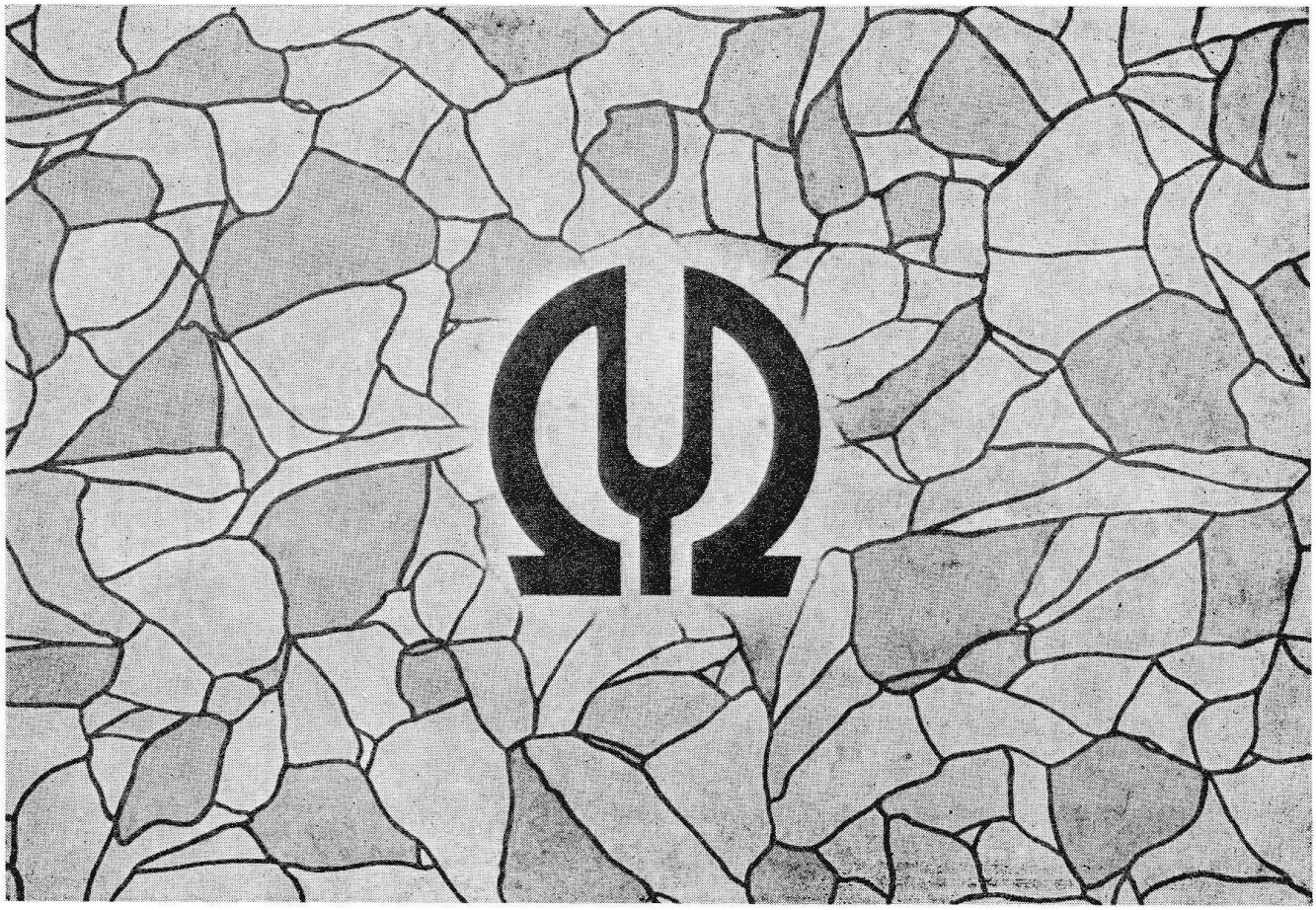
TECHNICAL GUIDE FOR SERVICE

TROUBLE SHOOTING METHOD
O.C.L. MAIN AMPLIFIER CIRCUITS

PIONEER®

SERVICE DEPARTMENT INTERNATIONAL DIVISION



TROUBLE SHOOTING METHODS FOR OCL MAIN AMP CIRCUIT

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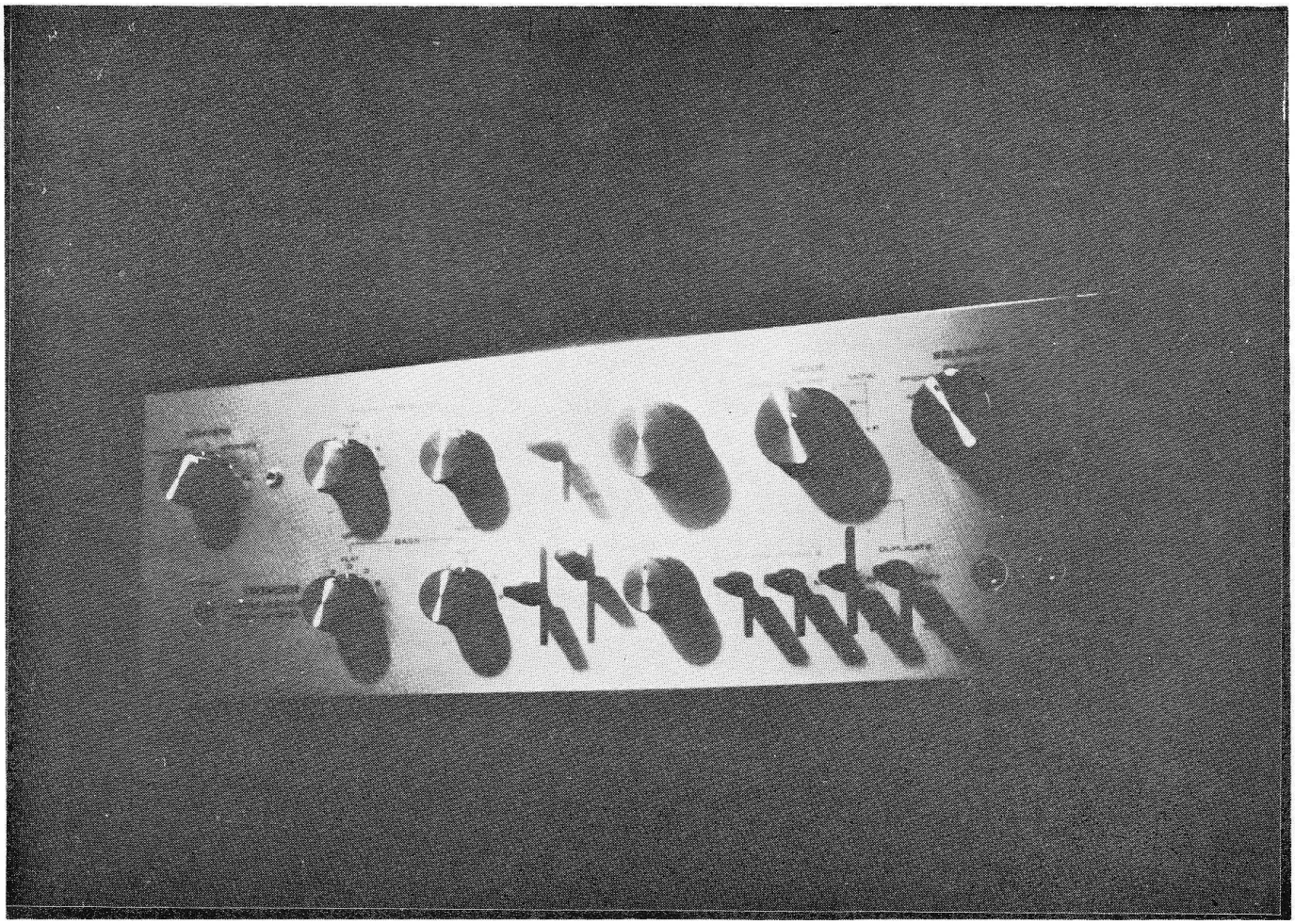
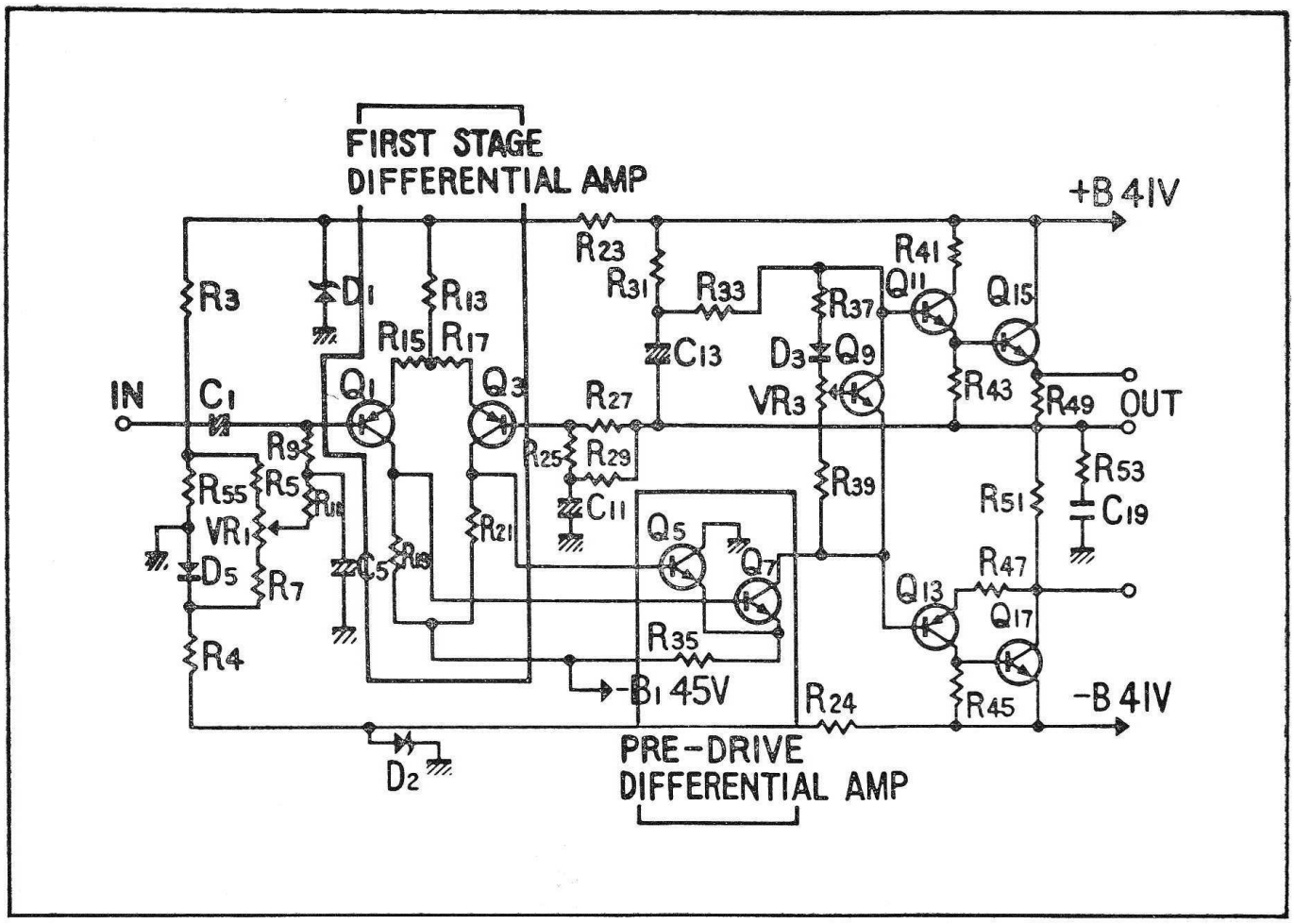
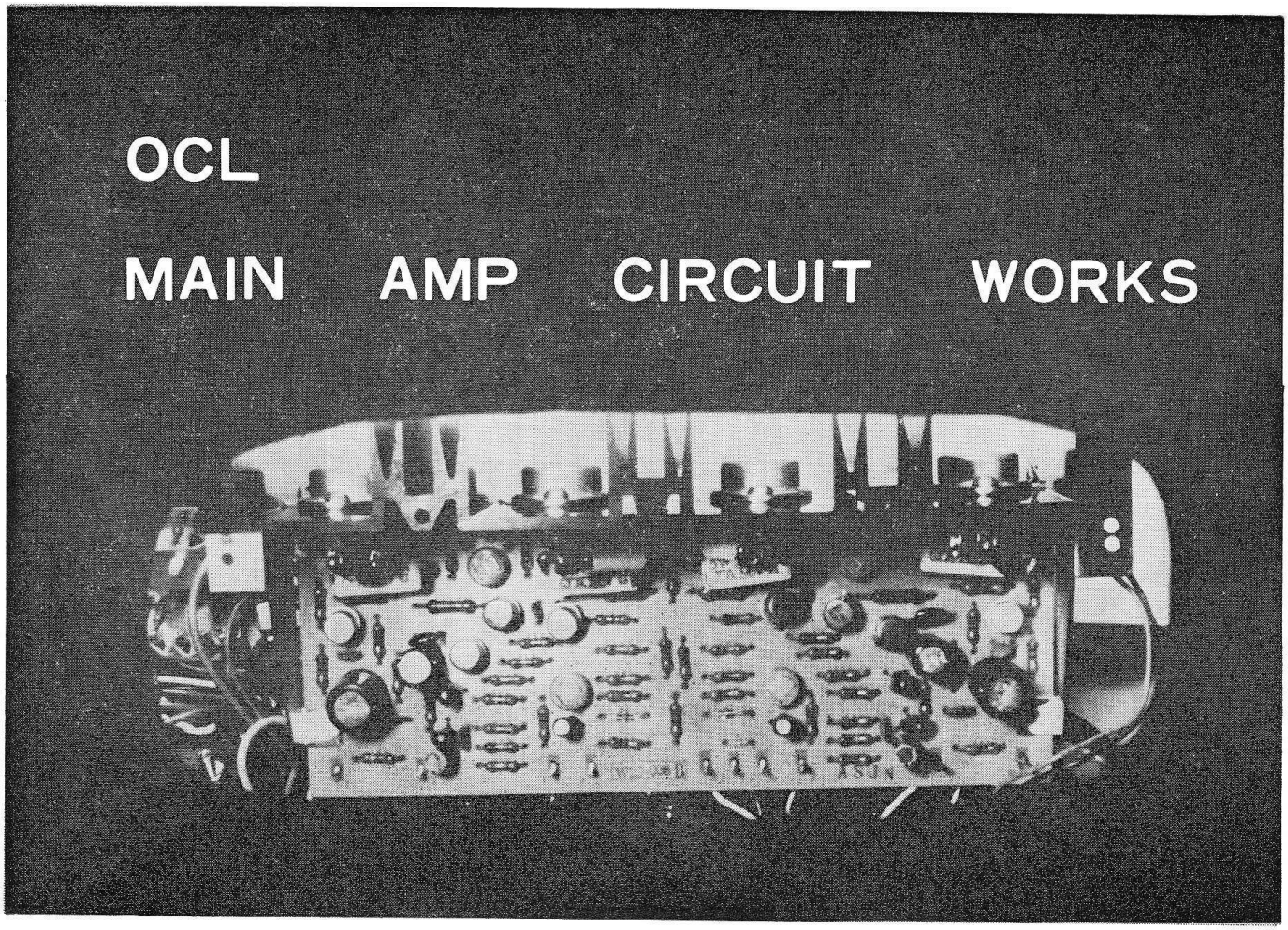


3. IN STATE-OF THE ART MAIN AMPLIFIERS, COMPLETE DIRECT COUPLING IS USED. THIS MEANS FROM THE INPUT TO THE OUTPUT OF THE AMPLIFIER THERE ARE NO CAPACITORS USED TO COUPLE ONE STAGE TO THE NEXT. THIS INCLUDES THE OUTPUT OF THE AMPLIFIER WHICH IS DIRECTLY CONNECTED TO THE SPEAKER.

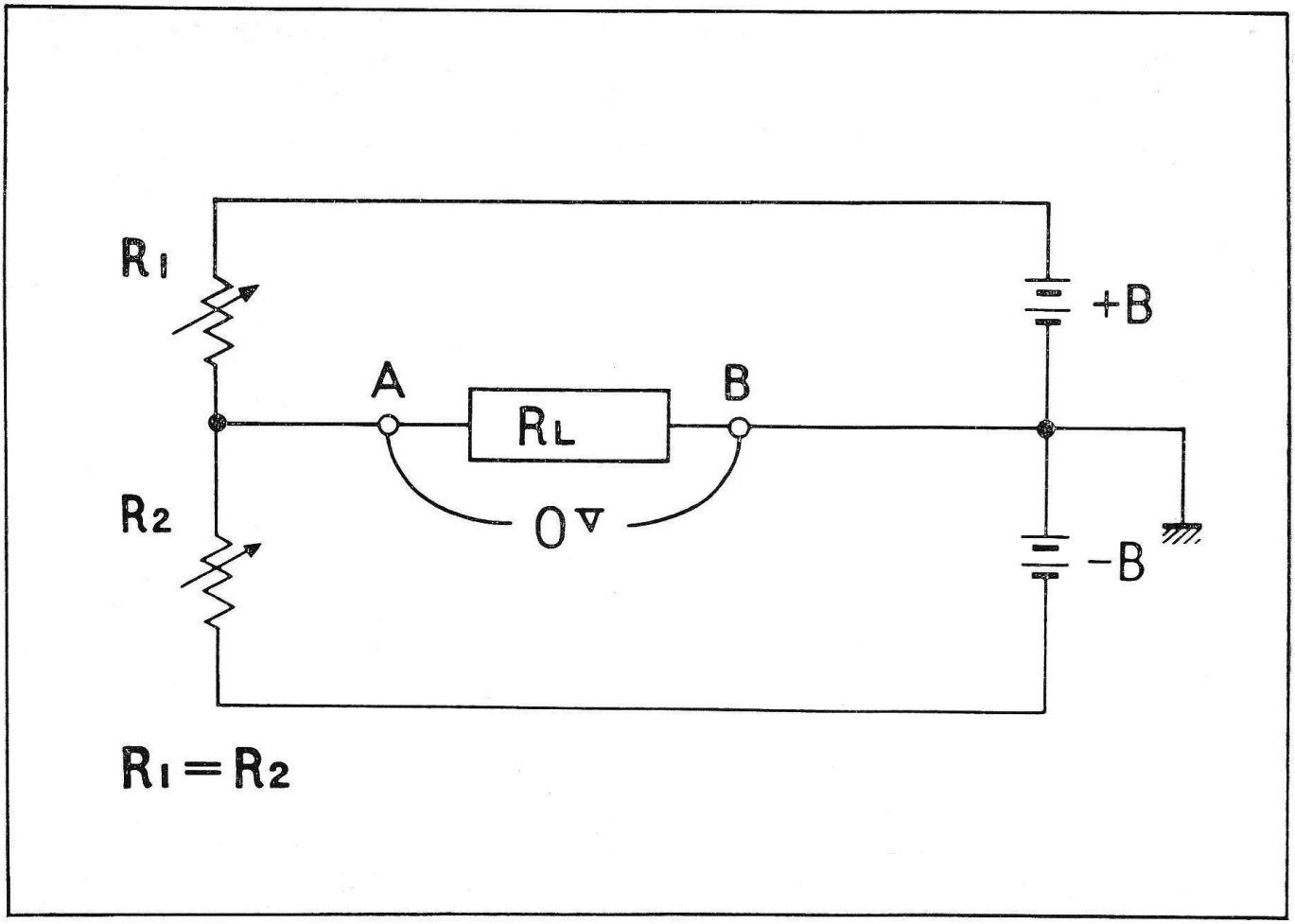


4.

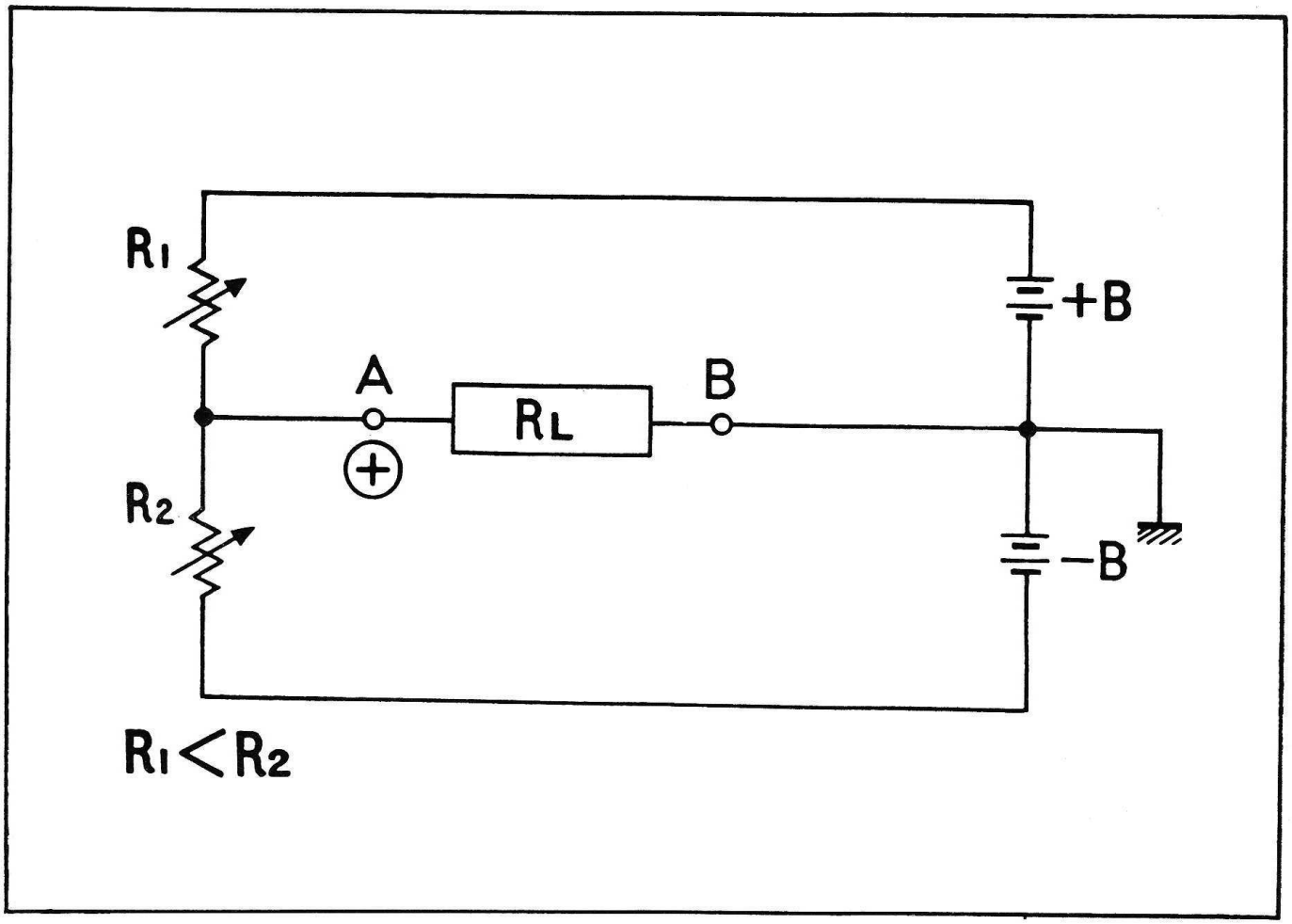
THE O.C.L. AS IS SHOWN BY IT'S NAME, HAS NO CAPACITOR IN ITS OUTPUT CIRCUIT. THE APLIFIER OUTPUT IS DIRECTLY CONNECTED TO THE SPEAKER. IN THE CAPACITOR COUPLED OUTPUT AMPLIFIER, THE CAPACITOR IS NECESSARY TO ISOLATE THE OUTPUT SIGNAL FROM THE D.C. VOLTAGE WHICH IS NECESSARY TO OPERATE THE AMPLIFIER. TO ELIMINATE THE OUTPUT CAPACITOR, PIONEER USES A SOPHISTICATED CIRCUIT CALLED A DIFFERENTIAL AMPLIFIER. ELIMINATION OF THE OUTPUT CAPACITOR RESULTS IN IMPROVED BASS RESPONSE AND LESS PHASE SHIFT AND DISTORTION. THIS TYPE OF AMPLIFIER IS MORE COMMONLY CALLED "DIRECT COUPLED".



5. NOW LET US SEE HOW THE DIRECT COUPLED TYPE OF AMPLIFIER WORKS.

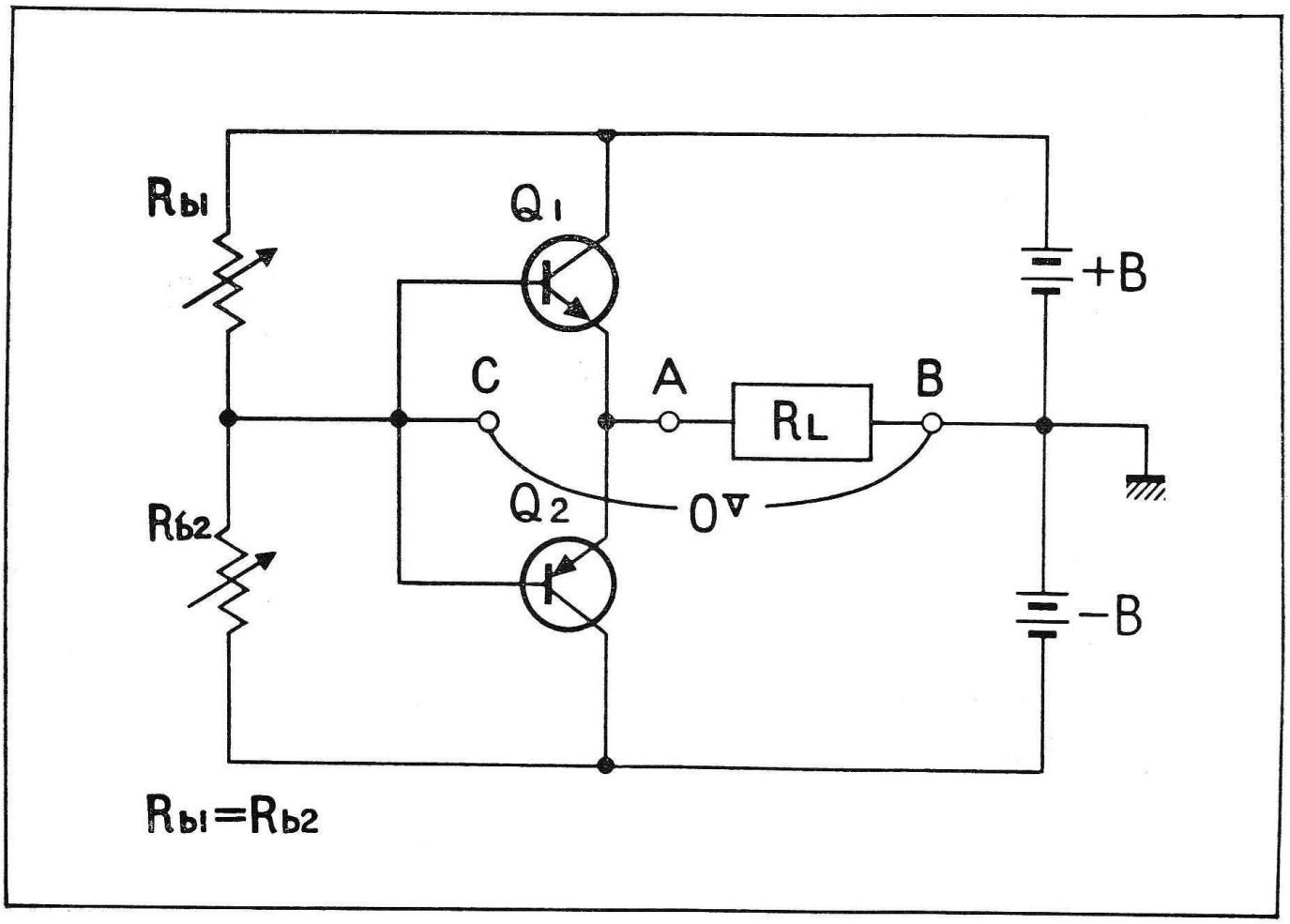


6. IN A DIRECT COUPLED AMPLIFIER WE CANNOT ALLOW D.C. TO FLOW THROUGH THE SPEAKER. THEREFORE, BY DESIGN WE MUST PROVIDE SOME METHOD OF ALLOWING ONLY THE A.C. SIGNAL TO REACH THE SPEAKER. TO DO THIS WE BALANCE THE AMPLIFIER BY USING TWO POWER SUPPLIES, ONE POSITIVE AND THE OTHER NEGATIVE BOTH WITH THE SAME VOLTAGE LEVEL. TO ILLUSTRATE HOW THIS BALANCE IS ACHIEVED, WE WILL CONNECT TWO VARIABLE RESISTORS, R-1 AND R-2 IN SERIES ACROSS THE SUPPLY. WHEN WE ADJUST BOTH THE RESISTORS SO R-1 = R-2, THEN THE VOLTAGE BETWEEN "A" AND "B" WILL BE ZERO. THIS IS BECAUSE THE VOLTAGES PRESENT AT POINT "A" ARE EQUAL, BUT OPPOSITE IN POLARITY. BECAUSE OF THIS THEY CANCEL EACH OTHER.



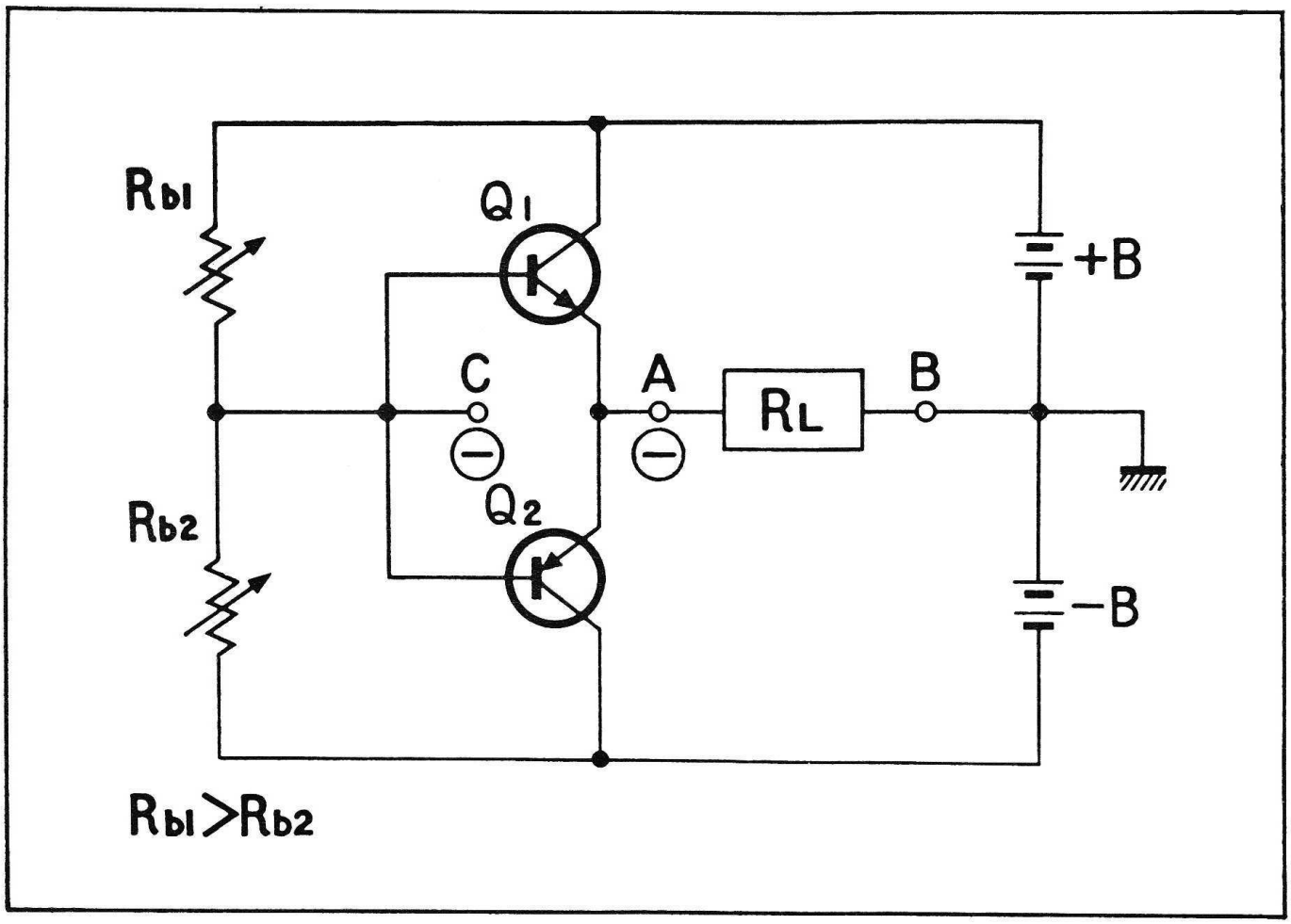
7.

IF WE REDUCE THE VALUE OF R-1 KEEPING R-2 CONSTANT, THEN POINT "A" WILL BE POSITIVE. THIS IS BECAUSE R-1 HAS LESS RESISTANCE AND LESS VOLTAGE DROP. NOW THAT THE TWO VOLTAGES ARE NO LONGER EQUAL, THEY WILL NOT COMPLETELY CANCEL EACH OTHER. THE SAME IS TRUE IF WE REDUCE THE VALUE OF R-2 AND KEEP R-1 CONSTANT, EXCEPT NOW THE VOLTAGE AT POINT "A" WILL BE NEGATIVE.



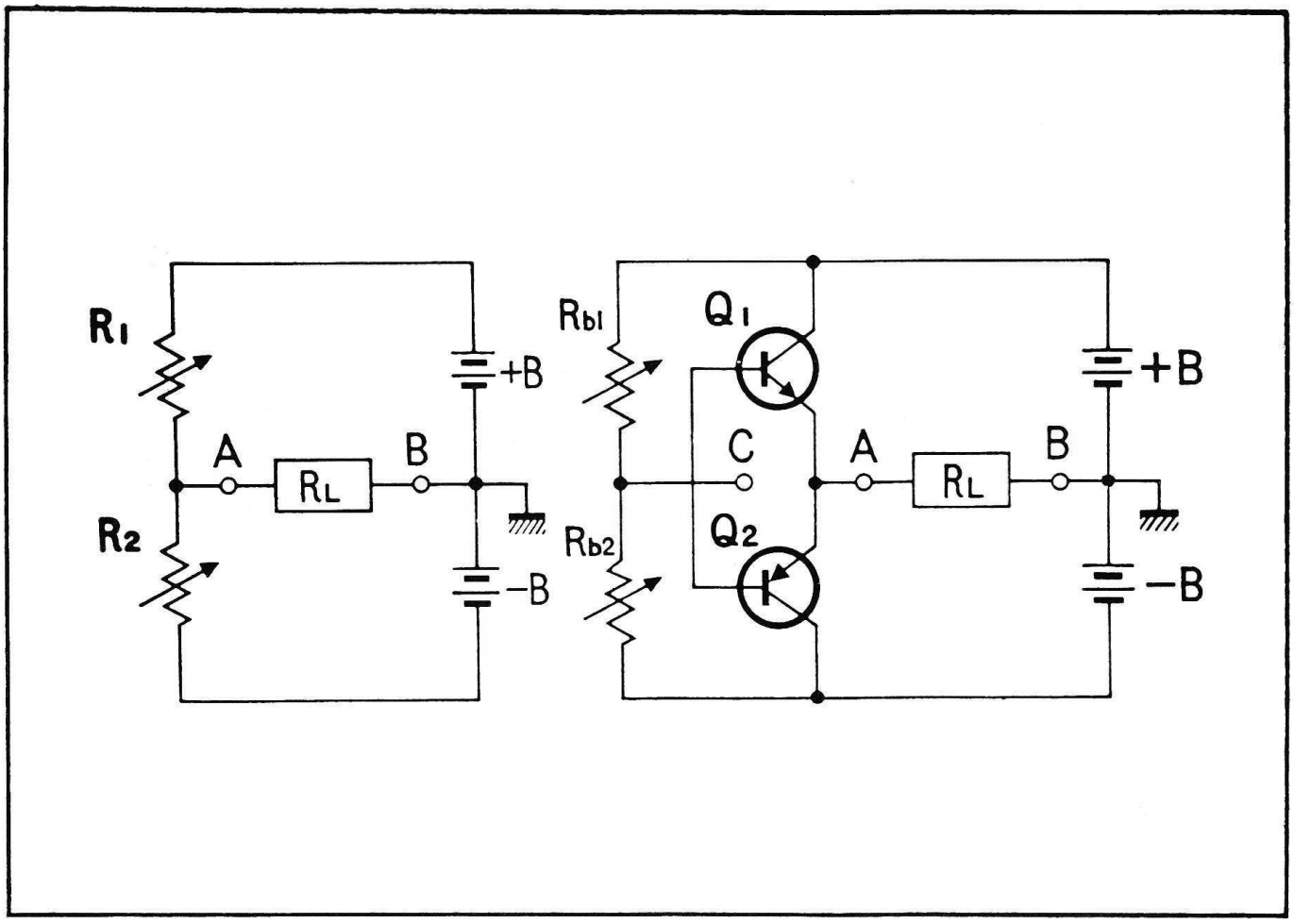
8.

NOW WE WILL REPLACE R-1 AND R-2 WITH TRANSISTORS Q-1 AND Q-2. AS SHOWN IN THE LAST SLIDE WHEN Rb-1 , = Rb-2, THE VOLTAGE BETWEEN "C" AND "B" WILL BE ZERO, FOR THE REASONS EXPLAINED PREVIOUSLY. SINCE THE BASES OF Q-1 AND Q-2 ARE CONNECTED AND NO VOLTAGE IS PRESENT THEY CANNOT CONDUCT. NO VOLTAGE WILL BE PRESENT BETWEEN "C" AND "B". SINCE NO D.C. VOLTAGE DEVELOPS ACROSS "A" AND "B", NO CURRENT CAN FLOW THROUGH R-L, EVEN THOUGH IT IS DIRECTLY CONNECTED.



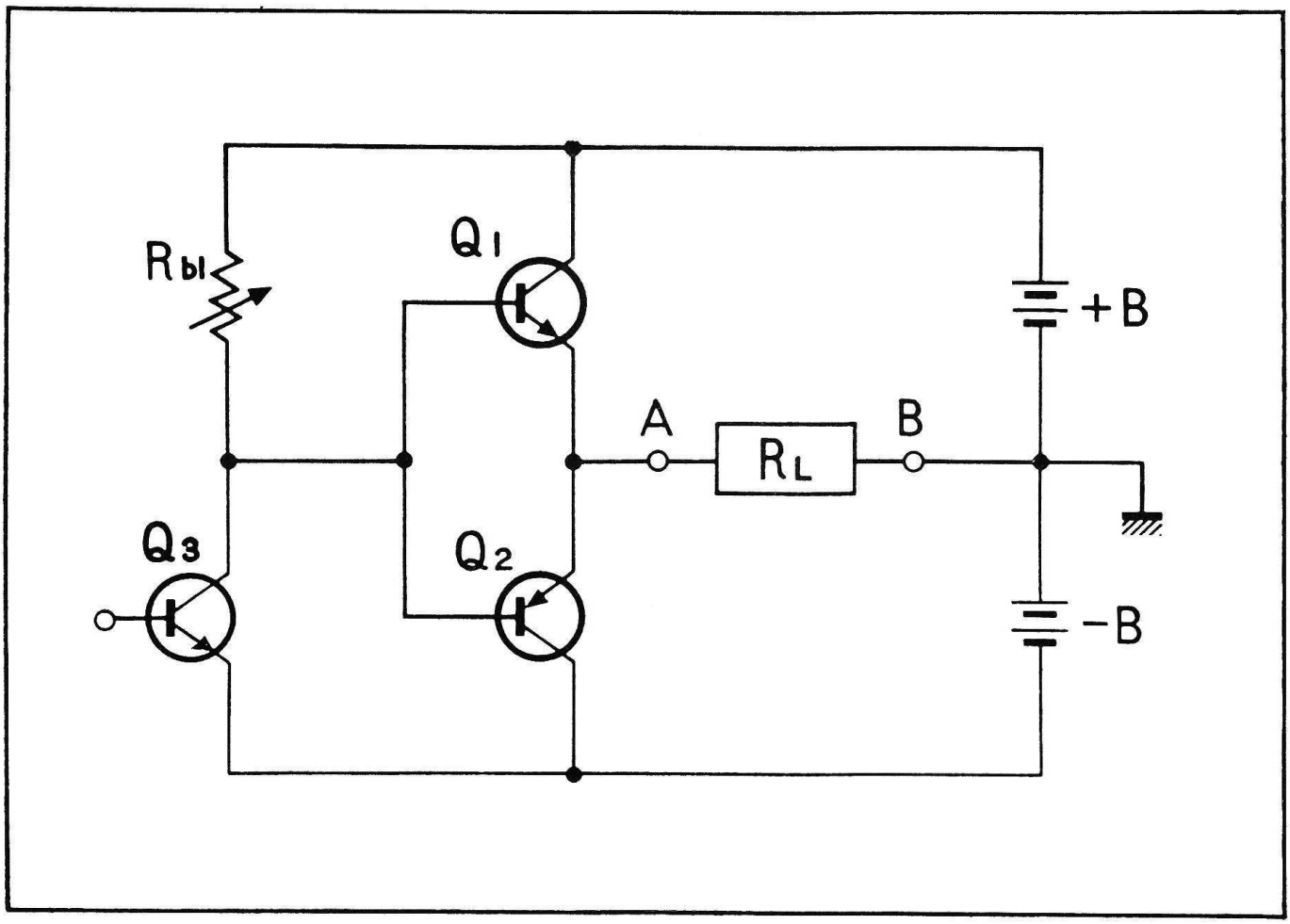
9.

AGAIN, IF WE REDUCE THE VALUE OF Rb-2 KEEPING Rb-1 CONSTANT, VOLTAGE AT POINT "C" WILL BE NEGATIVE, LETTING Q-2 CONDUCT AND NEGATIVE VOLTAGE WILL BE PRESENT AT POINT "A". THE OPPOSITE IS TRUE IF WE KEEP Rb-2 CONSTANT AND CHANGE Rb-1. NOW Q-1 WILL CONDUCT AND POINT "A" WILL BE POSITIVE. TO SUMMARIZE, A CHANGE IN Rb-1 OR Rb-2 WILL AFFECT THE BIAS OF Q-1 AND Q-2, DEVELOPING VOLTAGE AT POINT "A".



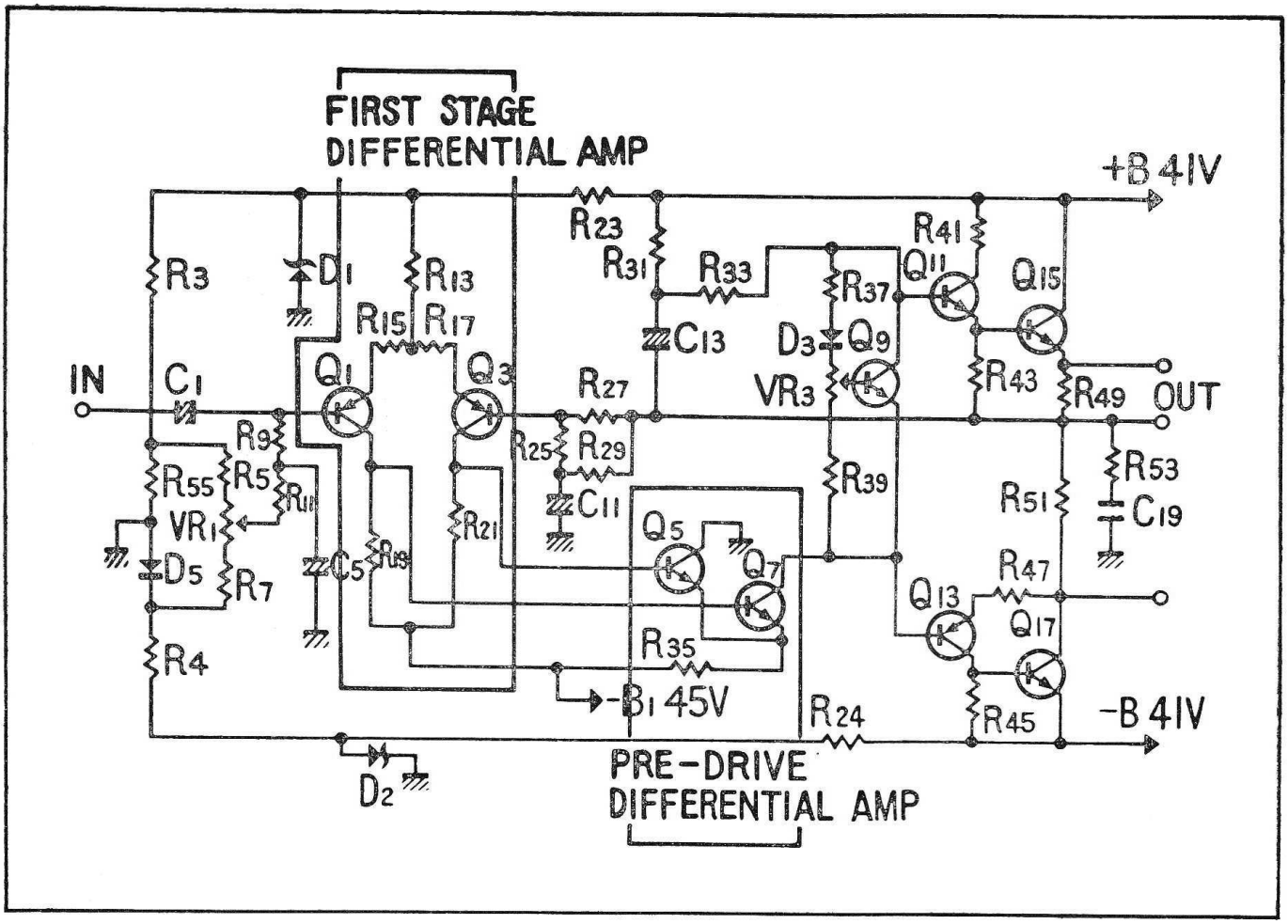
10.

AS SHOWN ON THE SCHEMATIC ON THE LEFT, ANY CHANGE IN R-1 OR R-2, MAY BE CONSIDERED TO BE THE SAME AS A CHANGE IN INTERNAL RESISTANCE BETWEEN THE COLLECTOR AND EMITTER OF Q-1 AND Q-2 WITH RESPECT TO D.C. AS SHOWN IN THE RIGHT SCHEMATIC.



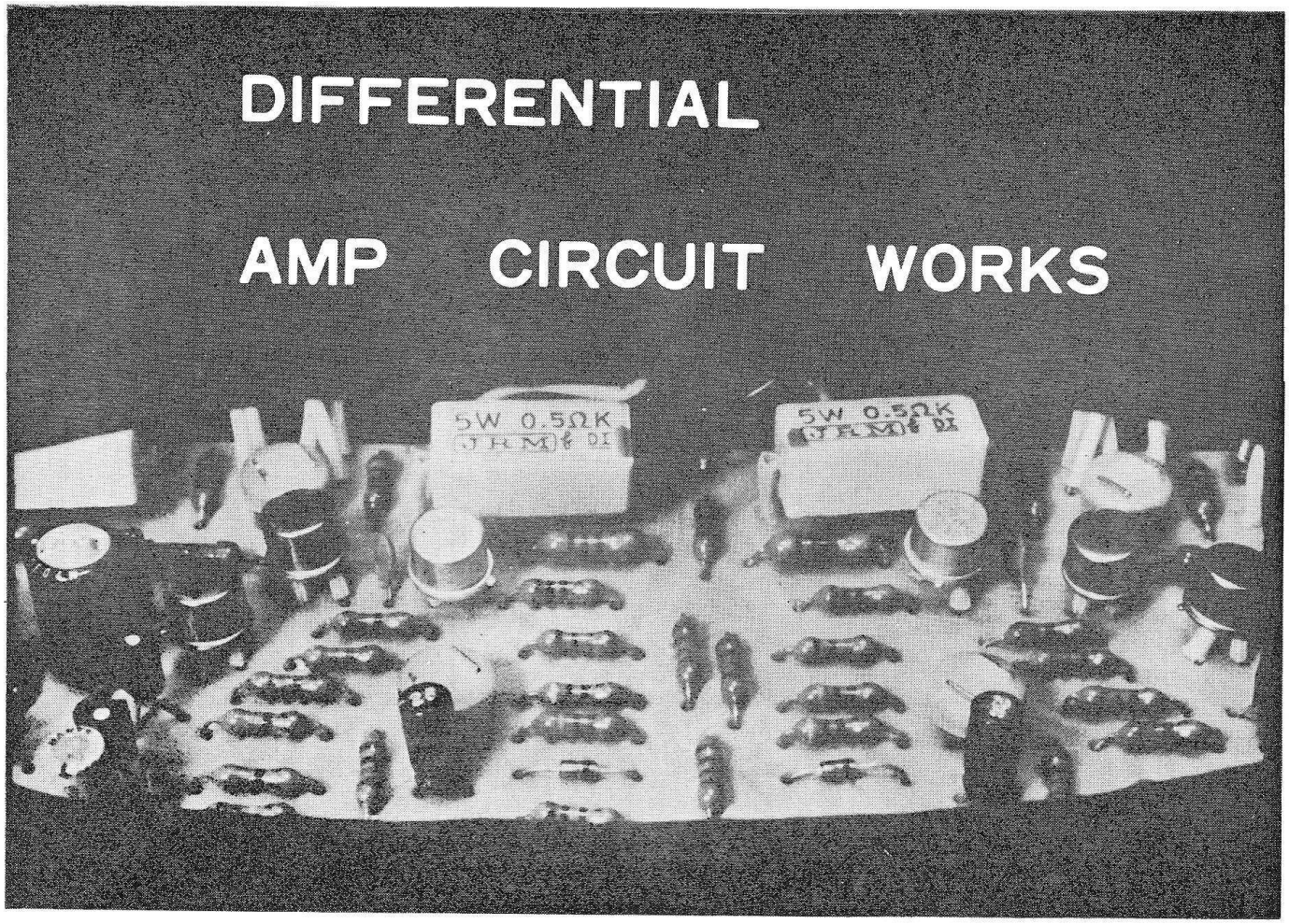
11.

IN THE ACTUAL CIRCUIT, TRANSISTOR Q-3 IS USED INSTEAD OF Rb-2. ANY CHANGE IN Q-3'S INTERNAL RESISTANCE BETWEEN THE EMITTER AND COLLECTOR WILL CHANGE THE VOLTAGE AT POINT "A".



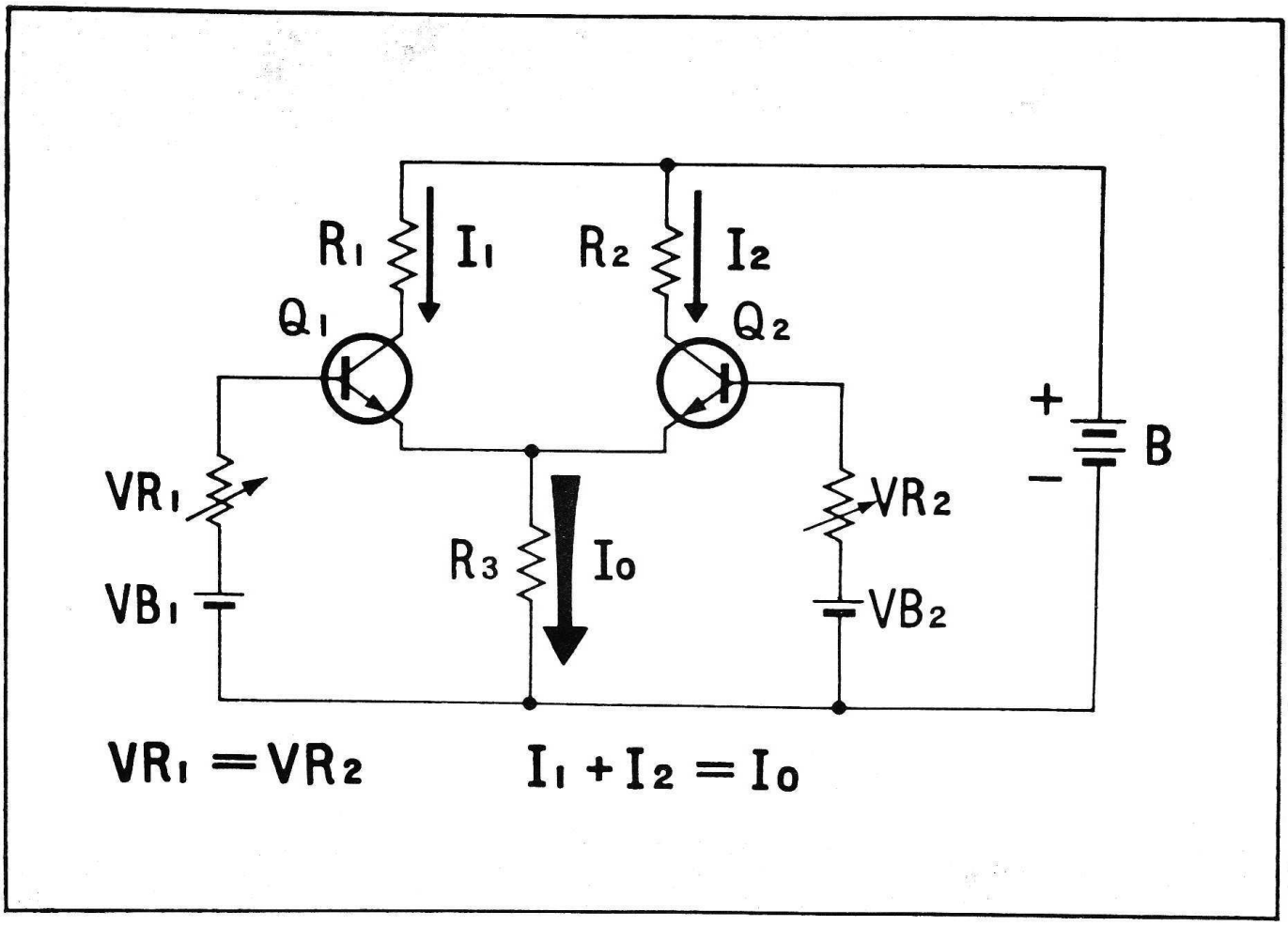
12.

IN AN ACTUAL AMPLIFIER A D.C. VOLTAGE MAY DEVELOP ACROSS THE LOAD IF THE OPERATIONAL CHARACTERISTICS OF THE TRANSISTORS ARE NOT EQUAL. VARIATIONS IN POWER SUPPLY VOLTAGE, AND CHANGES IN AMBIENT TEMPERATURE, MAY ALSO CAUSE THIS. TO CORRECT THESE POSSIBILITIES, A DIFFERENTIAL AMPLIFIER CIRCUIT IS USED SO THAT VOLTAGE ACROSS R-L WILL NOT HAVE ANY D.C. COMPONENTS.

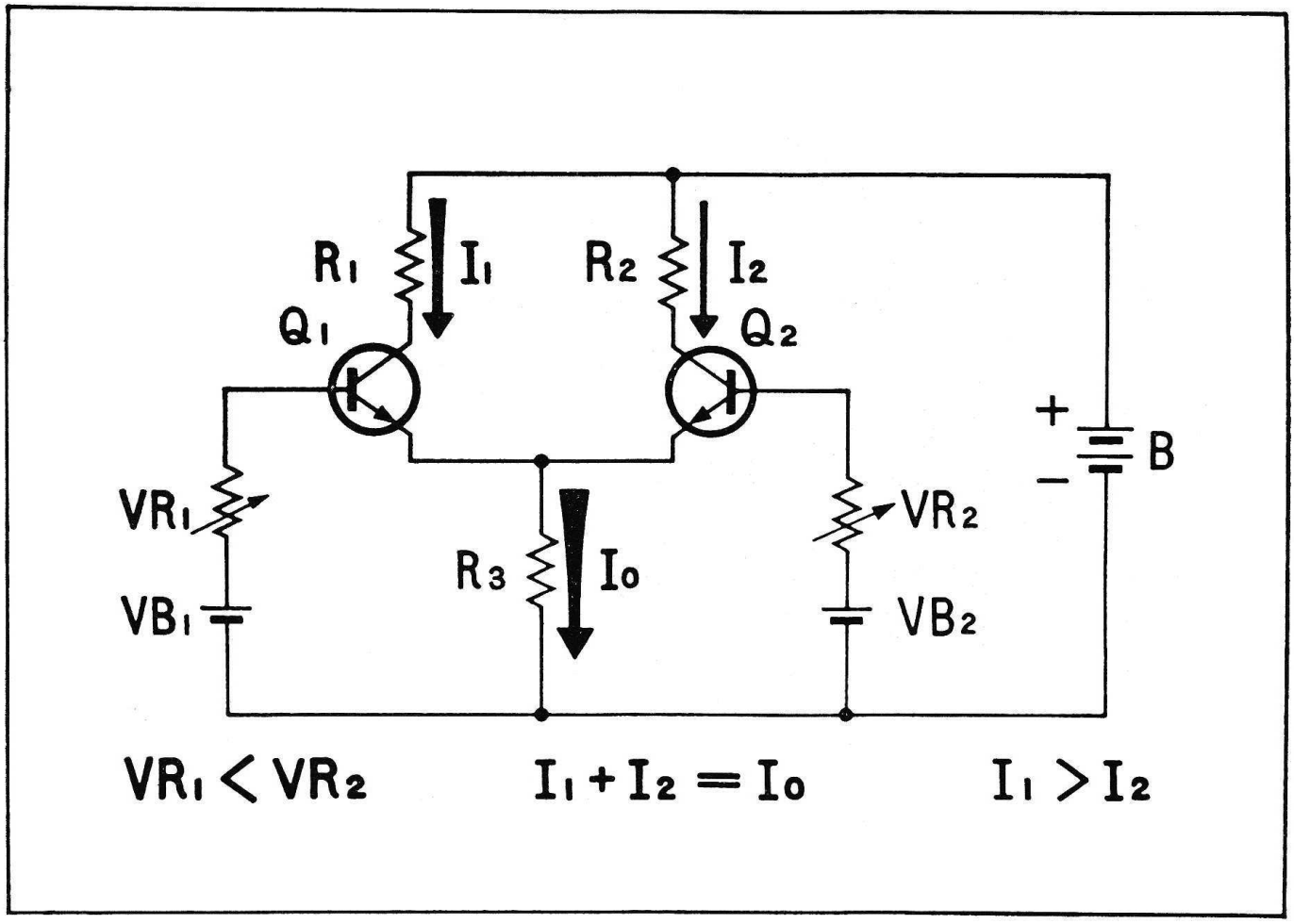


13.

NOW WE WILL SEE HOW THIS DIFFERENTIAL AMPLIFIER WORKS.

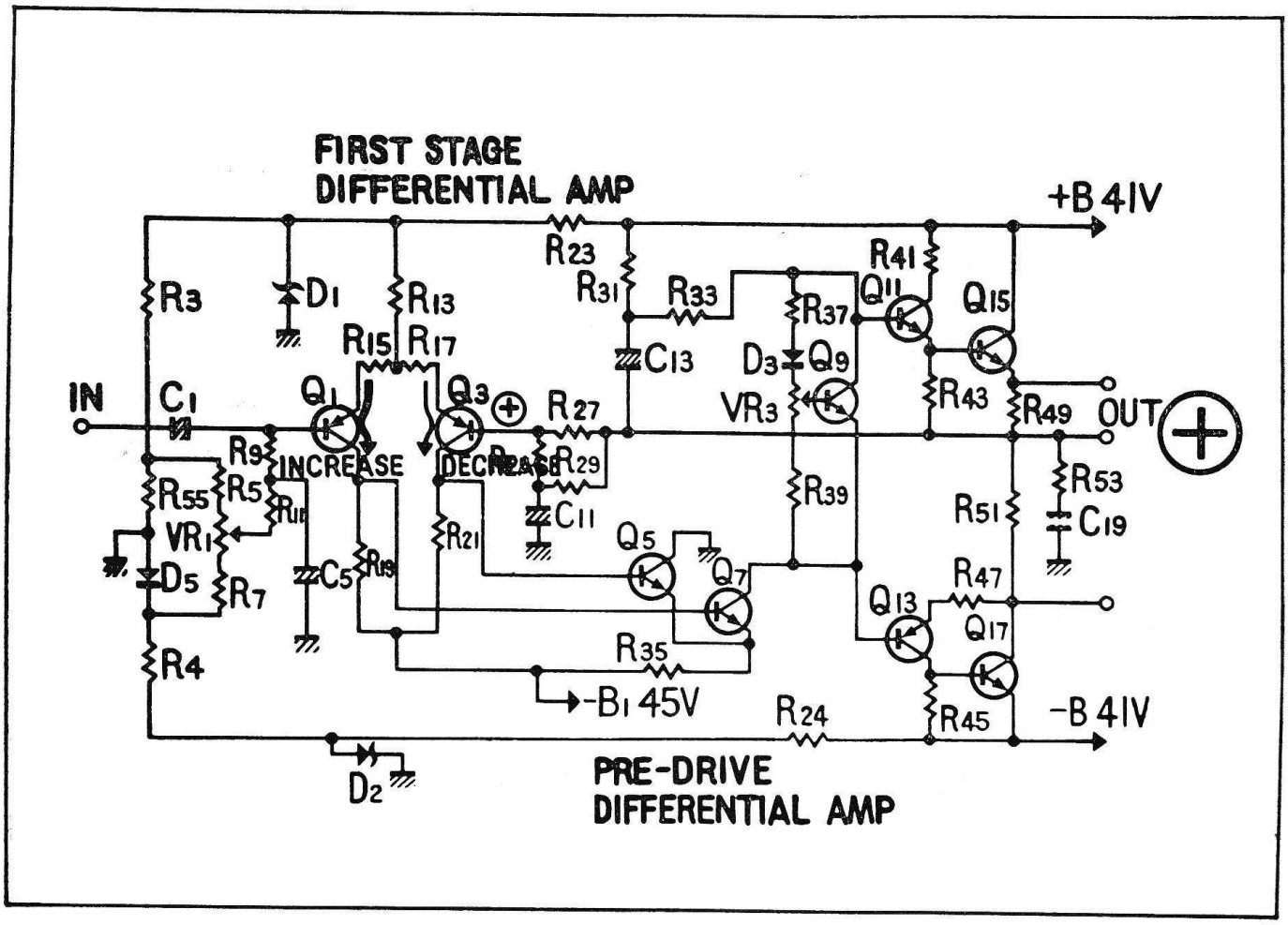


14. HERE IS A SCHEMATIC OF A DIFFERENTIAL AMPLIFIER. IF TRANSISTORS Q-1 AND Q-2 HAVE THE SAME CHARACTERISTICS AND VR-1 EQUALS VR-2, THEN THE CURRENT THROUGH R-1 AND R-2 EQUALS THE CURRENT THROUGH R-3. STATED SIMPLY IF VR-1 EQUALS VR-2, THEN I-1 PLUS I-2 EQUALS I-0. THE DESIGN OF THIS CIRCUIT IS SUCH THAT I-0 IS CONSTANT AND DOES NOT CHANGE.



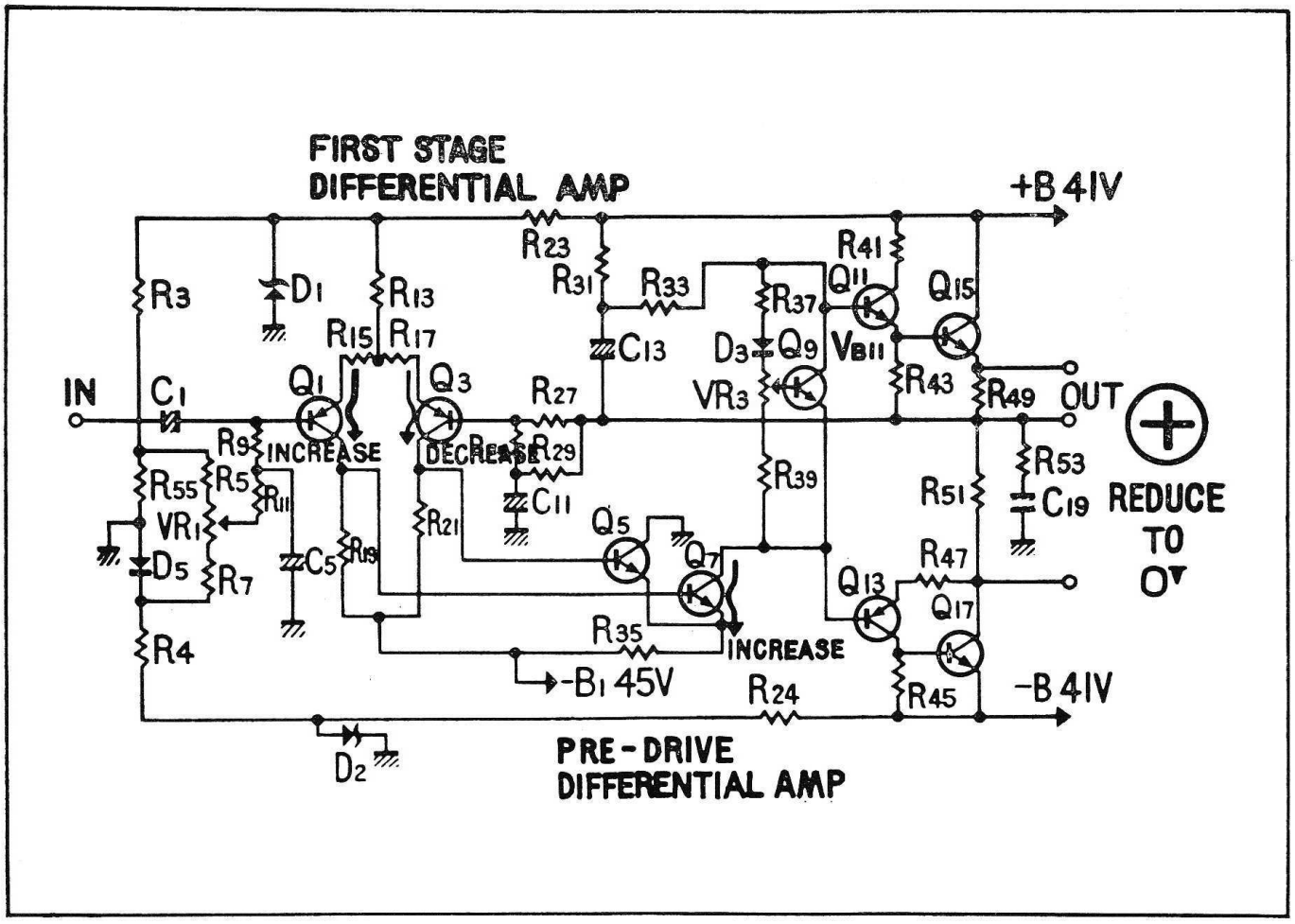
15.

IF THE VALUE OF VR-1 IS REDUCED AND VR-2 IS KEPT CONSTANT, THE BIAS OF Q-1 WILL INCREASE. THEREFORE, I-1 THAT FLOWS THROUGH Q-1 WILL INCREASE, BUT SINCE I-0 REMAINS CONSTANT, I-2 THAT FLOWS THROUGH Q-2 WILL DECREASE BY THE INCREASED AMOUNT OF I-1. THUS IF I-1 INCREASES, I-2 WILL DECREASE AND IF I-2 INCREASES, I-1 WILL DECREASE.

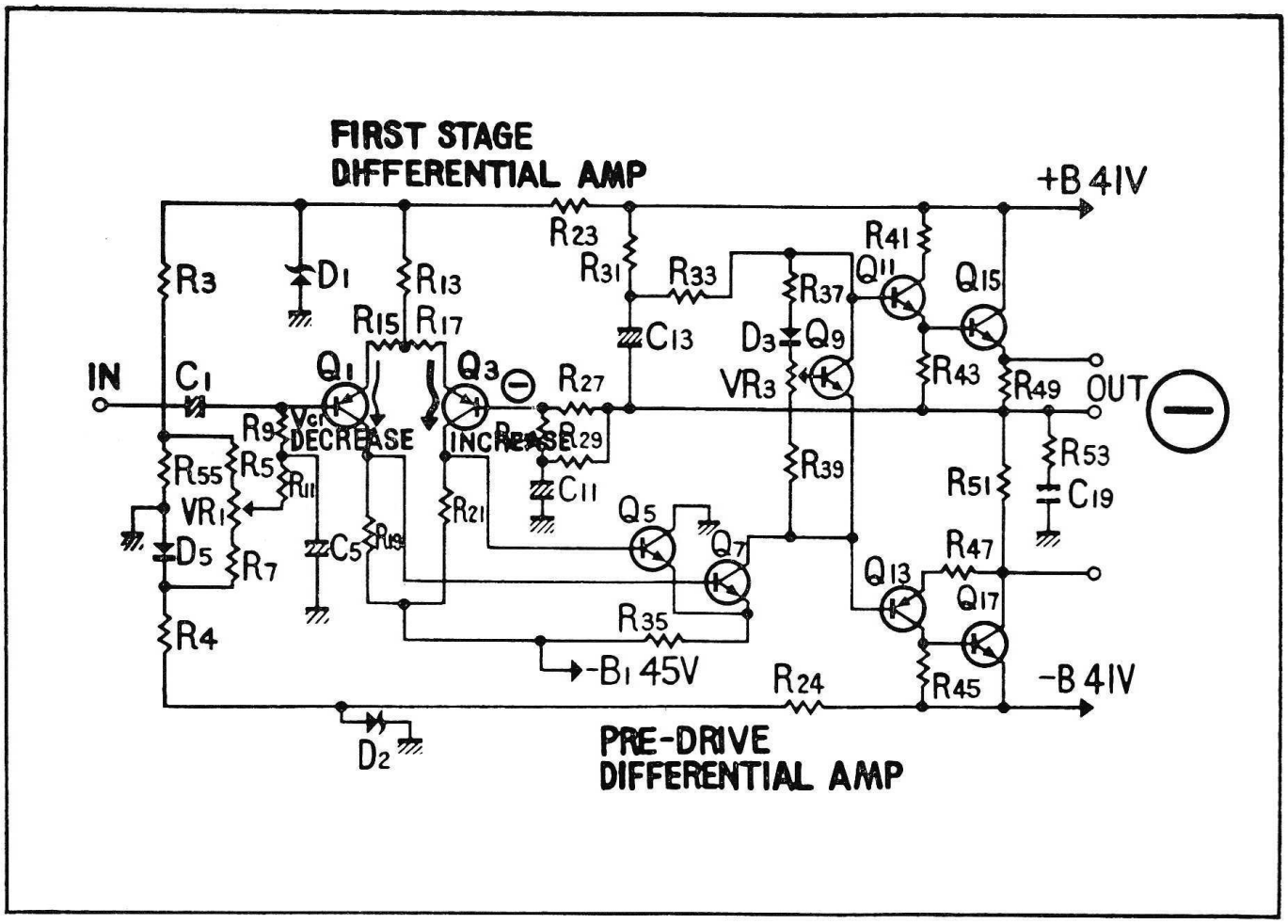


16.

NOW WE WILL LOOK AT THE ACTUAL DIFFERENTIAL CIRCUIT USED IN AN SA-1000 MAIN AMPLIFIER. WE WILL ASSUME A POSITIVE D.C. VOLTAGE IS DEVELOPED AT THE OUT TERMINALS FOR SOME REASON. THIS VOLTAGE WILL BE APPLIED THROUGH R-27 TO THE BASE OF Q-3 OF THE FIRST STAGE DIFFERENTIAL AMPLIFIER CIRCUIT. THIS WILL CAUSE THE BIAS OF Q-3 TO DECREASE AND THE COLLECTOR CURRENT WILL DECREASE ACCORDINGLY. FOLLOWING THE PRINCIPLES OF A DIFFERENTIAL AMPLIFIER CIRCUIT, THE COLLECTOR CURRENT OF Q-1 WILL INCREASE BY THE AMOUNT OF DECREASE OF Q-3 AND THE COLLECTOR VOLTAGE WILL BE RAISED.

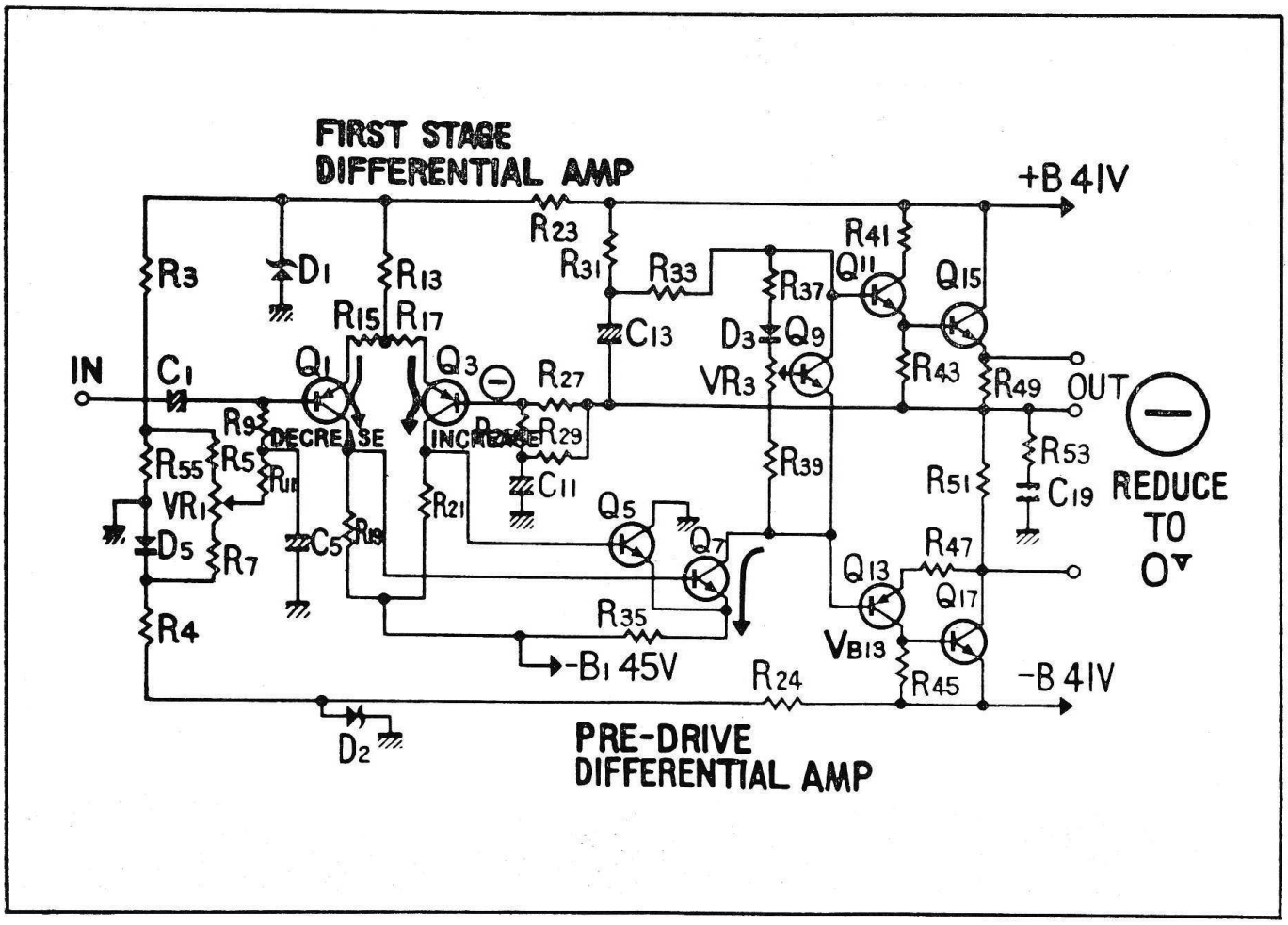


17. THIS ACTION WILL CAUSE THE BIAS OF Q-7 IN THE DIFFERENTIAL AMPLIFIER CIRCUIT OF THE PRE-DRIVE STAGE TO INCREASE, CAUSING THE COLLECTOR CURRENT OF Q-7 TO INCREASE. THIS LOWERS THE VOLTAGE TO THE BASE OF Q-11 WHICH REDUCE AND DOES NOT LET COLLECTOR CURRENT FLOW IN Q-11. THIS ACTION INCREASES THE INTERNAL RESISTANCE OF Q-11 BETWEEN THE EMITTER AND COLLECTOR WITH RESPECT TO D.C.. AS A RESULT THE POSITIVE VOLTAGE AT THE OUTPUT WILL BE REDUCED TO ZERO VOLTS.



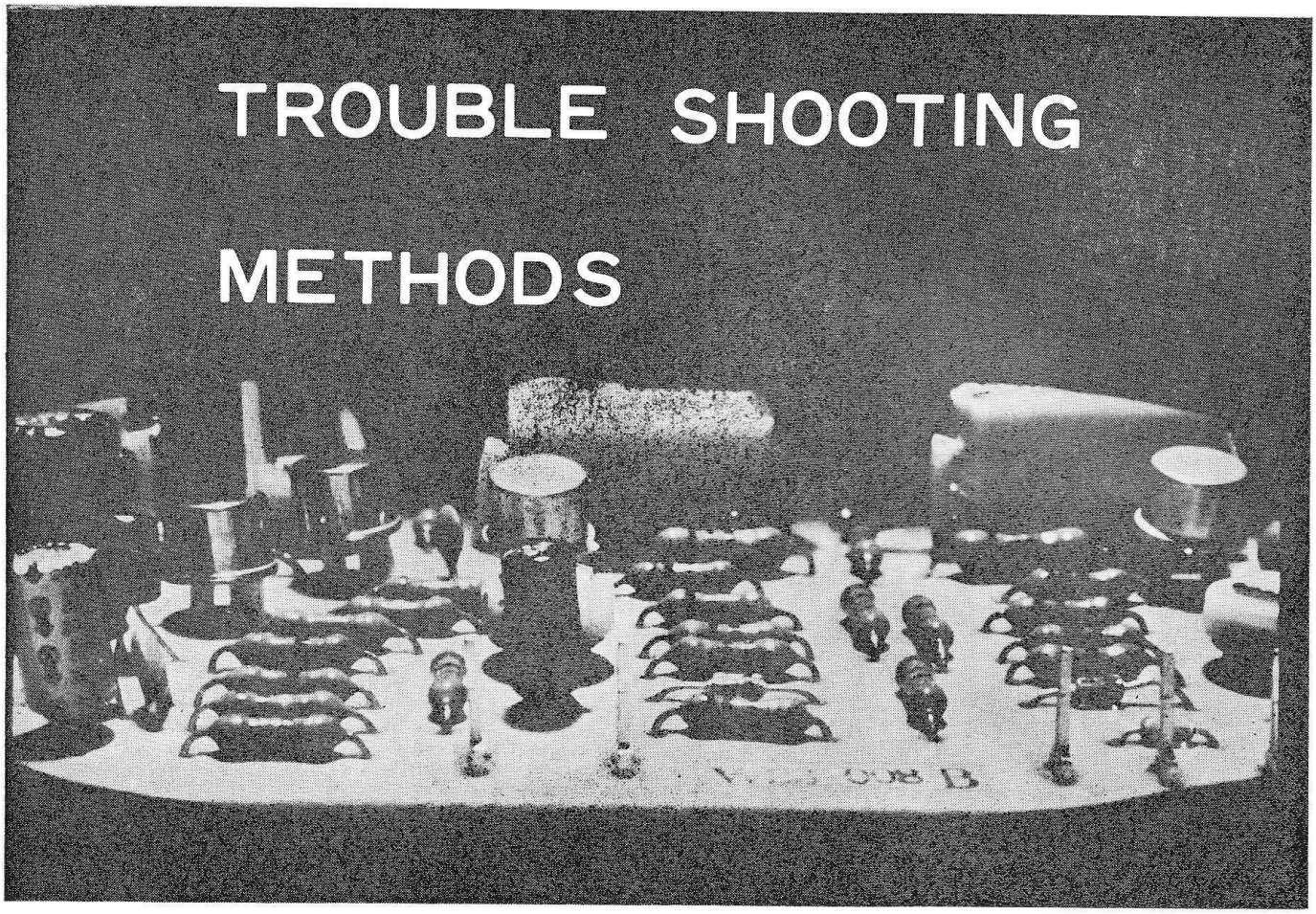
18.

IF A NEGATIVE D.C. VOLTAGE IS PRESENT AT THE OUTPUT, THIS WILL CAUSE AN INCREASE OF THE BIAS OF Q-3 THROUGH R-27. Q-3'S COLLECTOR CURRENT WILL INCREASE. THE COLLECTOR CURRENT WILL DECREASE BY THE AMOUNT OF INCREASE OF Q-3, CAUSING Q-1'S COLLECTOR VOLTAGE TO BE REDUECED.



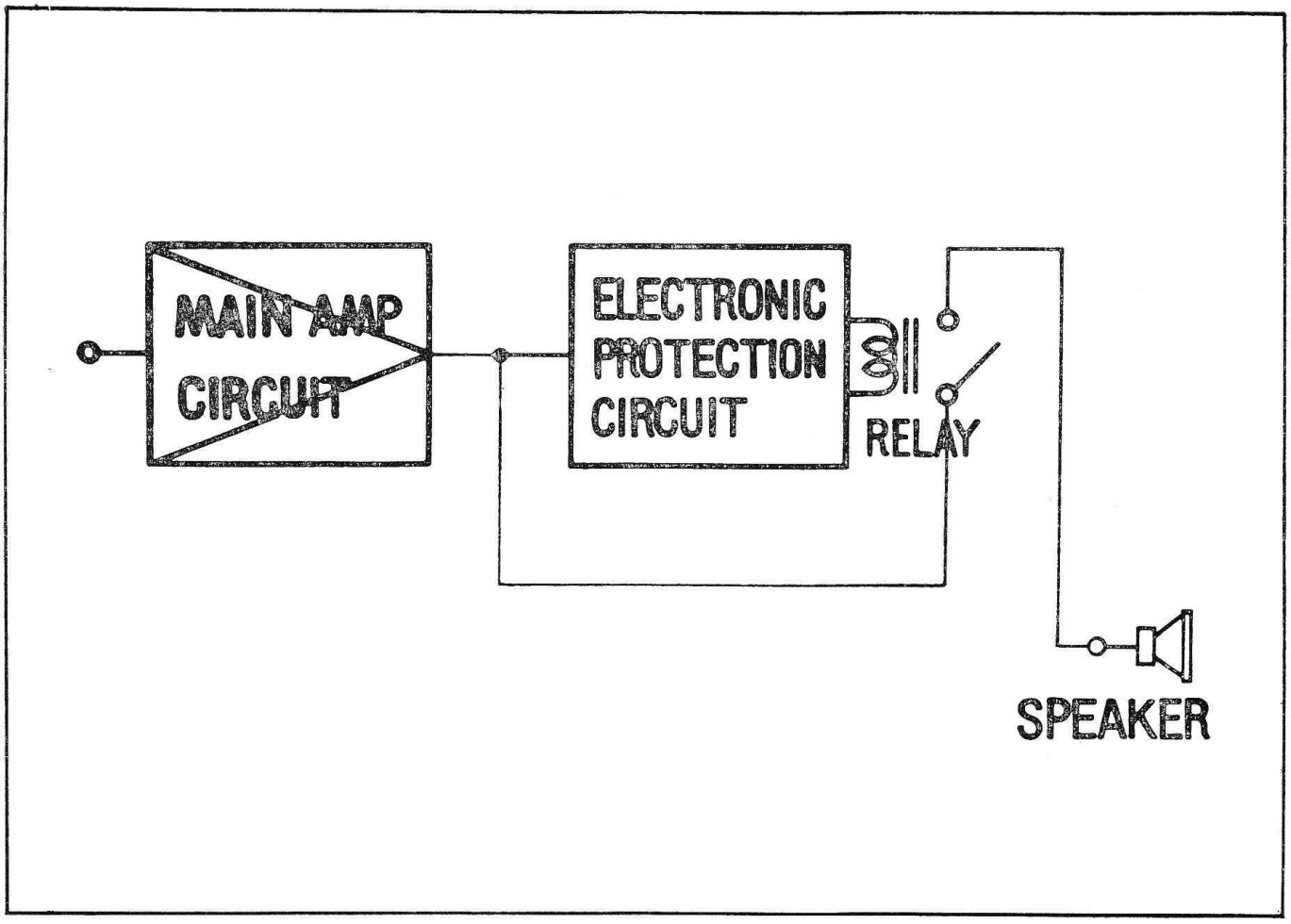
19.

Q-1'S REDUCED COLLECTOR VOLTAGE WILL DECREASE THE BIAS OF Q-7 WHICH REDUCES THE COLLECTOR CURRENT. Q-13'S BASE VOLTAGE WILL INCREASE, REDUCING THE BIAS. THE INTERNAL RESISTANCE OF Q-13 BETWEEN THE EMITTER AND COLLECTOR WILL INCREASE WITH RESPECT TO D.C., REDUCING ANY NEGATIVE VOLTAGE AT THE OUTPUT TOWARD ZERO. IN THIS MANNER, THE DIFFERENTIAL AMPLIFIER WILL KEEP THE OUTPUT OF THE MAIN AMPLIFIER AT ZERO VOLTS WITH RESPECT TO D.C.

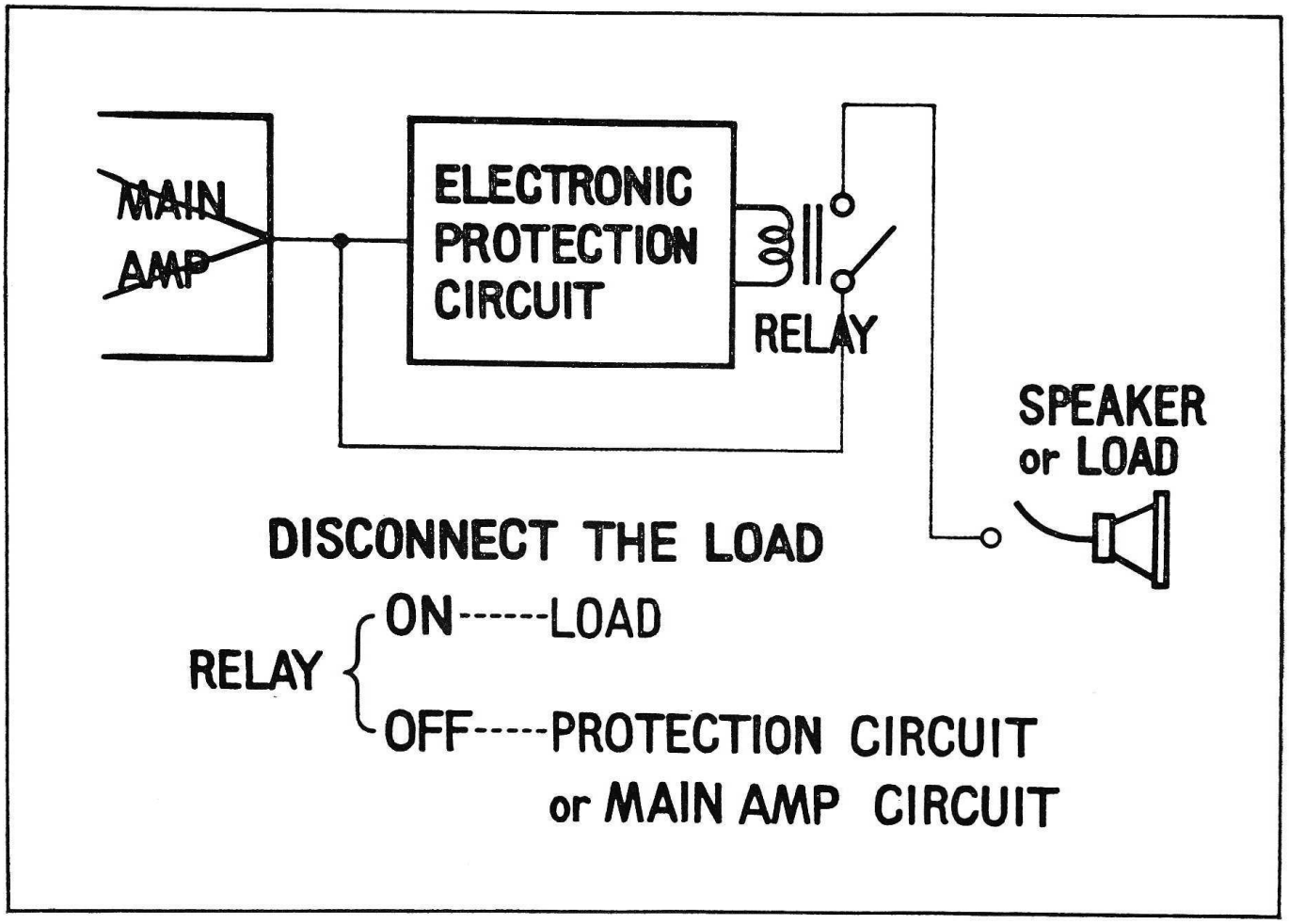


20.

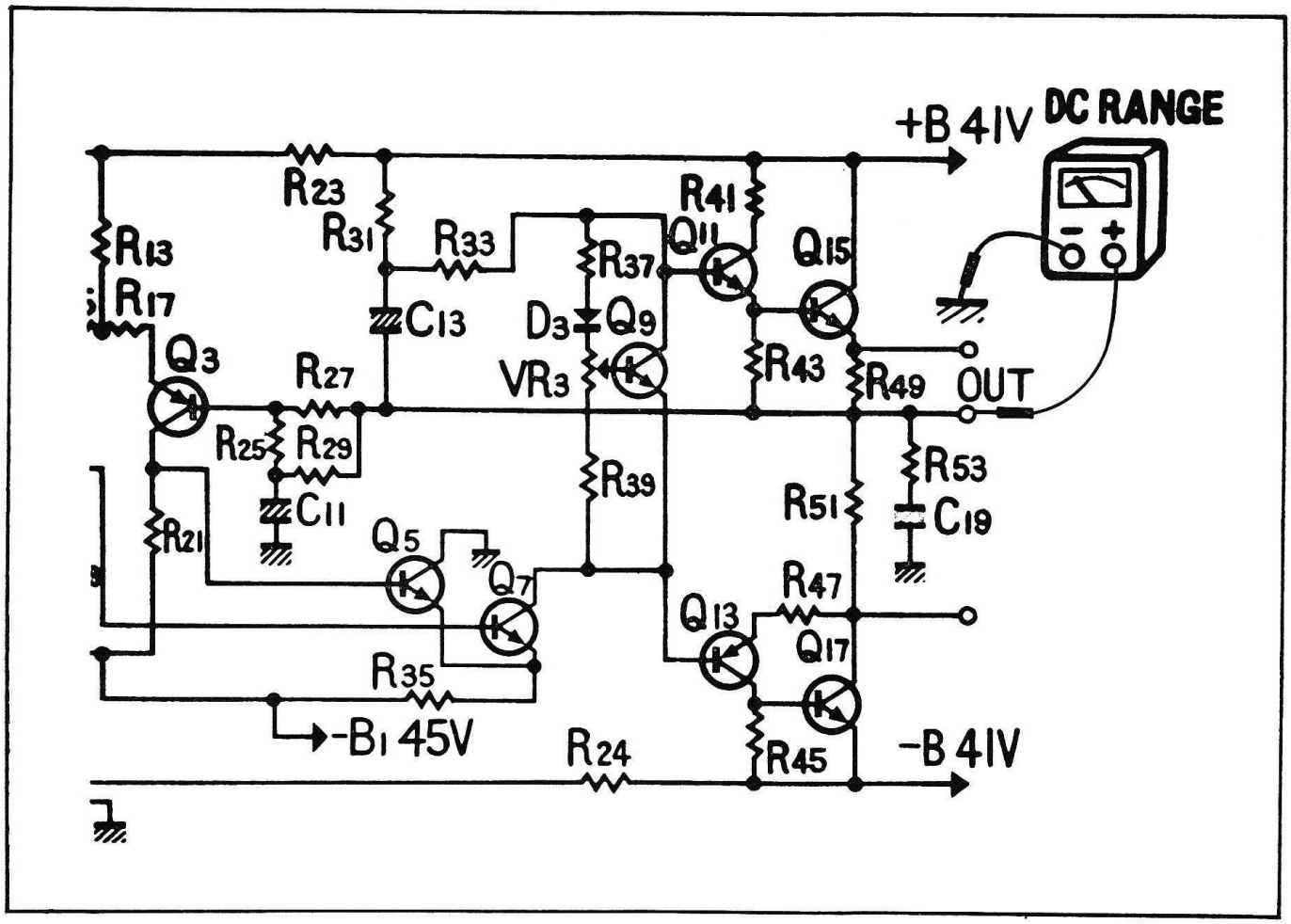
NEXT WE WILL SEE HOW TO TROUBLESHOOT OCL MAIN AMPLIFIER CIRCUITS BASED ON THE CIRCUIT PRINCIPLE THAT WE'VE JUST LEARNED.



21. ALL OF PIONEER'S OCL MAIN AMPLIFIERS HAVE A PROTECTIVE CIRCUIT THAT DISCONNECTS THE LOAD FROM THE AMP WHENEVER THE AMP FAILS OR THE LOAD SHORTS OR IS OF TOO LOW IMPEDANCE. THEREFORE, IF PROTECTIVE CIRCUIT HAS WORKED THEN YOUR FIRST STEP IS TO DISCONNECT THE LOAD FROM THE AMPLIFIER.

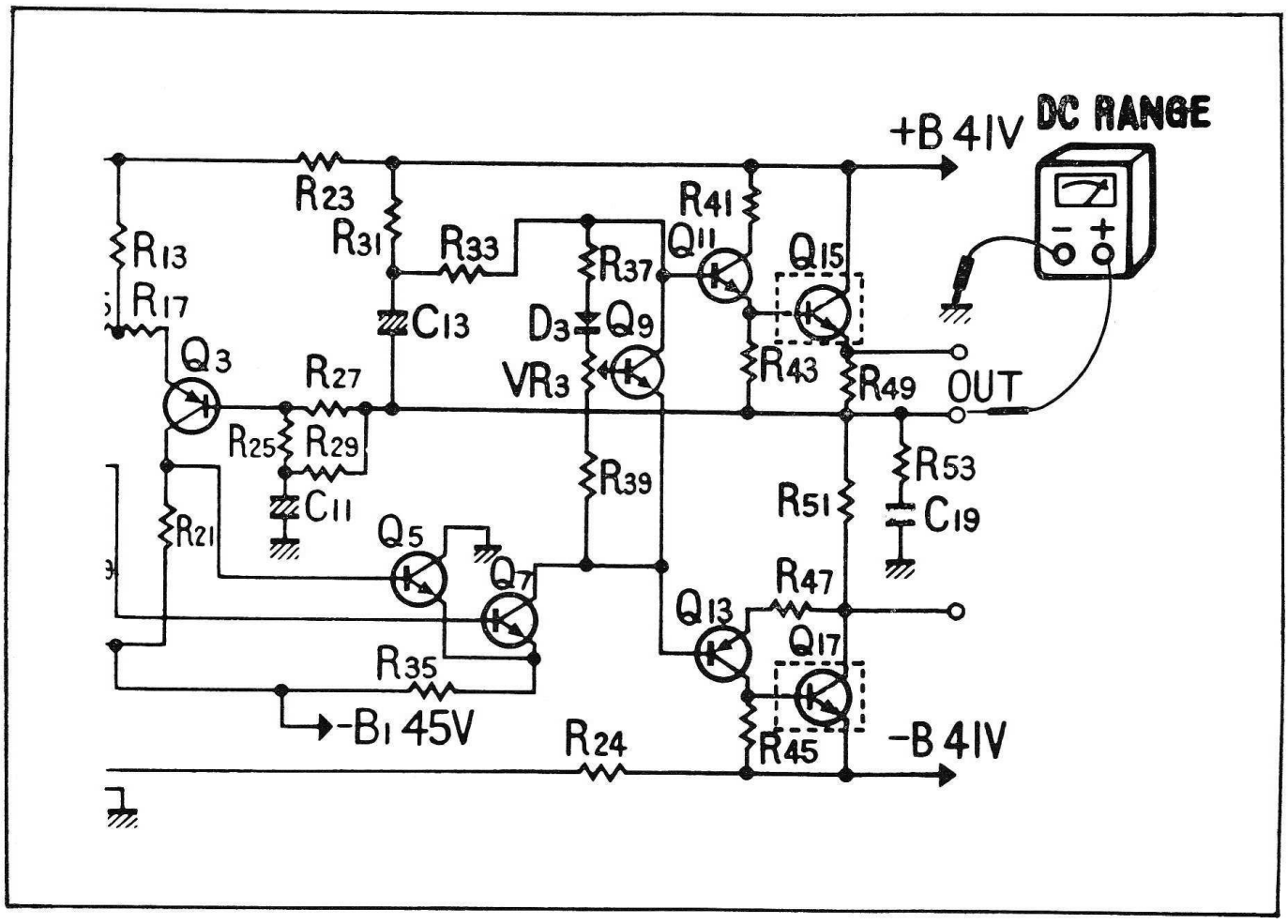


22. IF REMOVING THE LOAD FROM THE AMPLIFIER ALLOWS THE PROTECTION CIRCUIT TO RETURN TO ITS NORMAL OPERATING CONDITION, THEN YOU MAY ASSUME THE PROBLEM LIES IN THE LOAD. HOWEVER, IF THE PROTECTION CIRCUIT STAYS ENERGIZED AFTER REMOVING THE LOAD, THEN THE PROBLEM MAY BE IN THE PROTECTION CIRCUIT OR THE MAIN AMP.



23.

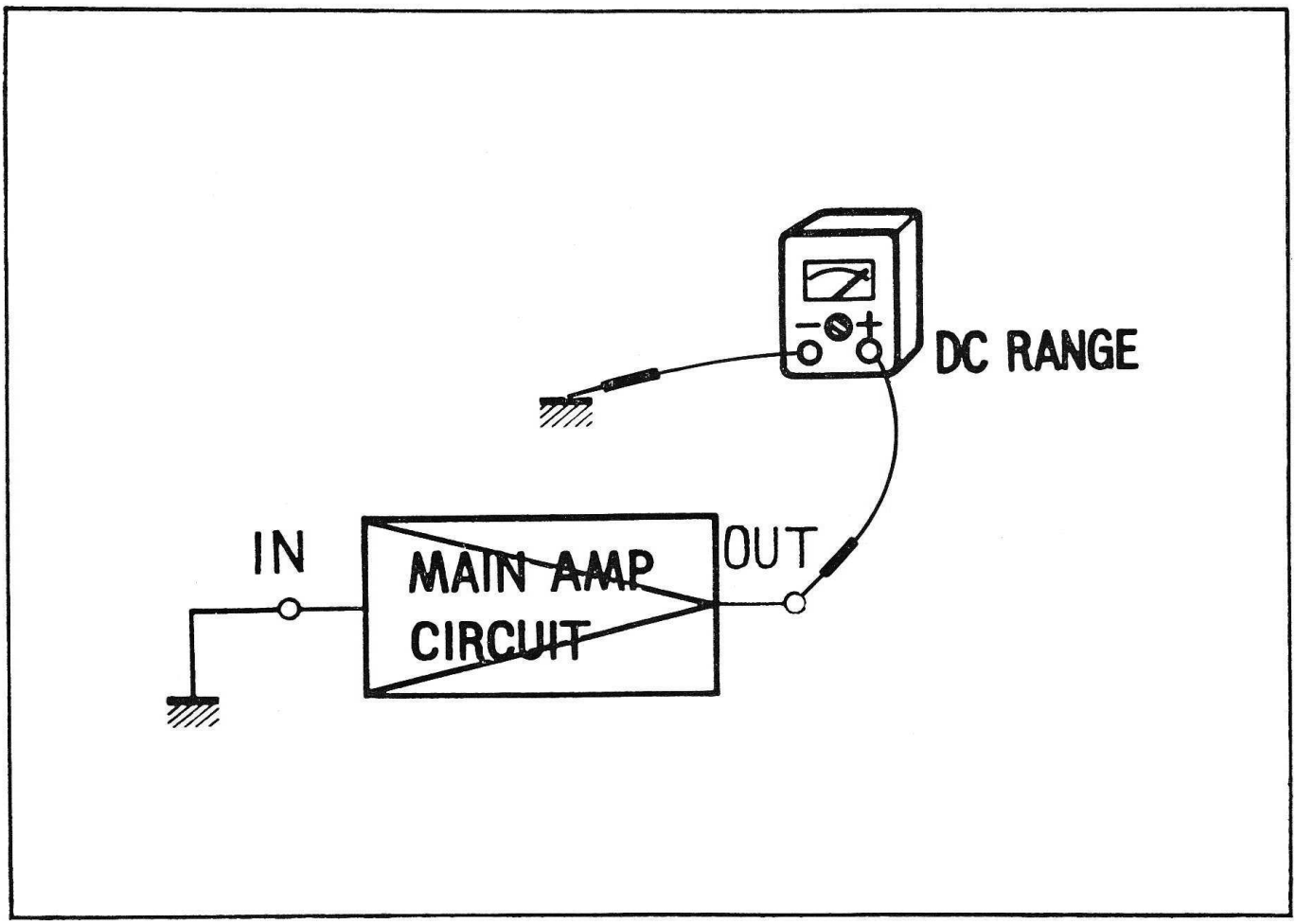
BEFORE STARTING TROUBLESHOOTING PLEASE OBSERVE THE FOLLOWING POINT. CONNECT A SPEAKER LOAD TO THE AMPLIFIER UNDER TEST. ONLY IF THERE IS NO D.C. VOLTAGE PRESENT AT THE OUTPUTS. IF THERE IS NONE PRESENT THEN THE AMPLIFIER IS BALANCED. IN THE INITIAL TROUBLESHOOTING, A RESISTIVE DUMMY LOAD IS RECOMMENDED RATHER THAN SPEAKERS.



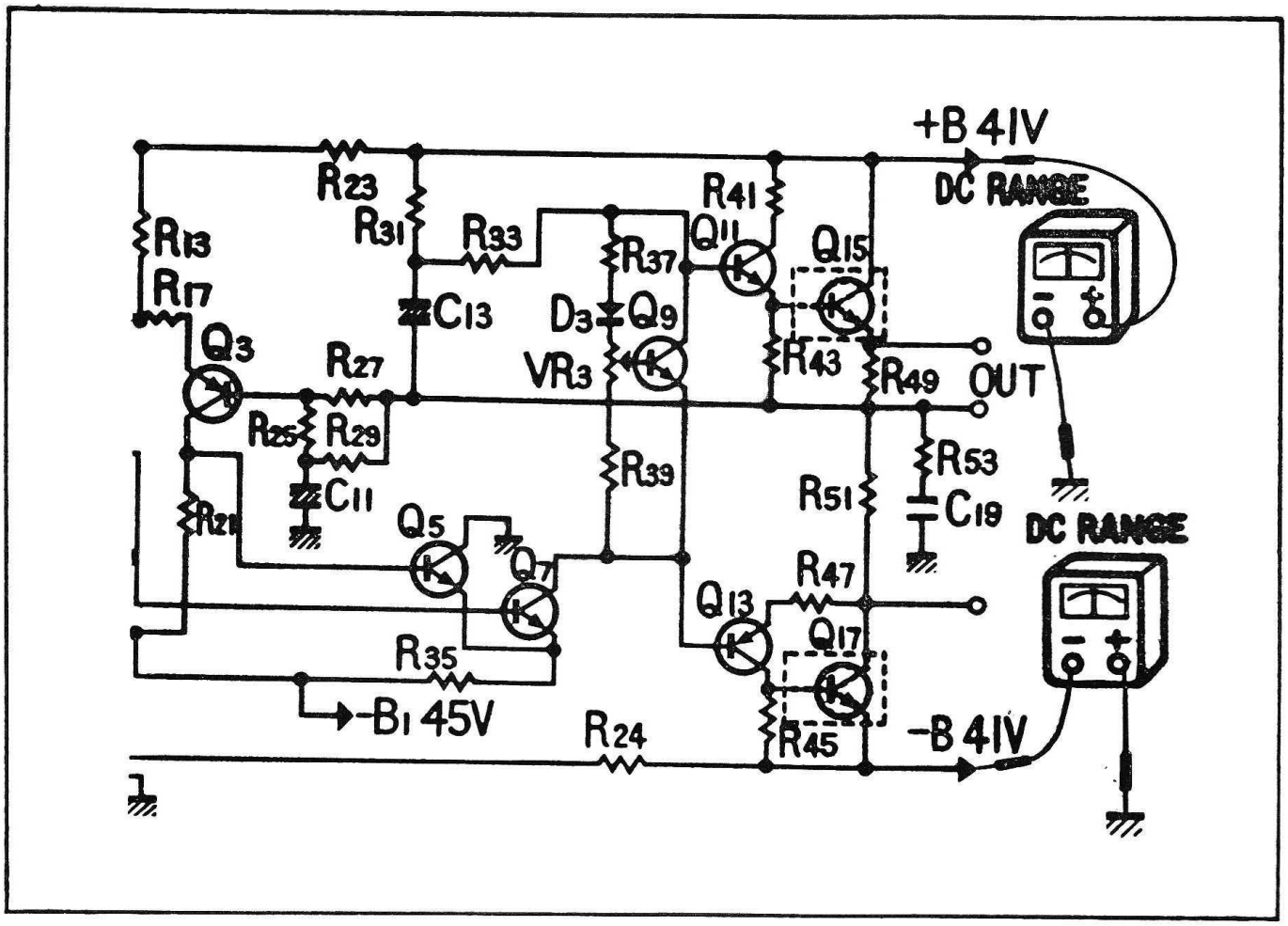
24.

IF D.C. VOLTAGE IS PRESENT AT THE OUTPUT TERMINALS, YOU MUST REMOVE THE POWER TRANSISTORS BEFORE YOU START TROUBLESHOOTING. WITHOUT POWER TRANSISTORS, THE AMPLIFIER WILL STILL OPERATE NORMALLY BUT WILL ONLY PRODUCE ABOUT ONE WATT OF OUTPUT. AFTER REPAIRS OR ADJUSTMENT OF THE AMP, YOU MAY INSTALL NEW POWER TRANSISTORS IF THE VOLTAGE AT THE OUTPUT IS ZERO VOLTS PLUS OR MINUS TEN MILLIVOLTS.

THE DRIVER STAGE AND POWER STAGE ARE DRIVEN BY ONE TRANSISTOR IN THE LATEST AMPLIFIER WITH SMALL OUTPUT LESS THAN 10 WATTS PER CHANNEL (BOTH CHANNEL DRIVEN). IN SUCH A CASE, THE EXAMINATION IS CARRIED OUT WITHOUT REMOVING THE POWER TRANSISTOR.

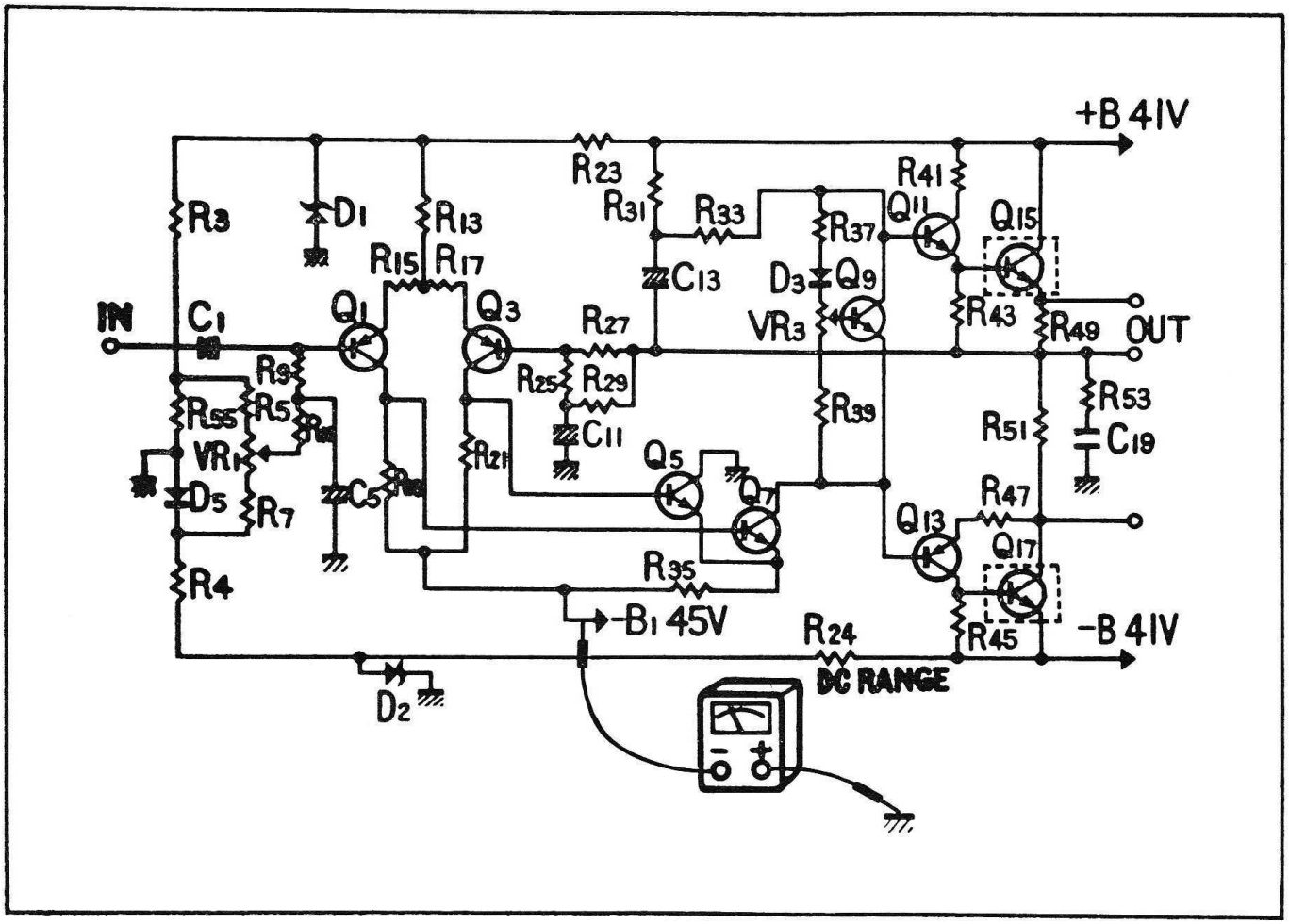


25. THE FIRST THING TO CHECK AS YOU TROUBLESHOOT A OCL MAIN AMPLIFIER IS TO INSURE THERE IS NO VOLTAGE PRESENT AT THE OUTPUT TERMINALS. IF NONE IS PRESENT THE D.C. BALANCE OF THE AMP IS O.K.. IF THE AMP IS OUT OF BALANCE THERE WILL BE A D.C. VOLTAGE AT THE OUTPUT. WE CAN COMMENCE TROUBLE-SHOOTING AS FOLLOWS. YOU MUST REMOVE THE POWER TRANSIS-TORS BEFORE YOU START TROUBLE SHOOTING.



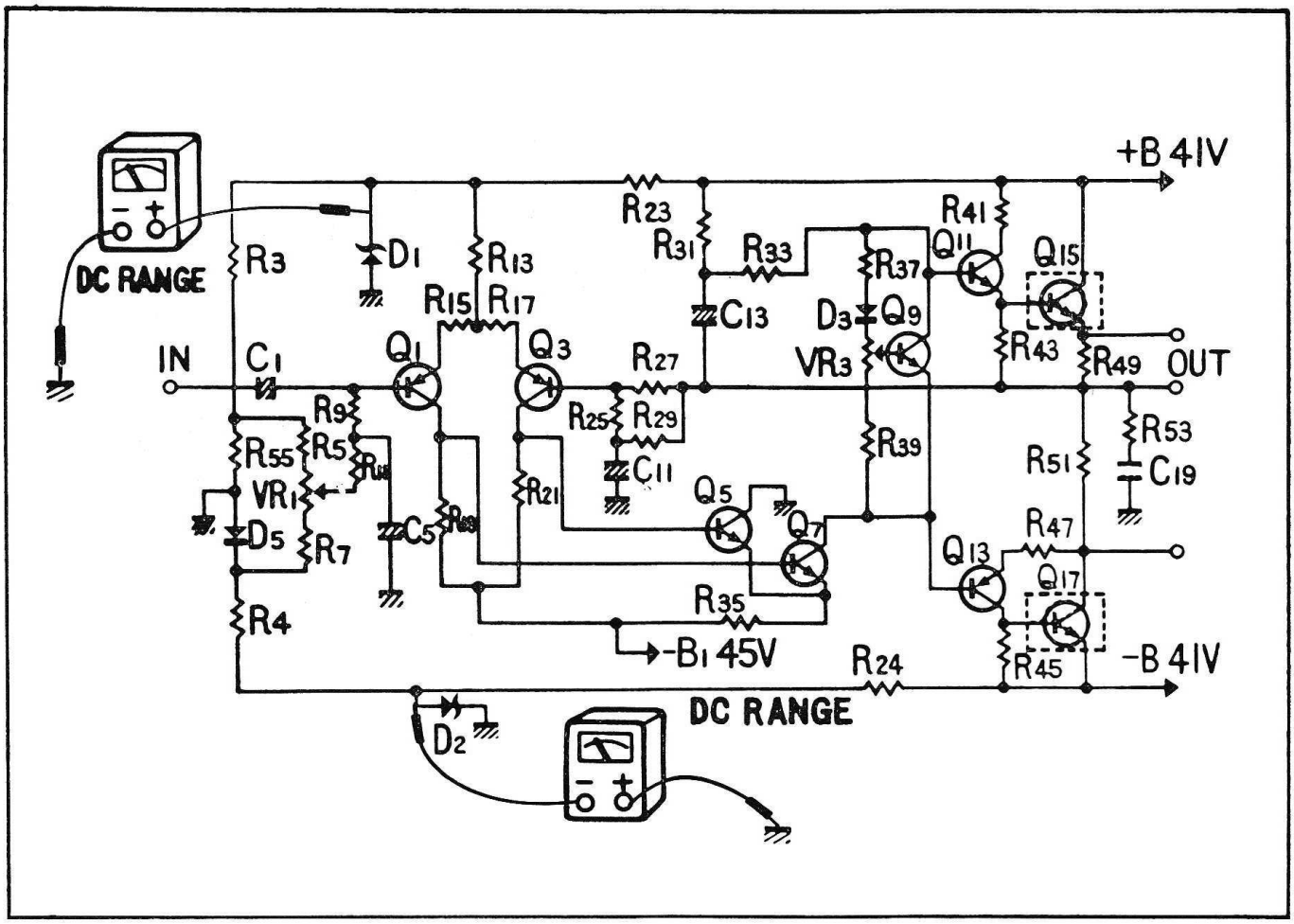
26.

CHECK THE POSITIVE AND NEGATIVE POWER SUPPLY VOLTAGES TO SEE IF THEY ARE EQUAL. IF THEY ARE EXTREMELY DIFFERENT FROM EACH OTHER THEN YOU MAY SUSPECT THE POWER SUPPLY IS AT FAULT.



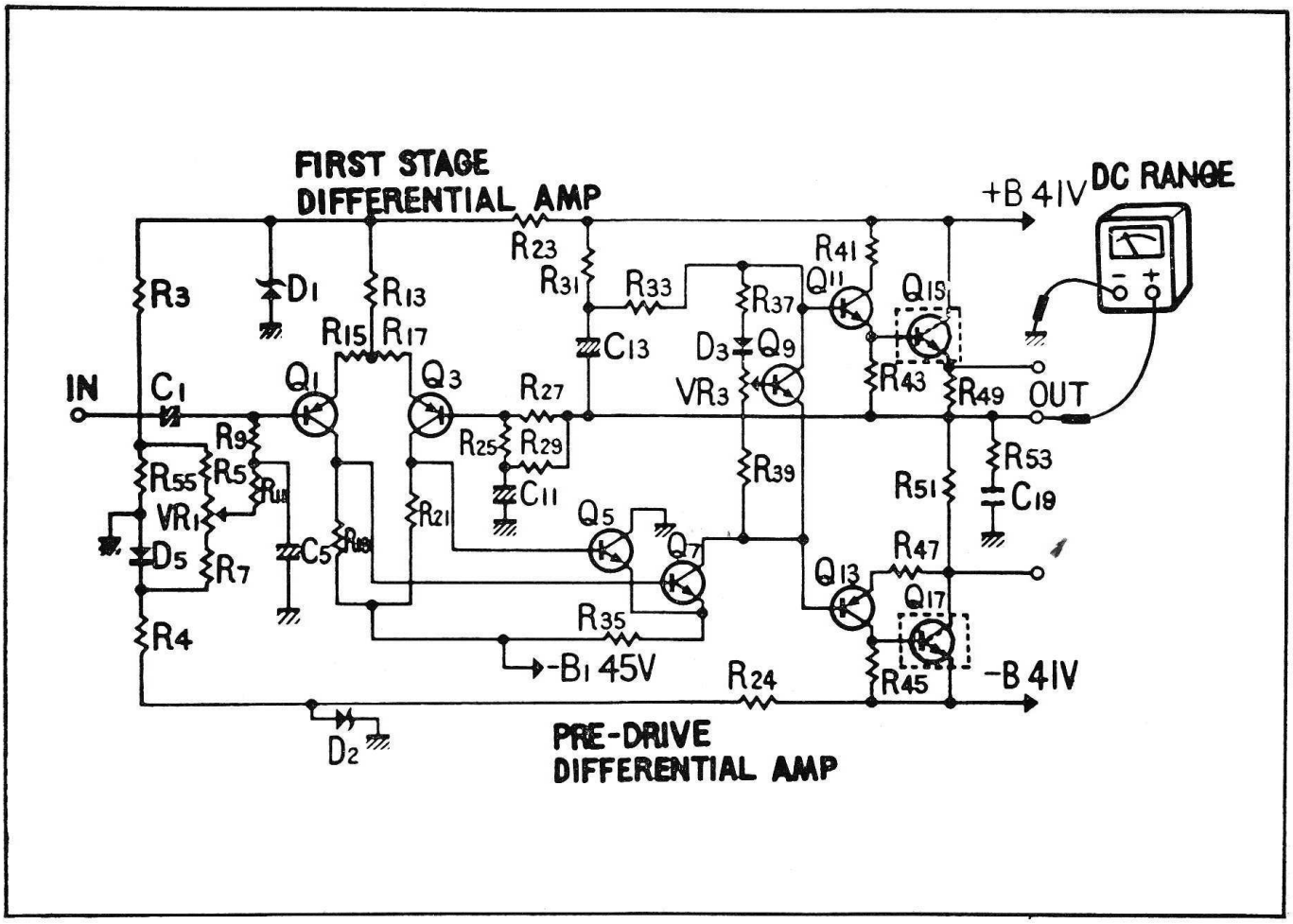
27.

CHECK THE NEGATIVE B-1 SUPPLY VOLTAGE FOR THE PRE-DRIVER AND THE FIRST STAGE DIFFERENTIAL AMPLIFIER CIRCUIT. IF YOU HAVE A LARGE DIFFERENCE FROM THAT SPECIFIED, THE POWER SUPPLY MAY BE THE CAUSE.



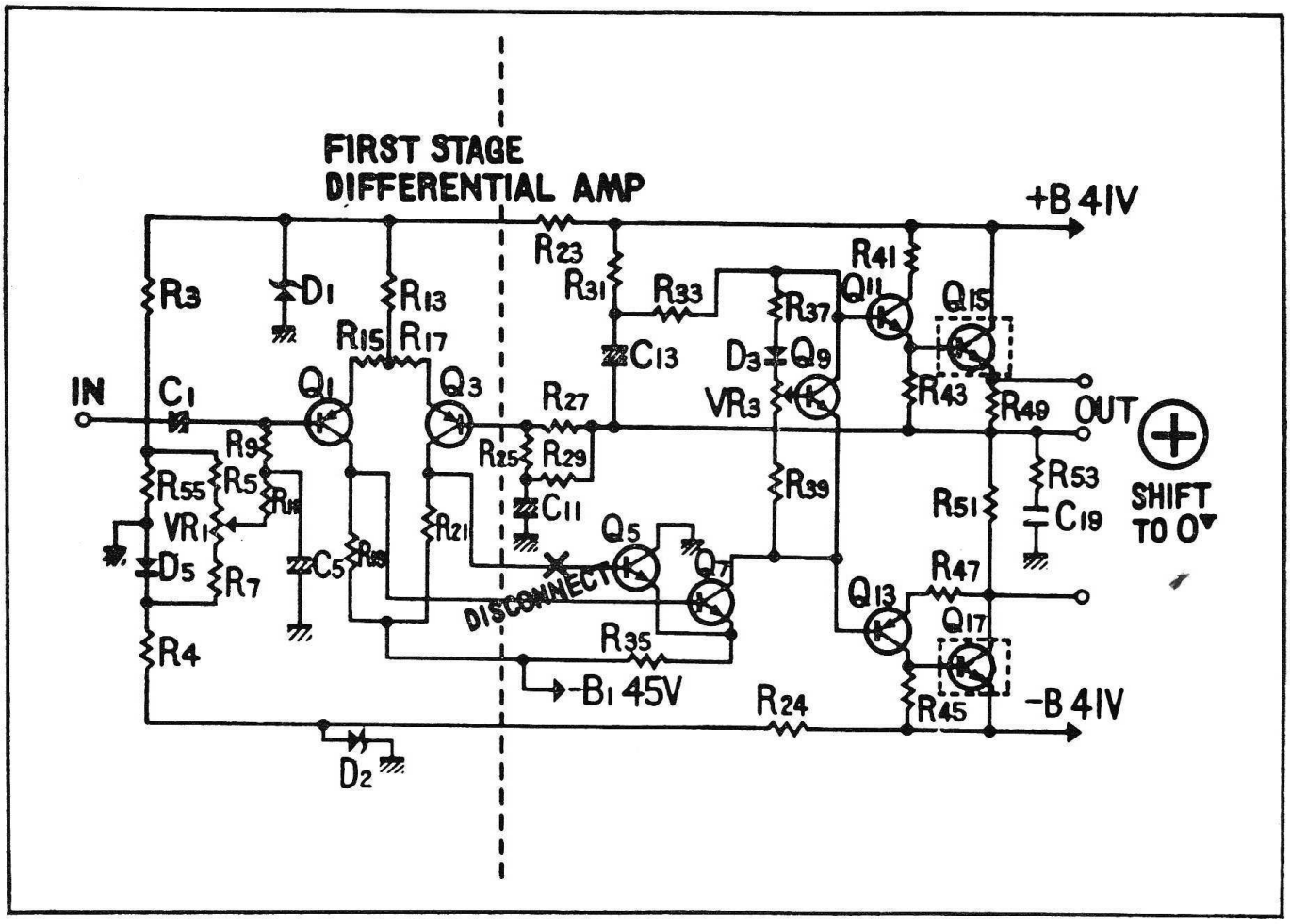
28.

CHECK AND CONFIRM WHETHER THE VOLTAGE ACROSS ZENER DIODES D-1 AND D-2 ARE AS SPECIFIED. IN DOING THIS TAKE CARE THAT THE POLARITY OF D-1 IS POSITIVE AND D-2 IS NEGATIVE. IF THERE IS A LARGE DIFFERENCE THEN D-1 OR D-2 MAY BE CONSIDERED TO BE DEFECTIVE.



29.

NEXT WE WILL LEARN HOW TO DETERMINE IF THE FAILURE IS IN THE FIRST STAGE DIFFERENTIAL AMPLIFIER OR THE PRE-DRIVE DIFFERENTIAL AMPLIFIER AND THE PRECEDING STAGES. THE FIRST CHECK TO MAKE, IS IF THE VOLTAGE AT THE OUTPUT TERMINAL IS POSITIVE OR NEGATIVE.

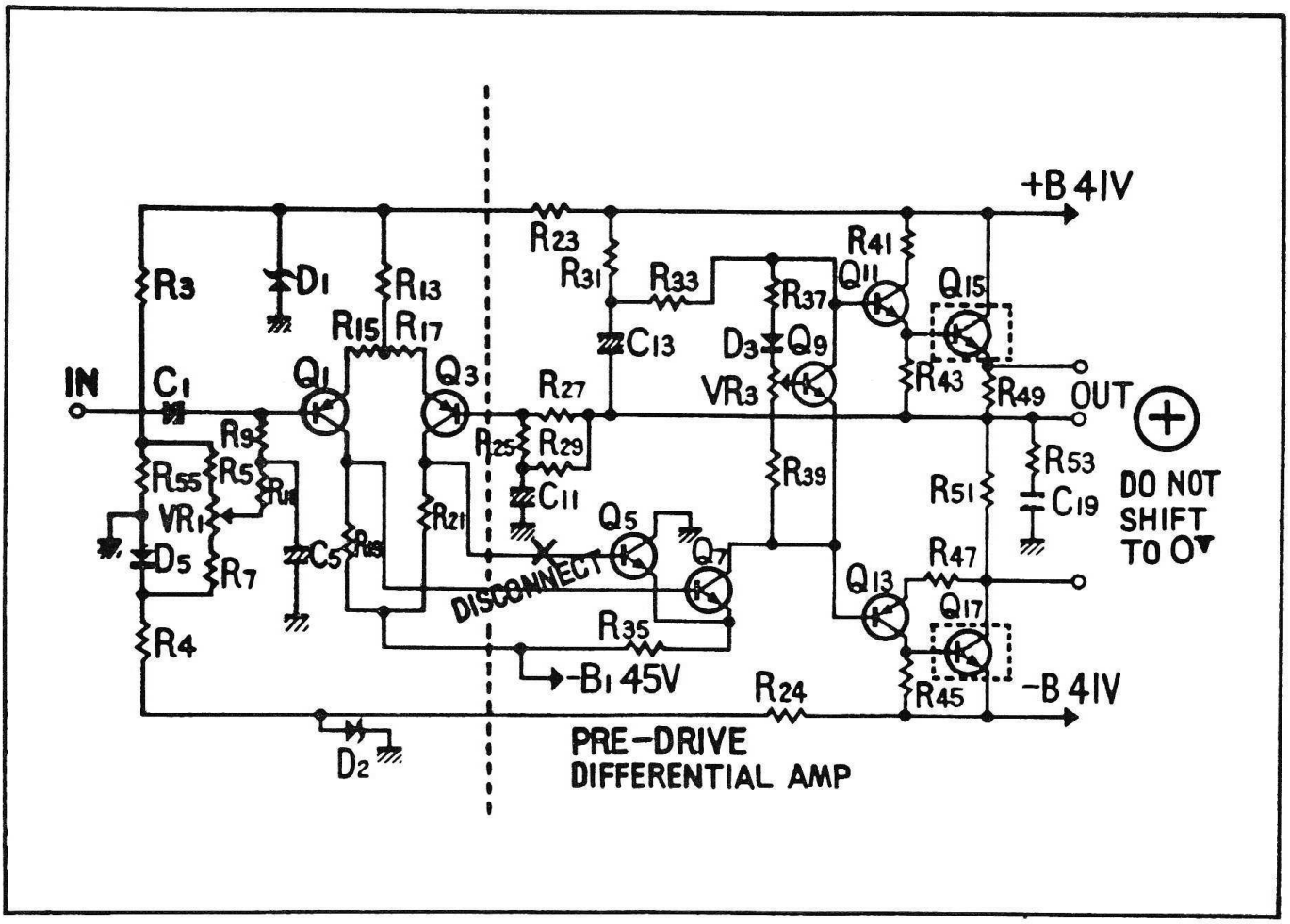


30.

IF THE VOLTAGE AT THE OUTPUT IS POSITIVE, DISCONNECT THE BASE LEAD OF TRANSISTOR Q-5. IF THE VOLTAGE DROPS TO ZERO, THEN THIS INFORMS YOU THAT THE PRE-DRIVE AND SUCCEEDING STAGES ARE OPERATING NORMALLY AND THE FIRST DIFFERENTIAL AMPLIFIER STAGE IS DEFECTIVE.

REASON

CUTTING OFF THE BASE WIRING OF Q-5 MEANS THAT Q-5 BECOMES OPEN AND THE CURRENT WHICH HAS BEEN FOR Q-5 FLOWS INTO Q-7 ADDITIONALLY. THEN, THE COLLECTOR VOLTAGE OF Q-7 REDUCES, THE BIAS OF Q-13 INCREASES AND Q-11 DECREASES. ACCORDINGLY, SO LONG AS NO ABNORMALITY EXIST IN THIS CIRCUIT, THE VOLTAGE OF OUTPUT TERMINAL MOVES TO 0 VOLT.



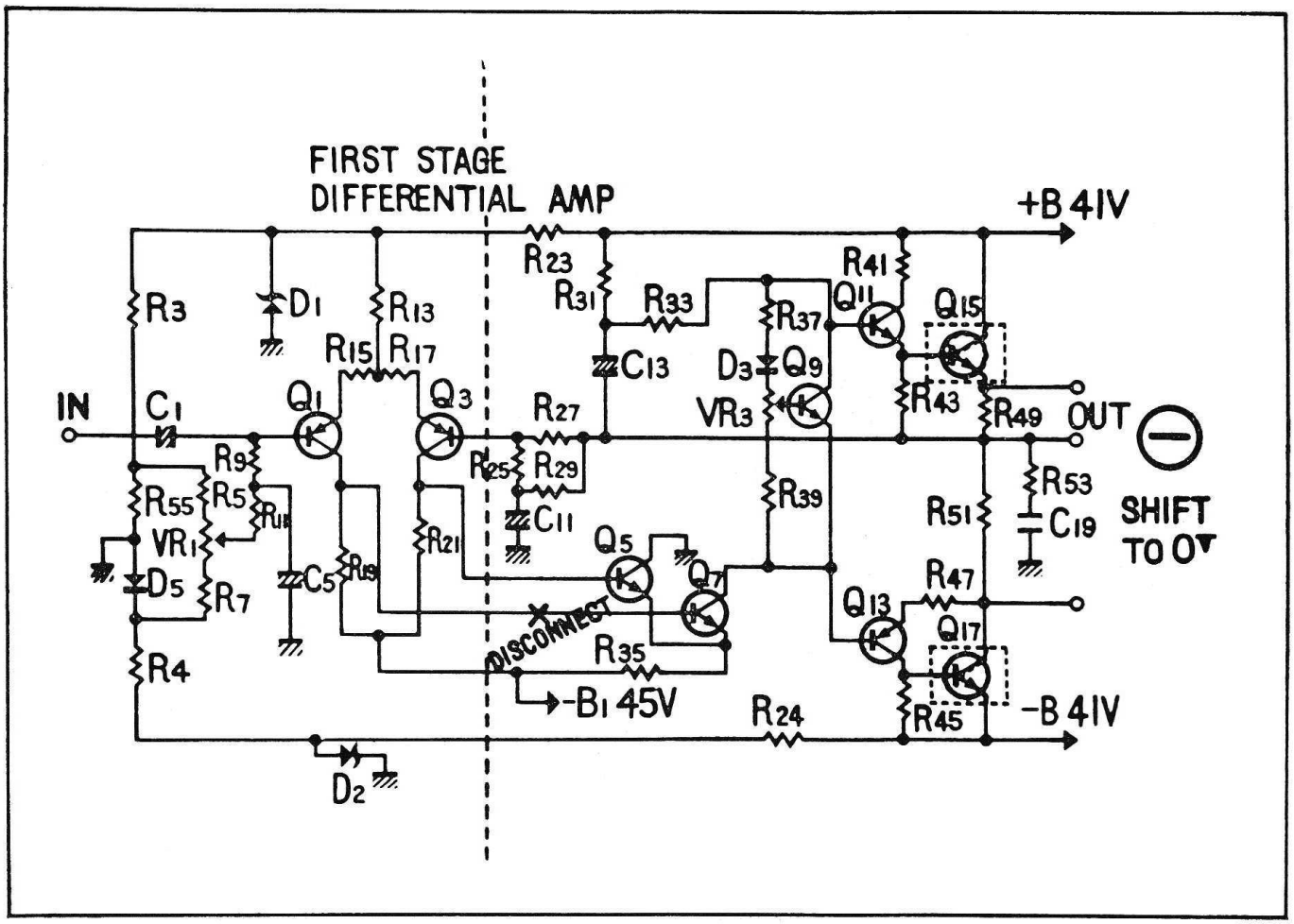
31.

IF THE VOLTAGE AT THE OUTPUT REMAINS POSITIVE, THIS INDICATES THE PRE-DRIVE DIFFERENTIAL AMPLIFIER OR SUCCEEDING STAGES ARE DEFECTIVE.

PRINCIPAL CAUSE.

1. OPEN OF Q-7 OR SHORT OF Q-5.
2. SHORT OF Q-11.
3. OPEN OF Q-13.

THE ABOVE THREE CAUSES MAY BE POSSIBLE.

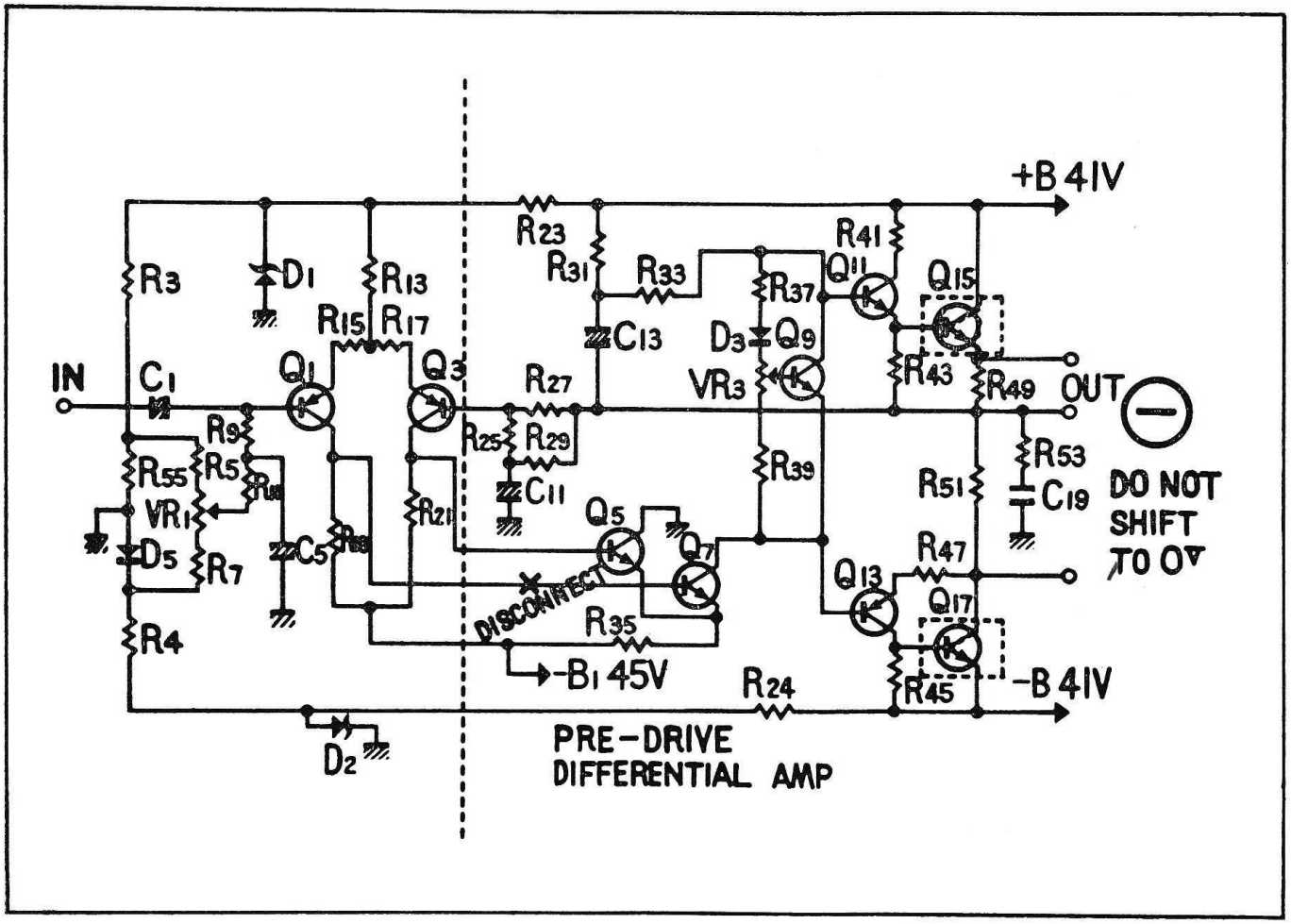


32.

NOW WE WILL CONSIDER THE CASE IN WHICH THE VOLTAGE PRESENT AT THE OUTPUT IS NEGATIVE. IF DISCONNECTING THE BASE LEAD OF Q-7 LETS THE VOLTAGE RETURN TO ZERO, THEN THE PRE-DRIVE AND SUCCEEDING STAGES ARE GOOD AND THE PROBLEM IS IN THE FIRST STAGE DIFFERENTIAL AMPLIFIER.

REASON

BY CUTTING OFF THE WIRING OF BASE OF Q-7. Q-7 BECOMES OPEN AND THE COLLECTOR VOLTAGE OF Q-7 BECOMES HIGHER. THEN THE BIAS OF Q-13 DECREASES AND Q-11 INCREASES. ACCORDINGLY, SO LONG AS THE NO ABNORMALITY EXIST IN THIS CIRCUIT, THE VOLTAGE OF OUTPUT TERMINAL MOVES TO 0 VOLT.



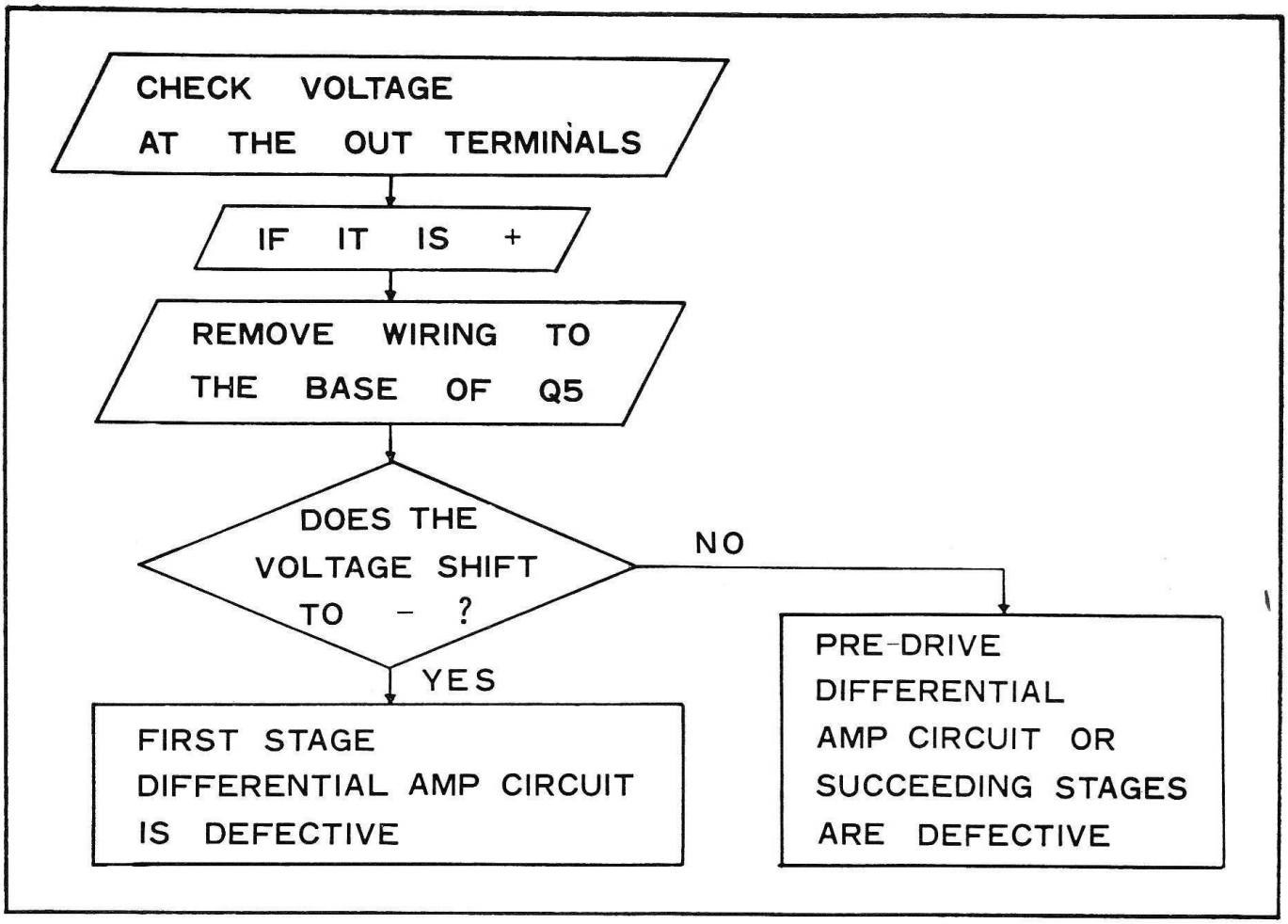
33.

IF THE POTENTIAL AT THE OUTPUT REMAINS THE SAME AFTER YOU DISCONNECT THE BASE LEAD OF Q-7, THEN YOU MAY CONSIDER THE PRE-DRIVE DIFFERENTIAL AMPLIFIER OR PRECEDING STAGES TO BE DEFECTIVE.

PRINCIPAL CAUSE.

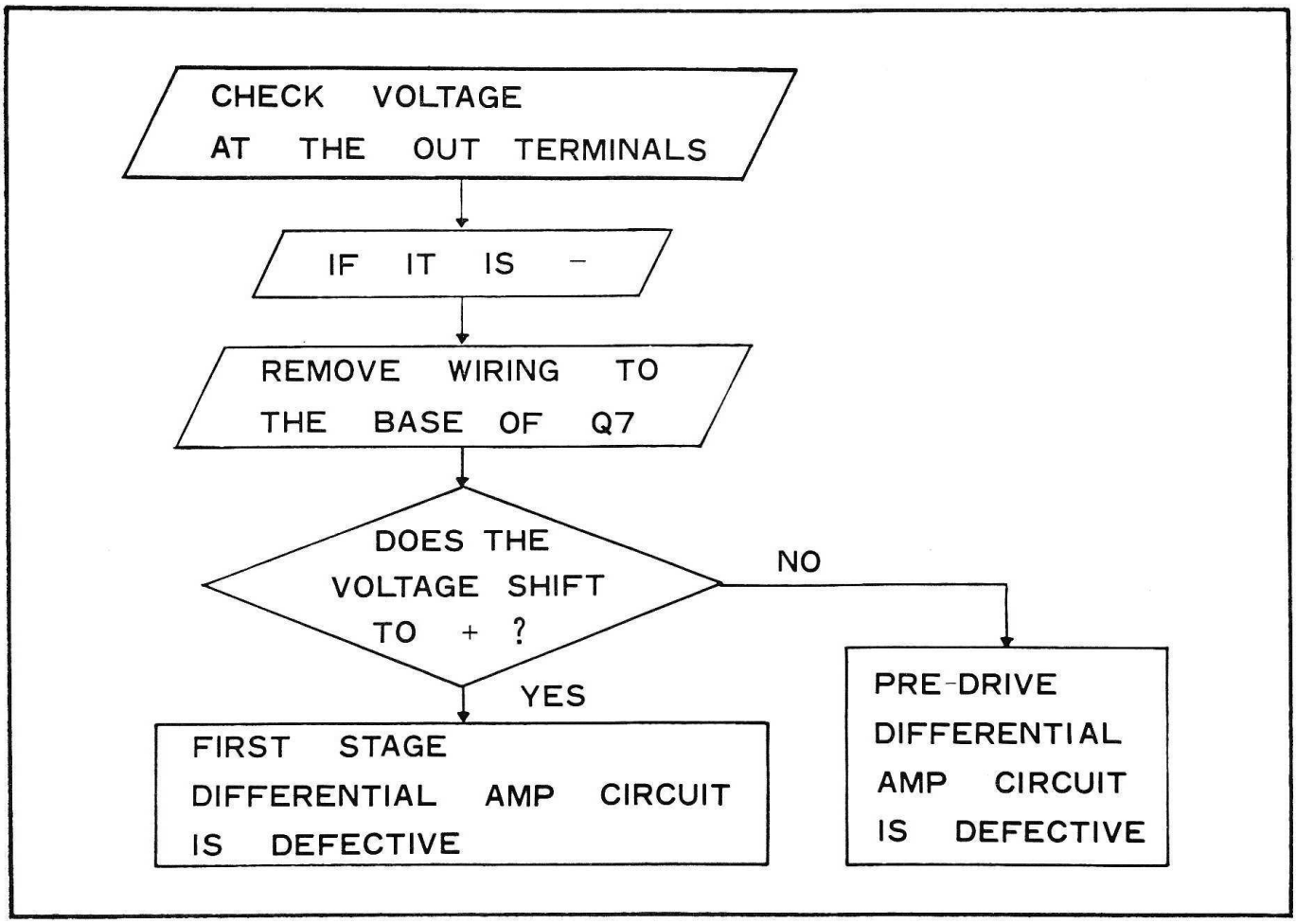
1. SHORT OF Q-7 OR OPEN OF Q-5.
2. OPEN OF Q-11.
3. SHORT OF Q-13.

THE ABOVE THREE CAUSES MAY BE POSSIBLE.



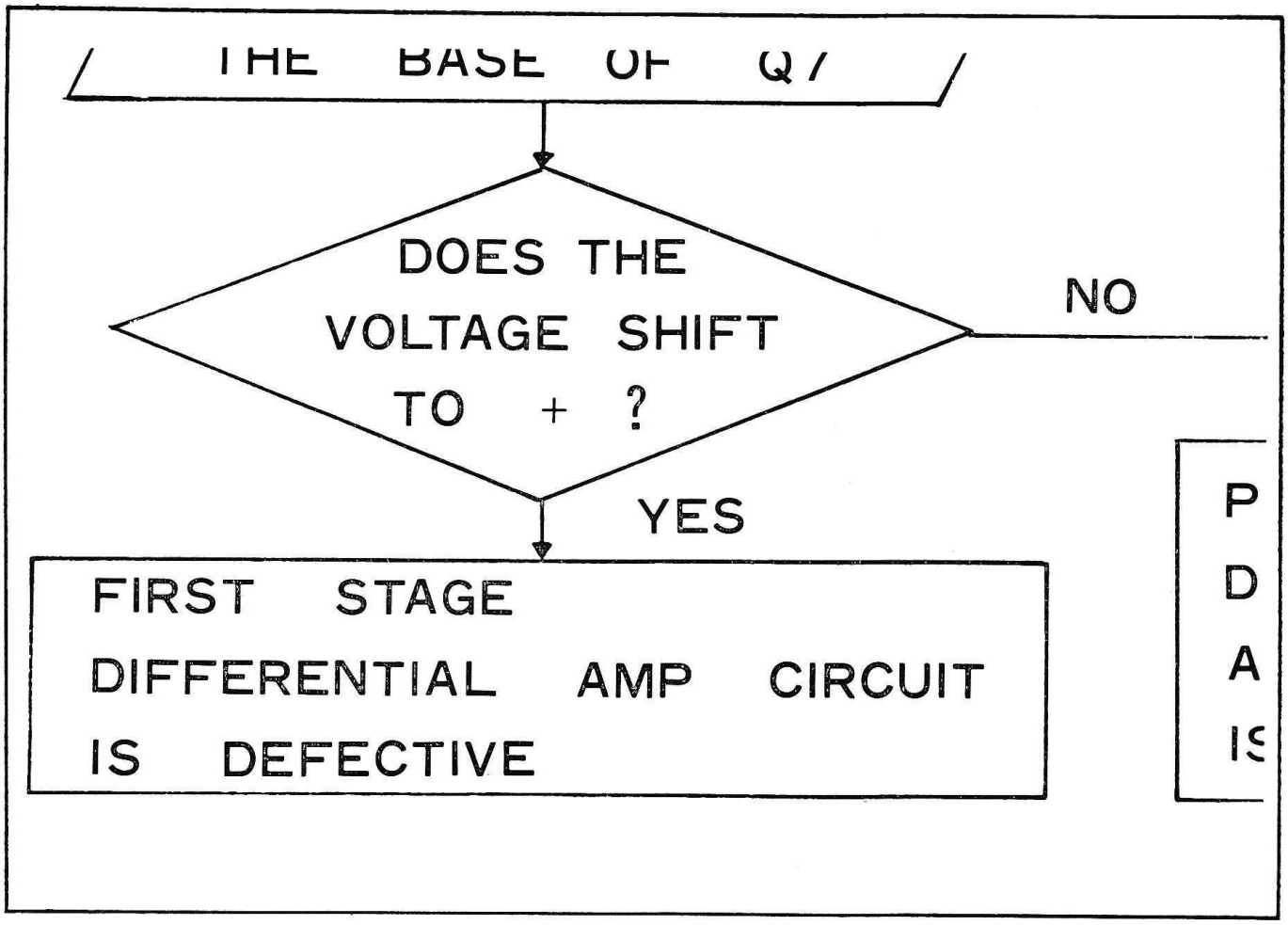
34.

LET US SUMMARIZE WHAT WE HAVE JUST EXPLAINED. CHECK FOR VOLTAGE AT THE OUTPUT TERMINAL. IF IT IS POSITIVE DISCONNECT THE BASE LEAD OF Q-5. DOES THE VOLTAGE AT THE OUTPUT SHIFT FROM POSITIVE TO NEGATIVE? IF THE ANSWER IS YES, THEN THE FIRST STAGE DIFFERENTIAL AMPLIFIER IS DEFECTIVE. IF THE ANSWER IS NO, THEN THE PRE-DRIVE DIFFERENTIAL AMPLIFIER OR SUCCEEDING STAGES ARE DEFECTIVE.



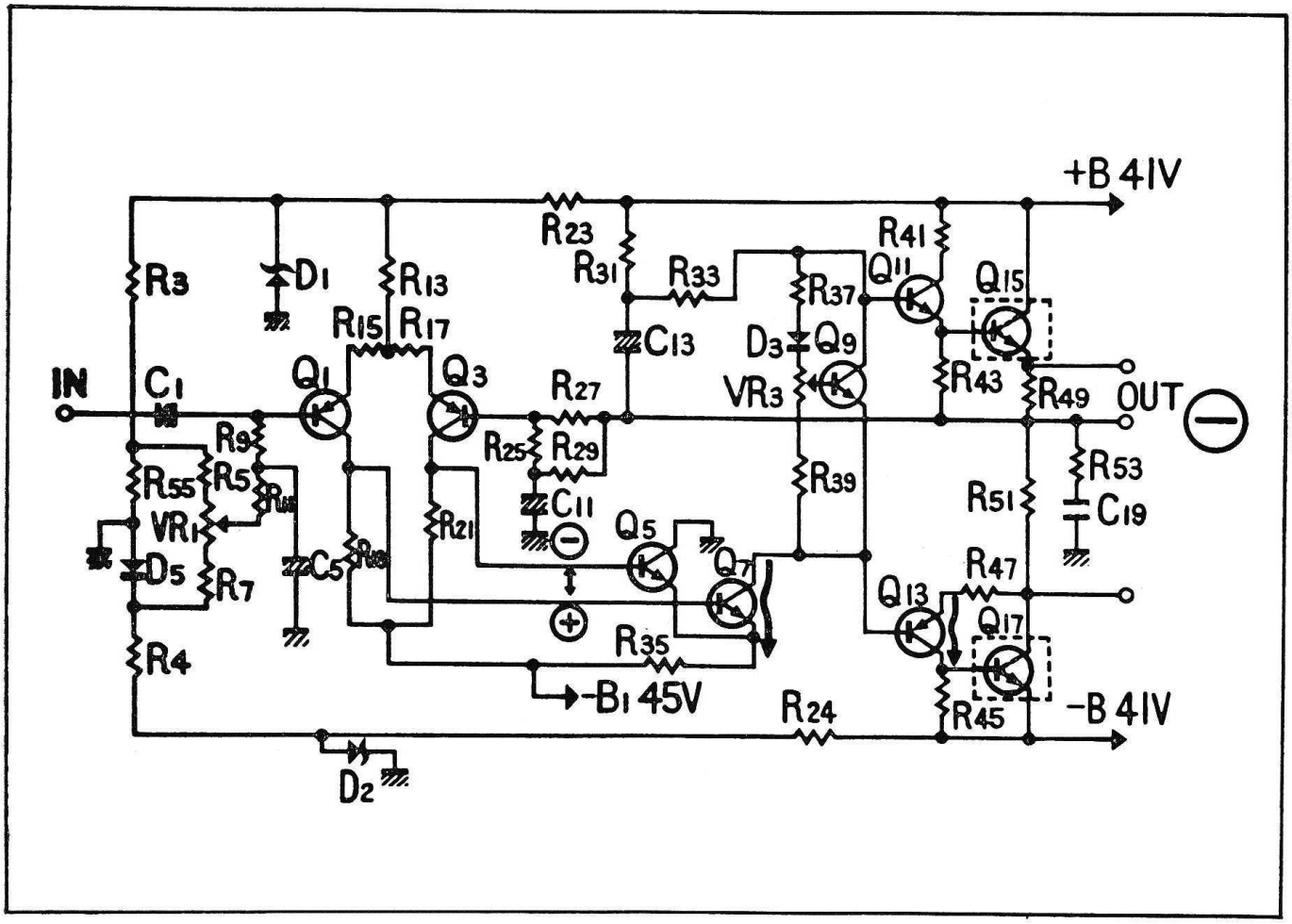
35.

IF THE VOLTAGE AT THE OUTPUT TERMINAL IS NEGATIVE, THEN DISCONNECT THE BASE LEAD OF TRANSISTOR Q-7. DOES THE VOLTAGE POLARITY CHANGE TO POSITIVE? IF THE ANSWER IS YES, THEN THE FIRST STAGE DIFFERENTIAL AMPLIFIER IS DEFECTIVE. IF THE ANSWER IS NO, THEN YOU MAY CONSIDER THE PRE-DRIVE DIFFERENTIAL AMP STAGE IS DEFECTIVE.



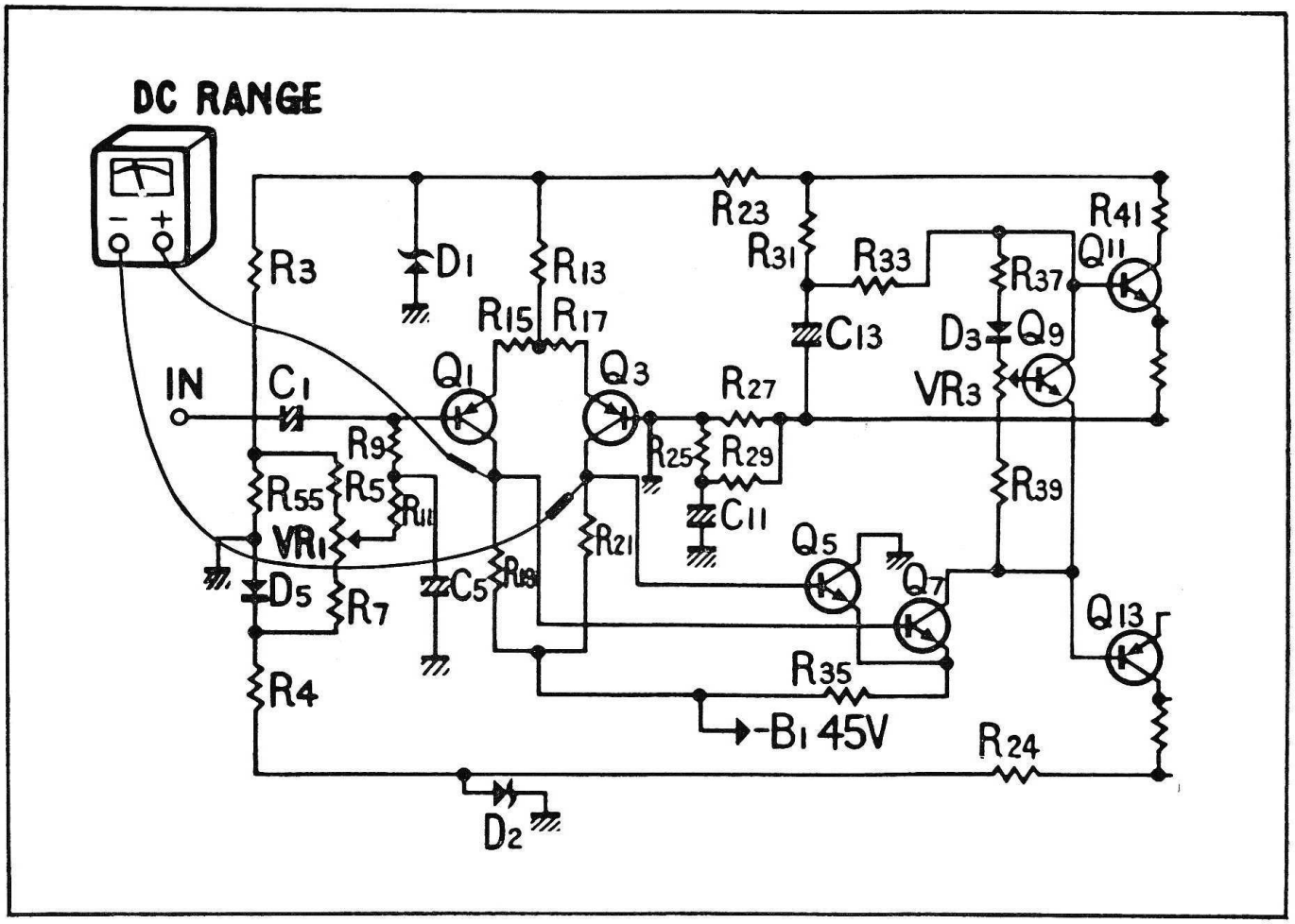
36.

NOW WE WILL INVESTIGATE EACH SECTION OF THE MAIN AMPLIFIER IN DETAIL. WE WILL FIRST CONSIDER THAT THE FIRST STAGE DIFFERENTIAL AMP CIRCUIT IS TO BE DEFECTIVE. THIS WAS CONCLUDED BY DISCONNECTING THE BASE LEADS OF Q-5 OR Q-7. IN ALL OF THESE CHECKS PLEASE INSURE THAT THERE IS NO SIGNAL TO THE INPUT OF THE AMPLIFIER.



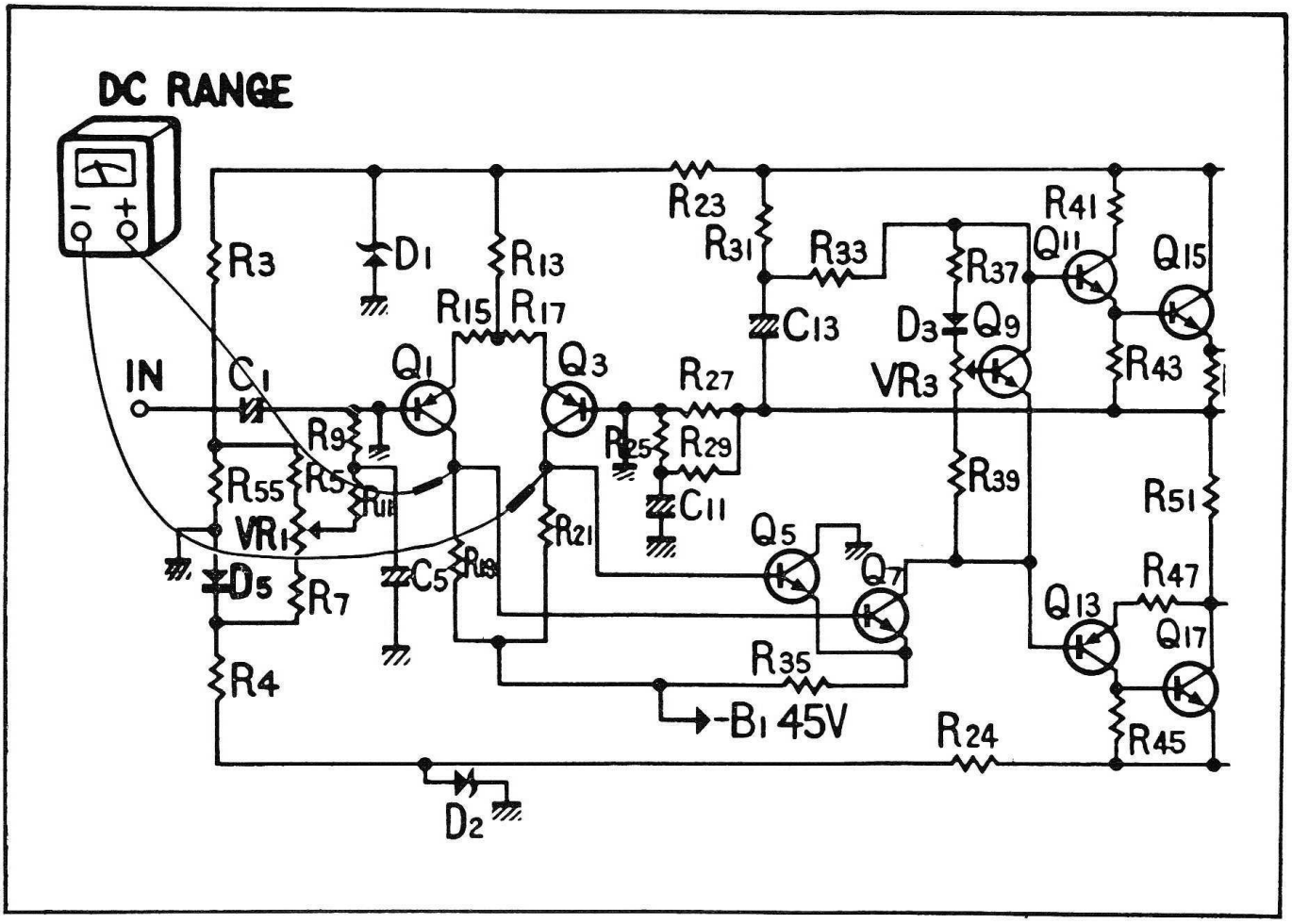
37.

YOU MAY BE WONDERING WHY A D.C. VOLTAGE WILL DEVELOP WHEN THE FIRST STAGE DIFFERENTIAL AMP CIRCUIT IS DEFECTIVE. LET US CONSIDER WHAT HAPPENS WHEN THERE IS A FAILURE IN THE FIRST STAGE DIFFERENTIAL AMP CIRCUIT. THIS WILL CAUSE A VOLTAGE TO DEVELOP BETWEEN THE BASES OF Q-5 AND Q-7. ASSUME THAT THE BASE OF Q-7 IS POSITIVE WITH RESPECT TO THE BASE OF Q-5. SINCE THE BIAS OF Q-7 HAS INCREASED, THE COLLECTOR CURRENT WILL INCREASE, THEREBY, LOWERING THE COLLECTOR VOLTAGE. THIS INCREASES THE BIAS ON Q-13 LOWERING THE EMITTER-COLLECTOR VOLTAGE OF Q-13. AS A RESULT A NEGATIVE VOLTAGE OCCURS AT THE OUTPUT. IF THE BASE VOLTAGE AT Q-7 IS NEGATIVE, COMPARED TO Q-5, THE VOLTAGE AT THE OUTPUT WILL BE POSITIVE.



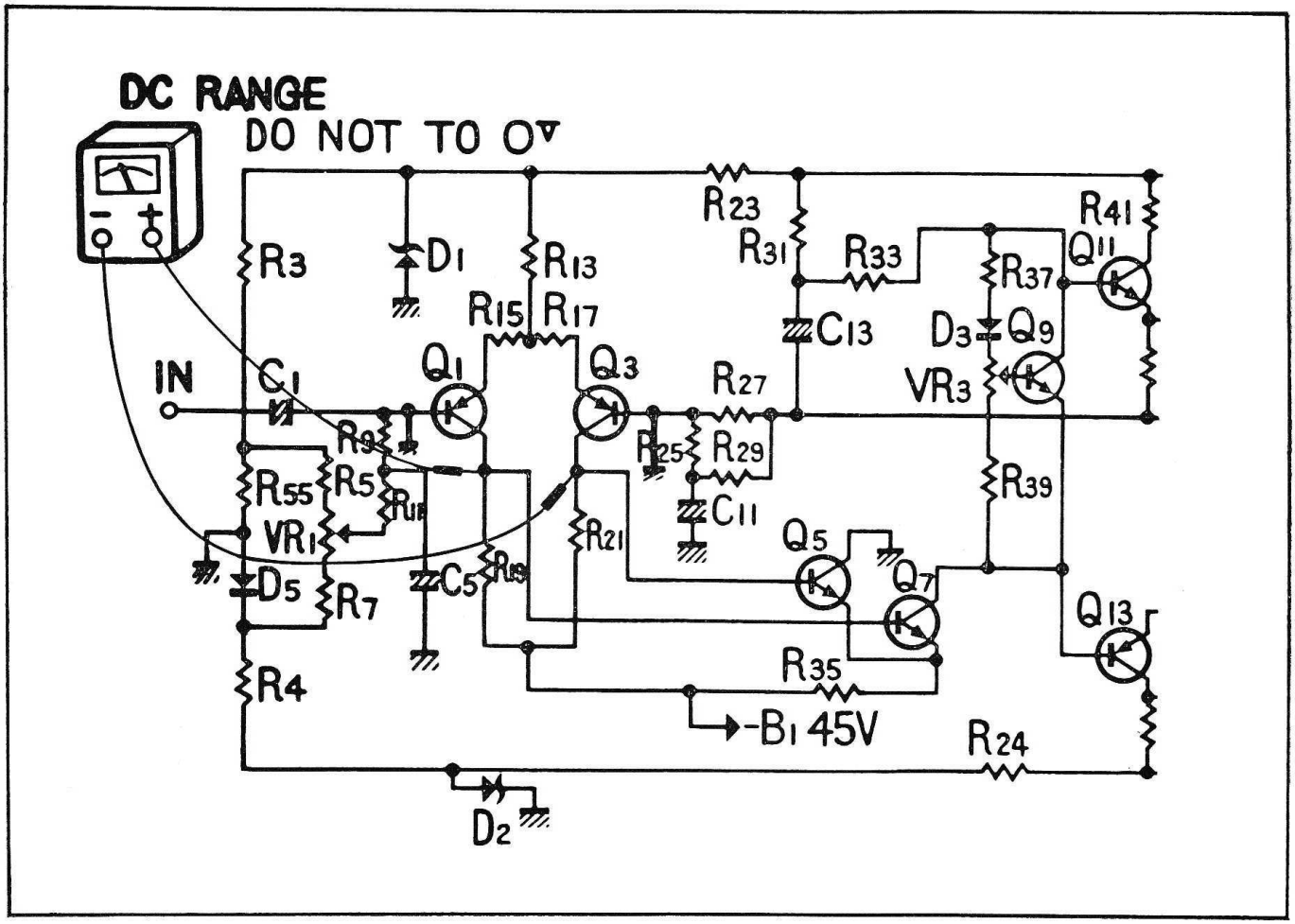
38.

TO TROUBLESHOOTING THE FIRST STAGE DIFFERENTIAL AMPLIFIER, SHORT THE BASE OF TRANSISTOR Q-3 TO GROUND. WITH A D.C. VOLTMETER CONNECTED BETWEEN THE COLLECTORS OF TRANSISTORS Q-1 AND Q-3. ADJUST VR-1 SO YOU HAVE A ZERO METER READING. IF YOU ARE ABLE TO ADJUST VR-1 FOR A ZERO READING, THEN THE CIRCUIT IS OPERATING NORMALLY, AND THE VOLTAGE WAS CAUSED BY MISADJUSTMENT OF VR-1 AND SUBSEQUENT IMBALANCE OF DIFFERENTIAL AMPLIFIER Q-1 AND Q-2.



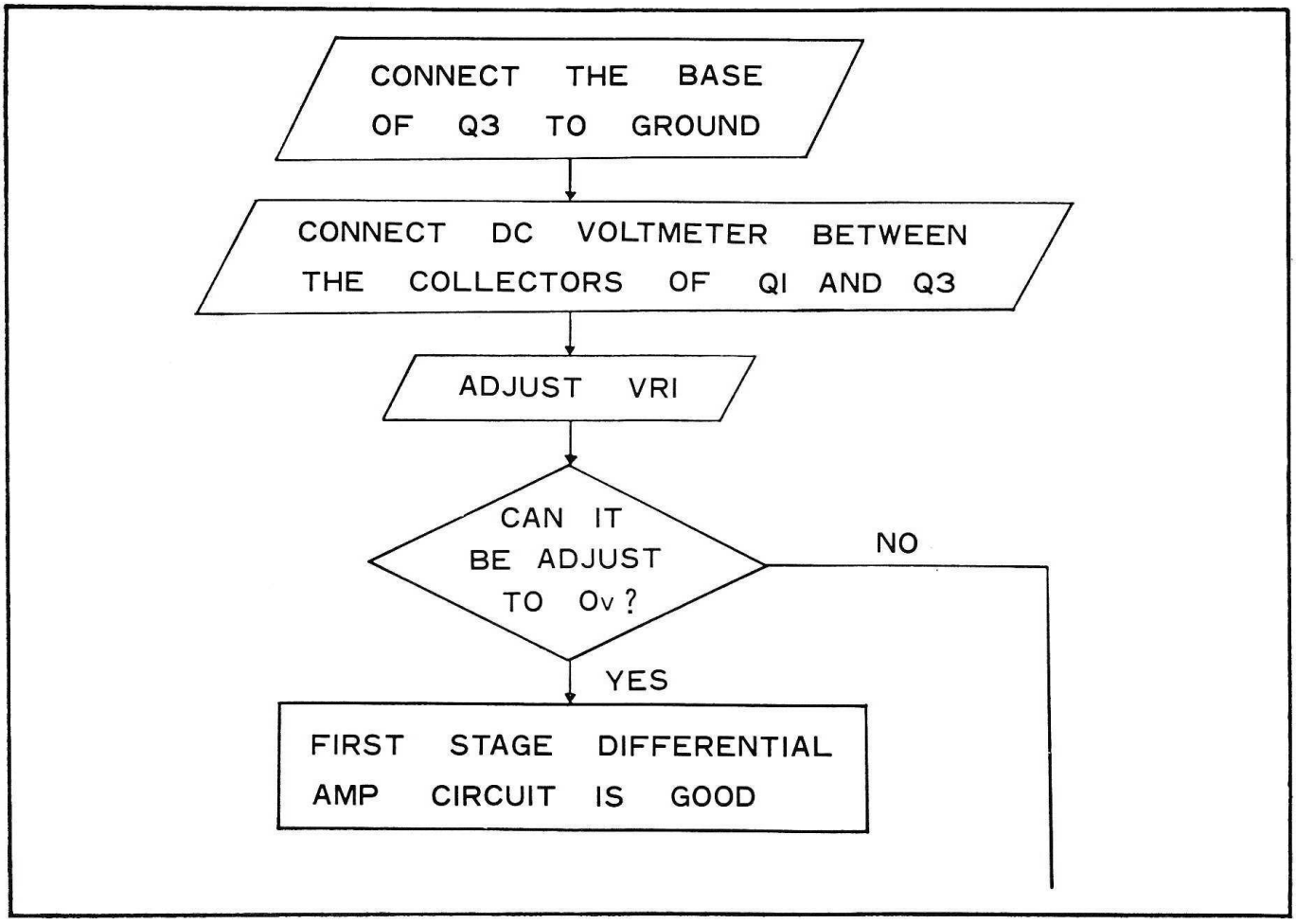
39.

WHEN YOU ADJUST VR-1 AND CANNOT OBTAIN A ZERO METER READING, THEN WE START TROUBLESHOOTING BY GROUNDING THE BASE OF TRANSISTOR Q-1. IF YOU NOW HAVE A ZERO READING THEN Q-1 AND Q-3'S OPERATION IS NORMAL. THE PROBABLE CAUSE IS FAILURE OF DIODE D-5.



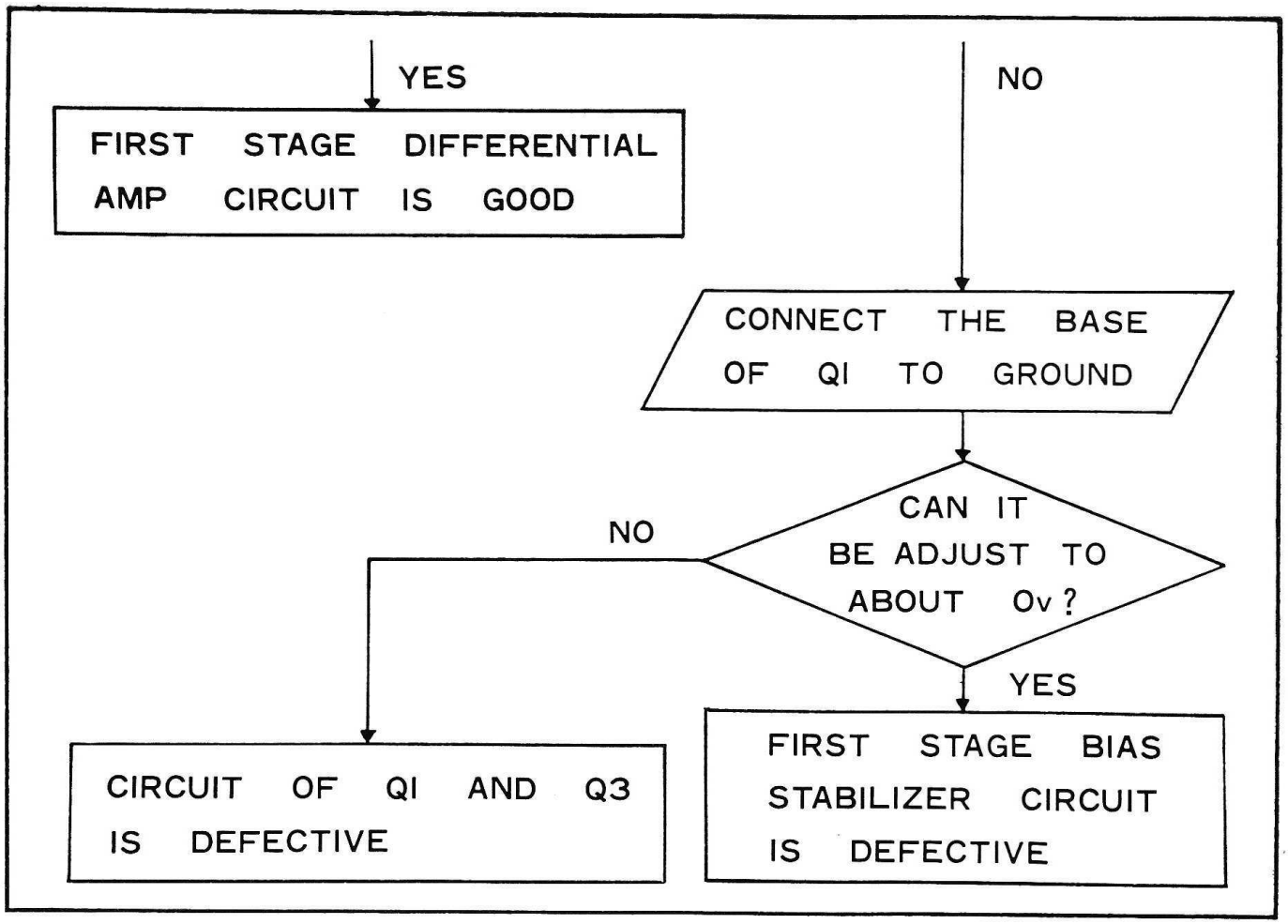
40.

IF A ZERO VOLTAGE READING CANNOT BE OBTAINED BY THE GROUNDING OF THE BASES OF Q-1 AND Q-3, THEN THE DIFFERENTIAL AMP CIRCUIT COMPOSED OF THESE PARTS IS DEFECTIVE. TWO POSSIBLE CAUSES ARE THAT Q-1 AND Q-3 ARE MIS-MATCHED OR THE EMITTER OR COLLECTOR RESISTORS ARE OPEN OR SHORTED.



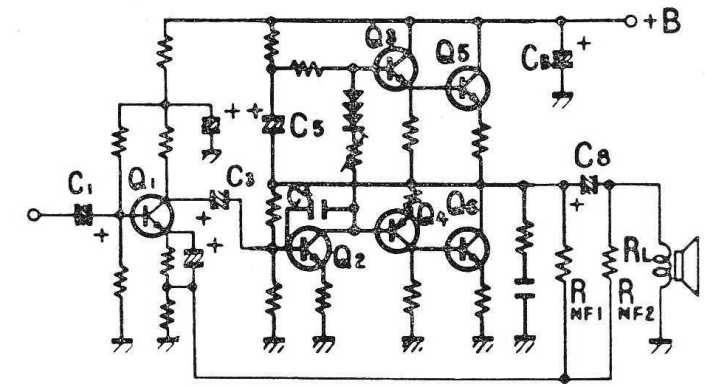
41.

TO SUMMARIZE: WITH NO INPUT TO THE UNIT, GROUND THE BASE OF Q-3, CONNECT A D.C. VOLTMETER BETWEEN THE COLLECTORS OF Q-1 AND Q-3, ADJUST VR-1 FOR A ZERO READING ON THE METER. CAN YOU ADJUST VR-1 FOR A ZERO READING? IF THE ANSWER IS YES, THEN THE FIRST STAGE DIFFERENTIAL AMPLIFIER IS OPERATING NORMALLY.

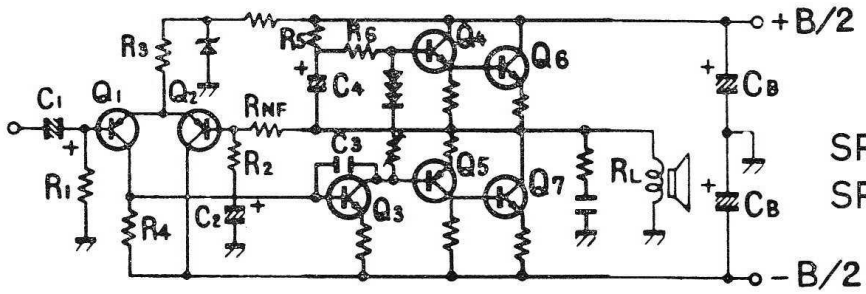


42.

CAN VR-1 BE ADJUSTED FOR A ZERO READING? IF THE ANSWER IS NO, THEN CONNECT THE BASE OF Q-1 TO GROUND WHILE THE BASE OF Q-3 IS ALSO GROUNDED. DO YOU GET A ZERO READING? IF THE ANSWER IS YES, THE FIRST STAGE OF THE BIAS STABILIZER IS DEFECTIVE. IF THE ANSWER IS NO, THEN THE CIRCUIT OF Q-1 AND Q-3 IS DEFECTIVE.



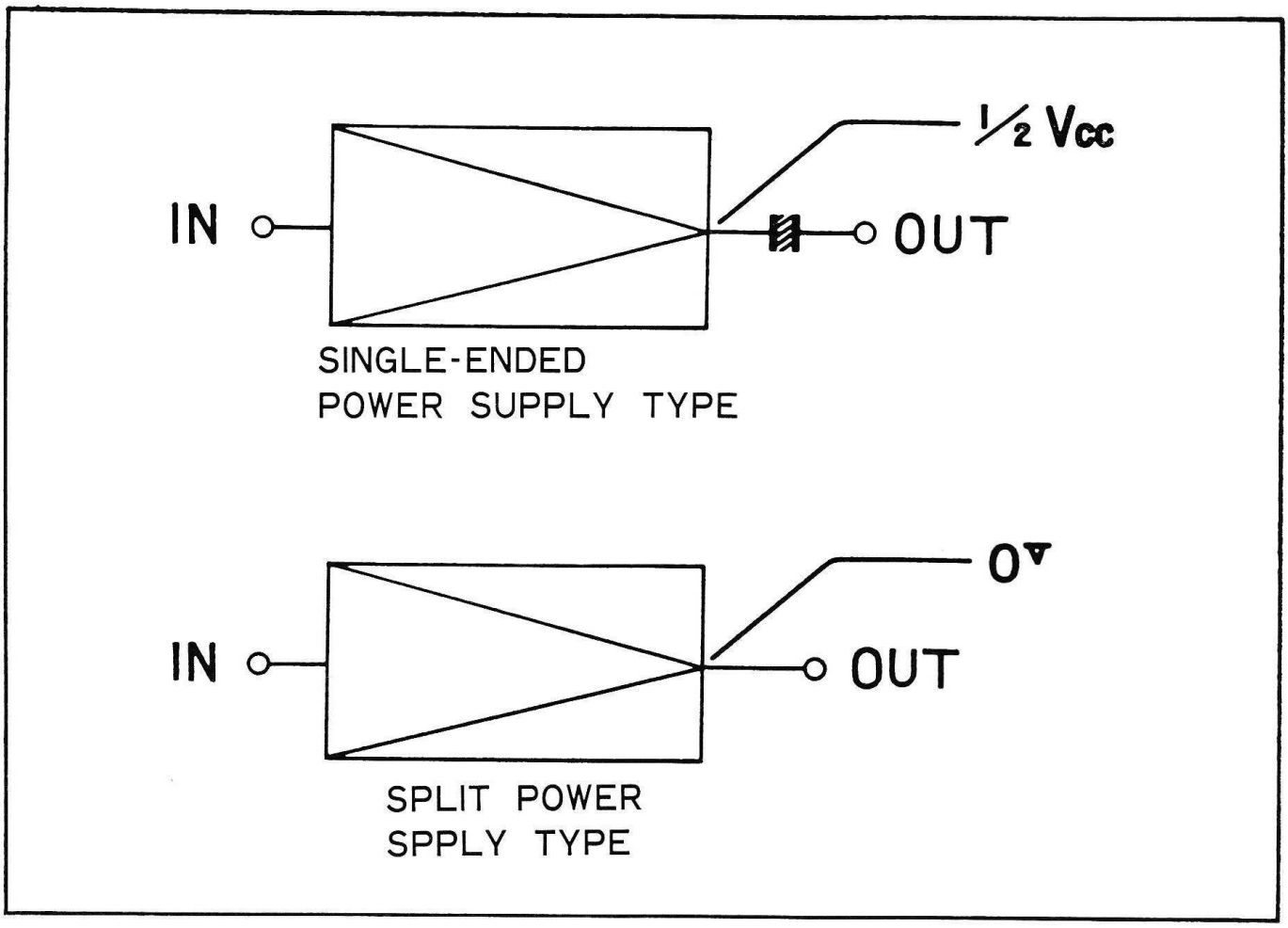
SINGLE-ENDED
POWER SUPPLY TYPE



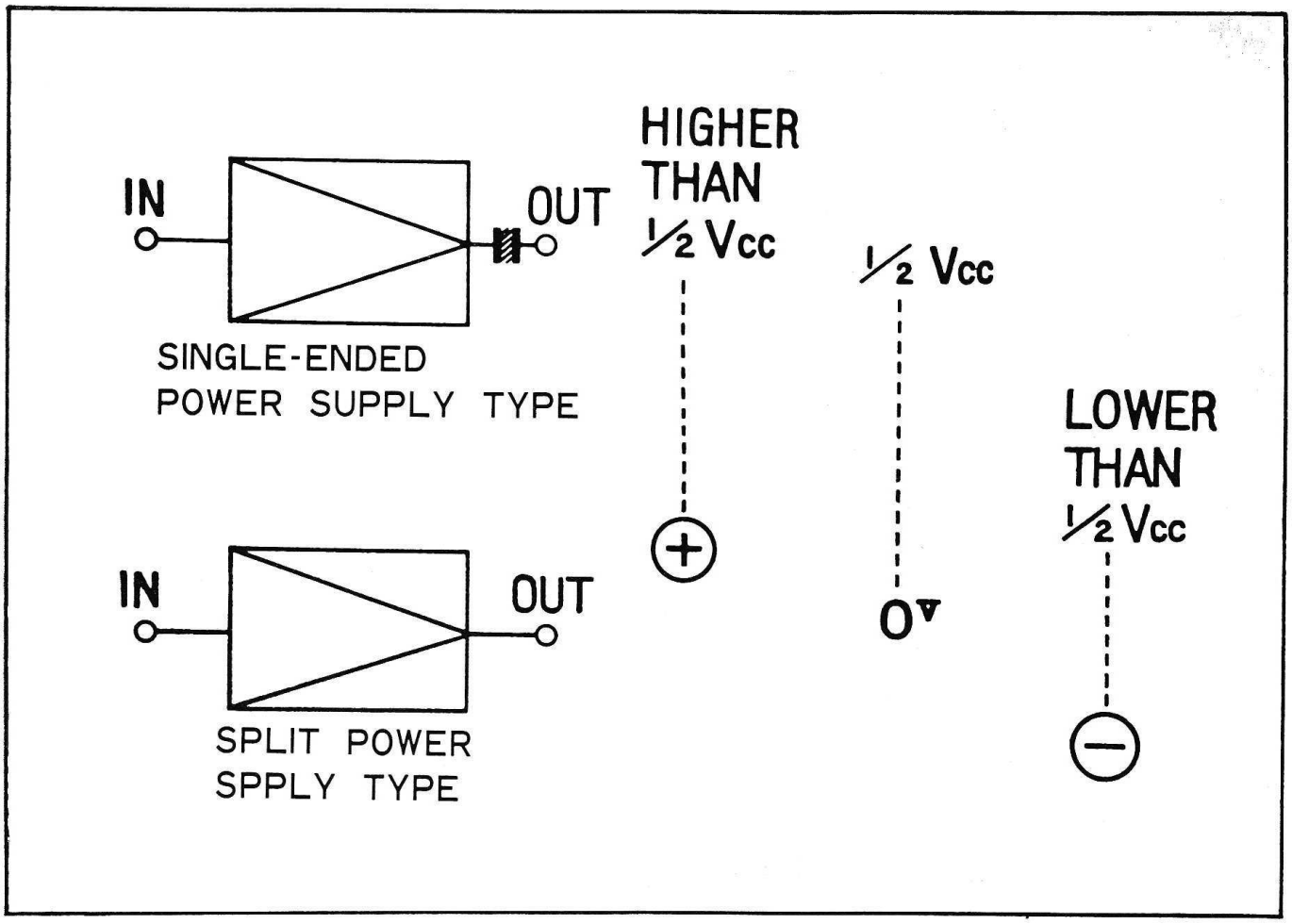
SPLIT POWER
SPPLY TYPE

43.

NOW, LETS EXPLORE A CASE IN WHICH THE PRE-DRIVE OR SUCCEEDING STAGES ARE SUSPECTED OF BEING DEFECTIVE. THE CIRCUITRY AFTER THE PRE-DRIVE STAGE CAN BE CONSIDERED TO BE THE SAME AS A QUASI-COMPLEMENTORY CIRCUIT IN A CONVENTIONAL MAIN AMP WITH SINGLE-ENDED POWER SUPPLY. IN THE OCL MAIN AMP, THE CENTER VOLTAGE IS CONTROLLED BY Q-7'S COLLECTOR CURRENT.

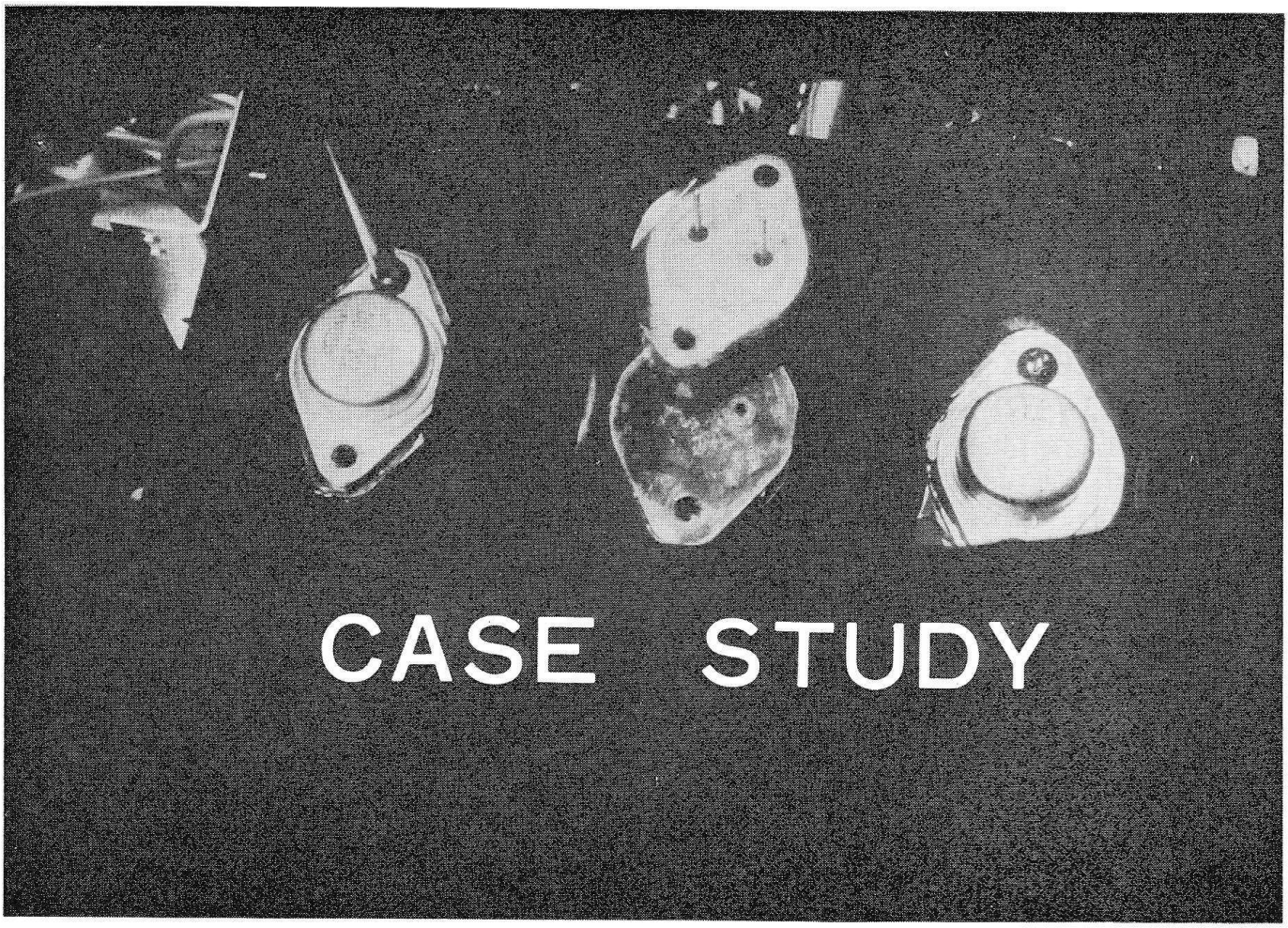


44. AS YOU REMEMBER THE VOLTAGE AT THE CENTER POINT OF A SINGLE-ENDED POWER SUPPLY, CAPACITOR-COUPLED AMPLIFIER IS ONE HALF OF THE SUPPLY VOLTAGE. IN A DIRECT-COUPLED AMP, IF OPERATION IS NORMAL, NO D.C. VOLTAGE IS PRESENT AT THE CENTER, OR OUTPUT.



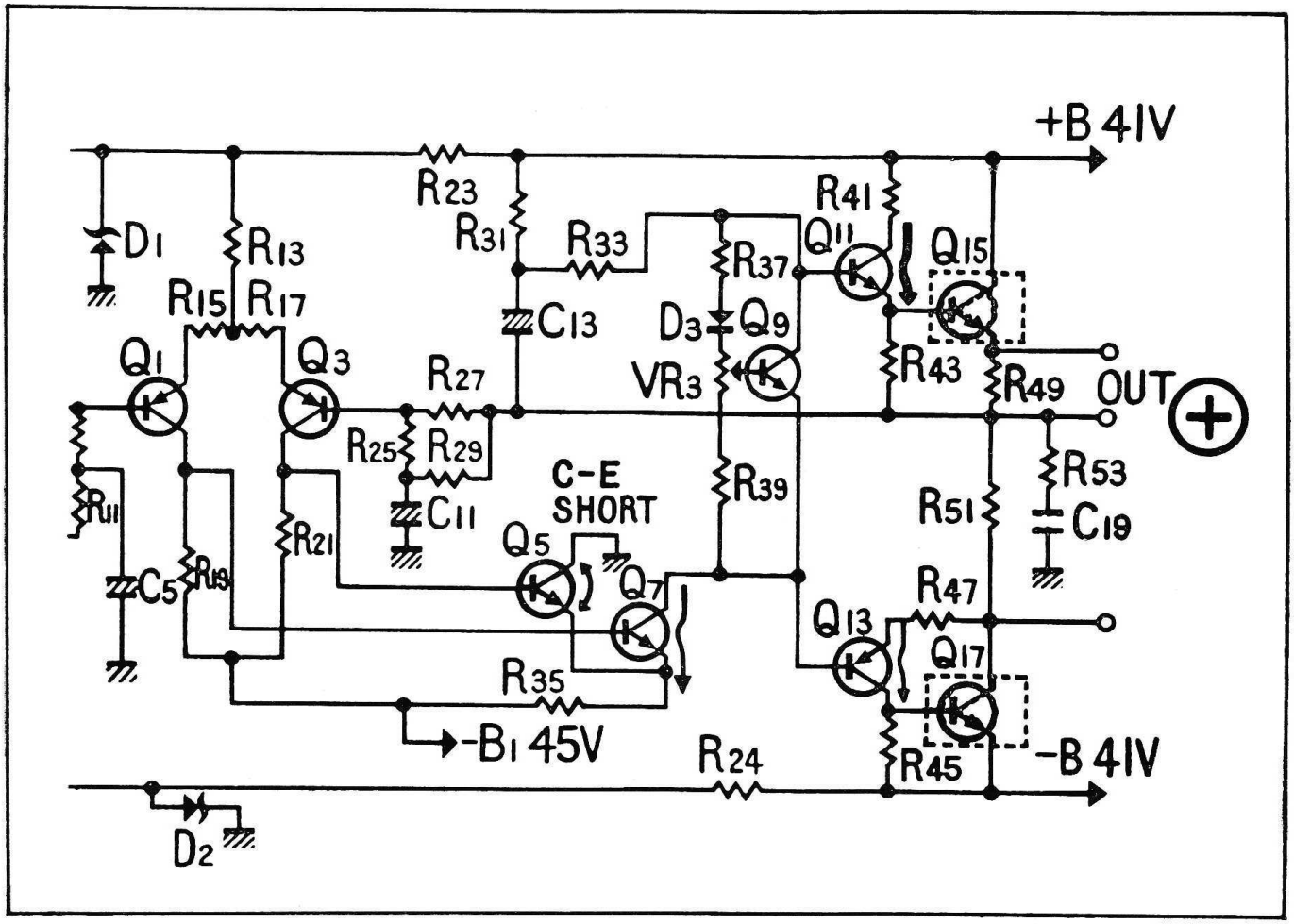
45.

IN A CAPACITOR-COUPLED AMPLIFIER, IF THE CENTER VOLTAGE IS HIGHER THAN ONE-HALF VCC, THEN THIS IS EQUIVALENT TO OCL MAIN AMP WITH POSITIVE VOLTAGE AT THE OUTPUT. CONVERSELY, IF THE CENTER VOLTAGE IS LOWER THAN ONE-HALF VCC IN A CAPACITOR-COUPLED AMPLIFIER, THIS IS EQUIVALENT TO NEGATIVE VOLTAGE AT THE OUTPUT IN A OCL MAIN AMPLIFIER.



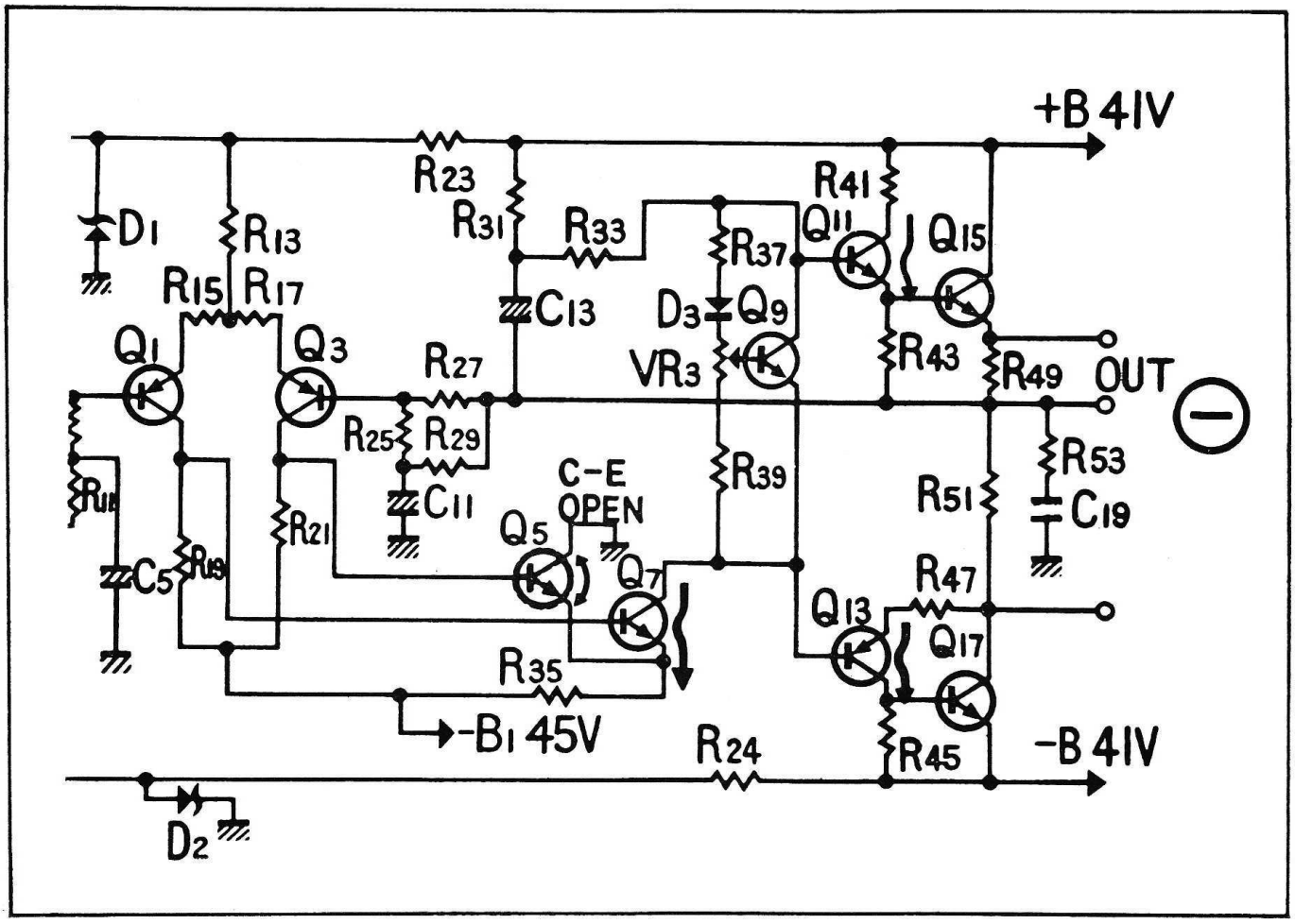
46.

ASSUMING WE HAVE A DEFECT, WE WILL SEE HOW AN SA-1000 MAIN AMPLIFIER'S D.C. BALANCE WILL CHANGE. TO TROUBLESHOOT ANY TYPE OF MAIN AMP REMEMBER ALWAYS TO REMOVE THE POWER TRANSISTORS.



47.

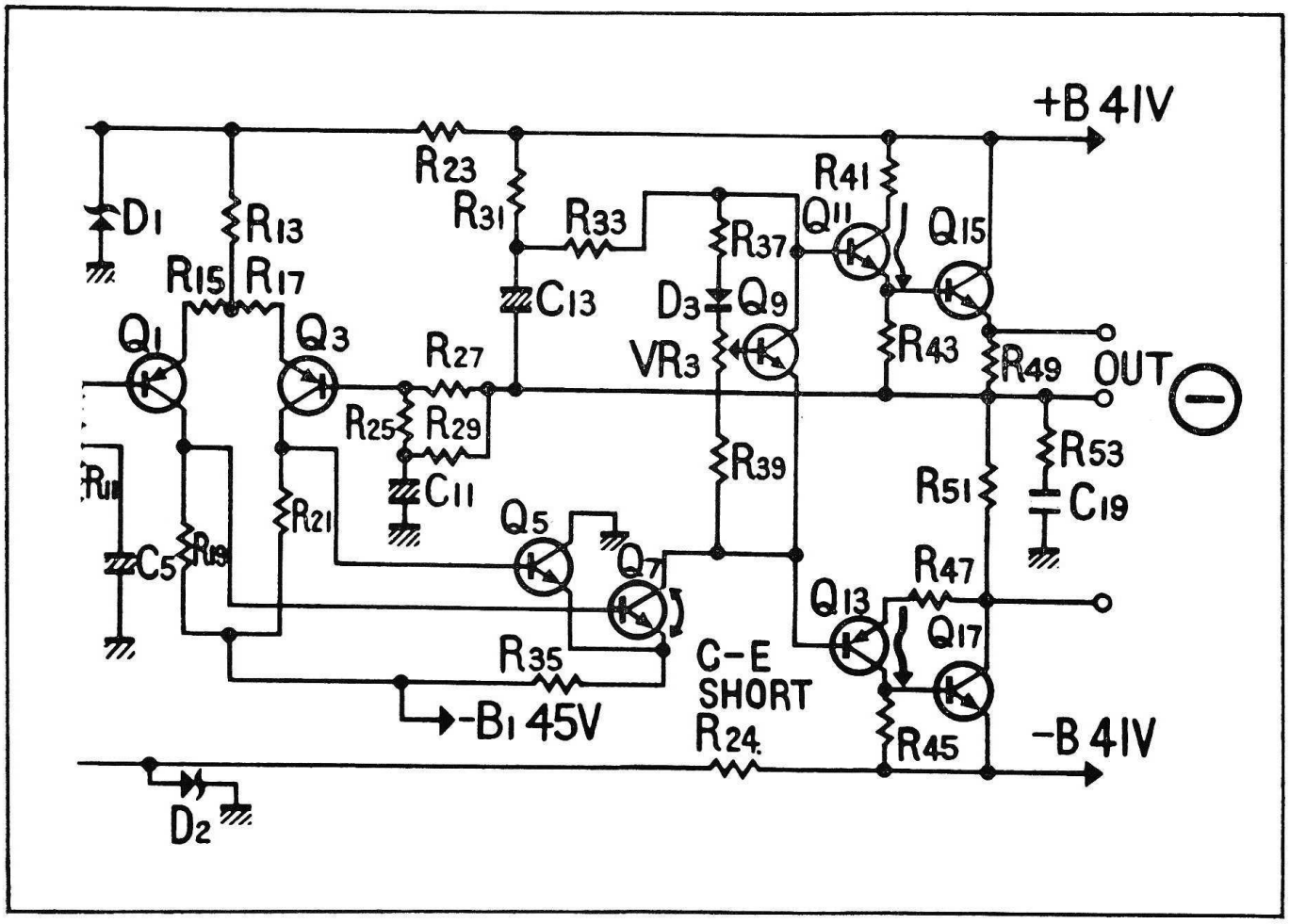
ASSUME TRANSISTOR Q-5 SHORTS BETWEEN COLLECTOR AND EMITTER. WHAT HAPPENS? ACCORDING TO THE PRINCIPLES OF A DIFFERENTIAL AMPLIFIER, Q-7'S COLLECTOR CURRENT WILL DECREASE AND COLLECTOR VOLTAGE WILL INCREASE. BECAUSE OF THIS, THE BIAS OF Q-13 WILL INCREASE AND VOLTAGE BETWEEN THE COLLECTOR AND EMITTER WILL ALSO BE RAISED. AT THE SAME TIME, BIAS ON Q-11 WILL INCREASE CAUSING INCREASED COLLECTOR CURRENT AND DECREASING COLLECTOR-EMITTER VOLTAGE. THIS ACTION CAUSES POSITIVE VOLTAGE TO APPEAR AT THE OUTPUT TERMINAL.



48.

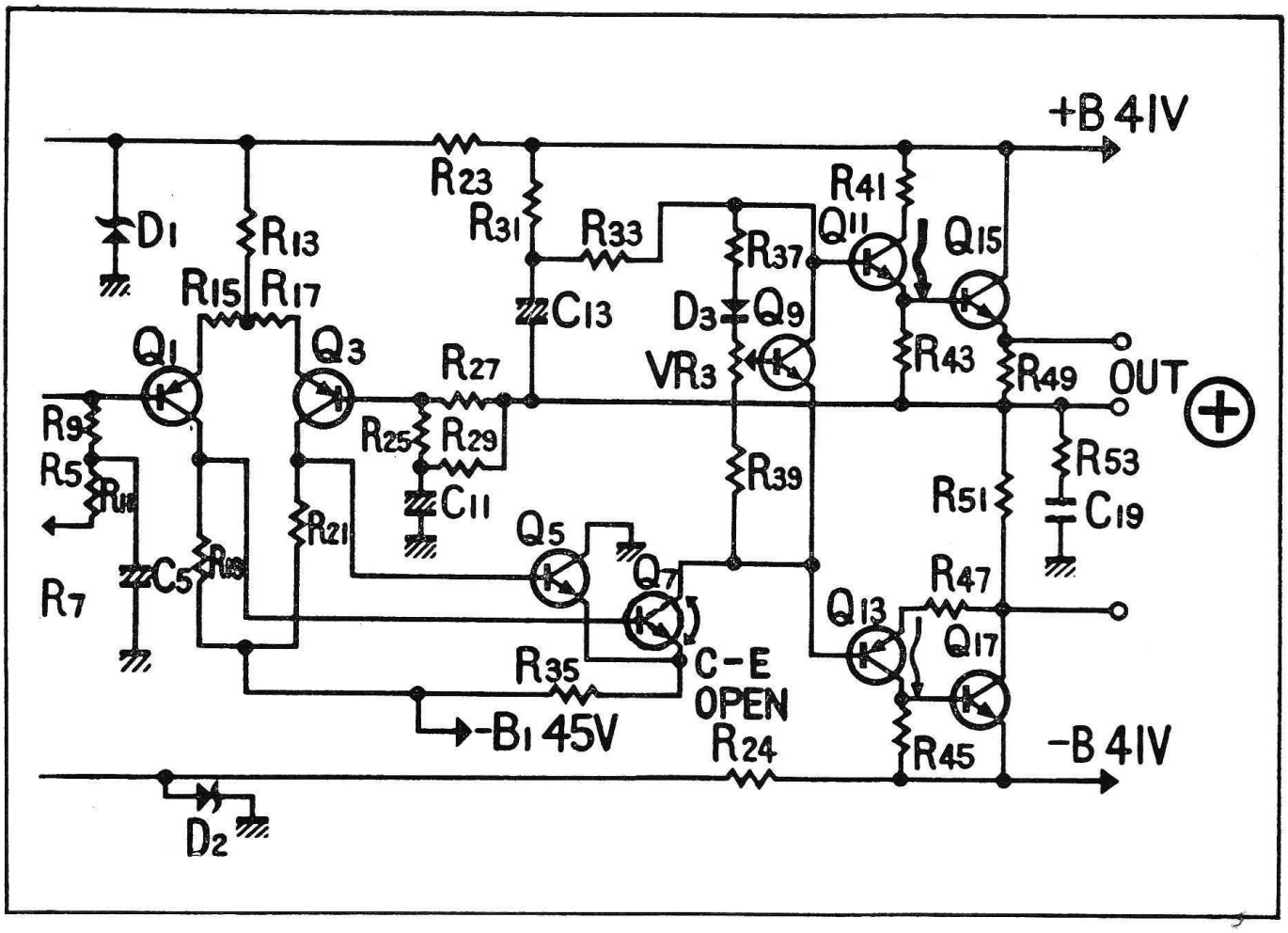
INSTEAD OF Q-5 HAVING A COLLECTOR-EMITTER SHORT, IF THE COLLECTOR EMITTER JUNCTION WAS OPEN THEN THE REVERSE OF WHAT WAS JUST EXPLAINED WOULD OCCUR AND THE VOLTAGE AT THE OUTPUT WOULD BE NEGATIVE.

IN THESE CASES, ONLY SMALL VOLTAGE (ALMSOT 0 VOLT) IS PRODUCED AT OUTPUT TERMINAL. THIS IS BECAUSE THE FIRST STAGE OF DIFFERENTIAL AMPLIFIER CIRCUIT IS WORKING. THEREFORE, IF THE BASE OF Q-3 IS SHORT TO GROUND, LARGE VOLTAGE IS PRODUCED AT OUTPUT TERMINAL.



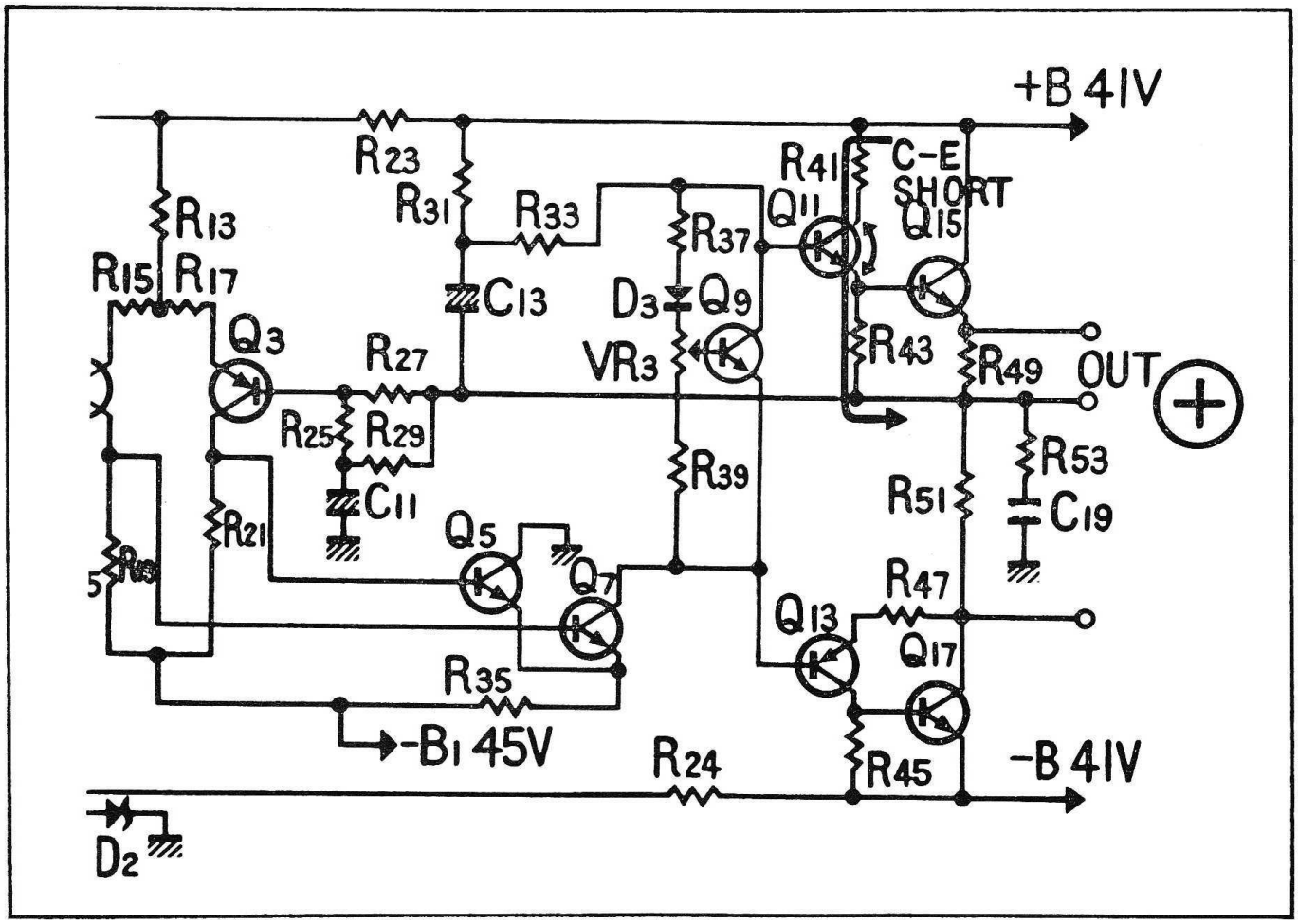
49.

IF TRANSISTOR Q-7 HAS A COLLECTOR-EMITTER SHORT AND Q-5 IS OK, THEN Q-7'S SHORT WILL CAUSE THE BIAS OF Q-13 TO INCREASE WHICH LOWERS ITS COLLECTOR-EMITTER VOLTAGE AND PERMITS A NEGATIVE VOLTAGE TO APPEAR AT THE OUTPUT.



50.

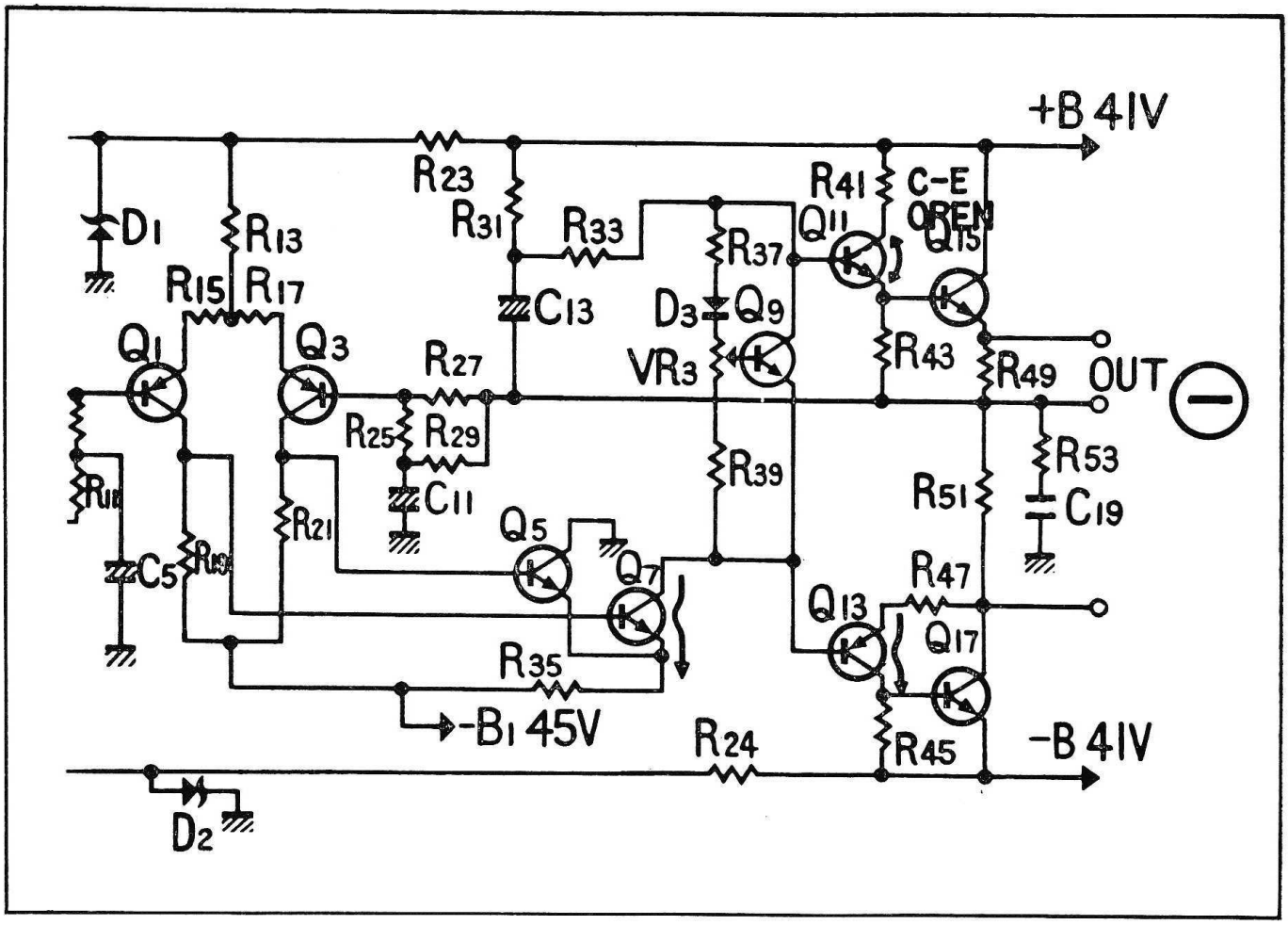
IF Q-7 IS OPEN BETWEEN THE COLLECTOR-EMITTER RATHER THAN SHORTED, THE COLLECTOR VOLTAGE WILL INCREASE. THIS LOWERS THE BIAS TO Q-13, INCREASING THE EMITTER-COLLECTOR VOLTAGE. Q-7'S DEFECT ALSO INCREASES BIAS ON Q-11, INCREASING COLLECTOR CURRENT WITH A CORRESPONDING DROP IN COLLECTOR VOLTAGE. THIS ACTION PERMITS A POSITIVE VOLTAGE TO APPEAR AT THE OUTPUT.



51.

IF TRANSISTOR Q-11 SHORTS BETWEEN THE EMITTER AND COLLECTOR, +B WILL FLOW THROUGH R-41 AND R-43 TO THE OUTPUT TERMINAL. THIS OBVIOUSLY CAUSES A POSITIVE VOLTAGE CLOSE TO +B TO APPEAR.

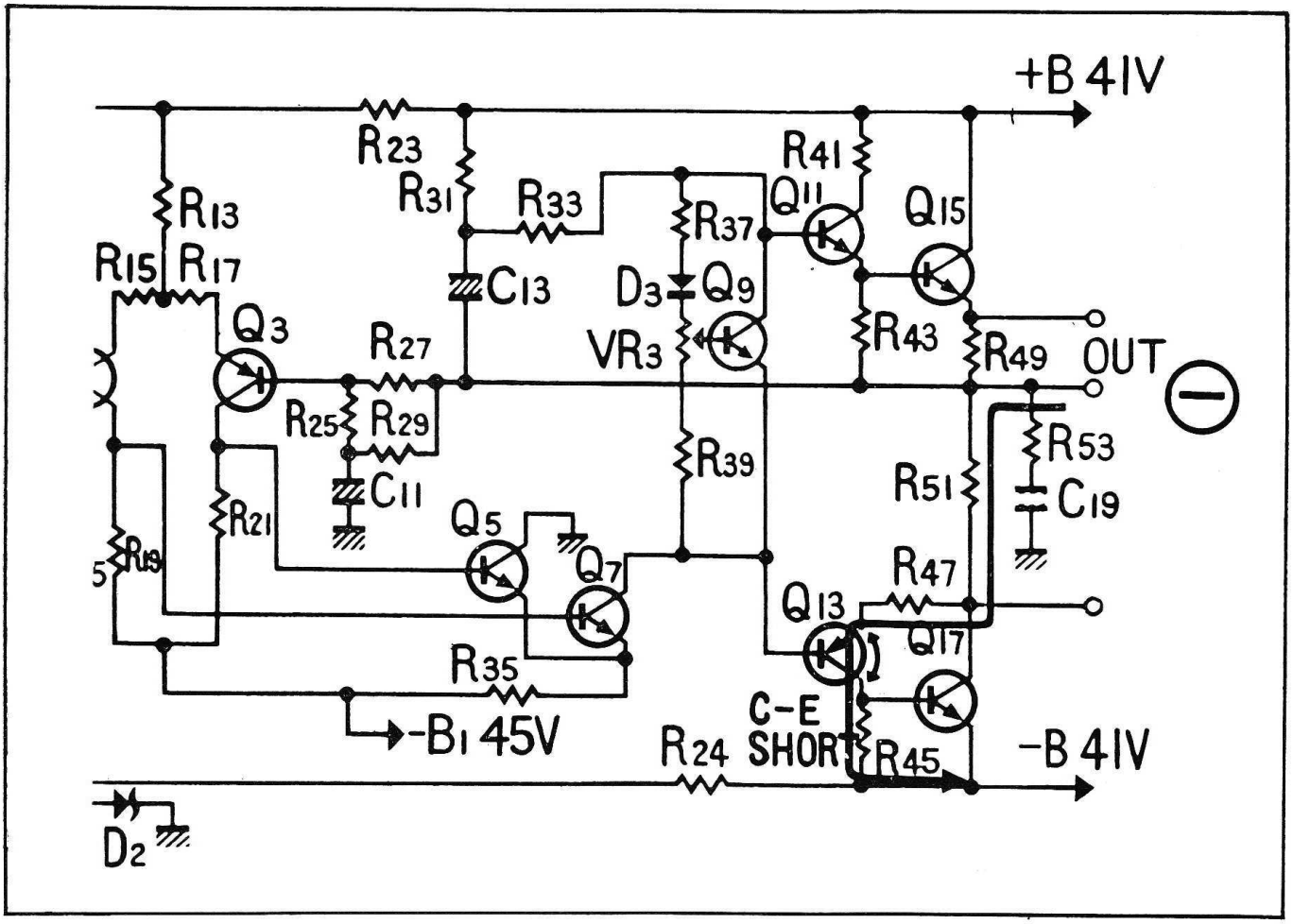
IN THIS CASE, EXCESSIVE CURRENT FLOWS THROUGH Q-11 AND R-41 AND R-43 WILL BE BURNED OUT.



52.

IF Q-11 IS OPEN RATHER THAN SHORTED, NO CURRENT CAN FLOW THROUGH THE EMITTER-COLLECTOR JUNCTION EVEN THOUGH Q-11 IS STILL BIASED. TRANSISTOR Q-7 STILL HAS BIAS AND WILL ALLOW COLLECTOR CURRENT TO FLOW, THUS PROVIDING BIAS TO Q-13. THIS LOWERS THE COLLECTOR-EMITTER VOLTAGE, ALLOWING A NEGATIVE VOLTAGE TO APPEAR AT THE OUTPUT.

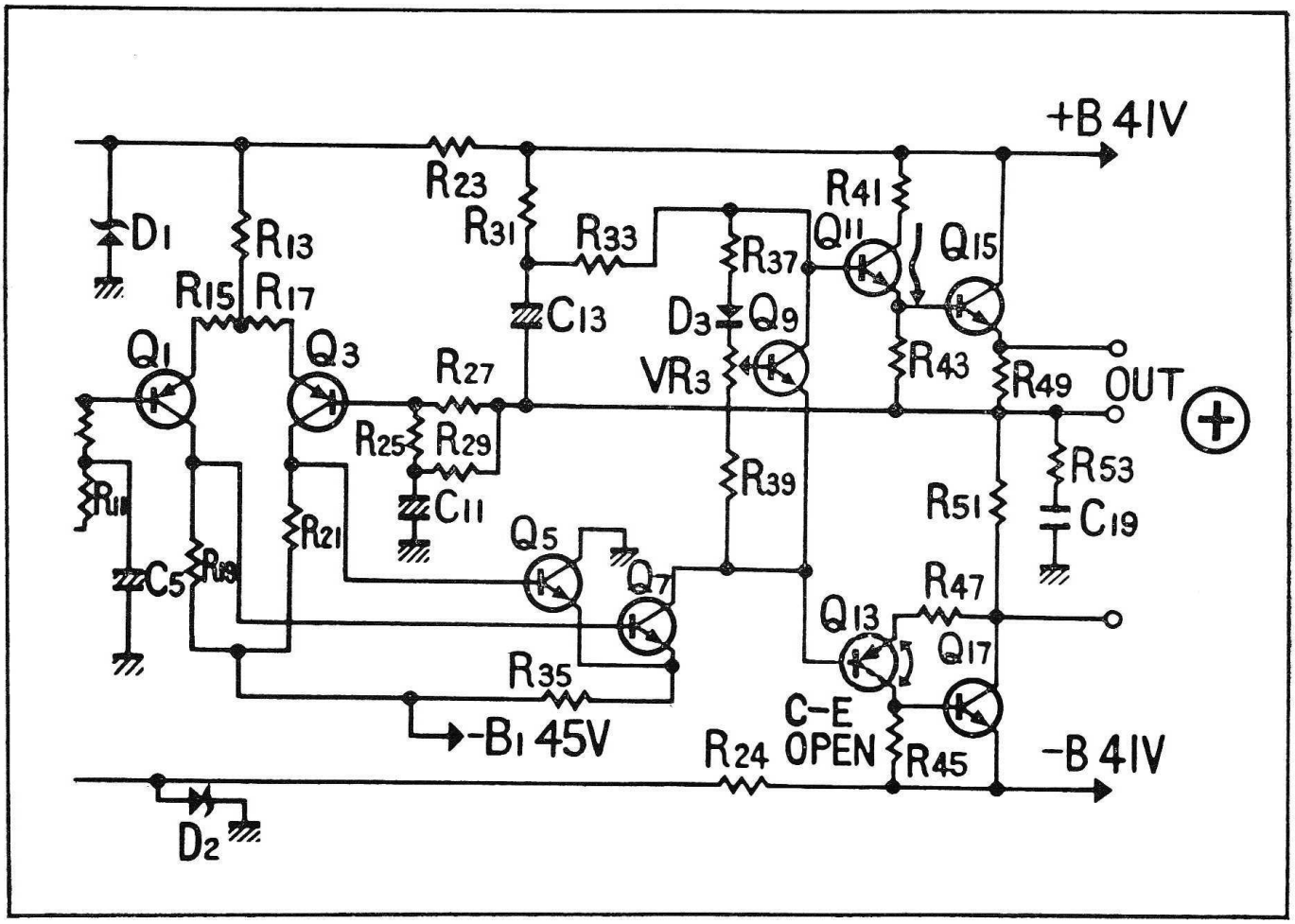
IN THESE CASES, ONLY SMALL VOLTAGE (ALMSOT 0 VOLT) IS PRODUCED AT OUTPUT TERMINAL. THIS IS BECAUSE THE FIRST STAGE OF DIFFERENTIAL AMPLIFIER CIRCUIT IS WORKING. THEREFORE, IF THE BASE OF Q-3 IS SHORT TO GROUND, LARGE VOLTAGE IS PRODUCED AT OUTPUT TERMINAL.



53.

NOW WE WILL LOOK AT WHAT HAPPENS WHEN Q-13 HAS A COLLECTOR EMITTER SHORT. –B FLOWS THROUGH THE SHORTED COLLECTOR-EMITTER JUNCTION, R-51, R-47 AND THEN THROUGH R-45 TO THE NEGATIVE POWER SUPPLY. THIS VOLTAGE THAT APPEARS AT THE OUTPUT WILL BE CLOSE TO –B.

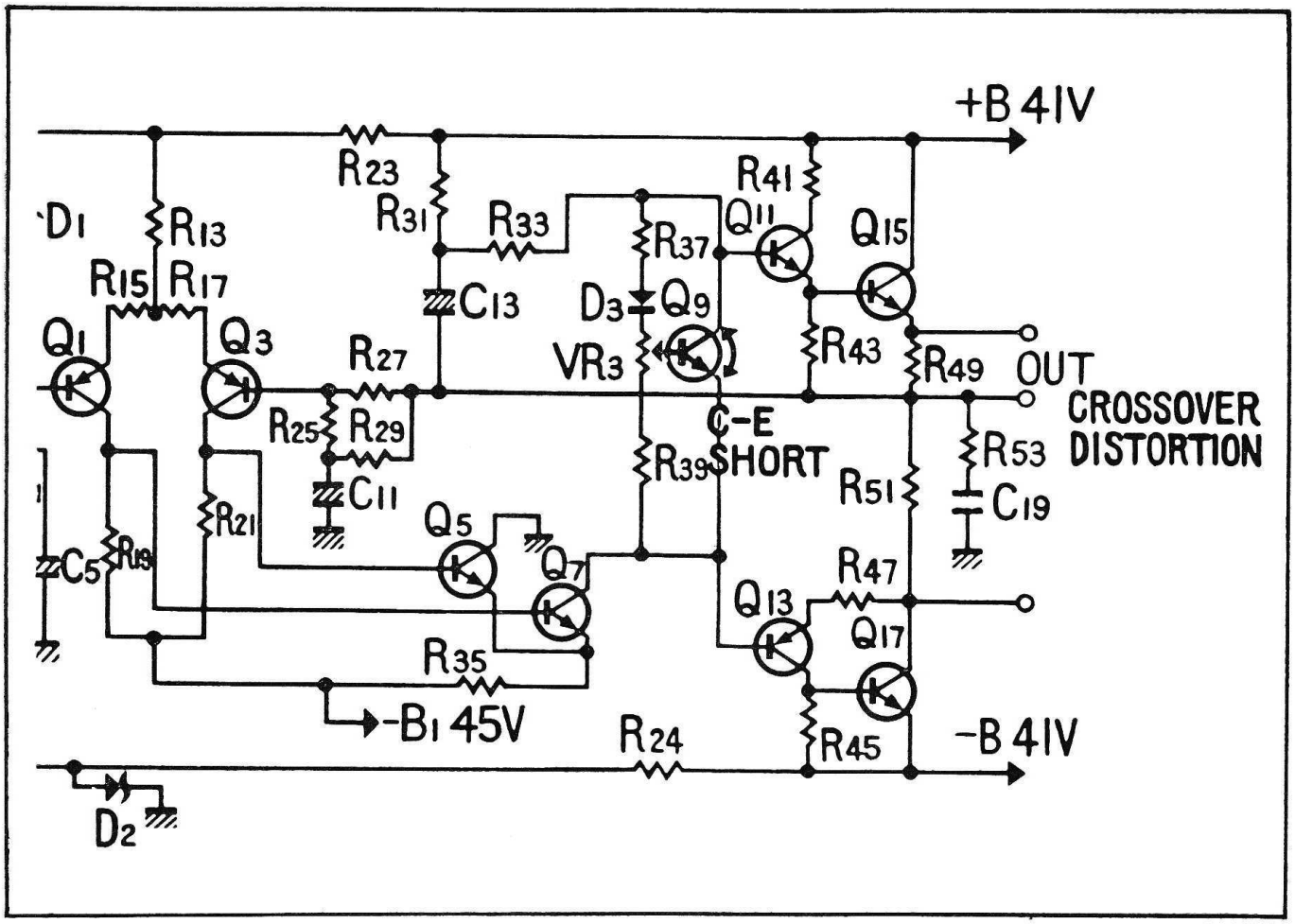
IN THIS CASE, EXCESSIVE CURRENT FLOWS THROUGH Q-13 AS IN THE CASE OF SHORT Q-11 AND ACCORDINGLY R-45 AND R-47 WILL BE BURNED OUT.



54.

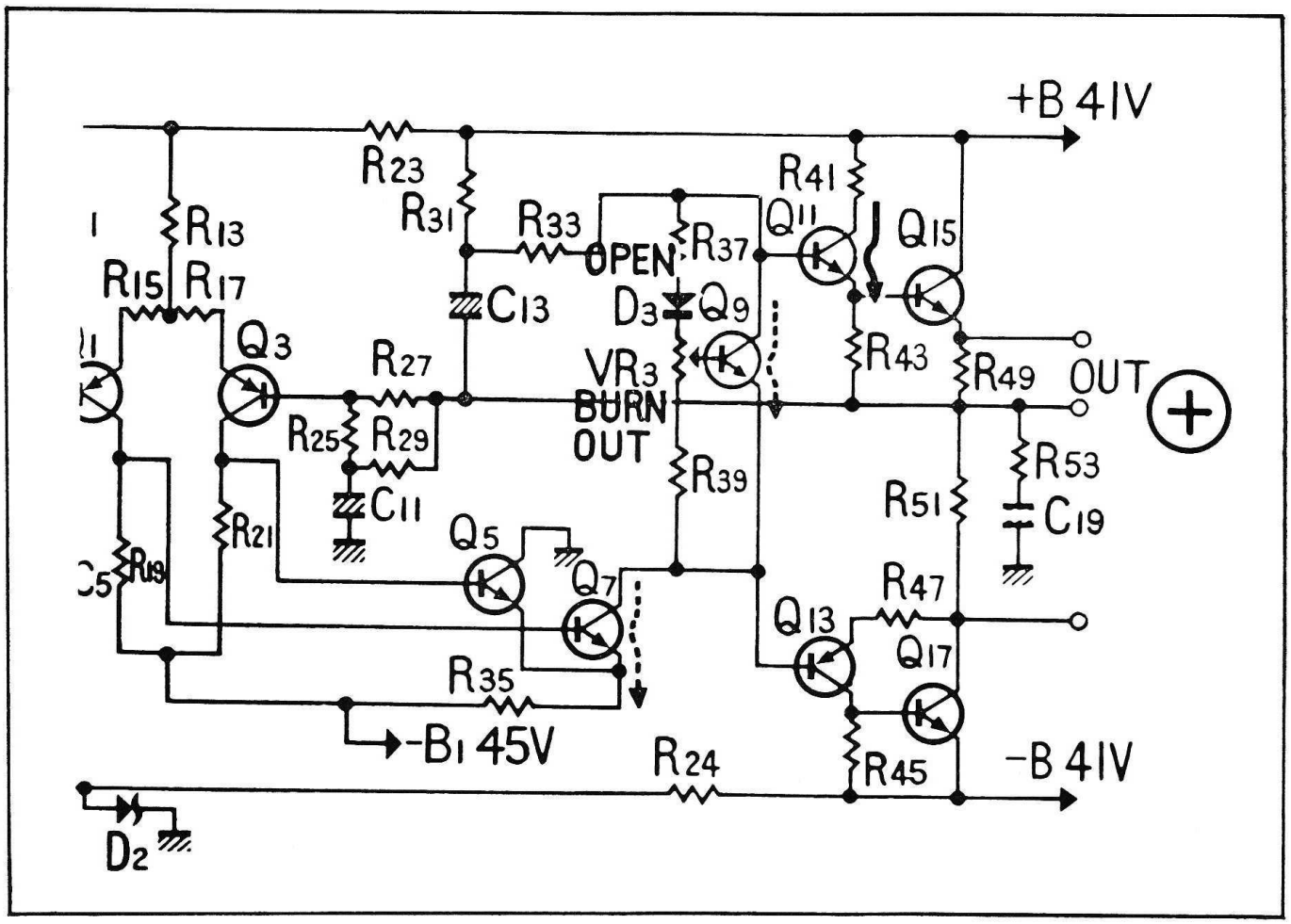
IF Q-13 IS OPEN VOLTAGE WILL FLOW THROUGH Q-11 BECAUSE IT IS BIASED. Q-11'S COLLECTOR-EMITTER VOLTAGE IS LOWERED AND A POSITIVE VOLTAGE DEVELOPS AT THE OUTPUT.

IN THESE CASES, ONLY SMALL VOLTAGE (ALMSOT 0 VOLT) IS PRODUCED AT OUTPUT TERMINAL. THIS IS BECAUSE THE FIRST STAGE OF DIFFERENTIAL AMPLIFIER CIRCUIT IS WORKING. THEREFORE, IF THE BASE OF Q-3 IS SHORT TO GROUND, LARGE VOLTAGE IS PRODUCED AT OUTPUT TERMINAL.



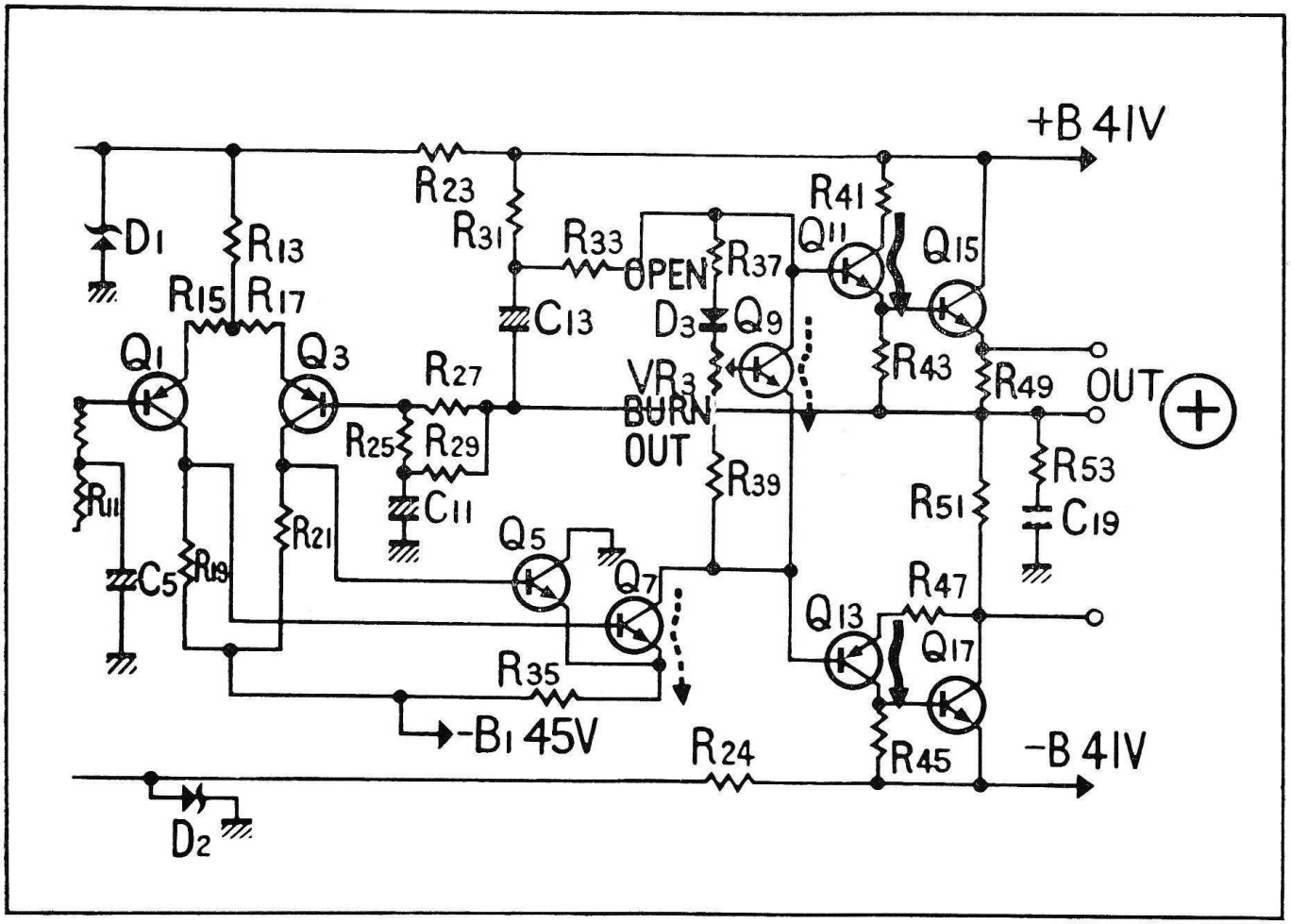
55.

NOW LET US CONSIDER THE CASE WHEN THE COLLECTOR AND EMITTER OF Q-9 IS SHORTED. BIAS TO THE DRIVER AND OUTPUT STAGES WILL DECREASE, CAUSING THE OPERATING CHARACTERISTICS OF THESE STAGES TO SHIFT TO THE Vb-Ic CURVE. THIS WILL CAUSE CROSSOVER DISTORTION.



56.

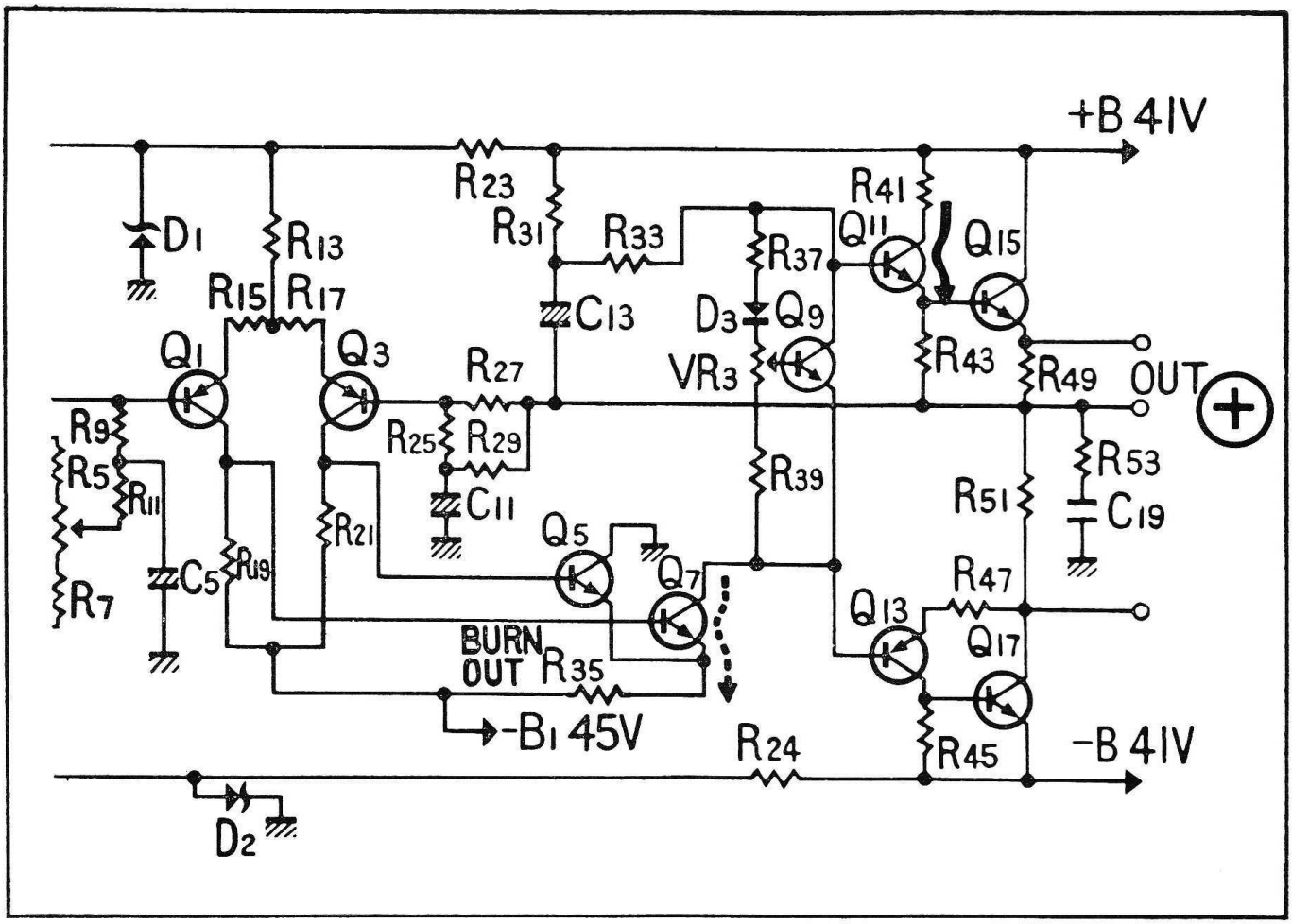
WHAT IF DIODE D-3 OPENS OR VR-3 IS BURNED OUT? IF THIS HAPPENS THE BIAS ON Q-9 WILL DECREASE AND Q-9 WILL CUT OFF. COLLECTOR CURRENT THROUGH Q-7 WILL CEASE AND Q-11 BASE VOLTAGE WILL INCREASE, CAUSEING COLLECTOR-EMITTER VOLTAGE TO DECREASE ..... .



57.

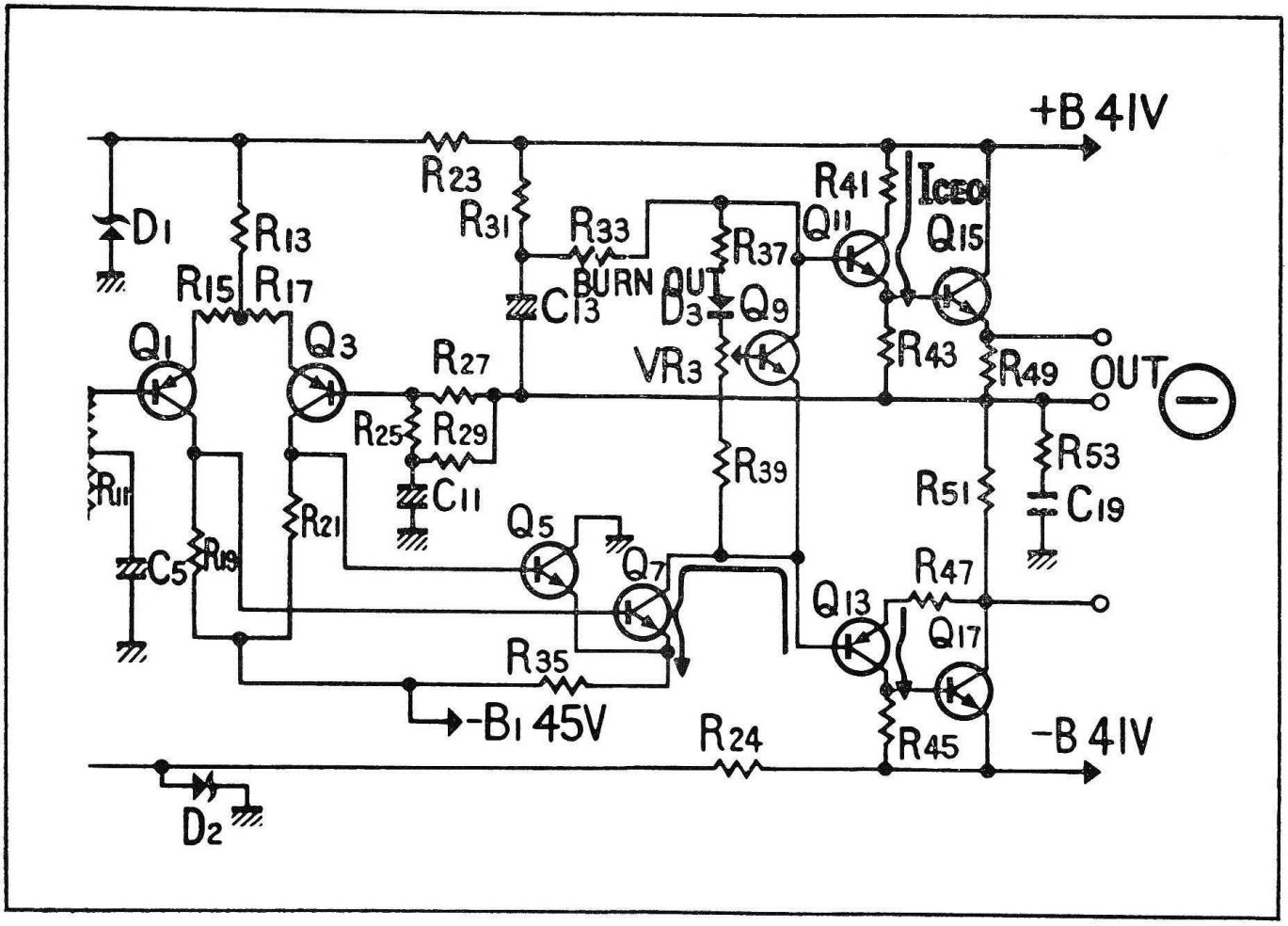
AND SINCE Q-7 IS STILL BIASED Q-13'S BASE CURRENT WILL INCREASE DUE TO THE LEAKAGE CURRENT FROM THE EMITTER TO THE BASE. THIS INCREASES THE BASE BIAS WHICH TURNS Q-13 ON MORE AND THE OUTPUT VOLTAGE IS KEPT AT ZERO VOLT.

HOWEVER, A HEAVY CURRENT FLOWS THROUGH Q-13 AND Q-11. THIS WILL CAUSE POSSIBLE DAMAGE TO BOTH TRANSISTORS.



58.

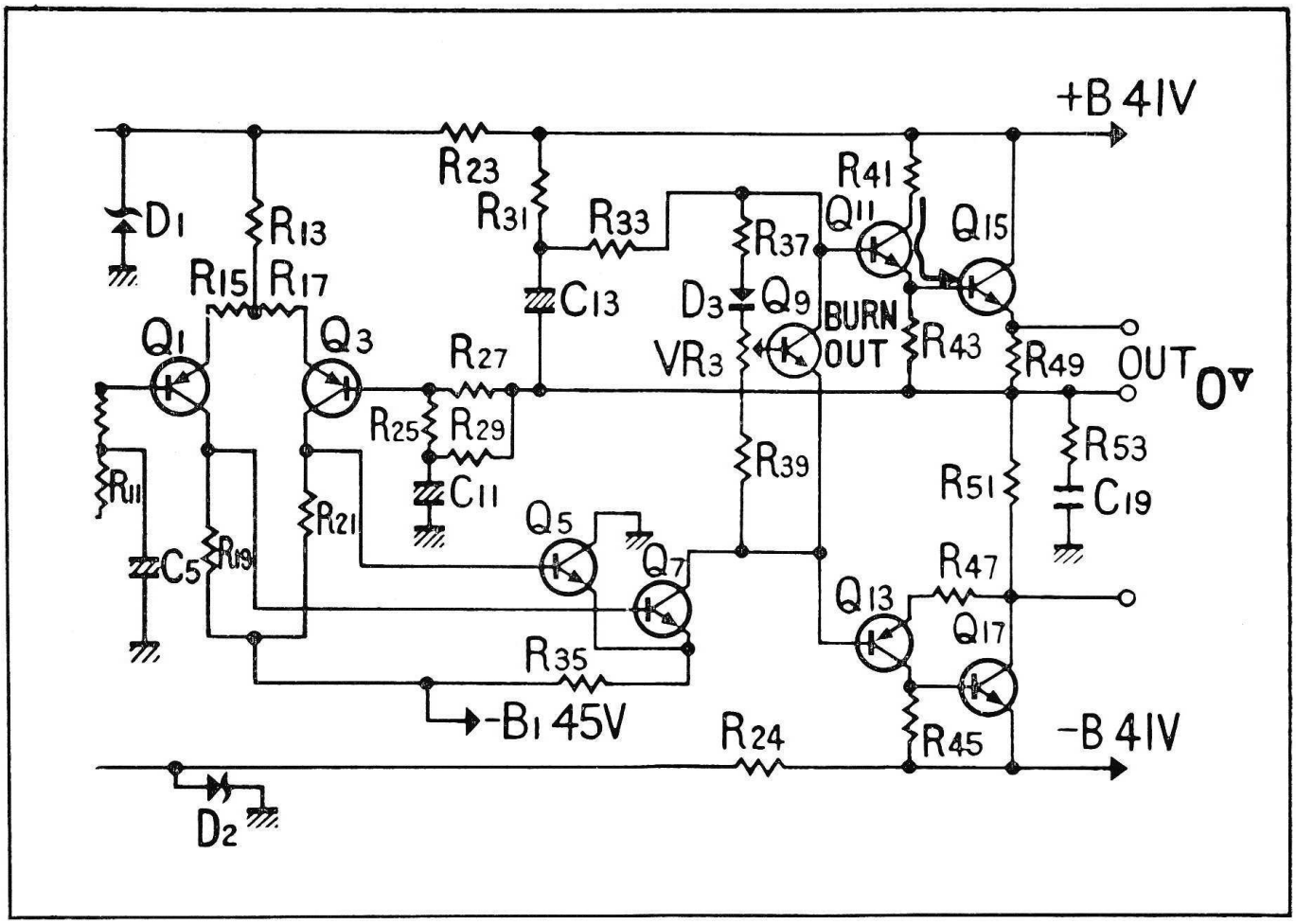
NOW WE WILL CONSIDER THE RESISTORS IN THE CIRCUIT. WE WILL START WITH R-35. IF R-35 IS OPEN, NO CURRENT WILL FLOW THROUGH Q-7. THE COLLECTOR VOLTAGE WILL INCREASE AND Q-11'S BIAS WILL ALSO INCREASE. THIS LOWERS THE COLLECTOR-EMITTER VOLTAGE, CAUSING A POSITIVE VOLTAGE AT THE OUTPUT.



59.

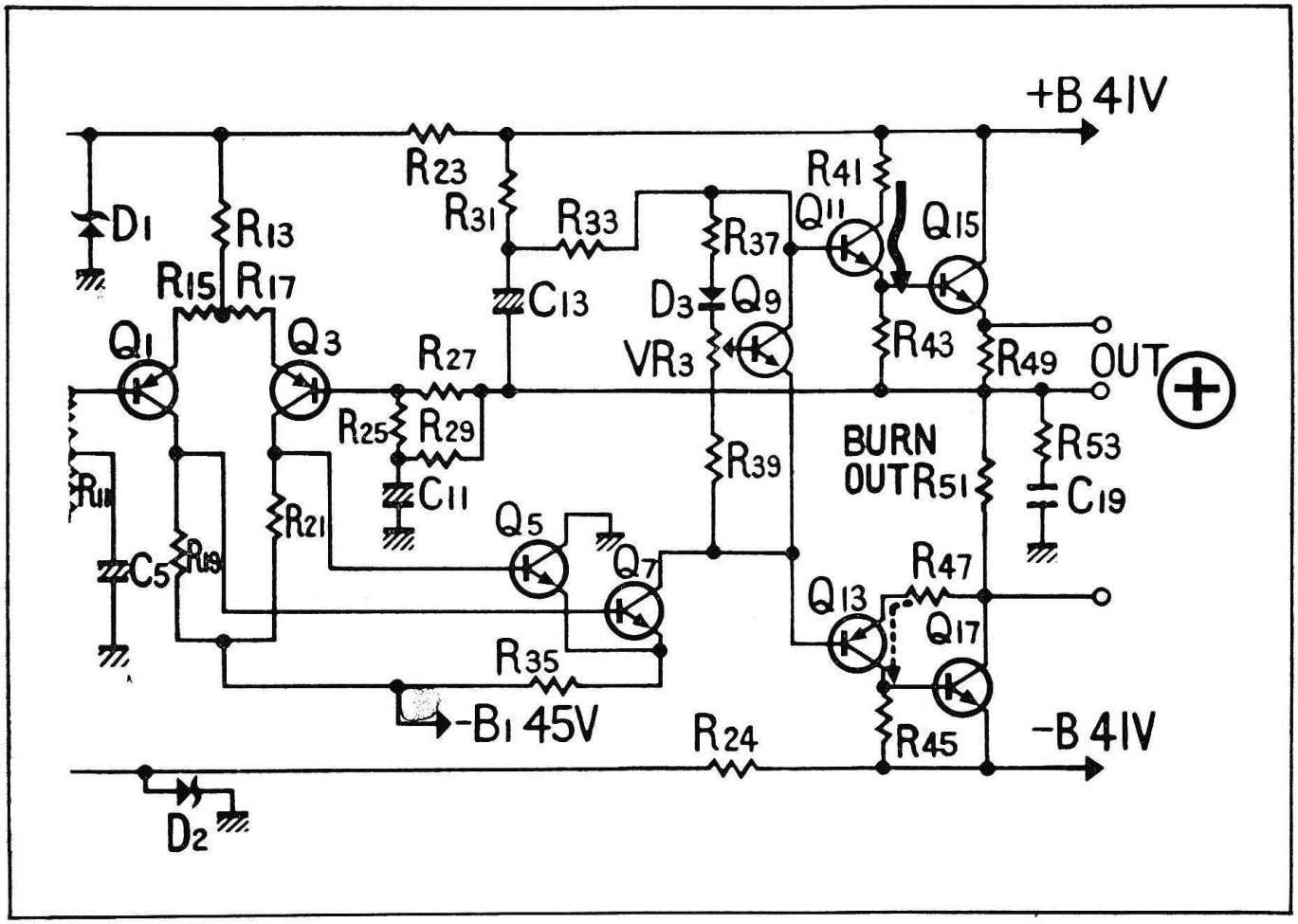
IF R-33 IS OPEN, NO BIAS IS PROVIDED TO Q-11 AND COLLECTOR CURRENT WILL CEASE, EXCEPT FOR COLLECTOR CUT OFF CURRENT I_{CEO}. BECAUSE OF THIS, BASE CURRENT OF Q-13 WILL FLOW INTO THE COLLECTOR OF Q-7 TURNING Q-13 ON, LOWERING THE COL LECTOR-EMITTER VOLTAGE. THE OUTPUT VOLTAGE WILL BE NEGATIVE.

IN THESE CASES, ONLY SMALL VOLTAGE (ALMSOT 0 VOLT) IS PRODUCED AT OUTPUT TERMINAL. THIS IS BECAUSE THE FIRST STAGE OF DIFFERENTIAL AMPLIFIER CIRCUIT IS WORKING. THEREFORE, IF THE BASE OF Q-3 IS SHORT TO GROUND, LARGE VOLTAGE IS PRODUCED AT OUTPUT TERMINAL.



60.

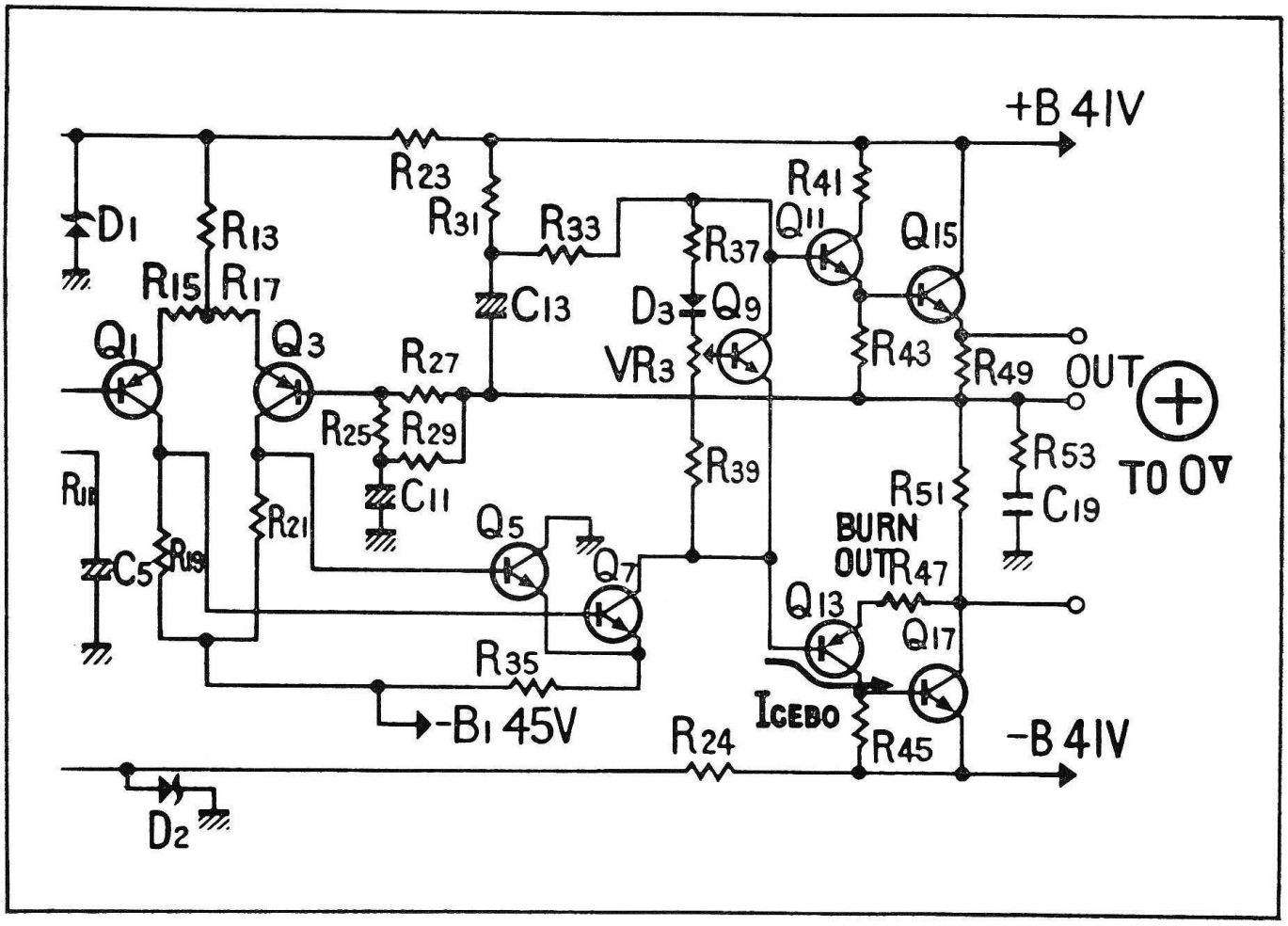
IF EMITTER RESISTOR R-43 IS OPEN AND Q-15 WERE DISCONNECTED, NO COLLECTOR CURRENT OF Q-11 WOULD FLOW. HOWEVER, IN THE ACTUAL CIRCUIT Q-15 IS CONNECTED, SO THE EMITTER CURRENT OF Q-11 WILL BE THE BASE CURRENT OF Q-15 AND THE D.C. BALANCE WILL BE MAINTAINED. NO VOLTAGE WILL DEVELOP AT THE OUTPUT, BUT DISTORTION OF THE AMP WILL INCREASE AND POWER IS REDUCED.



61.

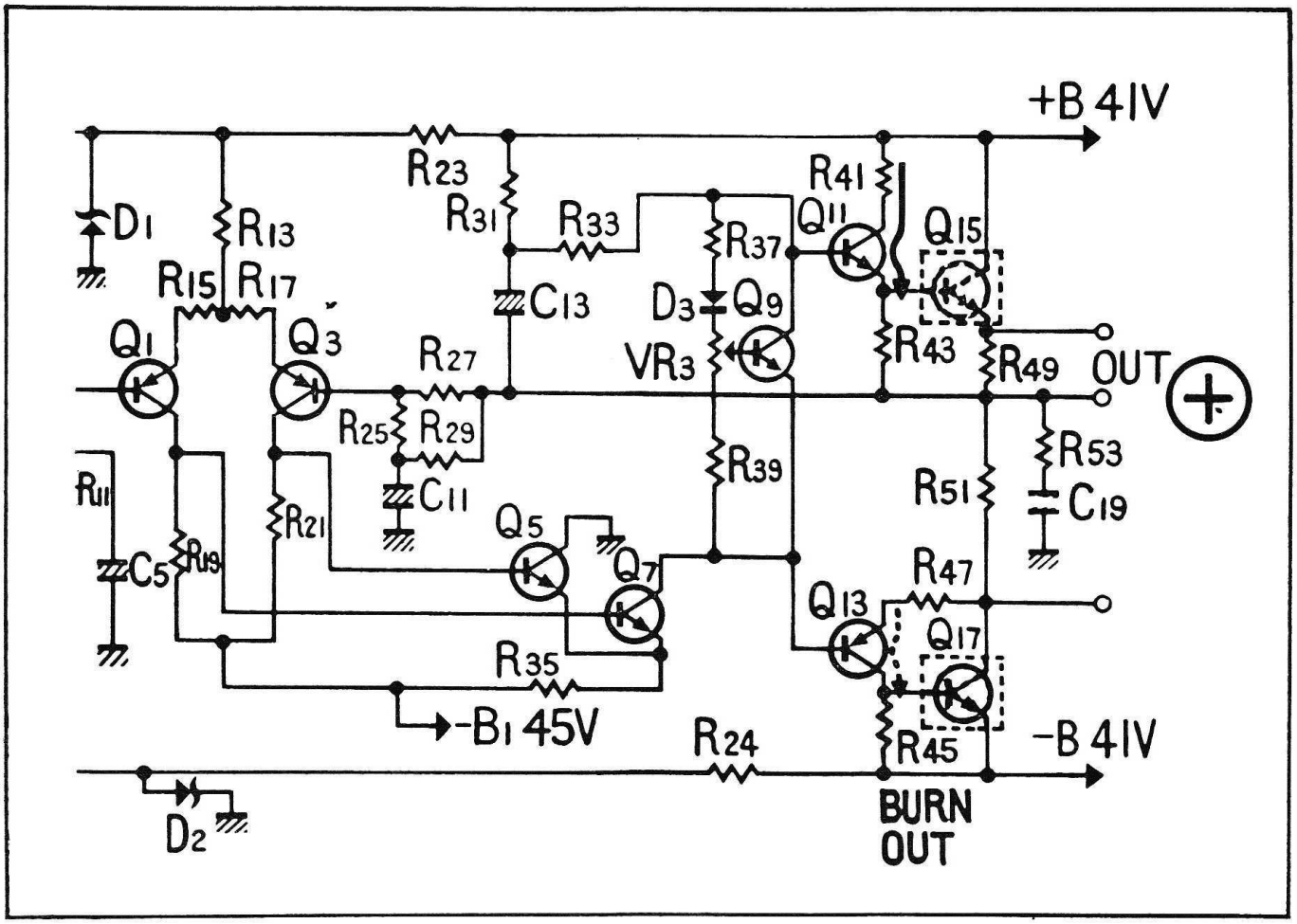
WHAT HAPPENS IF R-51 IS OPEN? Q-13'S EMITTER CURRENT WILL NO LONGER FLOW, BUT SINCE Q-11 IS STILL BIASED EMITTER-COLLECTOR VOLTAGE WILL BE LOWERED AND A POSITIVE VOLTAGE WILL APPEAR AT THE OUTPUT.

IN THESE CASES, ONLY SMALL VOLTAGE (ALMSOT 0 VOLT) IS PRODUCED AT OUTPUT TERMINAL. THIS IS BECAUSE THE FIRST STAGE OF DIFFERENTIAL AMPLIFIER CIRCUIT IS WORKING. THEREFORE, IF THE BASE OF Q-3 IS SHORT TO GROUND, LARGE VOLTAGE IS PRODUCED AT OUTPUT TERMINAL.



62.

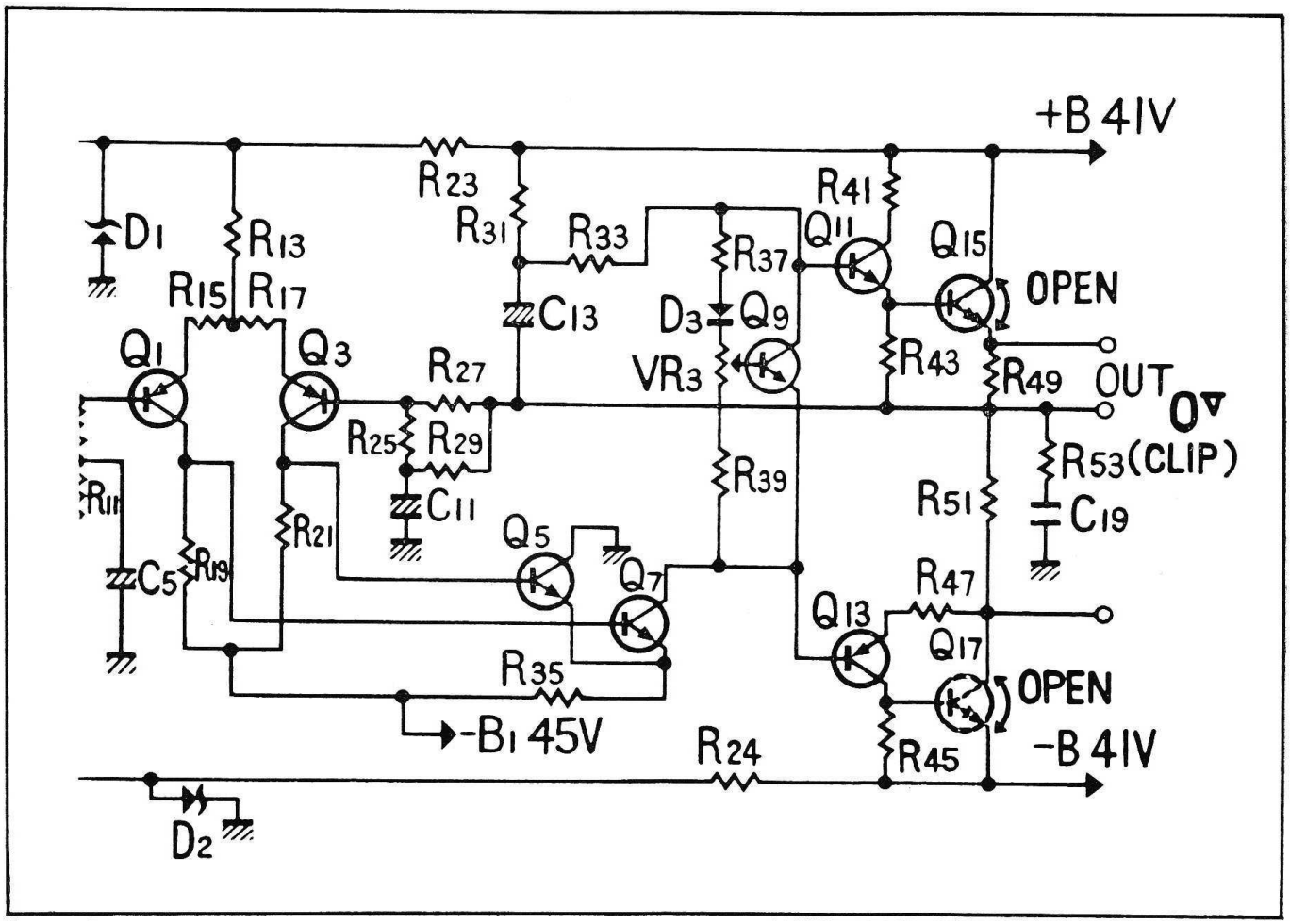
IF R-47 OPENS IT MIGHT APPEAR THAT THE AMPLIFIER WOULD HAVE THE SAME SYMPTOM AS IT DOES WHEN R-51 IS OPEN. HOWEVER, SINCE Q-17 IS CONNECTED THE COLLECTOR-BASE I_{cbo} CURRENT OF Q-13 WILL BE THE SAME AS THE BASE CURRENT OF Q-17. THIS IS BECAUSE IF R-47 IS OPEN, THE EMITTER OF Q-13 IS NOT CONNECTED TO ANYTHING. THE I_{cbo} CURRENT IS DEPENDANT ON THE INPUT SIGNALS TO Q-13. THEREFORE, VOLTAGE FROM OV TO POSITIVE VOLTAGE WILL APPEAR AT THE OUTPUT IN PROPORTION TO THE INPUT SIGNAL.



63.

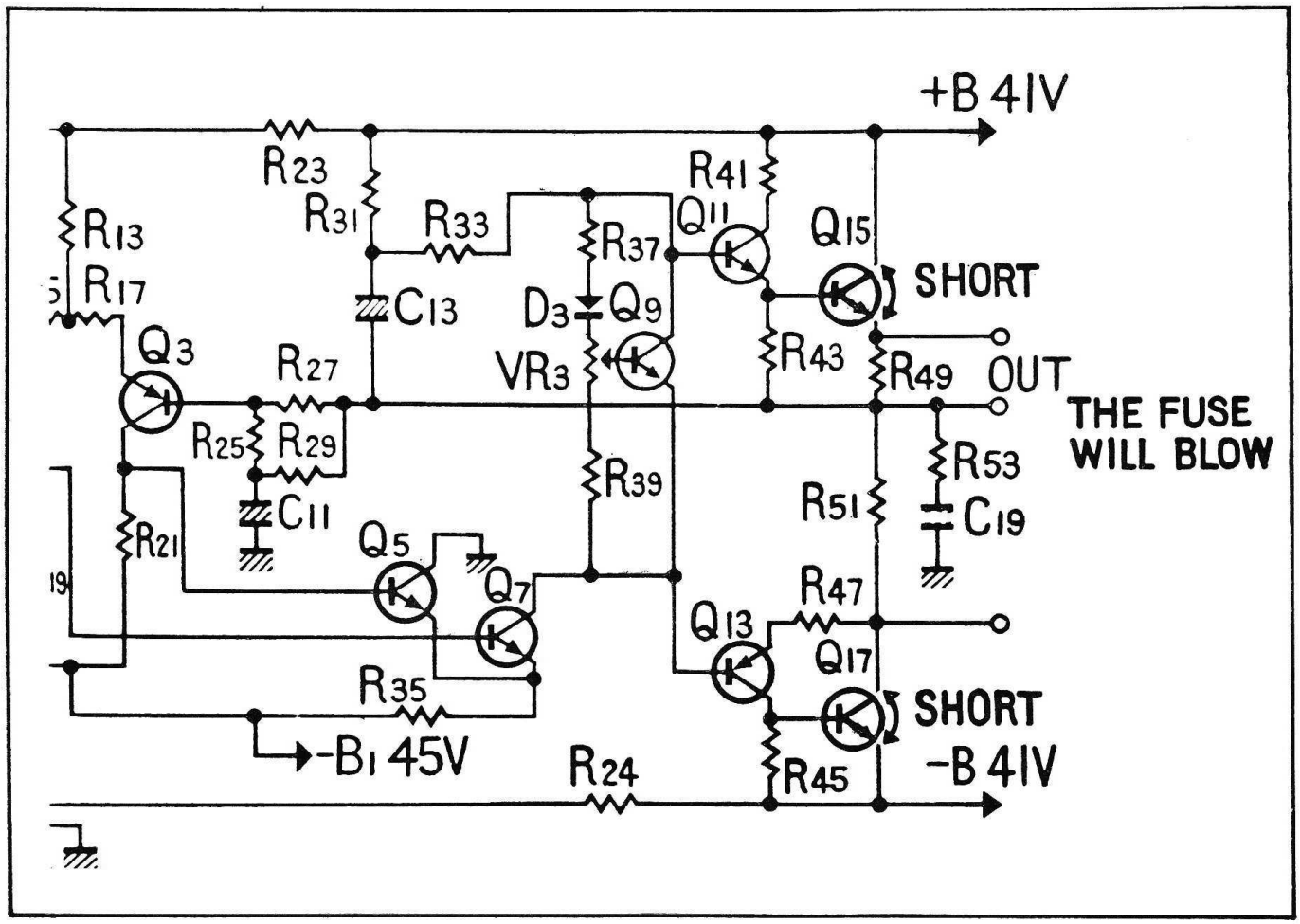
IF R-45 BURNS OUT AND Q-17 IS NOT CONNECTED THEN NO COLLECTOR CURRENT WILL FLOW THROUGH Q-13. SINCE Q-11 IS BIASED COLLECTOR-EMITTER VOLTAGE WILL DROP AND AS A RESULT, A POSITIVE VOLTAGE WILL APPEAR AT THE OUTPUT. HOWEVER, IN THE ACTUAL CIRCUIT Q-17 IS CONNECTED AND NO VOLTAGE WILL DEVELOP AT THE OUTPUT, SINCE THE COLLECTOR CURRENT OF Q-13 WILL BE THE BASE VOLTAGE OF Q-17.

IN THESE CASES, ONLY SMALL VOLTAGE (ALMSOT 0 VOLT) IS PRODUCED AT OUTPUT TERMINAL. THIS IS BECAUSE THE FIRST STAGE OF DIFFERENTIAL AMPLIFIER CIRCUIT IS WORKING. THEREFORE, IF THE BASE OF Q-3 IS SHORT TO GROUND, LARGE VOLTAGE IS PRODUCED AT OUTPUT TERMINAL.



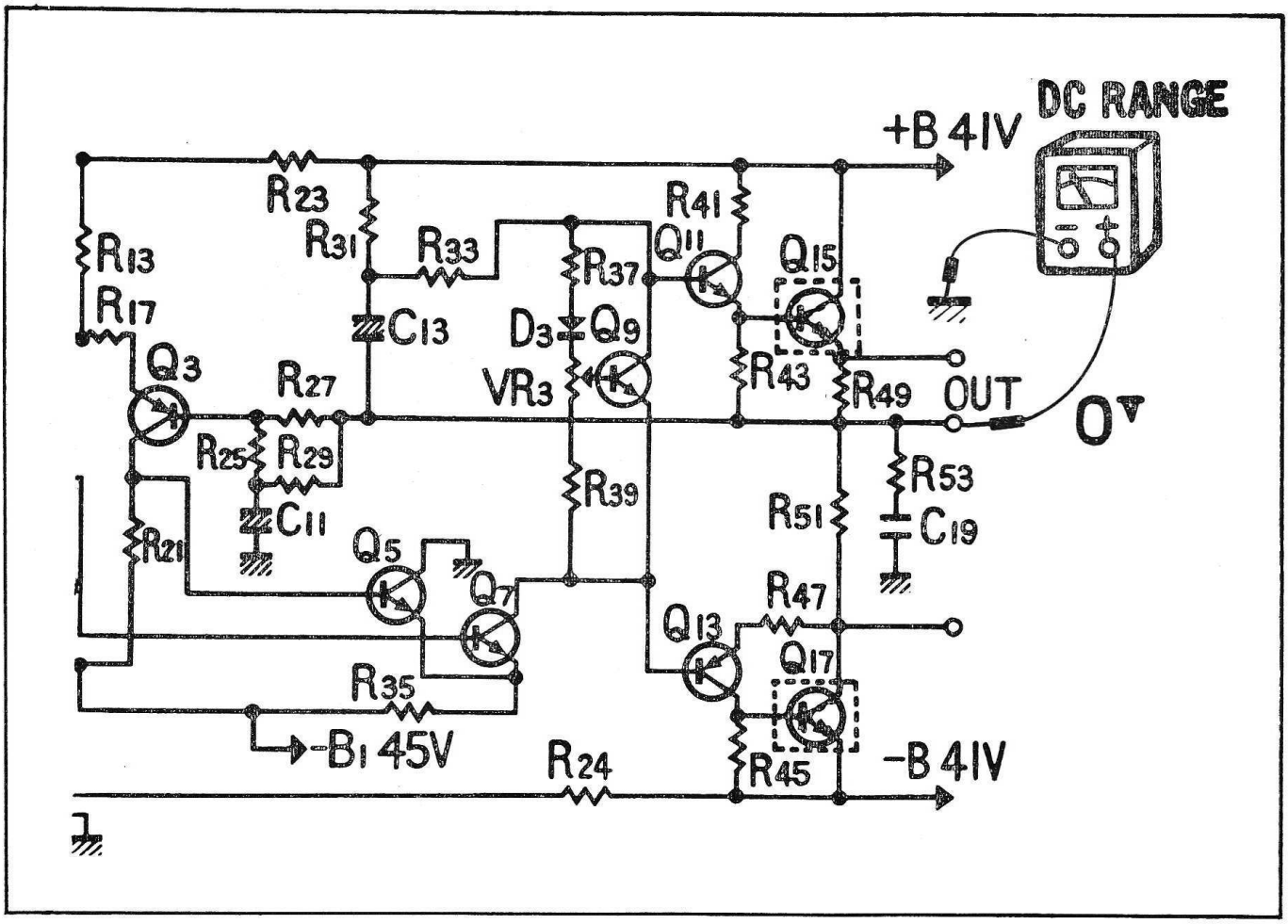
64.

IF POWER TRANSISTORS Q-15 AND Q-17 ARE OPEN, THE D.C. BALANCE OF THE AMP WILL BE NORMAL, BUT POWER OUTPUT WILL BE WEAK AND WILL CLIP EASILY. AT SMALL VOLUME LEVELS OPERATION WILL APPEAR TO BE NORMAL.



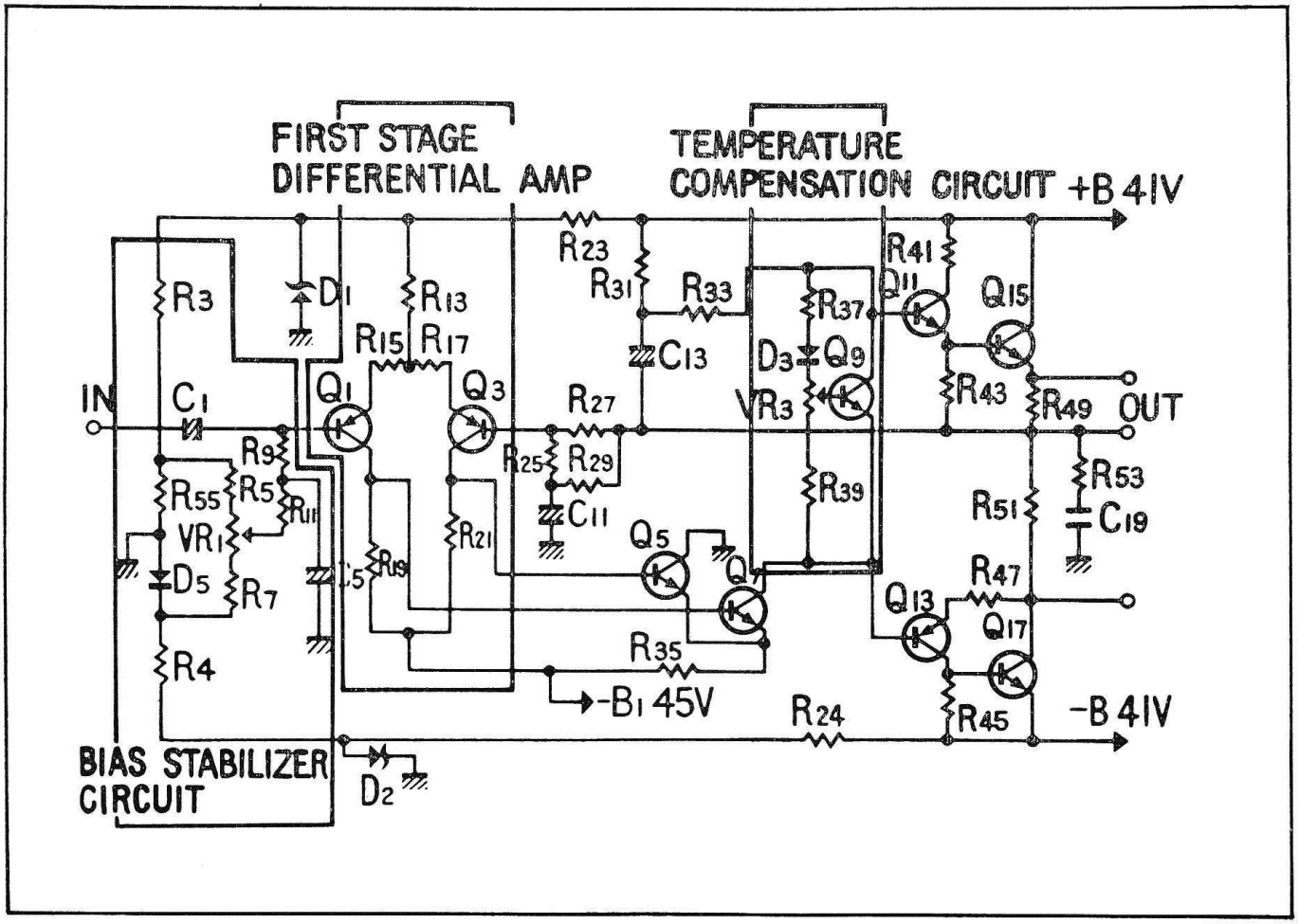
65.

IF Q-15 AND Q-17 SHORT THEN A HEAVY CURRENT WOULD THEN FLOW FROM THE POWER SUPPLY. ALSO, THE PROTECTION CIRCUIT WILL SENSE THE IMBALANCE AND DISCONNECT THE LOAD FROM THE AMP. THE HEAVY POWER SUPPLY CURRENT MAY ALSO BLOW THE MAIN LINE FUSE. THEREFORE, IT IS NOT POSSIBLE TO MEASURE THE VOLTAGES, IF THIS IS THE CASE.



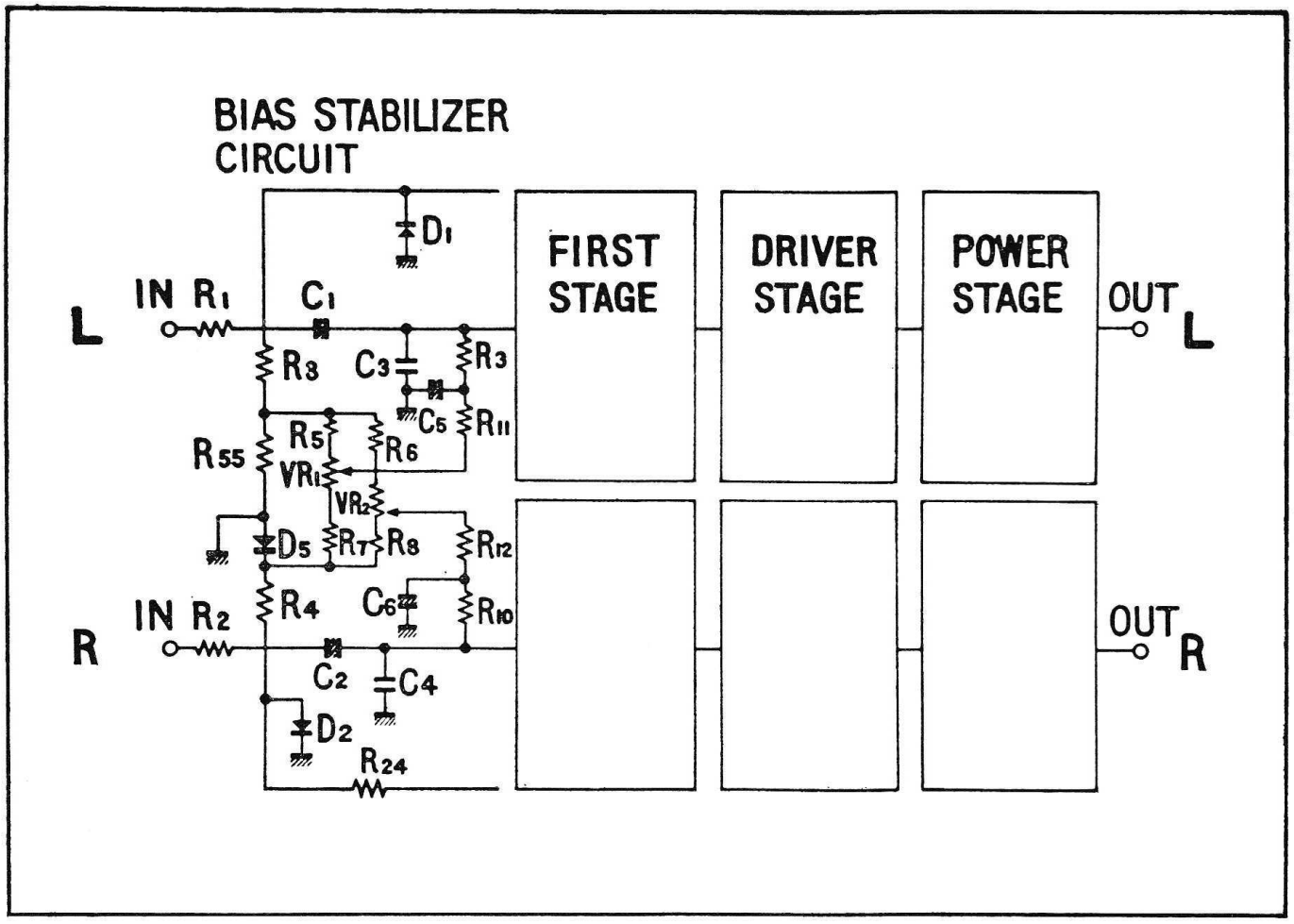
66.

TO CHECK THE VOLTAGE, REMOVE THE POWER TRANSISTORS AND CHECK THE VOLTAGE AT THE OUTPUT TERMINAL. LOOK AT THE REST OF THE AMP TO BE SURE THERE ARE NO BURNT OR DAMAGED PARTS. IF THE VOLTAGE IS ZERO, THE REST OF THE AMP SHOULD BE O.K. AND YOU CAN INSTALL NEW POWER TRANSISTORS.



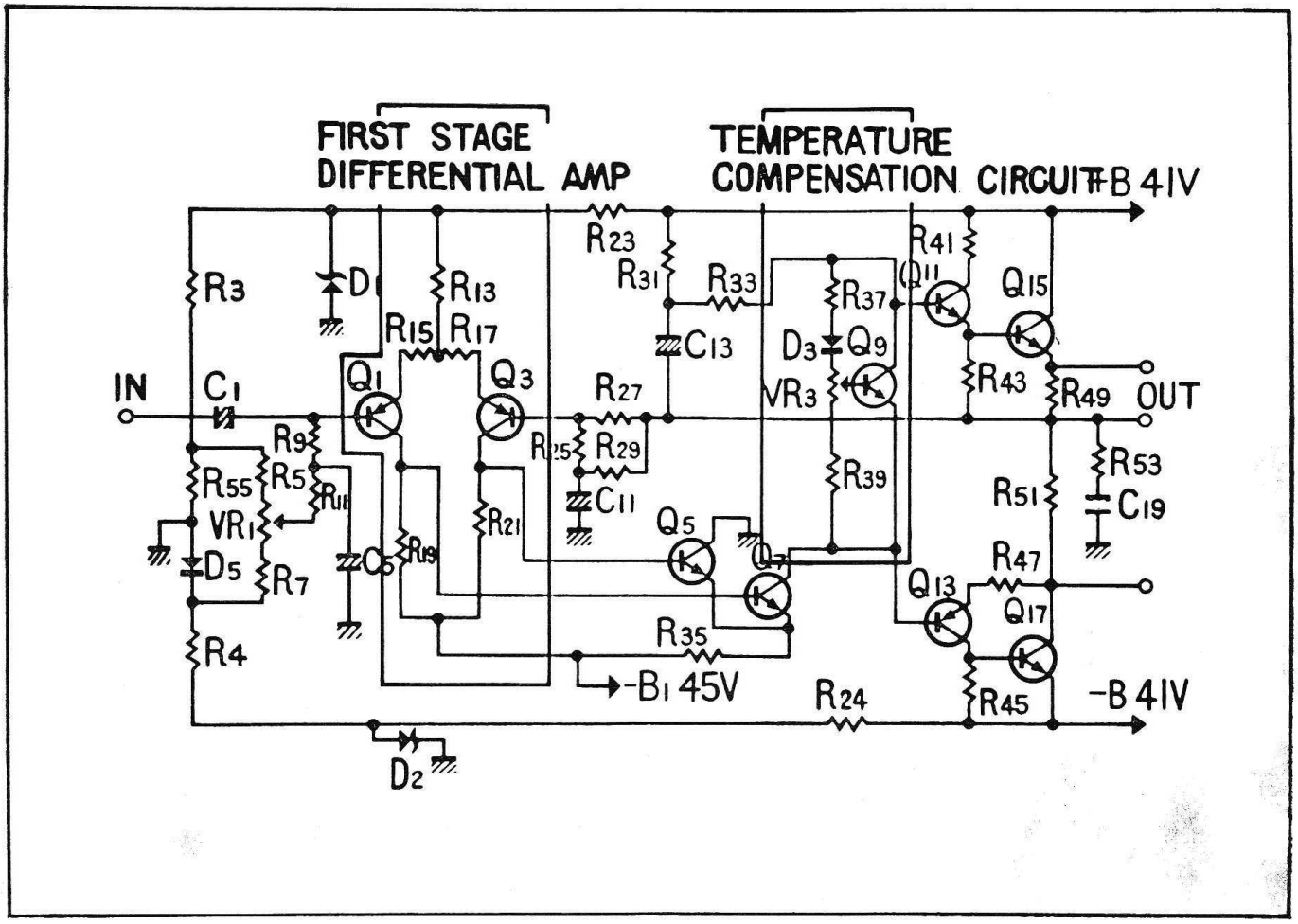
67.

OUR LAST CASE, IS ONE IN WHICH A AMPLIFIER WILL DEVELOP A D.C. VOLTAGE AT THE OUTPUT ONLY AFTER IT HAS BEEN OPERATING AWHILE. USUALLY THIS IS DUE TO TEMPERATURE SENSITIVITY, WHICH CHANGES THE BALANCE OF THE AMPLIFIER. THIS MAY BE CAUSED BY DEFECTIVE TEMPERATURE COMPENSATION IN THE DRIVER OR BIAS STABILIZATION CIRCUITS OR THE FIRST STAGE DIFFERENTIAL AMPLIFIER.



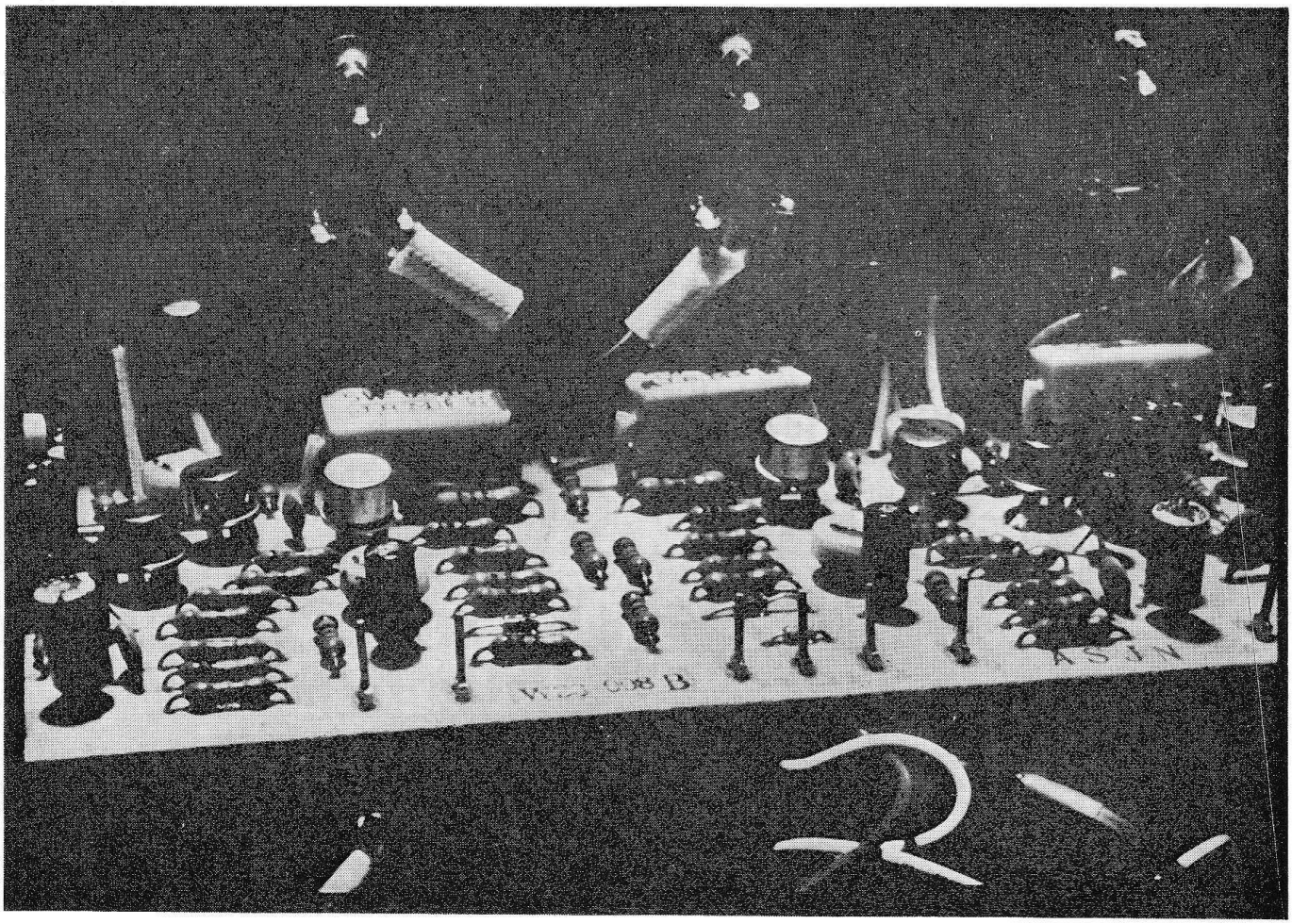
68.

IN THE CASE OF THE SA-1000 THE BIAS STABILIZATION CIRCUIT IS CONNECTED TO BOTH CHANNELS OF THE AMPLIFIER. IF THIS CIRCUIT IS DEFECTIVE, THE VOLTAGE OF THE SAME POLARITY WILL DEVELOP AT THE OUTPUT TERMINALS. DIODE D-5 IS THE PROBABLE CAUSE.



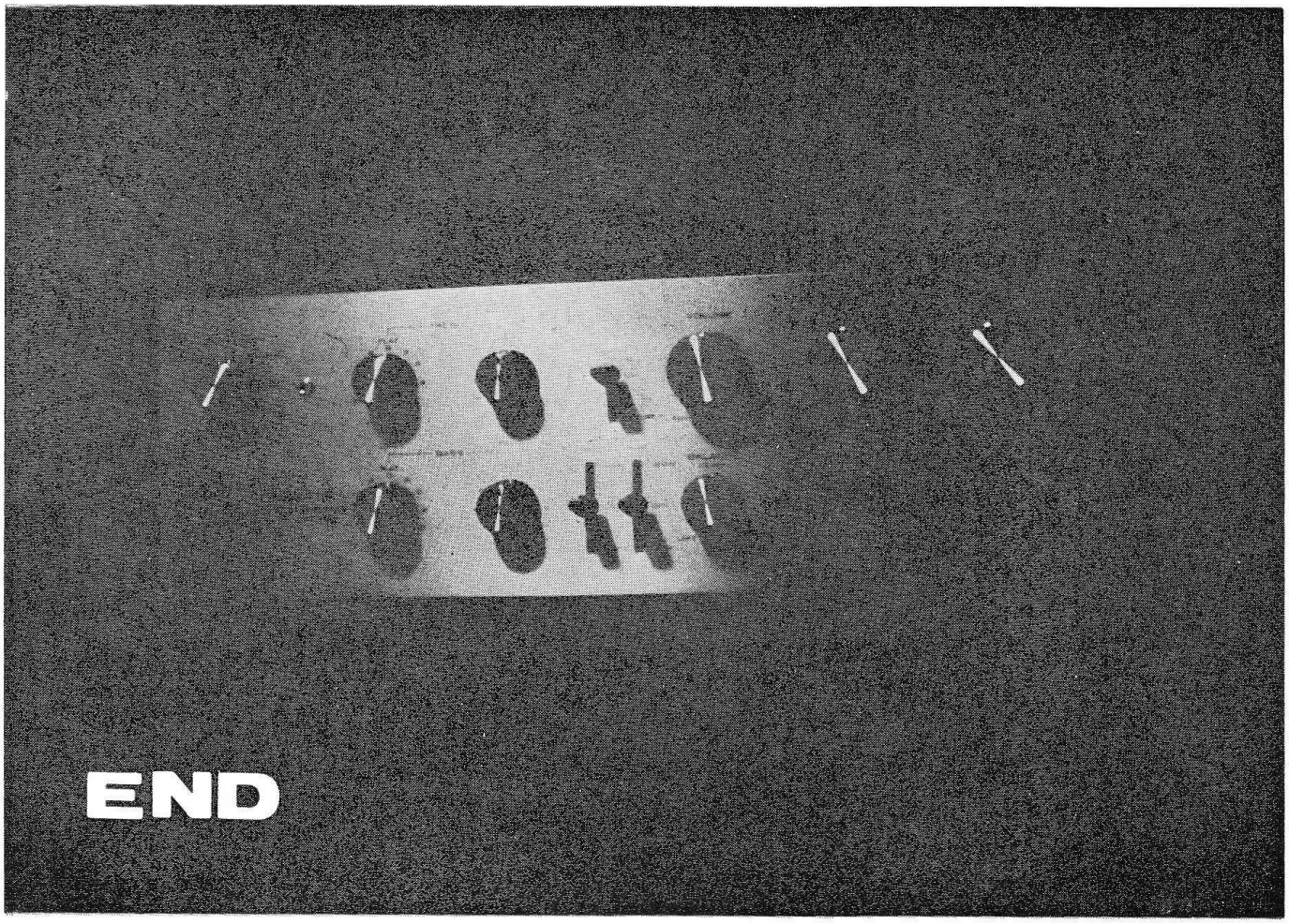
69.

IF A VOLTAGE DEVELOPS AT THE OUTPUT AFTER THE UNIT WARMS UP, THE TEMPERATURE CO-EFFICIENT OF THE TRANSISTORS IN THE DIFFERENTIAL AMPLIFIERS MAY BE DIFFERENT. THE SAME IS TRUE FOR THE DRIVER STAGE.



70.

AS YOU HAVE SEEN, YOUR BIGGEST CLUE TO REPAIR OF OCL MAIN AMPS IS TO CHECK IF THE D.C. BALANCE IS NORMAL. THIS IS INDICATED BY ZERO VOLTAGE AT THE OUTPUT' WITH ANY REPAIR YOU MUST OBSERVE ANY SYMPTOMS THE AMPLIFIER HAS AND FOLLOW A LOGICAL TROUBLESHOOTING PROCEDURE. IF YOU REMEMBER A OCL AMP IS VERY SIMILAR TO A CAPACITOR COUPLED UNIT AS FAR AS REPAIRS ARE CONCERNED, YOU WILL EASILY REPAIR ANY TYPE OF AMPLIFIER.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