Oct. 20, 1931. V. P. THORP 1,827,860

CARRIER TELEGRAPH SYSTEM

Filed Oct. 22, 1929 2 Sheets-Sheet 1

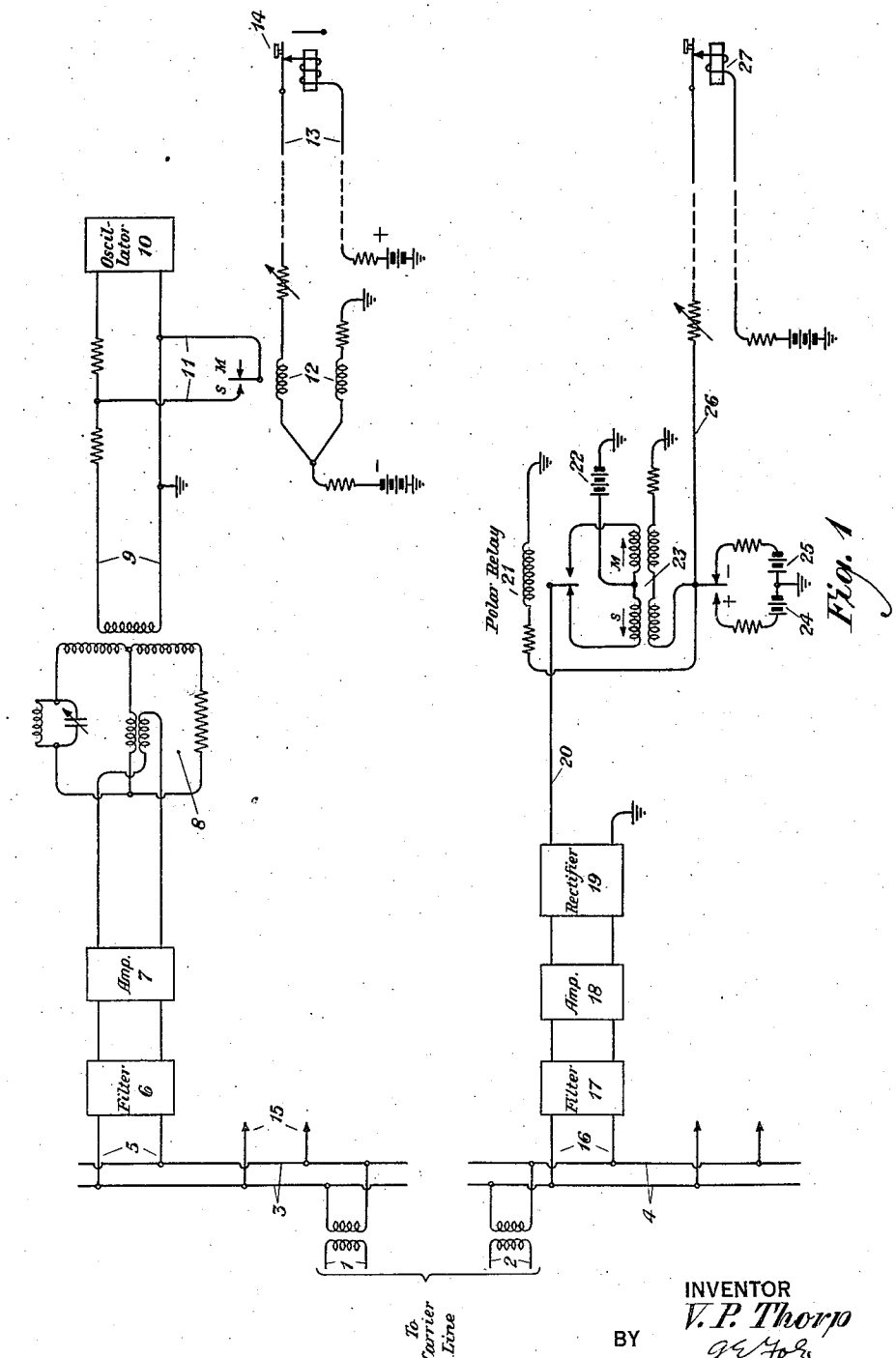


Fig. 1

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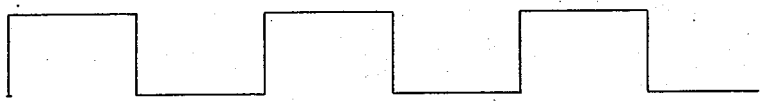


Fig. 2

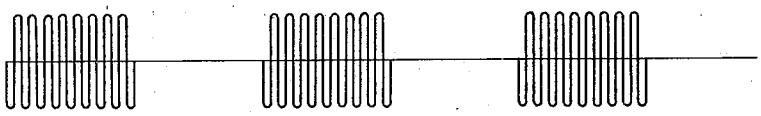


Fig. 3

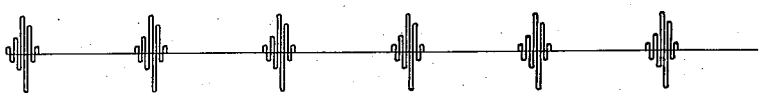


Fig. 4

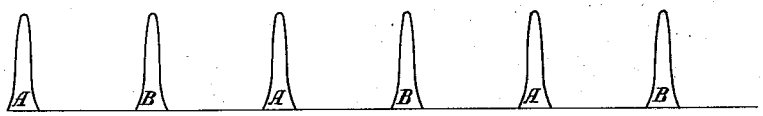


Fig. 5

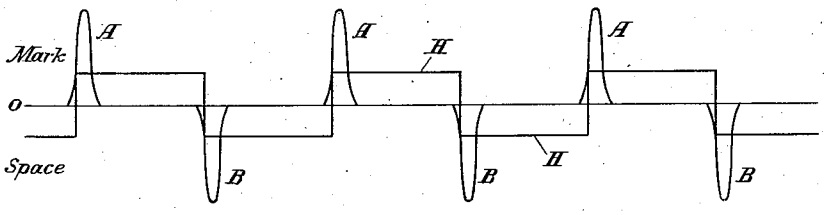


Fig. 6

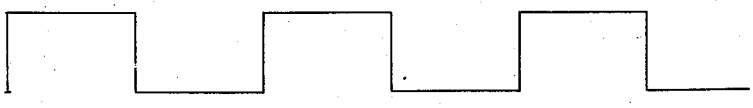


Fig. 7

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Patented Oct. 20, 1931 1,827,860

UNITED STATES PATENT OFFICE

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CARRIER TELEGRAPH SYSTEM

Application filed October 22, 1929. Serial No. 401,513.

This invention relates to telegraph systems and more particularly to improvements in systems utilizing carrier frequency currents in connection with the transmission of the telegraph messages.

In the arrangements of this invention the carrier frequency current is suppressed and either one or both sidebands of the signal-modulated carrier are transmitted over the line. Receiving arrangements are provided in the system which require no local carrier current. A system embodying the features of this invention will provide improved signal transmission in that it affords the equivalent of polar operation. A further feature of the arrangements of the invention is that the effect of line equivalent changes on bias in signal reception will be minimized. Furthermore, an increased number of channels in the same frequency range may be provided with the arrangements of the invention. The arrangements also cause the signal to noise ratio to be increased, thus reducing interference with the signals. Further objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description, together with accompanying drawings in the Figures 1, 2, 3, 4, 5, 6 and 7 of which the invention is illustrated. Fig. 1 is a circuit diagram illustrating a preferred embodiment of the invention. Figs. 2 to 7, inclusive, illustrate the wave shape of the signaling currents in various portions of the system.

In Fig. 1 is shown a circuit diagram of sending and receiving apparatus located at one end of a carrier telegraph line. A connection may be established with the carrier telegraph line by circuit 1 which is connected to a common sending circuit 3. Connected to circuit 3 is a circuit 5 which includes a filter 6, an amplifier 7, and a "frequency bridge" 8. The bridge 8 is connected to a circuit 9 which will include an oscillator or source of carrier frequency 10. The application of carrier current from this source to circuit 9 may be controlled by the short-circuit 11, which in turn is controlled by the sending relay 12 in the subscriber's loop circuit 13. A key 14 is shown for operating the sending relay 12. When the sending relay armature is on its spacing contact, the output of the carrier oscillator is short-circuited. When the armature is on its marking contact, the carrier current is allowed to flow into the "frequency bridge" 8. This bridge circuit is balanced at the carrier frequency by a resistance and a parallel tuned circuit tuned to the carrier frequency. The neutral points of the bridge are connected to one winding of a transformer, the secondary of which is connected to amplifier 7 if necessary, otherwise directly to the sending filter 6. It is evident that no carrier current will pass to the amplifier through the bridge circuit, but frequencies other than the carrier frequency will pass through with relatively small attenuation. When a signal modulated carrier wave is applied to the bridge circuit, such as occurs when the subscriber's telegraph key is closed, the side band frequencies will pass through the frequency bridge to the sending amplifier and filter. This will consist of a short train of waves at the beginning and end of a dot signal. This is more clearly shown in Fig. 4, which is labeled "line current and input to detector". Fig. 2 shows the sending loop current and Fig. 3 shows the carrier input to the frequency bridge. Other carrier channels might be connected to the sending circuit 3 by means of circuits such as 15.

Frequencies similar to those heretofore described transmitted from the distant end of the carrier line, are transmitted over circuits 2 and 4 and thence over circuit 16 to the receiving filter 17. They would then be transmitted through amplifier 18 to the detector 19. The detector output circuit 20 is completed over the contacts of a polar relay 21 and thence through either of the operating windings of the receiving relay 23 to the battery 22. The holding windings of the receiving relay 23 are connected over the armature and contacts of said relay to the oppositely poled batteries 24 and 25. The loop circuit 26, which includes the sounder 27, is connected to the armature of the receiving re-

lay. The circuit for the polar relay 21 extends from ground to the armature of the receiving relay 23 and thence to the batteries 24 and 25 to ground.

The output of the detector is, as shown in Fig. 5, a unidirectional current pulse at the beginning and end of a dot signal. As has been pointed out, a differential connection to the receiving relay operating windings is made through the armature and contacts of the polar relay 21, which is operated in a leak circuit from the receiving relay armature to ground. In Fig. 1 the receiving relay circuit is shown just after a marking pulse has been received and in condition to receive a spacing pulse when it comes in from the line. A holding current is passed through the lower windings of the receiving relay, as shown in Fig. 6, and serves to keep the receiving relay armature on the proper contact between pulses. Let it be assumed that the telegraph key at the sending station is opened and the carrier input to the frequency bridge is suddenly stopped. A train of waves will be again transmitted over the line and rectified at the receiving end. The rectified current passes through the armature and contact of relay 21 and one winding of the receiving relay in such a direction as to cause it to overcome the effect of the holding current and move to its spacing contact. After this has occurred, the holding current reverses and holds the armature on the spacing contact; the auxiliary polar relay 21 connects the receiving relay winding to the detector plate circuit in such a way that the next incoming pulse will operate the receiving relay armature to its other contact.

Since the above described arrangement is in effect one in which the transmission of signals is "polar", a poorer wave shape may be used than if the transmission were of the "open and close" type. For this reason, it would be possible to use filters having a smaller band width and thereby obtain more channels in a given frequency range.

If the filters are made with a sharp cut-off, it may be possible to locate the carrier frequency near the outer edge of the normal band used for signaling and thereby eliminate one of the side bands. It seems that this could be done readily since the frequency bridge eliminates the carrier frequency and attenuates considerably the frequencies close to it on either side. The amount of attenuation of the lower frequency components varies inversely with the sharpness of tuning of the tuned circuit in the frequency bridge. For signaling speeds up to 24 cycles, it would probably be desirable to make the tuned circuit resistance as low as practicable in order to prevent excessive attenuation to the lower frequencies.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. The method of telegraph signaling which comprises modulating a carrier frequency current with telegraph signals so as to produce pulses of current of the carrier frequency, suppressing said carrier and transmitting sidebands of the signal-modulated carrier at the beginning and end of each pulse of current of the carrier frequency which are also produced by modulation.

2. In a carrier telegraph system the method of signaling which comprises transmitting only the sidebands of the signal-modulated carrier frequency current for brief intervals at the beginning and end of each transmitted pulse of carrier frequency current.

3. In a carrier telegraph system the method of signaling which comprises modulating carrier current in accordance with signals so as to produce pulses of the carrier current and sidebands which occur only at the beginning and end of each pulse of the carrier current, transmitting only the sidebands of the signal-modulated carrier frequency current, receiving said transmitted sideband currents, rectifying said received sideband currents, and utilizing said rectified current to operate signaling means.

4. A telegraph line, sending apparatus connected thereto comprising a source of carrier frequency current, means for interrupting current from said source in accordance with signaling currents so as to produce sidebands at the beginning and end of each pulse of carrier current, a Wheatsone bridge circuit for suppressing the carrier component of said signal-modulated carrier frequency current, and means for transmitting said sidebands of said signal-modulated carrier to said line.

5. A telegraph line, a sending circuit connected to said line, a source of carrier frequency current connected to said sending circuit, means connected to said sending circuit for modulating the carrier current transmitted over said sending circuit with signaling currents so as to produce pulses of the carrier current and sidebands which occur at the beginning and end of each pulse of the carrier current, and a frequency bridge circuit in said sending circuit balanced at said carrier frequency whereby said carrier frequency will be suppressed and the sideband components transmitted to said telegraph line.

6. A telegraph line, sending apparatus connected thereto comprising a source of carrier frequency current, means for modulating current from said source with signaling currents, means for suppressing the car-

rier component of said signal-modulated carrier frequency current, means for transmitting the sidebands of said signal-modulated carrier over said telegraph line, and receiving apparatus connected to said telegraph line comprising a detector, a receiving relay and a polar relay, said receiving relay having operating windings differentially connected in the plate circuit of said detector over the contacts of said polar relay, and a circuit for said polar relay completed over the armature of said receiving relay.

7. A frequency bridge circuit for carrier signaling systems designed to suppress the carrier waves after modulation, comprising an anti-resonant circuit tuned to the frequency of the carrier waves and connected as one of the arms of the bridge circuit, and a resistance connected as another of the arms of the bridge circuit having a magnitude equal to the resistance of the anti-resonant circuit at the frequency of the carrier waves.

In testimony whereof, I have signed my name to this specification this 21st day of October, 1929.

VAUGHN P. THORP.