Jan. 7, 1936. A. H. TURNER 2,026,758

SECRET SIGNALING

Filed Dec. 21, 1932

Fig. 1.

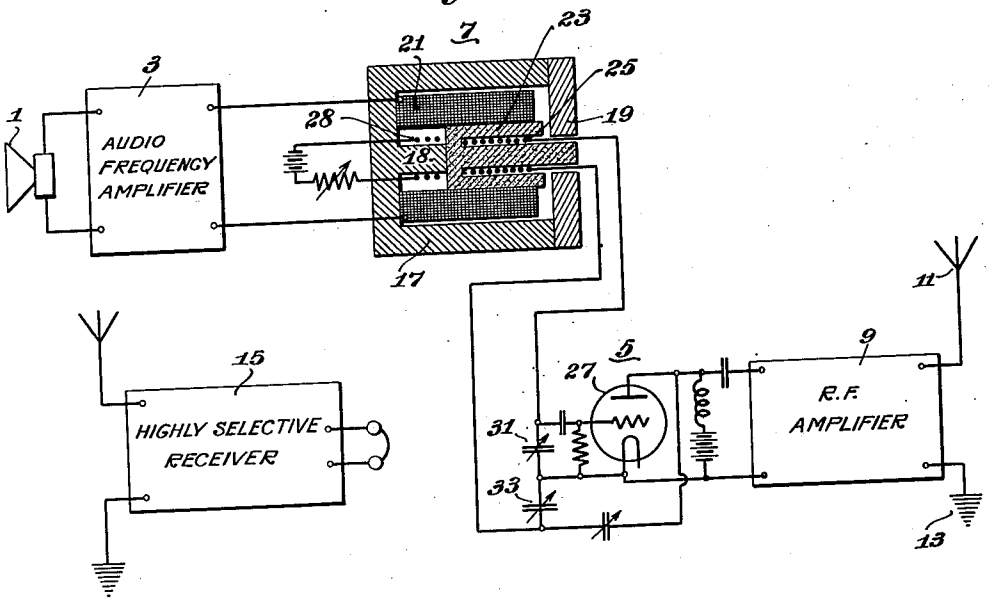
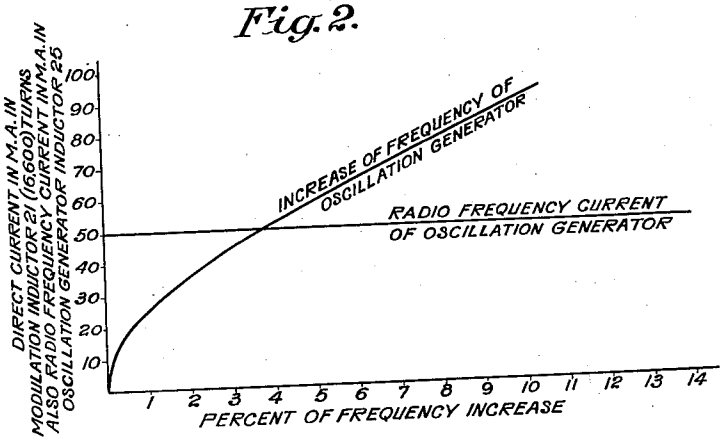


Fig. 2.



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SECRET SIGNALING

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3 Claims. (Cl. 179—171)

My invention relates to secret signaling and, more particularly, to apparatus and methods for obtaining semi-secrecy through modulation of the frequency of a carrier wave unaccompanied by appreciable changes in the amplitude thereof.

For certain purposes as, for example, in commercial radio transmission from city to city, a reasonable amount of secrecy is desirable. That is to say, although absolute secrecy is not necessary, it still is desirable to so conduct the transmission of messages that their interception by unauthorized persons is difficult.

It is, accordingly, an object of my invention to provide a novel method and improved apparatus whereby semi-secrecy in radio transmission and reception may be attained.

Another object of my invention is to provide a radio transmitting system that shall radiate a carrier wave the frequency of which is modulated without appreciable modulation of the amplitude thereof.

The foregoing objects and other objects ancillary thereto I prefer to accomplish by providing a transmitter including an oscillation generator of the type having a frequency determining element, such as an inductor, and I cause the effective reactance of the inductor to change in response to the signal it is desired to transmit, whereby the frequency of the generated oscillations changes slightly at the signal rate.

Specifically, I prefer to utilize an oscillation generator of the Colpitts type wherein one of the frequency determining elements is an inductor provided with only two output leads and substantially enclose the inductor within magnetically permeable material which is effective at radio frequencies. In addition I provide voice or signal responsive means for altering the permeability of the material, and thus cause the generated oscillations to depart slightly from a normal frequency in response to alterations in the permeability of the core. At the receiving end, I prefer to make use of a highly selective radio receiver of the tuned radio frequency type or of the superheterodyne type provided with one or more piezo-electric crystal inter-stage couplings. The coupling device shown in the patent to G. L. Beers, No. 1,883,490 is one that gives entire satisfaction.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment, when read in connection with the accompanying drawing, wherein

Fig. 1 is a diagrammatic view of a radio system including a preferred embodiment of my invention, and

Fig. 2 is a diagram exemplifying the manner in which my improved modulator operates.

Referring specifically to Fig. 1 of the drawing, the transmitting portion of a radio system constructed according to my invention preferably includes a source of signal frequencies exemplified by a microphone 1, an audio frequency amplifier 3, a carrier wave generator 5, my improved frequency shift modulating device 7, shown in cross-section, a carrier wave amplifier 9, and the necessary radiating structure such as an antenna 11 and a ground connection 13. The receiving portion is constituted by a highly selective radio receiver 15.

As hereinbefore mentioned I accomplish semi-secrecy in transmission of radio signals by causing the frequency of a carrier wave to be very slightly shifted, in response to the signals it is desired to transmit, without causing appreciable change in the amplitude of the wave. To this end, my improved modulating device is so constructed that a portion of it which is in intimate relation with an inductor carrying currents at radio frequencies is constructed of finely comminuted magnetizable material and a portion which carries flux varying at audio or signaling frequencies is solid or is laminated as is usual in audio frequency transformers. I also find it highly desirable to provide a minor substantially closed magnetic path for the radio-frequency flux and to include the said path as a part of the main magnetic circuit carrying the audio frequency flux.

It will be noted, from an inspection of the drawing, that my improved modulator 7 bears some resemblance to magnetic modulators utilized in the past for amplitude modulation comprising, as it does, a cup shape element 17 having a central pole 18 and an annular yoke element 19, constituting the main magnetic structure and having associated therewith an inductor 21, through which pass currents at audio or modulating frequency derived from the amplifier 3.

The minor magnetic path for flux at radio-frequencies is constituted by an extension 23 of the central pole-piece of the element 17, the extension having therein an axial cylindrical opening wherein is disposed an inductor 25, the terminals of which are connected, respectively, to

the grid and plate of a thermionic tube 27 which functions as an oscillation generator. Although I have illustrated the generator as being of the well-known Colpitts type, it is to be understood that my invention is not limited thereto, since generators of other types may, of course, be substituted therefor. The Colpitts system, however, is very convenient in view of the fact that the main frequency-determining inductor thereof requires but two external leads as opposed to three leads for the Hartley type and four leads for oscillators of the tickler feed-back type. A piezo-electric crystal may be connected in this oscillation generator to provide good unmodulated frequency stability when only very slight frequency modulation is required for signaling.

The pole-piece extension 23, since it carries flux at radio frequencies, must have very low losses and be highly permeable. To this end, I find it expedient to utilize finely comminuted iron imbedded in an insulator, such as bakelite or the like, and molded under heavy pressure. Many methods of making magnetic cores from iron dust and binder are known to those skilled in the art, the method given in British Patent 366,475 being, perhaps, as satisfactory as any.

In order to reduce the amplitude of the second harmonics of the audio modulation, the main magnetic circuit should be polarized by magnetic flux generated by direct current. This direct current may be the anode current of the modulator tube in the amplifier 3 flowing through the main inductor 21, or it may be adjustable direct current flowing through a third winding 28 which surrounds the central pole piece 18.

In the operation of my improved system output currents from the oscillation generator 5 are amplified to any desired degree in the power amplifier 9 and are radiated as a carrier wave. The amplifier may be tuned, if desired, provided that proper precautions are taken against self oscillation, or may be aperiodic. The frequency of the generated oscillations is determined by the inductance of the coil 25 and the magnitude of a plurality of tuning condensers 31 and 33 serially connected in shunt thereto. The inductance of the coil is a function of the permeability of the core extension 23 and the losses therein, as well as of the physical dimensions of the coil itself and the number of its turns. As the flux from the main magnetic circuit passes through the core extension, the reluctance thereof varies in accordance with variations in the flux and, as a result, the frequency of the oscillations is caused to fluctuate above the normal unmodulated frequency of the oscillator at a rate determined by the audio input to the microphone 1. If the frequency shift is kept within reasonable limits, the losses in the core-extension do not change even though its reluctance is changing, with the result that the amplitude of the generated oscillations remains substantially constant.

By keeping narrow the range of frequency shift, it is extremely difficult to receive, on an ordinary receiver, the signals radiated by my improved transmitting system whereby transmission, for all practical purposes, is semi-secret in character. Satisfactory reception of the signals, however, at authorized points, may be had through utilization of a receiver having "knife-like" selectivity which is capable of translating the frequency modulation into amplitude modulation before final detection. Such receiver, preferably, is of the type wherein one or more piezo-electric crystals are employed as inter-tube coupling elements or as filters permitting the passage only of the frequency to which they are naturally resonant.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In combination, an oscillation generator provided with a frequency-determining inductor, a substantially closed minor magnetic circuit, wherein losses at radio frequencies are substantially zero, surrounding said inductor, a second major magnetic circuit, one element of which is constituted by the minor magnetic circuit, means for causing unidirectional flux to traverse the second magnetic circuit and means for altering the flux density at signal-frequencies, whereby the frequency of the generated oscillations may be caused to vary at the signal frequencies without accompanying variation in the amplitude thereof.

2. The invention set forth in claim 1 wherein the minor magnetic circuit is composed of minute particles of permeable material held in situ by an insulating binder.

3. The invention set forth in claim 1 characterized in that the core material has an effective permeability of 10 at 550 kilocycles.

ALFRED H. TURNER.