

**Aug. 16, 1938.**

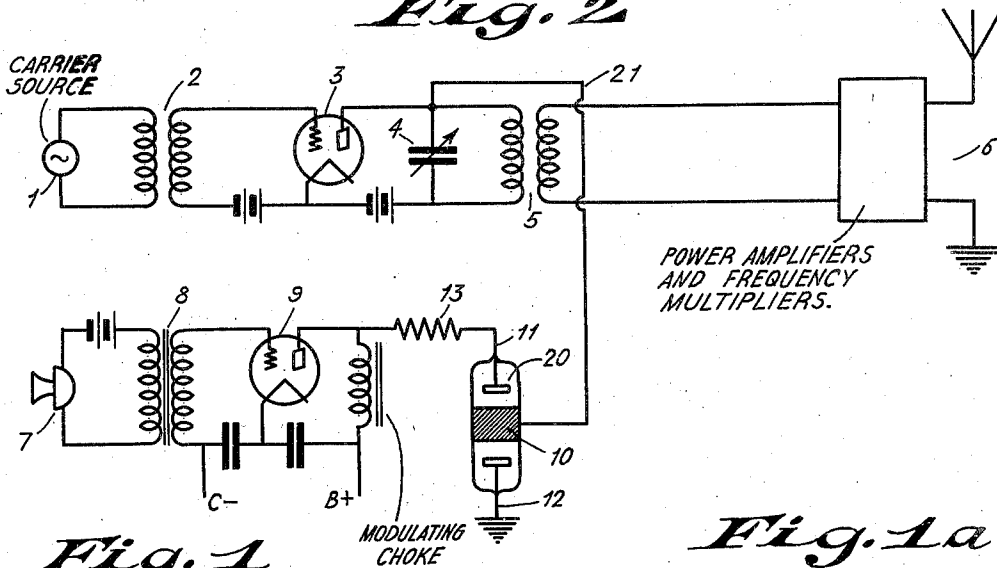
**M. G. CROSBY**

**2,127,486**

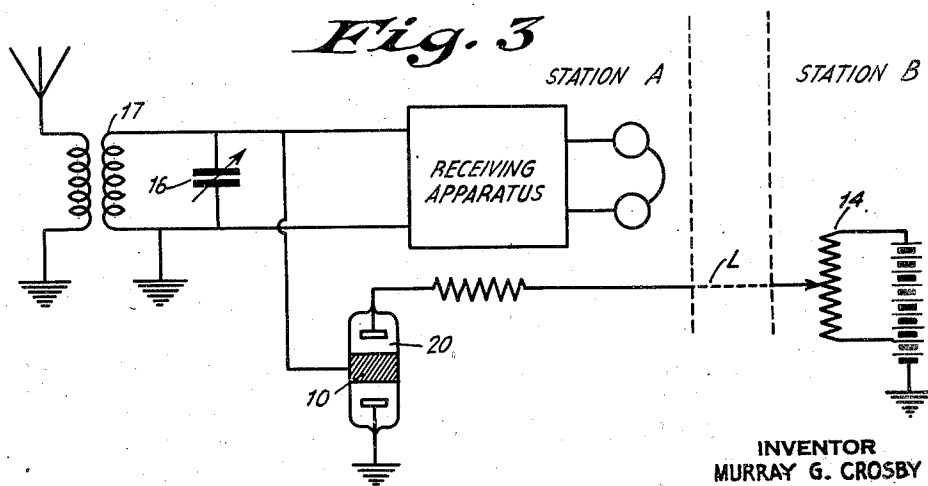
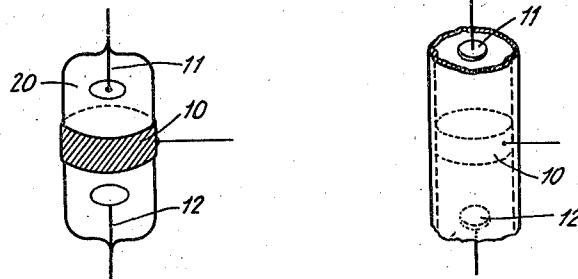
## PHASE MODULATION

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*Fig. 2*



*Fig. 1a*



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## UNITED STATES PATENT OFFICE

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## PHASE MODULATION

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Original application October 16, 1931, Serial No.  
569,144. Divided and this application Novem-  
ber 14, 1934, Serial No. 752,961

2 Claims. (Cl. 179-171)

This invention relates to improvements in phase modulation circuits and more particularly the use of the novel condensers of the variable type as disclosed in my United States application #569,144 filed October 16, 1931, United States Patent #2,012,710, October 27, 1935, in a novel circuit to accomplish phase modulation of a carrier wave. This application is a division of said copending application.

In general, this invention contemplates the use of a variable condenser having no mechanical working parts as a means to accomplish phase modulation of a carrier wave. This aim is accomplished by utilizing a glow discharge tube having a plurality of electrodes between which a stream of electrons is arranged to flow. Encircling the tube and separated from the electrodes there is provided an electrical conducting plate which forms one of the capacitive elements of the glow tube. As potential is applied to the electrodes of the tube, the glow in the tube is arranged to vary in intensity and to act, in turn, as one of the plates of the condenser, the capacity of which is varied as the current through the tube is effectively varied. The controlling potentials may be characteristic of signals. And the variable effects are used to vary the phase of a carrier wave.

Referring to the drawing, Figs. 1 and 1a illustrate, in perspective, a variable condenser of the glow tube type constructed in accordance with the principles of this invention; and Figs. 2 and 3 illustrate, diagrammatically, typical circuit arrangements wherein such glow tube may be employed.

In Fig. 1 is shown a glow tube 20 comprising a sealed glass envelope within which are located two electrodes 11 and 12. This tube, it is to be understood, is only illustrative of any type of glow discharge tube which may be employed and may comprise a neon tube, cathode ray tube or any other suitable electron tube. Encircling the outside of the envelope or bulb is an electrical conducting plate 10 made of tinfoil or other suitable material. This plate, if desired, may be mounted within the envelope as shown in Fig. 1a. The spacing of the elements of the tube is so arranged that plate 10 and each of the electrodes 11 and 12 form capacitive elements of condenser circuits wherein a capacity exists between plate 10 and each of the electrodes. Normally, when there is no current flowing through the tube between the electrodes 11 and 12, this capacity is fixed. The application of a potential across electrodes 11 and 12, however, starts a glow and

varies the capacity between the elements, the glow discharge in such case acting as a conducting plate. The variation of this glow, due to potential variations between the electrodes causing effective changes in the size of the electronic stream, produces a variation in capacity between plate 10 and the electrodes 11 and 12.

In Fig. 2 is shown a complete transmitting circuit adapted for phase modulation wherein a glow tube is advantageously employed to vary the tuned output circuit of an amplifier. In this arrangement conductor 6 represents a suitable antenna circuit connected to the transmitting system by suitable power amplifiers and frequency multipliers. The waves to be transmitted by antenna circuit 6 are generated by carrier frequency source 1 which is connected by means of a transformer 2 to an amplifier tube 3. The usual tuned circuit in the amplifier arrangement comprises a condenser 4 and an inductance 5 connected in shunt relation to the condenser. The output circuit of this arrangement is associated with the usual power amplifiers and frequency multipliers which are indicated in the rectangular box. Directly connected to the anode of the amplifier tube 3 by means of conductor 21 is the variable condenser or glow tube 20, one electrode 11 of which is connected to the anode of modulating tube 9 through resistance 13, and the other electrode 12 of which is connected directly to ground. A modulating choke coil connects the plate voltage with the anode of tube 9. A transmitter 7 which may comprise any suitable input device is employed to produce signal waves which are fed through transformer 8 to the modulator tube 9.

The variable condenser or glow tube, it is to be noted, is connected in series with the plate impedance of the modulator tube 9 but effectively connected in parallel with condenser 4. Consequently, any variation of the plate impedance of tube 9, such as may be caused by message waves impinging on the diaphragm of transmitter 7, will cause a variation of the effective capacity of the glow tube. This variation of the effective capacity of the glow tube will vary the resultant capacity of the tuned circuit 4, 5 in such manner that the output of the amplifier is phase modulated in accordance with the signal wave.

To those who are skilled in the art it will be obvious that a variable capacity as described herein may be employed to vary the tuning of an oscillator circuit to obtain frequency modulation in a manner similar to that used to obtain phase modulation.

Fig. 3 illustrates a remote control system wherein the glow tube 20 is employed to vary the tuning of the receiving circuit at station A. In this circuit a movement of the potentiometer 14 at station B will vary the voltage applied to the distant glow tube at station A over transmission line L. This tube is adapted to vary the resultant capacity of tuned circuit 17, 16 in response to a variation in potential caused by a movement of potentiometer 14.

A particular advantage of the glow discharge tube described herein is that it is much simpler and more positive in action than the usual type of variable condenser which employs a condenser shaft and suitable driving means.

It is to be understood that the circuits illustrated and described herein have been selected only for the purpose of clearly setting forth the principles involved and that the invention is susceptible of being modified to meet different conditions encountered in its use without departing from the spirit and scope of the invention.

What is claimed is:

1. A device for producing capacity variations which are linear with respect to signaling potentials and for modulating the phase of carrier waves in accordance with said capacity variations comprising, a repeater circuit including a reactance tuned to the frequency of the carrier wave to be modulated in phase, a gaseous discharge tube comprising a gas filled envelope, a pair of electrodes spaced from each other within said envelope, leads connected with said electrodes and

passing through the walls of said envelope, means for applying signaling potentials to said leads connected with said electrodes whereby the conductivity of the gas between said electrodes is altered at signal frequency, a condenser plate supported externally of said envelope and adjacent the path between said electrodes, whereby capacity variations controlled by said signaling potentials are produced between said condenser plate and the electron stream between said electrodes and a circuit connecting said condenser plate with said reactances in said repeater circuit to alter the tune of said circuit at signal frequency.

2. In a phase modulation system, a source of oscillations of carrier wave frequency, an output circuit, a circuit coupling said source of oscillations to said output circuit, a capacitive device connected to said coupling circuit, said capacitive device including an hermetically sealed container enclosing a pair of electrodes in a gaseous atmosphere, a capacity element supported externally of said container and adjacent the current stream between said electrodes, and means for varying the current flow between said pair of electrodes of said device in response to signalling waves to thereby vary the effective capacity between said capacity element and said stream whereby the oscillations fed into said output circuit from said source of oscillations are varied in phase in accordance with said signalling waves.

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