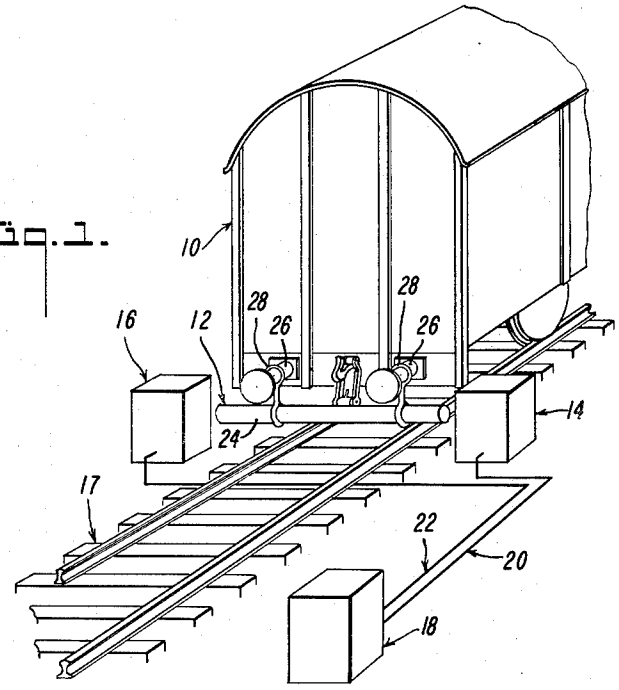
Jan. 31, 1961 A. KAROLUS 2,970,211

TRAIN-END SIGNALLING DEVICE

Filed April 1, 1958 5 Sheets-Sheet 1

Fig. 1.



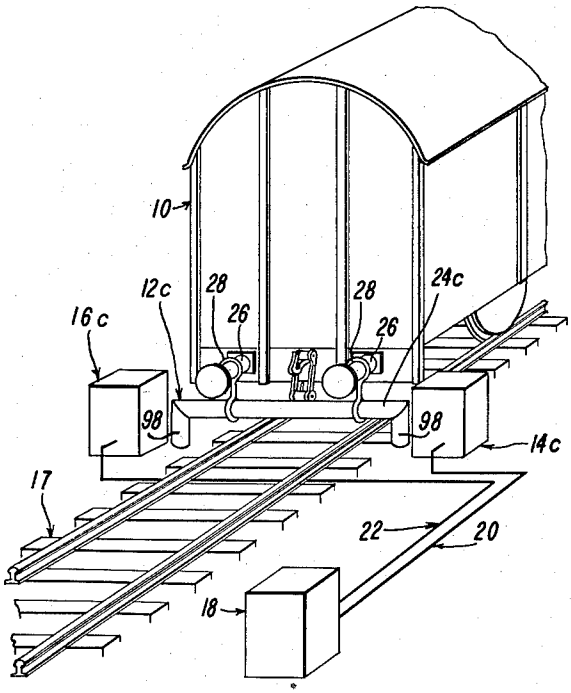




Fig. 6.

INVENTOR.
AUGUST KAROLUS
BY Walter S. Preston
ATTORNEY

Jan. 31, 1961 A. KAROLUS 2,970,211

TRAIN-END SIGNALLING DEVICE

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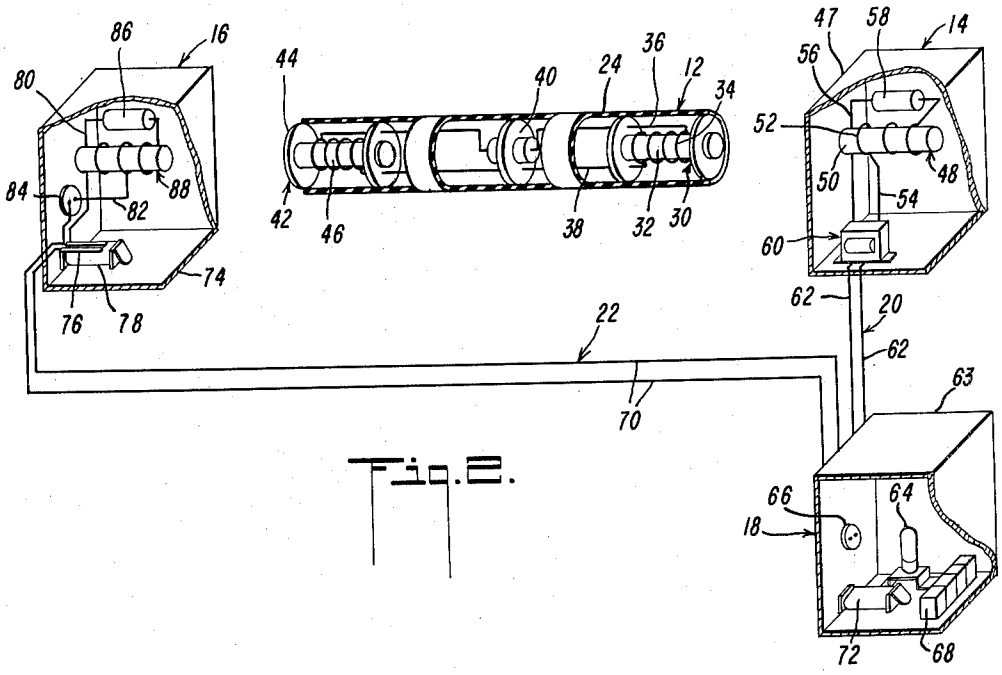


Fig. 2.

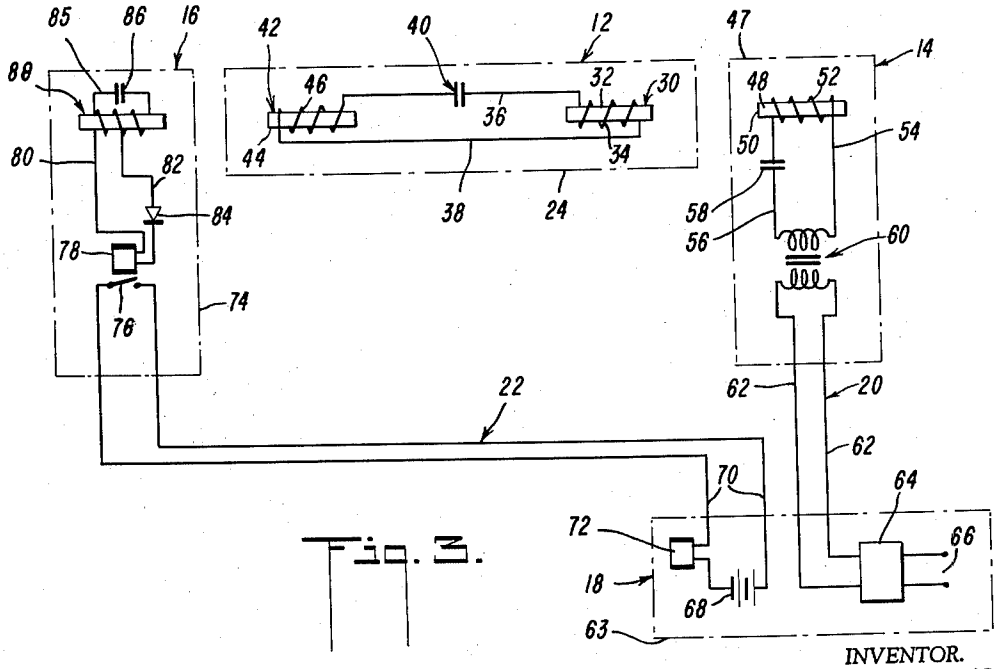


Fig. 3.

INVENTOR.
AUGUST KAROLUS

BY Walter S. Bleeton

ATTORNEY

Jan. 31, 1961 A. KAROLUS 2,970,211

TRAIN-END SIGNALLING DEVICE

Filed April 1, 1958 5 Sheets-Sheet 3

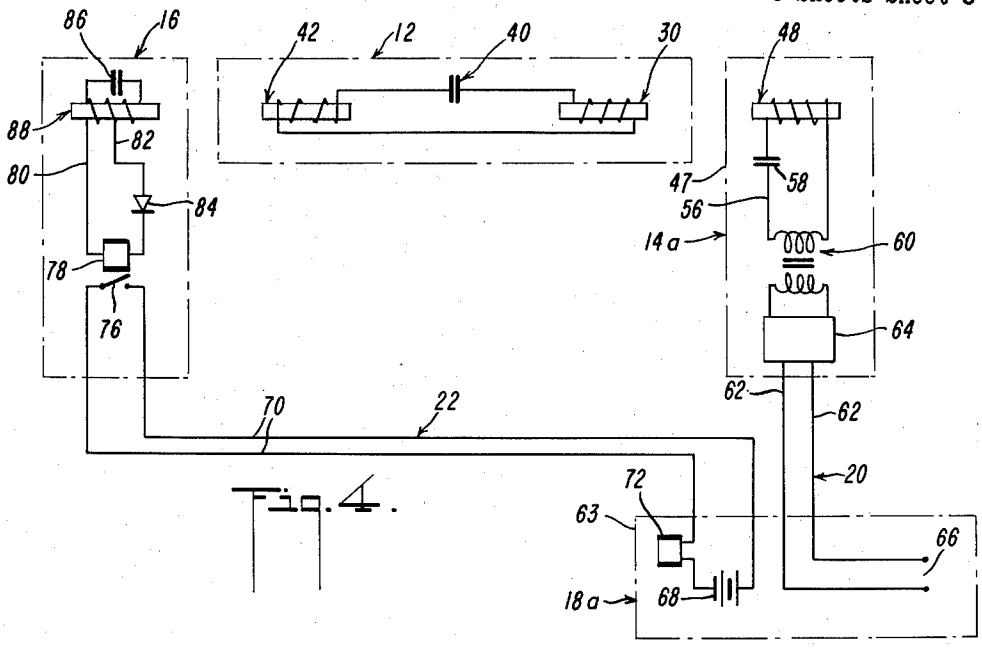


Fig. 4.

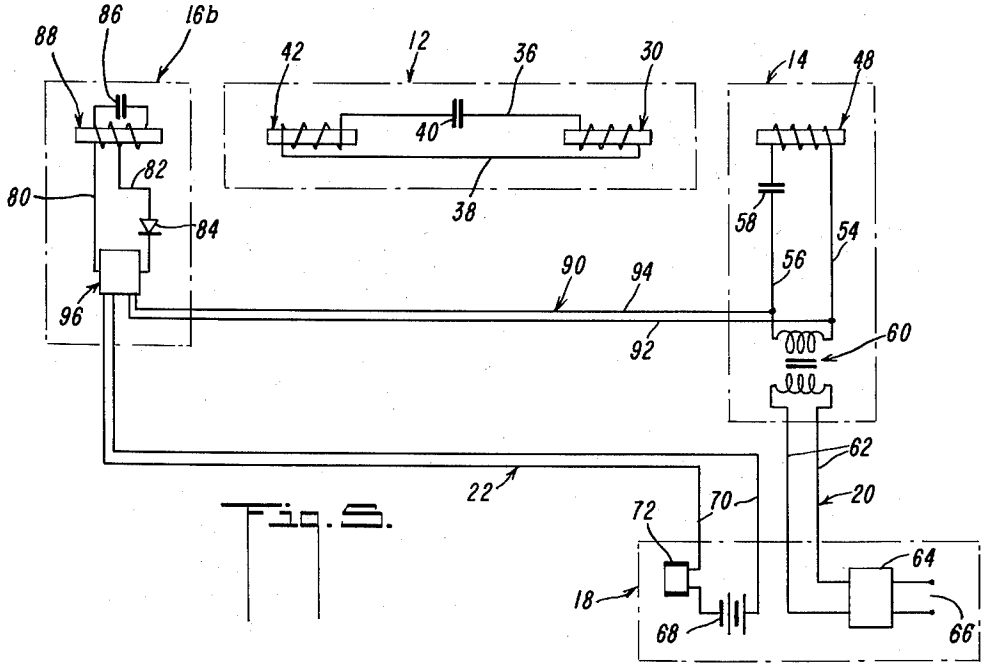


Fig. 5.

INVENTOR.
AUGUST KAROLUS

BY Walter S. Hester

ATTORNEY

Jan. 31, 1961 A. KAROLUS 2,970,211

TRAIN-END SIGNALLING DEVICE

Filed April 1, 1958 5 Sheets-Sheet 4

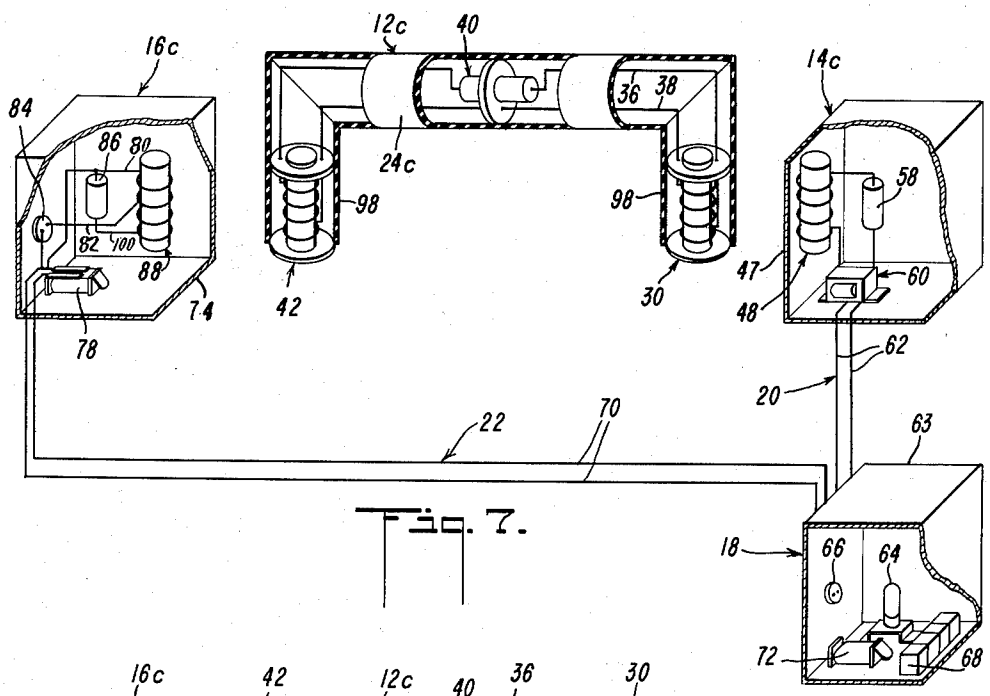


Fig. 7.

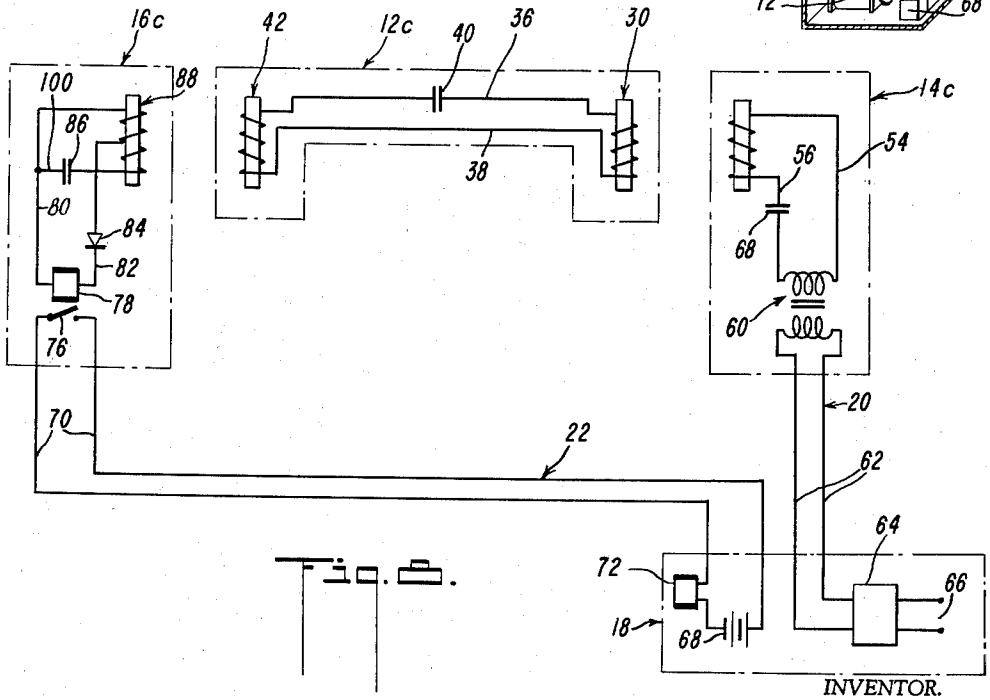


Fig. 8.

INVENTOR.
AUGUST KAROLUS
BY Walter S. Fleeton
ATTORNEY

Jan. 31, 1961 A. KAROLUS 2,970,211

TRAIN-END SIGNALLING DEVICE

Filed April 1, 1958 5 Sheets-Sheet 5

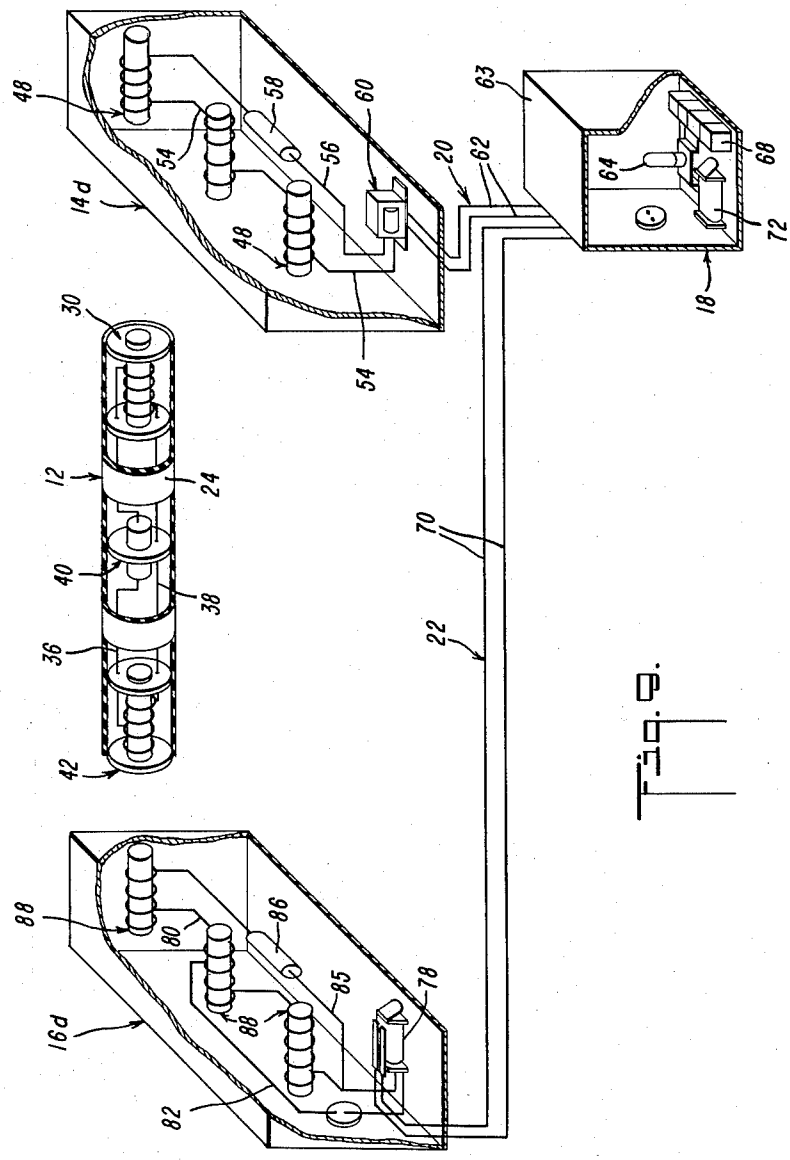


Fig. 5.

INVENTOR.
AUGUST KAROLUS
BY Walter S. Preston
ATTORNEY

United States Patent Office 2,970,211
Patented Jan. 31, 1961



2,970,211

# TRAIN-END SIGNALLING DEVICE

August Karolus, Zollikon, Switzerland, assignor to Societe Technique pour l'Industrie Nouvelle S.A. Stin, Vevey, Switzerland, a Swiss corporation

Filed Apr. 1, 1958, Ser. No. 725,657

1 Claim. (Cl. 246—249)

This invention relates generally to improvements in railway signalling apparatus, and more particularly has reference to that type of device, falling within this general category, known as a train-end signalling device.

This application is a continuation-in-part of my application Serial No. 503,947 filed April 26, 1955, now abandoned.

Such devices are used to provide a signal, at one or more selected locations along the right-of-way, that a train, and more particularly the rear end thereof, has completely passed a given point along the track.

A large number of devices have been proposed for accomplishing the above stated purpose, with the general function of all such devices being the transmission of signals between train and track. Said devices are of an electrical nature, and it is particularly known to provide train-end signalling devices the operating characteristics of which are based on an inductive action.

However, serious difficulties have been noted in connection with devices having the characteristics described above. Mainly, said difficulties reside in the fact that disturbances that would otherwise arise, due to the metallic walls and large masses of iron and steel components found in all railroad cars, must be eliminated. Removing these components as factors tending to disturb the proper operation of the mentioned type of apparatus in an electrical sense produces other problems, and among these is the fact that the apparatus on the train and at trackside tends to become too bulky. When, however, one attempts to produce devices of the character described which are not bulky and cumbersome in nature, it becomes difficult to maintain the spacing between the apparatus (provided at trackside) and the apparatus (provided on the car) sufficiently small to maintain the profile of the car within the prescribed limits.

The difficulties noted above are particularly great in the case of a so-called train-end indicator, where it is necessary to equip the last car of the train with a light, readily exchangeable apparatus which does not require a source of electrical energy and which, when passing cooperating devices at trackside, enters into an operative relationship with said complementary or cooperating devices, to provide the desired train-end signal at a selected, remote point.

That the train-carried components of the apparatus should have the characteristics of lightness and ready removability is, of course, of prime importance, since when a train is made up, any of a large number of cars might be used as the rear car. Obviously, the train-end indicating means should, desirably, be as readily portable and removable as the various other train-end devices that are placed upon a last car of a train, such as the end lamps, etc.

The mentioned difficulties are accented even more by reason of the fact that the train-carried components of the apparatus must be so mounted upon its associated car that its geometric location will be identical for any of the large number of different types of cars on which such



a component might be placed during the ordinary use thereof. To so locate the end signal on the various types of cars in use, it has been found that the minimum spacing between the train-supported components, and the cooperating components disposed at trackside, must be of a value or magnitude of about fifty centimeters. In fact, even if the end signal is arranged below the buffers of the car, a minimum spacing of about thirty centimeters must still be maintained.

The relatively high value or magnitude of this minimum spacing between the locations of the mutually interacting train-supported and stationary components of train-end signalling devices has heretofore, it has been found, rendered the practical realization of efficiently operating train-end indicators impossible. The various difficulties indicated, in fact, have necessitated in all instances that the metal components of the cars, having the characteristic of creating electrical disturbances and consequent inefficient operation of a train end signal, come much closer to the components disposed at trackside, than do the train-mounted components.

It has been proposed, in various of the devices noted above, that one employ a reaction of an electrical nature, by the train-supported components of the apparatus upon the transmitting components, for signalling purposes. However, the sensitivity to electrical disturbances, in circumstances such as these, would be excessive in view of the fact that any fluctuations in the oscillator (for example, voltage changes) can have exactly the same effect on the signalling apparatus as that produced by the train itself. As a result, a serious tendency toward malfunctioning and unreliable operation manifests itself.

In view of the difficulties which have heretofore persisted, it is proposed to provide a generally improved train-end indicating device that will not have the deficiencies noted above, and that will have all the characteristics hereinbefore indicated as being desirable in devices of this type.

Accordingly, summarized briefly, the present invention includes a transmitting coil the physical shape of which is that of a long solenoid. Within this coil, a generator creates a magnetic alternating field. The invention includes a receiver tuned to the same frequency as the transmitting coil, with an inductance which conforms to the transmitting coil in its dimensions.

According to the present invention, the transmitting and receiving coils are so spaced apart, or are so arranged geometrically with respect to each other, that the direct reciprocal effect between them is negligible. Nevertheless, an energy efficient for signalling purposes is transmitted by use of the apparatus, that is, the end-signal removably attached to the rear end of the last car of the train. The train-supported component of the device comprises, in a basic or simplest form of the invention, two coils. One of these, when the train passes cooperating devices mounted at opposite sides of the track, enters into a coactive relationship with an oscillator coil or coils stationarily mounted at one side of the track. The other enters into a similar relationship with a receiving coil or coils stationarily mounted at the opposite side of the track.

Both coils of the train supported component of the device are electrically connected, with a condenser being provided in the connection so that a resonant circuit is formed in the train-supported component of the device, tuned to the same frequency as the oscillator and the receiver mounted at trackside. The conductive connection between the coils can be of a length such that the distance between the coils, or between the transmitter and receiver, can be made substantially larger than the sum of the air gaps of the magnet system.

In accordance with the invention, all the coils that in-

fluence one another, that is, the coils provided on the track-mounted components as well as those mounted upon the train, contain cores of ferro-magnetic material in order to increase the magnetic induction. Iron oxides (ferrites) developed industrially in recent years have been employed to particular advantage. The cores are in the shape of rods or tubes which, in a preferred embodiment of the invention, are each approximately thirty centimeters in length. Preferably, further, the ferro-magnetic cores of the coils are selected to show minimum losses for the frequency employed, and a permeability as great as possible, in order to be capable of transmitting over an air space, of two times thirty to fifty centimeters, a sufficient energy to effect a transmission from the transmitting assembly mounted at one side of the track to the receiving assembly mounted at the other side of the track.

Since the length of the transmitting and receiving coils amounts, in each instance, to approximately thirty centimeters, and since these coils are spaced from one another approximately three meters, that is, ten dipole lengths, a negligibly small voltage will be transmitted at times when the end signal carried on the train is not interposed between the transmitter and receiver, and is not producing a direct electrical coupling between the same. However, this small voltage does not affect adversely the efficient operation of the device. This is because the nature of and the distance between the transmitter and receiver are such that the direct, disturbing, transmission of energy from the transmitter to the receiver, mounted at opposite sides of the track, is reduced to a rate which is distinctly less than the energy transmitted during the actual operation of the device. The operative signal, that is, the so-called "useful voltage" produced in the receiver during the intended actual operation of the device, amounts to ten to 100 times the residual voltage whenever the train-carried end-signal component passes between the transmitter and receiver and produces operation of the apparatus.

It is appropriate, further, to consider the effect that metal components of the cars would have on the transmitter and receiver, and the invention is such that said metallic portions of a train can only reduce the value of the transmission of energy that is transmitted directly between the transmitter and receiver, at times when the train-carried transmitting coils are not interposed electrically therebetween. This is true when iron tubes or rods, extending transversely of a car and constituting ordinary components of the car or part of the load carried by the car, come to be coaxially aligned with the transmitter and receiver or are otherwise interposed directly therebetween. Even if one substitutes ferrite rods, several meters in length, for the tuned coupling coil means comprising the train-supported component of the invention, the energy transmitted from the transmitter to the receiver remains extremely small. Thus, it will be seen that malfunctioning of the apparatus is eliminated as a factor tending to militate against commercial acceptance thereof.

The frequency of the train-end indicator is between five and fifty kc. In this range, the upper limit is established by the losses due to the eddy currents in the cores which reduce the quality factor of the resonant circuit. The lower limit is defined by the fact that during the time of the passage of the train apparatus, the resonant circuit of the latter and the resonant circuit of the receiver must build up electrically. Only when all circuits are built up to a useful voltage, that is, a voltage of a predetermined value required to effect the signalling action, will said voltage be transmitted between the transmitter and receiver of the stationary components of the device mounted at trackside. This "useful voltage" is quite large as compared to the residual voltage that has previously been described herein, and that occurs at times other than when the end of the train is passing between the transmitter and receiver. In this connection, it should be noted that the duration of the time during which the building up of the voltage is occurring increases in direct proportion or ratio to the quality factors of the circuits. All building up processes must be completed in about one-fiftieth second for a maximum train speed of about thirty meters per second.

A number of examples of the signalling apparatus constituting the present invention will be described in detail herein, with reference to the accompaning drawing, in which:

Fig. 1 is a diagrammatic, perspective view showing the rear end of a train, and illustrating the physical relationship of the train-supported components and the remaining components of the invention;

Fig. 2 is a diagrammatic, perspective view of the various components of the invention, illustrating the details of construction thereof;

Fig. 3 is a wiring diagram of the embodiment of the invention shown in Figs. 1 and 2;

Fig. 4 is a wiring diagram of a modified construction;

Fig. 5 is a wiring diagram of another modification;

Fig. 6 is a view like Fig. 1 showing yet another form of the invention;

Fig. 7 is a view like Fig. 2, of the form of the invention shown in Fig. 6;

Fig. 8 is an electrical diagram of the modification shown in Figs. 6 and 7; and

Fig. 9 is a view like Fig. 2 showing still another modification.

Referring to the drawing in detail, and considering first the form of the invention shown in Figs. 1 to 3, mounted upon the rear end of the last car **10** of a railroad train, is a train-supported component of the invention. In railroad parlance this is ordinarily called, in and of itself, the "end signal," but for the purpose of the present application it is more appropriately termed the connecting or coupling assembly **12** of the apparatus constituting the present invention. The assembly **12** is termed a connecting or coupling assembly for the reason that it provides the electrical connecting or coupling action between a transmitting assembly generally designated **14**, and a receiver assembly generally designated at **16**. These are mounted in transverse alignment with each other in close proximity to and at opposite sides of the railroad track or right-of-way, generally designated **17** in Fig. 1.

As previously noted, there is a very small residual voltage or transmission between assemblies **14** and **16**, at times when the connecting assembly **12** is not interposed directly therebetween in the position shown in Fig. 1. However, this direct transmission, without passage through the intervening assembly **12**, does not affect adversely the proper operation of the device. Further, any transmission through metal components of the cars or through a car-carried load, does not increase the residual voltage and in fact tends to reduce the same.

Designated generally at **18** is the indicating or signalling unit or assembly, which can be located at any remote point, as for example, in a station building, blocking station, or other control point where it is desired to note, either by automatic recordation or by visual observation, the fact that the train end has passed the location of the units **14**, **16**, and the exact time at which the passage occurred.

As shown in Fig. 1, an electrical connection **20**, comprising a two lead conductor, extends between units **14**, **18**, while a similar connection **22** extends between unit **18** and unit **16**.

In Figs. 2 and 3, the details of construction of the apparatus shown in Fig. 1 are provided. Considering the particular construction of the several units, the train-mounted coupling unit **12** will first be described, and has been shown to particular advantage in Fig. 2. Said unit comprises, in this form of the invention, a straight, elon-

gated, constant-diameter, cylindrical casing 24 of electrically insulative material, arranged perpendicularly to the length of the train, so as to extend transversely of the track 17. Housing 24 is suspended from the conventional buffer necks 26 of the car 10, through the provision of clamps or hangers 28. Casing 24 is extended transversely of the train, perpendicularly to the right-of-way, and at its opposite ends terminates at the opposite sides of the car 10, so that it will pass in close proximity to the units 14, 16 during the normal usage of the apparatus.

In this form of the invention, the coupling unit includes a pair of coils, said coils being mounted in the opposite ends of the housing in coaxial alignment with each other and with the elongated housing 24. One of these coils has been generally designated at 30, and includes a core 32 about which is coiled a winding 34. Connected to one end of the winding 34 is a lead 36, while a lead 38 is connected to the other end of the winding.

Connected in the lead 36, medially between the opposite ends of the housing, in a condenser generally designated 40.

Lead 38 (see Fig. 3) is connected to the outer end of the winding 34, and is extended to a coil 42 provided in the opposite end of the housing. Coil 42 includes a core 44 about which is coiled a winding 46, the inner end of which is connected to the lead 36 and the outer end of which is connected to the lead 38.

Designated at 47 is a housing of the transmitter unit 14. Within housing 47 there is mounted a transmitter coil 48 including a core 50 coaxially aligned with the cores 32, 44 momentarily, as the train end passes between the units 14, 16. Coiled about the core 50 is a winding 52 of the transmitting coil 48. Referring to Fig. 3, leads 54, 56 are connected to the opposite ends of the winding 52, and connected in the lead 56 is a condenser 58.

The leads 54, 56 are connected to the secondary winding of a transformer generally designated 60, mounted within the housing 47.

Connected to the terminals of the primary winding of the transformer 60 are leads 62, these comprising the leads of the electrical connection or conductor 20. Leads 62 extend into the housing 63 of the indicator apparatus or unit 18, and within the housing 63 are connected to two terminals of an alternating current generator 64 of the tube generator type, having, in a preferred embodiment, a fixed frequency of about ten kilocycles.

As shown in Fig. 3, connected to the generator 64 is a power supply 66 or source of electrical power 66.

Also contained within the housing 63 of the indicator unit 18 is a battery or equivalent source of electrical power 68. Connected to the opposite terminals of the battery are the leads 70 of the electrical conductor 22, and series-connected in one of the leads 70 is an electrically actuated signal element 72, such as the winding of a relay. It will be understood that the relay 72 would be any suitable type of indicating means, and said relay could operate to either close or open contacts, not shown, connected in circuit with a conventional visual or audible signal device, such as a lamp or bell, also not shown. Therefore, the relay 72 is illustrated as a broad showing of an electrically energizable signal element, the energization of which signals the passage of the train end.

In any event, the leads 70 extend into the housing 74 of the receiver unit 16, and within said housing normally open switch contacts 76 are connected to the leads 70, so that the switch contacts 76 are series-connected with the signal element 72 and the source of power 68. Contacts 76 are normally open so that when closed they cause a circuit to be established through the signal element 72, energizing the same.

Adapted to close the contacts is a relay 78, within housing 74, the opposite terminals of which are connected to leads 80, 82. Connected in the lead 82, in series circuit with the relay 78, is a rectifier 84. A condenser 86 is connected in a lead 85. Lead 85 is connected to lead 80 which is connected to one end of a winding of a receiving coil 88, lead 82 being connected to said winding at any selected location along the length of the winding.

In the use of the apparatus, as previously mentioned, at a time when a train is not passing, there may be a negligably small direct reciprocal effect between the transmitting and receiving units 14, 16, respectively. Said small voltage is of a value which is so small in relation to the useful signal voltage as to be inconsequential and not affect in an adverse manner the efficient use of the device. This is also true of all metal parts of a train that may pass between the units 14, 16.

When, however, the train end passes between the units 14, 16, there will be a momentary coaxial alignment of the coils 48, 30, 42 and 88. When this happens, a sudden increase in the voltage occurs in the receiving coil 88 amounting to ten to 100 times, in any of various commercial embodiments, the mentioned residual or ineffective voltage.

In other words, on the momentary disposition of the train end signal or coupling unit 12, and of the coils 48, 88, in a common vertical plane perpendicularly intersecting the length of the right-of-way, a maximum energy transmission takes place from the transmitter unit 14 to the receiving unit 16.

This is due to the fact that the coils 30, 42 are tuned by the condenser 40, and coil 88 is tuned by the condenser 86, to the frequency of the transmitter 14.

The magnetic alternating field of the transmitting coil 48 is created by the alternating current generator 64, which transmits its alternating voltage to the transmiting coil 48 through the cable or conductor 20, transformer 60 and condenser 58.

At the increase of the voltage flowing through the coil 88 to the above mentioned useful value, relay 78 is energized, closing normally open contacts 76 and hence closing the circuit to and through the electrically actuated signal element 72 located at any desired location, as for example a location remote from the units 14, 16.

In Fig. 4, there is shown a modification of the invention. In this form of the invention, all components are identical to those described with reference to Figs. 1 to 3, except for the slight modification of the transmitting unit, which in Fig. 4 has been generally designated at 14*a*, and of the indicator unit, generally designated 18*a* in this figure of the drawing. Even these components are identical to those illustrated in Fig. 1, except for the fact that the generator 64 is physically located within the housing of the transmitting unit 14*a* rather than in the housing of the indicator unit 18*a*. Thus, the generator 64 is connected by leads 62 to the power supply 66, and as in the first form of the invention has connections also to the opposite terminals of the primary winding of the transformer 60.

In both forms of the invention, the energy transmitted from unit 14 or 14*a* through the train-mounted component 12 to the receiving unit 16 is rectified in the receiving unit by means of the rectifier 84 which might, in a typical embodiment, be a germanium diode, with the rectified current energizing the relay 78.

It will be understood that in the forms of the invention so far illustrated and described, the duration of the action and reaction between the transmitting and receiving units can be increased, by predetermined increase in the measurements of the transmitting and receiving coils.

In Fig. 5 there is shown a modification which utilizes a train-mounted coupling unit 12, a transmitter unit 14, and an indicator unit 18 all formed as in the Fig. 1 embodiment of the invention. In this form, however, there is a modification in the receiving unit, which has been generally designated 16*b*.

In the receiving unit, all components are formed and

arranged as in the first form of the invention, except that instead of the relay 78 and contacts 76, there is provided a magnetic amplifier generally designated 96. The input or feeding current of the amplifier is taken directly from the transmitting unit 14, through a conductor 90 comprising leads 92, 94 connected to the leads 54, 56, respectively.

The amplified and rectified outgoing signal of the amplifier 96 is transmitted to the indicating unit 18 through the leads 70 of the conductor 22. The magnetic amplifier, excited by the transmitter frequency in the operating relationship of the several components, has a sufficiently small time of response.

Of course, excitation of the amplifier serves to energize the signal relay 72 in the same manner as closure of the contacts 76.

In Figs. 6 to 8 there is shown another modification. In this form of the invention, the indicator unit 18 is identical to that of the first form of the invention. However, there are modifications in the train-mounted coupling unit, which has been designated 12*c*; the transmitting unit, designated in this form of the invention at 14*c*; and the receiving unit, designated 16*c*.

So far as the coupling unit 12*c* is concerned, the basic change from the first form of the invention resides in the dispcsition of the axes or longitudinal median lines of the coils 30, 42 vertically, in parallel relation. This is distinguished from the first form in which said axes are disposed in horizontal positions in coaxial or longitudinally aligned relation.

Referring to Figs. 6 and 7, it will be seen that to provide this arrangement, the housing 24*c* is of inverted U-shape, having an elongated body or bight portion extending transversely of the track 17, said body being connected at its opposite ends in communication with depending, vertical extensions 98 within which the coils 30, 42 are mounted, as shown in Fig. 7.

In this form of the invention, coils 48, 88 of transmitting and receiving units 14*c*, 16*c*, respectively, are also vertically mounted so that their axes are parallel to the axes of the coils 30, 42.

Apart from this, the construction in this form of the invention is identical to that of the first form, and it will be noted that at one end, the winding of coil 88 is connected by lead 100 to the lead 80, with condenser 86 being connected in the lead 100, with lead 80 being connected to the other end of the winding of coil 88, and lead 82 being connected to said winding intermediate the opposite ends thereof. In actuality, this arrangement is identical to that of the first form.

As will be noted, at the moment the unit 12*c* passes and is in operative relationship to the tranmitting and receiving units, all the coils 48, 30, 42 and 88 are in a common vertical plane, just as they are in a common vertical plane at the same moment when the invention is made as in Figs. 1 through 5. The coils, further, are at right angles to the direction of travel at the moment of operative coupling of the transmitting to the receiving unit by the coupling unit 12*c*. Again, this is true also of the first form of the invention illustrated and described herein. However, the coils are not in coaxial alignment but rather have their axes in parallel relation and dispcsed vertically. The invention, in this connection, operates efficiently with this arrangement as well as with the first arrangement.

In the form of the invention shown in Fig. 9, the coupling unit 12 is identical to that shown in Fig. 1. This is true also of the indicator or received signal unit 18. Modifications, however, are incorporated in the transmitting and receiving units 14*d*, 16*d*, respectively.

In this connection, as previously mentioned herein, the measurements of the coils can be increased in the forms of the invention already illustrated and described herein, to increase the duration of the action and reaction between transmitter and receiver. However, it may be advantageous to use the arrangement shown in Fig. 9 for the same purpose, that is, for multiplication of the duration of the action and reaction.

In this arrangement there is provided a plurality of transmitter and receiver coils, spaced apart longitudinally of the track 17. In the illustrated example there are three transmitter coils 48, each of which will be brought into coaxial alignment with coils 30, 42, in successively following relation. All the coils 48 are connected in series and will be excited in phase. As will be readily apparent, the three coils 48 are series-connected in the lead 48, with the end coil being connected to the lead 56 in which is the condenser 58.

The same arrangement is followed in the receiving unit 16*d*. There are three coils 88 in this arrangement, each of these being coaxially aligned with the corresponding coil 48 of the transmitter unit 14*d*. Preferably, adjacent transmitter or receiver coils are spaced apart a distance about twice the length of the coils. In this arrangement, the lead 82 would be connected to the winding of the middle coil 88, in a typical embodiment.

In all forms of the invention, there is the common characteristic wherein there is a light, readily portable, quickly attachable and detachable train-mounted coupling unit 12, which provides at the moment it passes between transmitting and receiving units a transmission of electrical energy at a predetermined value, distinctly higher than any residual voltage transmitted directly from the transmitting to the receiving units with the difference between the residual and useful voltages being such as to effect electrical energization of a signal element at any desired location.

There is also the common characteristic, in all forms of the invention, of a minimal effect on the train-end signalling apparatus, by metallic masses provided in the rolling stock. Minimizing of electrical disturbances that might otherwise result from said metal walls and various electrical conductive masses is achieved without increasing the size of the train-and-trackside-mounted components to such an extent that they would become bulky. Yet the device can be used on any conventional cars with the profile of the car being kept clearly within the prescribed limits. All the difficulties, discussed in the portion of this application containing the objects and the description of the problems hereinbefore encountered, are thus met by the invention, and a wholly efficient, exceedingly simple, train-end signalling apparatus is thus provided.

It will be apparent to those skilled in the art that many alterations and modifications of the structure and circuits shown and described may be made without departure from the spirit and essence of the invention which for that reason shall not be limited but by the scope of the appended claim.

I claim:

An apparatus for signaling the passage of a train along a track past a given check point, comprising a stationary transmitting unit at one side of said track, a stationary receiving unit opposite said transmitting unit at the other side of said track, and a train-borne coupling unit positioned for momentary operative alignment with both of said stationary units upon the movement of the rear end of said train past said check point; said transmitting unit comprising a first tuned resonant circuit including a plurality of first helically wound elongated ferrite core inductance coils, of a length substantially one-tenth the distance between said stationary units, electrically connected in series with one another, said coils being spaced along said track at a distance from one another of twice the length of one of said coils, and energizing means for supplying to said coils an alternating current of the frequency of said tuned resonant circuit; said receiving unit comprising a second tuned resonant circuit including a like plurality of second helically wound elongated ferrite core inductance coils, of the same length as said first

coils, electrically connected in series with one another and having a capacitor connected across the end terminals thereof, positioned along said track with the same spacing as said first coils, with successive pairs of said first and second coils, respectively, having their longitudinal axes in the same plane, rectifier means connected at one side thereof to the electrical center of said plurality of series connected coils, and a signal means responsive to a voltage of predetermined magnitude induced in said second coils connected between the other side of said rectifier and an output lead extending from a common connection between said series connected coils and said capacitor; said coupling unit comprising a third tuned resonant circuit including two series-connected helically wound elongated ferrite core inductance coils having the longitudinal axes thereof mutually parallel



with the longitudinal axes of said first and second coils and positioned for simultaneous passage through successive pairs of said first and second coils, respectively; all of said tuned resonant circuits being resonant at the same frequency whereby the resulting repetitious coupling action between the plurality of spaced inductance coils in said transmitting and receiving means causes the voltage induced in the tuned resonant circuit of said receiver to build up to a steady state value and energize said signal means.

**References Cited** in the file of this patent

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| Re. 20,507 | Andrews | Sept. 14, 1937 |
| 2,620,435 | Vogt | Dec. 2, 1952 |
| 2,753,550 | Treharne | July 3, 1956 |