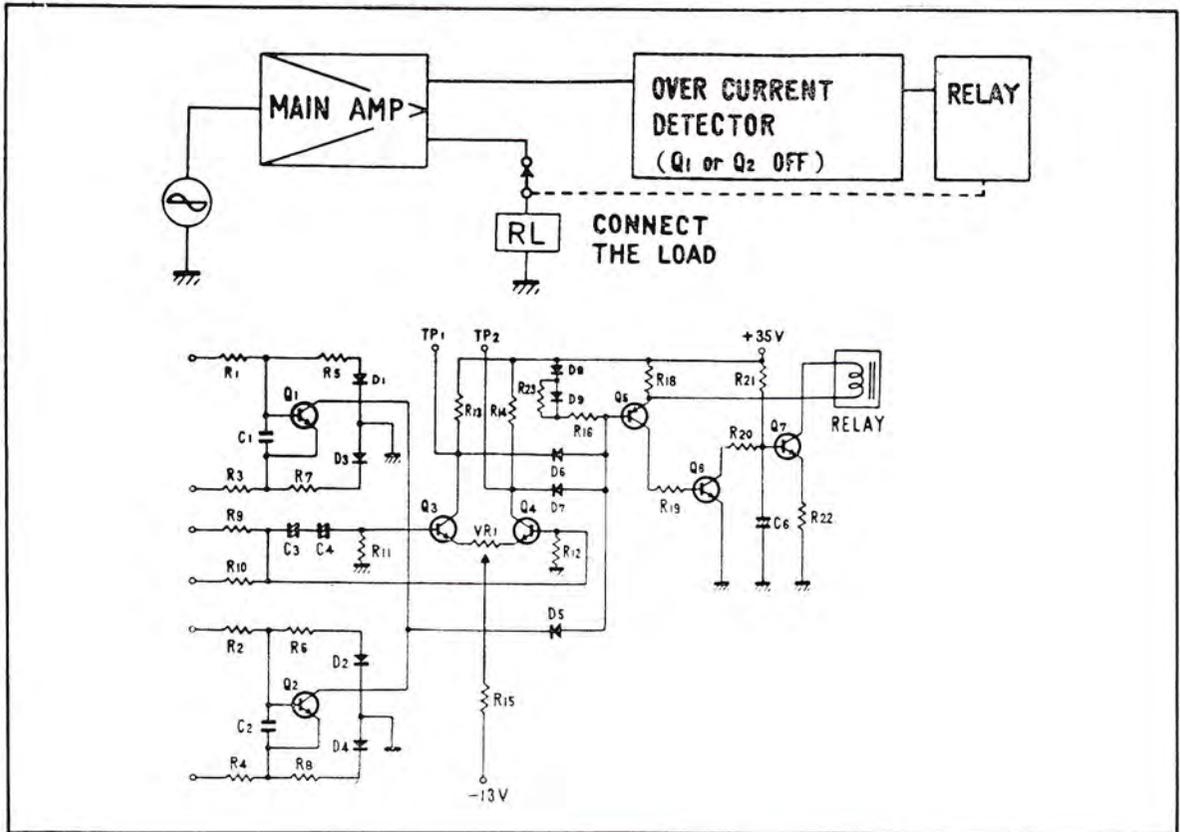
54.

NORMALLY IF SOMETHING IS DEFECTIVE IN THE D.C. VOLTAGE DETECTION CIRCUIT THE RELAY WILL NOT CONNECT THE SPEAKERS TO THE AMP. NOW WE WILL INVESTIGATE THE PROBLEM OF THE PROTECTION CIRCUIT ACTUATING EVERY FIVE SECONDS.



55.

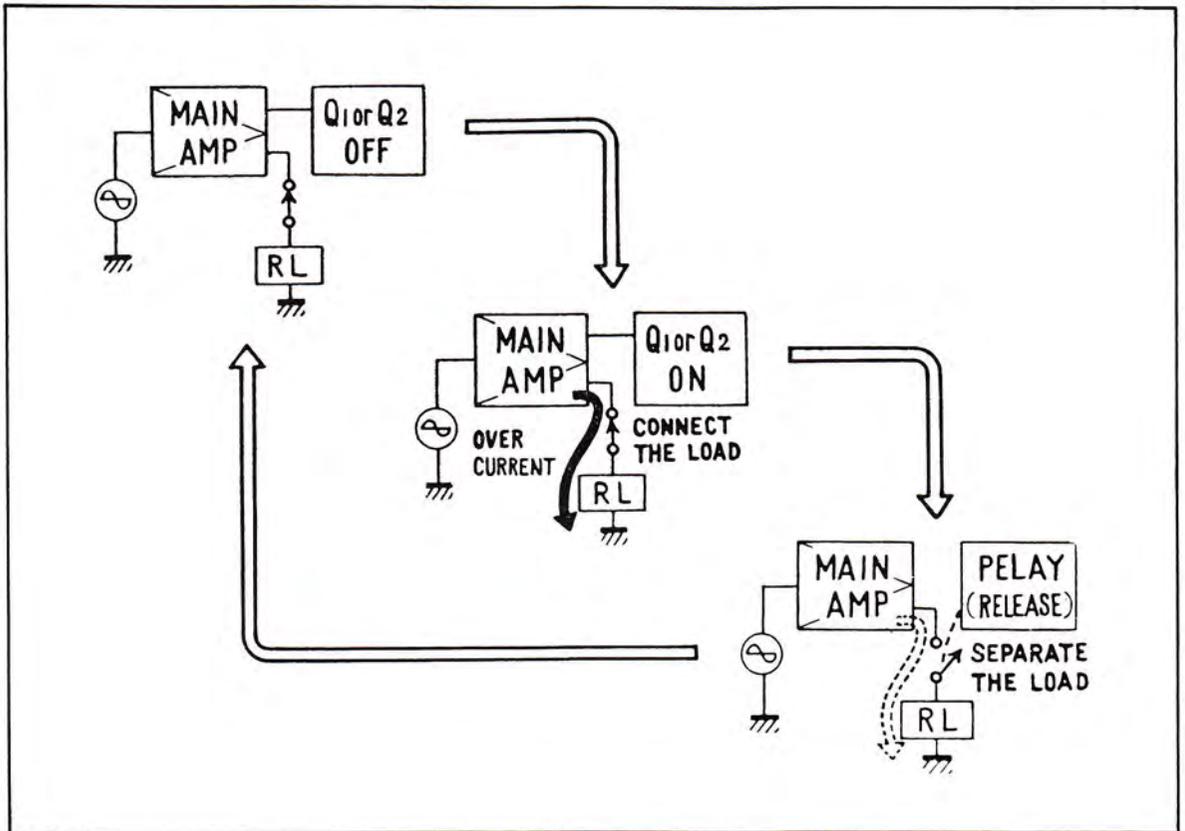
WHEN AN EXCESSIVE CURRENT FLOWS THRU THE LOAD VIA THE MAIN AMP, THE EXCESSIVE CURRENT SENSOR ACUATES THE RELAY AND DISCONNECTS THE LOAD FROM THE AMPLIFIER. NO EXCESS CURRENT WILL FLOW THRU THE POWER STAGE.



56.

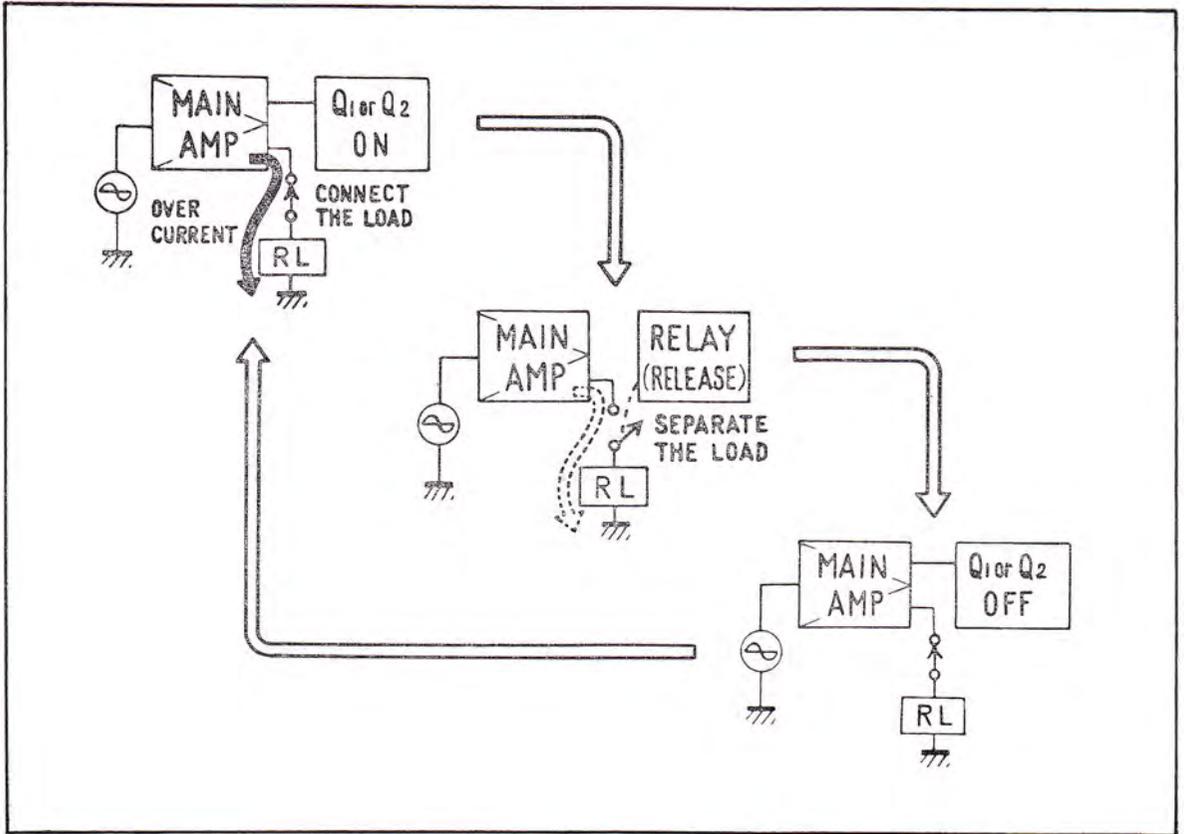
WHEN THE EXCESSIVE LOAD IS SENSED BY THE CURRENT CIRCUIT, IT WILL TURN OFF Q-1 OR Q-2 AND ALSO TURN OFF Q-5 AND Q-6 WHICH WILL TURN ON Q-7. THIS WILL CLOSE THE RELAY AND AGAIN CONNECT THE LOAD TO THE AMP.

- 1) THE ACTIVATE OF RELAY AT EVERY FIVE SECONDS IS DUE TO THE TIME CONSTANT OF MUTING CIRCUIT. SEE CUT 28 AS TO THE DETAILS.
- 2) AS THE CAUSE OF MAIN AMPLIFIER SIDE, THERE IS THE ABNORMAL INCREASE OF IDLE CURRENT, AND AS THE CAUSES OF LOAD SIDE, THERE ARE THE SHORT CIRCUIT OF LOAD, CONNECTION OF VERY LOW VALUE LOAD, ETC.



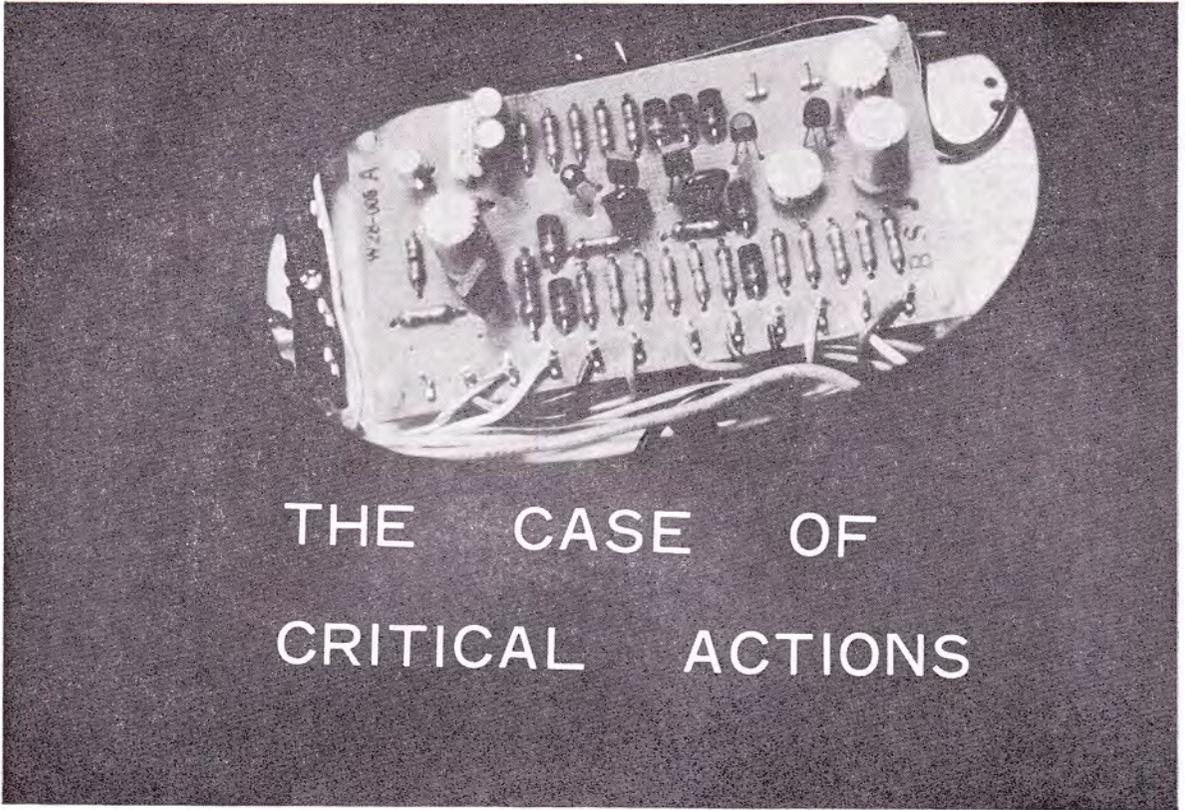
57.

AS SOON AS THE LOAD IS CONNECTED, EXCESSIVE CURRENT WILL FLOW AND THE RELAY WILL DISCONNECT.



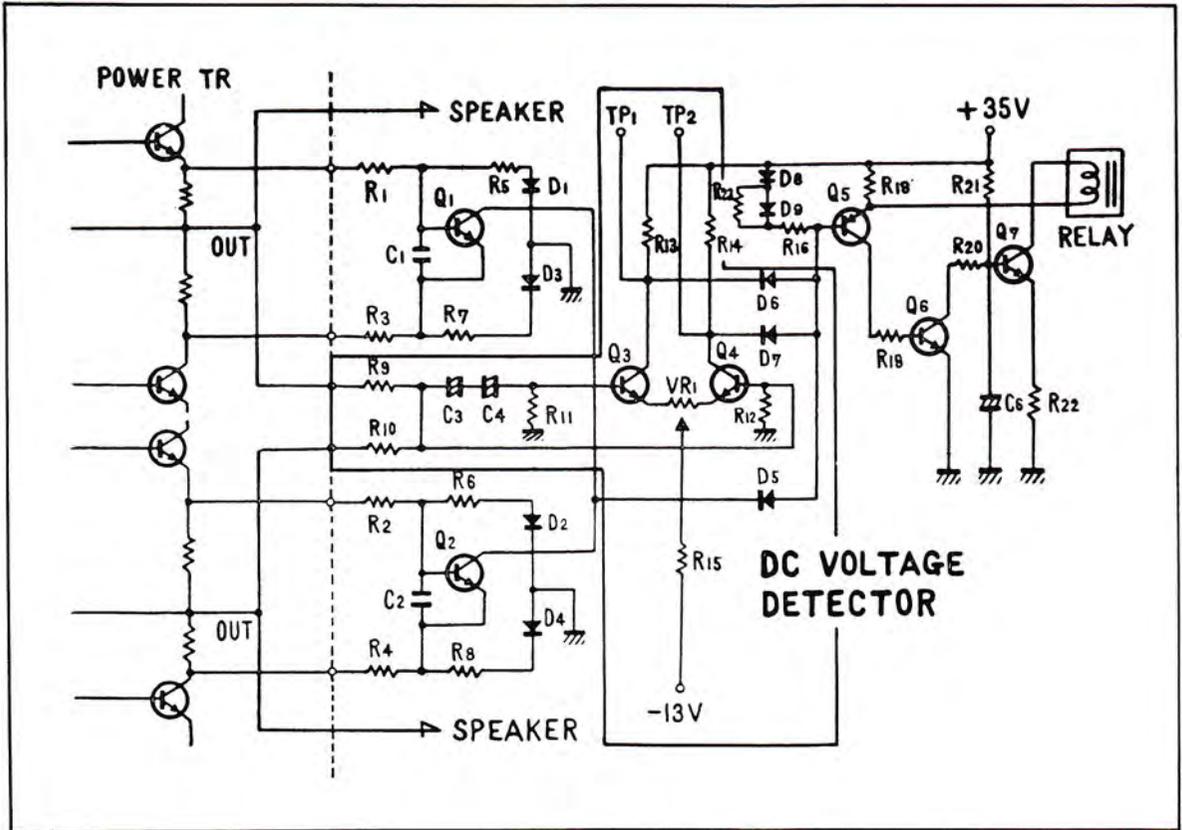
58.

IN THIS MANNER, THE PROTECTION RELAY WILL CYCLE ABOUT EVERY FIVE SECONDS. WHENEVER THIS SYMPTOM IS NOTED THE PROBLEM IS EITHER IN THE MAIN AMP OR THE LOAD.

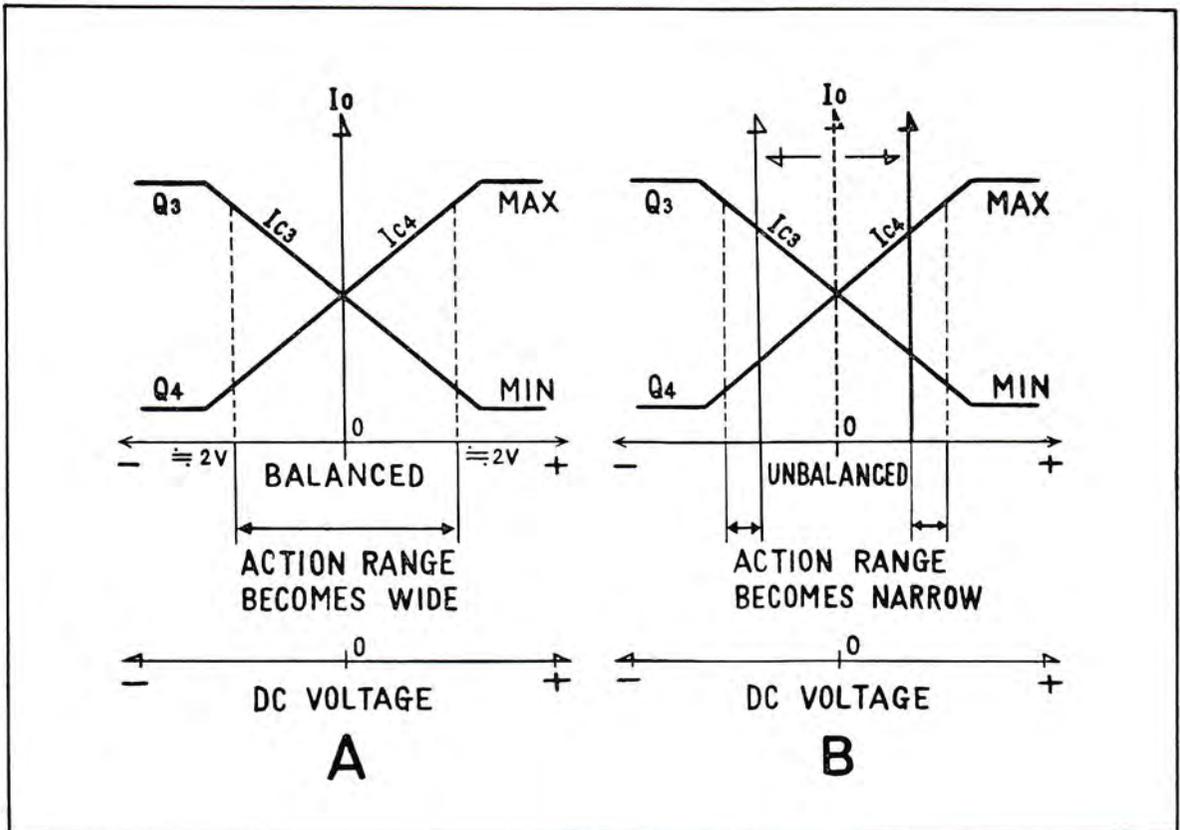


THE CASE OF CRITICAL ACTIONS

59. OUR NEXT PROBLEM IS TO CONSIDER A PROTECTION UNIT THAT IS TOO SENSITIVE. THE OPERATING RANGE OF THE PROTECTION CIRCUIT MAY BE TOO NARROW.

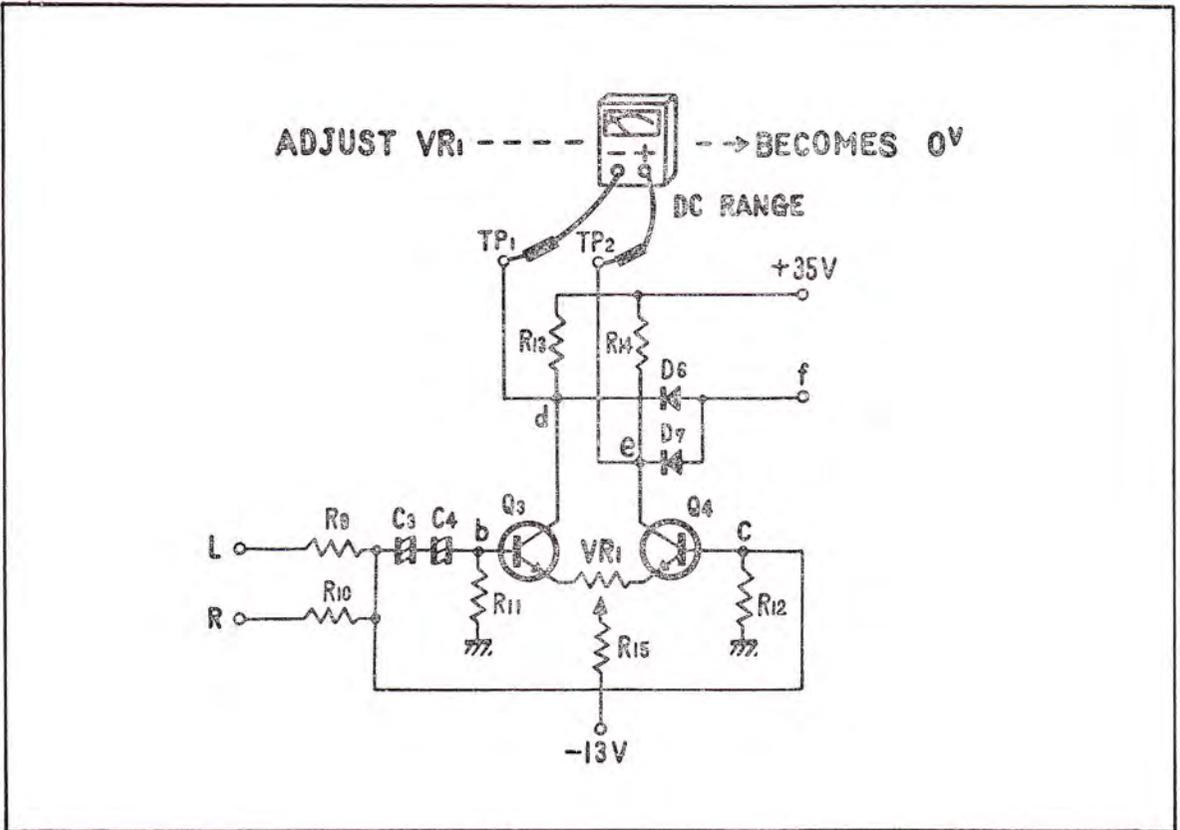


60. MOST LIKELY THIS IS CAUSED BY AN UNBALANCED DIFFERENTIAL AMP IN D.C. DETECTION CIRCUIT.

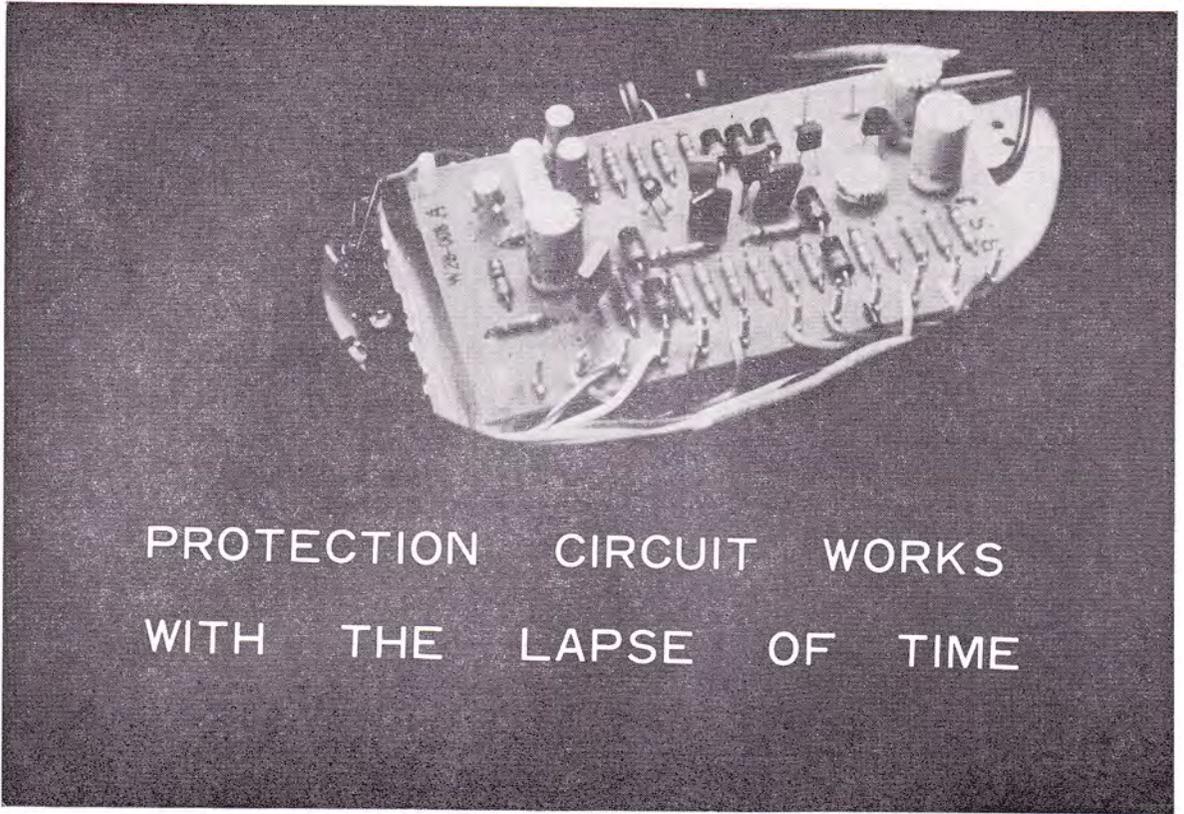


61.

IF THE CIRCUIT IS BALANCED, AS SHOWN, IN FIG. A THEN WE HAVE A WIDE OPERATING RANGE SO THE UNIT DOES NOT OPERATE UNLESS IT IS SUPPOSED TO. IF THE CIRCUIT IS UNBALANCED THE OPERATING RANGE IS NARROW AND ANY INPUT WHATSOEVER WILL ACTIVATE THE RELAY.

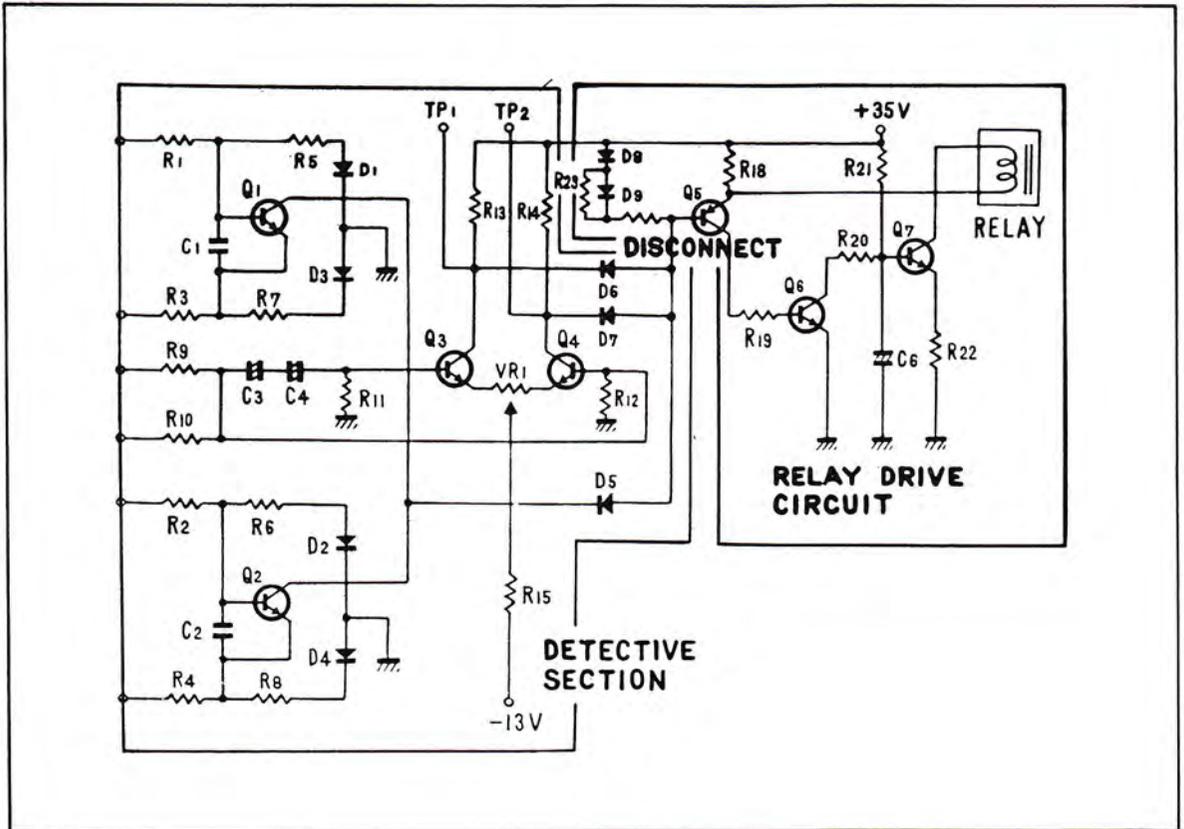


62. THE REMEDY FOR THIS PROBLEM IS SIMPLE. JUST ADJUST VR-1 WITH YOUR METER SET TO CHECK D.C. VOLTAGE BETWEEN PINS TP-1 AND TP-2. SET VR-1 SO YOU HAVE A ZERO VOLTAGE READING.



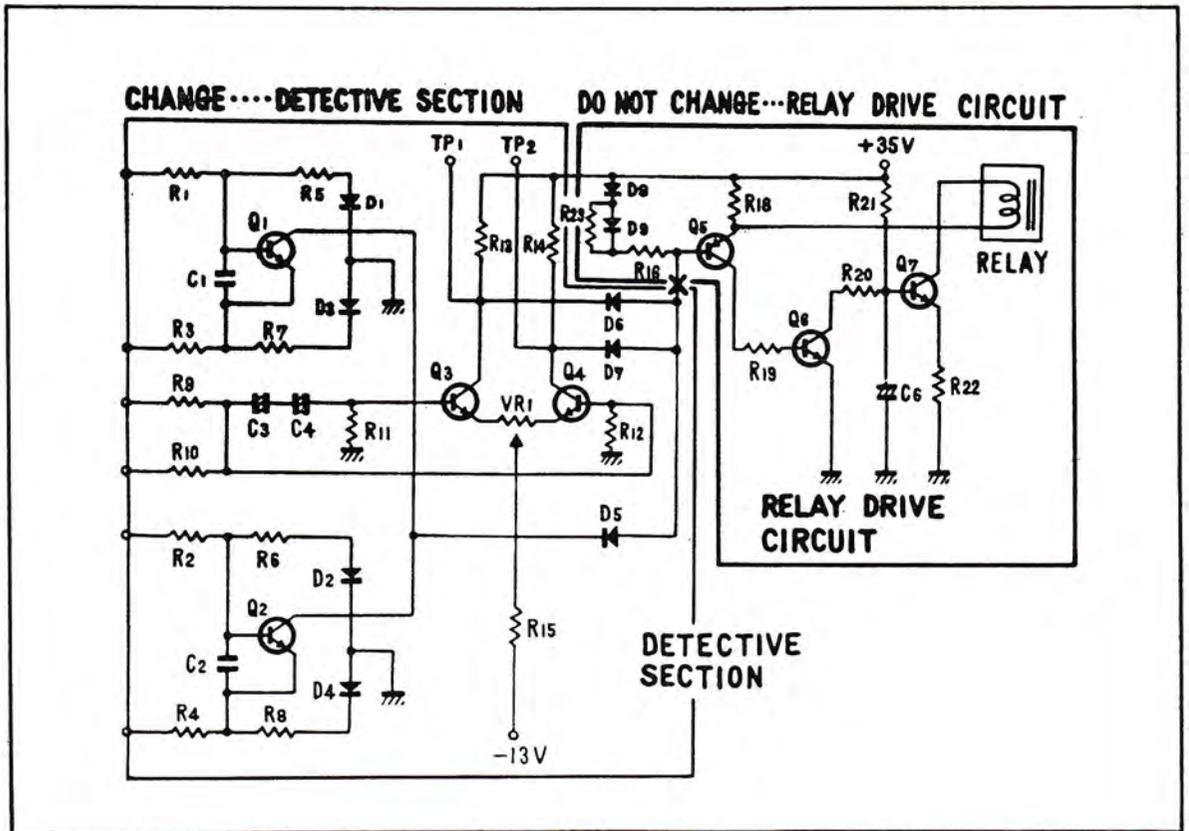
63.

OUR LAST PROBLEM IS WHEN THE PROTECTION CIRCUIT OPERATES AFTER THE UNIT HAS BEEN ON AWHILE AND WARM UP. THIS MAY BE CAUSED BY TEMPERATURE SENSITIVITY OF SOME COMPONENTS IN THE PROTECTION UNIT.



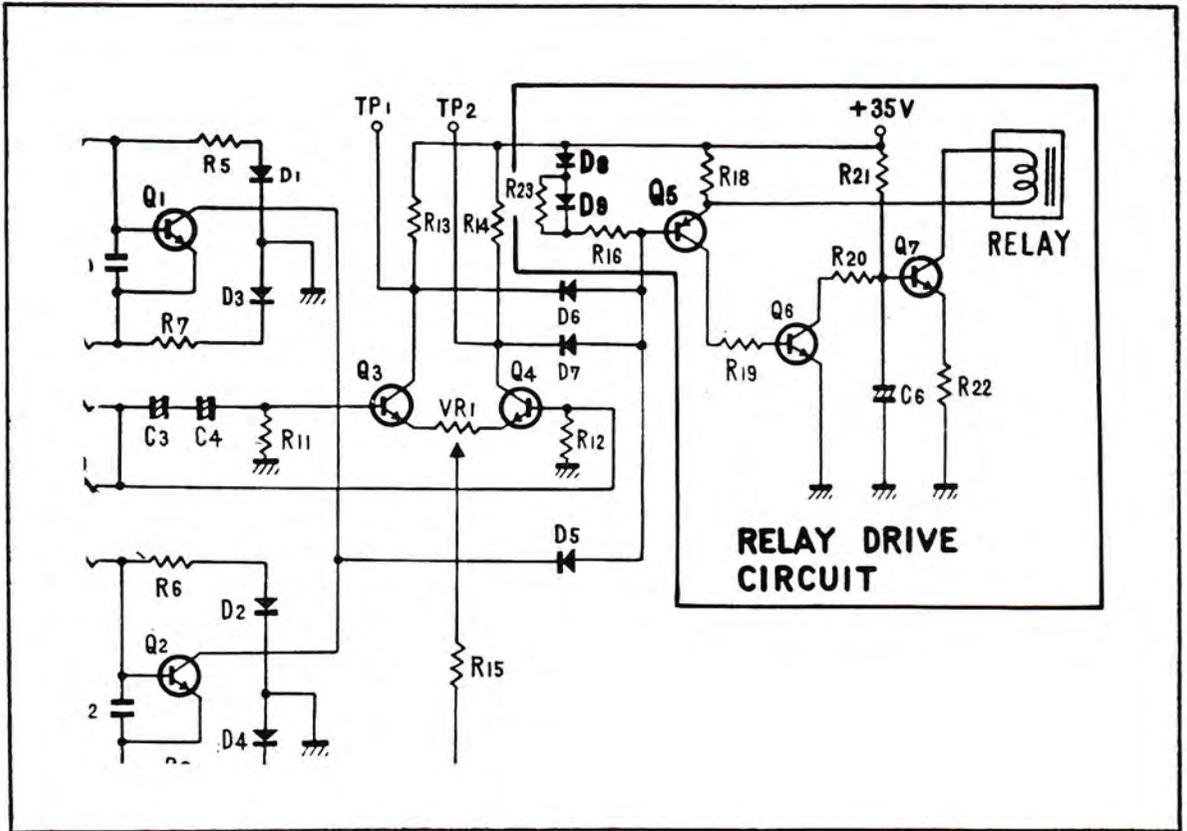
64.

TO TELL WHICH SIDE HAS THE PROBLEM YOU MUST SEPARATE THE RELAY DRIVE CIRCUIT FROM THE DETECTION CIRCUIT. THE RELAY ITSELF WILL GIVE YOU A CLUE AS TO WHICH SIDE IS BAD.

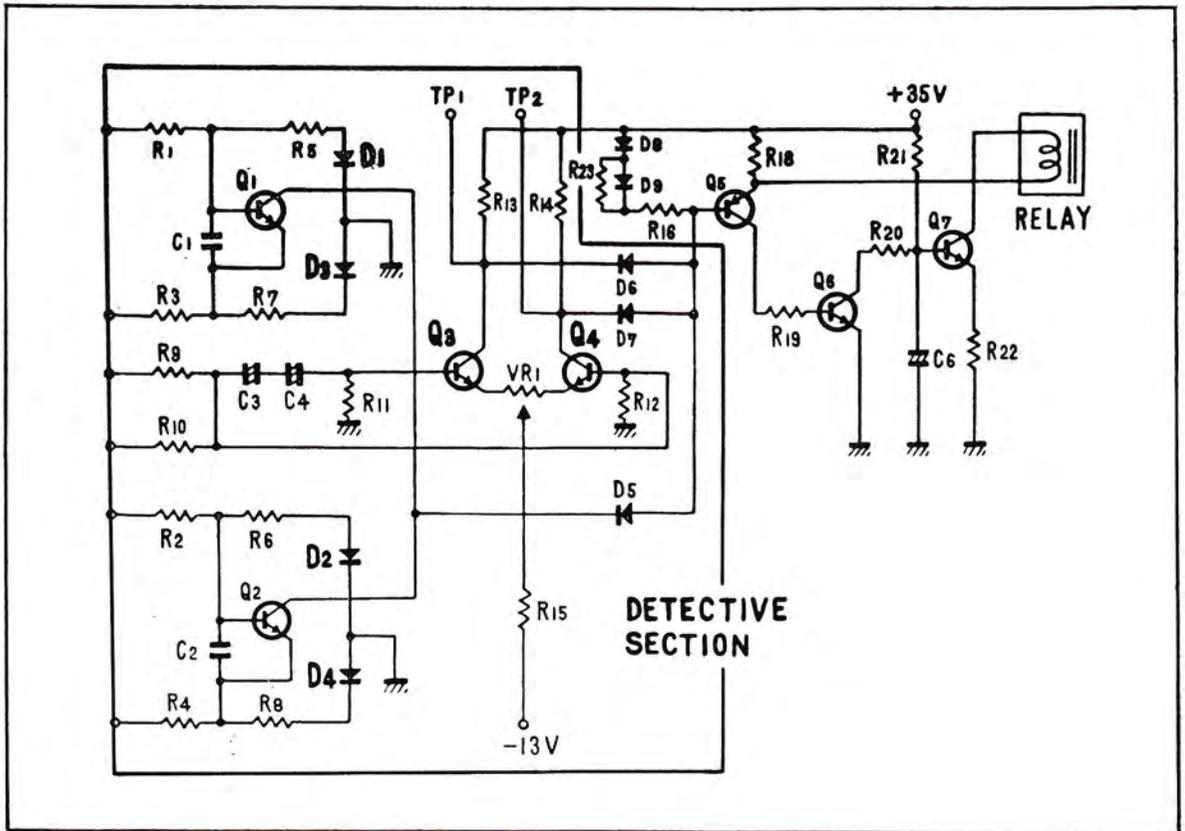


65.

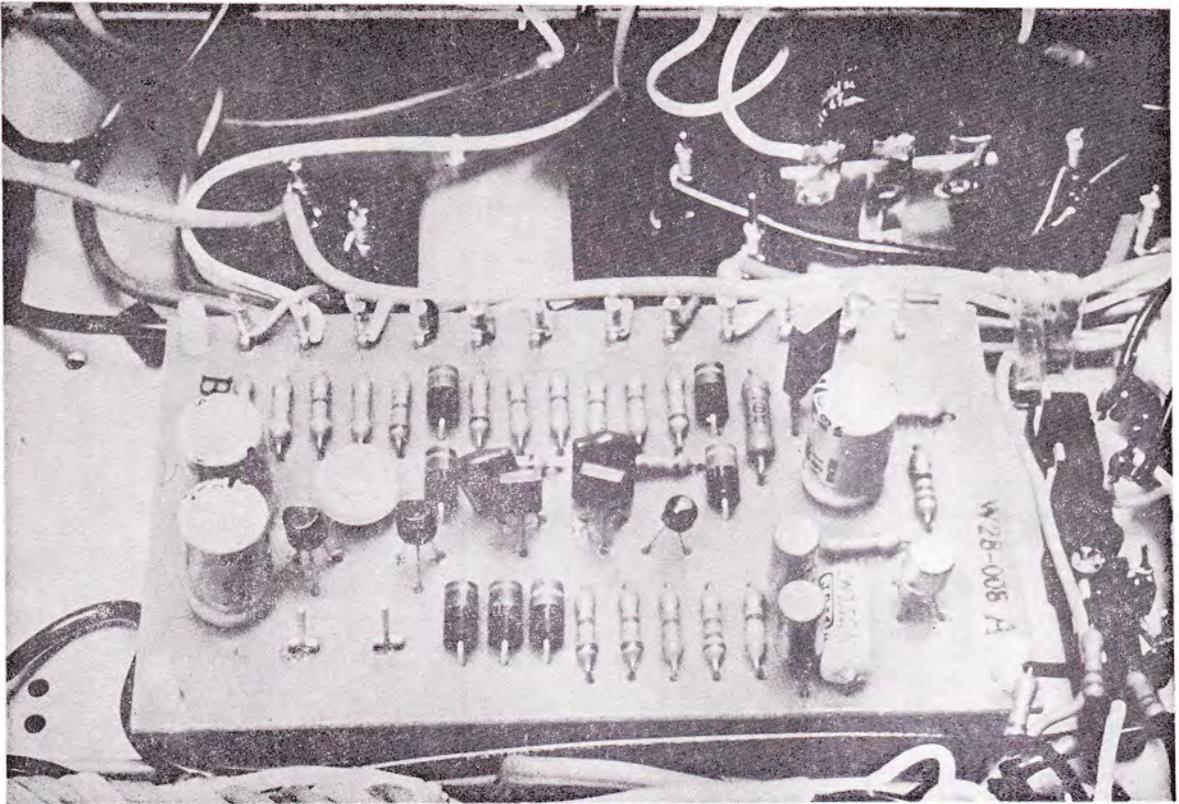
IF, AFTER YOU DISCONNECT THE TWO CIRCUITS THE RELAY STAYS THE SAME AS IT WAS BEFORE YOU SEPARATED THE TWO UNITS, THEN THE RELAY CIRCUIT MAY BE DEFECTIVE. IF THE RELAY RETURNS TO NORMAL OPERATION THE DETECTION CIRCUIT IS PROBABLY AT FAULT.



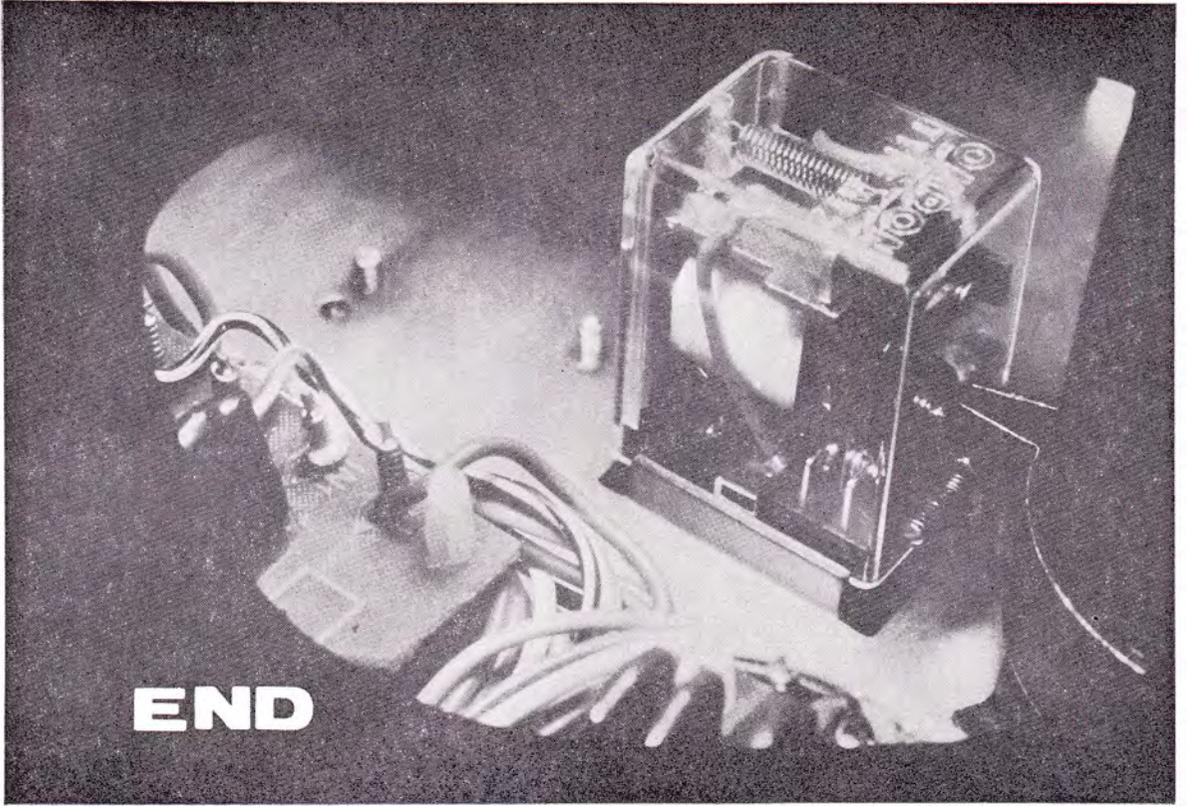
66. MOST TEMPERATURE SENSITIVITY PROBLEMS IN THE RELAY DRIVE CIRCUIT ARE CAUSED BY Q-5 OR D-8 AND D-9.



67. POSSIBLE CAUSES FOR TEMPERATURE SENSITIVITY IN THE DETECTION CIRCUIT ARE AN UNBALANCING OF THE DIFFERENTIAL AMPLIFIER CAUSED BY Q-3, Q-4 OR D-1 THRU D-4.



68. AS YOU HAVE JUST SEEN, IT IS IMPORTANT TO NOTICE FAILURE SYMPTOMS CAREFULLY AND FOLLOW A LOGICAL PROCEDURE TO REPAIR PROTECTION UNITS.



69. END MUSIC.

