Sept. 15, 1936. J. S. STARRETT 2,054,664

MULTIPLE DUTY TUBE CIRCUIT

Filed Nov. 10, 1933

Fig. 1

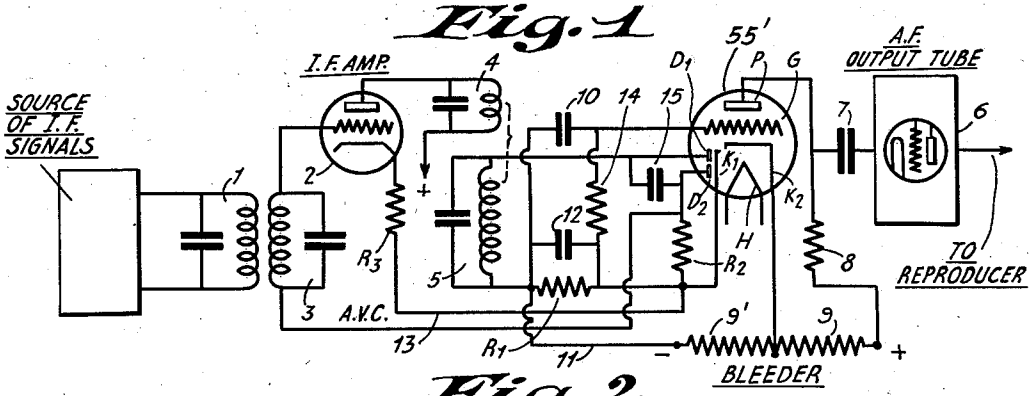


Fig. 2

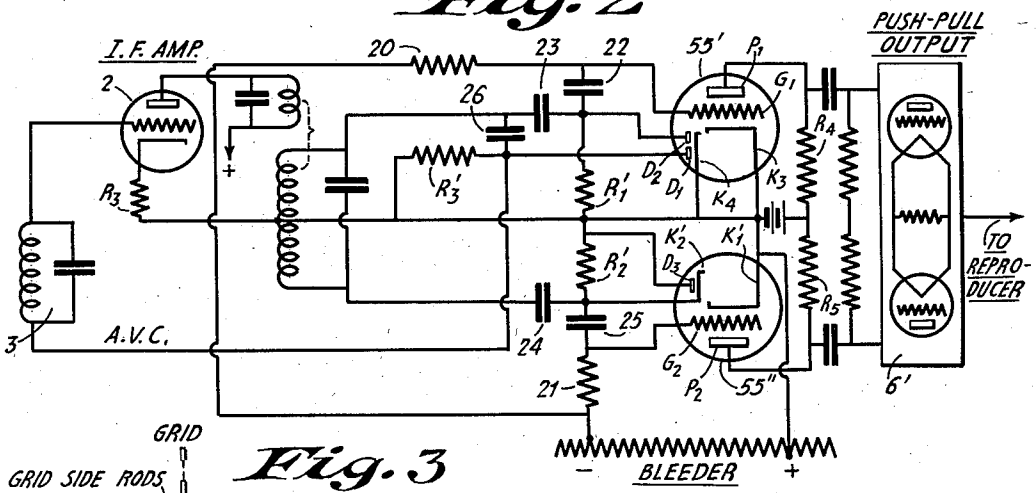
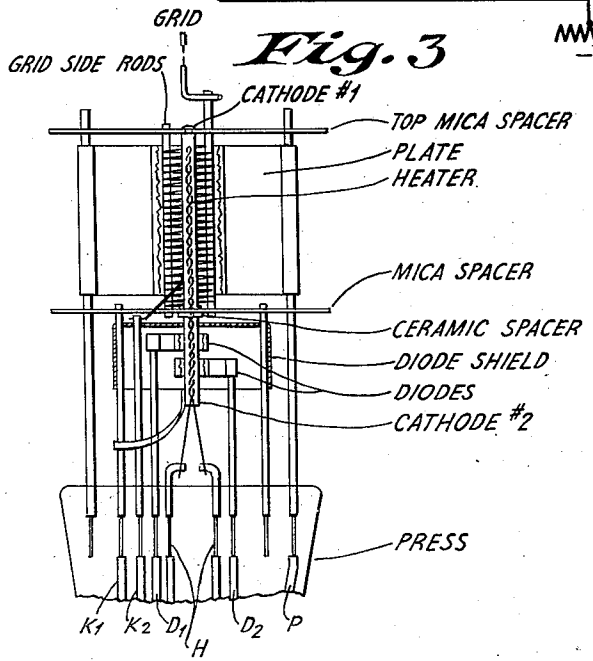


Fig. 3



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Patented Sept. 15, 1936 2,054,664

UNITED STATES PATENT OFFICE

2,054,664

MULTIPLE DUTY TUBE CIRCUIT

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Application November 10, 1933, Serial No. 697,387

4 Claims. (Cl. 250—20)

My present invention relates to circuits employing multi-function tubes, and more particularly to radio receiver circuits utilizing multiple duty tubes adapted to simultaneously perform detection, audio amplification, automatic gain control, and interchannel noise suppression functions.

In my co-pending application, Serial No. 644,160, filed November 25, 1932, Patent No. 2,023,448, granted December 10, 1935, there are disclosed various circuit arrangements for utilizing a duplex diode triode tube, also known as a 55 type tube, for a plurality of simultaneous functions. The multiple duty tube disclosed by me in the said patent employs a tube whose construction is specifically described and claimed by T. M. Shrader, in application Serial No. 622,140, filed July 12, 1932. In my aforesaid patent the 55 tube is utilized to perform simultaneously detection, automatic gain control, and interchannel noise suppression functions. The triode section of the multiple duty tube is used in such circuits to control the cut-off of the audio amplification stage following it, and hence is not available for audio amplification. Such arrangements require a stage of audio frequency amplification between the multiple duty tube and the power output tube.

It is one of the main objects of the present invention to employ a modified multiple duty tube and to obtain four functions with it, instead of the three functions disclosed in my aforesaid patent, an important feature of the invention comprising the coupling of an audio power tube directly to the triode section of the multiple duty tube.

Another important object of the present invention is to modify a multiple duty tube of the type described in the aforesaid Shrader application, so that there are separate cathodes provided for the diode and triode sections of the duplex diode triode tube, whereby, in addition to the three simultaneous functions disclosed in my aforesaid patent, there is additionally secured an audio frequency amplification function in the triode section of the tube.

Another object of the invention is to provide in a radio receiver a pair of multiple duty tubes arranged in push-pull relation, whereby the triode section of the tubes function as a push-pull audio amplifier, whose common output feeds a push-pull audio power output stage.

Still other objects of the invention are to improve generally the efficiency of radio receivers employing multiple duty tubes of the 55 type, and to particularly provide a modified type of diode-triode tube which is not only reliable in operation, but economically manufactured and assembled in a radio receiver.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, will best be understood by reference to the following description, taken in connection with the drawing, in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect. In the drawing:

Fig. 1 diagrammatically shows an arrangement embodying the invention,

Fig. 2 diagrammatically shows a modified form of the invention,

Fig. 3 is a front view of the tube structure of a modified 55 tube, certain of the electrodes being partly broken away.

Referring now to the accompanying drawing wherein like reference characters in the different figures designate similar circuit elements, there is shown in Fig. 1 those portions of a superheterodyne receiver which are essential to an understanding of the present invention. In general, the circuit shown in Fig. 1 is similar to circuits disclosed and claimed by me in my aforesaid patent. Thus, the source of intermediate frequency signals is conventionally represented, and it is to be clearly understood that such a source may comprise the tuned output circuit 1 of the first detector stage of a superheterodyne receiver. The intermediate frequency amplifier 2 has a resonant circuit 3 in its grid circuit, and the circuit 3 is coupled with the tuned circuit 1. The tuned circuit 4 in the anode circuit of the tube 2 is coupled to the tuned circuit 5, and both circuits 4 and 5 are tuned to the operating intermediate frequency.

The multiple duty tube is designated by the reference numeral 55′, and it is to be understood that it simultaneously performs second detection, audio frequency amplification, automatic gain control, and interchannel noise suppression functions. The triode portion of tube 55′ includes the cathode K_2, the signal grid G, and the plate P, the amplified audio frequency energy in the plate circuit of this triode section being impressed upon an audio frequency power output tube which is conventionally represented by the numeral 6. The grid of the output tube 6 is coupled to the plate P through a coupling condenser 7. The potentials for the electrodes of tube 55′ are provided from a voltage supply source which is not shown, but the bleeder across the voltage source

is shown. The plate P is connected to the positive side of the bleeder resistor through a resistor 8, and the bleeder resistor portion connected between the cathode K_2 and the positive terminal side of resistor 8 is designated by the numeral 9.

The signal grid G of the triode section is connected to the negative side of the bleeder resistor portion 9' through a path which includes the audio frequency coupling condenser 10 and the lead 11. The duplex diode section of the tube includes the independent cathode K_1 and the auxiliary anodes, or diode anodes, D_1 and D_2. It will be understood from the conventional showing of Fig. 1 that the heater element H functions to heat both cathodes K_1 and K_2 in common. In Fig. 3 is shown a view of the modified 55 tube with certain of the electrodes partly broken away. For convenience in understanding the construction, the various elements of the tube have been labeled in Fig. 3, and it is, therefore, not believed necessary to describe the nature of these elements in any great detail.

It will be noted that the cathode 1 is the cathode K_2 of Fig. 1, while the cathode 2 is the cathode K_1 of Fig. 1. It will, also, be observed that the heater element H is common to the cathodes K_1 and K_2, and passes through the ceramic spacer disposed between the mica spacer and the flanged top of cathode K_1. It will be noted that structurally the arrangement shown in Fig. 3 resembles the 55 tube construction disclosed in the aforementioned Shrader application. One of the main points of divergence is found in the cathode, which is shown in the present case in two sections separated by a ceramic spacer. The two cathode sections should be well insulated from each other. It is believed that when using chemically pure material for spraying the filament or heater element, the heater cathode resistance will be sufficiently high for practical considerations, especially since the resistance of the two paths will be in series.

The lower cathode K_1 is shown slightly flanged at the top, so that the diode shield serves as the support, and the lower end of cathode K_1 is electrically connected to the shield rod. The shield side rods are extended upward through small holes in the mica spacer, to prevent strain upon the filament or the ceramic spacer section in case of movement of the upper or triode section with respect to the lower diode section.

Returning now to Fig. 1, it will be observed that the diode anode D_1 is connected to the cathode K_1 through a path which includes in series the tuned circuit 5 and the resistor R_1, a by-pass condenser 12 being connected across the resistor R_1. A resistor 14 is connected between the grid side of condenser 10 and the cathode side of resistor R_1. The cathode of the amplifier tube 2 is connected to the cathode K_1 through a path which includes the resistor R_3 and the lead 13. The diode anode D_2 has signal energy applied to it through the condenser 15, a resistor R_2 connecting the anode D_2 to the cathode K_1. The automatic gain control connection is represented by "AVC", and is made between the diode anode side of resistor R_2 and the grid circuit of amplifier tube 2.

In considering the operation of the arrangement shown in Fig. 1, it is first pointed out that the triode portion of tube 55' is biased to cut-off by the bleeder potential between cathode K_2 and signal grid G, when no signal is received from the preceding amplifier stage. When a signal of sufficient magnitude is received, the rectified signal voltage developed in the diode circuit including anode D_1, which voltage is developed across resistor R_1, partly cancels the cut-off bias on signal grid G, and the triode section performs audio frequency amplification of the audio component which is fed to the signal grid through the condenser 10.

Cut-off bias is partially cancelled since the input and AVC are so adjusted that normal operating bias is present on grid G, thereby allowing audio amplification only when a signal is present in the input circuit 5. Noise suppression is thereby secured, since with no signal the audio stage is cut off and inoperative. The other diode anode D_2 functions as the automatic volume control instrumentality and develops the gain control potential across R_2 which is applied to the grids of the preceding radio frequency stages. It will, therefore, be seen that the diode circuit which includes anode D_1 develops across resistor R_1 an audio component and a direct current component, the audio component being amplified in the triode section of the tube, and the direct current component being used to render the triode section operative for audio amplification.

Therefore, it will be noted that the interchannel noise suppression function is accomplished only when the signal input to the second detector rises above a predetermined intensity level. The rectifier including diode anode D_2 performs the automatic volume control function. Due to the separate cathodes employed in tube 55', a seven pin base and top cap on the bulb would be necessary. Where it is desired to use the tube 55' in circuits such as disclosed in my aforesaid patent, the cathodes K_1 and K_2 would be connected together at the socket.

In Fig. 2 is shown a modified form of the invention, wherein the tube 55' shown in Fig. 1 is employed as one of a pair of such multiple duty tubes arranged in push-pull relation. The other of the tubes is designated by the numeral 55''. The diode anode D_1 is used in the usual manner for automatic volume control, and the rectifier circuit including this diode anode may be traced as follows: Modulated signal develops a D. C. component across R'_3, the signal being applied to D_1, through condenser 26.

Rectification for second detection takes place in tube 55' between anode D_2 and cathode K_4, and in tube 55'' between diode anode D_3 and cathode K_2'. The second diode anode in tube 55'' is not shown, for the reason that there is no function for it to perform in this circuit. It may be connected to D_3 however.

Due to the circuit arrangement shown, grids G_1 and G_2 are swung to opposite polarities at an audio frequency rate corresponding to the modulation. Bias is applied to the grids G_1 and G_2 through resistors from the bleeder. The function of these resistors is to prevent one grid G_2 from being biased positively by the rectified voltage and the resistor R'_2. Resistors numbered 20 and 21 are used for the purpose of applying bias to grids G_1 and G_2; they might be termed "coupling resistors". Resistors R'_1 and R'_2 are in series with diodes D_2 and D_3, and are for the purpose of obtaining a D. C. drop when signal is applied through the coupling condensers 23 and 24. Resistor R'_3 is the AVC diode resistor across which the voltage which controls the preceding stages is developed. Condensers 22 and 25 are coupling condensers by means of which the audio component of the signal is applied to grids G_1 and G_2 for push-pull amplification.