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1,494,347

L. ESPENSCHIED

HIGH SPEED RADIO SYSTEM

Filed April 30, 1920

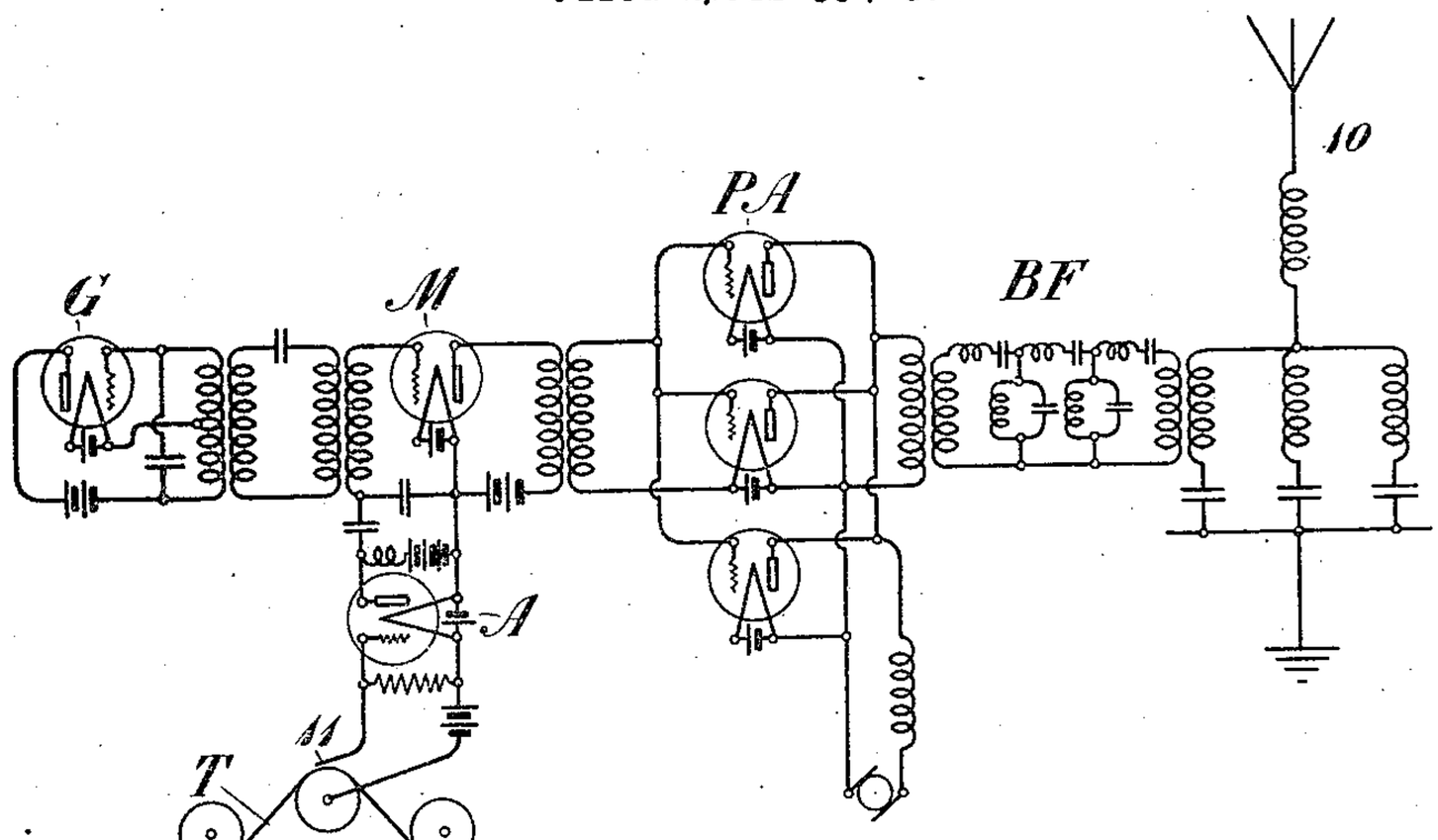

Fig. 1

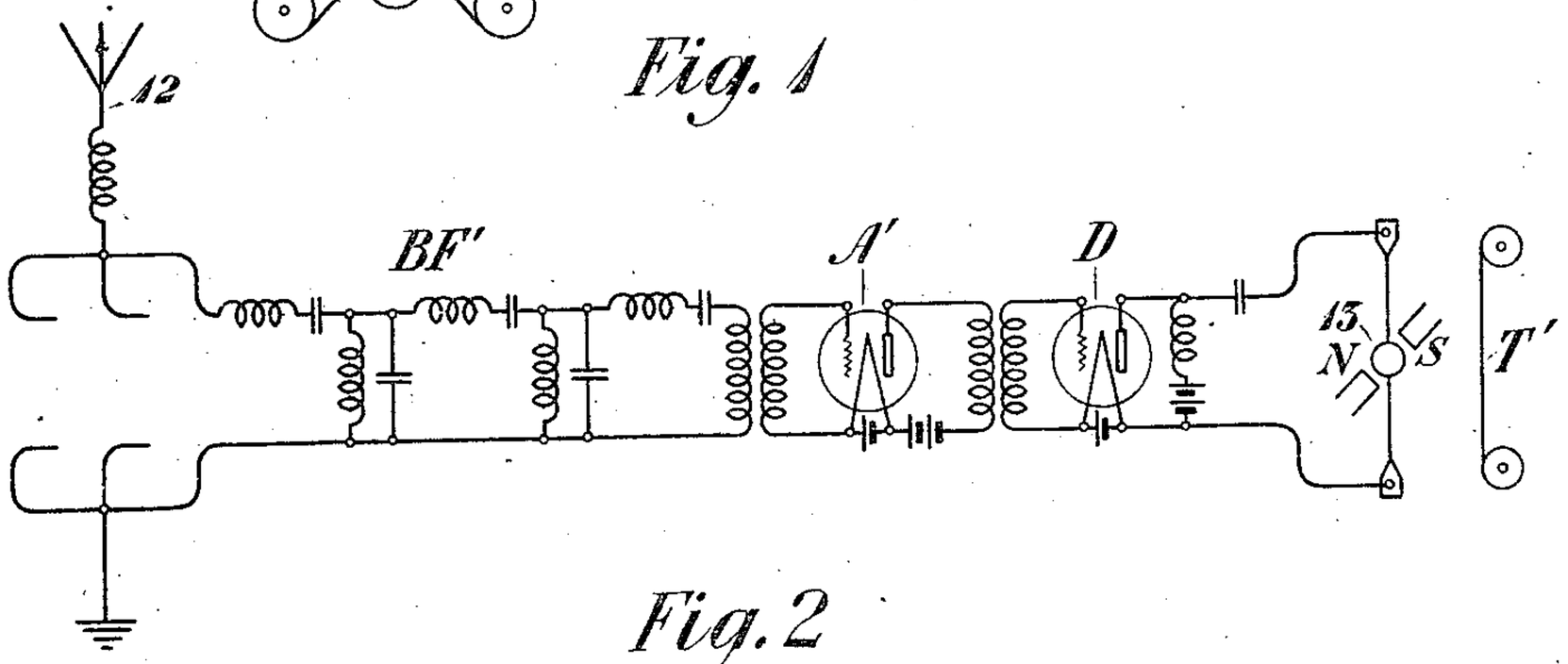

Fig. 2

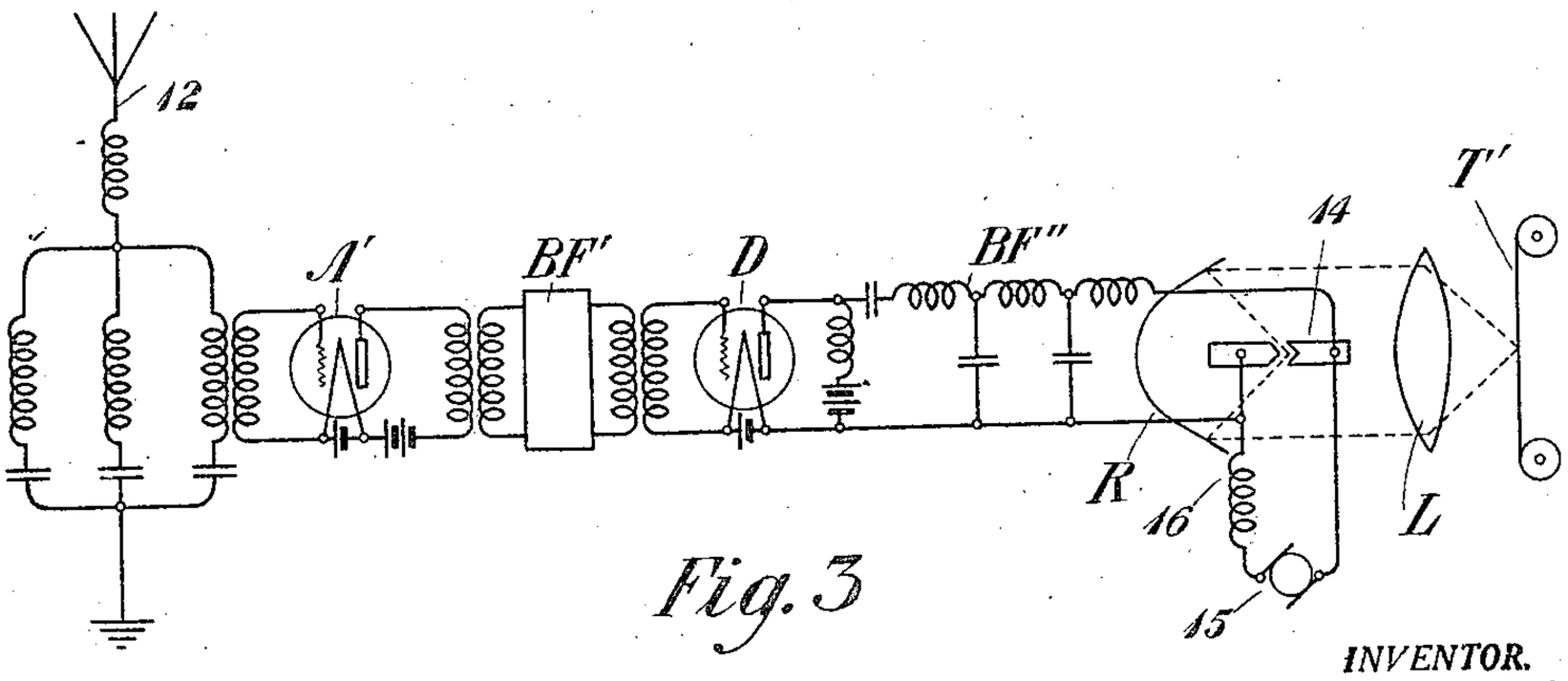

Fig. 3

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BY

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UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF QUEENS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

HIGH-SPEED RADIO SYSTEM.

Application filed April 30, 1920. Serial No. 377,875.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Queens, in the county of Queens and State of New York, have invented certain Improvements in High-Speed Radio Systems, of which the following is a specification.

This invention relates to signaling by means of carrier currents and more particularly to means and methods whereby the speed of the transmitted signals may be increased.

Heretofore in the transmission of telegraph signals by means of carrier currents particularly in radio systems, it has been necessary because of certain limitations in the apparatus employed to signal at a relatively low rate of speed. This low rate of signaling was necessary not only because of the difficulty of commutating large quantities of high frequency energy at a high speed but also because the sharply tuned selective circuits heretofore used were incapable of transmitting without distortion a signaling band of any considerable width, such as would result from modulating a carrier current by high speed telegraph currents. Furthermore, the recording apparatus heretofore employed in the art of radio telegraphy was subject to the disadvantage of having considerable inertia so that it could not be used for recording high speed signals.

The low speed signal methods heretofore employed are disadvantageous for the reason that each channel of communication, while of relatively narrow width, had to be considerably spaced from adjacent channels in the frequency spectrum in order to prevent interference. This resulted not only in considerable duplication of transmitting and receiving apparatus in order to accommodate the desired volume of traffic but in a wasteful appropriation of the frequency spectrum so that the volume of signaling traffic which could be accommodated by the frequency range available was unnecessarily limited.

In accordance with the present invention it is proposed to overcome these difficulties by signaling at a high rate of speed and modulating the carrier frequency employed for transmission in accordance with the high speed signaling currents. This results in the employment of a wider band of high frequencies for each channel of communication. In order to accommodate the increased width of the band it is proposed to use for obtaining selectivity, band filters of the general type disclosed in the United States Patent to George A. Campbell, 1,227,113, issued May 22, 1917. Band filters of this type have the advantage over sharply tuned circuits that the selected frequency range may be made as wide as desired while the cut-off at the edges of the transmission band may be made quite sharp.

By this method of signaling each channel of communication will accommodate a much larger volume of traffic because of the high speed rate of production of signals. As the channels need not be more widely separated than in the case of the narrow channels previously employed, it will be at once apparent that the percentage of the total available frequency spectrum actually usefully employed for transmission purposes is much greater than in the case of the methods heretofore practiced. This is a very considerable advantage since due to the increase in the number of signaling stations, the available range of the frequency spectrum is rapidly being pre-empted so that any economy in the utilization of this range becomes of first importance.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing, Figure 1 of which is a circuit diagram of the transmitting apparatus employed, while Figs. 2 and 3 are circuit diagrams of two forms of receiving apparatus.

Referring to Fig. 1, 10 designates an antenna structure for radiating telegraph signals, said antenna structure being provided with three branches through which different signaling channels may be associated with the antenna. Only one signaling channel is illustrated, however. The parallel branches of the antenna structure may be roughly tuned so as to secure partial selectivity between the several channels. For sharp selectivity between the channels, however, each channel will be provided with a band filter such as BF, this filter being of the general

type disclosed in the Campbell patent, above referred to.

The fundamental carrier frequency for the channel illustrated is supplied by means of a generator G, which may be of any well known type, but is illustrated as being a vacuum tube oscillator. The carrier frequency supplied by this oscillator is applied to a modulating arrangement M whereby the signals may be imposed upon the carrier frequency. The modulating apparatus M may be of any well known type but is illustrated as a vacuum tube modulator of well known construction. In order that the signals may be produced at a high rate of speed, a perforated tape transmitter T of well known construction is provided, the tape being so arranged that as it passes under a brush 11, the potential applied to the grid of a vacuum tube amplifier may be varied in accordance with the signals to be transmitted. As illustrated the potential of the grid is varied by opening and closing the connection of a battery in the grid circuit. As a result of this action amplified signaling currents appear in the output circuit of the amplifier A and are imposed upon the modulator M. This results in the production of a band of modulated frequencies in the neighborhood of the fundamental carrier frequency supplied by the oscillator G and the width of the band will increase as the speed of signaling is increased.

The modulating arrangement above described is such that the modulation of the carrier currents in accordance with signaling currents is accomplished under conditions involving small amounts of energy. In order to increase the energy for purposes of radiation, a power amplifier PA is provided. This amplifier may be of any well known type but as illustrated comprises a multiple arrangement of vacuum tubes capable of handling large quantities of energy. By means of the amplifying arrangement, the relatively small quantity of energy employed for modulation may be greatly augmented.

As is well understood in the art, the modulation of a carrier frequency by a signaling band, such as is involved in rapidly produced telegraph signals, results in the production of two side bands on either side of the fundamental carrier frequency, each side band having a width equal to that of the signaling band. As it is not necessary to radiate both side bands, the band filter BF may be designed to eliminate one side band while freely transmitting the other, thereby economizing in the percentage of the frequency range employed for the channel.

For receiving purposes, an arrangement, such as is shown in Fig. 2, may be employed. In this figure 12 designates the receiving antenna which may be multiplexed as indicated by the provision of a plurality of branches, so that a receiving channel may be associated with each branch. The signaling channel associated with but one of the branches is illustrated and this channel includes a band filter BF′ of the type disclosed in the above mentioned Campbell patent. This filter is so designed as to accommodate a band of frequencies of the width of that transmitted from the channel of the station illustrated in Fig. 1, while suppressing frequencies lying without its range. An amplifier A′ is provided for the purpose of amplifying the high frequency oscillations transmitted through the band filter. This amplifier may be of any well known type but for purposes of illustration a vacuum tube amplifier has been employed. In order to detect from the received band of frequencies, the signaling currents in accordance with which the carrier frequency was modulated at the sending station, a detector D is provided. While this detector may be of any well known type, it is preferably a vacuum tube detector since this form of detector is inertialess and furthermore functions to amplify the detected signaling current corresponding to the signals originating at the sending station.

Since the detected signaling currents will be of fairly high frequency where a high speed transmitter is employed, some recording apparatus must be associated with the output circuit of the detector which is capable of responding to currents of such frequency. A recording device to serve this purpose should be substantially free of mechanical inertia and should preferably be capable of making a visible record of the received signal. In Fig. 2, the recording means is illustrated as a device, such as the well known Einthoven oscillograph, by means of which a beam of light from a mirror 13 may be caused to oscillate upon a photographic recording tape T′.

A slightly modified form of receiving circuit is illustrated in Fig. 3. In this case the amplifier A′ and the band filter BF′ may be interchanged if desired, as it is immaterial whether the filter or the amplifier be placed in the channel first. The parallel branches of the antenna may, if desired, be roughly tuned as described in connection with the antenna of Fig. 1. The selectivity attained through thus tuning the branches is not of a very high degree, the band filter BF′ being depended upon for sharp selectivity. In the case of Fig. 3, the recording device is illustrated as an arc 14 supplied from a direct current source 15 through an impedance coil 16, so that when the arc is active a stream of light is emitted. The output circuit of the detector D is connected as a shunt to the electrodes of the arc, so that the detected currents corresponding to the signals at the transmitting station modulate

the arc and vary its intensity. If desired, a band filter BF'' of the Campbell type may be employed for suppressing any high frequency components appearing in the output circuit of the detector D. A reflector R may be provided in connection with the arc for reflecting the beam of light generated by the arc so that it falls upon a lens L. The beam of light is thus focused upon the surface of a sensitive recording tape T' and the modulations of the arc corresponding to the signal generated at the distant station will thus be recorded.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. The method of radio signaling which consists in modulating a carrier frequency in accordance with signaling current produced at a speed sufficiently high so that the band of frequencies resulting from modulation will be too wide for transmission through a sharply tuned selective circuit, and selecting the modulated band with substantially negligible and uniform attenuation while sharply discriminating against and substantially suppressing adjacent frequencies lying without the band.

2. The method of radio signaling which consists in modulating a carrier frequency in accordance with signaling currents produced at a speed sufficiently high so that the band of frequencies resulting from modulation will be too wide for transmission through a sharply tuned circuit, selecting the modulated band with substantially negligible and uniform attenuation while sharply discriminating against and substantially suppressing adjacent frequencies lying without the band and detecting signaling currents from the selected band.

3. The method of radio signaling which consists in modulating a carrier frequency in accordance with signaling currents produced at a speed sufficiently high so that the band of frequencies resulting from modulation will be too wide for transmission through a sharply tuned circuit, selecting the modulated band with substantially negligible and uniform attenuation while sharply discriminating against and substantially suppressing adjacent frequencies lying without the band, detecting from the selected band signaling currents corresponding to the high speed signals originally produced and modulating a light stream in accordance with said signaling currents.

4. In a radio signaling system, a modulator, means for supplying carrier currents thereto, an automatic transmitter for controlling said modulator, said transmitter being operated at a speed sufficiently high so that the band of frequencies resulting from modulation will be too wide for substantially distortionless transmission through sharply tuned circuits, a band filter for selecting the band of frequencies resulting from modulation and means for detecting from the transmitted band signaling currents corresponding to the signals produced by the automatic transmitter.

5. In a radio signaling system, a modulator, means for supplying carrier currents thereto, an automatic transmitter for controlling said modulator, said transmitter being operated at a speed sufficiently high so that the band of frequencies resulting from modulation will be too wide for substantially distortionless transmission through sharply tuned circuits, a band filter for selecting the band of frequencies resulting from modulation and a substantially inertialess recorder for translating the detected signaling currents into recorded signals.

6. In a radio receiving system, means for receiving a band of frequencies resulting from the modulation of a carrier by telegraph signals, the width of said band being too great for substantially distortionless transmission through sharply tuned circuits, a band filter for selecting the received band, an integrating detector for translating the received band into currents representing high speed telegraph signals and a substantially inertialess recorder associated with said detector.

7. In a radio receiving system, means for receiving a band of frequencies resulting from the modulation of a carrier by telegraph signals, the width of said band being too great for transmission through sharply tuned circuits, a band filter for selecting the received band, an integrating detector for translating the received band into currents representing high speed telegraph signals and means for translating the detected signaling currents into light waves.

8. The method of recording carrier current signals which consists in detecting currents of the original signaling frequency and wave form in accordance with which the carrier currents were modulated and in them impressing the detected currents upon a substantially inertialess recorder.

9. The method of recording carrier current signals which consists in detecting currents of the original signaling frequency and wave form in accordance with which the carrier currents were modulated and in then modulating an inertialess recording medium in accordance with said detected currents.

10. The method of recording carrier current signals which consists in detecting currents of the original signaling frequency and wave form in accordance with which

the carrier currents were modulated and in then modulating a light stream in accordance with the detected currents.

11. The method of recording carrier current signals which consists in detecting currents of the original signaling frequency and wave form in accordance with which the carrier currents were modulated, modulating a light stream in accordance with the detected current and then recording the modulations upon a medium sensitive to light.

In testimony whereof I have signed my name to this specification this 29th day of April, 1920.

LLOYD ESPENSCHIED.