

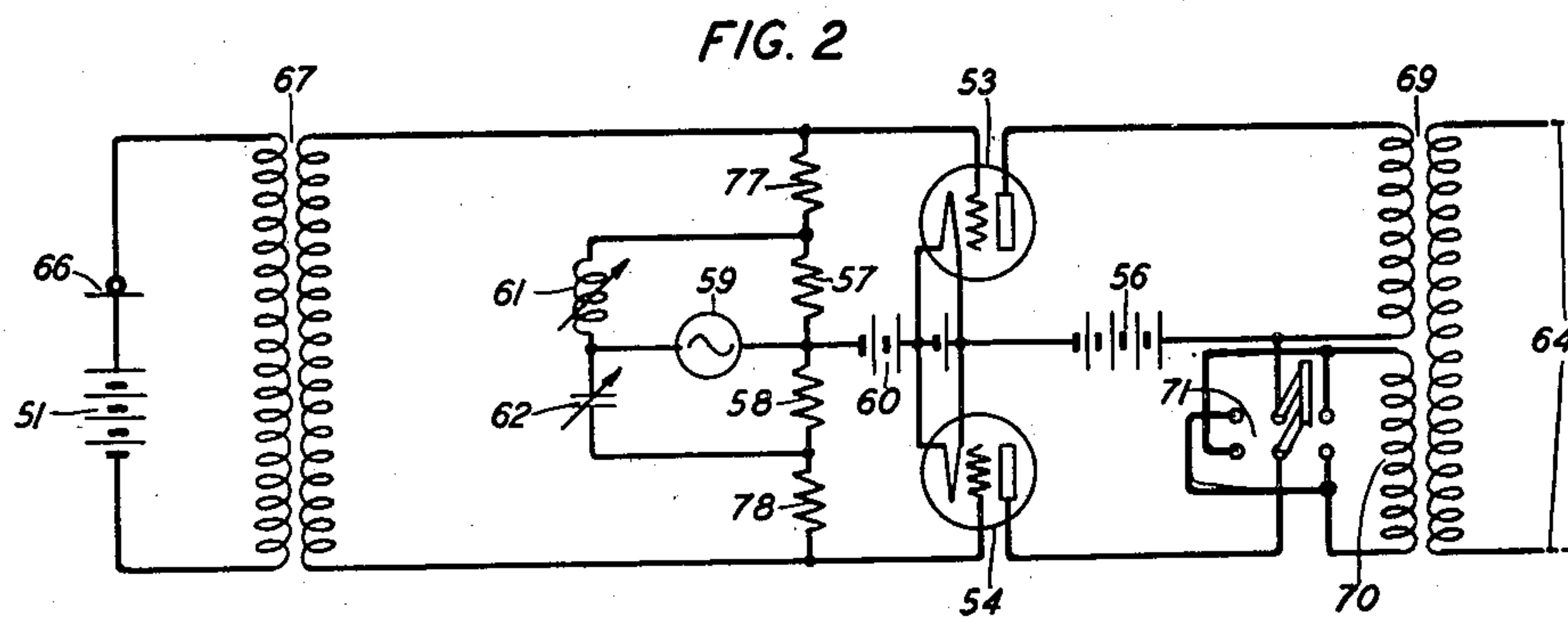
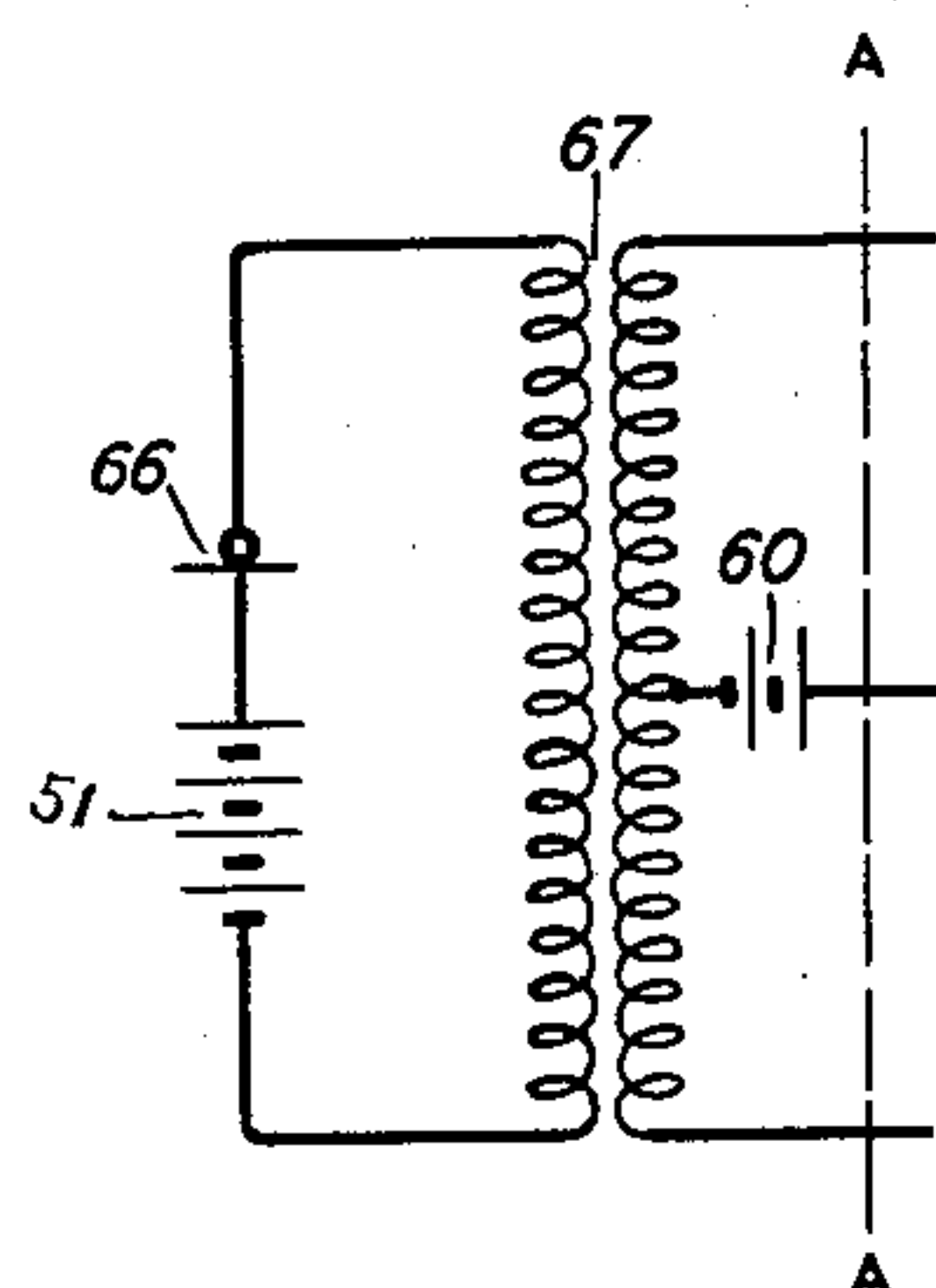
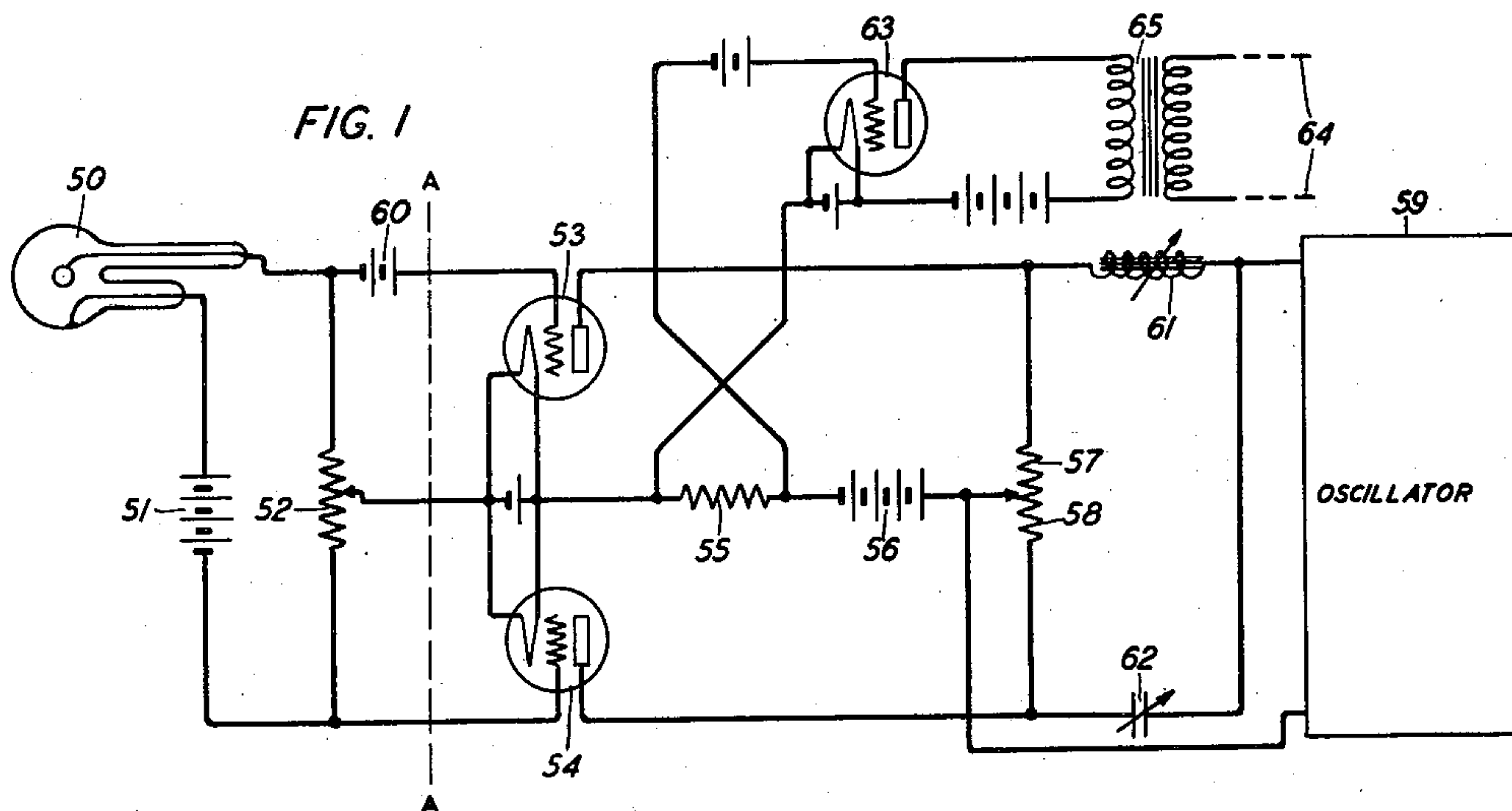
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MEANS FOR PRODUCING A PHASE MODULATED WAVE

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MEANS FOR PRODUCING A PHASE MODULATED WAVE

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1 Claim. (Cl. 179—171)

This invention relates to a method of and means for modulating the phase of a carrier wave in accordance with the variations of a modulating current.

In my copending application, Serial No. 279,041, filed May 19, 1928, which issued September 30, 1930, as U. S. Patent No. 1,777,016, I have disclosed and claimed a similar arrangement particularly adapted to control the production of an electro-optical image by a carrier wave which has been modulated with respect to phase. The present application is directed more generally to the production of a phase modulated wave irrespective of the purpose for which the wave is to be used, and contains matter which is disclosed but not claimed in the earlier application.

In accordance with the present invention, a carrier wave is impressed upon a divided circuit or phase-splitting arrangement having also a common portion containing a load circuit. In the individual portions of the divided circuit are contained unlike impedance elements adapted to produce a difference of phase between the waves in the respective branches. The individual portions also include variable resistance devices adapted to be controlled by modulating currents applied thereto. The relative value of the variable resistances may be varied in accordance with the variations in the modulating current, whereby the phase of the combined carrier wave in the common portion or load circuit is correspondingly varied and a phase modulated carrier wave results.

The phase modulated wave may be transmitted to a distance and detected by suitable means to reproduce the original modulating current for use in operating a telephone receiver or other device as in any well-known system of signaling by means of electrical waves. One form of detector for phase modulated waves is illustrated in connection with an electro-optical system in my above mentioned patent, but the invention is independent of the detector employed therewith.

A detailed description of several embodiments of the invention follows, reference being made to the accompanying drawing, in which:

Figure 1 is a diagram of a circuit for modulating the phase of a carrier wave in accordance with a current controlled by a photoelectric cell;

Fig. 1A is a modification of that portion of Fig. 1 to the left of the section line A—A, showing the manner in which a microphone circuit may be employed to modulate the phase of the carrier wave; and

Fig. 2 is a further modification of the circuit of Fig. 1, showing the carrier wave applied to the grid circuit of a system of modulating tubes instead of to the plate circuit.

In the circuit of Fig. 1, a photoelectric cell 50 is connected in series with battery 51 and resistance 52. The varying potential difference across the resistance 52 due to the variation in the light actuating the photoelectric cell 50, is impressed differentially on the control electrodes of the similar electron discharge devices 53 and 54 so that the output impedance of one of the discharge devices is increased when that of the other discharge device is decreased, and vice versa. A biasing battery 60 is employed so that the control electrodes of the two electron discharge devices will be biased equally, and therefore, so that these devices will have the same output impedance, when the photoelectric cell is not actuated by light. A resistance 55 and battery 56 are in a common portion of the anode circuits of the electron discharge devices 53 and 54. One of a pair of equal resistance elements 57 and 58 is connected in each of these anode circuits. A source of carrier current 59 is connected across resistance element 57 through an inductive reactance element 61 while the same current source is connected across resistance element 58 through a capacitive reactance element 62. The potential difference across element 55 is impressed on the input circuit of an electron discharge device 63, the output circuit of which is connected to a transmission channel 64 through transformer 63. The current from the source 59 travels by two paths. One path is through the inductive reactance element 61 and resistance 57, said resistance element having in shunt therewith the resistance element 55 and the output impedance of electron discharge device 53 connected in series. The other path is through the capacitive reactance element 62 and resistance element 58, said resistance having in shunt therewith the resistance element 55 and the output impedance of electron discharge device 54 connected in series. It is apparent that the current components reaching the resistance element 55 by way of these two paths, respectively, are out of phase and the electromotive force impressed on the input circuit of electron discharge device 63 is proportional to the vector sum of these two components. As the photoelectric cell 50 is actuated by light of varying intensity, and as a result the output impedance of one of the electron discharge devices 53 or 54 increases while the output impedance of the other device

decreases, and vice versa, the phase relation between the two current components in resistance element 55 changes, thus resulting in a corresponding change in the phase of the current transmitted over channel 64.

In one particular adjustment of the circuit, the resistances 57 and 58 may be made small relatively to the output impedance of the discharge devices and also relatively to the impedances of the reactances 61 and 62. Then as the relative value of the output impedances is varied the effect upon the individual phases of the two current components will be slight. The impedance variation will, however, materially affect the relative strength of the two components, increasing one and decreasing the other, or vice versa, thus resulting in a corresponding change in the phase of the current transmitted over channel 64.

In the modified input circuit shown in Fig. 1A a microphone 66, supplied with operating current from battery 51, generates the modulating current in place of the photoelectric cell 50 of Fig. 1. The modulating current acts upon the input terminals of the electron discharge devices 53 and 54 through a transformer 67. The biasing battery 60 is placed in the middle conductor so that the control electrodes of the two electron discharge devices will be biased equally, there being no current from battery 51 in the biasing circuit, due to the interposition of transformer 67. The varying current from the transformer 67 due to the variation in the sound waves actuating the microphone 66, is impressed differentially on the control electrodes of discharge devices 53 and 54 so that the output impedances are varied and modulation is effected as described in connection with Fig. 1.

In the embodiment shown in Fig. 2, the carrier waves from source 59 are impressed upon the control electrodes of the electron discharge devices 53 and 54 instead of the output or plate electrodes. One of the equal resistance elements 57 and 58 is connected in series with each of the control electrodes. Larger resistances 77 and 78 are also connected in series with the resistances 57 and 58, respectively, to prevent the latter resistances from producing too great a decrease in the impedance across the input terminals

of the electron discharge devices. The source of carrier current 59 is connected across resistance element 57 through the inductive reactance element 61 while the same current source is connected across the resistance element 58 through the capacitive reactance element 62. The microphone 66 and battery 51 generate the modulating current which is transmitted through the transformer 67 to the control electrodes of the devices 53 and 54. The biasing battery 60 is connected between the cathode circuit of the devices 53 and 54 and the common terminal of the resistance elements 57 and 58. The plate battery 56 is connected in a common portion of the anode circuits of the electron discharge devices 53 and 54. The individual portions of the anode circuits are connected to the respective portions of the divided primary winding of a transformer 69. One portion 70 of the primary winding may be reversed with the reversing switch 71. By this means the output currents from the anodes of the electron discharge devices may be combined either additively or differentially in transformer 69 and the arrangement giving the better form of combined wave may be determined by trial. The current induced in the secondary winding of the transformer 69 is supplied to the transmission channel 64.

What is claimed is:

A phase modulating system comprising a carrier source, a phase splitting network connected to said source and adapted to produce carriers of the same frequency but different phase in the respective branches thereof, said phase difference being between 10° and 170° , a signal source, a pair of vacuum tubes arranged to be differentially affected by said signal source, a relatively loose resistive coupling between each vacuum tube and a respective branch of said phase splitting network, said coupling being adapted to substantially prevent the signal source from affecting the phase of the carrier in either branch, and a load circuit for combining the carriers, whereby the phase of the combined waves is varied in accordance with the signal while the amplitude of the combined waves remains substantially constant.

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