A Serviceman's TUBE TESTER

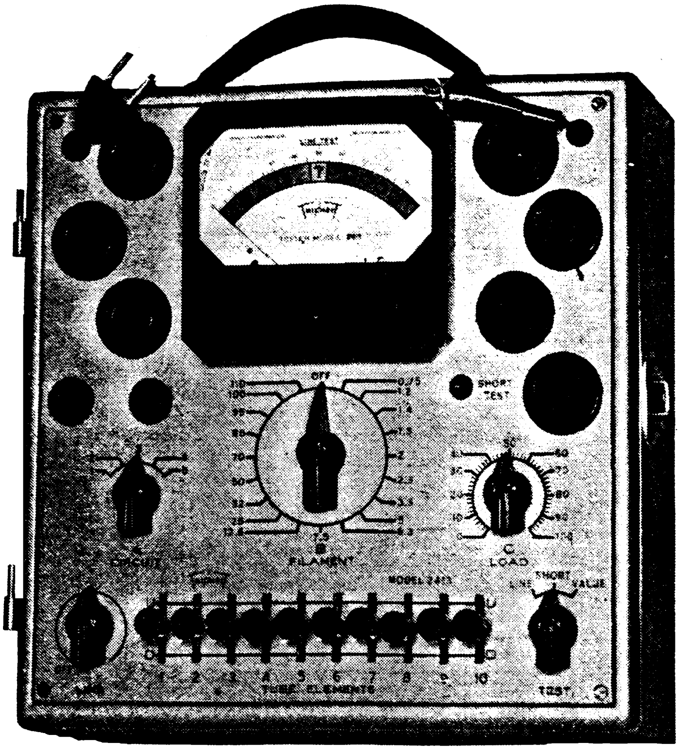

Fig. 1. Panel view of Triplett Model 2413 tube tester.

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Complete construction details for a commercially built service instrument.

IN DESIGNING a serviceman's tube tester, a number of factors must be taken into consideration and the proper proportion established between these factors just as in any other design problem. In addition to the usual requirements of accuracy, compactness, and minimum cost, the serviceman's tube tester must be simple to operate and yet have maximum circuit flexibility.

Simplicity of operation is not only indicated by a minimum of control settings but a great deal depends on the number and arrangement of the controls and the straightforwardness of the circuit. For example, a tube tester with only four control settings for a tube set-up may require considerable hunting through a multiplicity of controls which are *not* moved. This takes time, and more important, increases the possibility of error. In addition, the use of "trick" switching circuits, often used to keep control settings at a minimum, makes it more difficult for the serviceman to "picture" his tester circuit. Both of these features tend to slow up the rate of making the settings. On the other hand, a tester with a few more control *motions* may be faster in the long run. The fewer controls and the ability to "picture" the test circuit also help reduce the chances for tube damage due to an error in the test set-up.

Fig. 1 illustrates the panel arrangement of the *Triplett* Model 2413 tube tester.

In order to keep the circuit straightforward, and therefore, help the serviceman to "picture" what he is doing in making a tube check set-up, this tube tester uses a combination of lever and rotating switches with the lever switches numbered to correspond to the RMA tube pin numbers. These controls provide a maximum of flexibility and still retain clarity of circuit. This arrangement also gives maximum freedom from obsolescence due to changing tube types.

For maximum assurance against plugging tubes in the wrong socket, this tube tester provides one socket for each type of tube base. Tubes, therefore, cannot be plugged into the wrong socket simply because they will not fit! This not only is safer, but it also simplifies the set-up operation because it eliminates the reference to special sockets on the tube chart, the socket from the panel, and the operation of hunting for the special socket.

Fig. 2 shows the circuit of a *Triplett* Model 2413 tube tester. Most of the components may be obtained from regular radio parts suppliers. The transformer is special for this application and while generally not available on the open market, two or three separate transformers with secondary voltages as shown may be used instead. *(Editor's note: Tube tester transformers of various ratings are available from most parts dealers. Obtaining one with the exact ratings required is rather an impossibility, however as suggested by the author, two or possibly three separate transformers can be used. A transformer of this type can be home built. The article "Practical Transformer Design and Construction" published in the June, 1947 issue of* RADIO NEWS *will provide full details on how this can be done.)*

All Elements Check

The circuit permits a thorough test of tube elements, shields, and taps. The check for both short-circuited and open-circuited elements is generally more complete than that obtained with a dynamic mutual conductance test alone, as commonly made in portable type tube testers. The main reason for a dynamic mutual conductance test is to check for open or misplaced elements. It does not necessarily check for continuity to the shields, such as in metal tubes. A dynamic mutual conductance test alone does not provide a means of checking element taps of the type used in some of the newer high frequency type tubes and in some of the high voltage filament types. In order to make a complete tube test, it must be possible, as in this unit, to get at each tube pin and make an open and short check.

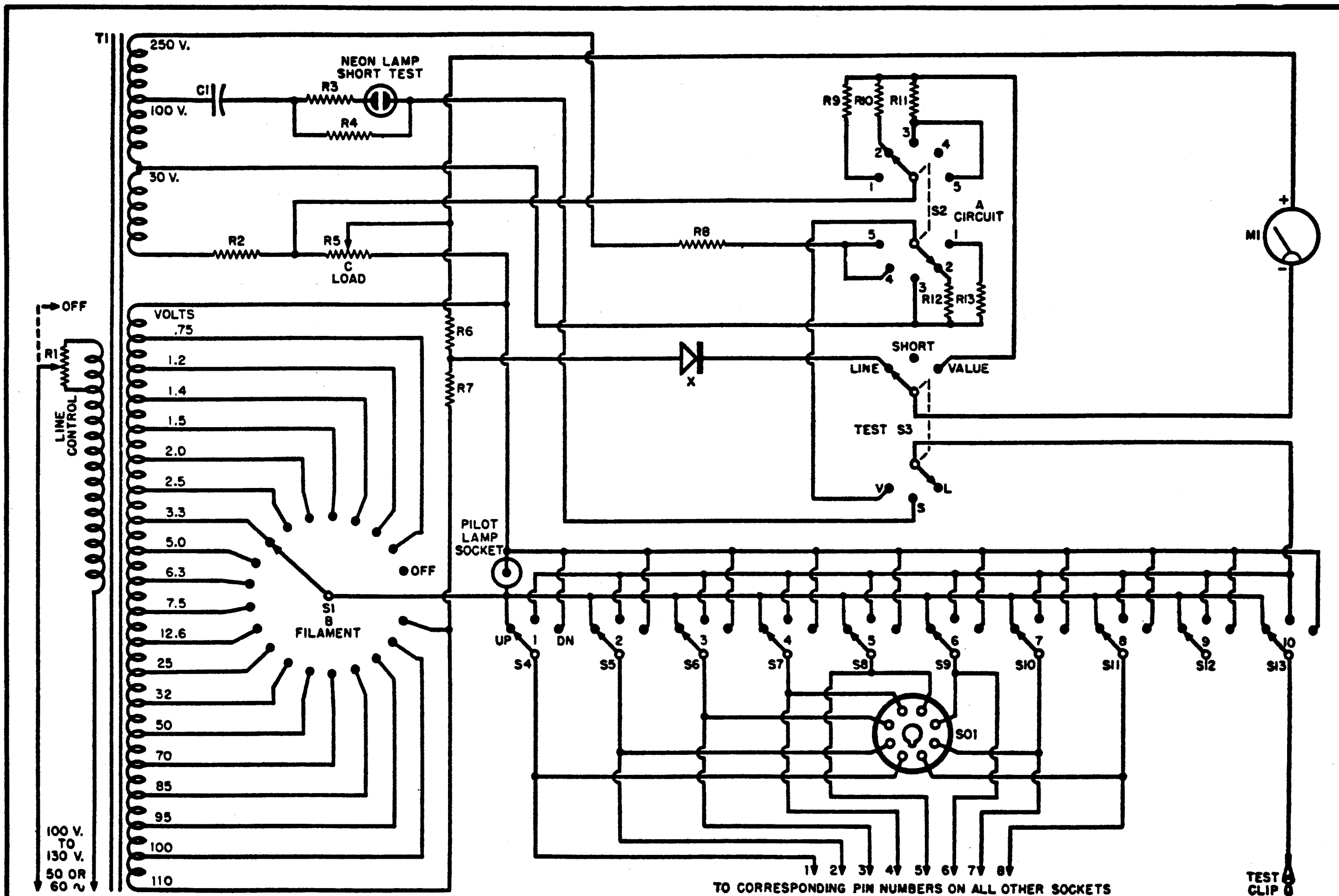
New Tube Types

The straightforward switching employed enables the serviceman to set up for new tubes without waiting for data from the tube tester manufacturer. This is a radically different approach to the tube testing problem not readily possible before, except in the laboratory type of tube tester. An example of such "set-up" instructions used for this tester is given below.

Use 3 or more new tubes and proceed as follows:

(*a*) Refer to manufacturer handbooks under the particular tube type for filament voltage and pin connections.

(*b*) Set *"A-CIRCUIT"* switch (S_2) as follows:



R_1—175 ohm pot with off-position (Ohmite Model H) (Line control)
R_2—50 ohm wirewound res. ± 1% (Cathode return coupling)
R_3—100,000 ohm, ½ w. res. (Current limiting neon)
R_4—250,000 ohm, ½ w. res. (Shunt, neon, calibration)
R_5—200 ohm pot. (Load control)
R_6—1200 ohm wirewound res. ± 1% (Line meter calibration)*
R_7—75,000 ohm, 1 w. res. (Line meter series)
R_8—5000 ohm, 10 w. res. (Current limiting)
R_9—.8 ohm, wirewound res. ± 1% (Tube test shunt)*
R_{10}—450 ohm, wirewound res. ± 1% (Tube test shunt)*
R_{11}—1800 ohm, wirewound res. ± 1% (Tube test shunt)*
R_{12}—1000 ohm, ½ w. res. (Current limiting)
R_{13}—5000 ohm, ½ w. res. (Current limiting)
C_1—.1 µfd., 400 v. cond. (Series condenser short test)
Pilot Light Socket—7-prong with lamp test socket (Amphenol Type S-7C)
M_1—1 ma., 100 mv., d.c. meter (Triplett #T-52-391)
X—Copper oxide, half-wave rectifier
S_1—20-pos., single-deck sw.
S_2—14-pos., double-deck sw. (5 active pos.)
S_3—3-pos., double-deck sw.
S_4 to S_{13}—3-pos., lever type sw.
T_1—117 v. pri., tapped sec. fil. & plate trans. (Triplett # T-23-10) (See text)
Pilot Lamp—Neon, 1/25 w. (General Electric)
Sockets with 4, 5, 6, 7, and 8 pins are wired in sequence. RMA pin numbering, 1 to 1, 2 to 2, 3 to 3, etc.
* Approximate value calibration res.

Fig. 2. Schematic diagram of tube tester. Circuit permits a thorough test of all tube elements, shields, and taps.

"1" for diode types.
"2" for filament types excluding diodes.
"3" for indirectly heated (cathode) types excluding diodes.
"4" for target or eye tubes.
"5" for gaseous rectifiers and gaseous control tubes.

(*c*) Set *"B-FILAMENT"* switch (S_1) to filament voltage.

(*d*) Refer to base drawing in "Manufacturer's Handbook" on tubes for the type being set up. Levers "1, 2, 3, 4, etc." (S_4 to S_{13}) compare to RMA pin numbers.

(*e*) Set all levers in normal or center position. This is plate position and all elements in this position are tied together.

(*f*) Find the first filament connection pin on tube base and move corresponding lever to *"UP"* position. This connects one side of filament to the filament transformer.

(*g*) Find the second filament connection pin on tube base and move corresponding lever to *"DN"* position. This connects the opposite side of the filament to the filament transformer. If filament is tapped, move corresponding filament pins to connect the two sections of filament in parallel.

(*h*) Find the cathode connection pin on tube base and move corresponding lever to *"DN"* position. This connects the cathode to one side of the filament transformer.

(*i*) If the tube is of the multi-section type, such as duodiodes, duotriodes, etc., find the elements not under test and move corresponding levers to *"DN"* position.

(*j*) Insert tube into proper socket.

(*k*) Hold *"TEST"* switch (S_3) in *"LINE"* position. Turn on *"LINE"* control and adjust so that meter reads at *"LINE TEST"* mark.

(*l*) Hold *"TEST"* switch in value position. Adjust *"C-LOAD"* (R_5) control for each tube so that the majority of the new tubes read 70 on the meter scale.

(*m*) List settings at end of tube chart for further reference.

Fig. 3 shows the simplified circuit of each of the several test circuits used in the tube tester. These simplified circuits are followed in most tube test set-ups, however, in some special cases such as in sub-miniature triodes, Fig. 3A will be used even though it is primarily designed for diode checks. In general, these circuits function as follows.

In the diode check, Fig. 3A, the plate voltage at the transformer is set to 30 volts. A 5000 ohm resistor is connected between the plate transformer tap and the diode plate to limit the plate current to a safe value. Due to the low permissible diode current, it is necessary in some diode checks to add a note "Good tube reads over 20," etc. This note indicates that the maximum diode current was less than that required to deflect the instrument into the "good" section and it was, therefore, necessary to establish a lower reference point on the scale. The .8 ohm resistor in series with the negative instrument terminal is used to adjust for small variations in the potentiometer, transformer, and instrument.

The 200 ohm potentiometer provides a vernier adjustment of the instrument full-scale current. The setting of this control is determined from the average of "good" tubes as noted in operation (*l*) under the section headed "New Tube Types." The 50 ohm resistor in series with the low side of the high voltage winding is used as a combination limiting resistor and fuse. It serves to reduce possible damage to the transformer and instrument in the event of an improper set-up, etc.

In the filament type triode and pentode check, Fig. 3B, the plate voltage at the transformer is again set to 30 volts. The 1000 ohm series resistor between the transformer and the tube under test permits greater current to flow from the filament and helps insure sufficient loading to approximate most operating conditions. The 450 ohm resistor in series with the negative instrument terminal increases the

(*Continued on page* 132)

Table 1. Operating instructions and tube chart. Switch and control settings for the most commonly used tubes are given.

LINE TEST

1. Insert power cord into a 110 volt, 60-cycle supply.
2. Set "A-CIRCUIT" knob (switch S_2) as shown in column "A-CIR."
3. Set "B-FILAMENT" knob (switch S_1) as shown in column "B-FIL."
4. Set "C-LOAD" knob (R_3) as shown in column "C-LOAD."
5. Set levers (switches S_4 to S_{13}) as shown in columns "UP" and "DN."
6. Insert tube in socket.
7. Turn "LINE" knob (R_1) until meter pointer reads at "LINE TEST" mark, with "TEST" knob (S_3) held in "LINE" position.

SHORT TEST ("TEST" knob in "SHORT" position)

8. Move each lever (switches S_4 to S_{13}) in center position one at a time down to position "DN" and back to center.

Move each lever in light face type (table below) one at a time up to center position and back.

A shorted tube is indicated by a bright red glow of the "SHORT TEST" neon lamp.

VALUE TEST

9. Hold "TEST" knob (S_3) in "VALUE" position and read tube condition on meter.
10. Release "TEST" knob. Return all levers to center position and turn "LINE" knob to "OFF."

CONTINUITY TEST (all tubes except ballast tubes.)

1a. Follow operations 1, through 9.

2a. With "TEST" knob in "VALUE" position, move each lever shown in light face type and active levers in center up one position and back. Refer to tube manufacturers' data for active pin numbers, these correspond to the lever numbers on the tester. Continuity between tube pin and the element being tested is indicated by a change in pointer deflection. A small change denotes a satisfactory plate or screen connection. A large change denotes a satisfactory grid or cathode connection.

3a. Release "TEST" knob.

4a. Move each lever in dark face type one at a time up one position and back. Continuity of the filament or other internal pin connections is indicated by a bright red glow of the "SHORT TEST" neon lamp.

CONTINUITY TEST (pilot lamps and other miniature base bulbs)

1b. Follow operations 1 and 7 under "LINE TEST."

2b. Set "B-FILAMENT" knob to voltage of lamp under test.

3b. Place lamp in center of 7-prong socket.

4b. A "good" lamp is indicated by normal lighting of its filament.

CONTINUITY TEST (ballast tubes and electrical appliances)

1c. Follow operations 1 and 7 under "LINE TEST."

2c. Place jumper lead in No. 1 position (marked) of octal base.

3c. Set "B-FILAMENT" knob to "OFF" position.

4c. Set lever 1 in "DN" position.

5c. Short grid cap lead and test probe clip together and note that the neon lamp glows. Connect grid cap clip and test probe clip to pins of ballast tube or to terminals of appliance being tested. A bright glow of the neon lamp indicates continuity.

CAUTION: Do not handle the metal parts of the test leads during the test.

6c. Refer to the ballast tube or appliance manufacturer's data for internal connections.

TUBE TYPE		KNOBS A Cir. (S_2)	B Fil. (S_1)	C Load (R_3)	LEVER POSITION UP	DN
5U4		3	5	35	2	48
5U4	(Test 2)	3	5	35	2	68
5W4		3	5	48	2	48
5W4	(Test 2)	3	5	48	2	68
5Y3		3	5	57	2	48
5Y3	(Test 2)	3	5	57	2	68
6A7		3	6.3	31	1	67
6A8		3	6.3	25	2	78
6AB7		3	6.3	23	2	57
6AC5		3	6.3	34	2	78
6AG5		3	6.3	20	4	237
		(Shows short on 2 and 7)				
6AG7		3	6.3	24	2	57
6AK5		3	6.3	20	3	247
		(Shows short on 2 and 7)				
6AL5		1	6.3	23	3	12456
6AL5	(Test 2)	1	6.3	23	3	14567
6B4		3	6.3	28	2	7
6B6		3	6.3	32	2	4578
6B6	(Test 2)	1	6.3	40	2	3478-10
6B6	(Test 3)	1	6.3	40	2	3578-10
6B8		3	6.3	45	2	4578
6B8	(Test 2)	1	6.3	40	2	34678-10
6B8	(Test 3)	1	6.3	40	2	35678-10
6C4		3	6.3	26	4	37
		(Shows short on 1 and 5)				
6C5		3	6.3	35	2	78
6C6		3	6.3	31	1	56
6D6		3	6.3	40	1	56
6E6		3	6.3	31	1	2347
6E6	(Test 2)	3	6.3	31	1	4567
6F5		3	6.3	30	2	78
6F6		3	6.3	32	2	78
6F7		3	6.3	43	1	4567
6F7	(Test 2)	3	6.3	82	1	2367-10
6G6		3	6.3	36	2	78
6H6		1	6.3	25	2	3478
6H6	(Test 2)	1	6.3	25	2	4578
6J5		3	6.3	27	2	78
6J7		3	6.3	31	2	78
6K5		3	6.3	26	2	78
6K6		3	6.3	34	2	78
6K7		3	6.3	30	2	78
6K8		3	6.3	22	2	34678-10
6K8	(Test 2)	1	6.3	22	2	678
6L5		3	6.3	32	2	78
6L6		3	6.3	27	2	78
6L7		3	6.3	25	2	78
6Q7		3	6.3	33	2	4578
6Q7	(Test 2)	1	6.3	47	2	3478-10
6Q7	(Test 3)	1	6.3	47	2	3578-10
6R7		3	6.3	37	2	4578
6R7	(Test 2)	1	6.3	33	2	3478-10
6R7	(Test 3)	1	6.3	33	2	3578-10
6SA7		3	6.3	26	2	67
6SC7		3	6.3	38	8	2367
6SC7	(Test 2)	3	6.3	33	8	4567
6SD7		3	6.3	23	2	57
6SF5		3	6.3	28	8	27
6SF7		3	6.3	30	8	357
6SF7	(Test 2)	1	6.3	40	8	23467
6SG7		3	6.3	19	2	357
		(Shows short on 3 and 5)				
6SH7		3	6.3	19	2	357
		(Shows short on 3 and 5)				
6SJ7		3	6.3	27	2	57
6SK7		3	6.3	34	2	57
6SL7		3	6.3	28	7	12368
6SL7	(Test 2)	3	6.3	28	7	34568
6SN7		3	6.3	29	7	34568
6SN7	(Test 2)	3	6.3	29	7	12368
6SQ7		3	6.3	30	8	3457
6SQ7	(Test 2)	1	6.3	40	8	23467
6SQ7	(Test 3)	1	6.3	40	8	23567
6SR7		3	6.3	37	8	3457
6SR7	(Test 2)	1	6.3	33	8	23467
6SR7	(Test 3)	1	6.3	33	8	23567
6SS7		3	6.3	30	2	57
6ST7		3	6.3	30	7	3458
6ST7	(Test 2)	1	6.3	95	7	23468
6ST7	(Test 3)	1	6.3	95	7	23568
6T7		3	6.3	35	2	4578
6T7	(Test 2)	1	6.3	40	2	3478
6T7	(Test 3)	1	6.3	40	2	3578
6U6		3	6.3	24	2	78
6U7		3	6.3	32	2	78
6V6		3	6.3	26	2	78
6V7		3	6.3	36	2	4578
6V7	(Test 2)	1	6.3	50	2	3478-10
6V7	(Test 3)	1	6.3	50	2	3578-10
6W7		3	6.3	33	2	78
6X5		3	6.3	28	2	378
6X5	(Test 2)	3	6.3	28	2	578
6Y6		3	6.3	19	2	78
7A4		3	6.3	27	1	78
7A5		3	6.3	23	1	78
7A6		1	6.3	28	1	24678
7A6	(Test 2)	1	6.3	28	1	23478
7A7		3	6.3	28	1	78
7A8		3	6.3	32	1	78
7B4		3	6.3	27	1	78
7B5		3	6.3	29	1	78
7B6		3	6.3	31	1	45678
7B6	(Test 2)	1	6.3	58	1	234578
7B6	(Test 3)	1	6.3	58	1	234678
		(Shows short on 4 and 7)				
7B7		3	6.3	33	1	78
7B8		3	6.3	27	1	78
7C5		3	6.3	29	1	78
7C6		3	6.3	33	1	45678
7C6	(Test 2)	1	6.3	40	1	234578
7C6	(Test 3)	1	6.3	40	1	234678
		(Shows short on 4 and 7)				
7C7		3	6.3	33	1	78
7E6		3	6.3	28	1	45678
7E6	(Test 2)	1	6.3	45	1	234578
7E6	(Test 3)	1	6.3	45	1	234678
		(Shows short on 4 and 7)				
7E7		3	6.3	36	1	3478
7E7	(Test 2)	1	6.3	40	1	235678
7E7	(Test 3)	1	6.3	46	1	245678
7F7		3	6.3	30	1	23478
7F7	(Test 2)	3	6.3	30	1	25678
7G7		3	6.3	19	1	78
7H7		3	6.3	22	1	78
7J7		3	6.3	33	1	3478
7J7	(Test 2)	3	6.3	33	1	25678
7L7		3	6.3	23	1	78
7N7		3	6.3	28	1	23478
7N7	(Test 2)	3	6.3	28	1	25678
7Q7		3	6.3	24	1	78
7Y4		3	6.3	33	1	378
7Y4	(Test 2)	3	6.3	33	1	678
7Z4		3	6.3	49	1	378
7Z4	(Test 2)	3	6.3	41	1	678
12SA7		3	12.6	24	2	67
12SC7		3	12.6	30	8	2367
12SC7	(Test 2)	3	12.6	30	8	4567
12SJ7		3	12.6	28	2	57
12SK7		3	12.6	28	2	57
12SQ7		3	12.6	28	8	3457
12SQ7	(Test 2)	1	12.6	40	8	23467
12SQ7	(Test 3)	1	12.6	40	8	23567
25Z5		3	25	25	1	2346
25Z5	(Test 2)	3	25	25	1	3456
35L6		3	32	20	2	78
35Z5		3	32	21	7	238
35Z6		3	32	20	2	3478
35Z6	(Test 2)	3	32	20	2	4578
50L6		3	50	21	2	78
80		3	5	55	1	24
80	(Test 2)	3	5	55	1	34
83		3	5	26	1	24
83	(Test 2)	3	5	26	1	34
83V		3	5	24	1	24
83V	(Test 2)	3	5	24	1	34
117L7		3	110	25	2	1678
117L7	(Test 2)	3	110	20	2	134578

Serviceman's Tube Tester

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instrument full scale current to permit an accurate setting of the 200 ohm potentiometer *"C"* load control.

In the heater cathode type triode and pentode check, Fig. 3C, the plate voltage at the transformer remains at 30 volts and is connected directly to the tube under test. The 1800 ohm resistor in series with the negative instrument terminal still further increases the instrument full scale current to permit proper instrument indication.

In the eye tube and gaseous rectifier check, Fig. 3D, sufficient voltage is applied to the plate to insure proper ionization of the gas. The 5000 ohm resistor in series with the 250 volt plate tap protects the tube against excessive current flow · yet it is low enough to insure full plate loading on gaseous rectifiers. The 1800 ohm resistor in series with one of the instrument terminals increases the current required for full scale deflection of the test instrument.

An eye tube is checked by visual inspection of the tube itself. 250 volts are applied to the eye control electrode plate for the eye-closed check and 0 volts for the eye-open check (250 volts are applied to the target in both tests).

The short-test circuit, Fig. 3E, consists of 100 volts a.c. applied to all elements through suitable limiting resistors, 100,000 and 250,000 ohms. The .1 μfd. blocking condenser in series with the 100 volt transformer tap prevents the neon lamp from glowing due to electron flow in the tube under test. By following the short-test procedure given in the instructions, a short check is made between each element of the tube including the shield. This test will generally indicate "shorts" of 500,000 ohms and less.

A continuity test of each element to its base pin and of all internal taps may be made as shown in the operating instructions. Moving an element connection will result in a change in instrument indication as the element connection is broken by the lever switch. Satisfactory internal pin connections, such as taps and jumpers, are indicated by a glow of the "short-test" lamp with the test knob in *"SHORT"* position.

Changes in line voltage and variations due to different filament currents are compensated for by adjustment of the line control knob (R_1). This changes the transformer primary voltage and the correct voltage is indicated by a rectifier type voltmeter connected across the transformer 100 volt secondary winding. The *"GOOD-BAD"* indicating instrument is converted to a simple rectifier type voltmeter by turning the "test" switch to *"LINE"* position. -30-

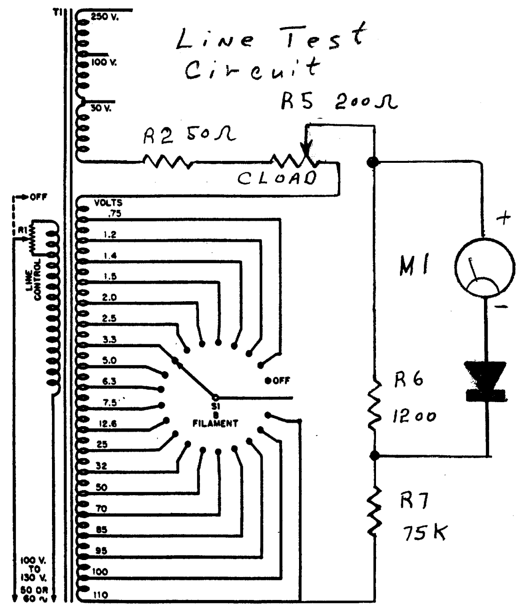

Fig. 3. Simplified circuit diagram of each of the several test circuits incorporated in tube tester: (A) for diode type tubes, switch S_2 in position 1; (B) for filament type triode and pentode tubes, switch S_2 in position 2; (C) for indirectly heated cathode type triode and pentode tubes, switch S_2 in position 3; (D) for target and eye tubes, switch S_2 in position 4 and for gaseous rectifiers and gaseous control tubes, switch S_2 in position 5; (E) short check, switch S_3 in "Short Check" position. Switch positions refer to the schematic diagram, Fig. 2.