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SYSTEM FOR COMMUNICATING WITH MOVING VEHICLES

Filed March 30, 1928

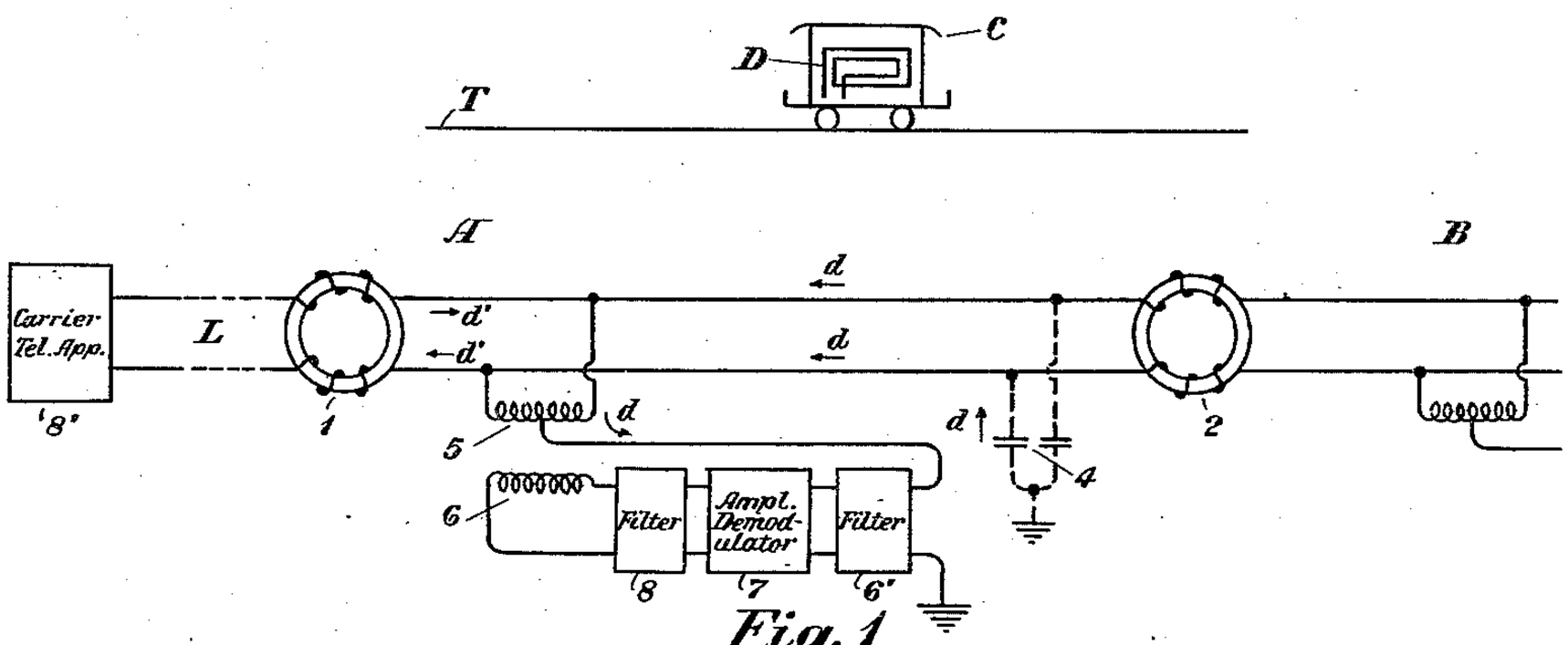


Fig. 1

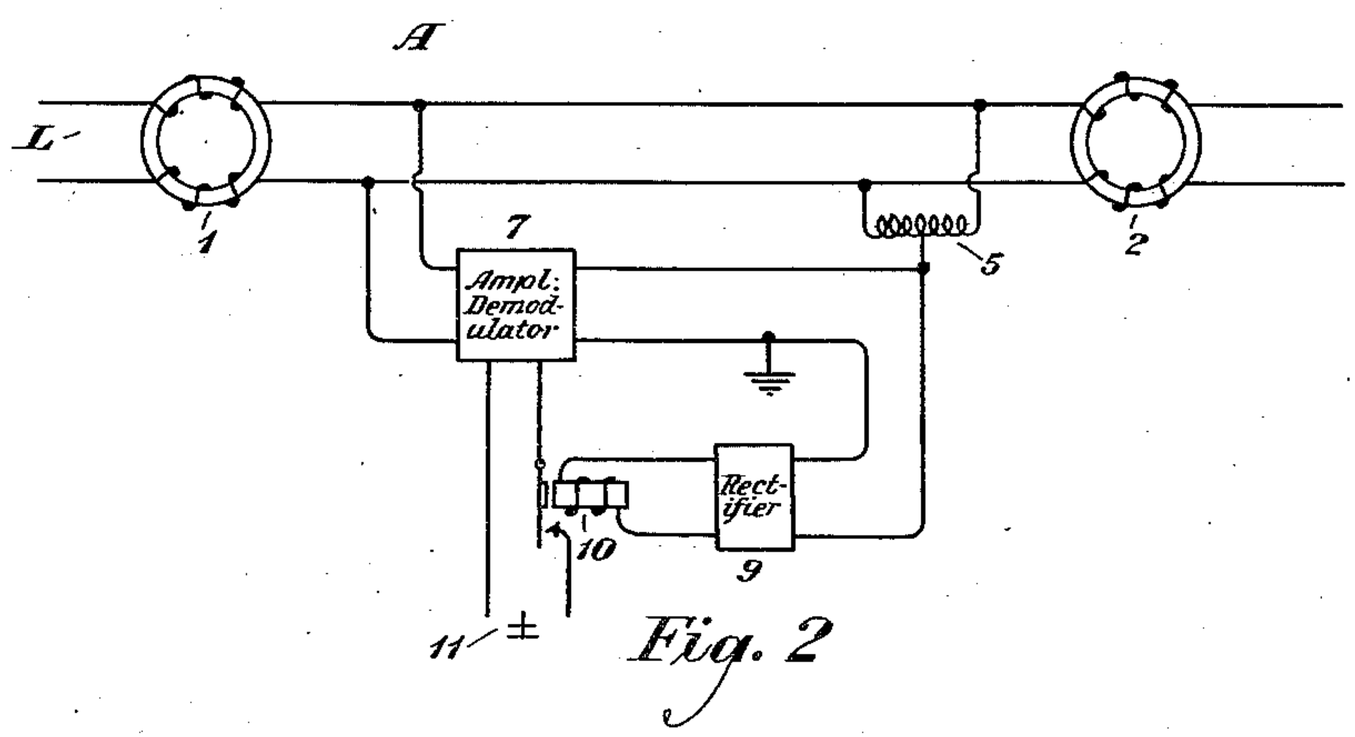


Fig. 2

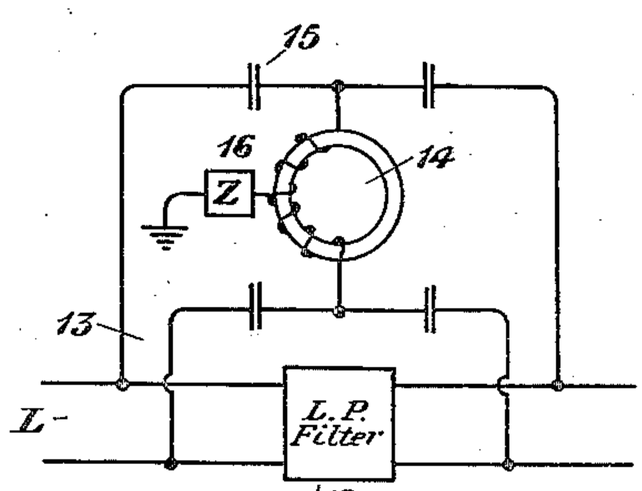


Fig. 3

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# UNITED STATES PATENT OFFICE

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## SYSTEM FOR COMMUNICATING WITH MOVING VEHICLES

Application filed March 30, 1928. Serial No. 266,092.

The invention relates to improved arrangements for establishing communication between a fixed transmission system and a moving vehicle, such as a railroad train.

In certain systems of the above type it has been proposed to transmit the signals along a line circuit paralleling the railroad track and to transfer the signaling energy across the gap between the fixed portion of the system, such as a transmission line, and the movable portion, such as the train, by induction. It has also been proposed to utilize relatively high frequency currents rather than ordinary voice currents, as it has been found that better coupling is obtained at the higher frequencies and hence there can be secured a greater transfer of energy across the gap to and from the moving vehicle than in the case of relatively low frequency signaling currents.

The use of high frequency currents in systems of this type to overcome the "induction attenuation" across the gap between train and line presents certain problems in connection with the attenuation to be encountered on the line circuit, as in general high frequencies are subject to greater attenuation on the line than low frequencies. Also, the transmission in the direction from the moving train to the fixed station presents a particularly serious problem because the transmitting level on the train must be sufficient to overcome the induction attenuation and provide on the wire circuit a level substantially above the level of the line noise. Accordingly, it is the primary object of arrangements of this invention to provide a fixed transmission system for use in communicating with a moving vehicle, which will permit high frequency currents to be utilized to reduce "induction attenuation" across the gap and in which the attenuation of such currents on the line will be materially reduced. 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 the accompanying drawing, in the Figures 1, 2 and 3 of which the invention is illustrated. In Fig. 1 is a circuit diagram embodying a preferred form of the invention. Fig. 2 shows a modification of a portion of the arrangements of Fig. 1. Fig. 3 shows a modification of another portion of the arrangements of Fig. 1. Similar reference characters have been utilized to denote like parts in all of the figures.

In the arrangements of Fig. 1 is shown a track T on which would be a moving vehicle, such as the car C. In the car C is shown a loop or antenna D to which would be connected high frequency carrier transmitting and receiving apparatus. In the vicinity of the track would be located a transmission line L. With one end of the line L would be associated high frequency carrier transmitting and receiving apparatus, such as 8'. The longitudinal circuit of the transmission line would be divided into certain sections, such as A and B, by means of inductance coils, such as 1 and 2. Connected to each of these line sections would be a translating device, such as 3.

Considering the transmission from the train to the fixed station, the high frequency carrier currents in the loop D on the train would be transmitted across the gap from the train to the transmission line L by induction and would traverse the conductors of the line in parallel with ground return due to the capacity between the conductors and earth, as indicated by the condensers 4, shown in dotted lines. In other words, under such conditions the line circuit L would operate as a longitudinal circuit with ground return. It is pointed out that the attenuation between a longitudinal circuit of this type and earth is ordinarily high as compared to the attenuation between a pair of conductors forming a metallic circuit and a greater amount of line noise is generally found on the longitudinal circuit. Furthermore, the longer the longitudinal line circuit the greater would be such attenuation. Accordingly, the longitudinal line circuit is, in accordance with the arrangements of the invention, broken up into a number of sections by the induction coils, such as 1 and 2. The windings

of these induction coils are arranged to be parallel aiding and hence produce a large flux in the core and a high impedance to the longitudinal currents. As the windings are series opposed the flux is negligible, and hence the impedance in a metallic circuit would be negligible. Bridged across each longitudinal section of the line would be a transformer winding, such as 5. The mid-point of this winding would be connected to ground through the filter 6′ which is connected to the input of a translating device such as the amplifier-demodulator 7. Connected to the output of the amplifier-demodulator 7 would be a filter 8 which might suppress undesired modulation products, and a winding 6 inductively related to the winding 5. The longitudinal currents induced in the section A of the line circuit by the currents in the loop D in the car might take the path shown by the arrows *d*. These currents in passing through the winding 6 would induce currents in the winding 5, which currents would be applied to the sides of the line circuit L in series or as if the line were now a metallic circuit. These currents are indicated by the arrows *d′*. These currents would readily be transmitted through the induction coils, such as 1 and 2, as the line would now be operating as a metallic circuit. Accordingly, these currents would be transmitted metallically to the apparatus 8′ at the end of the circuit. As has been previously pointed out, the attenuation of the signal currents when transmitted over a metallic circuit is smaller than when these currents are transmitted over a longitudinal circuit and the signals are less subject to line interference when they are being transmitted over the metallic circuit. Furthermore, the signaling currents will be reduced in frequency by the demodulator apparatus 7 either to the voice level or to a lower carrier level than their original level. These lower frequency currents will be obviously less subject to attenuation in transmission over the line circuit. Accordingly, the arrangements of the invention effect a large reduction in the attenuation of the currents in transmission over the fixed portion of the system, both by reducing the frequency of such currents and transmitting such currents metallically rather than longitudinally.

Transmission from the fixed station to the train might be accomplished without a change in the signal frequency, according to the general method described in my copending application, Serial No. 266,091, filed March 30, 1928, or it might be carried out in a manner precisely the reverse of that described for transmission from the train to the fixed station. These comparatively low frequency currents might be transmitted over the metallic circuit and then might be applied to the longitudinal line sections after being stepped up in frequency. Different frequency bands might be employed for transmission in opposite directions.

If the energy drain on the amplifier-demodulator apparatus, such as 7, presents a serious problem, it might be desirable to use an arrangement whereby the power supply of such apparatus is turned on only when the train enters the particular section of the line wherein such apparatus is located. This might be done in conjunction with the apparatus comprising the regular train automatic control, or the carrier signaling currents themselves might be employed for this purpose, as illustrated in Fig. 2. In this arrangement the longitudinal currents transmitted through winding 5 would be transmitted to ground through the input of the demodulator apparatus 7 in the usual manner. Bridged across this input circuit would be a rectifier 9 having a relay 10 included in the output circuit thereof. The signaling current thus transmitted to the demodulator would operate the relay 10 to connect a source of energy 11 to the demodulator apparatus 7 to cause it to operate. The output of the demodulator 7 would then apply the incoming currents to the line L metallically rather than longitudinally, as heretofore explained.

By the use of suitable filter circuits the employment of the line circuit may be made selective so that the high frequency carrier currents do not affect the regular telegraph or voice transmission uses of the circuit. If desired, the breaking up of the longitudinal circuit may be carried out by line filter type apparatus at the sectionalizing points, such as illustrated in Fig. 1, by the inductance coils 1 and 2, and the high frequency circuit may be manipulated independently of the low frequency or voice circuit. It may be desirable either to open up the longitudinal circuit for high frequency while maintaining continuity of the high frequency metallic circuit or to ground the longitudinal circuit or to terminate it in a definite impedance to ground. In Fig. 3 is shown an arrangement which might be substituted in the line at the sectionalizing points in place of the inductance coils, such as 1. A low-pass filter 12 would be provided in the line at such a point. Bridged around the low-pass filter would be a high-pass filter circiut 13, comprising inductance coils 14, which might be grounded at their central point through an impedance 16 and condensers, such as 15. With such an arrangement impedance conditions on the line might be adjusted to obivate reflection losses.

While the arrangements of the invention have been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that they are capable of embodiment in other forms without de-

parting from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A system for communicating with moving vehicles comprising a transmission line inductively associated with a moving vehicle, means for sectionalizing said line with respect to currents applied thereto in a certain manner, and means in each of said line sections to apply said currents to said line in a different manner, said sectionalizing means comprising a low-pass filter in said line, a selective circuit bridged around said filter, inductance coils in said bridged circuit having their windings parallel aiding, and means to ground the midpoints of said inductance windings through an impedance.

2. A system for communicating with moving vehicles comprising a transmission line inductively associated with signaling apparatus in a moving vehicle whereby currents will be induced from said signaling apparatus into said line and will traverse the sides of said line in parallel, means for dividing said line into sections with respect to currents traversing the sides of the line in parallel, means for reducing the frequency of currents thus traversing the line, and means for applying said currents as reduced in frequency to said line whereby they will traverse the sides thereof serially.

3. A high frequency system for communicating with moving vehicles comprising a transmission line inductively associated with signaling apparatus in a moving vehicle, means in said line for demodulating the currents induced therein from said signaling apparatus, and means for applying said demodulated currents to the sides of said line in series.

4. A high frequency system for communicating with moving vehicles comprising a transmission line inductively associated with signaling apparatus in a moving vehicle, means for sectionalizing said line with respect to currents induced by said signaling apparatus to traverse the sides of said line in parallel, a circuit individual to each of said line sections and responsive to said induced currents, a demodulator in each of said circuits, means associated with the input of each of said demodulators and responsive to said induced currents for energizing said demodulator, and means to apply the output current of the demodulator to the sides of the line in series.

5. The method of establishing communication between a transmission line and signaling apparatus in a moving vehicle which comprises causing said signaling apparatus to induce high frequency currents to traverse the sides of said line in an arbitrary manner, sectionalizing said line with respect to said induced currents, reducing the frequency of the induced currents traversing the sides of the line in said arbitrary manner, and applying said reduced frequency currents to said line in another manner.

In testimony whereof, I have signed my name to this specification this 28th day of March 1928.

HERMAN A. AFFEL.