

ProTach

ASSEMBLY INSTRUCTIONS

PARTS LIST

Semi technical circuit description.

Fig. 5 shows the circuit of a ProTach. Q1 is a photo-transistor whose output is a current proportional to the light level. Phototransistors have a better frequency response than the more conventional photocells, and the built in lens eliminates the need for a separate bulky lens or shielding tube.

R1, R2, and D1 form a signal compressor which provides an output voltage approximately proportional to the percent change in ambient light due to the rotating prop. This means that the output is not a function of the ambient light level, allowing the tach to function over a very large range of light levels, and making it less susceptible to reflections.

A1, through A5 are integrated circuit operational amplifiers. A1, A2, R4, R6, R7, R8, R9, C1, C3, C4, and C5 form a bandpass amplifier. This multiplies the signal about 5000 times while filtering out undesirable harmonics and other unwanted signals such as background movement

A3, R10, R11, R12, R13, and C6 form a Schmitt trigger which 'squares up' the signal from the prop. Hysteresis is incorporated to minimize reflection pickup. The output of A3 is used to trigger a monostable multivibrator via R14, C7, R15, and Q2.

Q3, Q4, Q5, R16, R17, R18, R19, R20, R21, and C8 form a monostable multivibrator. Its output is a pulse that goes from ground to -V when the output of A3 switches positive (decreasing light input). This pulse is a fixed width (time) determined by C8 and R17. The capacitor selected compensates the circuit over a wide temperature range, and the whole circuit operates from a regulated voltage, making the output immune to battery voltage changes. R21 is a multiturn potentiometer used to calibrate the unit.

A4, R22, R23, R24, and C9 invert the signal and filter it to provide a positive output voltage which is proportional to engine RPM.

A5 is a current subtractor that supplies a current to the meter equal to the current flowing through R29 (proportional to RPM) minus an offset current determined by S1. Resistors R31 through R35 each subtract a current equal to 4K RPM when connected through the switch to -V. In the 0-5 position, the current through the meter represents the RPM signal. In the 4-9 position, R31 subtracts 4K RPM. Each higher scale places an equal resistor in parallel, subtracting an additional 4K RPM. The current through these resistors is determined by the regulated supply voltage, -V, which is adjusted by potentiometer R5 to calibrate the meter offset. D2, R26, R27, and R28 protect the meter from overloads. S3 reverses the current through the meter for calibration. S3 is actually implemented on the PC board by mounting the meter through different holes. This allows the current through R31 to be read on the meter and the regulator adjusted for a reading of 4K RPM.

With all the buttons out, R30 is placed in series with R29 and this divides the current to the meter by five, providing the 0-25K RPM scale. When S2 is switched to the BATT position (spring return), R3 is connected to +V and to the input of A5. The RPM and offset signals are disconnected. R3 is chosen so that full scale on the meter occurs when the battery is at 18 volts. A half scale reading represents about 12 volts and is the recommended replacement voltage.

VR1 is an integrated circuit voltage regulator which supplies a constant voltage, controlled by R5, to all critical circuits. This also supplies the positive and negative voltages necessary to power the operational amplifiers.

Note:

The original construction article for the ProTach appeared in the July '75 issue of RC Modeler magazine. We wish to thank RCM for permission to include essential portions of their article in our instructions.

Quant.	Ref No.	Description	Part No.
3	R1,8,26	470 ohm 1/4W 10% resistor	000027
4	R2,16,19,25	10K 1/4W 10% resistor	000043
1	R3	240K 1/4W 5% resistor	000209
3	R4,11,23	4.7K 1/4W 10% resistor	000039
2	R6,13(test)	220K 1/4W 10% resistor	000059
7	R7,9,10,14,15,18,20	47K 1/4W 10% resistor	000051
1	R12	470K 1/4W 10% resistor	000063
2	R27,28	68K 1/4W 10% resistor	000053
6	R17,31,32,33,34,35	150K 1/8W 1% metal film resistor Type RN55,1503. Or equiv. (brn,grn,blk,org,brn)	006024
3	R22,24,29	10K 1/8W 1% metal film resistor Type RN55,1003. Or equiv. (brn,blk,blk,red,brn)	006022
1	R30	40.2K 1/8W 1% metal film resistor Type RN55,4022. Or equiv. (yel,blk,red,red,brn)	006023
2	R5,21	10K Multi-turn cermet pot Bourns 3006P or equiv.	006026
1	C1	1uf Tant. cap. 1.0m 25V or 105 35K	001134
1	C9	4.7uf Tant. cap. 4.7m 6V	001141
1	C10	15uf Tant. cap. 15uf 15V	001151
2	C2,7	100pf disc cap. 100pf	001200
2	C3,5	1000pf disc cap. .001uf or 10n	001035
2	C4,6	.1uf disc cap. 100nZ 12V or 12V 104Z	001050
1	C8	.0068uf Polyester film cap. Sprague 192P6829R8 or equiv.	001076
1	Q1	Photo transistor. Clairex CLT2130 or equiv.	006027
4	Q2,3,4,5	M400 Transistor	000443
5	A1,2,3,4,5	Amplifier, Motorola MC1741CPI or equiv.	006028
1	VR1	Voltage regulator. Motorola MC1723CL or equiv.	006029
2	D1,2	1N4148 Silicon diode	000405
1	S1	Pushbutton switch. Switchcraft 65061K-206	006030
1	S2	DPT slide switch. Lock/mom. Switchcraft 46313TDR	006031
1	M1	0-5 Microampere meter. Micronta 22-051	006032
2	PCB-1,2	Printed circuit boards (pair)	006025
1		Case complete	006035
2		Snap-on connectors for batteries	006033
11"ea.		#26 ga. wire black, orange	
13"ea.		#26 ga. wire red	
17"ea.		#26 ga. wire yellow	
6"ea.		1/16" heat shrink tubing	
3"ea.		1/8" heat shrink tubing	
4		4-40 x 3/8" long B.H. mach screw	002264
4		#4 int. tooth lock washer	002225
4		4-40 hex. nut	002218
2		4mm hex. nut	006034
4		#2 x 3/16" self-tap screw	002215
1		5/16" rubber grommet	002213

Tools Needed:

- Small dikes
- Soldering iron with 1/16" tip or smaller
30 to 50 watts.
- Small file
- Needle nose pliers
- Small X-Acto knife with #11 blade.
- Wire stripper
- Solvent, such as 1,1,1-Trichlorethane
- Small brush

ProTach assembly instructions.

WARNING!!!! Do not use acid core solder for construction

Use of acid core solder will void all warranties. Royal Electronics Corporation will not service any ProTach on which acid core solder was used.

Construction Notes.

- () Check the parts supplied against the parts list.
- () Check the etching on the clad sides of the PC boards for any imperfections.
- () Clean the leads of all capacitors for reliable solder joints.
- () The bodies of resistors and capacitors that lay down should contact the PC board. Refer to Fig. 8

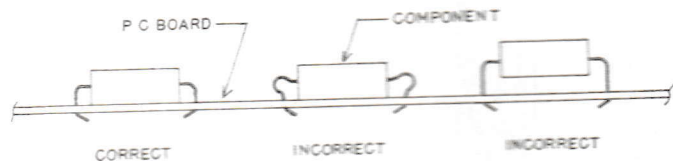


FIG. 8

Component leads:

Bend component leads per Fig. 6 and insert components in the PC board from the component side (not the clad side).

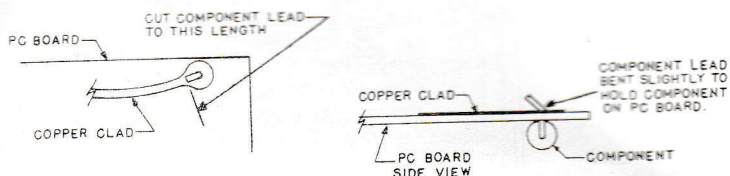


FIG. 6

The component leads should be clipped so that they do not extend over the outer edges of the clad. Refer to Fig. 6. Wherever possible, the lead should be bent to lay along the run of the clad rather than to the edge of the pad. Do not clip the component leads overly short as this will cause a bad solder joint.

- () Do not clip IC leads. Clip after soldering.
- () Use a small vise to hold the PC boards when soldering all connections.
- () Heat shrink tubing can be shrunk carefully with a match, but a heat gun does a better job.

Preliminary construction steps.

- () Enlarge the 36 holes in board #2 (smaller PC board) for the terminals of S1 (6 pushbutton switch) with a #51 drill.
- () Enlarge the 4 holes on board #1 (larger PC board) for the meter, with a #17 drill.
- () Cut off the terminals of S1 as shown in Fig. 7 with small dikes and file the rough edges smooth.

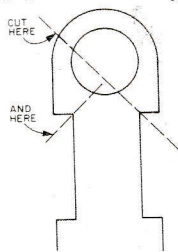


FIGURE 7

- () Enlarge the holes in board #1 for the .0068 cap. and R5, R21 with a #63 drill. Have all parts neatly arranged before beginning the step by step assembly for ease of construction.

Wire preparation.

Prepare the following wires by cutting to length. Strip 3/16" insulation from both ends of each wire and tin the ends.

Black	Red	Orange	Yellow
1- 3 3/4"	1- 3 1/2"	1- 3 1/2"	1 4 1/4"
1- 6 1/4"	1- 4"	1- 6 3/4"	1- 5"
	1- 5"		1- 7"

Refer to Fig. 9 and make a cable of the four wires that go from board 1 to board 2. The wires will be:

- 1- 5" Red
- 1- 6 1/4" Black
- 1- 6 3/4" Orange
- 1- 7" Yellow

Make the cable up directly over the full sized drawing.

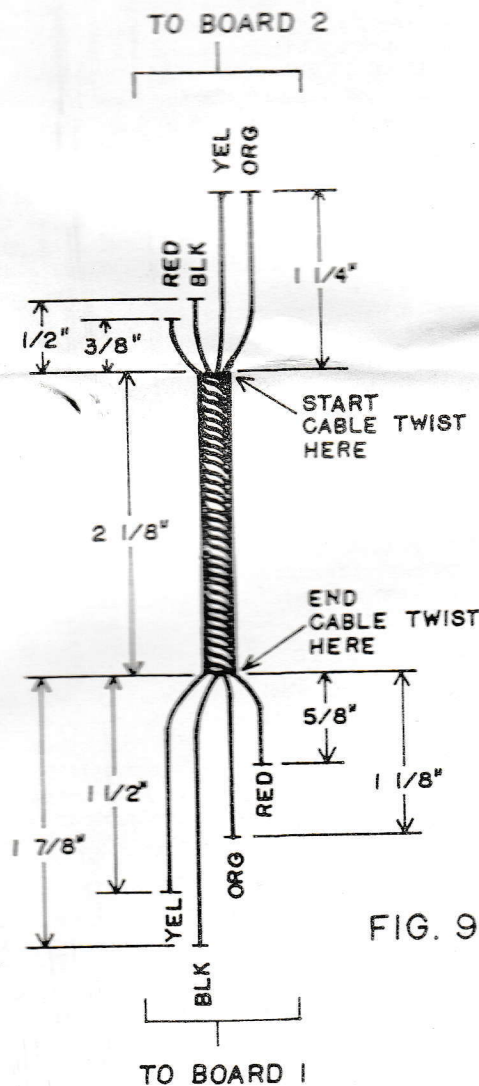
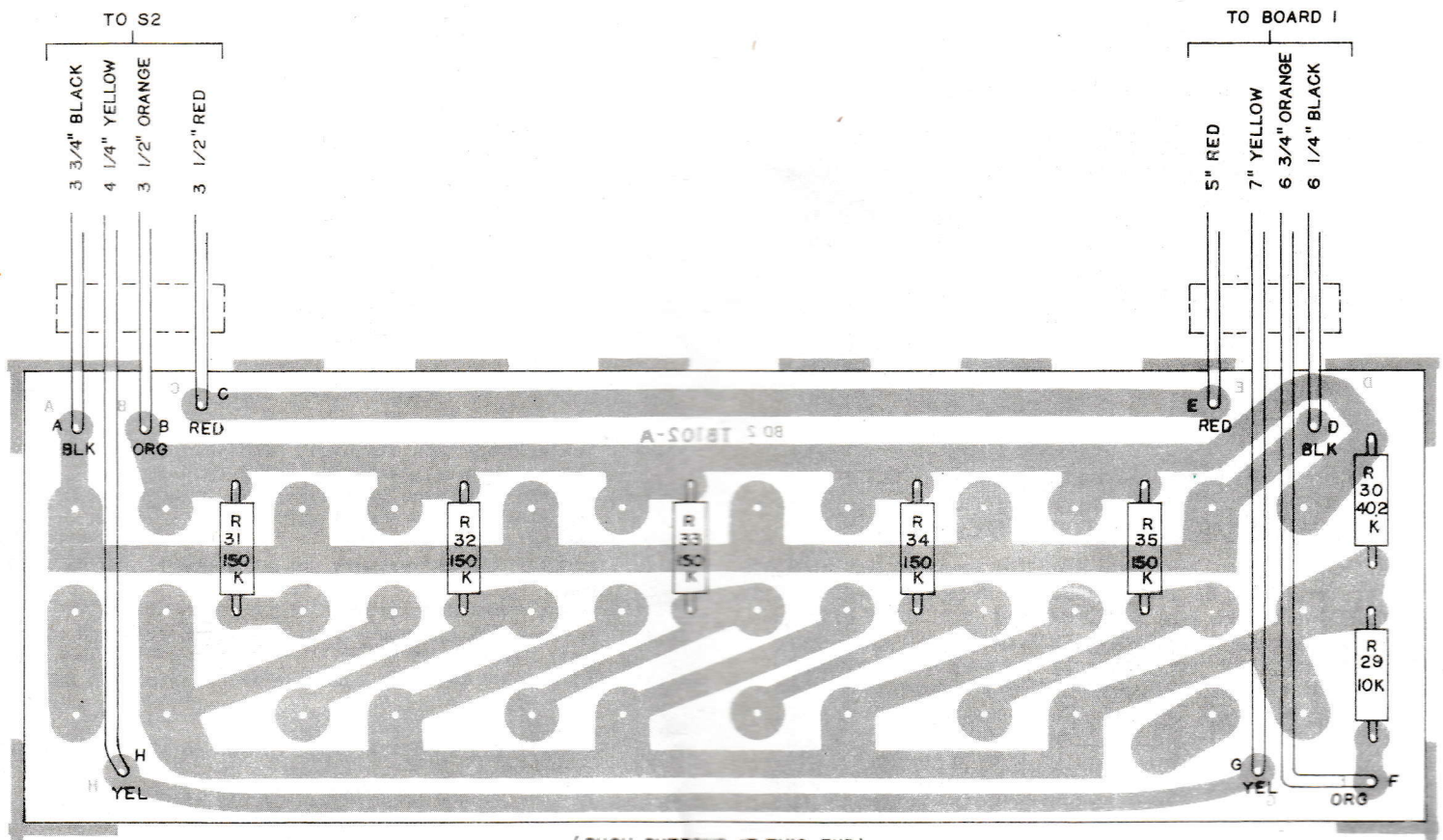


FIG. 9



ALL (7) RESISTORS
ON THIS BOARD
ARE 1% TOLERANCE

(PUSH BUTTONS AT THIS END)

ASSEMBLY OF BOARD 2

FIG. 1

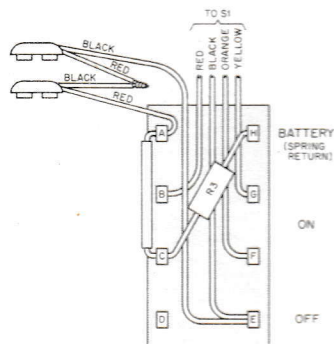
Board 2 Assembly

Board 2 is the smaller of the two boards. Refer to Fig. 1 for the following steps.

1. () Install R29 (10K 1%), R30 (40.2K 1%), and R31 (150K 1%).
2. () Install R32, R33, R34, and R35 (all 150K 1%).
3. () Install 3 3/4" black lead at A.
4. () Install 3 1/2" orange lead at B.
5. () Install 4 1/4" yellow lead at H.
6. () Install 3 1/2" red lead at C.
7. () Slide 1/2" long piece of large heat shrink tubing over these wires as far as it will go and shrink.

Assembly of S2.

Refer to Fig. 2 for the following steps.



ASSEMBLY OF S2
FIGURE 2

8. () Install the twisted four wire cable on board #2.
9. () Make sure the correct end of the cable is installed on this board.
10. () Install red lead at E, and black lead at D.
11. () Install yellow lead at G, and orange lead at F.
12. () Slide 1/2" long piece of large heat shrink tubing over these wires as far as it will go and shrink.
13. () Mount board on pushbutton switch S1 and solder all switch terminals. Make sure all wires are clear of switch terminals to avoid burning the wire insulation.
14. () Clip one lead of R5 (red,yel,yel) to 5/16", slide long end into C, and short end back into H. using pliers. Solder C and H.
15. () Slip 3/8" long piece of heat shrink tubing over leads from S1 (A,B,C,E).
16. () Clip one black lead of one battery connector to 4" and red lead to 2 3/4". Strip 1/4" off ends.
17. () Clip black lead of the other battery connector to 2 3/4" and the red lead to 3 1/4". Strip 1/4" off ends.
18. () Twist ends of short black and short red leads together and solder. Tin remaining two leads.
19. () Slip battery connector leads through heat shrink tubing on S1 leads from S1 end.
20. () Solder yellow wire to G, orange wire to F, and red wire from S1 to B. Insert black wire from S1 at E.
21. () Insert long black battery lead at E. Solder E.
22. () Insert red battery wire at A.
23. () Clip protruding R5 lead to 3/4", slip a 1/2" long piece of small heat shrink tubing over lead, and insert at A. Solder A.
24. () Slide large heat shrink tubing so that it covers exposed connected ends of battery connector wires, and shrink.

Preparation of Phototransistor Q1.

Refer to Fig. 3 for the following steps.

25. () Clip middle lead of Q1 (transistor with lens) as close to case as possible.
26. () Bend 1/8" hook in the ends of the two remaining leads of Q1.
27. () Bend hook in one end of 4" red lead, attach to Q1 lead closest to tab (emitter), bend hooks shut, and solder.
28. () Bend hook in one end of 5" yellow lead, attach to remaining Q1 lead (collector), bend hooks shut, and solder.

29. () Slip a 3/4" long piece of small heat shrink tubing over each Q1 lead and shrink, taking care not to heat Q1.
30. () Slip a 1/2" long piece of large heat shrink tubing over both leads as far as it will go, and shrink, taking care not to heat Q1.



FIGURE 3

Assembly of board 1.

Refer to Fig. 4 for the following steps.

31. () Install R1 (yel,purp,brn), D1 (1N4148), R2 (brn,blk,org), and C1 (1uf), checking orientation of D1 & C1.
32. () Install R4 (yel,purp,red) and C3 (.001uf disc).
33. () Install A1 (741 integrated circuit).
34. () Install R6 (red,red,yel) and C4 (.1 disc).
35. () Install C5 (.001 disc), C6 (.1 disc), and R9 (yel, purp, org).
36. () Install A2 (741 I.C.).
37. () Install A3 (741 I.C.).
38. () Install R7 (yel,purp,org), R8 (yel,purp,brn), and R11 (yel,purp,red).
39. () Install R10 (yel,purp,org), R12 (yel,purp,yel), and R13 (red,red,yel).
40. () Install A5 (741 I.C.).
41. () Install R25 (brn,blk,org), R26 (yel,purp,brn), R27 (blue,gray,org), and R14 (yel,purp,org).
42. () Install R28 (blue,gray,org), C10 (15uf) and D2, checking orientation of C10 and D2.
43. () Install VR1 (725 I.C.).
44. () Install R21 (adjustment potentiometer), and R5 (adj. pot).
45. () Install A4 (741 I.C.).
46. () Install R23 (yel,purp,red), R24 (10K 1%), and C2 (100pf disc).
47. () Install C9 (4.7uf), checking orientation and R22 (10K 1%).
48. () Install R20 (yel,purp,org).
49. () Install R19 (brn,blk,org), Q4 and Q5 (M400), and R17 (150K 1%).
50. () Install Q2 and Q3 (M400), and R18 (yel,purp,org).
51. () Install R15 (yel,purp,org), R16 (brn,blk,org), and C7 (100pf disc).
52. () Install C8 (.0068 tubular).

PROTACH
ASSEMBLY OF BOARD 1

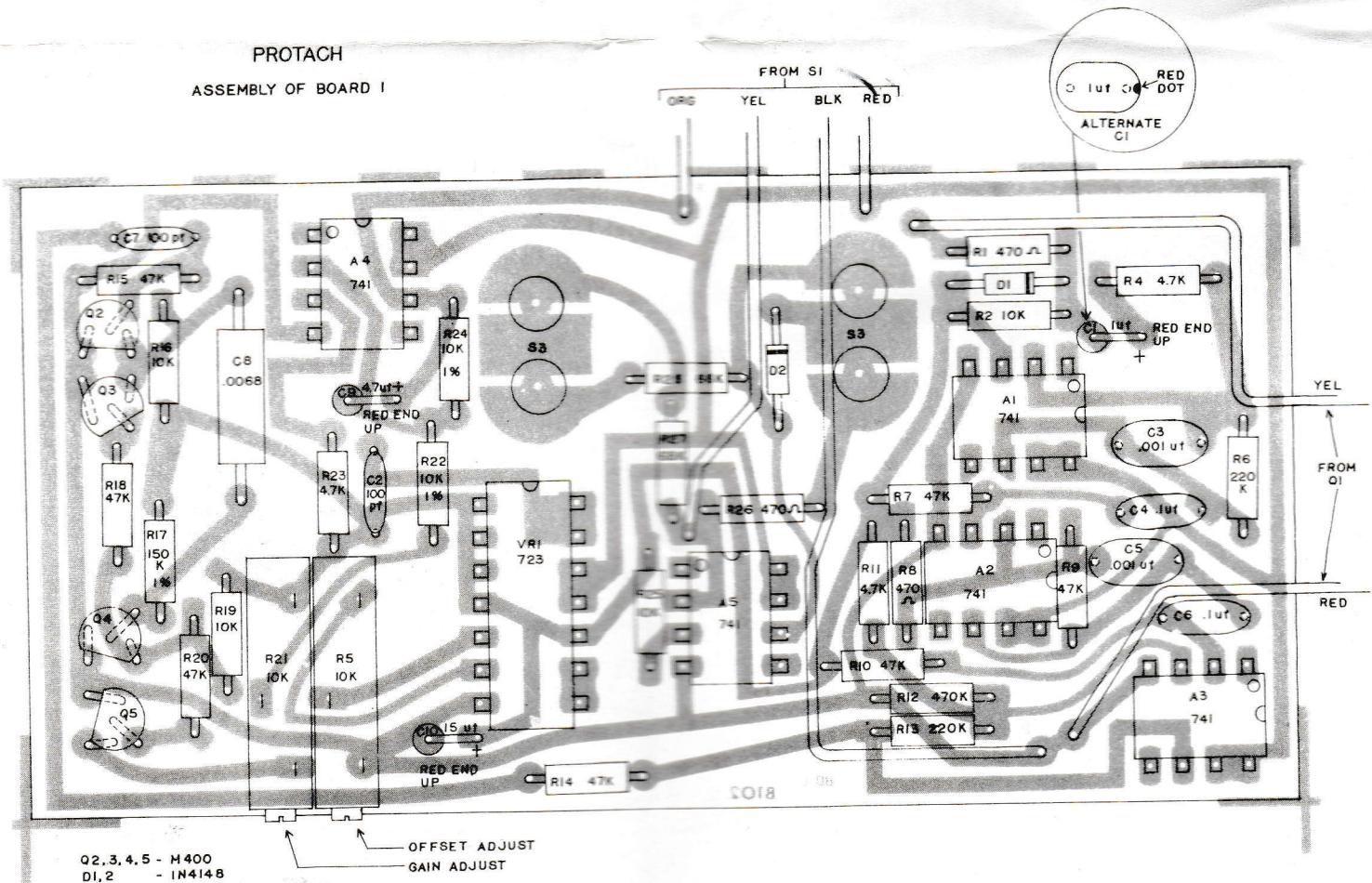


FIG. 4

Final wiring.

Refer to Fig. 4 and Photo A for the following steps.

53. () Slip a 1/2" long piece of small heat shrink tubing over the leads from Q1.
54. () Install red lead from Q1 to point C.
55. () Install yellow lead from Q1 to point A.
56. () Slide heat shrink tubing as close to the board as it will go and shrink.
57. () Slip a 1/2" long piece of large heat shrink tubing over S1 leads, (from board #2).
58. () Install red lead from S1 to point E.
59. () Install black lead to point D.
60. () Install orange lead to point F.
61. () Install yellow lead to point G.
62. () Slide the heat shrink tubing as close to board #1 as it will go and shrink.
63. () Clean all soldering resin from both PC boards with a small brush and solvent.

Tachometer assembly.

Refer to the photos for help in the following steps.

64. () Remove buss wire from the meter terminals.
65. () Remove the solder lugs from the meter terminals and discard.
66. () Mount meter (M1) with lockwashers and nuts provided.
67. () Mount S1 with two 4-40 x 3/8" long B.H. machine screws, two #4 internal tooth lock washers, and two 4-40 hex. nuts.
68. () Mount S2 in case top with two 4-40 x 3/8" long B.H. machine screws, two #4 internal tooth lock washers, and two 4-40 hex. nuts.
69. () Install grommet in Q1 mounting hole.
70. () Install Q1 into grommet until Q1 case ridge is evenly against grommet.
71. () Install two 4 mm hex. nuts on each terminal of M1.
72. () Mount board in normal position (closest to S1) with #4 lockwashers and 4 mm nuts, taking care not to get any wires caught.

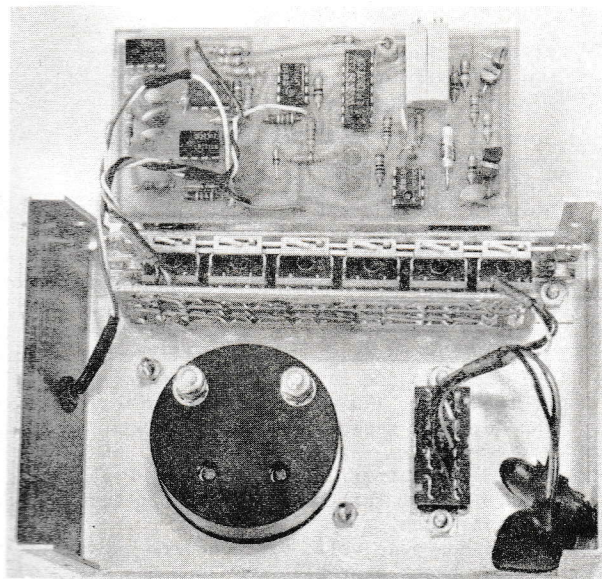


PHOTO B



PHOTO C

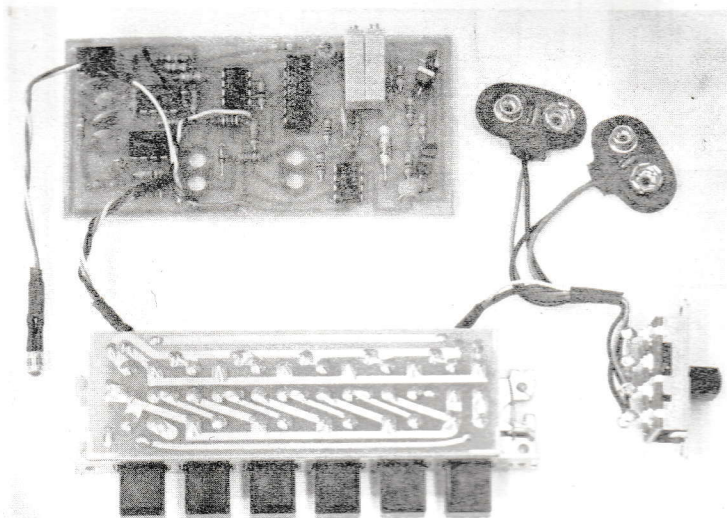


PHOTO A

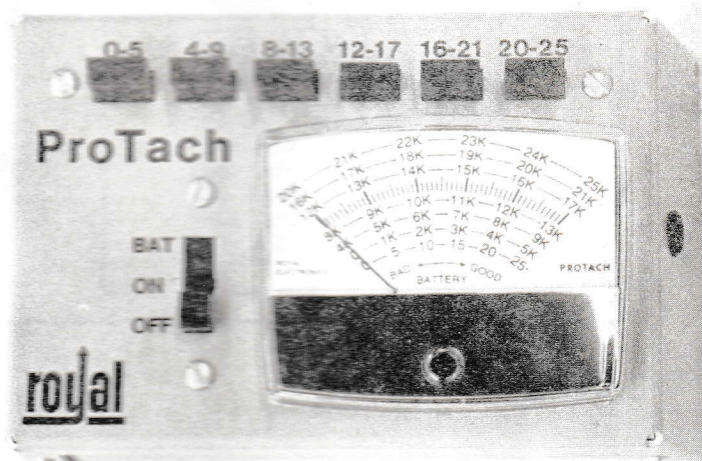


PHOTO D

Checkout.

- 73. () Turn R5 with a small screwdriver counterclockwise until hard to turn.
- 74. () Turn R21 clockwise until hard to turn.
- 75. () Turn S2 off, and set S1 to all buttons out (0-25K RPM).
- 76. () Install B1 and B2. Eveready #216 or equivalent.
- 77. () Turn tach on and point to an incandescent lamp. The meter should read somewhere around 5-10K RPM. Depress S1 buttons until a scale is found that gives an on-scale reading. Other higher scales should read off-scale to the left, and lower scales off-scale to the right. You might get an on-scale reading on two adjacent scales, but the readings should be different.
- 78. () Push S2 to battery check position. Meter should indicate around full scale if the batteries are fresh. Turn off tach.
- 79. () If all has gone well, proceed with the calibration. If not, check over all your work and all solder connections.

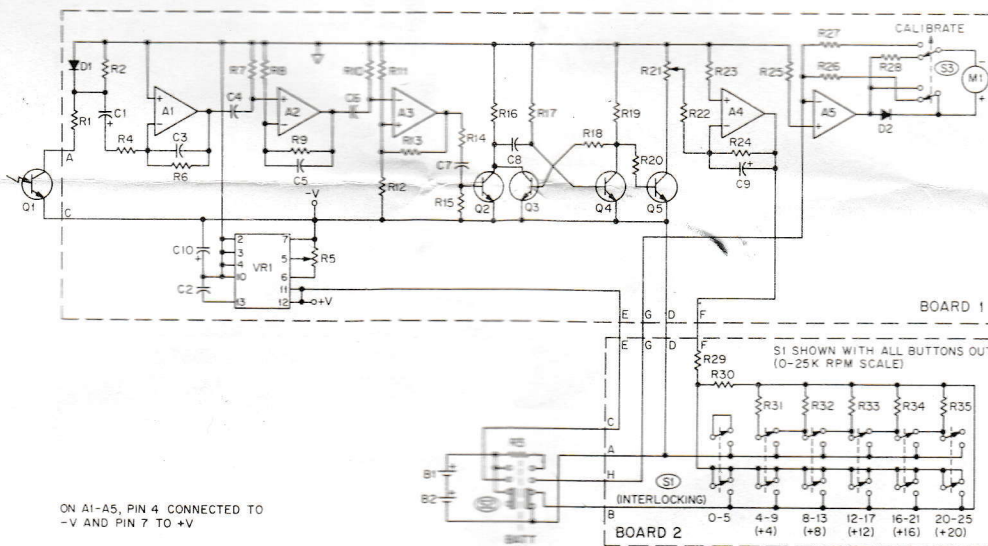
Calibration.

This tachometer was designed to be accurately calibrated without special equipment. However, note that tach accuracy will only be as good as your eyeball. Make all adjustments with the tachometer on a level surface, sighting vertically down on the meter needle

- 80. () Remount board 1 in calibrate position (meter holes closest to edge of board).
- 81. () Turn on tach with S1 set for 0-5K RPM. Cover Q1 and adjust meter screw for exactly zero RPM.
- 82. () Set S1 for +4 (4-9K) and adjust R5 for exactly a 4K meter reading with Q1 (phototransistor) covered. What is meant here is to adjust R5 so that the needle reads 8000. This is 40 microamps flowing through the meter.
- 83. () Repeat above two steps and get everything tuned up just right.
- 84. () Turn off the tach and remount board 1 in the normal position.
- 85. () Set S1 to 0-5K, turn tach on, and adjust meter screw for zero RPM with Q1 covered.
- 86. () Uncover Q1 and aim at an incandescent light source to obtain a reading. Adjust R21 for a reading of exactly 3600 RPM.
- 87. () Carefully redo the above two steps to make sure you have it just right.
- 88. () That's it. Don't forget to turn off the tach. Install the bottom cover with four #2 x 3/16" self-tap screws.

Using the tach.

Positioning the tach is not critical but the best signal can be found around the outside of the prop path. Don't point the tach at the spinner. Don't forget that three bladed prop readings need to be multiplied by two-thirds. Don't stick the tach in the prop or drop it on the runway. Careful handling will give you many years of use from your ProTach.



PROTACH
FIGURE 5

Pro Tach Alignment Procedure

The alignment of the Pro Tach will be accomplished by following the guide shown in Fig. 10. This guide is a flow chart. Start at the top of the chart and follow it through. The flow chart has been structured so that when trouble is experienced with the Pro Tach, the problem can be located and corrected. Fig. 11 shows how to trouble shoot the power supply. Fig. 12 describes a procedure for

locating problems in the circuitry associated with A5. A method for trouble shooting the amplifier and one shot circuitry is shown in Fig. 13. Finally, Fig. 14 describes other problems and their solutions.

A 0-20V voltmeter, a 9V battery and a 220k ohm resistor are needed to trouble shoot the Pro Tach. The 220k ohm resistor has been supplied in the kit.

Pro Tach Alignment Guide

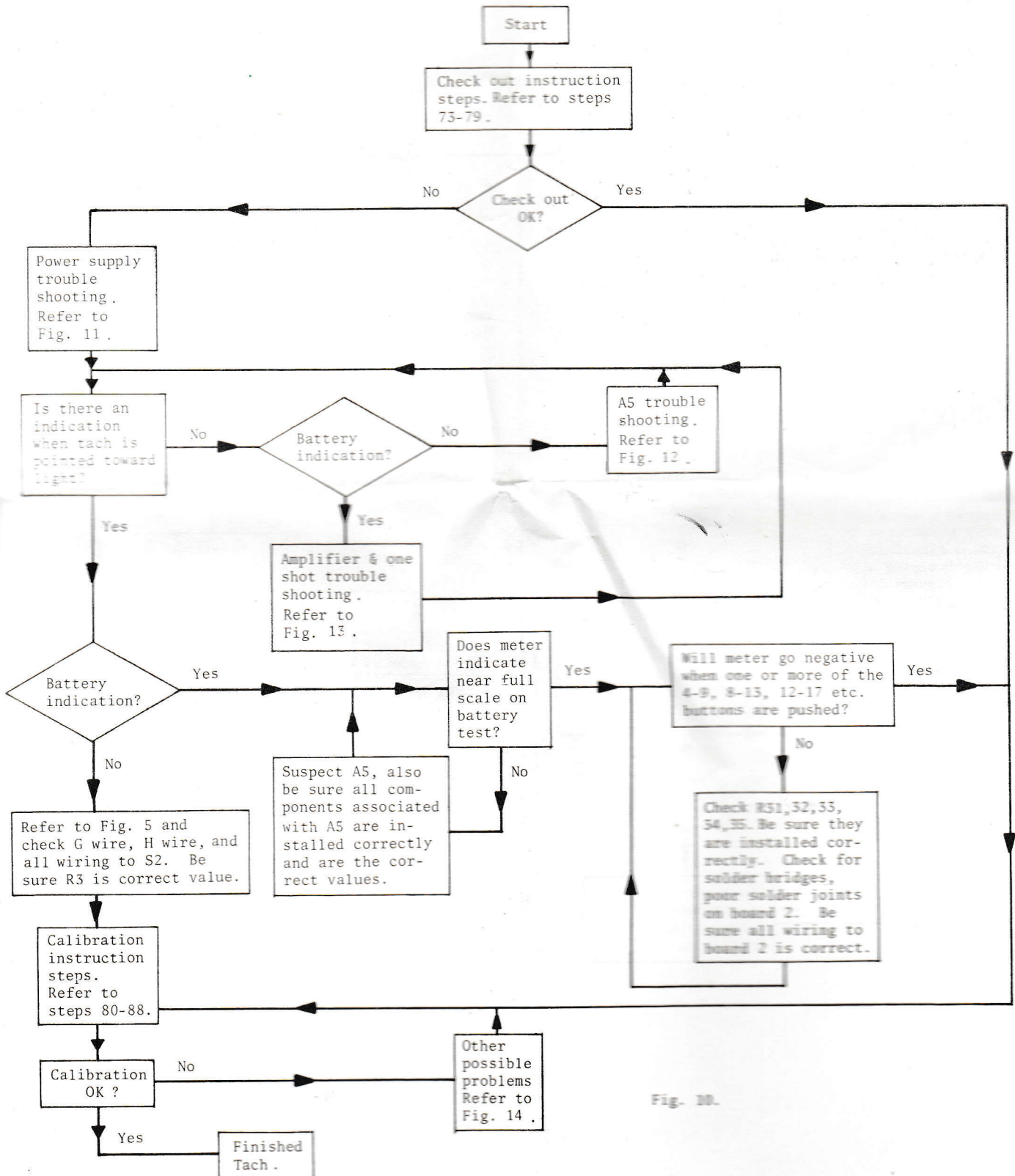
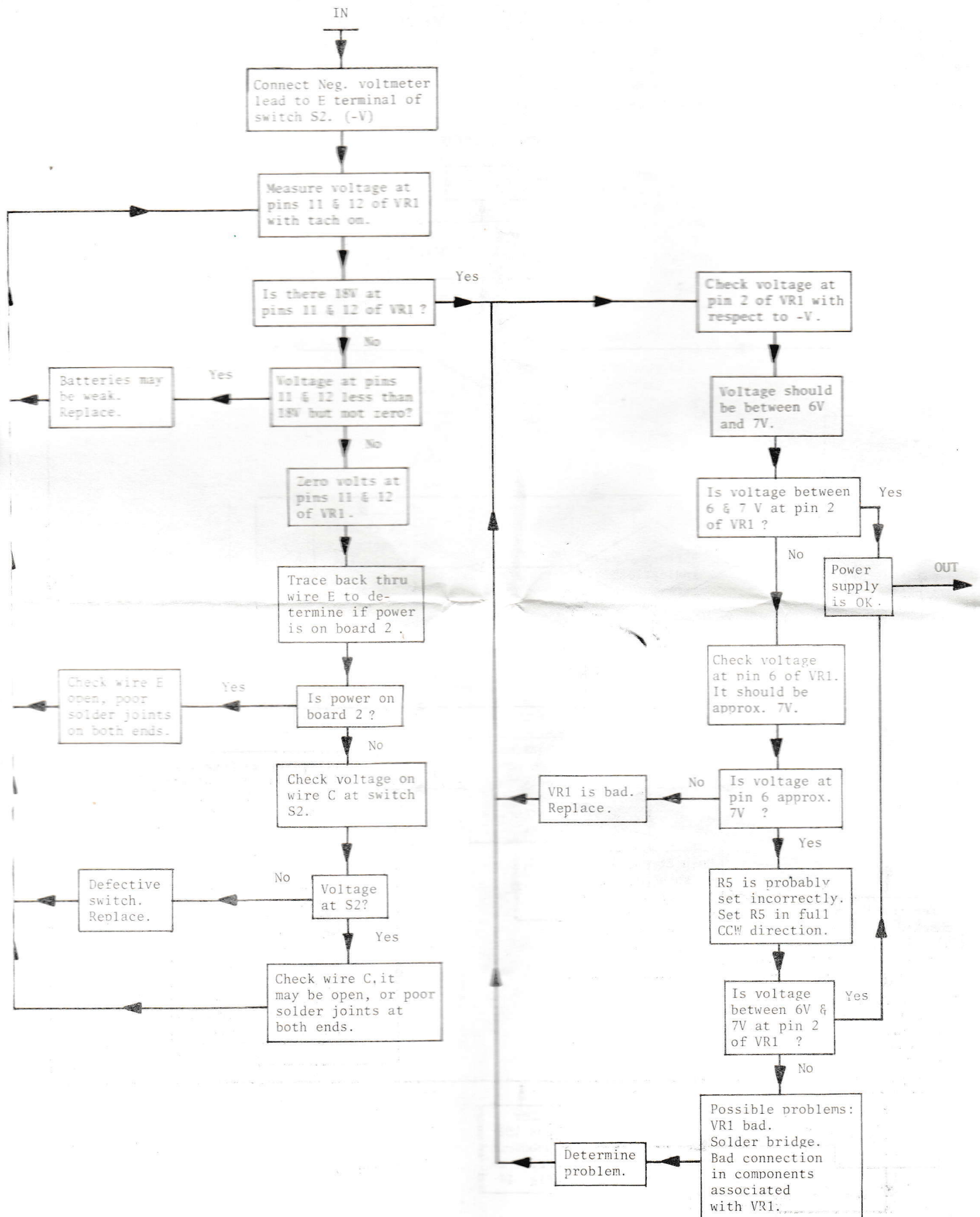
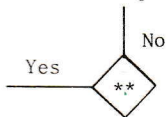


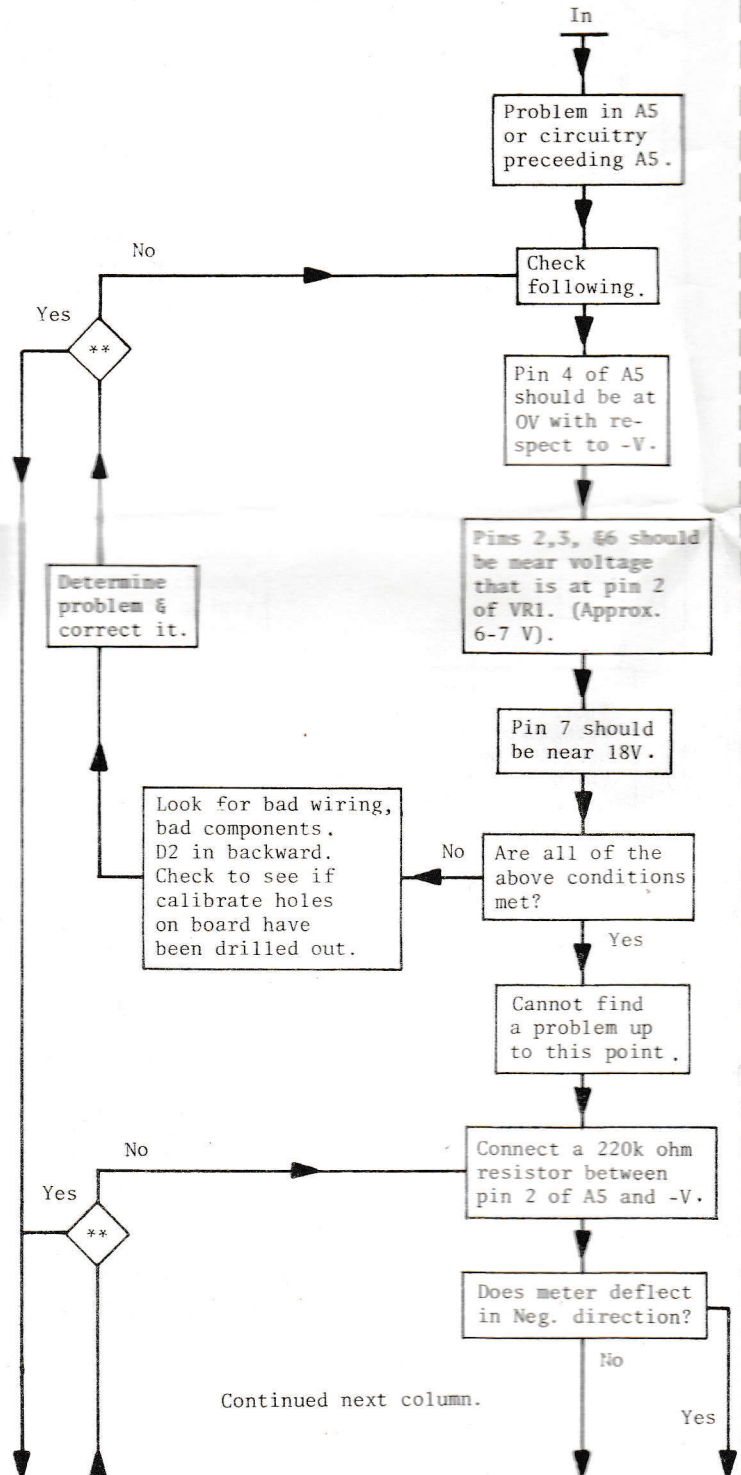
Fig. 10.



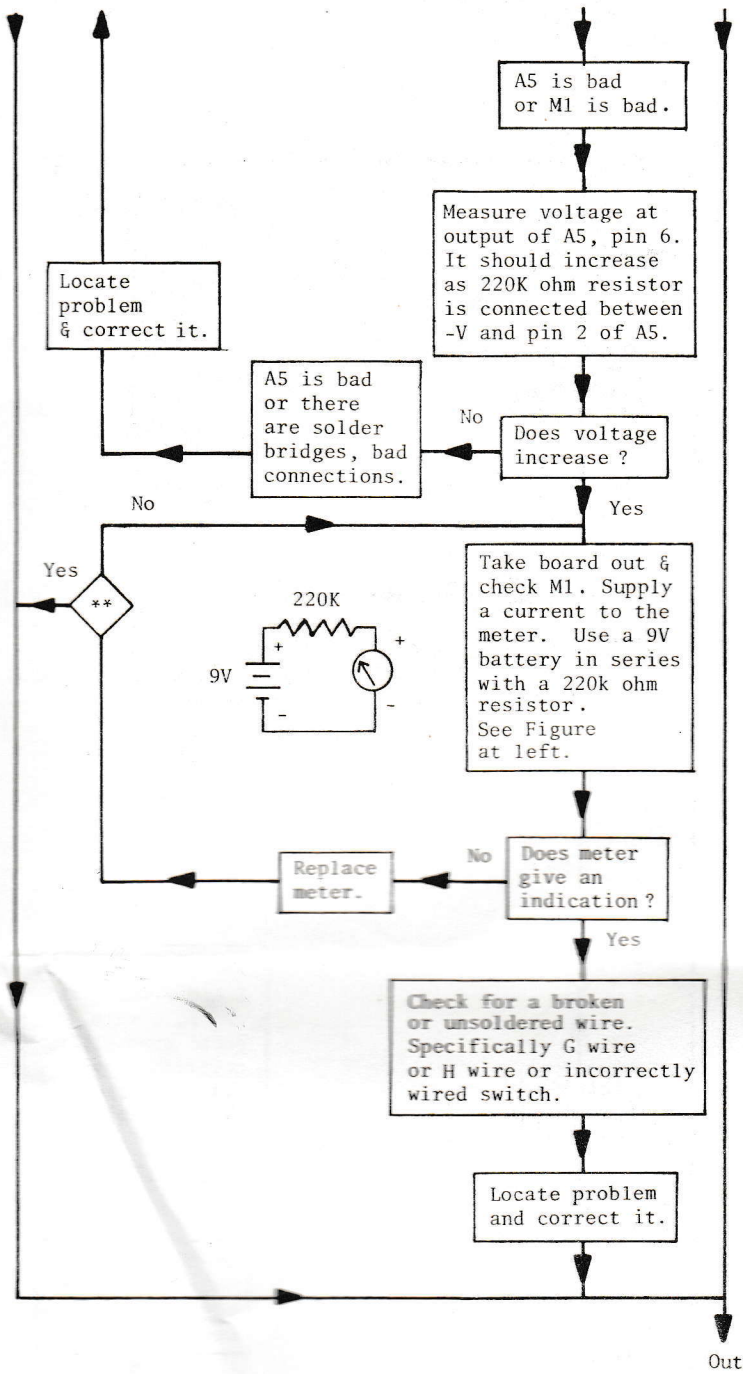
Note:
 When using this chart (Figs. 12 & 13) and you have checked out one set of steps and corrected the problem, you will arrive at a double asterisk diamond, which asks the question shown below.
 If no more problems are encountered you may proceed to "out". If other problems are encountered, proceed through the chart until the tach operates properly.



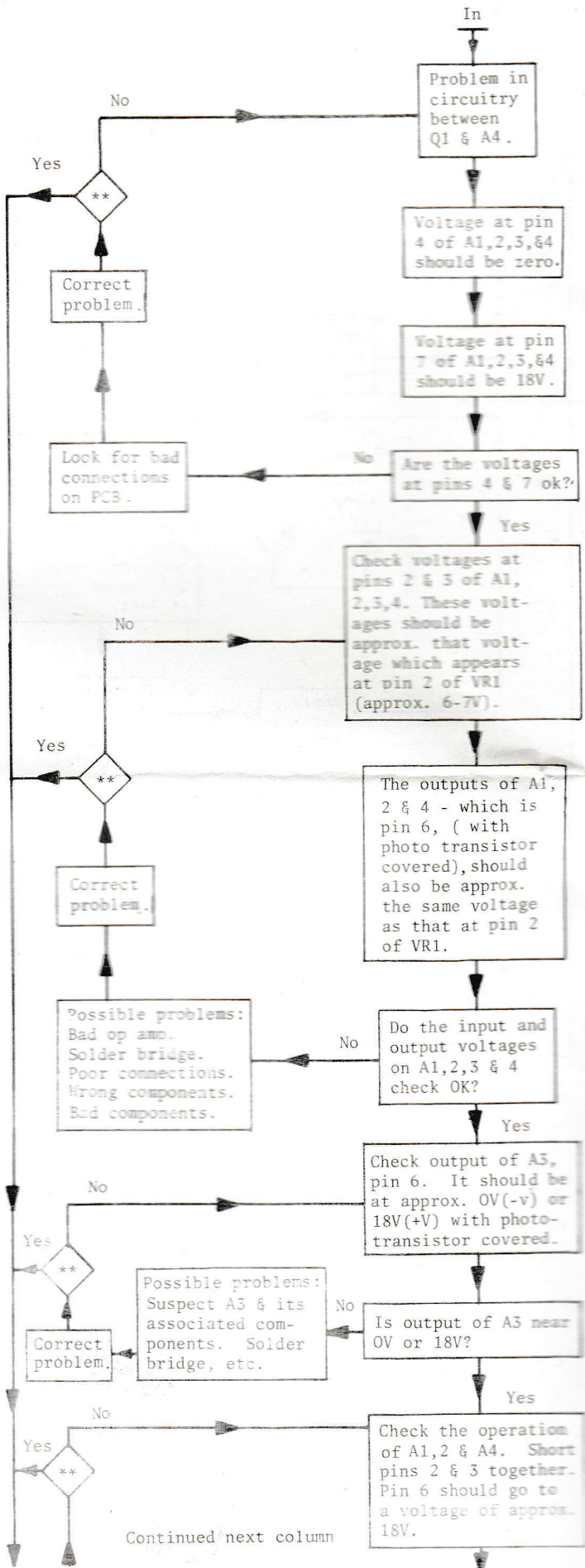
Does tach pass check out instruction steps?
 Refer to steps 73-79.



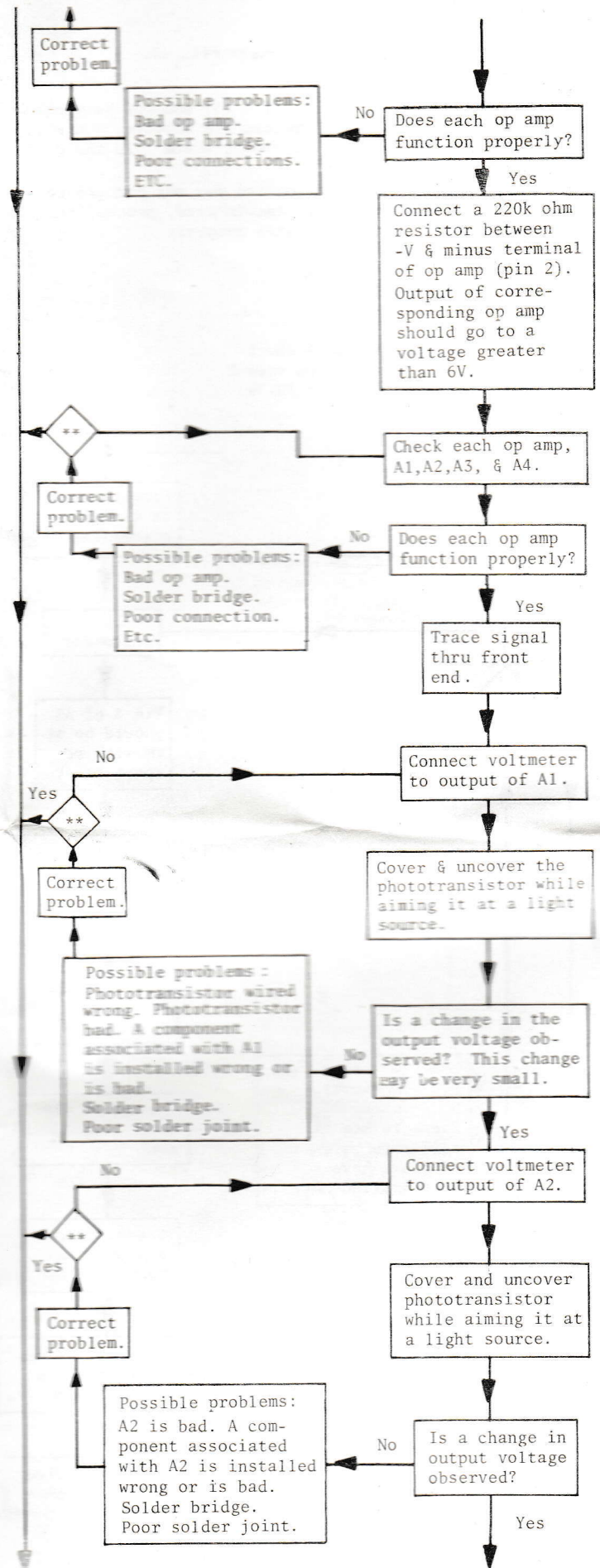
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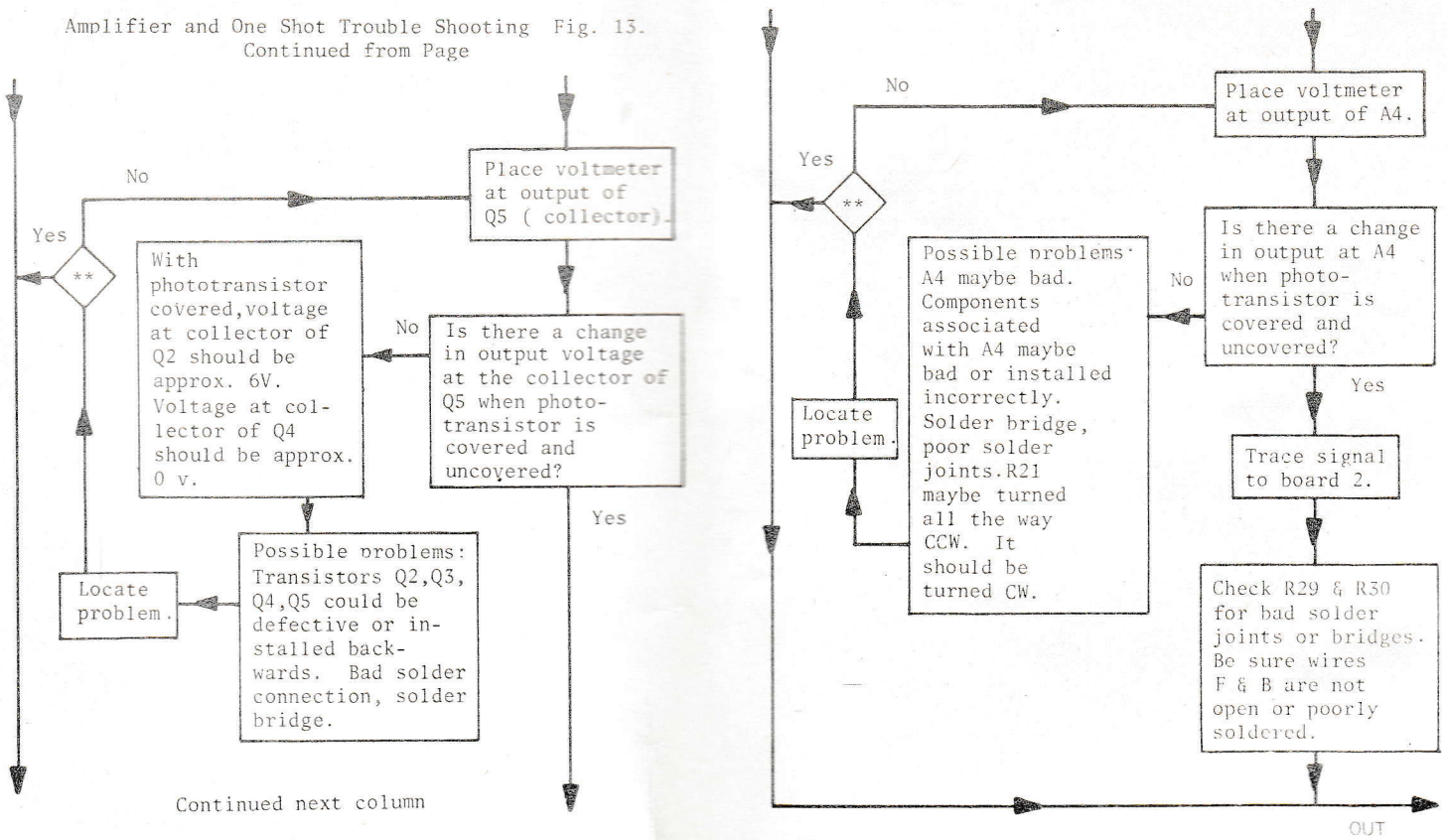
Out



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Block Diagram Of Pro Tach

FIG. 15

