Feb. 26, 1957 E. H. WEBER 2,783,369

RADIO TRANSMITTING AND RECEIVING SIGNAL SYSTEM

Filed Nov. 23, 1951 2 Sheets-Sheet 1

Fig. 1

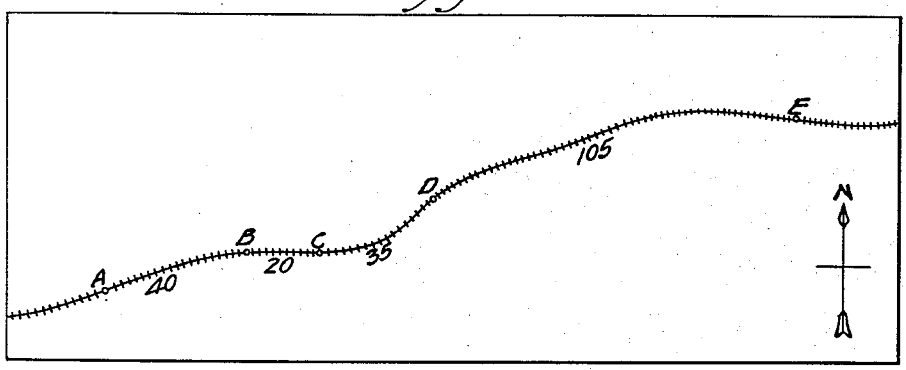


Fig. 2

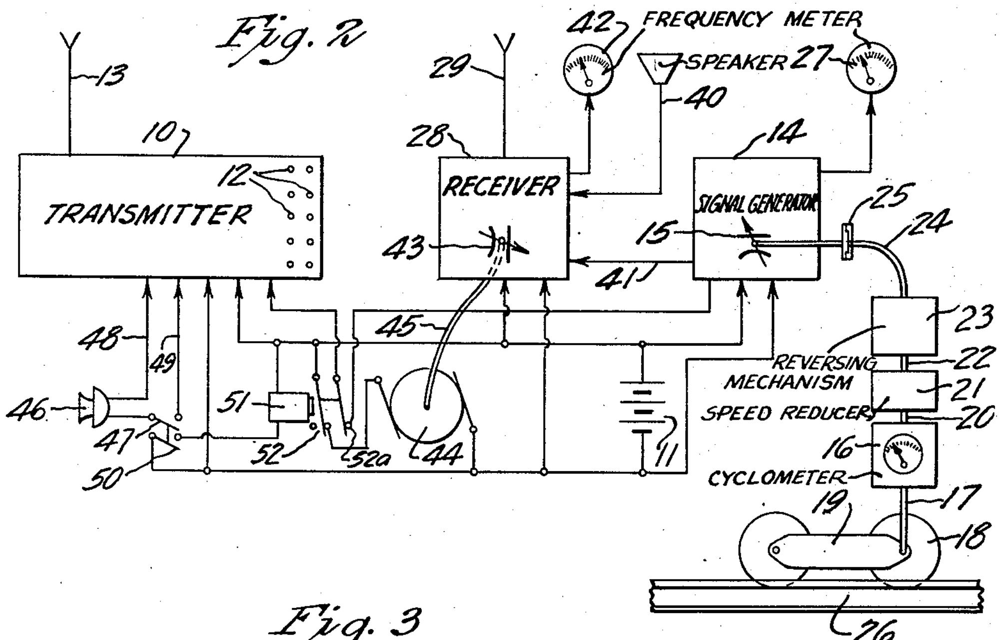
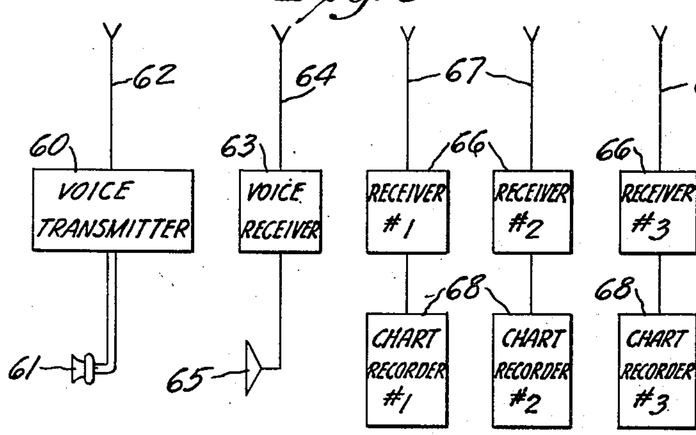


Fig. 3



Inventor
Edmund H. Weber
By Williamson & Williamson
Attorneys

Feb. 26, 1957 E. H. WEBER 2,783,369

RADIO TRANSMITTING AND RECEIVING SIGNAL SYSTEM

Filed Nov. 23, 1951 2 Sheets-Sheet 2

Fig. 4

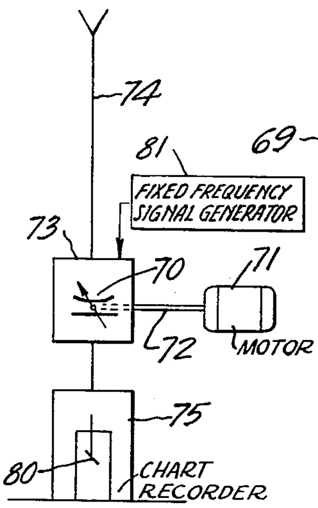


Fig. 5

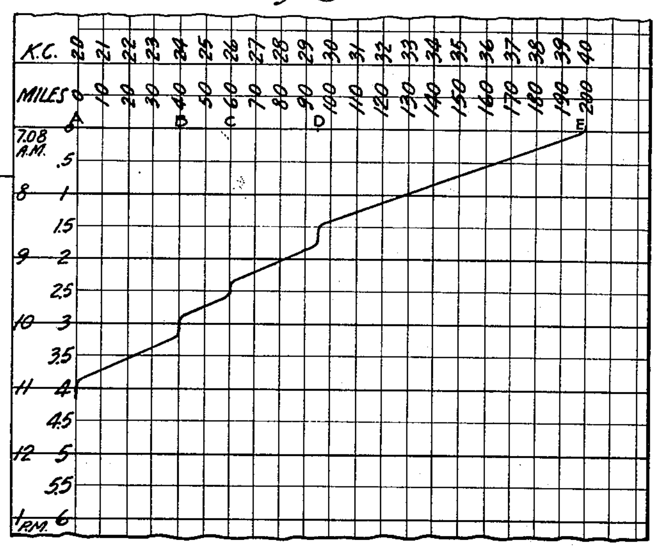


Fig. 6

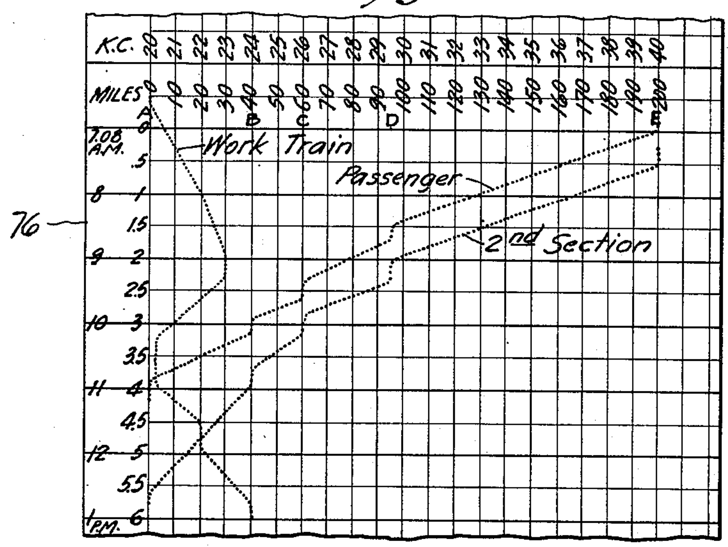
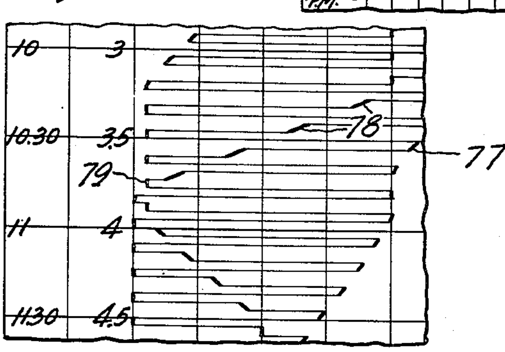


Fig. 7



Inventor
Edmund H. Weber
By Williamson & Williamson
Attorneys

United States Patent Office 2,783,369
Patented Feb. 26, 1957

2,783,369

RADIO TRANSMITTING AND RECEIVING SIGNAL SYSTEM

Edmund H. Weber, International Falls, Minn., assignor of one-half to Berthel K. Olsson, Fort Francis, Ontario, Canada

Application November 23, 1951, Serial No. 257,794

14 Claims. (Cl. 246—30)

This invention relates to railroad signal systems electronically produced and controlled for the purpose of minimizing accidents and for increasing the efficient operation and scheduling of all the trains currently running on the tracks of a division or subdivision of the railway system.

It is a principal object of this invention to provide means for generating electronic impulses within a train located on tracks of a railway system subject to operational control which varies in a predetermined manner with the travel of the train such that for any given location on the divisional tracks of the railway, a characteristic electromagnetic wave signal will be emitted from the transmitter of the train at such location and the signal will vary linearly with the distance traveled so as to always indicate by its frequency the exact location of such train.

It is another object of the invention to provide for the reception of transmitted signals associated with each train on a division or subdivision of a railway system and each emitting the same signal frequency whenever at any given same point in the division or subdivision of said railway system.

Another object of the invention is to provide for the reception of signal frequencies emitted from the transmitters of other trains by the receiver of a certain train for beating against the signal frequency of its own transmitter to create a measurable beat indicative of the relative distance within practical limits between it and each of such other trains regardless of their absolute positions in the railway division.

A further object of the invention is to provide for automatically controlling the signal frequency of a radio transmitter located upon a train operating within a railroad division so as to indicate to the dispatcher responsible for the scheduled movement of trains within the division by means of radio receiving equipment the exact location of such train.

It is a further object of the invention to provide for radio communicating means utilizing electromagnetic wave frequencies which are automatically varied in accordance with the travel of a train having a locomotive equipped with a transmitter and received by a dispatcher's office for correlating the information so obtained from all trains currently operating within the said division so that the dispatcher can determine absolute locations of each train as well as the distances between them.

Another object of the invention is to provide for radio signal equipment located in the cabs of locomotives operating within a railway division which have fixed carrier signals upon which signal modulating frequencies may be superimposed and which modulating frequencies vary linearly in accordance with the distance traveled by said trains.

A further object of the invention is to provide for radio signal equipment located in the cabs of railway locomotives which are capable of operating on an assigned radio frequency with a variable supersonic imposed modulating

frequency, the characteristic of which allows voice transmission to be carried on by the same equipment.

A still further object of the invention is to provide radio signaling equipment having in addition thereto a radio intercommunication system for engineers in locomotives operating within a division of a railway whereby the locomotive engineers, in response to warning signals, may communicate with one another and with the dispatcher's office.

These and other objects and advantages of my invention will more fully appear from the following description made in connection with the accompanying drawings wherein like reference characters refer to similar parts throughout the several views and in which:

Fig. 1 is a physical map of an area of ground including a railway right of way constituting a division.

Fig. 2 is a diagrammatic representation of transmitter receiver and supersonic signal generator housed within the cab of a railway locomotive using my signal system.

Fig. 3 is a diagrammatic representation of a voice transmitter, voice receiver and a plurality of supersonically modulated carrier receivers together with associated chart recorders.

Fig. 4 is a diagrammatic representation of one receiver and chart recorder together with a scanning switch device which may substitute for the plurality of receivers and chart recorders in Fig. 3.

Fig. 5 is a segment of the recorder tape taken from one of the receivers and associated chart recorders shown in Fig. 3 during the progress of a locomotive over the division illustrated in the map of Fig. 1.

Fig. 6 is a segment of the composite chart tape taken from the single chart recorder and signal receiver shown in Fig. 4 showing the visual progress of the same train recorded on the chart of Fig. 5 together with a record of the simultaneous travel of a work train and a second section of the passenger train.

Fig. 7 is an enlarged segment of the lower left hand corner of the chart segment shown in Fig. 6 illustrating the sequential travel of the recording pen of the apparatus shown in Fig. 4 to form a composite recording of the time and motion of the individual trains operating on the division.

Referring more particularly to the drawings, I have indicated a typical railway division in the map of Fig. 1 in which the division points A and E lie 200 miles apart and constitute cities in one of which a head dispatcher's office is located and the other of which an assistant dispatcher's office is located. Stations B, C and D are typically located along the track constituting the division so that in the illustrated map of Fig. 1 the trackage distance from station A to station B is 40 miles, the distance from B to C is 20 miles, the distance from C to D is 35 miles, and the remaining distance from station D to terminal station E is 105 miles. It is, of course, understood that within the main line constituting the division there may be double tracks and sidings which, of course, are within the contemplation of this invention. Spur tracks extending for some distance to the side of the main track and switch yards located at stations such as terminal A are not within the contemplations of this invention since locomotives operating therein are not traveling at such speeds as to constitute hazards to each other and furthermore are subject to rigid control and supervision of a local nature to minimize accidents from collision. The main difficulty which must be surmounted in the operation of the plurality of locomotives within a railway division is that of scheduling so as to avoid having two trains traveling at high speed on the same track coming towards one another or one train at high speed approaching another in a stationary position on the same track.

The enormous weight of the locomotive together with such cars as it may be hauling, is such as to create a momentum making it impossible for the engineer to come to a complete stop from full speed in sometimes as short a distance as two miles. Where all trains operate on a strict schedule and no trouble such as inclement weather or mechanical breakdowns cause the trains to become late the entire operation of the trains on a railway division may easily be controlled at the head dispatcher's office so as to have trains which are meeting or passing arrive on schedule at sidings where one may halt while the other one passes on the main line without entailing a long wait for the train which must pull on to the siding. However, since weather conditions and mechanical difficulties cannot be foreseen it becomes the duty of the dispatcher to watch constantly the schedules of all trains operating within the division and to be able to give new train orders which are picked up by the locomotive engineers as they pass through various stations which may change their schedule and cause them to lose a great deal of time waiting on sidings while another train passes through on the main line. Where time is short and a train might experience difficulty in getting to the next siding before an on-coming train passes through, it is customary for the engineer to exercise his judgment. Where caution dictates he must pull his train upon the siding and wait for the other train to pass by. Since the engineer has no direct knowledge of where the other locomotives are at any given time, except through relayed communication with the dispatcher's office in some railway systems, which in any event is a slow means of obtaining information, the human element very often enters in and through misjudgment of either of two engineers, of the dispatcher, or of a station agent along the division line, a disastrous and costly collision may occur. When such disaster occurs it is almost always with a loss of life and property damage extending into thousands and sometimes hundreds of thousands of dollars.

My invention seeks to utilize by a simple electronic phenomenon means for placing the responsibility of avoiding collisions upon the shoulders of the locomotive engineers themselves since they are the best equipped, both from the standpoint of time and interest in the well-being of the train. I have thus sought to minimize the number of hands through which train orders must go in making decisions where there is immediate danger of disaster. It is not my intention to revamp the systems of control which are extant in the railway world today but rather to supplement them with a positive and foolproof means of double checking the schedule and actual whereabouts of trains in the vicinity of other trains so as to give the engineers in the locomotives of such trains ample time to draw their own conclusions as to the proper course of conduct to follow and thereby avoiding the consequences of disastrous collisions. It is within the contemplation of this invention to provide for such extreme conditions that two approaching trains may even halt their forward progress in sufficient time to avoid collision at a point where no station, outdoor signal devices or sidings exist.

The equipment constituting my invention is largely electronic and may be included entirely within the confines of a locomotive cab although it is possible to have my railway signal system located elsewhere in the train and operated by the conductor, for example, who would in turn instruct the engineer when an emergency arises. It is also within the contemplation of the invention to equip some locomotives with less than the entire amount of complete radio equipment thereby to warn but one of two engineers, thus effecting a certain measure of safeguard. It is thought that railway companies employing the system will prefer to have the double-check heretofore mentioned whereby each engineer of both locomotives in the same vicinity have equal knowledge of the whereabouts of the other. In detailed description the equipment thus installed in one of the cabs is as follows, it being understood that all locomotives may be similarly equipped: A transmitter **10** as shown in Fig. 2 is operated by a battery **11** which likewise energizes all the electronic equipment within the cab. The battery **11** may be supplanted by an electric generator or by electric power the equipment for which is already installed in the locomotive. It is felt, however, that battery operation is to be preferred since failure of a generating system would disrupt the entire electronic operation of my invention. It is, of course, to be preferred that the battery **11** have means of recharging or replacement at any time. The transmitter **10** may be of ordinary construction capable of generating a radio signal of controlled frequency. This signal may be a supersonic modulated carrier signal as more fully described hereafter. Push buttons **12** may be employed to select the particular carrier signal frequency which will be used by the transmitter of the locomotive in question during a particular run on the railroad division. In order to prevent an accidental alteration of the preselected carrier signal frequency means not shown may be employed to place the signal frequency selector buttons or similar mechanism, under lock and key at the time the engineer begins his run. The transmitter has a transmitting aerial or antenna **13** from which the carrier signals emanate. This antenna may be directional or non-directional depending on the areas and directions which it is desired to cover during transmission of radio signals from the transmitter **10**. Electrically connected to the transmitter **10** and also operated by battery **11** is a signal generator **14** which is capable of generating sonic, or, as in the exemplified embodiment, supersonic frequency signals which may then be transmitted as by superimposing them upon the carrier signal generated by the transmitter **10**. It is to be understood that supersonic frequencies as used in this context refers to frequencies above the normal audible range and well below the frequency of the carrier wave where such is used. In conjunction with the supersonic signal generator **14** is a variable condenser or other control means **15** for varying the frequency of the signal generated by the supersonic signal generator **14** in a predetermined manner. There are several means which may be employed to create this controlled variation in supersonic frequencies such as variable capacitance, inductance or resistance. In each case, the variable control means **15** is capable of acting upon the supersonic generator for varying the frequency of the supersonic signal through a predetermined scale of values by physical movement of the control.

On the ordinary locomotive there is an instrument **16** called a cyclometer which is directly driven through a linkage such as cable **17** to the wheel **18** which may be one of the truck wheels on a truck mechanism **19** of the locomotive. Linkage **20** extends from the cyclometer to a speed reducer **21**. If so desired, the cyclometer **16** may not be employed but the linkage **20** may co-extend with **17** so as to form a direct driving connection with the speed reducer **21**. A driving connection **22** connects the speed reducer **21** with reversing mechanism **23** such that the take-off linkage **24** may be operated at the same speed ratio in either direction to drive the variable control **15** on the supersonic signal generator **14**. A clutch device **25** is interposed in the drive linkage **24** for resetting the variable control **15** at the beginning of each run and at various check points along the division whenever it becomes necessary to adjust and correct for misalignment or other cause of inaccurate translation of the rotating wheel **18** on the road track **26** to linearly vary the control **15**. The reduced speed of the linkage **24** attached to the variable control **15** as compared to the speed of wheels **18** is such an infinitesimal ratio that the entire run of the locomotive having the truck **19** and wheels **18** from the beginning of the division to the terminal thereof (such as from the point A on the map of Fig. 1 to the point E 200 miles away) will actuate the variable control 15 of the supersonic signal generator 14 through a relatively small physical distance so as to modify linearly the frequency of the supersonic signal through a predetermined range. By way of example, a useful rate of change of supersonic frequency is 100 cycles for each mile traversed. In terms of supersonic frequencies a frequency of 20,000 cycles may arbitrarily be selected to correspond with the beginning division point A and a frequency of 40,000 cycles assigned to the end of the division at point E, each mile of the 200 mile division corresponding to a hundred cycle change in supersonic frequency. It is to be noted that all locomotives traveling on this division will have their supersonic signal generators controlled by variable control 15 such that they will emit the same frequency of supersonic signal whenever at that same point along the division. When a train is running in a direction from division point A to terminal E the rotation of linkage 24 will be in one direction and when the train is running from division point E to terminal A the reversing mechanism 23 will be changed so as to operate the linkage 24 at the same speed in the opposite direction and the cycle change occurring in the supersonic signal generator 14 will be from 40,000 cycles back to 20,000 cycles, but always having a fixed value for any given point on the division.

At intervals along the track of the division may be placed indicia such as sign posts bearing the absolute value of the number of cycles corresponding to the checkpoint position along the tracks on the division. By way of example, for point B on the map of Fig. 1 the assigned supersonic frequency would be 24,000 cycles with point A assigned 20,000 cycles and point E assigned 40,000 cycles. Likewise, by way of further illustration point D would have an assigned supersonic frequency of 29,500. As the locomotive engineer passes any particular checkpoint he may refer to a dial associated with the variable control 15 on the supersonic generator or to a meter 27 which will indicate visually the absolute value of the supersonic frequency which is presently being generated by the supersonic generator 14. If this value is an excess of the assigned value at the particular check-point which he then is passing he will manually adjust the clutch device 25 so as to set back the variable control 15 to produce the corresponding frequency as shown by meter 27 and thereby correspond to the correct assigned frequency for the check-point. Likewise, if his visual indication of the frequency as shown on meter 27 is lower than that required by the check point he will manually adjust the clutch in the opposite direction until the two values coincide. The clutch device 25 may thus operate much in the same manner as the setting of the hands of a clock to the proper position without interfering with the subsequent continued operation of the device.

Also energized by the battery 11 is an electronic receiver 28 having a receiving antenna 29 which may be of a directional or a non-directional construction as desired. A loudspeaker 40 may be connected to the receiver 28 so as to give the locomotive engineer means for receiving audibly a signal from the electronic receiver 28. The receiver 28 is capable of receiving the supersonic signal generated and transmitted by other locomotives on the division through antenna 29 and is also capable of receiving a small low power portion of its own supersonic signal through the conductor 41 which will set up a beat frequency with the supersonic signal of any other locomotive in the vicinity which may be measured and indicated by a meter 42 indicating the frequency value of the beats between the supersonic signals of the two locomotives in question. This beat frequency likewise may be translated into an audible sound through speaker 40 so as to indicate the value of the beat frequency when it becomes low enough to fall within the audible range thereby indicating that another locomotive is within some predetermined distance such as 10 miles by way of example. Other means responsive to the beat frequency, such as a warning light which may flash at a predetermined beat frequency may be substituted or employed in addition to those devices already described. If the trains are approaching one another the beat signal will lessen in value as shown by the beat frequency meter 42 and may be further evidenced by a lowering of the tone generated and audibly produced in speaker 40. As the tone becomes lower and lower the distance between the trains is growing shorter and shorter and each engineer in each locomotive will be constantly reminded by the tone value of the speaker of his relative nearness to the other. Where, for example, a locomotive of one train is standing on a siding (always having its supersonic generator operating) and a moving train passes the stationary train on the main track the signal will acquire a zero beat at the exact point at which they pass, the tone again increasing after passing so as to continuously apprise the engineers of the relative distance separating them. There is an attribute of my invention inherent in that the signal strength of the supersonic signal produced by generators 14 in the various locomotive cabs are more strongly received by the near locomotive and less strongly received by those farther away. It is also an inherent feature of my invention that the beat frequency as well as the audible manifestation of the beat frequency, will always measure the relative distance between two locomotives regardless of where they are actually located on the entire length of the division. Thus a five mile separation near the division point E on the map of Fig. 1 will be evidenced by the same values of sound and the same meter reading, either expressed in beat cycles or directly as miles as a five mile separation at another location as in the vicinity of station C on the same division. This is true despite the fact that the absolute values of the supersonic signal in terms of cycles are different for each of the locomotives at the respectively different station locations.

We have now been considering the relative movements of only two locomotives on the division without regard to any other locomotives which may also be operating at the same time. In order to be constantly apprised of the relative positions of any locomotives which may be near enough to cause any degree of concern I have provided for a scanning switch 43 including a variable condenser or electronic tuning device which may be attached to receiver 28 and rotatable or reciprocable as required by such driving mechanism as motor 44 through linkage 45 to continuously scan the signals transmitted by all the trains on a division or all the classes of trains on one division as may be applicable to completely protect against collision. The scanning switch 43 may include a variable condenser adapted to rotate so as to tune in the wave lengths of the carrier signals of each of the classes of trains in consecutive order. Or, alternatively, it may include an electronic tuning device by which the scanning mechanism can sequentially contact each of the plurality of wave lengths each assigned to a train or to a class of trains. By way of example, it has been found that 10 carrier wave lengths are a useful number and may be assigned in such a manner that 5 of the wave bands may be given to 5 classes of trains moving in one direction on the railway division and the remaining 5 assigned to classes of trains moving in the opposite direction. More specifically, a practical example of the assignment of wave lengths is the division of trains into passenger trains on regular schedule, passenger extras, through freight trains, local freight trains and work trains. Assuming that 10 carrier frequencies are used, a band width, including a guard band between channels, of .50 megacycle would be a useful separation. Such band width would allow 15 kilocycles frequency modulation of the carrier signal in either direction from the zero reference line which amounts to a total band width of 30 kilocycles leaving a guard band of 20 kilocycles between channels. Thus, if a frequency of 28.50 megacycles were employed as the lower limit of the 10 frequencies chosen the upper or 10th band frequency would be 28.95 megacycles. The scanning switch 43 is so constructed that they will hold each channel of the 10 carrier frequency wave bands for a period just long enough to make a firm impression upon the engineer observing the signals but not so long as to unduly prolong the time for a complete cycle of the switch 43 through the 10 channels and back to the first. The reason for this latter limitation is that in case the engineer misses an impression where a train is traveling at a high rate of speed towards him in the vicinity of his own travel, several minutes translated into distances traveled may bring the trains into extremely close proximity before the engineers may be fully apprised of the danger. A practical time limit has thus been established in the neighborhood of 3 seconds for each transmitted wave length scanned by scanning switch **43**. Thus, in the example cited the entire cycle of scanning would comprise 30 seconds. A train traveling at 60 miles an hour would travel a half mile during the scanning cycle. Since it is only the beat frequencies which the engineer hears or sees on the dial arranged for that purpose, he will normally have no impression whatsoever from any of the 10 bands scanned by the switch 43 until a train comes within some predetermined distance such as 10 or 20 miles. In extreme cases there may be several trains within this distance in which case he will receive 3 second periods of audible tones whenever the scanner **43** is operative followed by other 3 second periods of silence for those trains not operating on so far distant as not to create an audible beat. The lowest of the audible tones will be obvious to him and will so identify the carrier band of the train which is nearest to him. The engineer of each train will obviously want to communicate with the other and find out if this proximity of the trains to each other is natural or unnatural and to decide what course should be pursued to best complete their individual schedules with the least amount of interference to the other. The communication is accomplished as follows: One of the two engineers picks up his microphone **46** which is normally disconnected from the transmitter **10** by the open switch **47** which interrupts the circuit through conductors **48** and **49**. The switch or contact **47** is connected in double-pole fashion to switch **50** both of which operate simultaneously and may be controlled as by a thumb button or other ordinary switch handle closely associated with the microphone **46**. When the double-pole switch is closed the microphone **46** is connected for use with the transmitter **10** and simultaneously with the closing of the switch **50** a relay **51** is energized so as to throw the closed switch **52** in the motor circuit to open position thereby interrupting the rotary movement of the motor **44** and the scanning of switch **43**. The engineer can thus close the double-pole switch **47—50** after receiving an audible impression from the locomotive to which is assigned a particular carrier wave length having a superimposed modulated frequency indicating unusual nearness. Since the impression will last for several seconds the immediate interruption of the motor **44** will stop the scanning switch **43** before the 3 second span has been traversed by scanner **43** and the receiving mechanism will be held in tuned cooperation with the desired carrier wave length. When the engineer begins to speak into the microphone **46** snatches of conversation will be heard by the other engineer when his scanning device contacts the carrier wave length received from the locomotive of the first engineer. He then likewise can close his double pole switch **47—50** at the proper point in the scanning cycle and established voice communication with the first engineer. It is to be noted that relay **51** will also open the closed switch **52*a*** which opens the circuit to the signal generator **15** thus interrupting the

propagation of a signal which will beat with that of the other engineer and interfere with intelligibility.

Although the signal system which has been described thus far will greatly aid in minimizing accidents through intercommunication between locomotives, I may further improve the railway signal system by providing for communication between the locomotive engineers and the dispatcher's office as well. Thus, it is possible for the dispatcher to have a continuous record of all trains operating in his division and to be able to selectively communicate with any engineer as he desires. Where the dispatcher has full knowledge of the positions and rates of speed of each of the trains, he is thereby able to change train orders in a much shorter time than if he were to receive the positions of trains from local station agents, correlate the information, re-schedule certain trains, relay the information to the station agents and finally have the station agents hand the engineers of the locomotives their new orders as the train passes the station. Many serious collisions have occurred because the last possible station for communication had already been passed by the engineer and there was no further means of reaching him. In such tragic circumstances it is not uncommon for the station agent who has knowledge of an impending collision to send out wrecking crews and ambulances well in advance of the collision which is certain to occur.

Referring to Fig. 3, the dispatcher's office may be equipped with a voice transmitter **60** which may be tunned to the carrier wave lengths of any of the trains operating on his division or may have a carrier signal of its own which may be scanned by scanning switch **43** in each locomotive as a separate carrier frequency in addition to those assigned to other locomotives. The voice transmitter may have push button selectors or a dial selector (not shown) which is common to voice transmitters. The microphone **61** is employed in the usual manner to generate an audio signal for transmission from antenna **62**. To complete the communication there is a receiving set **63** bearing an antenna **64** and connected to a loud speaker **65** which receiving set likewise is tunable to the various carrier wave lengths of the transmitters located on the individual locomotives. Since the dispatcher has cut in on one of the wave lengths being scanned by the locomotive scanning switch on its receiver the engineer can then stop the motor **44** in Fig. 2 so as to maintain contact with the carrier wave employed by the dispatcher's transmitter and in turn can establish through one of his selector buttons **12** a signal frequency to which the voice receiver **63** can be tuned. Also, in the dispatcher's office may be placed, a plurality of receivers **66** bearing antennae **67** and each having a chart recorder **68** which may be similar to the strip chart recorder manufactured by Leeds and Northrup called the Speedomax Recorder, sometimes used by the U. S. Weather Bureau. Each of the receivers would be permanently tuned to the carrier wave length of a locomotive so as to give a running recorded chart of its movement on the division. A section of the tape **69** such as is used in these recorders is illustrated in Fig. 5. In this instance the tape **69** is slowly progressing in an upwardly direction so that the hours signified at the left hand side of the tape pass a fixed point in the recorder at the exact time indicated thereon. The width of the tape corresponds to the mileage distance of the total division from beginning point A to the other terminal E as indicated on the map of Fig. 1. Corresponding to the mileage figures extending across the tape are the kilocycle values of supersonic frequencies matching the mileage figures.

Thus, by way of illustration a locomotive may have a carrier signal assigned it to be detected by receiver No. 1. The supersonic modulation imposed upon the carrier signal will vary as heretofore described but the carrier will remain a constant value so as to be constantly received by receiver No. 1. The chart recorder has recording means such as an ink point or pen commonly used in such devices. The pen will respond to the change in supersonic wave frequency so as to cause it to move across the tape between the kilocycle values of 20 to 40 as have been arbitrarily selected for the fanciful division shown in Fig. 1. The progress of the train as recorded on tape 69 in Fig. 5 is from terminal E to terminal A and beginning at 7:08 a. m. arriving at station D at 8:25, remaining at this station until 8:45 then proceeding to station C where it arrives at 9:20, remaining until 9:35 then proceeding again to station B arriving at 9:55 and leaving at 10:10 and finally proceeding to terminal A where it arrives at 10:55. The slope of the line across the chart indicates the rate of speed. The dispatcher thus can observe that the train traveled at a uniform rate of speed from station E to station D and in between the remaining stations traveled at a uniform speed slightly less than that between the stations E and D. The average speed, of course, may be determined by the slope of a straight line drawn between the intersection of the ink line with station E and the intersection of the same line with the line indicating station A.

Where there are a large number of locomotives operating on a division at the same time it may be inconvenient for the dispatcher to shift his attention one at a time to all the receivers which, under the system illustrated in Fig. 3, amounts to one receiver and recorder in the dispatcher's office for each locomotive. Where it is inconvenient for him to watch such a great plurality of recorders I have provided for a single receiver and recording mechanism having a scanning switch 70 as shown in Fig. 4. The scanning switch is driven by motor 71 through drive cable 72 and covers the range of carrier signals emanating from each locomotive in the same manner as the scanning switch 43 sequentially scans the carrier signals of other locomotives. The signal picked up by this composite receiver 73 through antenna 74 is thus recorded by chart recorder 75 to form a composite record on the tape 76 as illustrated in Fig. 6. This chart or tape shows three types of trains and their complete schedule over a period of time ranging from 6:30 in the morning to 1:00 p. m. in the afternoon. A single ink line is produced by the single recording device but the time periods selected by the scanning switch are such as to make several dotted lines indicating the relative positions of all trains rather than a single line for but one train. The path of the recorded line is illustrated in Fig. 7 which is an enlarged portion of the recordings of Fig. 6 in the time period including 10 o'clock in the morning to 11:30 in the same morning. It may thus be seen that the scanning device 70 causes the needle or pen 80 on the chart recorder 75 to first indicate for a small interval a portion of the travel of the second section as shown in Fig. 6. This line is indicated at 77 in Fig. 7. The recording needle or pen 80 then progresses to line 78 and records the progress of the passenger train shown in Fig. 6. After the prescribed interval of recording the pen 80 jumps over to the line 79 which indicates the same predetermined interval of the traveling of the work train whose complete path is shown in Fig. 6. As may be seen from viewing the composite line chart of Fig. 7 the spaces between the dotted lines may be physically filled in by the dispatcher in order to interpolate the path of each train during its unrecorded interval or may be read visually without the aid of such actual interpolation. In any event a complete composite recording may be made with a single chart recorder coupled with a single receiver scanned by a scanning mechanism 70 to thereby tune in for short periods of time, the carrier signals of all trains operating on a division at the same time.

It may thus be seen that I have established a railroad signal system which will save many lives and prevent damage to a great deal of personal property. In addition to the saving of lives and property, the system when extended and coupled with the dispatcher's office will also enable a faster and more efficient controlling and scheduling of the trains operating on a railway division thus saving considerable time in the transportation of passengers and goods. It is also possible to eliminate many of the intermediate station agents whose duties would become superfluous when my system is employed. Other than such curtailment of personnel, my system can easily be adapted to those already employed in present day practice by the majority of railroads.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts without departing from the scope of my invention.

What I claim is:

1. In a railway signal system for controlling the scheduling of a multiplicity of trains and locomotives operating on tracks within a given area of ground and for reducing hazards from collision therein, the novel combination comprising a radio transmitter associated with each locomotive having as three of the component parts thereof a signal generator for producing radio carrier waves of preselected fixed frequency, a generator for producing modulating signals of controlled frequency and a variable control unit for varying the said frequency of the modulating signals with movement of said variable control, driving linkage having a high ratio of reduction physically responsive to travel of said locomotive over said tracks, and a connection through said driving linkage with said variable control unit whereby movement of a locomotive with respect to said tracks will be linearly translated to a change in frequency of said modulating signals.

2. In a railway signal system for controlling the scheduling of a multiplicity of trains and locomotives operating within a given area of ground and for reducing hazards from collision therein the novel combination comprising, a radio transmitter associated with each locomotive having as component parts thereof a signal generator for producing carrier waves of preselected fixed frequency, a supersonic generator for producing signals of controlled frequency and a variable control unit for varying the said frequency of the supersonic signals with movement of said variable control, and linkage means connected to a locomotive wheel adapted to roll over the ground and also connected to said variable control whereby movement of a locomotive with respect to said ground will be linearly translated to a change in frequency of said supersonic signals.

3. In a railway signal system for controlling the scheduling of a multiplicity of trains and locomotives operating on tracks within a given area of ground and for reducing hazards from collision therein the novel combination comprising, a radio transmitter associated with each locomotive having as component parts thereof a first signal generator for producing modulated carrier waves within a preselected band, a second signal generator for producing modulating signals of controlled frequency and a variable control unit for varying the said frequency of the modulating signals with movement of said variable control, driving linkage having a high ratio of reduction physically responsive to travel of said locomotive over said tracks, and a connection through said driving linkage with said variable control unit whereby movement of a locomotive with respect to said tracks will be linearly translated to a change in frequency of said modulating signals.

4. A railway communication signal system for controlling the scheduling of trains and for reducing the likelihood of collision between trains comprising, a radio transmitter associated with a first of said trains for emitting carrier signals of predetermined frequency and with controlled modulating frequency superimposed thereon, means for varying the modulating frequency of said sig-

nals linearly with travel of said first train each point in the travel of said first train corresponding to a predetermined signal modulation frequency, a radio transmitter associated with a second of said trains for emitting signals of predetermined frequency, means for varying the frequency of modulation of said signals linearly with travel of said second train each point in the travel of said second train corresponding to the same said predetermined signal modulation frequency, and radio receiving means associated with each of said first and second trains for measuring the beat frequencies between the modulation signal of its own transmitter and the signal of the other train whereby the beat frequency between modulating frequencies becomes a measure of the physical distance between said first and second trains.

5. A railway communication signal system for controlling the scheduling of trains and for reducing the likelihood of collision between trains comprising, a radio transmitter associated with a first of said trains for emitting frequency modulated signals of preselected fixed carrier frequency and on which modulating signals of variable frequency are superimposed, means for varying the frequency of said modulating signals linearly with travel of said first train each point in the travel of said first train corresponding to a predetermined specific modulating frequency, a radio transmitter associated with a second of said trains for emitting frequency modulated signals of preselected fixed carrier frequency and on which modulating signals of variable frequency are superimposed, means for varying the frequency of said modulating signals linearly with travel of said second train each point in the travel of said second train corresponding to the same said predetermined specific modulating frequency, and radio receiving means associated with each of said first and second trains for measuring the beat frequency between the modulating signal of its own transmitter and the modulating signal of the transmitter of the other train whereby the beat frequency becomes a measure of the physical distance between said first and second trains.

6. In a railway signal system for facilitating the scheduling of a multiplicity of trains and locomotives operating on tracks within a given area of ground and which reduces hazards from collision therein the novel combination comprising, a radio transmitter associated with each locomotive having as component parts thereof a generator for producing a carrier signal, a supersonic generator for superimposing on said carrier signal modulating signals of controlled frequency and a variable control unit for varying the said supersonic modulating frequency by movement of said variable control, driving linkage having a high ratio of reduction physically responsive to travel of said locomotive over said tracks, a connection through said driving linkage with said variable control whereby movement of a locomotive with respect to said tracks will be linearly translated to a change of frequency of said modulating signal, and a radio receiver located in a station such as a dispatcher's office for automatically indicating to the dispatcher the position of each locomotive operating within said given area of ground at any given time.

7. The subject matter of claim 6 in which said radio receiver in said dispatcher's office operates in conjunction with a recording device for plotting the progress of each locomotive within said area of ground against time.

8. In a railway signal system for controlling the scheduling of a multiplicity of trains and locomotives operating on tracks within a given area of ground and which reduces hazards from collision therein the novel combination comprising, a radio transmitter associated with each locomotive having as component parts thereof a generator for producing a carrier signal a generator for producing modulating signals of controlled frequency for superimposing on said carrier signal and a variable control for varying the said modulating frequency by movement of said variable control, driving linkage having a high ratio of reduction physically responsive to travel of said locomotive over said tracks, a connection through said driving linkage with said variable control whereby movement of a locomotive with respect to said tracks will be linearly translated to a change of frequency of said modulating signal and a battery of radio receivers located in a dispatcher's office for simultaneously automatically indicating to the dispatcher the absolute position of each locomotive operating within said given area of ground at any given time.

9. In a railway signal system for controlling the scheduling of a multiplicity of trains and locomotives operating on tracks within a given area of ground and for reducing hazards from collision therein the novel combination comprising, a radio transmitter associated with each locomotive having as component parts thereof a signal generator for generating a carrier signal, a supersonic generator for producing modulating signals for superimposing on said carrier signal and a variable control for varying the said modulating frequency by movement of the variable control, driving linkage having a high ratio of reduction physically responsive to travel of said locomotive over said tracks, a connection through said driving linkage with said variable control whereby movement of a locomotive with respect to said tracks will be linearly translated to a change of frequency of said modulating signal, a radio receiver located in a dispatcher's office said receiver having a tuning switch scanning device for sequentially receiving the carrier signals together with the modulating signals respectively superimposed thereon for automatically indicating to the dispatcher the absolute position of each locomotive operating within said given area of ground at any given time.

10. The subject matter set forth in claim 8 in which the sequentially received modulating signal of each locomotive is visually recorded.

11. In a railway signal system for facilitating the controlled scheduling of a multiplicity of trains and locomotives operating upon tracks extending between terminals within a given area of ground and for reducing hazards from collision therein, the novel combination comprising, a signal transmitter associated with each locomotive having as two of the component parts thereof a signal generator for producing modulating signals of controlled frequency and a variable controlling mechanism for varying the frequency of the modulation, a signal receiver associated with one of said locomotives for scanning sequentially the transmitted signal of each of the other locomotives and mixing with its own generated modulating signal whereby an intermittent beat signal will be created with the signals of each of said other locomotives indicative of the relative distances between the one locomotive and each of the others, and linkage mechanism connected to a wheel of a locomotive on the tracks on the ground and also connected to said variable control mechanism whereby movement of a locomotive with respect to said tracks will be linearly translated to a modulation of frequency of said signals.

12. In a railway safety signal system for facilitating the controlled scheduling of a multiplicity of trains and locomotives operating over tracks within a given area of ground and for reducing hazards from collision therein, the novel combination comprising, a signal transmitter associated with each locomotive and adapted to produce a carrier signal of preselected frequency, a signal generator associated with said transmitter for superimposing upon said carrier signal a frequency modulation, a variable control mechanism having a movable element for varying the frequency of said modulation, and driving linkage having a high ratio of reduction physically responsive to travel of said locomotive over said tracks and a connection through said driving linkage with said variable control mechanism whereby movement of the locomotive with respect to said tracks will be linearly translated to a corresponding change in frequency of said modulation.

13. In a railway signal system for facilitating the controlled scheduling of a multiplicity of trains and locomotives operating upon tracks extending between terminals within a given area of ground and for reducing hazards from collision therein, the novel combination comprising, a radio transmitter associated with each locomotive having as two of the component parts thereof a generator for producing frequency modulated signals of controlled frequency and a variable control mechanism having a movable element for varying the said frequency specifically for each increment of the full extent of said tracks between the terminals thereof, and driving linkage connected to locomotive wheels traveling upon said tracks and also connected with the movable element on said variable control mechanism whereby movement of the locomotive with respect to said tracks will be linearly translated to a corresponding change in frequency of said modulation.

14. The subject matter as set forth in claim 13, and visible indicia at a plurality of check points positioned along said tracks and between said terminals said indicia having a specific frequency for each position whereby the engineer of each locomotive may check his indicated frequency with the actual frequencies as specified by said indicia.

References Cited in the file of this patent

UNITED STATES PATENTS

1,278,221	Rowntree	Sept. 10, 1918
1,747,041	Alexanderson	Feb. 11, 1930
1,804,770	Hershfield	May 12, 1931
2,460,597	Rodgers	Feb. 1, 1949
2,480,160	Poylo	Aug. 30, 1949