June 8, 1948. W. S. HALSTEAD 2,442,851

TRAFFIC SIGNALING SYSTEM

Filed Aug. 3, 1940 6 Sheets-Sheet 1

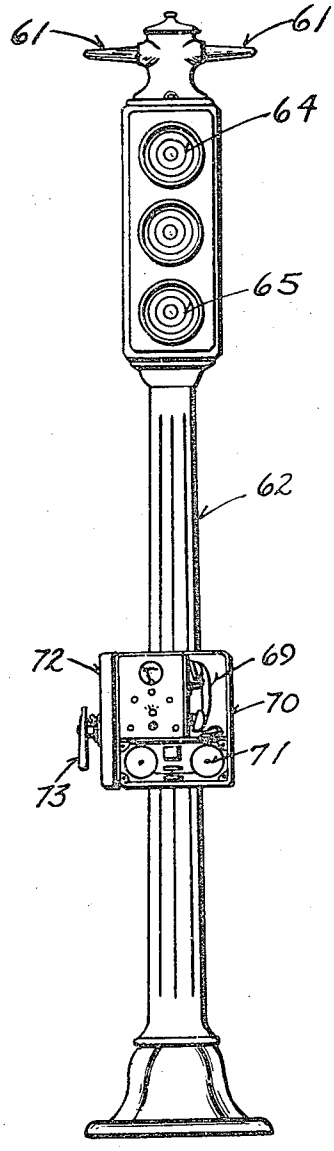

Fig. 1

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Filed Aug. 3, 1940 6 Sheets-Sheet 2

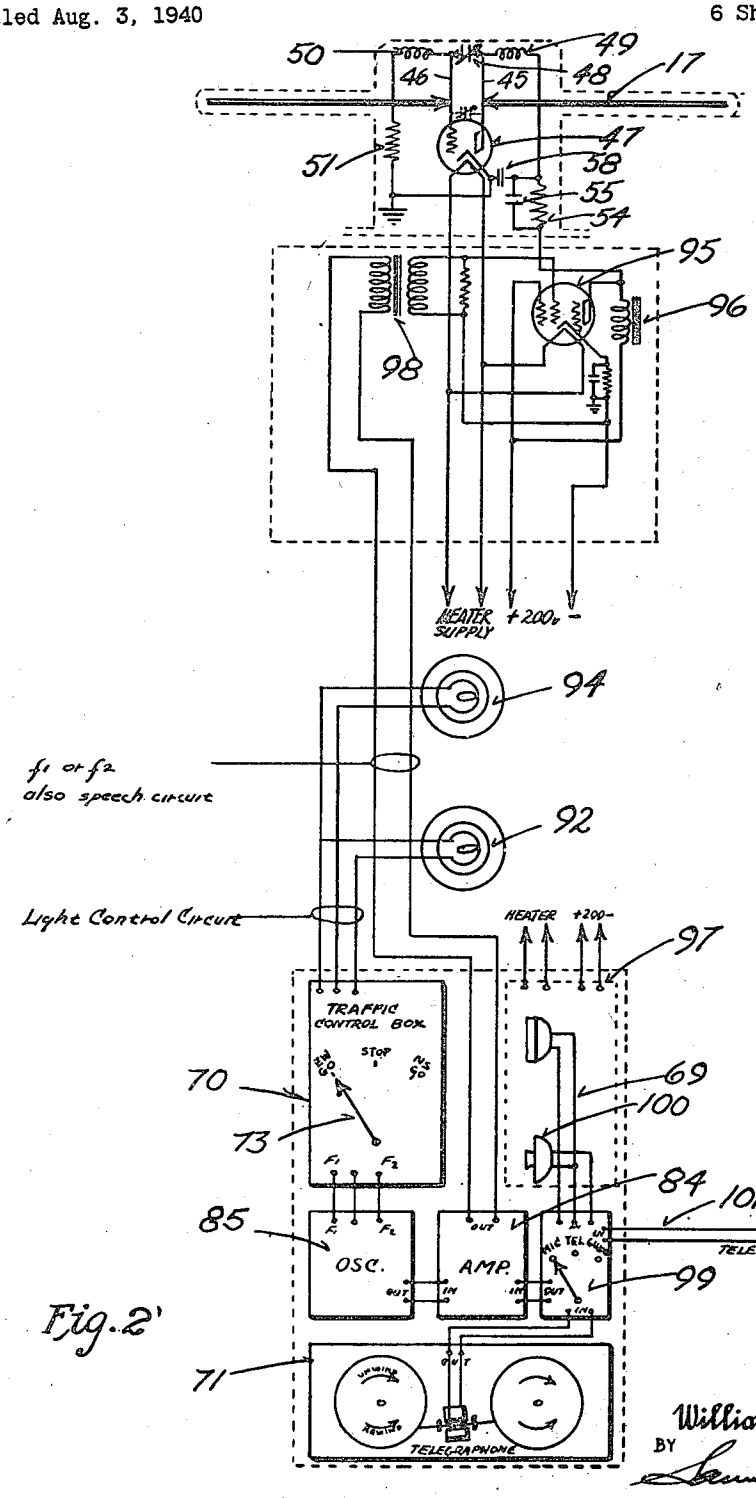

Fig. 2'

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TRAFFIC SIGNALING SYSTEM

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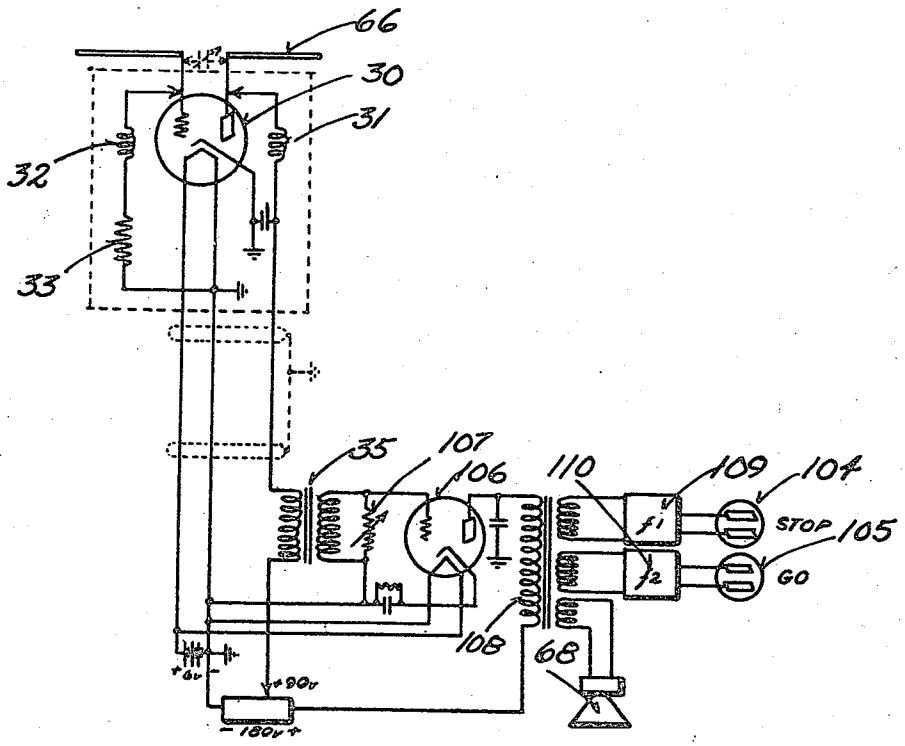

Fig. 3

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TRAFFIC SIGNALING SYSTEM

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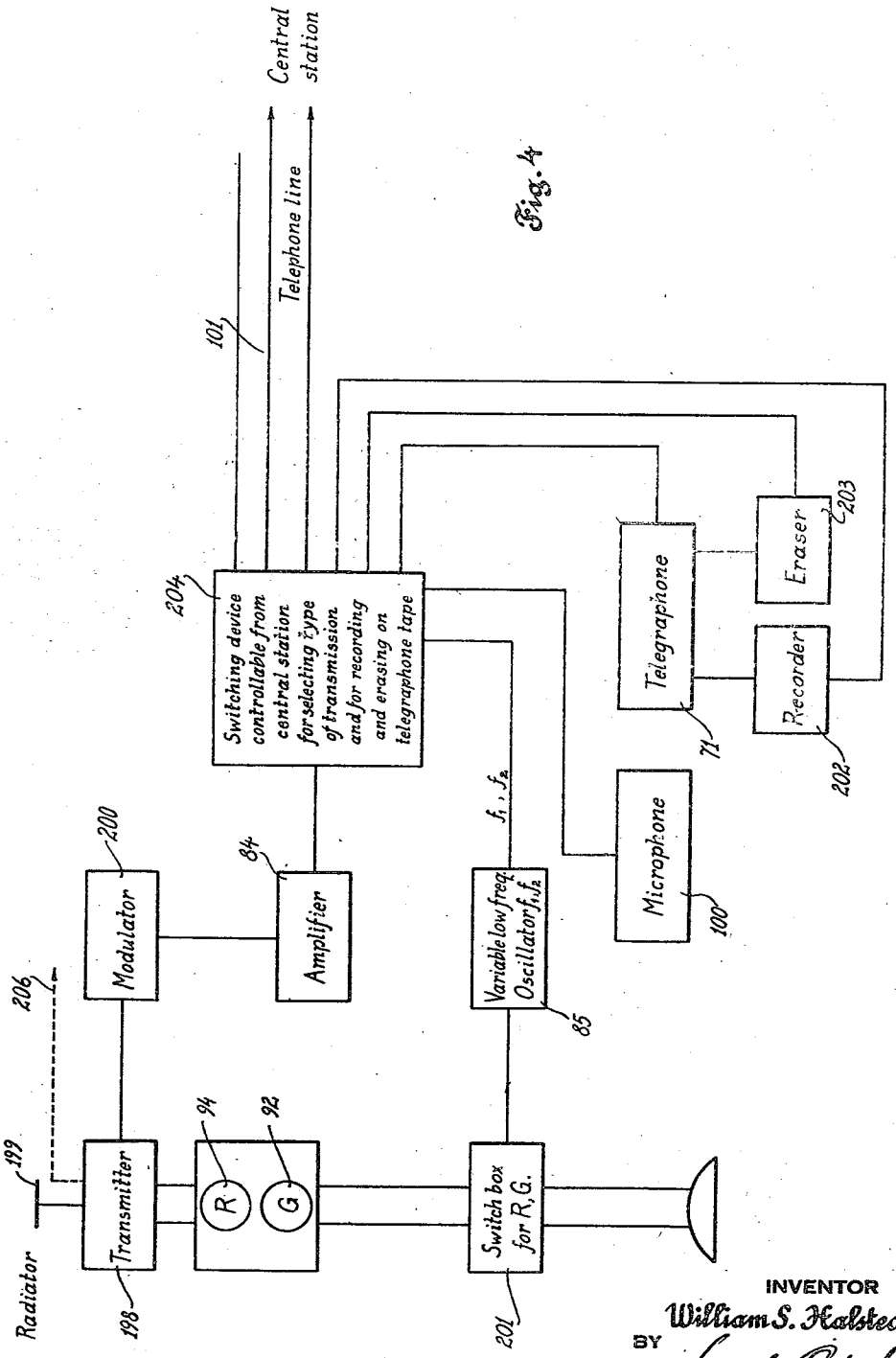
Fig. 4



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TRAFFIC SIGNALING SYSTEM

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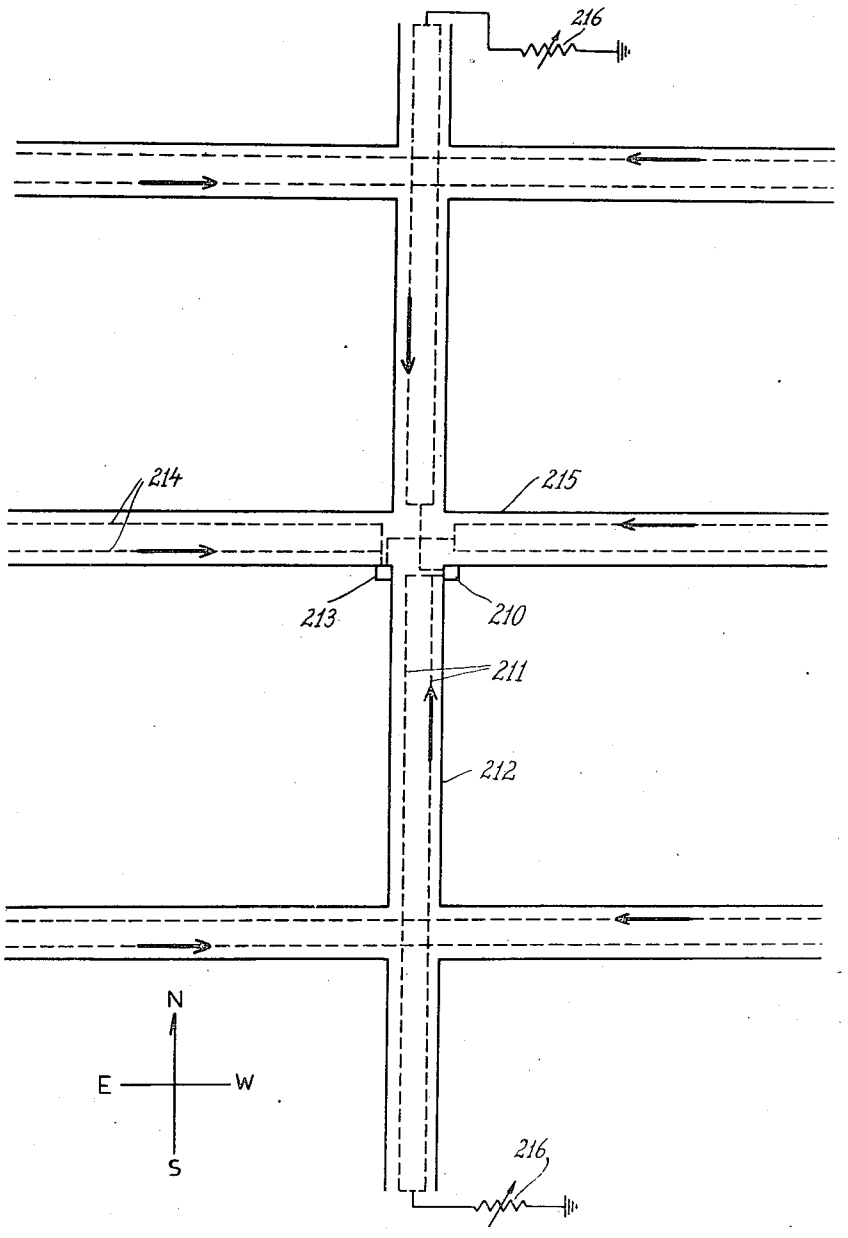

Fig. 5

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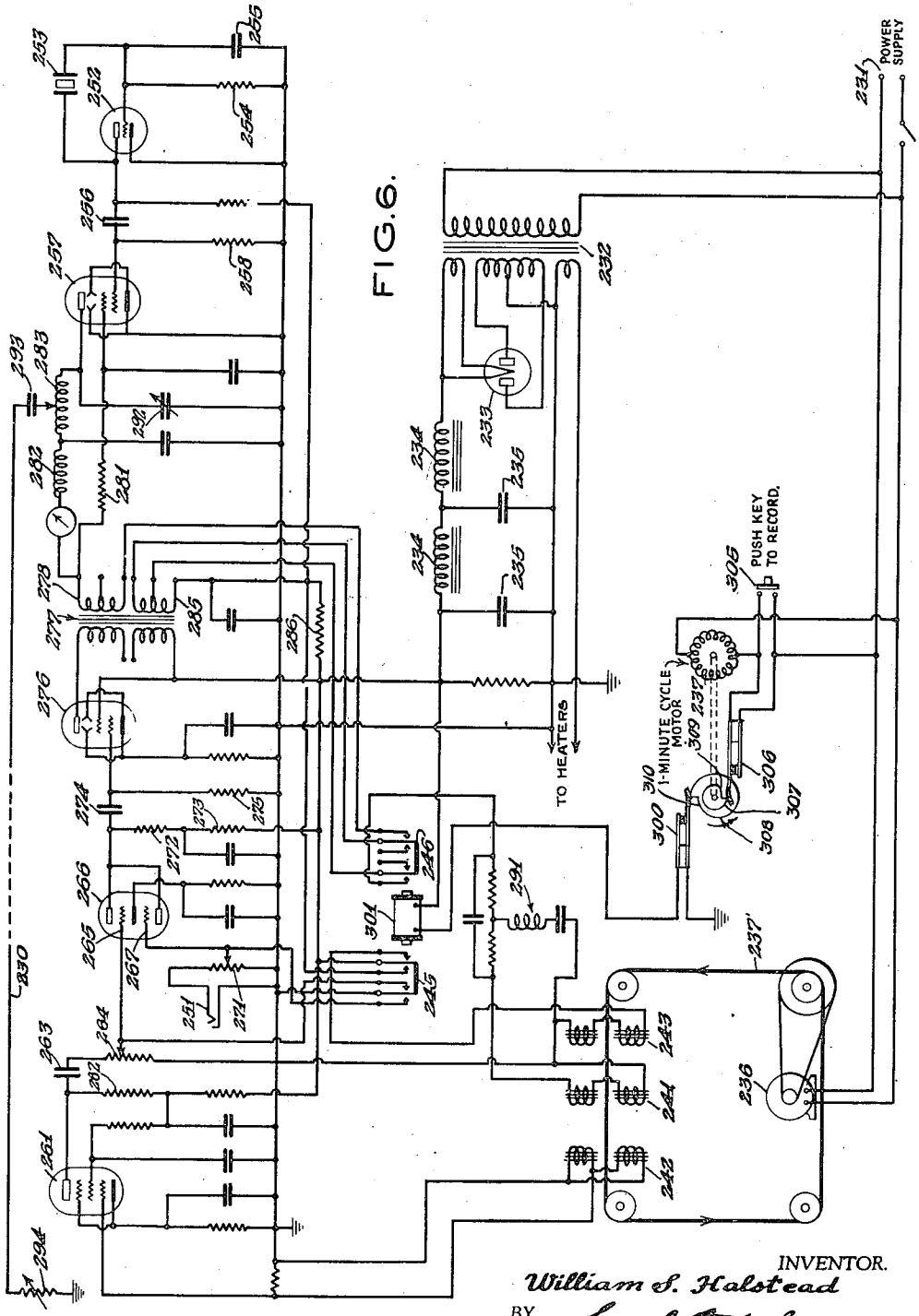

FIG. 6.

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Patented June 8, 1948 2,442,851

UNITED STATES PATENT OFFICE

2,442,851

TRAFFIC SIGNALING SYSTEM

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Application August 3, 1940, Serial No. 350,972

9 Claims. (Cl. 177—337)

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My invention relates in general to traffic signalling systems and more specifically concerns a system for regulating and coordinating the movement of vehicular traffic by visual and aural signals received within the vehicle itself.

My invention is of prime importance in traffic systems such as the usual parallel and intersecting lanes of city and rural traffic and the parallel and branch lanes of railroad traffic.

As is well known to those skilled in the art, many automobile traffic accidents may be attributed to poor judgment by the operator of a vehicle or to the division of the operator's attention between traffic on the road ahead and traffic signals or signs which he must observe for directions as to his movements.

In many instances, this visual information is obscure and the search for such information always distracts the operator's eyes from the path directly ahead of him, whereas it is an elementary safety requirement that the operator should keep his eyes constantly on the traffic ahead of him.

The operator's aural senses are at present not used for traffic control, while his visual senses are overtaxed. I have discovered that I may by a comparatively simple and inexpensive system provide the driver with aural information which will direct and aid him along his course, thus reducing the burden on his visual senses so that they may operate more effectively in safeguarding his course through the maze of complicated traffic movements now commonly found on streets and highways.

In my Patent No. Re. 21,818 issued June 3, 1941, I illustrated means for transmitting by directional radiant energy a series of signals which may be detected in a moving vehicle in operation in a given signalling zone along a particular traffic lane and which may be converted into aural or visible traffic control signals within the vehicle. The visible signals may be located, as indicated in the patent, on the instrument panel or elsewhere within the driver's field of vision.

By this novel system of visual indications within the vehicle itself and in the operator's line of vision his attention may be focussed directly upon the road and upon other objects therein without need to search for roadside signals. However, at extremely crowded intersections of multi-lane traffic arteries or at intersections where a plurality of lanes are joined, it is becoming necessary to employ some form of aural traffic guide which will aid the driver as he approaches the diversion

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points in order to avoid confusion at the route intersection.

Such an aural guiding signal of course must be quickly adaptable to meet the varying traffic conditions at the particular danger point. For example, it is well known that certain intersections or routes experience extremely heavy weekend traffic and relatively light midweek traffic. In order to equip the signal transmitters at each strategic intersection with means for broadcasting a pertinent message and means for quickly changing this message to meet varying traffic conditions, I employ in one modification of my invention a repeating telegraphone, (a device for magnetically recording messages upon a steel tape or wire and means for continuously reproducing the recorded messages) or any other of the well known signal storage devices, coupled to the transmitting device through a modulator. Thus my signalling device contains means for transmitting energy correlated with a traffic control signalling device such as traffic lights as well as voice modulated energy to correspond with the aural message carried by the telegraphone tape.

Each of my signal control devices is controllable from a central station over a telephone line and means are provided at both the central station and at the roadside traffic control unit for selectively coupling to the transmitter one of a plurality of signalling means such as, for instance, the repeating telegraphone, the aural control signals which are correlated with particular traffic control signals, such as red or green and amber lights, or the telephone line itself, in order that messages may be broadcast from the central station and radiated from particular zone signalling device and disposed at certain control points along a traffic lane.

In addition, a microphone and telephone receiver may be provided at each of the zone signal transmitters in order that the traffic officer on duty at a dangerous intersection may broadcast instructions relating directly to traffic conditions visible to him at a particular instant, by addressing operators of certain vehicles, thereby providing means to relieve traffic congestion in an orderly manner.

When my invention is employed in railroad operations, it is possible to permit each wayside signal transmitter to radiate control signals which correspond to particular "go," "stop" and similar traffic signals and simultaneously transmit aural instructions or messages, which may be received by the engineer of a locomotive proceeding along a particular signalling zone of a given

track. Such a message may carry to the engineer exact track conditions, warnings of the maximum possible speed at certain points, and such messages as these advising that work crews are engaged in repairs on the tracks ahead which fact requires that extreme caution will be necessary. Train orders may be received in the same manner while the train is proceeding through certain block signalling zones.

It is therefore an object of my invention to provide novel means for providing an aural traffic control system, traffic control by means of visible signals within the vehicle, and combinations thereof.

A further object of my invention is to provide novel means for traffic signalling effected within the moving vehicle.

Still a further object of my invention is to provide novel flexible means for providing communications with a moving vehicle.

Another object of my invention is to provide a novel traffic signalling device having a transmitter thereon for radiating control signals to correspond with visible signal indicators of the signalling device as well as aural instructions or other signals obtained from a telegraphone or other recording device.

It is a still further object of my invention to provide a traffic signalling device electrically related to a central station and controllable therefrom for transmitting radiant energy modulated in a manner to correspond with particular traffic signal indications and speech signals impressed upon a continuously repeating record or obtained from a microphone.

It is a further object of my invention to provide a traffic control device and a radio transmitter mounted thereon for radiating energy which corresponds with visible traffic signals of the traffic control device and the speech recorded upon the tape of a repeating telegraphone disposed in the traffic control device.

Still a further object of my invention is to provide for a traffic control device having a radio transmitter mounted thereon for radiating energy corresponding with particular traffic signals which may be recorded upon and erased from a telegraphone tape, contained within the traffic control device, from a central control station coupled to the traffic signal device through a telephone line and switching device.

These and other objects of my invention will be evident from the following specification taken in connection with the accompanying drawings in which:

Figure 1 is a front view of a traffic control device having a radiating member connected thereto and in which distinctive traffic-light signals are employed to regulate the flow of traffic in the particular lane and zone in which it is mounted.

Figure 2 is a circuit diagram of the traffic control device illustrated in Figure 1 and more clearly indicates the transmitter and modulator circuits and the connections of a repeating telegraphone microphone and telephone line coupled thereto.

Figure 3 is a preferred modification of a traffic signal particularly adapted to be mounted upon a moving vehicle for the reception of signals emitted by a signalling device such as shown in Figure 1 showing aural and visible traffic signal reproduction means.

Figure 4 is a block schematic diagram illustrating the various elements which may be coupled to the radio traffic signal transmitter for traffic control and the means for controlling the transmission by means of telephone line connections with a central station.

Figure 5 is a schematic illustration of the application of conductors or wave guides paralleling the traffic lane for limiting traffic signal transmissions thereto.

Figure 6 is a schematic wiring diagram of one modification of a traffic signal transmitter and its associated wave guide.

The traffic control device illustrated in Figure 1 contains in combination with visible traffic signal indicators for controlling the flow of traffic within a particular lane or zone, a means for transmitting energy for reception within the vehicles moving in the lane. The colored signals in this instance are primarily for the pedestrian inasmuch as the operator of a vehicle may obtain the signals upon the dash board of his vehicle by means of the transmission from a radio transmitter.

It is to be pointed out that the invention is not limited to the form of signal device indicated in Figure 1 but may be employed upon the semaphore of a railroad system or in any other system wherein it is desired to control traffic.

In this illustration of my invention, I employ a horizontally disposed di-pole antenna 61 mounted on top of the signal control device and perpendicular to the lane of traffic which it is desired to control.

Ultra high frequency radiations from this antenna will therefore be confined to the lane of traffic to which the antenna is perpendicular and it may be confined to a particular direction if it is desired to do such by mounting a metallic reflecting shield behind the antenna 61 and parallel thereto.

Mounted in an accessible position upon the signal control tower is a box 70 containing a plurality of control devices which may be operated by opening the cover 72 with the aid of handle 73. These control devices comprise a telephone hand set 69 and a repeating telegraphone 71 which are coupled electrically to a modulator which in turn is coupled to the ultra high frequency oscillator and di-pole antenna situated in the uppermost portion of the control tower.

Manual means are provided within the control box 70 for operating the distinctively colored correlated signal lights 64 and 65 which may, as conventional, be red and green, and in addition a yellow warning light may be provided, if desired.

Manual means are also provided within the control box 70 for selectively coupling either the hand set or the repeating telegraphone to the modulator of the ultra high frequency transmitter in order to radiate speech recorded upon the telegraphone tape or the speech of an attendant officer.

The wiring of the traffic control tower 62 which has been pictorially illustrated in Figure 1 is shown in greater detail in Figure 2 wherein an incoming telephone line 101, a repeating telegraphone 71, an oscillator 85 or a telephone hand set 69 may be selectively coupled to the input of a modulator tube 95 which in turn actuates an ultra high frequency oscillator and transmitting tube 47 that is coupled to the horizontal di-pole transmitting antenna 17.

The repeating telegraphone 71 is a device for selectively recording predetermined electrical variations upon a tape which may be continuously rewound and reproduced. The microphone

100 of the telephone hand set contained within the box on the traffic control tower may be coupled through the switching device 99 to the recording magnets within the schematically illustrated telegraphone 71.

Upon the completion of the recording which may be made by an attendant or police officer present when required, the message may be reproduced and checked within the reproducer of the hand set 69. If a recorded message is to be altered the tape may be demagnetized and remagnetized in accordance with a new message. The switching device 99 may then be actuated to couple the telegraphone output, that is, the electrical variations corresponding to the speech and reproduced therein, to the amplifier 84 of conventional design which in turn is coupled through transformer 98 to the modulator tube 95 of the ultra high frequency oscillator 47.

The traffic control box 70 provides switching means whereby the plurality of distinctly colored lights such as 92 and 94 may be operated from some power supply such as the local lighting means. This switching means may of course be controlled by a manual operating lever 73 or by a clock-work mechanism which alternately switches on the differently colored lights and maintains them in operation for a period as required by the traffic conditions in the lane and in the cross lane.

The switching means in addition to operating the plurality of distinctly colored light signals operates to vary the frequency of a low frequency oscillator 85. The oscillator 85 may comprise an ordinary tuned vacuum tube circuit and the switching means may operate to vary the inductance or capacitance within the tuned circuit in order to change the frequency of oscillation as is illustrated in my Patent No. Re. 21,818.

The distinct frequency which is generated for each particular color radiated from the traffic control tower 62 is coupled to the amplifier and then to the modulator 95 of the oscillator and transmitter. Although ordinarily, it may not be necessary to transmit signals corresponding with the particular colored signals radiated from the tower with an accompanying speech transmission, this may be accomplished when desired by merely coupling both oscillator and repeating telegraphone 71 or hand set 69 to the amplifier.

This of course assumes that the distinct frequencies generated to correspond with each of the differently colored lights do not conflict with the frequencies contained in the speech transmission in order that they may be selectively filtered at the receiver without any conflict therebetween.

One preferred circuit for the generation and radiation of polarized high frequency energy is illustrated in Figure 2 and is more completely described and explained in my Patent No. Re. 21,818. In this embodiment the two quarter wave sections of the di-pole transmitting antenna 17, which is mounted upon the top of the traffic control tower, are connected to the anode and grid circuits 45 and 46 respectively of the oscillator tube 47. A variable condenser 48 may be employed by the grid and anode circuits as shown to effect a degree of tuning.

Anode and grid choke coils 49 and 50 respectively are connected in series with the anode and grid leads of the oscillator tube 47 as indicated. Resistor 51 is connected in series between the grid choke 50 and the ground connection of the

transmitting device. A resistor 54 and shunting condenser 55 are connected in series between choke 49 and the source of anode E. M. F. which, as illustrated in Figure 2, is obtained from the source of E. M. F. 97 through the modulating circuit.

A by-pass condenser 58 is connected between the anode side of resistor 54 and the cathode to complete the circuit and the cathode in turn is grounded in this embodiment. The heater voltage and source of anode E. M. F. may be obtained again from a local power supply or, if the unit is isolated, from a series of storage batteries.

Modulation of the high frequency transmitter in this particular embodiment of the invention may be effected by any well-known speech modulating circuit for ultra high frequencies such as the Heising circuit illustrated herein in Figure 2 in which the anode lead of the modulator tube 95 is connected in a conventional manner to one end of the constant current choke coil 96 disposed in series with the positive lead from the source of anode E. M. F. 97 and to the anode circuit of the oscillator tube 47.

Modulating signal voltage generated by the tone oscillator or by any of the speech circuits contained within the signal tower or speech originating over the telephone line 101 is applied to the input circuit of the modulator tube through transformer 98 whose secondary leads are connected to the control grid and cathode leads of the modulator tube as shown.

The primary winding of transformer 98 is connected to the output circuit of amplifier 84 whose circuit is connected to the output of any of the sources of signal voltage. The control arm 73 of the traffic signal control box 70 as described heretofore effects control of operation of red and green signal lights 94 and 92 and simultaneously effects correlated and coordinated modulation of high frequency oscillator tube 47 by distinctive control frequencies and this modulated energy is emitted as horizontally polarized ultra high frequency radiant energy with the cooperative projection of the signal lights.

Thus in cooperation with a receiving device within a vehicle moving along a particular line of traffic within which the traffic control tower is mounted, radiation of signals may be effected to direct the flow of this traffic and these signals may comprise as required distinctive frequencies corresponding with distinctively colored and projected lights upon the control tower, a message from a repeating telegraphone which relates to traffic conditions and dictates specific instructions such as the type of turn allowed when the light is red and the like or the speech of an attendant at the control box or the speech received over a transmission line from a central station.

The means for mounting the high frequency radiator and the means for coordinating the signals radiating with the motion of a semaphore arm and with the control of traffic along a railroad line have been more fully described in my aforementioned patent. A cooperative receiver which may be mounted upon the vehicle proceeding in the lane of traffic has been illustrated in several forms in this patent and the means for orienting the receiving di-pole antenna and means for locking the receiver within the vehicle have also been illustrated therein.

Figure 3 is a preferred modification of a preferred high frequency detector circuit in which

two halves of a receiving di-pole 66 are connected as illustrated to the anode and grid of an ultra high frequency detector tube 30.

Radio frequency chokes 31 and 32 are employed in series with the anode and grid circuits respectively and the resistor 33 is connected in series with grid choke 32 to ground to which is also connected the cathode and one side of the heater circuit of the tube as shown.

The anode circuit of the detector is connected in conventional fashion through the primary windings of a transformer 35 to a source of E. M. F. The secondary winding of the transformer 35 is connected in well known manner to the input circuit of an amplifier tube 106, volume control being effected by a variable resistor 107 connected across the secondary windings of transformer 35 as shown.

The output circuit of tube 106 is connected to an output coupling transformer 108 in a conventional manner and the secondary windings thereof are employed to provide signal voltages to frequency selective devices 109 and 110 such as electrical wave filters tuned to respond respectively to the signals of distinct frequency which correspond to the distinctly colored lights emitted from the traffic control tower.

The output circuits of the filters 109 and 110 are connected to colored lamps 104 and 105 which are colored similar to the lamps upon the traffic control post which generates a frequency corresponding to the selective frequency of its associated filter. The output of transformer 108 is also connected to a loud speaker 60 as shown to give audible indication of the traffic light which the car is approaching. Inasmuch as the di-pole antenna of the receiver is mounted parallel to the di-pole antenna on the traffic control tower, the energy detected thereby will be a maximum and the detector will function to separate the modulating currents and pass them into the filters and loud speaker. The loud speaker functions when no speech is present to give an audible indication of the approach of a transmitting antenna or traffic control post and when speech modulations are present upon the ultra high frequency polarized carrier, the loud speaker will provide audible instructions for the operator of the vehicle.

In Figure 4 there is schematically shown another modification of my traffic control system. In this embodiment of my invention, the radiator 199 functions with its associated transmitter to emit signals corresponding to traffic control signals such as red and green lights 92 and 94 schematically illustrated upon the tower.

The transmitter comprises an oscillator as previously described which is actuated by the modulator 200 and the amplifier 84 which serves to amplify the speech and signalling frequencies.

A switch box 201 functions similarly to the switch box previously described in that it may be manually or automatically operated to alternately illuminate the red and green lights 94 and 92 and in addition operates the switching mechanism within the oscillator 85 for alternately changing the frequency thereof to correspond with the signal lights.

Conveniently situated within the traffic control tower is, in addition to the transmitting and switching equipment, a signal storage means which in Figure 4 is schematically illustrated as a telegraphone 71 associated with a recording mechanism 202 and an erasing mechanism 203, for electrically magnetizing the tape when recording and removing the same when it is desired to change the message. The recorder 202 of course may be operated in reverse, that is, a magnetized tape when passing through the electromagnetic means will generate a fluctuating voltage corresponding with the magnetic recording thereon.

The telegraphone and the necessary circuits required therewith, as well known to those skilled in the art, are connected to a switching device 204 which is controllable from a central station by means of a telephone line 101. Further, the microphone 100 and the variable low frequency oscillator 85 are coupled thereto. The output of the controlling device 204 is coupled to the amplifier 84 which then may be traced directly to the transmitting antenna 199.

The controlling mechanism 204 comprises a switching means controllable by any of the well known methods such as electrical impulses of distinctive amplitude, distinctive frequency or an electrical current of a distinct number of pulses. It may correspond in one form to the selective switching devices employed in telephone stations and exchanges for automatically connecting desired circuits in accordance with predetermined signals.

In practice, the embodiment of Figure 4 operates in the following manner: The central station operator establishes contact with the controlling device 204 over the schematically illustrated telephone line 101 by any of the well known telephone switching devices, and then transmits a series of predetermined signals from the central station which selectively operate the device 204 to establish contact between the various elements contained within the traffic control tower.

He may, for instance, transmit a series of signals which will interconnect the switch box 201 and its associated variable low frequency oscillator to the amplifier 84 thus allowing the device to operate as described hereinabove and in my aforementioned patent. Thus the system may be allowed to operate merely as a red and green light traffic control device, each of the colors being represented by a distinct low frequency.

If, however, traffic conditions demand, a particular message may be transmitted as for instance, a message relating to instructions at a rather complex intersection, as the well known "clover-leaf" intersection. The operator of a vehicle on receipt of specific instructions guiding him along the intersection, avoids confusion and proceeds along the correct route.

In railroad operation it may be desired to constantly transmit a message which notifies the engineer of a particular sharp curve or the need for a decrease in speed or the need for operating the locomotive's whistle at a grade crossing or the like. In this instance, the operator will transmit a series of impulses which again in the well known manner will actuate switching device 204 to join the circuit of telegraphone 71 to the amplifier 84 provided, of course, that the desired message has already been recorded upon the telegraphone tape. Means may again be provided for allowing the simultaneous transmission of the variable frequencies for visual signal control and the speech message for aural instruction for the operator.

Assuming that the message has not been recorded upon the telegraphone tape, the central station operator may then by remote means operate the controlling device to interconnect the telephone line and the telegraphone recording

circuit and thus the operator may record any message as desired.

Upon the completion of the recording process, he may again by a simple remotely controlled switching operation permit the play-back of the message in order that he may check it by means of his receiving equipment. If a message is not satisfactory, he may again actuate the erasing device 203 to obliterate the magnetic fluctuations within the tape and then record the corrected message.

When satisfied with the recording, he may then immediately switch the telegraphone to the input of the amplifier 84 for broadcasting from the transmitting antenna 199.

It is to be emphasized at this point that the entire system herein illustrated need not be limited to transmitting and radiating means mounted upon the signal tower. Transmission to the interior of the vehicle may be effected by the transmitter and antenna shown, or by a transmitter coupled to a conductor or wave guide which follows the traffic lane, designed to limit the transmission to the lane. With the aid of this type of radiator, transmission may be accomplished with the relatively low frequency carriers, without interference with broadcast stations.

Thus as indicated in Figure 4, the output of transmitter 198 may be joined by means of conductor 206 to a wave guide for limiting the radiations to the particular lane in which traffic regulation is desired. This will be more completely described in connection with Figures 5 and 6.

The telegraphone message as previously described may be constantly and automatically repeated by the device until it is desired by the central station to discontinue the message. If the central station desires to broadcast a relatively short message to relieve a traffic jam or to inform a locomotive operator of a work crew in a certain vicinity, he may directly connect, through the controlling device 204, the microphone at the central station and the amplifier 84, to permit such broadcast.

At the transmitting post, an attendant officer may manually operate the switching device 204 to perform any of the above mentioned functions. That is, a local microphone 100 is provided in order that the attendant officer may record upon the telegraphone tape or may transmit directly from the microphone through the dipole antenna 17.

A telegraphone has herein been described and illustrated as the means for recording and reproducing a message. It is to be understood, of course, that any of the well known recording or reproducing devices may be employed in place of the telegraphone. However, the telegraphone of this embodiment because of its simplicity and because the recording medium is endless and may be employed repeatedly by merely demagnetizing the previous message which has been recorded thereon, provides a greater degree of flexibility than is otherwise obtainable and therefore is especially suitable for my system.

The circuit illustrated in Figure 4 has been illustrated as a schematic block diagram in that each of the circuits is well known.

Certain traffic intersections may be particularly dangerous during certain periods and may have relatively light traffic during other periods. In this instance then it is not desirable to install all of the equipment illustrated in Figure 4 within the individual traffic control signal devices. The only equipment which need be installed therefore

is the plurality of switching members, the transmitter and the variable low frequency oscillator in order that the device may operate to broadcast visual signals which correspond with the red and green lights of the traffic posts.

A microphone may be installed if desired, so that if the traffic becomes extremely heavy and dangerous, an officer's broadcast may greatly aid in relieving traffic congestion. However, the telegraphone and its associated equipment may be installed at the central station and it is evident that if a great number of traffic control posts require the application of a telegraphone message only during particular periods, a great number of telegraphone units may be dispensed with.

If for instance the week end traffic at a certain intersection becomes exceptionally heavy, a telegraphone at the central station may be switched from a traffic control tower in a business section wherein traffic is particularly heavy throughout the remainder of the week. Thus it may be seen that a single telegraphone in cooperation with the associated telephone lines which bind each of the traffic control posts to a central station may be employed for several traffic control towers.

The switching control 204 need only under these circumstances, provide means for remotely controlling the interconnection of the variable low frequency oscillator 85 and the amplifier 84 and the interconnection of the telephone line 101 and the amplifier 84. This reduction in telegraphone equipment as is obvious is extremely feasible in traffic control within large cities wherein the volume of traffic is constantly shifting from point to point throughout the week.

In Figure 5, there is more clearly shown the application of the aforementioned wave guides to a plurality of intersecting and parallel traffic lanes. The modulated carrier energy is transferred from the radio traffic control device 210 to the cable or cables 211 disposed in the traffic lane 212. To preclude cross talk between adjacent lanes, different carrier frequencies may be employed with roadside markers at the necessary points to indicate the frequency.

A traffic control tower 213 may be employed in conjunction with wave guide cable or cables 214 for directing a desired transmission down lane 215 and similar transmitters may be operated to transmit signals along other lanes.

In order to eliminate radiation through the power line supplying the radio transmitter which would establish a radiation pattern over the traffic lane, it is necessary to install radio frequency filters in the power circuit leading to the transmitter to reject all radio frequency energy while accepting the relatively low frequency power line energy.

This filter is particularly important because without it a signal will be discernible for several miles along the power line supplying the transmitter which may result in the confusion of the operators of vehicles in other lanes which may pass over the power line.

The wave guide itself, schematically illustrated in Figure 5, may comprise a single wire or twisted pair with ordinary weather resistant insulation inasmuch as the voltage and current are relatively low.

The current flowing through the guide should be substantially constant throughout the length of the wire, which condition is obtained by properly terminating this wire at the far end. This termination may be in the form of a variable resistor 216 connected between the far end of the guide

211 and ground and is adjusted until the currents at both ends of the guide are the same. This precludes the formation of standing waves upon the wire and accordingly eliminates space radiation of a wave with the usual electromagnetic and electric components. A magnetic field of constant intensity from one end of the wire to the other is thus produced.

The receiver in the vehicle employs this magnetic field surrounding the wire, of constant intensity from one end to the other and therefore the signal received in the vehicle is of substantially constant strength as the vehicle proceeds along the lane served by the guide.

The magnetic field surrounding the guide 211 is approximately cylindrical and as is well known, the intensity thereof varies inversely with the square of the distance measured normal to the wire. This permits the current in the guide to be adjusted to value which will ensure a strong signal for reception in the moving vehicle while precluding interference with normal broadcasting.

The signal also decays very rapidly from the ends of the wire, and thus is definitely confined to the lane followed by the guide, which results in a directional characteristic similar to that obtained by the application of directional transmitting antennae and the like.

In Figure 6 there is shown another possible modification of a zone transmitter and a repeating telegraphone or other sound storage unit for broadcasting signals to aurally instruct the operator of vehicles within the zone. The wave guide 230 parallels the lane to which the transmission is to be confined as illustrated in Figure 5.

The circuit illustrated provides means for impressing upon the wave guide 230 a carrier current modulated by signals recorded upon a telegraphone tape and in addition provides means whereby the message recorded upon the telegraphone tape may be altered.

A microphone is employed as hereinabove described for impressing signals upon the recording coils of the telegraphone and the circuit permits the utilization of the same electrical channels for both recording and reproduction.

The power line 231 is joined to a source of power which may be of the conventional low frequency alternating current type and through the transformer 232 currents are obtained to operate the heaters of the vacuum tubes and the anodes of the rectifier 233.

In the conventional manner, the alternating current is rectified and filtered by means of the filter chokes 234 and condensers 235. In addition, current derived from the power line is employed to operate the two sources of motive power 236 and 237. The source of motive power 236 continuously rotates a steel tape or wire 237' through a plurality of coils disposed thereabout. By means of coils 241 electrical variations corresponding to speech variations are impressed upon the tape 237' to produce the desired recording. The magnetic variations in the steel tape 237' cause corresponding fluctuations in voltage in pick up coils 242 when moving therethrough and these electrical variations are impressed upon an amplifying and modulating circuit as will hereinafter be more completely described. Coil 243 is employed to remove any magnetic variations from the tape 237' when it is desired to change the message recorded thereon.

The switches 245 and 246 may be operated to selectively impress the speech voltages generated in pick up coil 242 upon the modulating circuit; or electrical signals entering the microphone connection 251 upon the recording coils after having passed through the necessary amplifying circuits.

The transmitter employed in conjunction with the wave guide 230 is preferably of the crystal controlled type as illustrated in Figure 6 and the power requirements thereof will be determined by the particular transmission requirements, that is the length of the wave guide 230 and the like.

As illustrated, the transmitter comprises an oscillator tube 252, the frequency of which is controlled in the conventional manner by crystal 253. The required grid biasing potential is secured by means of resistor 254 and its associated by-pass condenser 255. The output of the oscillator is coupled from the anode thereof, by means of condenser 256 and resistor 258, to the grid of a power amplifier 257 which, as illustrated, is a beam power tube. The power amplifier may be of the well known class C type and modulation of the carrier wave may be effected within this amplifier.

During the transmission of the signal recorded upon the telegraphone tape the fluctuating voltage developed within the pick up coil is transferred to the grid of a conventional amplifier 261 which is herein illustrated as a pentode. The anode circuit of this pentode is connected to the source of direct current through the load resistor 262 and as indicated, the screen grid and anode circuits employ a decoupling filter.

The amplified signal is then coupled by means of condenser 263 and volume control 264 to the grid 265 of another amplifying tube 266 which is herein illustrated as a duplex triode.

The control grid 267 of this tube is joined through volume control 271 to the microphone connection. As indicated, both anodes of the duplex tube are joined together and thus the signal appearing across load resistor 272 will depend upon the signals impressed upon both grids. The switches 245 and 246 insure that when signals are impressed upon one grid, the other is at ground potential or otherwise inoperative.

The anodes of the amplifying tube 266 are joined to the direct current source through load resistor 272 and as indicated through a decoupling filter 273 and the amplified signal is coupled by means of condenser 274 and resistor 275 to the control grid of an amplifier 276 which provides in the output thereof a signal large enough to modulate the carrier current originating at the oscillator.

The anode circuit of the amplifier 276 is electrically joined to the source of direct current through modulating transformer 277, the secondary of which is divided and contains a plurality of taps for reasons which will be more fully described.

One end of a section 278 of the secondary coil of transformer 277 drives a grid of the class C power amplifier 257 through resistor 281 and is in addition joined to the anode of tube 257 through a radio frequency choke coil 282 and through the inductance 283 of the transmitting tank circuit. The other end of this section of the secondary coil is joined to the one pole of the switching member 246. The radio frequency choke 282 is the filter system previously described for precluding radiations from the power supply.

The second section 285 of the secondary coil is joined to one pole of the switching member 245 and in addition to the source of high voltage

through resistor 286. The opposite end of section 285 of the secondary and the center tape thereof are in addition joined to poles of the switch 246.

Also joined to poles of switch 245 are both grids of amplifier tube 266 and the direct current source, and the recording coils 241 are joined through an equalizing network 291 to a pole of switch 246.

It may now be seen that the operation of switches 245 and 246 will provide means for permitting recording upon tape 237' or means for broadcasting the message contained thereon over the wave guide 230. Thus when the switching member 245 is moved to the left as viewed in Figure 6 and the switching member 246 is moved to the right, the voltage generated in the pick up coil 242 will be amplified in amplifier 261 and impressed upon the grid 265 of amplifier 266 while grid 267 of this tube will be grounded through switch 245. Accordingly the signal recorded upon the tape will be amplified by tube 266 and again by the beam power tube 276 and will be coupled to the secondary of the modulating transformer 277.

Switch 246 when in the position mentioned interconnects both sections of the secondary coil of modulating transformer 277 and switch 245 connects one end of the secondary to the source of direct current. The transformer 277 will function when the switches are thus oriented to modulate the carrier current supplied by oscillator 252.

The anode circuit of the class C amplifier 257 contains the tank circuit including inductance 283 and variable tuning condenser 292, and through condenser 293 the modulated carrier is coupled to the wave guide 230. This wave guide as previously described must be suitably terminated in order that the signals be confined to the particular lane while not interfering with broadcast transmissions. Thus the wave guide 230 is grounded through variable resistor 294 which is adjusted as previously described in connection with Figure 5, to eliminate reflections and space radiations therefrom.

When it is desired to record upon the tape 237', switching member 245 is displaced to the right and switching member 246 to the left as viewed in Figure 6.

This orientation of the switches grounds grid 265 of the duplex tube 266 and thus voltage fluctuations in pick up coil 242 are not amplified nor passed on to succeeding amplifying stages. On the other hand, grid 267 is no longer grounded and thus electrical variations entering through microphone connection 251 will be impressed upon grid 267 and amplified within the duplex tube 266. In the movement of switching member 245 from the left to the right as described, the resistor 286 is inserted between the anodes of tubes 257 and 252 and the source of direct current which results in a decrease in the anode potentials thereof thus rendering the tubes practically inoperative.

Also magnetizing coil 243 is joined to the source of high potential and thus the magnetic fluctuations within the tape are removed as the tape passes therethrough. Switching member 246 connects section 285 of the secondary of transformer 277 to the recording coils through the equalizing network 291 and thus signals entering the microphone connection 251 are amplified by tubes 266 and 276 and are impressed upon the recording coils 241.

It is obvious of course that the tape 237' must pass through the magnetizing coil prior to its passage through the recording coil in order that the message previously recorded thereon be removed before the replaced message is recorded. The speech to be recorded is derived from a microphone as mentioned hereinabove which may be at the transmitter or which may be joined thereto over a telephone line as pointed out in connection with the preceding figures. The operation of the tape 237' is continuous at a speed determined by the motor 236.

The message which is to be recorded upon the tape 237' must be of a length predetermined to correspond approximately with the time required for the tape to complete one cycle of rotation. Thus I employ a small motor 237 to initiate the recording cycle when desired and terminate the same automatically. As illustrated, the motor 237 when started by momentarily depressing push button 305, will actuate, by means of switch 300, electromechanical device 301 to orient both switching members 245 and 246 to the positions previously described for recording. Thus signals entering through microphone connection 251 will be recorded upon the tape 237'. Switch 306 is connected in parallel with push button 305 and is closed by the high cam surface 307 of cam 308 as rotation of the motor is commenced, thereby permitting the operator to release push button 305.

Upon the completion of a predetermined cycle, the motor 237 is automatically halted inasmuch as switch 306 is opened by the low cam surface 309 at the termination of each revolution of the cam 308. When the low cam surface 309 opens the switch 306, a timed low cam surface 310 engages the switch 300 to open the circuit through electromechanical device 301. The switching members 245 and 246 then assume their normal orientation which is that required for the repeated broadcasting of the message contained upon the tape.

It is pointed out that the figures which illustrate several embodiments of my invention are merely schematic and that variations in the form of my invention will be evident to those skilled in the art.

Therefore, I do not wish to be limited by the specific disclosures hereinabove set forth, but only by the appended claims.

I claim:

1. In a traffic signaling system of the class described for signaling to traffic in a predetermined signaling zone, a signaling transmitter having means for generating carrier wave energy, signal record means coupled to said transmitter for modulating said carrier wave energy, a timing device coupled to said signal record means for controlling the cycle duration of operation of the signal record means, a signal conducting transmission line having one end free and the other end thereof connected to said transmitter and extending along a lane of traffic to establish the length of the signaling zone, and terminating impedance means connected to the free end of the signal conducting medium and being grounded, said terminating impedance being equivalent to the characteristic impedance of said line to eliminate reflection and standing waves on said signal conducting transmission line, the duration of the timing cycle being sufficient to permit a unit of traffic traveling at maximum speed to receive carrier wave energy of a complete signaling cycle while negotiating the signal-

ing zone as established by the length of the signal conducting transmission line.

2. In a traffic signaling system having a carrier wave transmitter, signal record means coupled to said transmitter to effect repetitive modulation of transmitted carrier waves by audio-frequency signal energy impressed on said signal record means, the signaling cycle having a duration not greater than the time required for traffic to fully negotiate the signaling zone, and a transmission line extending along a lane of traffic for the length of a signaling zone, said transmission line being coupled to said transmitter and including a terminating impedance equivalent to the characteristic impedance of said line such that it emanates signal energy limited substantially to the electromagnetic type, whereby to restrict the effective signal field substantially to said zone.

3. In a traffic signaling system having a carrier wave transmitter, signal record means coupled to said transmitter to effect repetitive modulation of transmitted carrier waves by audio-frequency signal energy impressed on said signal record means, and a signal emanating transmission line extending along a lane of traffic for the length of a signaling zone, said signal emanating transmission line being coupled to said transmitter and including a terminating impedance equivalent to the characteristic impedance of said transmission line such that it emanates signal energy limited substantially to the electromagnetic type, whereby to restrict the effective signal field substantially to said zone.

4. In a system for signaling to traffic within a predetermined signaling zone, a signal transmitter having a carrier wave generator included therein, means for modulating carrier wave energy from said generator, a signal conducting transmission line having one end electrically connected to said transmitter for effecting impression of modulated carrier wave energy on said line, said line extending for a distance substantially equivalent to the length of said signaling zone, and a terminating impedance means electrically connected to said line, said terminating means being equivalent to the characteristic impedance of said line and effective in establishing substantially uniform distribution of the electric field surrounding said line throughout the length of said zone, said terminating means also being effective in restricting the longitudinal extension of said field substantially within the confines of said zone.

5. In a traffic signaling system having a carrier wave transmitter, a signal source electrically connected to said transmitter to effect modulation of said transmitter by audio-frequency signal energy, a signal conducting transmission line extending along a lane of traffic for the length of a signaling zone and having one end thereof electrically connected to the transmitter, and a terminating impedance connected substantially at the opposite end of said signal conducting line, said signal conducting line being grounded through said terminating impedance, the impedance value of said terminating impedance being substantially equal to the characteristic impedance of said signal conducting line.

6. In a traffic signaling system, a carrier wave transmitter for communicating with traffic proceeding through a predetermined signaling zone, a signal source electrically connected to said transmitter to effect modulation of transmitted carrier waves by audio-frequency signal energy, a timing device for controlling the duration of an operating cycle of said signal source to establish

a signaling cycle of predetermined duration, said signaling cycle having a duration less than the time required for traffic to negotiate the length of said signaling zone, a signal conducting transmission line extending along a lane of traffic and having one end thereof connected to the transmitter, and a terminating impedance connected to said signal conducting line at a point remote from said transmitter end, the value of said terminating impedance being substantially equivalent to the characteristic impedance of said line.

7. In a traffic signaling system of the class described for establishing communications with traffic proceeding along a traffic lane, a signaling transmission line disposed substantially along said lane of traffic to establish a signaling zone of predetermined length, means for impressing modulated carrier signaling energy upon said line, and terminating impedance means connected to the remote end of the signaling line, said terminating means having a value such that its impedance is equivalent to the characteristic impedance of said line to prevent reflection and standing waves thereon and to establish an electromagnetic field extending radially about said signaling line of substantially equal strength throughout the length of said signaling line with the electromagnetic field strength varying inversely as the square of the distance from the signaling line to provide a relatively rapid rate in decay of signal intensity in a lateral direction relative to said line and longitudinally beyond each end of said line.

8. In a traffic signaling system of the class described for establishing communications with traffic proceeding along a traffic lane, a signaling transmission line disposed substantially along said lane of traffic to establish a signaling zone of predetermined length, means for impressing modulated carrier signaling energy upon such signaling line, and terminating impedance means connected to the remote end of the signaling line, said terminating means being connected to ground and having a value such that its impedance is substantially equivalent to the impedance of said line with respect to ground to prevent reflection and standing waves thereon and to establish an electromagnetic field extending radially about said signaling line of substantially equal strength throughout the length of said signaling line with the electromagnetic field strength varying inversely as the square of the distance from the signaling line to provide a relatively rapid rate in decay of signal intensity in a lateral direction relative to said line and longitudinally beyond each end of said line.

9. In a system for signaling to traffic within a predetermined signaling zone, a signal transmitter having a source of carrier wave energy included therein, means for modulating carrier wave energy from said transmitter, and means for establishing a substantially restricted electromagnetic signaling field throughout said predetermined zone, said means comprising a signal conducting line having one end thereof electrically connected to said transmitter and extending for a distance substantially equivalent to the length of said zone and a terminating impedance means electrically connected to said signal conducting line, said impedance means being substantially equivalent to the characteristic impedance of said line whereby said line is effective for establishing an effective electromagnetic field of uniform intensity throughout the length of

said zone, said terminating means being effective in causing uniformity of said electromagnetic field.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
887,357	Stubblefield	May 12, 1908
1,518,656	Hanson	Dec. 9, 1924
1,696,230	Gilbert	Dec. 25, 1928
1,711,879	Ehret	May 7, 1929
1,787,992	McIlvaine	Jan. 6, 1931
1,815,976	Green	July 28, 1931
1,917,114	Hammond	July 4, 1933

Number	Name	Date
2,028,497	Clausing et al.	Jan. 21, 1936
2,080,812	Fairbanks	May 18, 1937
2,082,303	Schiller	June 1, 1937
2,098,133	Carnahan	Nov. 2, 1937
2,203,352	Goldmark	June 4, 1940
2,206,998	Beizer	July 9, 1940
2,221,883	Rowe	Nov. 19, 1940
2,224,244	Hicks	Dec. 10, 1940
2,255,055	Halstead	Sept. 9, 1941

OTHER REFERENCES

Publication I, "Motor Touring by Radio," by Albert Yates, New York Times, Sunday, Feb. 5, 1922.

Publication II, "Radio Guide to Tourists," by Jack Bront, "Science and Invention," August 1924, page 377.