Jan. 8, 1946. G. E. GUSTAFSON 2,392,665

RADIO RECEIVING SYSTEM

Filed Sept. 27, 1943 5 Sheets-Sheet 1

FIG. 1

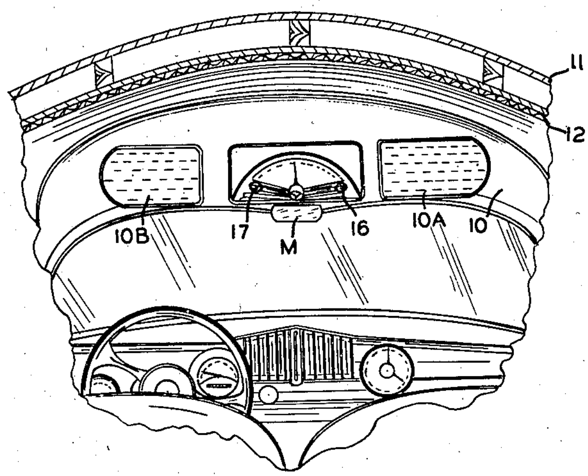
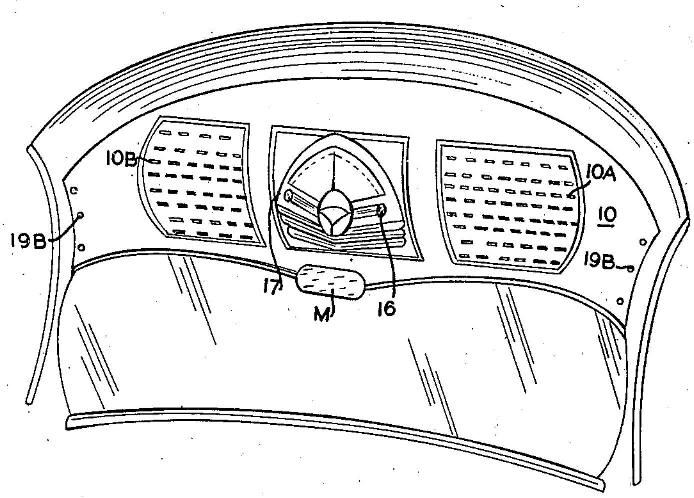


FIG. 2



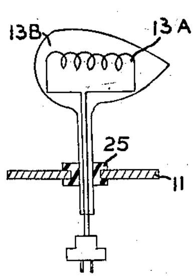


FIG 6

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Jan. 8, 1946. G. E. GUSTAFSON 2,392,665

RADIO RECEIVING SYSTEM

Filed Sept. 27, 1943 5 Sheets-Sheet 2

Fig. 4

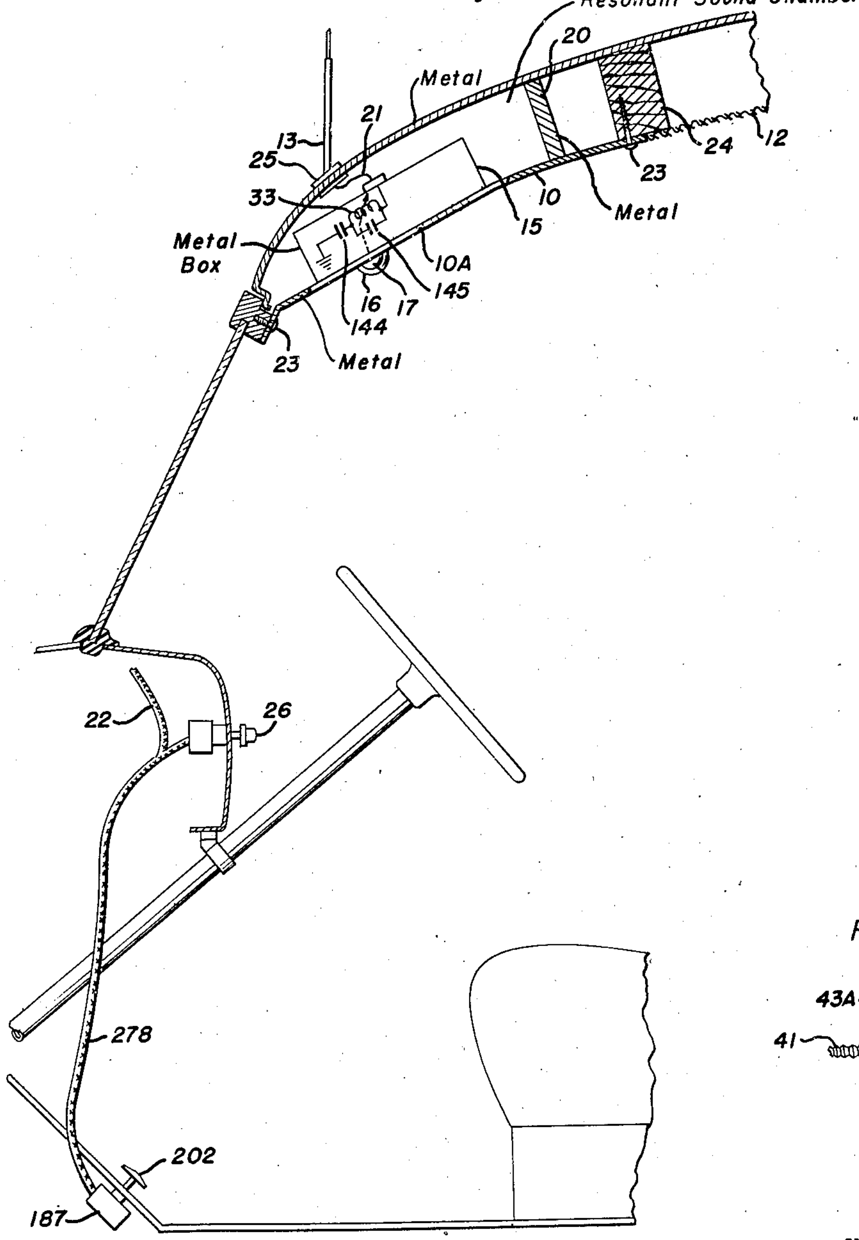


Fig. 8

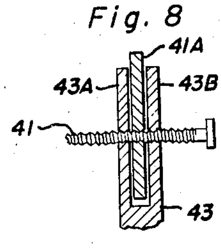
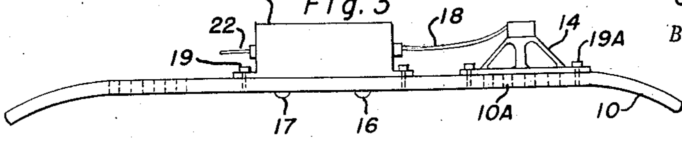


Fig. 3



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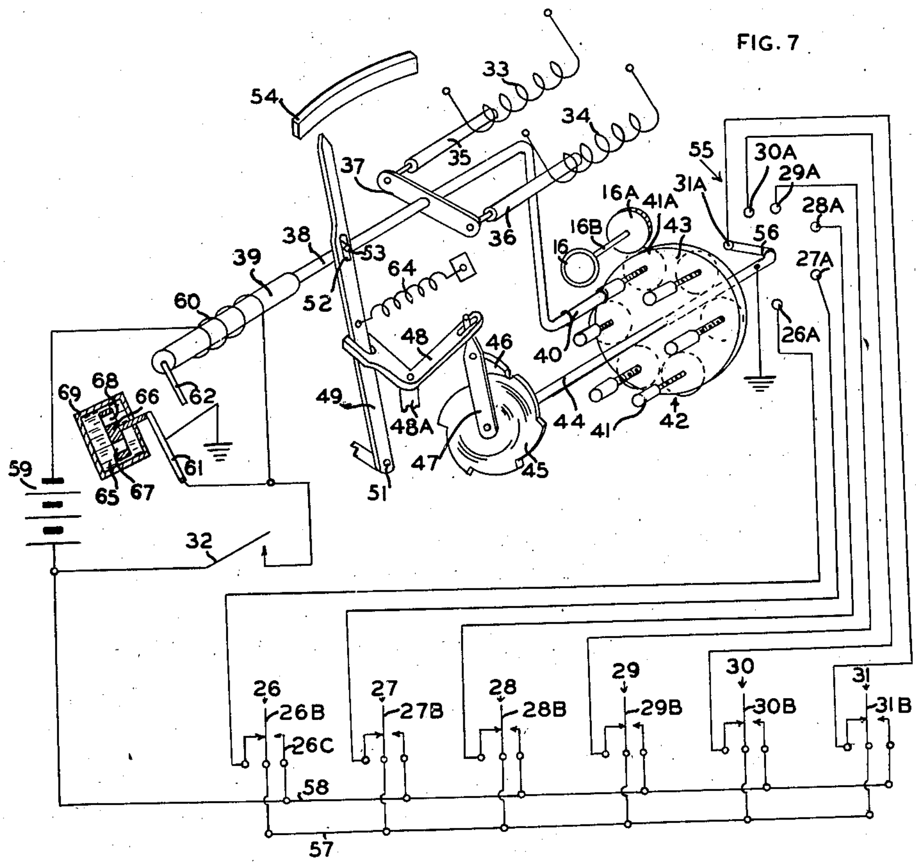
RADIO RECEIVING SYSTEM

Filed Sept. 27, 1943 5 Sheets-Sheet 3

FIG. 7



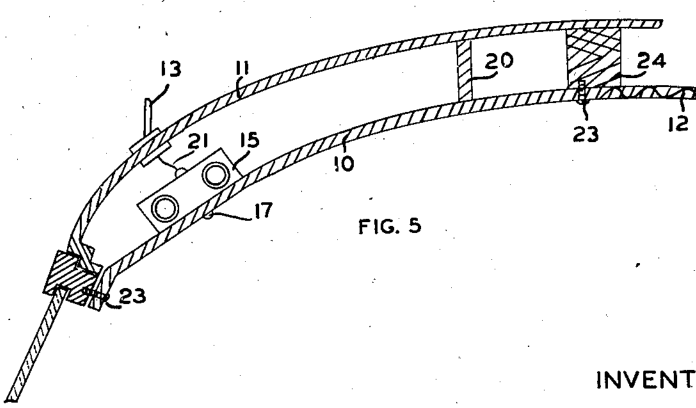


FIG. 5

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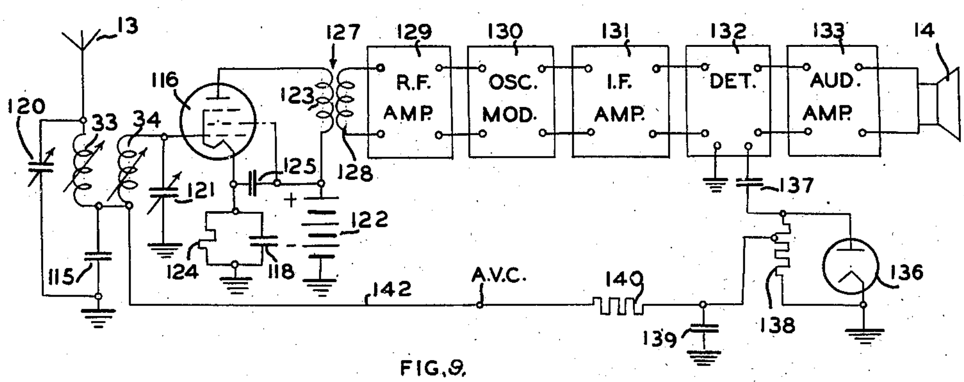

FIG. 9.

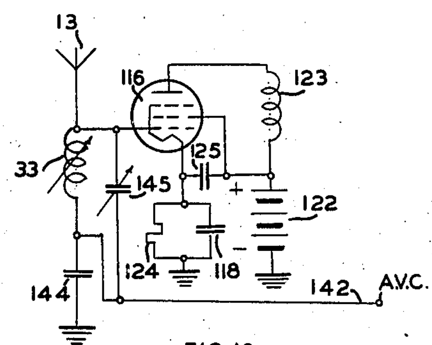

FIG. 10.

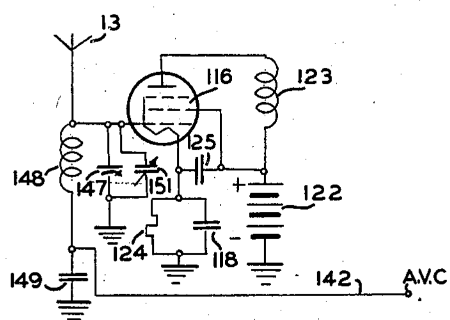

FIG. 11.

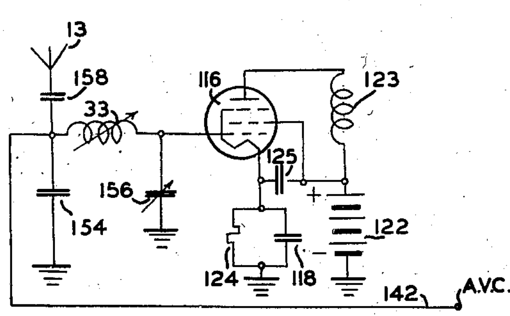

FIG. 12.

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Jan. 8, 1946. G. E. GUSTAFSON 2,392,665

RADIO RECEIVING SYSTEM

Filed Sept. 27, 1943 5 Sheets-Sheet 5

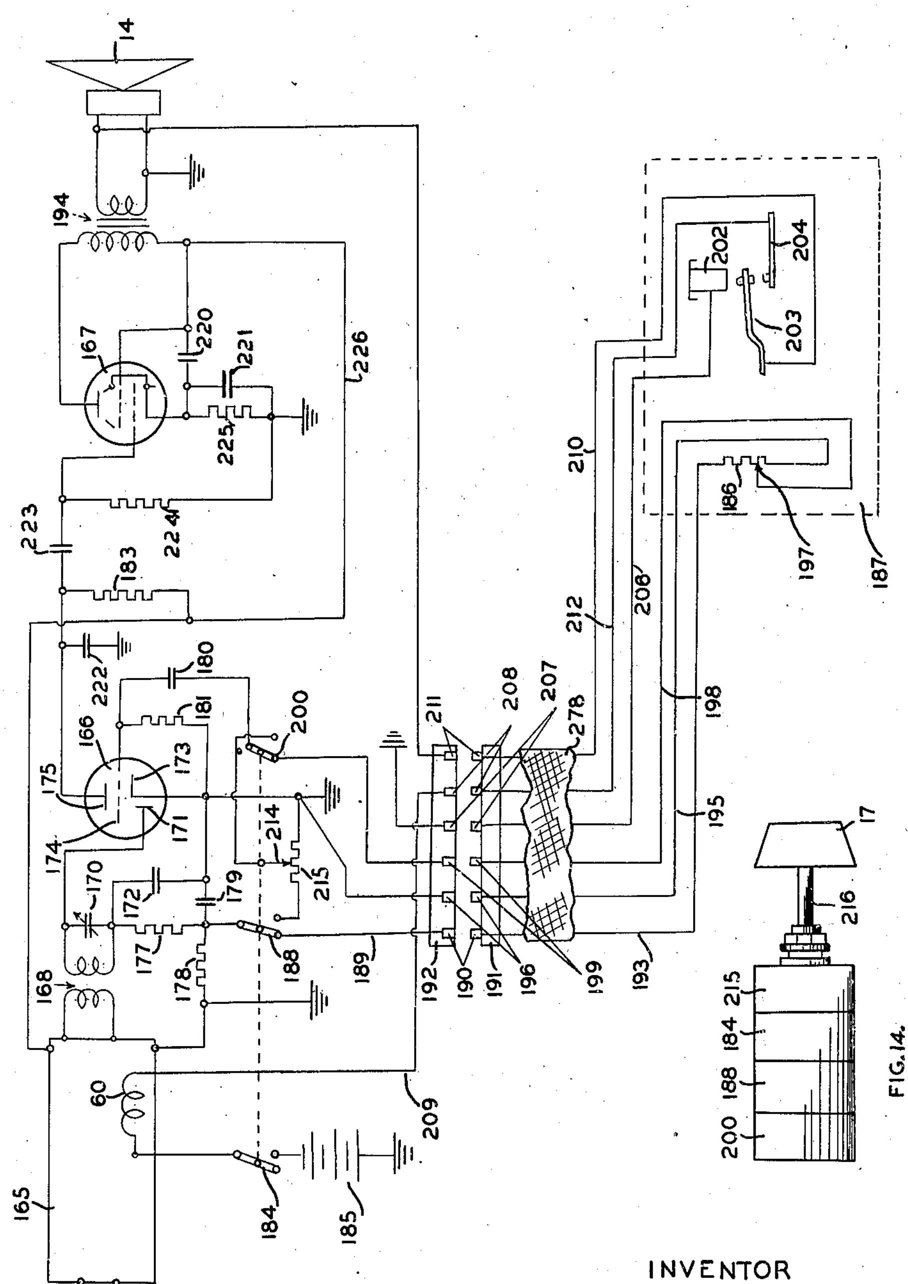

FIG. 13.

FIG. 14.

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Patented Jan. 8, 1946

2,392,665

UNITED STATES PATENT OFFICE

2,392,665

RADIO RECEIVING SYSTEM

Gilbert E. Gustafson, River Forest, Ill., assignor to Zenith Radio Corporation, a corporation of Illinois

Application September 27, 1943, Serial No. 503,868

19 Claims. (Cl. 250—14)

This invention relates to radio apparatus mounted in an automobile.

It is desirable to mount a radio receiver in a vehicle where it is convenient to observe indications on the dials thereof and yet where it occupies a position not necessary for other purposes and where the receiver is less apt to respond to extraneous annoying radiations.

It is also desirable to mount a radio receiver in a vehicle, such as an automobile, in such a position that the antenna leads thereto are of shortest possible length whereby leadin capacity is minimum. When so placed, mounting of the antenna is facilitated and the antenna leadin or antenna structure is less apt to impair the vision of the occupants of the vehicle.

It is also desirable to mount a radio receiver in a vehicle in such a manner that sound waves are directly transmitted to the listener without the loss of high frequency components which occurs when the sound waves reach a listener's ear by reflection from surfaces which usually reflect low frequency sound waves more than high frequency waves.

In the manufacture of radio apparatus for mounting in a vehicle, it is highly desirable that the radio apparatus may be manufactured, adjusted and calibrated in the factory and then placed in the vehicle without necessitating changes in adjustment or calibration. One of the most serious causes for making such additional adjustment after the apparatus is mounted in the vehicle is due to the antenna leadin. This is particularly true when the leadin is relatively long.

Furthermore long antenna leadins are usually formed with wire covered with a rubber cover and a connection shield braid. When the inner conductor is bent or kinked in manufacture, or where the leadin is bent in installation, the inner conductor usually is pressed near the outer shield braid so that stray capacity is increased.

Of importance is the fact that such long, bent leadins change their conformation as they age and as they are subject to vibration, and accordingly, change the stray capacity over a wide range, necessitating correspondingly large and frequent changes of adjustment of trimming capacity in the first tuned circuit of the receiver connected to such long leadin.

When the antenna leadin is relatively long its electrostatic capacity to various parts of the vehicle serves as an impedance for the introduction of voltages of noise frequency into the signal amplifying channel of the receiver. These voltages of noise frequency may, for example, be "hash" produced by a conventional vibrator power supply or electrical disturbances produced by the ignition system of the vehicle. These voltages of noise frequency induced in the antenna leadin may in some instances be eliminated by shielding the antenna leadin, by providing a modified bridge circuit for balancing out the effect of the voltages of noise frequency on the radio apparatus, or by filtering means. In each case, additional equipment is necessary and usually the adjustments necessary for suitable performance are different for different vehicles of the same nominal design and construction. Further, in some cases, large noise voltages, such as may be induced by ignition or the like, cause currents in the shield of the leadin such that intolerable noise voltages are induced in the leadin itself.

In addition to affecting the signal to noise ratio of the radio apparatus, the antenna leadin affects the performance of the radio receiver in reproducing signals transmitted from a broadcast station and especially the ganging of the tuning elements of the apparatus, the frequency selectivity of the apparatus, the frequency calibration of the apparatus, and loss of efficiency results due to the bad power factor of the insulation of the leadin under certain climatic conditions.

When the leadin to such radio apparatus is long or has large capacity, tuning of the first receiver circuit is made more difficult where capacity variation is used for tuning. In such apparatus, reduction of leadin capacity not only reduces loss of signal through insulation but also reduces the minimum circuit capacity so that capacity tuning is easier and the antenna tap on the input tuning coil may be moved up to increase signal transfer.

The services of a trained person are usually required for the installation and adjustment of the radio apparatus in present day vehicles.

It is, as pointed out, desirable to connect the antenna of automobile radio apparatus as close to the apparatus as possible, and it is also desirable for attaining economy and enhancing performance to use as few circuit elements as possible in coupling the antenna to the grid circuit of the first discharge device in the apparatus. For that reason, among others, it is desirable to tune a capacitive antenna by inductance means, since, of course, it is necessary to have both inductance and capacitance in a tuned circuit. Therefore, an object of my invention is to mount a radio receiver in the header space of present day vehicles, to supply the apparatus with radio energy from a capacity antenna and to tune the apparatus by using a variable inductance.

Another object of my invention is to provide an improved arrangement of a radio receiver in a vehicle so that all the above mentioned advantages are attained, and such that the receiver is positioned where the acoustical properties are optimum.

Another object of this invention is to mount the tuning means of a radio receiver in the header of an automobile and to provide means for manually tuning the receiver, and for tuning the receiver by a switch remote from the receiver.

A further object of my invention is to provide such an arrangement in which the remote switch mutes the loudspeaker of the receiver, or in which the remote switch both mutes the loudspeaker and tunes the receiver, or in which the remote switch also adjusts the volume of the loudspeaker output.

It is another object of my invention to provide a radio receiver which is more easily installed in a car and which is more easily adjusted during such installation.

Another object of my invention is to provide improved radio apparatus mounted in the header space of present-day automobiles, which apparatus is substantially free of the detrimental effects resulting from the use of antenna leadins with substantial stray capacity.

Another object of my invention is to provide radio apparatus mounted in the header space of present-day automobiles for use with an antenna mounted near the header space and having a short, low capacity leadin.

Yet another object of my invention is to position a radio receiver in the header space of an automobile and connect it through a low capacity leadin to a capacity antenna which is tuned to stations by means of a variable inductance.

Still another object of my invention is to provide a mounting for a radio receiver in an automobile wherein the receiver is better shielded from extraneous noise currents and voltages.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 illustrates a view, partly in section, of an embodiment of my invention;

Fig. 2 is a view of certain parts illustrated in Fig. 1, taken from a different angle;

Fig. 3 is a side view of certain parts illustrated in Fig. 1;

Fig. 4 illustrates an automobile and includes an embodiment of my invention;

Fig. 5 is a sectional view, taken from the side, of a modification of the arrangement illustrated in Fig. 1;

Fig. 6 is a view, partly in section, of a modification of that part of my invention illustrated in Fig. 4 as an antenna;

Fig. 7 is a schematic diagram of a circuit and certain associated parts especially suitable for use with my invention as illustrated in Figs. 1 and 2;

Fig. 8 is a detailed view of a certain part of the apparatus illustrated in Fig. 7;

Figs. 9 through 12 illustrate various circuit arrangements useful in connection with the apparatus illustrated in Figs. 1 through 5; and

Figs. 13 and 14 illustrate various control arrangements and switching means therefor useful in connection with the apparatus illustrated in Figs. 1 through 5.

Referring to Fig. 1, a header enclosure member or plate 10 extends substantially the full width of an automobile, upon which plate is fixedly mounted a complete radio receiver placed between the metal roof 11 which serves as a shielding element and header plate 10. The space which the radio receiver occupies is usually called the header space and in the conventional present-day automobile is the space defined by the roof of the automobile and decorative felt or cloth directly in front of a person when he is sitting in the driver's seat. The radio receiver and its supporting means are positioned in the header space so as to give a pleasing appearance without sacrificing the space normally required for a conventional rear vision mirror M.

Although I prefer to mount the radio receiver in the header space, the receiver may be mounted elsewhere in the space normally defined by the roof of the automobile 11 and decorative cloth or felt 12 without projecting unduly far from the surface defined by the decorative felt. In such case the antenna should be mounted on the vehicle roof near the tuner of the receiver and a short, low capacity leadin be used. Alternatively, the adjustable tuning part of the receiver may be so mounted near the antenna so that a short low capacity leadin may be used, and part or all of the rest of the receiver may then be put elsewhere.

I prefer to mount all of the components of the radio receiver on the single unitary enclosure member or plate 10 which may be made of pleasing appearance as shown in the copending design patent application Serial No. D-110,425 of Robert D. Budlong, filed June 10, 1943, and assigned to the assignee of this application. This plate is easily mounted in and dismounted from the automobile. It is realized that the header enclosure member or plate 10 may comprise more than one plate and that the header plate 10 may extend only a fractional part of the width of the automobile instead of substantially the full width as shown in Fig. 1.

The main operating elements of a conventional radio receiver, with the exception of antenna 13 (Fig. 4) and speaker 14, are mounted in a receiver unit 15 (Fig. 3) with manual tuning means 16 and volume control means 17 projecting through plate 10 upon which the receiver unit 15 is mounted. The antenna 13 and speaker 14 are preferably connected to the receiver circuit in receiver unit 15 by means of conventional plug in connections. As illustrated in the preferred embodiment, the tuning means 16 and volume control means 17 are disposed near the center of the automobile so as to be equally available to all occupants of the front seat of said automobile.

The receiver unit 15 and speaker 14 are fastened to the plate 10 by fastening means or screws 19 and 19A and the plate 10 then fastened to the automobile by fastening means or screws 19B so that the plate 10 closes off the header space with the components of the radio receiver confined therein.

Plate 10, preferably of pleasing appearance, has a set of openings 10A which readily allow the passage of sound waves into the car from the front side of the speaker 14 mounted on plate 10 directly behind openings 10A. Flexible leads

18 supply speaker 14 with audio current from receiver unit 15.

A set of openings 10B through the left hand side of plate 10 in Figs. 1 and 2 is symmetrically located with respect to the other set of openings 10A about an axis passing through the longitudinal center line of the car. Since the header enclosure member or plate 10 closes off completely the space within which the speaker 14 is located, it is desirable when that header space is large to provide openings 10B in plate 10 so that a listener may hear sound waves from the rear side of the speaker as well as from the front side for enhanced low frequency response. In instances where the header space is relatively small, it has been found desirable to close up the openings 10B for optimum tone quality without altering substantially the general outer appearance of plate 10.

The plate 10 may extend only far enough back toward the front seat of the automobile to cover the front part of the header section as shown in Figs. 1 and 2 or may extend back a greater distance, as shown in Fig. 5, to a supporting member 24 rigidly mounted in the automobile.

Under certain circumstances the tone quality of the radio receiver is enhanced by making the air space in the header space within which the receiver is disposed of suitably large volume. For instance, sound baffle 20 in Fig. 5 is so positioned on its supporting plate 10 that the position of the baffle 20 determines the volume of air entrapped in the header and hence the acoustical properties of the radio receiver. Baffle 20 is formed integrally with the plate 10 or fastened thereto by fastening means such as screws (not shown).

Besides serving as a supporting member for the radio receiver, plate 10 to some extent serves as a sounding board for sound variations produced by speaker 14. That is, the dimensions of plate 10, which carries the radio receiver and forms a closure member for the header space, affect the quality of sound heard by a listener.

It may be desired to utilize the sounding board characteristic of plate 10. In such case, the thickness of the plate should not be too large and the connecting leads 18, 21 and 22 connected respectively to the speaker 14, the fixedly mounted antenna 13 and control apparatus (described later) should be flexible so as to produce little restraining effect on the vibrational movement of plate 10. It is preferred, however, to make plate 10 relatively rigid, so that the baffled space between plate 10, roof 11 and baffle 20 is resonant at a relatively low sound frequency.

The entire radio receiver is mounted in the header of an automobile in such a manner that there is enhanced tone quality of sound reproduction and in such a manner that the entire radio receiver together with its effective air chamber for determining the quality of sound reproduction is easily removed from the automobile, for example, by removing fastening means or screws 19B in Fig. 2 and screws 23 in Fig. 5.

An important feature of my invention is that annoying extraneous radiations from the motor and other sources have little effect on the sound reproduced by the radio receiver because of the location of the radio receiving apparatus. Ignition voltage present on conductors in any region near the engine and instrument panel is high and it is accordingly desirable to place a radio receiver, highly sensitive to such undesirable voltages, far from such locations. The header space is desirably free from such voltages. Moreover, another feature of my invention is that the receiver is mounted in a position where an antenna having a short leadin may be used; that is, a capacity antenna, such as a "fish pole" antenna 13, which is mounted above the header space in insulating member 25 is used to great advantage. Also, since the capacity of the leadin is small, a loop antenna 13A, Fig. 6, of the directional or substantially non-directional type is also used to advantage. That is, a loop antenna 13A encased in a streamlined insulating housing 13B is mounted on the automobile roof 11 and supported by elastic insulating material 25 above the header space for connection to a radio receiver in the header space.

The receiver unit 15 is preferably tuned by means of a turret tuner of the type shown and claimed in United States Letters Patent No. 2,310,720 issued February 9, 1943, to Clarence W. Wandrey and assigned to the same assignee as the present application. The particular tuning means used to tune the apparatus in receiving unit 15 is shown in Fig. 7.

In Fig. 7, the receiving apparatus in radio receiver unit 15 is tuned by means of a turret tuner which is manually adjusted by tuning knob 16 located on the header plate 10. Alternatively, the receiving apparatus is tuned sequentially to one of a plurality of frequencies by sequential operation of a footswitch 32 controlled by the driver of the automobile, or tuned selectively and non-sequentially by actuating one of a series of switches 26, 27, 28, 29, 30 and 31 located on the header plate 10, or at the dashboard or other convenient place in the automobile. The arrangement illustrated in Fig. 7 tunes the apparatus in receiver unit 15 either upon actuation of the manual tuning knob 16, the footswitch 32 or any one of the selecting switches 26 to 31.

The receiver mounted in the header of the automobile is otherwise generally of conventional type and is preferably of the type which is tuned by inserting a member of relatively high permeability into a tubular inductance coil in such a manner that the inductance of the coil depends upon the relative position of the coil and high permeability member.

The inductances of coils 33 and 34 (Fig. 7) determine the frequency of the received signal and these inductances are varied respectively, by adjusting the position of members 35 and 36 of relatively high permeability with respect to coils 33 and 34. Only two tuning inductance coils are shown in Fig. 7 for simplicity but it should be understood that more than two and preferably three or four of such coils are tuned simultaneously by positioning relatively high permeability members similar to members 35 and 36 with respect to inductance coils which are connected in the radio receiving apparatus. The tuning members or control members, such as members 35 and 36, are carried on a movable carriage 37, which is secured upon a rod 38 connected to a movable solenoid core 39. The rod 38 has its forward end 40 bent so as to cooperate with one of a plurality of stops or abutments 41 of the assembly 42; and these stops 41 are adjustably held in a turret member 43 by cooperating screw threads on stops 41 and turret member 43 (Fig. 8).

The turret member 43 is secured upon a rotatable shaft 44 which carries a ratchet wheel 45 engaged with pawl 46 so as to rotate the shaft 44 one step or one sixth of a revolution for each reciprocation of the pawl 46. The pawl 46 is pivotally mounted on an arm 47 which swings about the shaft 44 and is pivotally and slidably connected to one arm of a bell crank 48 having its other arm pivotally and slidably connected to a lever member 49, the latter being pivoted on a fixed pivot pin 51. The lever member 49 extends from its pivot pin 51 and has a slot 52 to accommodate a pin 53 secured upon the rod 38. The upper end of the lever 49 is preferably positioned so as to be visible and cooperates with a scale 54 having suitable graduations thereon whereby a suitable indication of the position of rod 38 and tuning members 35 and 36 is obtained.

With the apparatus thus far described in Fig. 7, it is clear that when rod 38 moves to the left in the direction of its axis, the bell crank 48 rotates behind an adjacent tooth on the ratchet wheel 45, and that when the rod 38 returns to the right the ratchet wheel 45 is rotated one sixth of a revolution to a position where an adjacent stop 41 on turret 43 limits further movement of the rod 38 and inductance tuning members 35 and 36 carried thereon. The manner in which the solenoid core 39 and associated rod 38 are actuated by electromagnetic means is described hereinafter.

Upon turret shaft 44 is mounted homing device 55 having a rotatable and grounded electrical contact making member 56 which rotates when and as turret shaft 44 rotates for effecting suitable electrical switching. Homing device 55 has six equally spaced fixed contacts 26A, 27A, 28A, 29A, 30A and 31A arranged so that when the turret 43 is in one of its six positions corresponding to the position wherein rod 40 engages one of the stop members 41, the contact making member 56 engages one of the fixed contacts 26A to 31A on the homing device.

Each one of the contact members 26A, 27A, 28A, 29A, 30A and 31A is connected to a respective normally closed stationary contact on a respective one of the station selecting switches 26, 27, 28, 29, 30 and 31; and the other contacts 26B, 27B, 28B, 29B, 30B and 31B, which are movable, are each connected to a common low resistance conductor 57. Each one of the selecting switches 26 to 31 has a normally open fixed contact connected to corresponding contacts on the other selecting switches by means of low resistance connection 58 which is also connected to one terminal of a voltage source 59. The other terminal of voltage source 59 is connected to a terminal of actuating solenoid 60 which has its other terminal connected to ground through an automatically operated position responsive switch 61.

Thus, when one of the selecting switch contact members 26B to 31B, for example, switch contact member 26B, is moved from its normally closed position to the position where it engages contact 26C, current flows from one terminal of voltage source 59 through solenoid actuating winding 60, switch 61, ground, arm 56, contact 31A, the normally closed contact on electric switch 31, movable contact 31B, conductor 57, movable contact 26B, and the normally open contact 26C on selecting switch 26 back to the other terminal of voltage source 59.

When solenoid 60 is energized, for example, by thus producing a current flow through the normally open contact 26C on switch 26 in the manner described above, solenoid core 39 and rod 38 are moved to the left in Fig. 7 to a position where solenoid extension 62, of insulating material, engages and actuates the switch 61 from circuit closing position to circuit opening position and thus opens the circuit to solenoid winding 60 and in so doing allows solenoid core 39 to return to its furthermost position to the right under the influence of tension spring 64, after pawl 46 has turned the turret 43 an angular distance corresponding to the distance between adjacent stops 41.

In the return movement of rod 38 to the right, in order to be sure that the rod 38 moves sufficiently far to the right to move the ratchet wheel 45 one sixth of a revolution before the solenoid is energized again through switch 61, time delay means 65, illustrated as a fluid dashpot, are connected to the resilient movable contact of switch 61, which time delay means delays reclosing of the switch 61 after it has been opened by member 62. It is clear that the time delay means 65 may take other forms than the liquid dashpot shown in Fig. 7.

The liquid dashpot as illustrated has a movable piston 66 with an orifice 67 for controlling the speed of piston travel to the right in Fig. 7. A second and larger piston orifice 68 is opened by conventional means (not shown) only when the piston moves to the left in Fig. 7 in cooperating cylinder 69 so that the piston 66 may move faster to the left than it moves to the right with the same forces applied thereto.

In summary, when it is desired to select one of a plurality of broadcast stations determined by the relative position of a particular stop member 41 in turret member 43, one of the switches 26 to 31 corresponding to that particular stop member is actuated so as to energize solenoid 60. When solenoid 60 is energized due to current flowing from voltage source 59, solenoid rod 38 is moved to the left against the action of tension spring 64, and pin 53 on rod 38 engages lever 49 which pivots around its pivot pin 51 so as to rotate the bell crank 48 counterclockwise around its pivot member 48A. When and as bell crank 48 moves thus counterclockwise, arm 47 pivotally mounted on shaft 44 and having pivotally mounted thereon pawl 46, rotates counterclockwise about its supporting shaft 44 a distance somewhat greater than one sixth of a revolution so as to allow pawl 46 to drop behind and engage an adjacent tooth on ratchet wheel 45. When solenoid 60 is deenergized due to the opening of switch 61, tension spring 64 causes clockwise movement of lever arm 47 and causes the turret 43 to be moved an angular distance corresponding to the angular distance between teeth on ratchet 45 which distance corresponds to the angular distance between stops 41.

Such action continually repeats itself until wheel 45 and stops 41 together with arm 56 are turned to the fixed contact connected to that one of switches 26 to 31 which is actuated, and at that fixed contact, the circuit through the switches 26 to 31 being broken by its actuation, the repeated action stops and the desired station is selected.

Stops 41 are adjustably mounted in turret member 43 and the relative position of each particular stop 41 in turret member 43 determines the distance tuning members 35 and 36 project respectively within inductance coils 33 and 34 after the turret member 43 is rotated around to a position where that particular stop limits movement of rod 40.

It is thus clear that when one of the switches 26 to 31 is actuated the turret member 43 is rotated, due to current flow through solenoid 60, which current also flows intermittently through the normally open contact of that particular switch and the normally closed contact of the other switches until the rotating contact 56 of homing device 55 engages one of the contacts 26A to 31A corresponding to the switch which is actuated. When the rotating contact 56 engages the stationary contact corresponding to the particular switch actuated, then current flow to the solenoid 60 is interrupted. That is, when switch 26 is actuated turret member 43 is rotated until rotating contact 56 engages contact 26A, and when switch 27 is actuated contact 56 stops at contact 27A, etc.

It is also clear that when footswitch 32, which is connected in a series circuit with source 59 and solenoid 60, is closed solenoid 60 draws the core 39 to the left and causes the turret member 43 to rotate one step corresponding to the angular distance between stop members.

Therefore, in order to tune the receiver by actuating the footswitch 32, it is necessary that the switch 32 be sequentially closed and opened until a particular stop 41, corresponding to a desired station, limits movement of rod 40, whereas when the receiver is tuned by actuating one of the switches 26 to 31 the particular switch member, for example, switch member 26B, is moved to make contact with stationary contact 26C and the receiver is tuned without further actuation of switch member 26B.

Other time delay switching means, similar to the dashpot means shown in Fig. 7, may be used as shown in the copending application of Otto E. Wagenknecht, Serial No. 503,878, filed on even date herewith and assigned to the same assignee.

The receiver may be also tuned manually at the header plate 10 by turning tuning means 16. Referring to Fig. 7, tuning means 16 is arranged to adjust the position of at least one of the stop members 41 in the turret member 43. For that purpose, tuning means or knob 16 is coupled to gear 16A through shaft 16B which extends through header plate 10. Gear 16A is arranged to engage at least one of the stop gears 41A which, as shown in Fig. 10, is threaded on stop member 41 and is confined within a hollow portion of turret member 43 between walls 43A and 43B. Conventional means, not shown, is provided to prevent rotation of stop 41 within member 43 when gear 41A is turned. When knob 16 is turned manually, the stop 41 is turned in or out of turret member 43 in a direction depending upon the direction of rotation of knob 16; and rod 40 which is pressed against stop 41 by tension spring 64 follows the movement of stop member 41. The position of rod 40, as explained previously, determines the inductance of coils 33 and 34 and hence the tuning of the receiver.

In addition to serving as a manual tuning means, the knob 16 may be turned to adjust the position of the other stop members 41 in turret 43 so that the stop members 41 may be in suitable position for tuning when the footswitch 32 or one or switches 26 to 31 is actuated.

The switches 26 to 31 shown in Fig. 7 may be of the pushbutton type and may be mounted on header enclosure member 10, or on the instrument panel of the automobile or other convenient place.

Fig. 9 shows schematically the circuit of the radio receiving unit 15 located in the header space of a vehicle as in Fig. 3. Modulated radio frequency signals received on antenna 13 are applied to a superheterodyne receiving circuit in such a manner that the modulation envelope of the signal is reproduced by speaker 14. I prefer to tune the receiving apparatus, particularly the antenna circuit, by means of variable inductance.

Signal voltages appearing between antenna 13 and ground in Fig. 11 are impressed across the parallel resonant circuit including adjustable trimmer condenser 120 connected between antenna 13 and ground and variable inductance 33 and coupling and isolating capacitance 115 connected in series between antenna 13 and ground, the condenser 115 having one of its terminals connected to ground. The signal voltage developed across coupling capacitance 115 is applied between the grid and cathode of radio frequency amplifying discharge device 116 through the second variable inductance 34 and low reactance bypass capacitance 118, the inductance 34 being connected between the control grid of discharge device 116 and the junction point of inductance 33 and capacitance 115, and capacitance 118 being connected between ground and the cathode of discharge device 116.

Trimmer capacitance 121 is connected in parallel circuit relationship with inductance 34, between the grid of discharge device 116 and ground, to form a resonant circuit with inductance 34 and serve, together with condenser 120, as a means for providing a tuning and tracking adjustment when, as in mass production, an antenna having unpredictable characteristics is mounted on the automobile.

Radio frequency amplifying discharge device 116, of the variable mu type, is supplied with space current from voltage source 122, whose negative terminal is connected to ground and whose positive terminal is connected to the anode of discharge device 116 through a primary transformer winding 123. The cathode of device 116 is connected to ground through resistance 124, bypassed for high frequency current by condenser 118. The screen grid of discharge device 116 is connected to the positive terminal of voltage source 122 and is maintained at cathode potential for voltages of frequency corresponding to signal frequency by capacitance 125 which is connected between the cathode and screen grid. Discharge device 116 is preferably of the pentode type having its suppressor grid connected to its cathode. The grid of discharge device 116 is maintained at a minimum negative potential with respect to its cathode in conventional manner by the direct current voltage drop across resistance 124, which voltage drop is produced by anode and screen grid current flowing through resistance 124. Low reactance bypass capacitance 118, in conventional manner, is connected in parallel circuit relationship with resistance 124 so as to provide a low impedance path around resistance 124 for signals of frequency corresponding to the carrier frequency.

Radio frequency signals amplified by discharge device 116 are applied to the primary winding 123 of transformer 127, whose secondary winding 128 is coupled to another radio frequency amplifying stage 129. Signals from radio frequency amplifying stage 129 are then, in turn, in conventional superheterodyne fashion, applied to an oscillator-modulator stage 130, an intermediate frequency amplifier stage 131, a detector stage 132, and then to an audio amplifying stage 133 which is coupled to speaker 11.

An amplified radio frequency voltage from the input to the detector stage 132 is applied between the anode and cathode of rectifying device 136 through capacitance 137 for the production of a unidirectional potential for controlling the gain of the receiver. That is, an automatic volume control (A. V. C.) is provided. The unidirectional voltage developed across resistance 138 which has one terminal connected to the anode of discharge device 136 and the other terminal connected to the grounded cathode is filtered by means of filter capacitance 139 and resistance 140, acting together with condenser 115, and then applied between the grid and cathode of radio amplifying device 116. In the particular arrangement shown in Fig. 9, the automatic volume control lead 142 having one terminal connected to a point on resistance 138 through filtering resistance 140 has its other terminal connected to the junction point of coupling and isolating capacitance 115 and variable inductance 34. The cathodes of discharge devices 116 and 136 each have a direct current path to ground so that the potential of lead 142 effects a change in grid bias voltage of device 116. Since discharge device 116 is of the variable mu type, the degree of amplification produced thereby is dependent upon the direct current potential of lead 142 with respect to ground, or is dependent upon the amplitude of amplified radio frequency voltage.

Fig. 10 shows another inductance tuned circuit for coupling antenna 13 directly to the grid of the first radio frequency amplifying device 116, when, as in this instance, the antenna leadin capacity is very small. The radio frequency voltage appearing between the antenna 13 and ground is applied to a series circuit including variable inductance 33 and low reactance isolating capacitance 144. Trimmer capacitance 145 connected across terminals of variable inductance 33 serves as a means for providing a tuning adjustment, when as in mass production, an antenna having unpredictable characteristics is mounted on the automobile. The A. V. C. lead 142 is connected to the junction point of inductance 33 and capacitance 144.

In the arrangement shown in Fig. 10, substantially all of the voltage appearing between antenna 13 and ground is applied between the grid and cathode of discharge device 116. The grid is connected directly to the junction point of the antenna 13 and variable inductance 33 and the cathode is connected to ground through the low reactance bypass capacitance 118. When the antenna leadin is long and has a comparatively high capacity to ground, it is usually undesirable to couple the antenna directly to the grid of discharge device 116 as shown in Fig. 10. In that case, the antenna coupling arrangement shown in Fig. 14 and described hereinafter is more desirable. With such a high capacity leadin, the arrangements of Fig. 9 or 10 could be used if the antenna trimmer condenser 120 or 145, respectively, were connected in series with the antenna 13, with a corresponding loss of signal.

One of the important features of this invention is that, when the antenna leadin capacity is small, the antenna coupling and tuning arrangements are simplified. This is particularly true when a variable inductance is used to adjust the resonant frequency over a given band of frequencies, because a capacity antenna tuned with a variable inductance does not increase minimum circuit inductances, and so does not decrease the maximum tunable frequency in the frequency range.

When a capacity antenna is tuned with adjustable capacity, most small antennas being capacitive, conditions are not so favorable, but are greatly improved by the use of my arrangement with a short leadin of low capacity. Minimum circuit capacity includes antenna capacity, leadin capacity, and the minimum tuning condenser capacity, all of which acts to reduce the maximum tunable frequency. When leadin capacity is reduced as in my arrangement, the reduction of maximum tunable frequency is minimized. This minimizing of minimum circuit capacity by reducing leadin capacity and loss also makes it possible to connect the antenna tap higher up on the input tuning inductance, which increases available signal at the control electrode of the first high frequency amplifier.

By low leadin capacity I mean to include not only capacity between the leadin proper and the vehicle body but also that part of the antenna capacity across which substantially no signal voltage is developed. That is, parts of the antenna near the vehicle body are not very effective in developing signal voltage and should be considered part of the leadin.

In the modified arrangement shown in Fig. 11, substantially all of the voltage appearing between antenna 13 and ground is applied between the grid and cathode of discharge device 116 and the antenna input circuit is tuned to a station in the broadcast band by variable capacitance 147. The voltage appearing between antenna and ground is applied to the series circuit including fixed inductance 148 and capacitance 149, and is then applied between the grid and cathode of discharge device 116 through low reactance bypass capacitance 118. Tuning capacitance 147 and trimmer capacitance 151 are connected in parallel circuit relationship with each other and in parallel with the series circuit including fixed inductance 148 and isolating capacitance 149. The A. V. C. lead 142 is connected to the junction point of inductance 148 and capacitance 149. Such an arrangement with antenna 13 connected to the grid of device 116 directly can be used over a wide tuning range only when leadin capacity, and therefore minimum circuit capacity, is minimized in accordance with my invention.

In comparing the inductance tuning arrangement shown in Fig. 10 and the capacitance tuning arrangement shown in Fig. 11, it is noted that one additional element, the trimmer 151, is required in the arrangement shown in Fig. 11. Also, the ratio of inductance to capacity in the tuning arrangement shown in Fig. 10 may be greater than the equivalent ratio of the tuning arrangement shown in Fig. 11, and the circuit impedance is correspondingly higher, resulting in greater signal voltage gain. Moreover, the signal to noise ratio of the receiver incorporating the inductance tuning arrangement shown in Fig. 10 is higher and more constant over the tuning range than the receiver incorporating the capacitance tuning arrangement shown in Fig. 11.

Fig. 12 shows another antenna coupling circuit tuned by a variable inductance. The voltage appearing between antenna 13 and ground is applied through a coupling condenser 158 across condenser 154 of relatively high capacitance. The voltage developed across capacitance 154 is applied between the grid and cathode of discharge device 116 through variable tuning inductance 33 and low reactance bypass capacitance 118, the inductance 33 being connected between antenna 13 and the grid of discharge device 116, and capacitance 118 being connected between ground and the cathode of device 116.

Trimmer capacitance 156 connected between the grid of discharge device 116 and ground completes the tuned circuit 13, 33, 154 and 156 and serves as a means for providing an adjustment, when as in mass production, an antenna having unpredictable characteristics is mounted on the automobile. The A. V. C. lead 142 is connected to the grid of discharge device 116 through inductance 33 and is bypassed to ground for high frequency currents through capacitance 154.

It is understood that the complete radio receiving unit 15 mounted in the header space includes all of the elements shown in Fig. 12 and also may include conventional means, such as a vibrator power supply (not shown), for converting into a high continuous voltage the low continuous voltage of a conventional automobile storage battery for supplying space current to the discharge devices. The battery is located in its conventional place in the automobile and is preferably connected to the receiver unit 15 by a conventional electric plugin connection.

Alternatively, the unit 15 mounted in the header space may include only device 116, the amplifier 129, the frequency converter 130 and the associated circuits, the remainder of the complete receiver being placed elsewhere in the vehicle.

The header plate 10 and baffle 20 are of electricity conducting material and the components in receiving unit 15 are encased in a box of electricity conducting material. The roof 11 of the automobile is of electricity conducting material and as a consequence, in the arrangement shown in Fig. 5, the elements in the receiving unit 15 are doubly shielded. That is, the metal box encasing the receiving elements in receiving unit 15 comprises one shield and the metal plate 10, roof 11 and baffle 20 form another shield. The plate 10, baffle 20 and roof 11 may be bonded together electrically by means of low electrical resistance connections. The metal box enclosing the receiving unit 15 of course serves as a good electrostatic shield for preventing an electrostatic component of noise voltages from being induced in the elements in unit 15, but by providing doubly shielded arrangement as shown in Fig. 5 the elements in unit 15 are effectively shielded also from the influence of the magnetic component of noise voltages. In addition, the metal plate 10, baffle 20 and roof 11 form an electrostatic shield for leadin 21.

It is understood that the switch 32 shown in Fig. 7 is a footswitch operable by the driver of the automobile and may be of the type disclosed in the patent of Eugene F. McDonald, Jr., Number 2,216,671, issued October 1, 1940. Alternatively, the switch 32 may be a push button type of switch having features of the footswitch shown in the McDonald patent and being mounted on the plate 10.

The volume of the audio signal reproduced by speaker 14 may be controlled by an arrangement similar to one disclosed in the copending application of Eugene F. McDonald, Jr., Serial Number 468,478, filed December 10, 1942. That is, the volume may be controlled either by manipulating knob 17 on plate 10 or by operating a foot control operable by the driver of the vehicle.

Fig. 13 shows an arrangement wherein the output volume of signals reproduced by the receiver mounted in the header space is controlled by manipulating knob 17 at the header space or by actuating a member, preferably a foot control member, located at a remote point.

In Fig. 13, a radio receiver arranged to be installed in the header space of the automobile includes antenna 13, a selective tuner mechanism, amplifier and power supply represented by a rectangle 165, an electron discharge device 166 arranged to detect an amplified signal, received by the antenna 13 and tuned and amplified by the tuner and amplifier 165, a power amplifier discharge device 167 and speaker 14. The operation of the radio receiver is normal insofar as it successively receives a modulated carrier wave from the antenna 13, tunes and amplifies such wave through the tuner and amplifier 165, detects the signal in accordance with which the carrier wave is modulated, such detection being carried out in the circuits associated with the discharge device 166, amplifies such signal through devices 166 and 167, and reproduces the signal in speaker 14.

The signal detection circuit associated with the discharge device 166 includes a high frequency transformer 168 whose primary winding is energized by the amplified carrier wave from the tuner and amplifier 165, the secondary of transformer 168 being tuned to resonance at the frequency of such carrier wave by a capacitance 170. One terminal of the secondary of the transformer 168 is connected to the anode 171 of a diode section of the electron discharge device 166 and the other terminal is connected for high frequency current through a capacitance 172 to the cathode 173 of the discharge device 166, which cathode is associated with the diode section including anode 171, and with the triode section including a control electrode 174 and an anode 175. To complete a path for a continuous current through the anode 171 the cathode 173 is grounded, and that terminal of the secondary of the transformer 168 which is connected to the condenser 172 is grounded through two serially connected resistances 177 and 178. A point between resistances 177 and 178 is connected to ground and to the cathode 173 through a high frequency bypassing capacitance 179, whereby signals detected in the detection circuit appear across the resistance 178.

The signal across the resistance 178 is transferred through either of two circuits to be described hereinafter and through a coupling capacitance 180 to the control electrode 174 of discharge device 166. This control electrode 174 is connected through a suitable grid resistance 181 to the cathode 173. The anode 175 is connected through a suitable load resistance 183 to a source of positive potential illustrated schematically by the rectangle 165, which source of positive potential is supplied with power through a switch 184 from a suitable battery 185 which may be the storage battery of a vehicle, such as the automobile mentioned previously.

Amplified signal potentials appearing across the load resistance 183 are amplified further through the power amplifier discharge device 167, which is connected in usual fashion, and such amplified signals are transferred through an output transformer 194, the secondary of which is connected to energize the speaker 14.

One circuit for transferring signals from the resistance 178 to the control electrode 174 includes the volume control resistance 186, which is embodied in a unit 187, suitable for mounting near the feet of an operator of the vehicle in which the receiver is mounted. The ungrounded terminal of the resistance 178 is connected through a switch 188, conductor 189, terminals 190 of a plug 191 and socket 192, and a conductor 193 to one terminal of resistance 186. The other terminal of resistance 186 is connected through a conductor 195 and terminals 196 of the plug 191 and socket 192 to ground. This ground is preferably the chassis of the receiver at a point near the points where cathode 173 and one terminal of resistance 178 are grounded. To ground a terminal of the resistance 186 in any other place would make it possible for extraneous voltage between such ground point and the chassis of the receiver to produce undesirable current flow through resistance 186, which would result in undesirable noise being produced in speaker 14.

The movable contact 197 of the volume control resistance 186 is connected through a conductor 198, terminal 199 of the plug 191 and socket 192, a switch 200, and condenser 180 to the control electrode 174. By such connections, signal voltage appearing across the resistance 178 appears also across the volume control resistance 186, so that any desired portion of this signal voltage across resistance 186 may be impressed through movable contact 197 upon control electrode 174, thereby controlling the output of speaker 14. Suitable means are provided, as described in the copending application of Eugene F. McDonald, Jr., Serial Number 468,478, filed December 10, 1942, to control the position of the movable contact 197 by foot operation of the vehicle driver.

In the unit including the foot operated volume control resistance 186, there is also provided means operable by the foot of the vehicle driver for silencing the speaker 14 and for changing the tuning adjustment of the tuner represented by rectangle 165. This means includes a switch contact 202, movable by the foot of the vehicle driver, a second switch contact 203, movable when engaged with contact 202, and a third, fixed switch contact 204. Contact 202 is connected through a conductor 206 and terminals 207 of the plug 191 and socket 192 to ground. The contact 204 is connected to switch 184 through a conductor 212, terminals 208 of the plug 191 and socket 192, a conductor 209 and operating coil 60 of an electromagnet suitably arranged for changing the tuning adjustment of a selective tuner of the type previously described. The contact 203 is connected through a conductor 210 and terminals 211 of the plug 191 and socket 192, to one terminal of the secondary of output transformer 194. The other terminal of the secondary of transformer 194 is grounded.

In operation, the driver of a vehicle in which this receiver is installed may at will control the output volume of the receiver by moving by a foot operation the movable contact 197 of the resistance 186, or he may depress the movable switch contact 202 until it touches contact 203, at which time a short circuit is placed across the secondary of output transformer 194 thereby instantaneously silencing the speaker 14. Such silencing is frequently desirable to allow a conversation or to listen for a train whistle at railroad crossings.

Further depression of the switch contact 202, so that it carries the movable contact 203 with it to complete a circuit between the contacts 203 and 204, energizes the operating coil 60 from battery 185, so long as switch 184 is closed, to change the tuning adjustment of the tuner represented by the rectangle 165 so as to receive a different station.

Switches 184, 188 and 200, as well as the movable contact 214 of the volume control resistance 215, are mechanically arranged to be controlled by operation of a single operating element 17, such as shown in Fig. 14 and disclosed in the above mentioned copending application of Eugene F. McDonald, Jr., Serial Number 468,478, filed December 10, 1942, which element is preferably so positioned that it may be operated by an occupant of the vehicle other than the driver, and preferably so located that it also may be operated by the driver.

Upon initial movement of the operating element 17 shown in Fig. 14 from one extreme position, the switch 184 is first closed without affecting switches 188 and 200 so as to energize the receiver power supply represented by the rectangle 165, and so as to connect the operating coil 60 of the station selecting electromagnet in readiness for energization by the movable contact 203 in unit 187. A slight additional movement of this operating element 17 is effective then to change the position of switches 188 and 200, so as to disconnect the upper terminal of resistance 186 in unit 187 from resistance 178, and to disconnect the movable contact 197 from capacitance 180. Such movement of the operating element 17 in Fig. 14 simultaneously connects volume control resistance 215 in parallel circuit relationship to resistance 178, and connects the movable contact 214 of volume control resistance 215 through capacitance 180 to the control electrode 174. Still further movement of this operating element leaves switches 184, 188 and 200 in the position, to which they may have been moved, and thereafter moves contact 214 along resistance 215 to increase that portion of the signal potential across resistance 178 which is applied through resistance 215 to control electrode 174.

In Fig. 14 there is shown a side view of such an operating element, illustrated as a knob 17 which may suitably be turned by hand. This knob 17 is arranged to turn a shaft 216 on which is mounted the volume control resistance 215 and switches 184, 188 and 200. This unit may be so mounted that knob 17 projects from the header plate 10 as shown in Fig. 1, so that it may conveniently be operated by the driver of the vehicle or by a passenger.

In either of the two cases wherein the volume output of the receiver is controlled by adjusting the tap 214 on resistance 215 or by adjusting the tap 197 on resistance 186, the detected and amplified signal from device 166 appears across anode resistance 183 which is connected between the anode 175 and the cathode 173 through low reactance bypass capacitances 220 and 221. The output circuit comprising resistance 183 is made relatively insensitive to voltages produced by currents of carrier frequency by connecting capacitance 222 of very low reactance for signals of carrier frequency but of relatively high reactance for signals of audio frequency between anode 175 and cathode 173.

Output signals appearing across resistance 183 are applied between the grid and cathode of discharge device 167 through combination coupling and continuous current blocking capacitance 223 and capacitance 220, which grid is maintained at a suitable operating potential by connecting resistance 225 between the cathode of device 167 and ground and by connecting resistance 224 between the grid and ground thus utilizing the voltage drop occasioned by space current of device 167 flowing through resistance 225 as grid bias voltage for device 167.

Discharge device 167 is preferably of the pentode type having its suppressor grid connected to its cathode and with its anode and screen grid at substantially the same continuous current operating potential. The high potential lead 226 is connected to the screen grid, and to the anode through the low resistance primary winding of audio output transformer 194. It is understood that the high potential lead 226 is connected to the positive terminal of a voltage source in unit 165, the other terminal of the voltage source being connected to ground.

In conventional manner, the cathode of device 167 is maintained at substantially ground potential for high frequency currents by connecting capacitance 221 of relatively low reactance between cathode and ground; and the screen and cathode are maintained at substantially the same audio frequency potential by connecting capacitance 220 between the screen grid and cathode.

It is understood, of course, that the switch 32 shown in Fig. 7 may be mounted in any convenient place in the automobile, for example, on the header plate 10 or on the dashboard of the automobile. Also, the composite switch and volume control shown in a single unit in Fig. 13 may be mounted in any convenient place in the automobile, for example on the header plate 10 or on the dashboard of the automobile. When the composite switch 230 shown in Fig. 13 is mounted on the header plate 10, it may not be necessary to include the volume control 186 and in that case volume is controlled by manipulating knob 16 in Fig. 1 and the switch 230 in Fig. 13 is effective to mute and tune the receiver.

It is understood, of course, that the radio receiver mounted in the header space may be provided, in conventional manner, with a tone control which may be effected by manually operating push buttons mounted on the header plate 10.

It should also be understood that, while I have illustrated and described my invention in connection with a radio receiving tuning unit mounted in the roof of a vehicle and connected through a very short, low-capacity leadin to an antenna mounted above the roof, a remote switch being provided to operate the tuning unit, the arrangement is equally useful in radio transmitters, the tuning unit being utilized to adjust the output frequency of the transmitter.

While I have shown and described the particular embodiments of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects, and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

I claim:

1. In combination, a radio tuning unit mounted substantially just under the metal roof of a vehicle between its roof and ceiling lining, means arranged to hold said tuning unit between said roof and lining, a low capacity antenna mounted above said roof and adjacent said unit, and a leadin of low capacity having a length below said roof less than the distance between said roof and ceiling and connecting said antenna to said tuning unit.

2. In combination, a radio tuning unit mounted substantially within the header space just under the metal roof of a vehicle between its roof and ceiling lining, means arranged to hold said tuning unit between said roof and lining, a low capacity antenna mounted above the roof of said vehicle adjacent said header space, and a leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining connecting said antenna to said tuning unit.

3. In combination, a radio tuning unit comprising a tuned circuit including an adjustable inductance and a capacity all mounted substantially in the header space of a vehicle between its roof and ceiling lining, means arranged to hold said tuning unit within said header space, an antenna mounted above the roof of said vehicle adjacent said header space, and a leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining connecting said antenna to said tuning unit, said adjustable inductance being arranged to tune the antenna to a frequency in an extended frequency range.

4. In combination, a radio receiver including a speaker mounted substantially in the header space of a vehicle between its roof and ceiling lining, means arranged to hold said receiver including said speaker within said header space, an antenna for the reception of radio signals mounted above the roof of said vehicle adjacent said header space, and a leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining connecting said antenna to said receiver.

5. In a radio system in a vehicle having a metal roof, a lining within said vehicle spaced just under said roof, a radio inductance tuning unit mounted substantially in the space defined by said lining and roof, means holding said unit within said space, a low capacity antenna mounted above said roof adjacent said unit, and a leadin of low capacity having a length below said roof less than the distance between said roof and lining connecting said antenna to said unit, said radio tuning unit and leadin being so disposed in close proximity to said roof that said roof serves as a shield for the radio tuning unit and leadin.

6. In a vehicle having a metal roof and a header space, a complete radio receiver mounted substantially in and confined within the header space between the metal roof and vehicle ceiling lining, means arranged to hold said receiver within said header space, a low capacity antenna mounted on said roof above the header space for the reception of high frequency signals, said radio receiver being so disposed in close proximity to said metal roof that said metal serves as a shield for the radio receiver, and a short low capacity leadin having a length below said roof less than the distance between said roof and ceiling lining and connecting the receiver to the antenna.

7. In a radio receiving system in an automobile, said automobile having a header space defined by the automobile roof and ceiling lining, a complete radio receiving apparatus including a speaker and an input circuit confined substantially entirely within said header space, means arranged to hold said apparatus within said space, an antenna mounted above and contiguous to the header space for the reception of high frequency signals, a short leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining connecting the antenna to the input circuit, and variable tuning means in the header space for tuning the antena input circuit.

8. In a radio receiving system in an automobile having a header space, a complete radio receiver including a speaker mounted substantially in and confined within the header space defined by the automobile roof and ceiling lining, means

arranged to hold said receiver within said space, a low capactiy antenna mounted above the header space for the reception of high frequency signals, a short leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining and connecting the antenna to the receiver, and variable inductance tuning means located in the header space and arranged for tuning the antenna.

9. In a radio receiving system in an automobile having a header space, ceiling lining, and a metal roof, a complete radio receiving apparatus including a speaker confined substantially entirely within said header space defined by said metal roof and automobile ceiling lining, means arranged to hold said apparatus within said header space, a low capacity antenna mounted on the roof above the header space for the reception of high frequency signals, a short leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining and connecting the antenna to the receiver, said radio receiver and antenna leadin being located in close proximity to said roof whereby said roof serves as an electro-static shield for said radio receiver and antenna leadin, and variable tuning means within the header space for tuning the antenna.

10. In a radio receiving system in a vehicle having a header space, a ceiling lining, and a metal roof, radio tuning apparatus confined substantially entirely within said header space defined by said roof and ceiling lining, means arranged to hold said apparatus within said header space, an antenna mounted on the roof above the header space for the reception of high frequency signals, a short leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining and connecting the antenna to the receiver, said radio receiver and antenna leadin being so disposed in close proximity to said roof that said roof serves as an electro-static shield for the radio receiver and antenna leadin, and variable inductance tuning means within the header space and arranged for tuning the low capacity antenna to frequencies in an extended frequency range.

11. In a radio receiving system in an automobile, said automobile having a header space, a ceiling lining, and a metal roof, a complete radio receiver mounted in and confined substantially within the header space defined by said roof and ceiling lining, means arranged to hold said receiver within said header space, a low capacity antenna mounted above the header space for the reception of high frequency signals, a short leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining and conecting the antenna to the receiver, variable inductance tuning means in the header space arranged for tuning the antenna, said radio receiver and antenna leadin being so disposed in close proximity to said roof that said roof serves as an electro-static shield for the radio receiver and antenna leadin and means arranged for actuating the tuning means from a remote point in the automobile.

12. In a radio receiving system in an automobile, said automobile having a header space, a ceiling lining, and a metal roof, a complete radio receiver mounted in and confined substantially within the header space defined by said roof and ceiling lining, means arranged to hold said receiver within said header space, a low capacity antenna mounted above the header space for the reception of high frequency signals, a short leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining connecting the antenna to the receiver, variable inductance tuning means located in the header space for tuning the antenna, said radio receiver and antenna leadin being so disposed in close proximity to said roof that said roof serves as an electro-static shield for the radio receiver and antenna leadin and means including a footswitch operable by the driver of the automobile and arranged for actuating the inductance tuning means.

13. In a radio receiving system in a vehicle having a header space, a roof, a ceiling lining, and a floorboard, a complete radio receiver mounted substantially within the header space defined by said roof and ceiling lining, means arranged to hold said receiver within said header space, a low capacity antenna mounted above the header space, a leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining and connecting said receiver to said antenna, and means arranged on the floorboard for controlling the volume of signals reproduced by said receiver.

14. In a radio receiving system in an automobile having a header space defined by the roof and ceiling lining of the automobile, a complete radio receiver including an inductance tuning unit mounted substantially within the header space, a low capacity antenna operatively connected to said receiver and arranged to be tuned by said inductance unit, means arranged to hold said receiver within said header space, a leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining and connecting said antenna to said receiver, means arranged for actuating said unit from a remote point in the automobile, and additional means arranged for controlling the volume output of signals reproduced by the receiver from said remote point.

15. In a radio receiving system in an automobile having a header sepace defined by the roof and ceiling lining of the automobile, a complete radio receiver mounted substantially in the header space, means arranged to hold said receiver within said header space, a low capacity antenna mounted above said header space, a leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining and connecting said antenna to said receiver, means operable by the foot of the automobile driver for controlling the volume of output of said radio receiver, means operable at the header space for controlling the volume of output of said radio receiver, and means responsive to an adjustment of said means at the header space for transferring control between said means at said header space and said foot operable means.

16. In a radio receiving system in an automobile, said automobile having a header space defined by the roof and ceiling lining of the automobile, a complete radio receiver mounted in and confined substantially within the header space, means arranged to hold said receiver within said header space, an antenna mounted above the header space and arranged for the reception of high frequency signals, and arranged for the transfer of energy therebetween, a short leadin of low capacity having a length below said roof less than the distance between said roof and ceiling lining and connecting the antenna to the receiver, variable tuning means located in the head-

er space and arranged for tuning the antenna, means arranged for controlling the volume of said receiver, means arranged for muting said receiver, and means including a single operating member movable to actuate said tuning means, muting means and volume control means.

17. In combination, a radio receiver mounted substantially in the header space of a vehicle between its roof and ceiling lining, a metal box enclosing high frequency elements of the radio receiver, said metal box being so disposed in relation to said roof that said roof additionally shields the high frequency elements, an antenna mounted above said roof and insulated therefrom, and a leadin of low capacity having a length below said roof less than the distance between said roof and ceiling and connecting said antenna to said high frequency elements.

18. In combination, radio frequency apparatus mounted in the header space of a vehicle substantially between its roof and ceiling, means arranged to hold said radio frequency apparatus substantially within said header space, an antenna mounted substantially above the roof of said vehicle adjacent said header space, and a leadin having a length below said roof not substantially greater than the distance between said roof and ceiling lining and connecting said antenna to said radio apparatus.

19. In combination, a radio tuning unit comprising a tuned circuit including a tuning element mounted in the header space of a vehicle between its roof and ceiling lining, means arranged to hold said tuning unit substantially within said header space, an antenna mounted substantially above the roof of said vehicle adjacent said header space, and a leadin of low capacity having a length below said roof not substantially greater than the distance between said roof and ceiling lining and connecting said antenna to said tuning unit, said tuning element having an impedance over its tuning range conjugate to the impedance of said antenna over the same tuning range.

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