

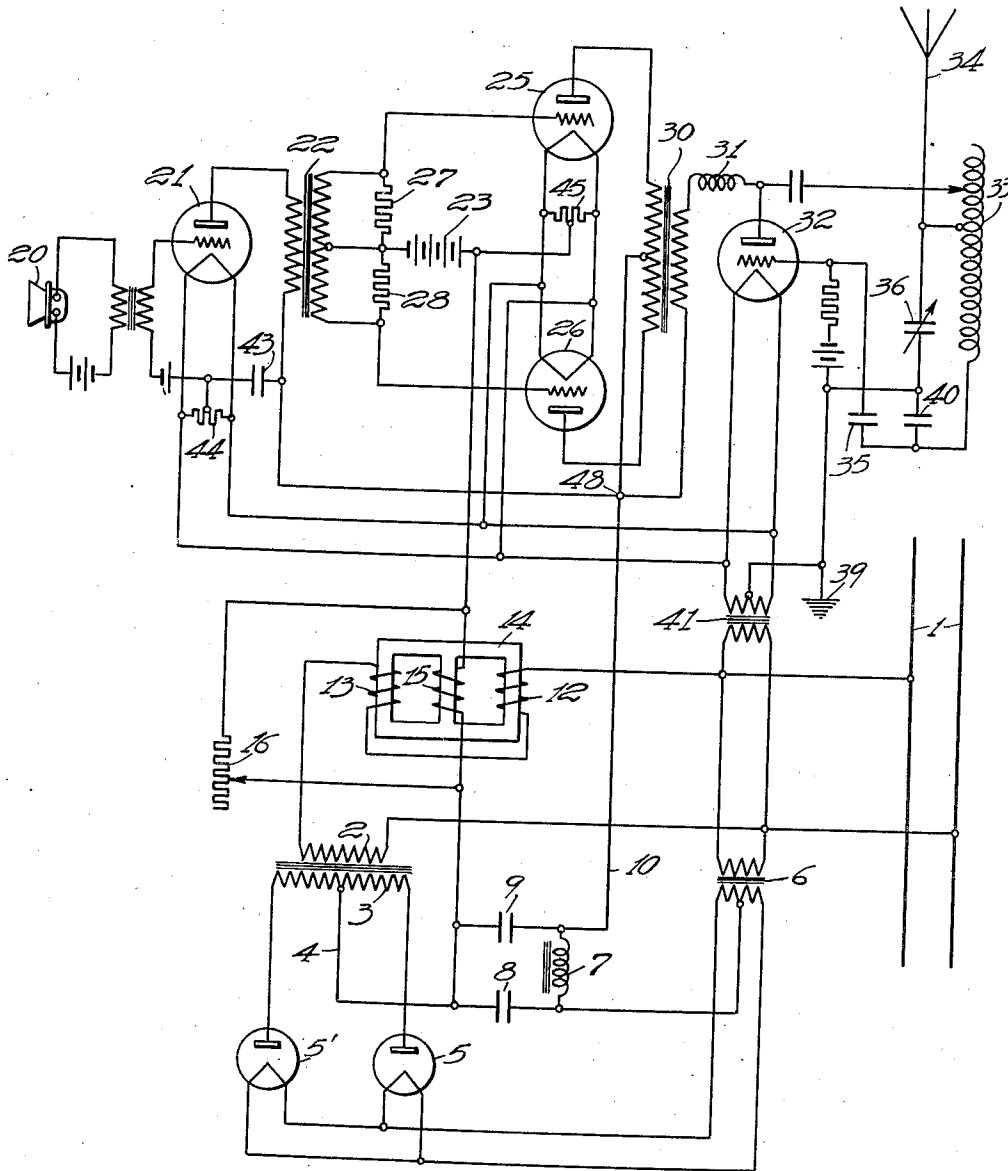
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HIGH EFFICIENCY MODULATOR WITH AUTOMATIC REGULATOR OF POWER SOURCE

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HIGH EFFICIENCY MODULATOR WITH
AUTOMATIC REGULATOR OF POWER
SOURCE

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My invention relates to radio transmission stations and particularly to means for supplying plate current to the vacuum tube devices in such stations.

5 It has become frequent practice to use for an amplifier a device which draws practically zero current in the absence of a signal and draws a substantial current when responding to one. Thus, in a radio sending station, the amplifier, 10 when acting to modulate the output of the oscillator, draws current but at other times draws substantially none. Ordinarily, the increase in current drawn causes diminution in the potential of the source of supply of the plate current. 15 This produces an unfortunate result in the radiated signal because less power is available at the time of maximum modulation, which is the time when it is particularly important that full power be available.

20 It is an object of my invention to remedy the foregoing defect.

Stated in another way, it is an object of my invention to counteract the consequences of poor regulation in the supply system.

25 It is another object of my invention to obtain from the plate current of the modulator an effect which shall counteract the fall in potential of the source of direct current supply. I accomplish this by causing this effect to increase 30 the supply of power from the alternating current line to the power rectifier.

I have described the application of my invention to a radio-sending station but it can be usefully applied wherever an amplifier of a 35 type drawing little current in the absence of a signal and substantial current when responding to a signal is used in a situation in which it is desirable to automatically regulate the voltage supplied to the plate circuit either of said amplifier or of any tubes associated therewith. 40 Public address systems, electrical carillons, and radio receiving sets are examples of such situations.

45 Other objects of my invention and the details of the structure employed will be apparent from the following description and the accompanying drawing which is a diagram of the circuits and the apparatus employed. In the drawing, the line 1 represents a source of alternating current which supplies the primary 2 of a transformer constituting part of the power rectifier. The power rectifier includes the secondary 3, rectifying tubes 5 and 5', connected 55 respectively to the two terminals of the sec-

ondary 3 and a connection from the midpoint of said secondary.

The output connections from the rectifiers 5 and 5' include a filter comprising an inductor 7 in series and condensers 8 and 9 across the 5 output. If the tubes 5 and 5' are of small internal impedance, such as mercury vapor tubes, the condenser 8 may be omitted. This filter and the rectifiers may be considered together as the source of direct current analogous to the 10 power pack often used with radio receivers.

The filaments for the rectifiers 5 and 5' are energized from a transformer 6 which is connected to the line 1. A connection to the midpoint of the secondary of the transformer 6 15 constitutes one side of the filter and the conductor 10 extending from the filter constitutes the terminal of the direct-current source opposite the terminal represented by the conductor 4.

The connections from the line 1 to the primary 2 includes two coils 12 and 13 wound upon 20 a common core 14 in such sense that their magneto-motive forces produce additive effects in the core 14. This core is equipped with a central leg carrying a coil 15 which is included 25 in the conductor 4. Shunted around the coil 15 is an adjustable resistor 16 by which the average current through the coil 15 may be adjusted.

In the illustrated embodiment of my invention, 30 the signal is represented by the sound delivered into the microphone 20. The potential changes corresponding to the signal are amplified by the tube 21, and impressed upon the primary of a transformer 22. The secondary 35 of the transformer 22 has a mid-tap connected to the negative terminal of a grid-biasing battery 23. The grids of the tubes 25 and 26 are connected, respectively, to the two terminals of the secondary of transformer 22, each half of 40 the secondary being shunted by a high resistance 27 and 28, respectively. The battery 23 is of such a voltage that the normal potential of the grids of the tubes 25 and 26 is very near the cut-off point, whereby, in the absence of a signal, 45 very little current flows in the plate circuits of these tubes.

The plates of the tubes 25 and 26 are connected to opposite terminals of the primary of a transformer 30, the midpoint of this primary 50 being connected to the conductor 10. The secondary of the transformer 30 delivers potential through a radio frequency choke 31 to a plate of an oscillator tube 32. The plate of tube 32 is also connected to the coil 33 of a tank circuit 55

associated with the antenna 34. The grid of the oscillator 32 is connected through a condenser 35 to the end of the coil 33 opposite the plate connection.

5 An intermediate point of the coil 33 is connected through an adjustable condenser 36 to the filament of the tube 32, and also to ground as shown at 39. A condenser 40, in series with the condenser 36 and connected to the same
10 terminal of the coil 33 as the grid, completes the tank circuit and the coupling thereof to the oscillator tube. A filament heating transformer 41 is shown for the tube 32. The primary of this transformer is connected directly across
15 the line 1. Obviously the filaments supplied by the transformer 41 and those supplied by transformer 6 could be supplied by a common transformer if desired. The transformer 41, as shown, supplies the filaments of tubes 21, 25
20 and 26 in addition to that of the tube 32, but it is obvious that separate transformers may be used if desired or whenever convenient.

A condenser 42 is illustrated as completing the plate circuit for tube 21, one terminal of
25 this condenser being connected to the midpoint of a resistor 44 across the terminals of the filament. It will be observed that the condenser 43 is in shunt to the source of direct-current power, since it is connected between the conductor 10 and, through the filament-heating circuit, to the conductor 4.

The connection of the conductor 4 to the two sides of the filament heating circuit, as shown, is by means of a resistor 45 connected across
35 the filaments of tubes 25 and 26, but it is obvious that the resistor 44 or the connection to the midpoint of the secondary of the transformer 41 could be used with equal effectiveness if convenient. The resistor 45 also serves, in
40 the illustrated system, to connect the positive pole of the battery 23 to the filaments of the tubes 25 and 26, but this connection also may be made in any desired way. It should also be noticed that the ground 39 grounds the filament of all the tubes 21, 25, 26 and 32. The
45 filaments of tubes 5 and 5' are at positive direct-current plate potential above ground. The midpoint of secondary 3 is at ground potential except for the drop across coil 15.

50 In the operation of the device, power is delivered from the line 1 to the primary 2. The potential at the primary 2 is less than that at the line 1, because of the drop over coils 12 and 13. This drop will change with the inductance
55 of these coils which will change with saturation of the core 14. The primary 2 delivers power to the secondary 3 which is rectified by the tubes 5 and 5' and delivered through the filter to the terminals 4 and 10. The filter removes
60 the ripple which remains after the action of the rectifier. The potential delivered by the lead 10 is, therefore, substantially free from ripple.

At the point 48 the current supplied by the
65 lead 10 divides and a portion of it supplies the direct-current component in the plate circuit of oscillator 32. The average or direct current to tube 32 does not change between the condition of modulation or no modulation except
70 due to distortion in tube 32 which is usually negligible. Another branch from the point 48 supplies the direct-current component in the plate circuit of the tube 21. Changes in this current are small and need not be further
75 discussed.

The remaining branch from the point 48 is to the middle of the primary of the transformer 30 and supplies current to the back-to-back amplifier including tubes 25 and 26. This current, in the absence of a signal, will be small
5 but, when the signal is present, the current through the tubes 25 and 26 will become of substantial amount, that is, while the signal persists, first one and then the other of these tubes draws a substantial current. 10

Modulation of the output of the tube 32 by the action of the voltages generated in the secondary of the transformer 30 is well understood and need not be described in detail here.

When a signal is present, the current through
15 the tubes 25 and 26 increases, with the result that the current through the return conductor 4 increases, and, therefore, the magneto-motive force caused by the coil 15 increases. This causes an increase in the flux in both branches
20 of the core 14. This will bring the magnetization of the iron inside of coils 12 and 13 nearer the saturation point. During one-half cycle of the alternating current, the magneto-motive forces of coils 12 and 15 are additive and during
25 the other half cycle they are opposed. The approach toward saturation during the additive relation is much greater than the departure from saturation during the other half cycle. On the average, therefore, an increase in current
30 in coil 15 is accompanied by a decrease in the effective impedance of the coil 12. A similar effect takes place in coil 13 except that the approach toward saturation occurs during
35 the opposite half cycle from that for the coil 12.

The consequence of a decrease in the apparent impedance of coils 12 and 13 is an increase in the voltage impressed across the primary 2 and consequently an increase in the voltage delivered by the rectifiers through the filter to the
40 vacuum tubes.

Stated from a somewhat different viewpoint, when the apparent inductance of coils 12 and 13 is decreased the power factor of the connections from the line 1 to the source of direct-
45 current power is increased and, therefore, the power delivered from the line 1 is increased.

When a signal is being transmitted, therefore, the modulator uses more current, but instead of
50 thereby causing a fall in potential at the terminals of the direct-current power source it causes a correction in the power factor of the connections between the line 1 and the rectifier, the potential delivered from the source of direct-current power being thus kept at its normal
55 value.

The direct-current potential impressed upon the oscillator 32 is thereby kept constant, with the result that the only changes in the magnitude of the radiations from the antenna 34 are
60 those corresponding to the modulation. A greater faithfulness in the representation of the signal is thus obtained.

It is difficult to so design the device having core 14 that some alternating current potential
65 is not induced in the winding 15. With an amplifier of the type shown, this causes no harm because the resulting currents in the two halves of the primary of transformer 30 offset each other and so introduce no hum into the secondary. 70

Many variations in detail will occur to those skilled in the art. The specific illustration and description of one embodiment of my invention is, therefore, not to be regarded as a limitation. 75

The only limitation intended are those required by the prior art or indicated in the accompanying claims.

I claim as my invention:

- 5 1. In combination, a pair of electron discharge devices having output circuits connected back-to-back, a load supplied from said output circuits, a source of voltage supply for the anodes of said electron discharge devices, said source being common to said output circuits and comprising a rectifier drawing power from alternating-current lines a coupling between the input and
10 output circuits of said rectifier for varying the input voltage to said rectifier in accordance with current in said rectifier output circuit.
15 2. In combination, a pair of electron discharge

devices having output circuits connected back-to-back, a load supplied from said output circuits, a source of voltage supply for the anodes of said electron discharge devices, said source being common to said output circuits and comprising a rectifier drawing power from alternating-current lines means controlled by current in the output circuit of said rectifier for compensating for changes in input voltage to said rectifier produced by changes in current in said rectifier output circuit, said means comprising an inductor having a three-legged magnetic core with a winding connected in said alternating-current lines on two of said legs, and a winding connected in said rectifier output on the third leg.
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