

Feb. 5, 1946.

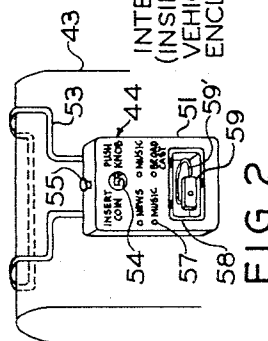
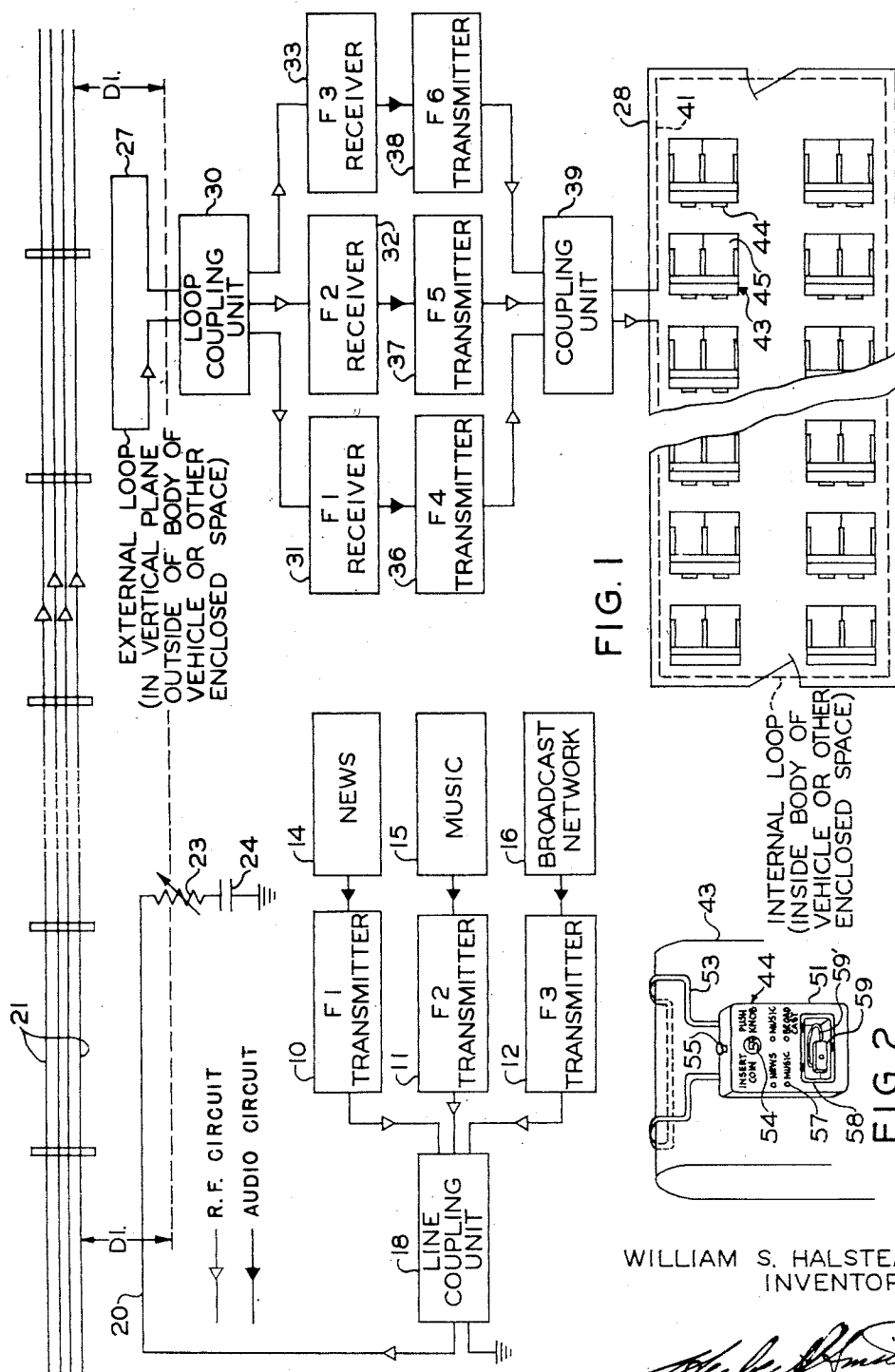
W. S. HALSTEAD

2,394,444

INDUCTION RADIO SYSTEM

Filed March 24, 1945

3 Sheets-Sheet 1



WILLIAM S. HALSTEAD
INVENTOR

William S. Halstead
ATTORNEY

Feb. 5, 1946.

W. S. HALSTEAD

2,394,444

INDUCTION RADIO SYSTEM

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FIG. 5

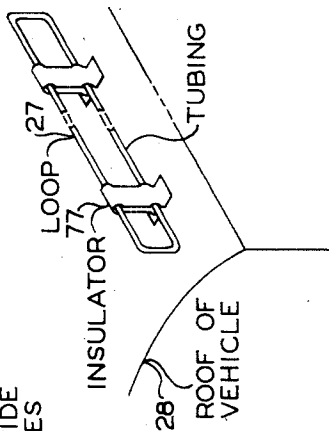
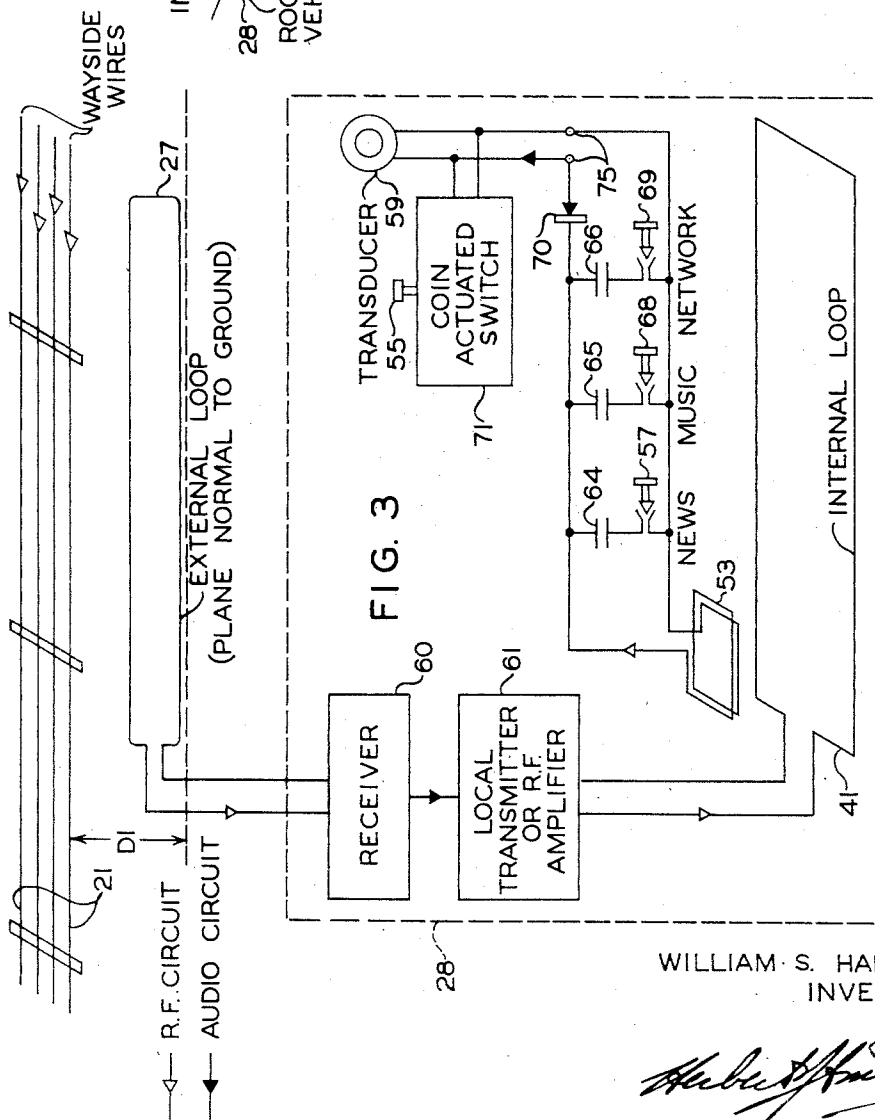
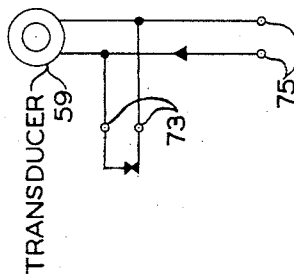


FIG. 4



WILLIAM S. HALSTEAD
INVENTOR

Hubert S. Halstead
ATTORNEY

Feb. 5, 1946.

W. S. HALSTEAD
INDUCTION RADIO SYSTEM

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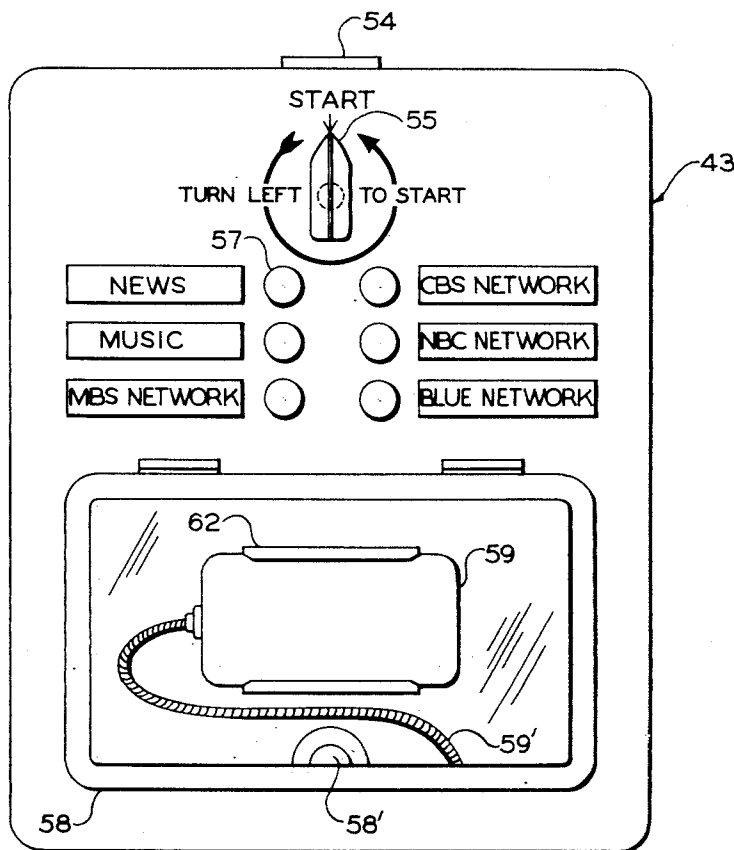


FIG. 6

WILLIAM S. HALSTEAD
INVENTOR

Robert S. Smith
ATTORNEY

UNITED STATES PATENT OFFICE

2,394,444

INDUCTION RADIO SYSTEM

William S. Halstead, Purchase, N. Y., assignor, by
mesne assignments, to Farnsworth Television
& Radio Corporation, Fort Wayne, Ind., a cor-
poration of Delaware

Application March 24, 1945, Serial No. 584,588

10 Claims. (Cl. 179-6.3)

This invention pertains to radio communica-
tions, and more particularly to a distribution sys-
tem for distributing one or more radio signals or
programs to at least one receiver. In accord-
ance with the invention, each receiver is prefer-
ably provided with a separate loop antenna dis-
posed within or adjacent an internal master loop
included in the receiving portion of the system.

More specifically, the invention provides a plu-
rality of transmitters operating on different fre-
quencies with varying types of intelligence im-
pressed on the various transmitters. The trans-
mitted intelligence is inductively impressed upon
a distribution network, which intelligence is re-
impressed upon an external loop disposed adja-
cent the distribution network and coupled to a
plurality of receivers, the output of said plurality
of receivers being coupled to a plurality of com-
plemental transmitters, and the output of said
transmitters being coupled to a master internal
loop. In operation, the master internal loop pro-
vides a concentrated signaling field within the
confines thereof, so that one or more portable
receivers may be disposed within the confines of
the loop, or adjacent thereto, for reception of
signal intelligence from the plurality of trans-
mitters. The portable receivers preferably in-
clude means for selecting any one of a number
of programs, and said portable receivers may, if
desired, have their operation initiated by the in-
sertion of a coin in a coin-controlled timing
mechanism which places the receiver in opera-
tion.

The system of the invention is particularly
adapted for use in signal receiving areas which
may be either stationary or movable. The dis-
tribution network may be conventional wayside
conductors, such as rails, telegraph lines, tele-
phone lines, power circuits or other signal con-
ducting media; or conductors may be installed
to supplement the ordinary wayside wires where
the wayside conductors are not disposed for ade-
quately meeting the requirements of the system.
In the present specification and appended claims
the term "wayside wires" may therefore be un-
derstood to include any functionally equivalent
conductors.

A particular application of the invention is
used in conjunction with moving vehicles, such
as a railway coach or omnibus, so that the signals
which are impressed from the transmitters upon
the distribution network may be picked up by
the external loop disposed on said railway coach
or omnibus, and redistributed either by amplifi-
cation or retransmission to a master internal loop

installed within the railway coach or omnibus.
In this manner, a portable receiver or a plurality
of portable receivers may be used within the mov-
ing vehicle for selectively receiving any of the
signals impressed upon the distribution network
from the transmitting portion of the system.

One of the primary objects of the invention is
to provide a radio distribution system in which
a plurality of transmitters are coupled to a dis-
tribution media for distributing signal energy
which is to be received by receivers having the
output thereof impressed upon a master receiving
loop, so that a plurality of portable receivers may
be disposed within the master receiving loop
which provides the concentrated signaling field
which is utilized by said plurality of portable re-
ceivers.

One object of this invention is to provide a
radio program distribution system in which a
number of transmitters, each modulated by a sepa-
rate intelligence bearing signal, for example
news, music, or the program of a broadcast net-
work, are all coupled, via a common line coupling
unit, to the wayside wires previously mentioned,
so that a plurality of carrier currents, each bear-
ing a distinct program, are transmitted along
such wayside wires, from which they may be
picked up by suitable devices located upon a ve-
hicle proceeding alongside such wires.

Another object of this invention is to provide
a vehicle receiving and distribution system for
radio programs, in which a single pickup loop
is inductively coupled to wayside wires carrying
programs upon carrier current frequencies and
the output of the loop is fed to a number of re-
ceivers, each tuned to a separate carrier fre-
quency, the outputs of all the receivers being re-
transmitted upon separate frequencies and re-
radiated by a common antenna, such as a loop
of the concentrated induction field type, so as
to supply the reradiated programs only over the
limited area embracing the vehicle itself.

Yet another object of this invention is to pro-
vide radio program service in a moving vehicle,
for use by the individual passengers therein, in-
cluding a number of compact receivers distrib-
uted throughout the vehicle and capable of in-
dividual control so as selectively to receive a
desired program.

Still another object of this invention is to pro-
vide individual radio receivers of a relatively
cheap, simple and compact construction which
may be operated by passengers in a vehicle upon
insertion therein of a coin, so that such receivers
can constitute a source of revenue.

Another purpose of this invention is to provide a radio program distribution system in which vehicles proceeding along highways or railroad tracks having electrical conductors adjacent thereto, such as telegraph, telephone, or other signaling circuits, may be enabled to pick up radio programs distributed over such wayside wires, thereby reducing the necessity of employing upon the vehicle sensitive receivers capable of picking up programs radiated over a considerable extent of free space, such sensitive receivers being subject to extraneous interfering influences acting to prevent the reception of desired radio programs with sufficient clarity and consistency.

Yet another purpose of this invention is to provide a radio program distribution adapted for supplying programs to a number of moving vehicles without the necessity of any vehicle being equipped with sensitive and comparatively long range radio receivers, whereby operation of the receiving devices upon the various vehicles is greatly simplified and reception of high quality programs is facilitated.

Still another purpose of this invention is to supply a carrier current transmission system whereby traffic instructions and the like may be readily communicated to the operators of moving vehicles such as buses or railroad trains, without the employment of radiated energy effectively covering a large area, the energy being guided along wayside wires near which the vehicle is traveling.

An additional object of this invention is to provide a radio program distribution system in which a plurality of programs are transferred at a single fixed point, in the form of modulated carrier currents, to wayside wires and are picked up from the inductive field of such wayside wires by a suitable compact antenna located upon a moving vehicle adjacent such wires and are then reradiated throughout the interior of the vehicle to a number of individual radio receivers provided with program selecting devices and optionally with coin controlling and timing devices.

Other objects and advantages of this invention may be and may become apparent to those skilled in the art from the following detailed description, and it is to be understood that the illustrations presented herein are merely representative of the invention and that modifications may be made therein without departing from the spirit of the subjoined claims.

In the drawings:

Fig. 1 is a block diagram of one form of the system showing the transmitters disposed adjacent a distribution media or network, and a receiving system disposed to receive signals picked up from the distribution network, with the output of the receivers coupled to an antenna loop providing a concentrated signaling field within the loop so that one or more local receivers may be disposed within or adjacent said concentrated signaling field.

Fig. 2 is a perspective view of one form of the individual receiver having a receiving loop connected thereto, which loop is used as a means for supporting the receiver.

Fig. 3 is a partly schematic and partly block diagrammatic representation of one form of the receiving system showing the individual receiver loop disposed adjacent the master internal loop.

Fig. 4 is a schematic diagram of one circuit form of the coin controlled switching means for controlling operation of the receiver.

Fig. 5 shows one form of the roof-mounted antenna which may be employed as the external loop of the receiving system.

Fig. 6 is a front elevation of an illustrative form of individual receiver which may be used with the present invention.

Referring to the drawings, and more particularly to Fig. 1, there is shown a block diagram of the system in which are illustrated three transmitters 10, 11, and 12, operating on frequencies F1, F2, and F3, respectively. The input of transmitter 10 connects to a news program source 14, that of transmitter 11 to a music program source 15 and transmitter 12 to a broadcast network program source 16. While there are indicated only three transmitters with their respective programs, the system can readily include additional transmitter units operating on separate frequencies with their corresponding program units, which may include other music or broadcast network programs.

The above-mentioned transmitters are coupled through a line coupling unit 18 to a radiofrequency transmission line 20, said line usually extending for a distance of several hundred feet parallel to and in close proximity to wayside wires 21 which normally extend along a highway or railroad right of way. The transmission line 20 is terminated to ground through a suitable terminating unit, shown in this instance as a variable resistor 23 and a capacitor 24, to inhibit formation of standing waves on the line with consequent likelihood of appreciable space radiation of radio wave energy. The combined induction and radiation fields surrounding transmission line 20 extend laterally for a substantially limited effective signaling distance usually less than $\lambda/2\pi$, where λ is the wavelength in meters of the carrier signal, as is more fully described in my copending application Serial No. 514,094, filed Dec. 13, 1943. The carrier signal induced along wayside wires 21 in turn establishes combined induction and radiation fields about the wires 21, extending laterally on each side of the wayside wires for an effective signaling distance DI, as shown on the drawings.

A loop 27 normally placed in a vertical plane parallel to the wayside wires and outside of the body of a vehicle, such as railway coach or motor bus 28 is connected through loop coupling unit 30 to receivers 31, 32, and 33, these receivers being tuned to frequencies F1, F2 and F3, respectively, as indicated by legend, and having their output circuits connected respectively to the signal input circuits of transmitters 36, 37, and 38, these latter mentioned transmitters being tuned to frequencies F4, F5, and F6, respectively.

The output circuits of transmitters 36, 37 and 38 are fed to coupling unit 39 which is in turn connected to the loop 41 inside of the railway coach or bus 28. Loop antenna 41 may extend around the inside walls of the vehicle at slightly below ceiling level or at any desired height from the floor.

With the system just described, a simple receiving set provided with a loop antenna responsive to the combined induction and radiation fields surrounding loop 41 will pick up any of the programs injected inside of the vehicle, when the set is tuned to the proper frequency, such as F4, F5, or F6, or to F1, F2, and F3 if the same carrier frequencies originating at the transmitters 10, 11, and 12 are injected into the interior of the vehicle. The vehicle 28 is indicated with

double seats arranged on each side of the center aisle, such as the dual seat 43. On the rear of each seat or at any other suitable location may be positioned individual receiving sets such as 44 so that a passenger or person seated in one of the seats, such as 43, may have access to the receiving set directly in front of his seat, such as 44.

Fig. 2 illustrates one form of the receiving set with a loop 53 and coin-operated radio receiver 44 in combination. The receiver 44 may consist of a compact case 51 of plastic or other suitable material, to hold the various radio parts and coin mechanism and the case is supported by a flexible plastic covered loop 53. The equipment supporting loop 53, as shown, positions the unit on the rear of the seat 43 in the vehicle. The receiving set is provided with an opening 54 in which a coin may be inserted and a plunger 55, which is pressed downward after the coin is inserted, allowing the receiver to be placed in operation either for the duration of the trip or arranged so that a mechanical timing device is set in operation by the movement of the plunger 55 to provide a predetermined unit of time during which the receiver is operative, such timing devices being well known in the coin machine art.

Program selector push-buttons or switches such as 57 may also be provided to permit selection of news, music or broadcast network programs by the user.

The door 58, provided with a transparent window, may be arranged so that it is normally locked in the closed position and is unlocked when the above-mentioned coin is inserted and plunger 55 is operated, as may be accomplished by any well-known mechanical arrangement, thereby providing access to a transducer unit 59, such as an earphone, connected to the receiver proper by the conducting cord 59'.

It will be observed that by the use of individual earpiece transducer a user may receive an individually-selected program without causing interference with or disturbing a person in an adjoining seat, who may be receiving another program or who may not wish to hear any radio program.

Fig. 3 is another illustrative diagram showing one possible general electrical circuit arrangement which may be used with the receiving portion of the system of the invention.

In the figure, 21 represents the wayside conductors along the highway or railroad right-of-way with the distance DI indicating the lateral extent of the useful induction and radiation field in one direction from the wayside conductors. Loop 27 is shown installed in a vertical plane and extending parallel to the wayside conductors 21. Loop 27 is normally mounted externally on the vehicle and connects to the radio-frequency input circuit of a multi-channel receiver 60, different channels of the receiver being tuned to the incoming frequencies, such as F1, F2, and F3.

The multi-channel output circuits of receiver 60 in turn are connected with multi-channel input circuits of the local transmitter or radio frequency amplifier, 61. The multi-channel output of the transmitter of radiofrequency amplifier 61 is tuned to frequencies such as F4, F5 and F6, or F1, F2, and F3 if the same frequency is used in retransmission and connects to loop 41, this last loop being arranged in such manner that it extends in a horizontal plane around the inside of the vehicle, represented by dotted line 28, so as to reduce coupling between loops 27 and 41.

A receiver in which coin-actuated switch 71 is a part operates in combination with pickup loop 53 and may be tuned by the user to the desired frequencies such as F4, F5 and F6 by capacitors 64, 65, and 66 which are selectively connected in the tuned circuit of which loop 53 is a part, by program selector switches 57, 68, and 69 respectively. As an example, switch 57 connects capacitor 64 across the loop 53 to receive a news program on frequency F4. Alternatively, switches 68 and 69 may be actuated to connect condensers 65 or 66, respectively, across loop 53 to tune the receiver to other frequencies, for example, frequencies on which are broadcast music or network programs. The switching arrangement may be of well-known interlocking type, not illustrated, so that when the selected switch is pressed the other switches are automatically restored in their "off" position. A radiofrequency rectifier 70, such as a selenium detector of fixed-adjustment type, converts the radiofrequency signal to audio frequency, the audio frequency signals being applied to receiver output terminals 75 and transducer 59, connected therewith.

The coin-actuated switch 71 may be of such a design that by inserting the proper coin, the radio receiver will operate for the duration of a trip, or it may consist of a mechanical escapement device, or the like, whereby the pressing of lever 55 allows the radio receiver to operate for a predetermined length of time before restoring it to the "off" position, such devices being well known in the coin machine art.

Fig. 4 shows one arrangement of transducer 59 in which contacts 73 of coin actuated switch 71, Fig. 3, normally forms a short-circuit across transducer 59, and are opened when the coin is inserted. The terminals 75, Fig. 4, are identical with terminals 75, shown in Fig. 3.

Fig. 5 is an illustrative showing of one possible arrangement of receiving loop 27 on the top of a vehicle 28, such as a railroad coach, in which the loop may consist of rigid copper tubing held in place at intervals by stand-off insulators, such as plastic or ceramic insulator 77.

With the above described method of mounting the loop no trouble will be experienced when the vehicle passes under tunnels or low obstructions with limited clearances. At the same time, an efficient means of pickup is provided.

Fig. 6 shows one form of coin-operated radio receiver 43 which may be employed in the system of the invention and which is provided with coin slot 54 and timer re-set lever 55, said re-set lever being turned counter-clockwise after the proper coin is inserted in the coin slot 54. The turning of lever 55 in a counter-clockwise direction winds any suitable timing mechanism, as well-known in the art, which, after being wound measures off and maintains the receiving circuit in operative condition for a given amount of time, and also releases spring catch 58' which allows door 58 to be opened, thereby providing access to the transducer unit 59 attached to cord 59'. When not in use transducer 59 is held in place by spring clip 62.

Program selector buttons such as 57 enable the user to select a program and are of the interlocking type so that when the selected switch is pressed, any previously-operated switch is automatically restored to its "off" position.

What is claimed as new and desired to secure by Letters Patent of the United States is:

1. A radio program distribution system especially for moving vehicles, along a lane of traffic,

including means for generating a plurality of primary carrier currents, means for separately modulating each carrier current, a wayside conductor extending along the lane of traffic, means for transferring all said carrier currents to said wayside conductor, means located upon a vehicle for picking up all said carrier currents from said wayside conductor, means for separating said carrier currents from one another, means for generating a plurality of secondary carrier currents, each of said last carrier currents being modulated by the modulations of a respective one of said separated primary carrier currents, means for reradiating said secondary carrier currents over an area embracing the interior of said vehicle and a plurality of receiving means located within said vehicle, each of said receiving means being provided with program selective and electro-acoustical transducer means.

2. A program distribution system of the type described, including a main transmitter, a main receiver and a carrier current transmission line extending from a point closely adjacent said transmitter to a point closely adjacent said receiver, said transmitter including at least two separately modulated sources of carrier currents, a first unitary coupling unit receiving the outputs of all said sources and a first coupling loop adjacent said transmission line and receiving the output of said coupling unit, whereby the respective outputs of said carrier current sources are all impressed upon said transmission line, said receiver including a second coupling loop picking up the carrier currents from said transmission line, a second coupling unit fed from said second loop, at least two receivers fed from said second coupling unit and each tuned to a different received carrier frequency, at least two local transmitters each modulated by the output of one of said receivers, a third coupling unit fed by the output of all said local transmitters, a loop antenna energized from said third coupling unit so as to produce an induction radio field extending over a limited area, and a final receiver including carrier frequency selective means, electro-acoustical transducing means and a loop for picking up energy from said induction radio field, and said carrier current transmission line including at least one wayside conductor.

3. A multiple-channel radio transmission system effective in serving vehicles proceeding along a lane of traffic including at a central transmitting point at least two program sources, at least two main transmitters emitting energy at differing frequencies at said central transmitting point, means for modulating each transmitter from a separate one of said program sources, a transmission line extending substantially parallel to the path traversed by said vehicles, single means coupling the output of all said main transmitters to said transmission line, a main receiver mounted upon a vehicle, said receiver comprising single means picking up the transmitted energy from said transmission line, a plurality of demodulators, each tuned to the respective frequency of one of said transmitters, single coupling means conveying energy from said pickup means to all said demodulators, a plurality of ancillary transmitters, each emitting energy at a differing frequency and each modulated from a respective one of said demodulators, an antenna of the concentrated field type positioned so as substantially to embrace said vehicle, a single coupling unit transferring the energy output of all said ancillary transmitters to said antenna, and a

plurality of ancillary receivers, each including an electro-acoustical transducer and means for tuning said ancillary receiver to a selected one of the frequencies emitted by said ancillary transmitters, all said ancillary receivers being located within the induction field of said antenna.

4. In a carrier current radio program distribution system of the type described and using wayside wires as carrier current transmission lines, electro-magnetic coupling means at the transmitter for impressing upon said wayside wires a modulated carrier current, electro-magnetic means at the receiver responsive to an induction field surrounding said wires and caused by said carrier currents flowing in said wayside wires, means for amplifying said received carrier current, a limited service area antenna at the receiver, means for energizing said antenna with the amplified carrier current, a final receiving loop antenna positioned within the field of said limited service area antenna, tuning and demodulating means connected to said final loop antenna, and a transducer connected to the output of said demodulating means.

5. A program distribution system for vehicles and the like, including a first generator of modulated carrier current, means for impressing output energy from said first generator upon wayside wires, a first receiver coupled to said wayside wires and demodulating a received portion of said carrier current, a second generator of carrier current differing in frequency from said first carrier current and modulated by said first receiver, an induction type antenna fed by said second generator, a pickup loop within the field of said antenna, a second receiver fed by said loop and a transducer fed by said second receiver.

6. In a system of the type described, a plurality of carrier current generators, a plurality of program sources, each modulating a respective generator, a carrier transmission line receiving the outputs of all said generators, a plurality of primary receivers coupled to said transmission line and each delivering a separate demodulated carrier current representing a single program, a plurality of local transmitters each modulated by the output of a respective primary receiver, an induction type antenna fed by the output of all said local transmitters, a pickup loop within the field of said antenna, and a secondary receiver fed by said loop, said secondary receiver including program selecting means, current demodulating means, an electro-acoustical transducer, and coin control switching means rendering said secondary receiver operative for a predetermined length of time for each coin inserted therein.

7. In a radio program distribution system of the type described, a main transmitter including means for generating a plurality of separately modulated carrier currents, a transmission line conveying said currents from said main transmitter to a receiving point, a main receiver including common pickup means and separate demodulating means for each of said carrier currents, separate local transmitters, each modulated by the output of a single demodulating means, common coupling means receiving the output of all said local transmitters, an induction loop antenna fed by said coupling means, and a plurality of individual secondary receivers, all located within the field of said induction loop antenna, each individual receiver including means for picking up energy from the induction field, program selecting means, coin controlled switching means, a compartment, an earphone located

within said compartment when said individual receiver is inactive, a door closing said compartment, locking means on said door, releasing means connecting said locking means and said coin controlled switching means, whereby the insertion of a coin activates said individual receiver and unlocks said door of said compartment, and an extensible connecting cord extending from said earphone to the body of said receiver, whereby said earphone can be withdrawn from said compartment for application to the ear of the user of said individual receiver.

8. A multiple-channel radio transmission system effective in serving moving vehicles proceeding along a predetermined path including a plurality of generators of program-modulated signal carriers, a wayside wire circuit extending along said predetermined path, means for impressing output energy from said generators upon said wayside wire circuit, a first receiver on a moving vehicle and coupled to said wayside wire circuit for simultaneously demodulating said plurality of program-modulated signal carriers, a plurality of generators of carriers differing in frequency from said first carriers and modulated by said first receiver, a metallic conductive means extending within a moving vehicle and coupled to said last mentioned generators for distributing said last mentioned modulated carriers and a selective receiver coupled to said metallic conductive means for reproducing selected program signals.

9. A program distribution system for vehicles

and the like, including a first generator of modulated carrier signal energy, a wayside wire circuit, means for impressing output energy from said first generator upon said wayside wire circuit, a first receiver on a vehicle and coupled to said wayside wire circuit for demodulating received carrier signal energy, a second generator of carrier signal energy differing in frequency from said first carrier signal energy and modulated by said first receiver, a metallic conductive means within the vehicle and fed by said second generator, a second receiver coupled to said metallic conductive means and a transducer fed by said second receiver.

10. A multiple-channel radio transmission system effective in serving moving vehicles proceeding along a predetermined path including a plurality of generators of program-modulated signal carriers, a wayside wire circuit extending along said predetermined path, means for impressing output energy from said generators upon said wayside wire circuit, a first receiver on a moving vehicle and coupled to said wayside wire circuit for simultaneously receiving a plurality of program-modulated signal carriers, a metallic conductive means extending within a moving vehicle and coupled to said first receiver for distributing received program-modulated signal carriers and a selective receiver coupled to said metallic conductive means for reproducing selected program signals.

WILLIAM S. HALSTEAD.