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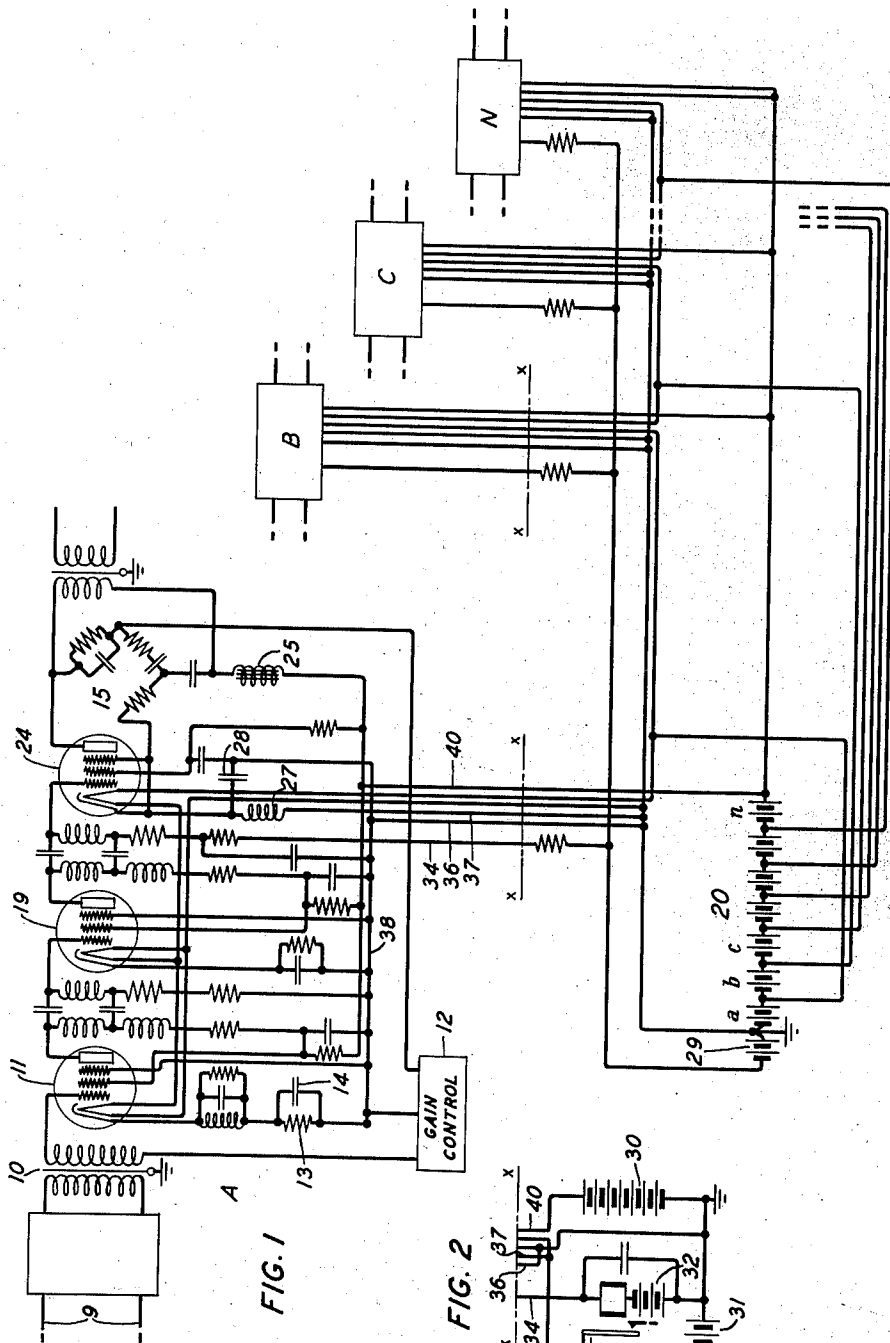
J. O. EDSON ET AL

2,191,167

AMPLIFIER

Filed May 27, 1936

2 Sheets-Sheet 1



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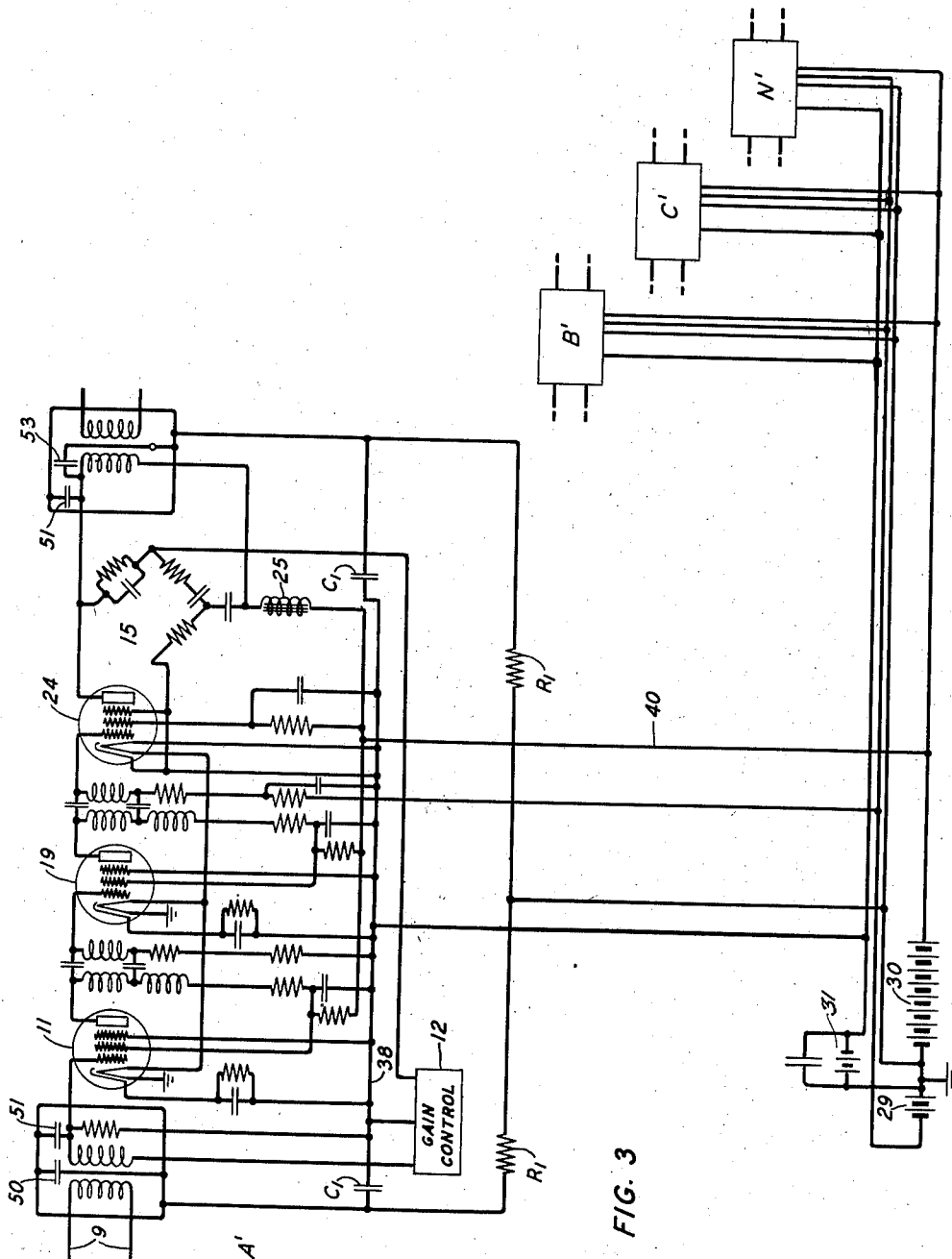


FIG. 3

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AMPLIFIER

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4 Claims. (Cl. 179—171)

The present invention relates to improvements in amplifiers and more particularly to a power supply for a number of amplifiers such as are operated continuously.

5 An object of the invention is to increase the power output of a repeater amplifier by the use of the combined filament and plate battery voltages as plate voltage.

10 A further object of the invention is the provision of a single battery for use with a large number of amplifiers for both filament lighting and for plate voltage without resulting irregularities in the drain and without undue coupling or cross-talk between amplifiers supplied by the same battery.

Further objects and advantages of this invention will appear from consideration of the specification and drawings illustrative of typical embodiments of the invention in which drawings:

20 Fig. 1 shows a single power source, used both for filament lighting and for plate current, the full voltage of which is employed for plate voltage and successive sections of which are tapped for filament lighting for separate repeater amplifiers;

Fig. 2 shows the adaptation of the usual power batteries at an existing repeater station to the amplifying system of Fig. 1; and

30 Fig. 3 shows a possible adaptation of an existing amplifying system at a repeater station to employ the filament and plate battery in series for plate voltage on all tubes with provision against undue cross-talk between the amplifiers connected to the common batteries.

35 Fig. 1 shows schematically a group of amplifiers A, B and C to N, each amplifier being associated with a communication circuit or telephone pair, of which a large number are employed, for example, in a lead covered cable in a carrier telephone system. The circuits may be open wire pairs, radio circuits or any suitable medium as well as those of a lead covered telephone cable or the like. The amplifier A is associated with one of the circuits or pairs 9 through an input transformer 10 having suitable shielding. The secondary winding of the transformer 10 is connected in this case to the control grid of a power pentode 11 of the type known as 310-A Western Electric pentode tube. The gain of the amplifier is controlled at 12 by some suitable means not shown in detail for varying impedance in shunt of the circuit connecting the input to the output bridge 15. The tube itself is self-biased by resistance 13 in shunt with a 55 condenser 14.

The amplifier A of itself forms no part of the present invention and will not be described in all its details. It is chosen for illustration because it represents a type of repeater to which the power supply circuits of the invention are well adapted. For information as to structure and performance of a repeater of generally similar type, reference may be made to U. S. patent to H. S. Black No. 1,956,547 granted May 1, 1934.

5 The tube 11 is connected to a succeeding amplifying tube 19 through an interstage network as shown. The plate voltage and the positive screen grid voltage of the tubes 11 and 19 are fed by the same plate battery 20 through the usual connecting impedance elements from lead 40. 15 The second amplifying tube 19 is connected to an output or power tube 24 through an interstage network similar to that preceding the tube 19. The output or power tube 24 is a 311-A Western Electric power amplifier pentode. The plate of the power amplifying pentode is connected to the positive pole of the plate battery through lead 40 in series with an inductance 25 and through the customary primary winding of the output transformer. The cathode of the power tube is connected to the negative side of the plate supply battery and to ground through an inductance 27. In shunt therewith is a condenser 28 furnishing an alternating current bypass to ground. 30

The battery 20 employed in Fig. 1 for both filament lighting and plate voltage supply is a single storage battery of about 150 volts subdivided by taps into n , in this case, seven sections, a , b , c , etc. The amplifier A has its filaments lighted from section a . The amplifier B has its filaments lighted from section b of the battery and so on while the eighth amplifier at a repeater station has its filaments lighted from the first section a of the battery the ninth from section b and so on. 40

Where the number of amplifiers at a station is less than the number of sections in which the plate battery is divided, or is not an even multiple of such number, individual filament lighting sections not heavily enough loaded may be loaded with dummy loads, such as leak resistances. The drain on the main supply battery 20 is thus kept uniform throughout its length and the usual practice may be followed of keeping 50 the battery on a uniform charge between its end terminals without the necessity for frequent attention to each individual cell to bring it up to normal charge.

It has been noted that the first two tubes of 55

the amplifier are self-biased. A suitable wet or dry biasing C battery 29 is furnished for the power amplifying pentode in ordinary manner.

The power supply system of Fig. 2 is connected to the amplifier A or to a similar amplifier B along the line X—X. The power supply of Fig. 2 comprises the customary plate voltage battery 30 and filament voltage battery 31 of the prior art repeater station. The C battery 32 connects to amplifier A over lead 34. The connections to the amplifiers are such that the filament lighting battery and plate battery are employed in series for the plate voltage of the power tube 24 with the filament battery below ground potential. The connection through the inductive winding 27 (see Fig. 1) over lead 37 to the negative side of the filament heating battery 31 provides a good direct current path to the negative pole of the filament battery. The condenser 28 (see Fig. 1) and lead 36 give a good alternating current path from the cathode of tube 24 to the ground of the amplifier panel and of the building housing the apparatus. The customary ground lead wire 33 (Fig. 1) in the amplifier set is connected by lead 36 to ground potential which is the potential of the positive side of the filament battery.

The circuit connection of Fig. 2 thus provides the cathode of tube 24 with a direct current connection through its associated inductance 27 to the negative pole of the filament battery 31, 24 volts lower than ground instead of providing the usual connection to ground. By this connection it is possible to obtain the full voltage of about 154 volts of the combined A and B batteries instead of the usual 130 volts of the B battery alone for supply of the plate voltage for the power tube. There results a material increase in the available power output from the repeater amplifier. The condenser 28 effectively connects the cathode to actual ground as a path for alternating current of frequencies to be transmitted by the amplifier. Thus condenser 28 working in conjunction with inductance 27 serves as a filter which reduces the flow of alternating current through the filament battery 31 while permitting the use of this battery as part of the effective plate supply. When the amplifier is to be used in a new office the power supply is that of Fig. 1 and the coil 27 and condenser 28 would not be needed because of the direct connection of the cathode to ground.

Fig. 3 shows an embodiment of this invention where a repeater amplifier is modified to use the combined filament and plate batteries for plate voltage on all of the tubes of each amplifier A', B' . . . N'. Each and every cathode is at the potential of the negative side of the filament battery 31 below ground so that the normal ground connecting wire within the amplifier is really at a potential negative with respect to the potential of the building ground. If, as is the common practice, the transformer shielding were connected to the amplifier panel and this were grounded as usual the cross-talk between amplifiers operated from the two batteries as a common source of supply would be excessive. The cross-talk trouble can be alleviated by insulating the transformer shielding from the panel and connecting it to the common cathode return wire. This expedient has the disadvantage that a potential difference equal to the filament battery voltage, 24 volts in this case, exists between the transformer shielding and the closely adjacent grounded panel. Any accidental short cir-

cuit to ground would burn out fuses and disable repeater circuits. This invention makes it possible to obtain the electrical advantages sought without incurring the disadvantages. The shields for the input and output transformers are insulated from their supports and ground and are connected back to a common cathode return wire 38 within the amplifier each through a condenser C₁. Each shield is connected to ground itself through a resistance R₁. The resistance R₁ is small enough to maintain the potential of the shield at ground potential as far as direct current is concerned, yet large compared to the reactance of C₁. These resistance connections between actual ground and any shielding, that may be necessary, protect the fuses while the condensers give the cross-talk advantage of direct connection to lead 38. Alternatively, the entire panel might be insulated from the relay rack and the entire amplifier treated in the ordinary manner, namely, by the connection of the low potential parts back to panel ground and by connecting the individual shields to the panel. When this is done the panel should be connected to the negative end of the filament battery or to wire 38 through a condenser C₁ and to ground through a resistance R₁.

The existence of this resistance connection R₁ to ground from a shielding means, results in that an accidental grounding of the shield of a transformer only results in an increase in cross-talk between the amplifier so grounded and the other amplifiers but does not result in a short-circuit or in the blowing of a fuse.

The condensers 50, 51 and 52 illustrated as connecting parts of the transformers to outer shields are virtual or inherent condensers only, indicating the naturally existing capacity between the parts of the transformer and the shielding means. It is these virtual or distributed capacities that cause undesired cross-talk if any shield or exterior shielding became accidentally grounded on a supporting frame.

The choke coil connection 27 noted in Fig. 1 from the cathode to actual ground is omitted in the amplifier of Fig. 3 since it is unnecessary to connect the cathode of the power pentode to ground through a choke, the ground being identical for all of the tubes in the amplifier of Fig. 3.

The power supply systems disclosed are not limited in application to telephone repeater service or to the use of either wet or dry battery supply.

The subject-matter of this specification directed to the embodiment exemplified by Fig. 1 is also being disclosed and is being specifically claimed in the copending application Serial No. 228,987 of I. G. Wilson, filed September 8, 1938.

What is claimed is:

1. The combination of a plurality of amplifiers, a source of cathode-heating current common to said amplifiers, said source being connected to said amplifiers such that cross-talk between said amplifiers may take place through said source, and means including an inductive impedance connected between said source and each amplifier for limiting the flow through said source of alternating current from said amplifiers.

2. In combination, a plurality of amplifiers, each including a stage having an electron discharge device with a cathode, a cathode-heating filament and an anode, a source of heating current for said filament, said source being common to all of the amplifiers and providing a portion of the effective anode potential for said stage, and

means for reducing cross-talk between said amplifiers through said common source, said means including an inductive impedance connected between each cathode and the low potential terminal of said source.

5 3. In a telephone repeater station, the combination of a plurality of amplifiers, each of which is in a separate communications circuit and each of which includes a stage having an electron discharge device with a cathode and an anode, a
10 common source of current for heating the cathodes of said devices, each of the cathodes being connected to the low potential terminal of said source, the high potential terminal being con-
15 nected to ground, a common source of anode potential having its low potential terminal con-

nected to ground and its high potential terminal connected to the anodes of said devices, and means for reducing the flow through said common heating source of the alternating current component of the cathode-anode circuit current of each amplifier, whereby cross-talk between
5 said amplifiers is minimized.

4. The combination of the next preceding claim in which said means comprises a high alternating current impedance path between each cathode
10 and the heating source and a low alternating current impedance path between each cathode and ground.

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