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SHORT WAVE AMPLIFIER

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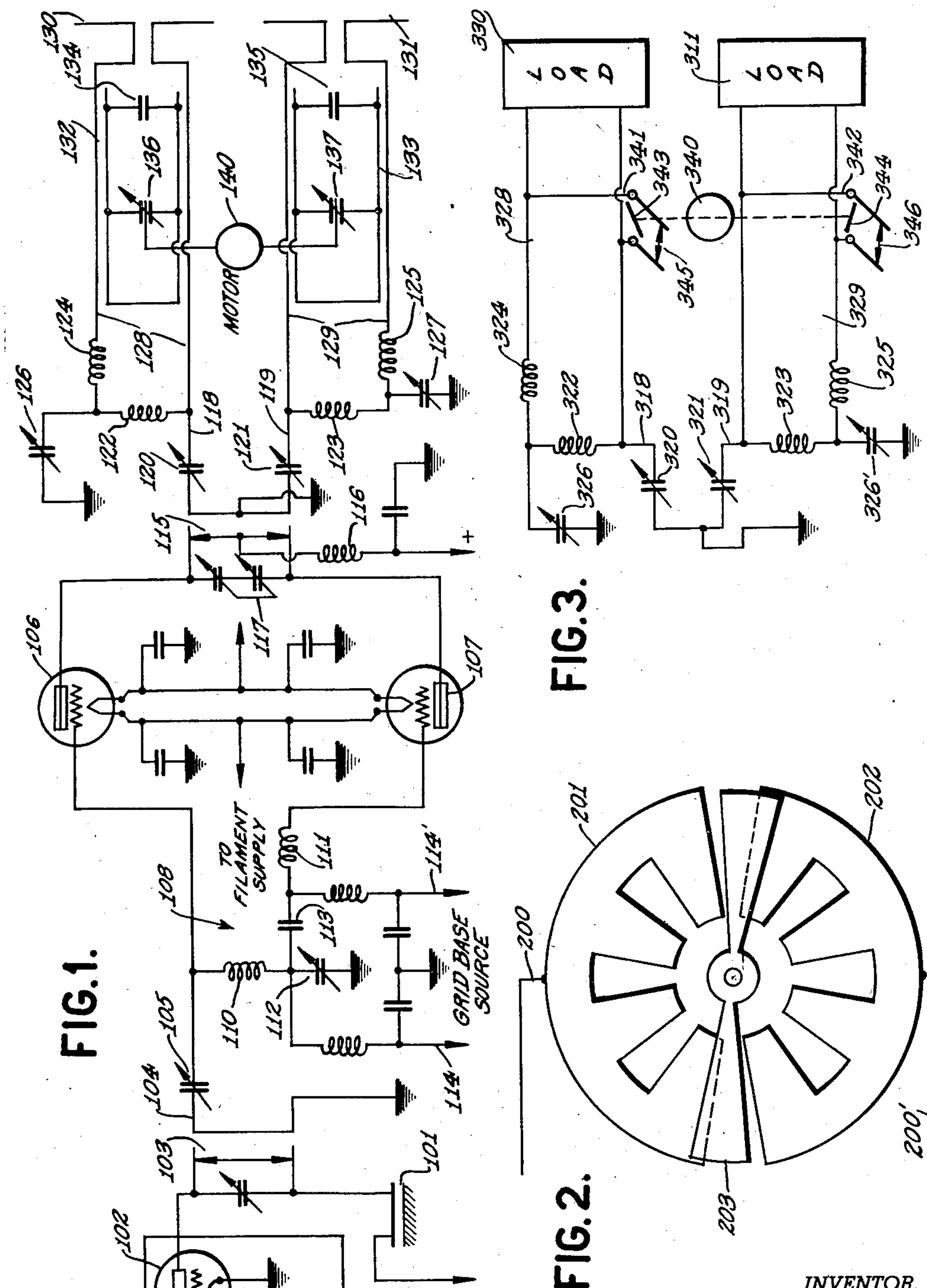

FIG. 1.

FIG. 2.

FIG. 3.

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SHORT-WAVE AMPLIFIER

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2 Claims. (Cl. 178—44)

My invention relates to high frequency transmission systems and more particularly to radio frequency transmission circuits adapted to supply energy to two or more symmetrical loads from an unsymmetrical source of supply or from a single symmetrical two conductor line or loop. This invention is a division of my copending application Serial No. 263,367, filed March 22, 1939, and entitled "Short-wave transmitters," issued on June 9, 1942, as Patent No. 2,285,851.

It is often desirable to transmit energy from an unsymmetrical source such as an oscillator or frequency multiplier grounded on one side, to two or more symmetrical loads, for example, radiating antennae. This type of arrangement is particularly useful for supplying energy to transmitting antennae which may be used for defining a beacon course, since under these circumstances it is desirable that the load be properly balanced in order that the system be efficient and a suitable radiation pattern be secured. Furthermore, in beacon systems it is often desired to separately adjust the power fed to each of the radiating antennae, so that the course line may be properly defined and maintained. Similarly it may be desired to connect two or more balanced lines over which energy is transmitted to a single unbalanced line or to a single balanced line.

It is an object of my invention to provide a radio frequency transmission system which is suitable for intercoupling two or more balanced lines and an unbalanced line.

It is a further object of my invention to provide a radio transmitter in which energy from an unbalanced source is applied to a plurality of antennae each connected to a separate balanced line.

It is a further object of my invention to provide in a radio transmitter a system which permits the independent adjustment of energy to the separate balanced antennae.

It is a still further object of my invention to provide the combination of a radio frequency source, a balanced amplifier and a plurality of balanced loads connected to the output of the amplifier.

It is a still further object of my invention to provide a radio transmitter with a balanced line feed for two or more separate antennae, in which the energy fed to the antennae may be separately modulated or keyed.

It is a still further object of my invention to provide a novel keying arrangement for use with a pair of symmetrical radio beacon antennae.

The above mentioned and further features and objects of my invention and the manner of attaining them will be apparent from a particular description of my invention made in accordance with the accompanying drawing, in which

Fig. 1 illustrates a preferred embodiment of a radio transmitter made in accordance with my invention,

Fig. 2 illustrates a form of split stator condenser suitable for use in the modulation system of Fig. 1, and

Fig. 3 illustrates an alternative modulation system in accordance with my invention which may be used in place of that disclosed in Fig. 1.

Turning now to the drawing and particularly to Fig. 1, **100** represents a source of radio frequency energy which may be, for example, an oscillator or a frequency multiplier. In source **100** at **102** is indicated a vacuum tube which may represent the last stage of the radio frequency circuit within **100**. The anode of tube **102** is connected to a positive voltage supply as indicated, and is connected through the primary of transformer **103** to ground for radio frequencies through the radio frequency condenser **101**. Transformer **103** is designed for high frequencies and constitutes a single turn for the primary and secondary so that the coupling between the primary and secondary is made by means of a distributed inductance and capacity only. Coupling transformer **103** is made adjustable so that the coupling between the windings may be varied.

The secondary of the transformer **103** is connected to ground on one side and on the other side to a transmission line **104**, through a variable power controlling condenser **105**. It is evident that this arrangement forms an unsymmetrical line portion. This unsymmetrical line is connected to a push-pull amplifier comprising vacuum tubes **106**, **107**. Since, in order for the vacuum tubes to operate properly in push-pull the input thereto should be balanced, I provide a network to achieve this balance indicated generally at **108**. At lower ratio frequencies balanced input may be obtained by merely grounding the center point of a transformer and connecting the outer ends through lines to the grid. However, at higher frequencies balance cannot be obtained so simply. A balance may be obtained by connecting in series across the line a pair of impedances such as **110**, **111**, and connecting these impedances to ground through a third impedance **112**. In the circuit shown in Fig. 1, impedances **110** and **111** are inductances, whereas impedance **112** is a condenser. A balance may be obtained in this way provided impedances **110**, and **111** are properly related to impedance 112 in value and are of a sign opposite to that of 112. In the preferred arrangement impedances 110 and 111 are made equal and impedance 112 is made equal to one-half the value of either of the impedances 110, or 111. However, a considerable departure from this relationship may occur in practice, approximate equality of impedances 110 and 111 being sufficient, and a considerable variation in the relationship of the impedance values of 112 and 110, 111 being permissible for most applications. In order that a complete balance may be obtained inductances 110 and 111 are arranged so as to have very little, if any, mutual coupling between them. A blocking condenser 113 is provided between inductance 111 and the junction points of 110 and 112, so that grid bias power may be supplied to the grid of tubes 106 and 107 through the leads 114, 114' independently of each other. This arrangement permits the use of separate grid meters to indicate the operation of the tubes. The output circuit of the vacuum tubes 106, 107, is connected to a high frequency variable transformer 115, the primary of which is connected to a power supply through radio frequency choke 116. Tuning condensers 117 are provided to tune the output of push-pull amplifier. Coupled to the secondary of transformer 115 are conductors 118, 119, which together form a balanced output line. The separate conductors 118, 119, are unbalanced with respect to ground so that each conductor may be considered as a further unsymmetrical line. The midpoint of the secondary of transformer 115 is grounded so that in effect each of lines 118 and 119 may be considered as an independent unbalanced line with a ground return. In lines 118, 119, are provided variable condensers 120, 121 which may serve to independently control the power output over the respective lines.

In line 118 is provided another high frequency network which serves to produce a balanced output from the unsymmetrical line 118. This network comprises inductance elements 122, 124, connected similar to inductance elements 110, and 111, and to a variable condenser unit 126, corresponding to condenser 112. Condenser 126 is made variable so that its impedance may be adjusted to balance precisely transmission line 128. Similarly, line 119 is branched to form a balanced transmission line 129 through a network comprising inductance elements 123, and 125, and a variable capacity element 127.

To the outer end of transmission line 128 is coupled an antenna 130, shown as a dipole antenna, and to line 129 is coupled another dipole antenna 131. While I have shown antennae 130 and 131, as dipoles, it should be distinctly understood that they may be of any desired form so long as they are designed to form a balanced load. Furthermore, it is clear that instead of leading to antennae, transmission lines 128 and 129 may lead to any desired type of symmetrical load.

If it is desired to use antennae 130 and 131 as a radio beacon, these antennae should be arranged at a suitable angle with respect to each other to produce the desired wave pattern. Arrangements of antennae for radio beacon transmission are well known so no specific illustration thereof is made in this application.

In order that the signals from the separate antennae may be distinguished, I provide means to modulate the energy fed to the antennae to form the distinctive signals. Any desired modulating means may be used as the method of modulation in such as to preserve the symmetry of the system. In the arrangement according to Fig. 1, I provide, for modulating the antennae, a filter, comprising resonant quarter wavelength frames 132 and 133 constituting sections of transmission line and loosely coupled to the transmission line. These frames are coupled to the transmission line inductively primarily through capacitive induction and may be precisely tuned by means of trimming condensers 134, 135. When these frames are properly positioned with respect to the transmission line and accurately tuned, they will operate to substantially stop all of the energy from flowing along the transmission line. Although I have illustrated these tuned coupled sections as open-ended frames, they may have other forms, such as closed frames of proper length or may be of various other formations. For structural details of the various forms of transmission modifying networks, reference may be had to Patent No. 2,159,648, issued May 23, 1939, on an application of Andrew Alford, Ser. No. 162,853 filed September 8, 1937. Since the filtering action of coupled transmission line sections, such as shown at 132 and 133 are very critical with tuning, their effect on the flow of energy through transmission lines 128, 129, may be modified by slightly detuning the section. This fact is made use of in producing the modulation of the energy transmitted to the antennae. Across each of networks 132, 133, I provide split-stator condensers 136, 137. These condensers are arranged with the fixed plates coupled to the separate conductors of the transmission line, while the rotary plates are driven at a uniform rate by means of a motor 140 or other means. Condensers 136 and 137 may be made with a different number of notches in the stator plate so that the energy flowing along transmission lines 128, 129 is interrupted at a different rate to impress a different modulation upon the energy radiated from antennae 130, 131.

One form of split-stator condenser suitable for use in the system of Figure 1, is illustrated in Figure 2. This condenser comprises fixed toothed stators 201, 202, connected to the opposite side of a balanced line 200, and a single rotary plate element 203. When 203 is rotated at a uniform rate the tuning of the condenser is varied periodically, depending upon the speed of the rotor 203 and the number of teeth on stator plates 201, 202. Thus a chopping or keying of energy may be accomplished by means of this rotary condenser connected across a tuned frame such as 132. The frequency of modulation may be varied by varying the number of teeth on the condenser or by driving the rotors of the condensers at different speeds. The percentage or depth of modulation may be controlled by so choosing the condensers as to provide the desired preciseness of tuning of the coupled sections.

While in Fig. 1 I have illustrated the arrangement wherein an amplifier is utilized between the source of radio frequency oscillation and the load, it should be distinctly understood that this amplifier may be omitted, and the energy and amplification taken care of in other parts of the circuit, if desired. Also, it should be understood that the balancing network need not be composed of two inductances and a single capacity as shown, but may be of any form of impedance so long as they satisfy the requirement specified above. It is thus clear that in place of inductances 110 and 111 of 108, equal capacities should be substituted therefor and an inductance reaction used in place of condenser 112. However, I prefer to use the inductance arrangement since it permits a separate energization of the grid. Similarly, the impedance element in the network associated with the separate antennae circuit could be of different values if desired without altering the scope of my invention. It should further be understood, according to the general reciprocity theorum, that instead of a transmitter, the system may constitute a receiving arrangement. Antennae 130, 131 receive radio signals and transmit them over balanced lines to an unbalanced receiver. In Fig. 3, I have illustrat d an alternative form of modulating system which may be substituted for that illustrated in Fig. 1. In this arrangement 320, 321, 318 and 319, represent the power adjusting condensers and the conductors of the transmission line similar to that disclosed in Fig. 1. Similarly the network comprises inductances 322, 324 and capacity 326, and inductances 323, 325, capacity 326, correspond to similar elements in Fig. 1. Loads 330, 331, may be antennae corresponding to 130, 131 or any other form of symmetrical load. The modulating system, however, differs from that shown in Fig. 1. At 341, 342 are illustrated two half-wave length short circuited frames connected at the proper point across balanced transmission lines 328, 329, respectively. At a point midway of the length of transmission line sections 341, 342 are provided short circuiting switches 343, 344, which are driven by means of a motor 340. Adjustable short circuiting bars 345, 346, are provided on each of the sections 341, 342.

This modulating system operates as follows: When a short circuiting switch 343 is crosswise so as to short circuit the network 341, this network forms a short circuited quarter wavelength line connected across transmission line 328. Aside from resistance and radiation losses the circuit will not drain nor hamper flow of energy along transmission line to load 330. When switch 343 is turned to the open position the effective circuit from the transmission line extends out to the short-circuited end of the half-wavelength section 341. This then constitutes a half-wavelength short circuited filter across the main line preventing substantially all of the energy from flowing to the antenna. Thus the modulation may be obtained by interrupting the flow of energy along the line by means of the short circuiting switch 343. Similarly modulations may be effected in the energy of line 329 by short circuiting switch 344. These switches may be provided with a plurality of segments so as to interrupt the flow at different rates in the two different lines so as to provide different modulations of the energy for the two loads. If it is desired to utilize less than 100% modulation, short circuiting bars 345, 346 may be changed in position so as to alter the length of the section from that of a full half-wavelength.

While I have described my invention with references to figures illustrating a preferred embodiment thereof, it should be understood that this description is merely by way of illustration and not a limitation of the scope of my invention, which is defined in the accompanying claims.

What I claim is:

1. Radio frequency system including an unbalanced energy source, two push-pull electronic tubes, means for feeding said tubes from said source in symmetry, including, connected between the input grids of said tubes, two inductances connected adjacent to each grid and a blocking condenser connected between said inductances, so that the direct current potential of said two grids may be independent, a second condenser connected from one side of said first condenser to ground, unbalanced feed means extending from said source to ground and directly to one of said grids, and grid biasing means connected respectively to the two sides of said blocking condenser.

2. System according to claim 1, additionally including a variable condenser connected in series between said source and the grid fed directly therefrom, said variable condenser being of a value not influencing the balancing of said system, but acting as a variable power adjusting means.

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