United States Patent [19]

Gorcik et al.

[11] **3,720,874**

[45] **March 13, 1973**

[54] **DIPOLE ANTENNA ARRANGEMENT FOR RADIO WITH SEPARATE SPEAKER-MICROPHONE ASSEMBLY**

[75] Inventors: **Stanley W. Gorcik**, Des Plaines; **Richard A. Kamysz**, Roselle, both of Ill.; **Charles T. Hilton, Jr.**; **John W. Faltz**, both of Fort Lauderdale, Fla.

[73] Assignee: **Motorola, Inc.**, Franklin Park, Ill.

[22] Filed: **Nov. 8, 1971**

[21] Appl. No.: **196,433**

[52] **U.S. Cl.** **325/16**, 325/111, 325/118, 325/178, 343/841

[51] **Int. Cl.**.....**H04b 1/04**

[58] **Field of Search**.....325/16, 111, 112, 118, 119, 325/178, 361, 365; 343/841

[56] **References Cited**

UNITED STATES PATENTS

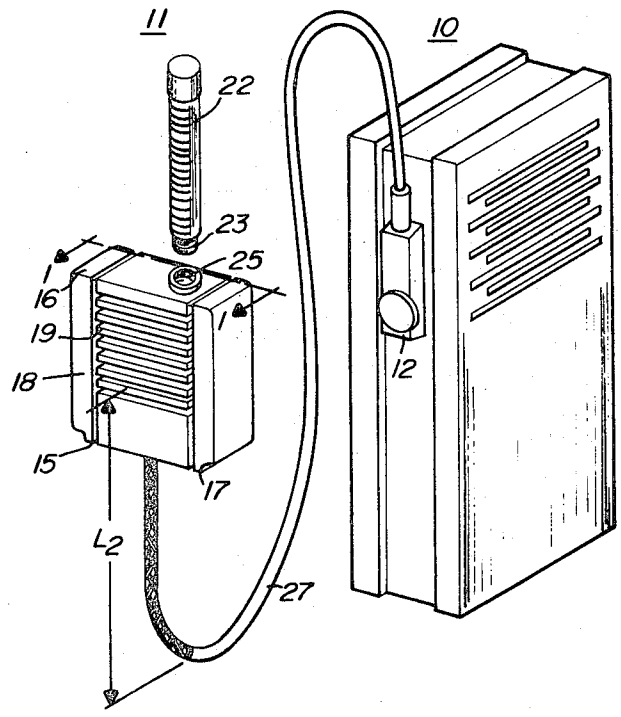
2,943,188	6/1960	Knott et al.	325/178 X
3,134,074	5/1964	Litke	325/118

Primary Examiner—Benedict V. Safourek
Attorney—Vincent J. Rauner et al.

[57] **ABSTRACT**

A speaker microphone assembly, used with a portable radio unit containing receiving and transmitting equipment for receiving and transmitting radio signals, includes a housing with a helical antenna element mounted to the top wall to form one element of a dipole antenna. A coaxial cable having inner and outer conductors is connected from the portable unit equipment to the speaker microphone housing. The center conductor is connected to the helical antenna and the outer conductor is terminated in the housing at a first point which is ground potential. A second outer conductor surrounds and is insulated from the first outer conductor, and is connected to the first outer conductor at the first point. The second outer conductor extends for a predetermined length along the first outer conductor to form the other element of the dipole antenna.

16 Claims, 4 Drawing Figures



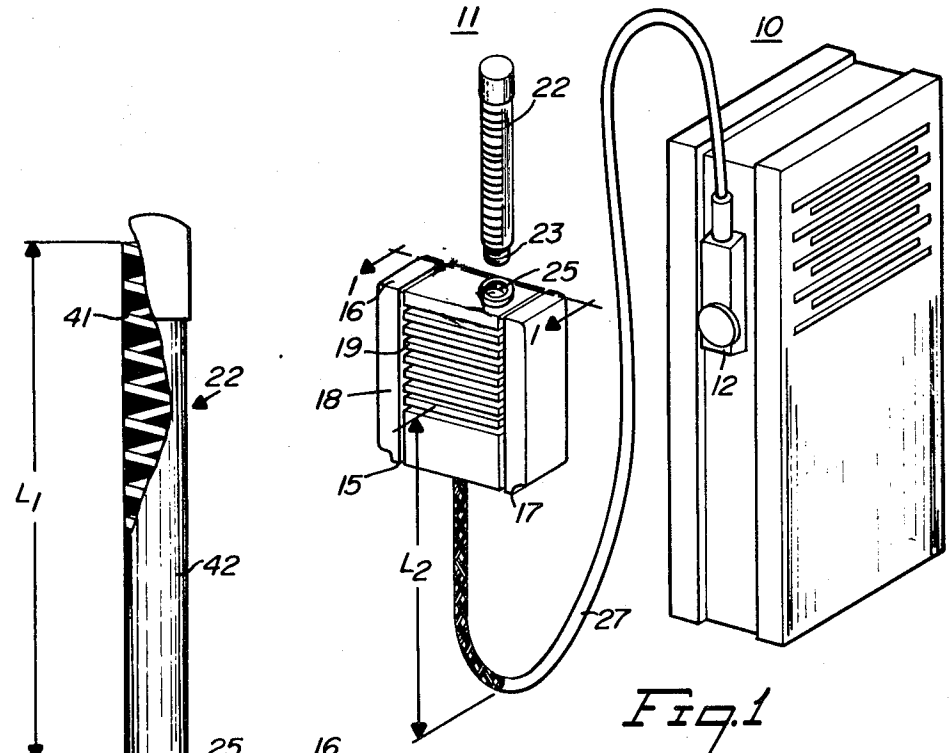


Fig. 1

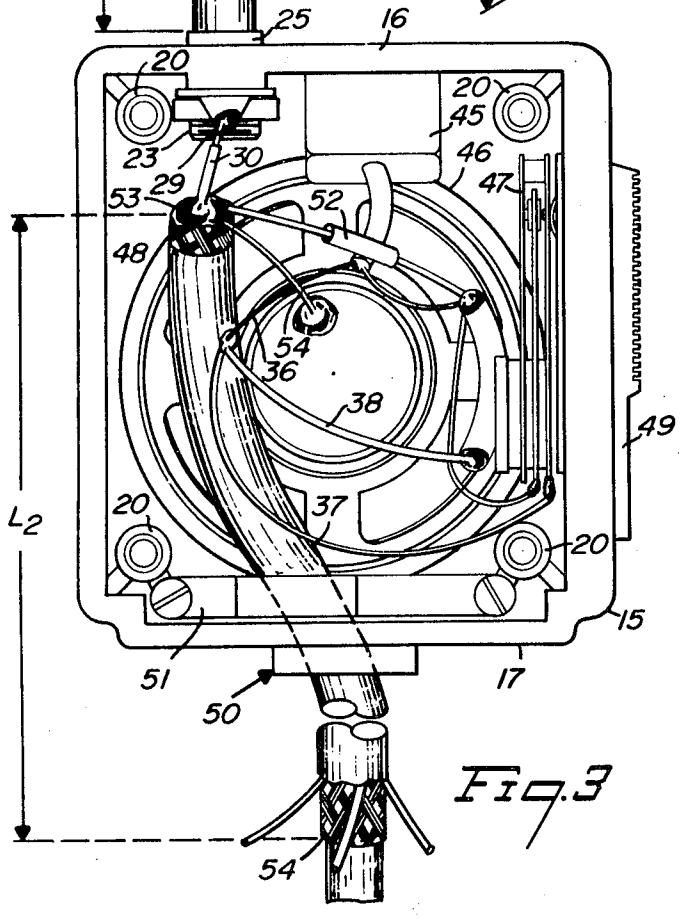


Fig. 3

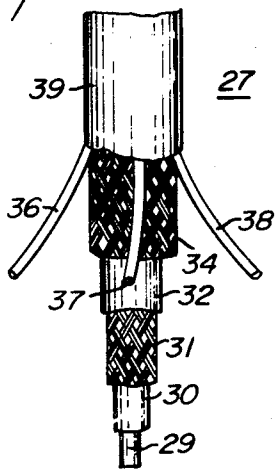


Fig. 2

INVENTORS:
JOHN W. FALTZ
STANLEY W. GORCIK
CHARLES T. HILTON JR.
RICHARD A. KAMYSZ
BY: Marshall N. Diebler
ATTY.

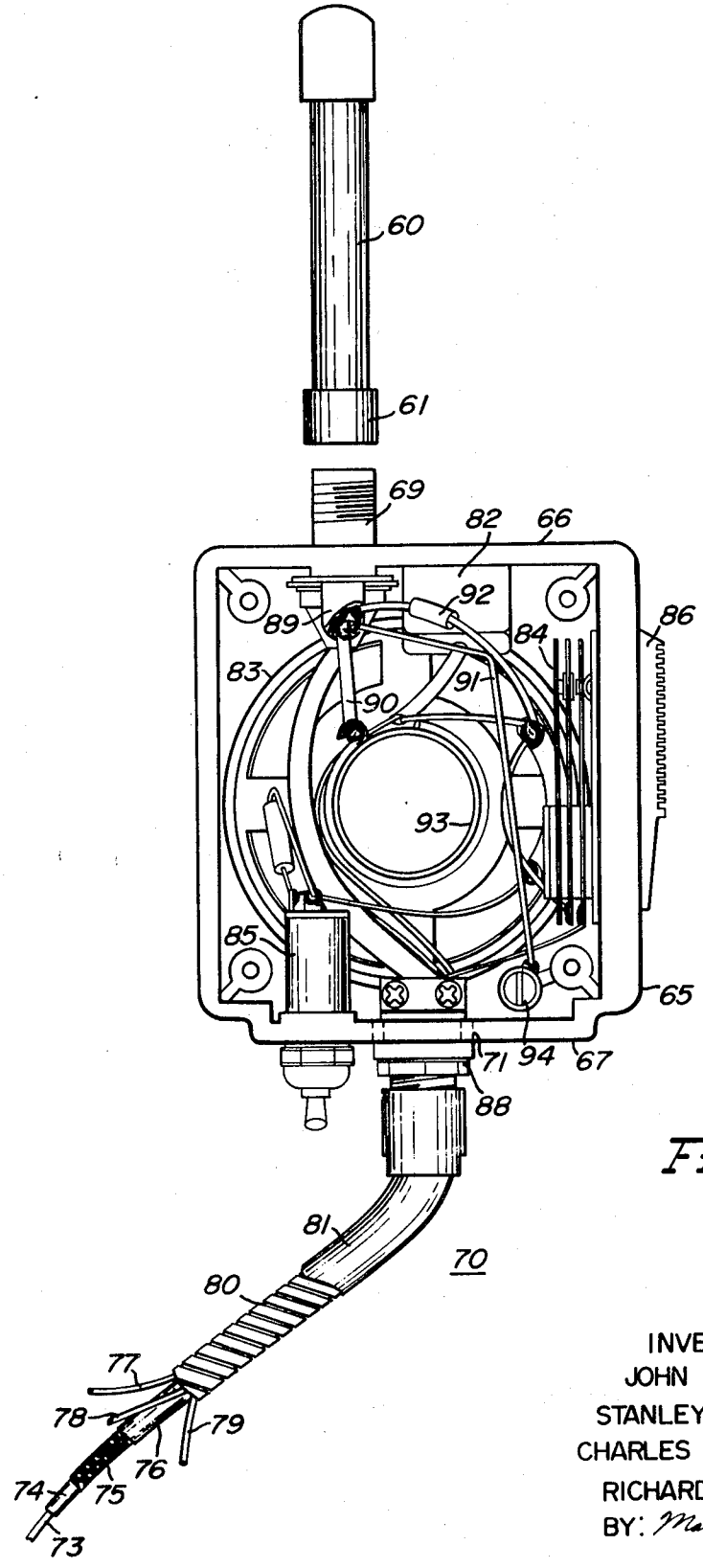


Fig. 4

INVENTORS:
JOHN W. FALTZ
STANLEY W. GORCIK
CHARLES T. HILTON JR.
RICHARD A. KAMYSZ
BY: Marshall N. Dicker
ATTY.

DIPOLE ANTENNA ARRANGEMENT FOR RADIO WITH SEPARATE SPEAKER-MICROPHONE ASSEMBLY

BACKGROUND

Speaker microphone assemblies currently employed, such as that described in U.S. Pat. No. 3,370,236, issued to R. H. Walker, and assigned to the same assignee, include an antenna element mounted thereon for radiating the transmitted radio signals and receiving radiated signals. Such assemblies have been used to advantage for a number of years. However, the antenna configuration does not result in a fully satisfactory radiation pattern because the assembly itself does not provide a substantial ground plane for the antenna element. Furthermore, the assembly does not isolate the antenna element from the portable radio unit thus allowing the radiated signals to affect the operation of the radio unit.

Although a speaker microphone assembly as described in the above patent is designed to be held in the hand, doing so can cause a degradation in antenna efficiency due to the presence of the body capacitance of the user.

Antenna elements used with assemblies such as that described above have a lower input impedance than the equipment with which they are associated. In order to match the equipment to the antenna element, carefully selected discrete matching components must be added to the assembly. The component selection and placement is critical, and the added component and labor costs will increase the unit cost.

SUMMARY

It is an object of this invention to provide a speaker microphone assembly for a radio unit including an antenna mounted thereon for radiating and receiving signals, wherein the antenna configuration provides an improved radiation pattern.

Another object of this invention is to provide a speaker microphone assembly having an antenna element thereon, which has structure providing a substantial effective ground plane for the antenna element.

Yet another object of this invention is to provide a speaker microphone assembly for a radio unit which has structure providing substantial isolation between the antenna element and the radio unit.

Still another object of this invention is to provide a speaker microphone assembly having an antenna mounted thereon wherein the antenna performance and efficiency is not substantially degraded due to the presence of the body capacitance of the user.

Another object of this invention is to provide a speaker microphone assembly with an antenna mounted thereon which does not require discrete components for matching the antenna element to the radio equipment.

In practicing this invention, a speaker microphone assembly is provided for use with a portable unit containing receiving and transmitting equipment for receiving and transmitting signals, wherein the assembly is adapted to be held in the user's hand. The assembly includes a housing having top, bottom and side walls, with transducer elements and equipment actuating switches mounted therein. Conductors couple the transducer elements and switches to the radio equipment. A helical antenna element is detachably mounted to the top wall of the housing and acts as one portion of a dipole antenna for radiating and receiving signals. A coaxial transmission line having outer and inner conductors couples the equipment to the speaker microphone assembly. The outer conductor is terminated at a first point in the assembly housing which is the antenna feed point. The inner conductor is connected to the connector which detachably mounts the antenna element. A second outer conductor surrounds and is insulated from the outer conductor of the coaxial transmission line and is connected to the transmission line outer conductor at the first point in the housing. This outer conductor extends for a predetermined length along the coaxial transmission line. The coaxial transmission line outer conductor and the second outer conductor act to form the second portion of the dipole antenna. As the housing is located at the low impedance point or feed point of the dipole, it has a minimal effect upon the dipole antenna performance.

In an alternate embodiment, the housing walls are coated with a conductive material which is connected to the first point and acts to form the second portion of the dipole antenna.

THE DRAWINGS

FIG. 1 is a view of a speaker microphone assembly with an antenna element mounted thereon connected to the portable radio unit with which the assembly is used.

FIG. 2 is a view of the cable connecting the portable radio unit and the speaker microphone assembly.

FIG. 3 is a view with the cover open taken all along the lines 1—1, illustrating the speaker microphone assembly, dipole antenna and mounting arrangement.

FIG. 4 is a view with the cover open of a second embodiment of the speaker microphone assembly, dipole antenna and mounting arrangement.

DETAILED DESCRIPTION

Referring to FIG. 1, there is shown a portable radio unit **10** which contains an FM radio transmitter and receiver, and a battery for operating the transmitter and receiver. One terminal of the battery (not shown) provides a reference or ground potential. A speaker microphone assembly **11** is connected to the portable radio unit via a connector **12**. Radiated radio frequency signals are received by an antenna including antenna element **22** on assembly **11** and coupled to the receiver in portable unit **10** where they are demodulated to produce audio signals. The audio signals are coupled from the receiver in unit **10** through connector **12** to assembly **11** where they are reproduced by speaker **46**, shown in FIG. **3**, enabling the user to hear the message. Audio messages to be transmitted are received at assembly **11** where they are converted to electrical signals by microphone **45**, shown in FIG. **3**. The electrical signals are coupled through connector **12** to the transmitter in radio unit **10** for modulating a radio frequency carrier signal. The modulated radio frequency carrier signal is coupled from the transmitter in unit **10** through connector **12** to speaker microphone assembly **11** where it is radiated by the antenna including element **22**.

Speaker microphone assembly 11 includes a housing 15 which has a top wall 16, a bottom wall 17 and side walls 18. One of the side walls 18 has a grillework 19 thereon for allowing audio to be conducted therethrough from speaker 46 to microphone 45. The side wall opposite grillework 19 (not shown) may be a removable cover which is secured to the assembly with screws at 20. A helical antenna element 22 is detachably secured to housing 15. Antenna element 22 includes a threaded rod 23 which mates with a connector 25, mounted to top wall 16 of housing 15. A cable 27 extends through bottom wall 17 of housing 15 and is connected to connector 12 for providing an electrical connection between speaker microphone assembly 11 and portable radio unit 10.

Portable radio unit 10 is adapted to be carried on the person in a location such as on the user's belt. Housing 15 is adapted to be held in the user's hand while he is using portable unit 10 for communicating with a remote point. It may also be supported on the user's belt or shirt by an attachment to the removable cover such as is shown in patent No. 3,370,236.

Referring to FIG. 2, there is shown a portion of cable 27 speaker microphone assembly 11. Cable 27 includes a coaxial transmission line consisting of a center conductor 29, a dielectric insulating material 30, a braided shield or outer conductor 31, and an outer insulation 32. Surrounding the coaxial transmission line and extending for a predetermined length therealong, is a second braided shield or second outer conductor 34. Second outer conductor 34 will be explained in greater detail in a subsequent portion of this application. Conductors 36, 37 and 38 are also provided in cable 27 for interconnecting the components located in housing 15 with the equipment in portable radio unit 10. An outer insulating cover 39, formed of a plastic material, encases conductors 36, 37 and 38, second outer shield 34, and the coaxial transmission line.

Referring to FIG. 3, antenna element 22 includes an antenna radiating element 41, shown in the cutaway section of antenna element 22. Radiating element 41 consists of a heavy gauge wire conductor and is formed into a helix to provide a helical antenna. The heavy gauge conductor provides effective signal reception and transmission and allows antenna element 22 to be maintained in a semi-rigid condition. An outer plastic jacket 42 surrounds radiating element 41, and acts to insulate the element and assist in maintaining antenna 22 in a semi-rigid condition. Threaded rod 23 is attached to one end of radiating element 41 and is shown inserted into connector 25 in FIG. 3.

Helical antenna element 22 forms one portion of a dipole antenna which is resonant at a particular frequency. A dipole antenna provides an improved radiation pattern over monopole antennas which have been employed. In the embodiment shown, the dipole antenna is resonant at approximately 460 MHz. The physical length L_1 of helical antenna element 22 is selected such that its electrical length is approximately a quarter wavelength at the resonant frequency of the dipole antenna.

Housing 15 of speaker microphone assembly 11 has a microphone 45, a speaker 46 and a switch 47 mounted therein. Speaker 46 includes a frame 48 for supporting the speaker cone and mounting the loudspeaker in the housing. Conductor 36 in cable 27 provides an electrical connection between microphone 45 and the transmitter in portable unit 10. Conductor 37 provides an electrical connection between switch 47 and the transmitter in portable unit 10. Switch 47 when actuated by actuation lever 49, secured to a side wall of housing 15, energizes the transmitter in portable unit 10. Conductor 38 provides an electrical connection between the receiver in portable unit 10 and speaker 46.

Cable 27 enters housing 15 through aperture 50 in bottom wall 17, and is retained by cable clamp 51, secured to the inner surface of housing 15. Center conductor 29 of the coaxial transmission line is connected to connector 25 for providing an electrical interconnection between the transmitter and receiver in portable unit 10 and helical antenna element 22. Outer conductor 31 of the coaxial transmission line in cable 27 is connected, through connector 12, to ground potential in portable unit 10, and has its other end terminated at a first point 53 in housing 15. This first point is connected via conductor 54 to frame 48 of speaker 46, and to microphone 45 and switch 47 for providing ground potentials thereat. First point 53 is also connected to one terminal of speaker 46 through RF choke 52 to provide a ground potential for the speaker. Choke 52 acts to prevent RF energy from being coupled to speaker 46.

The second outer conductor 34 extends from first point 53 to a point 54 along cable 27 which is external to housing 15. Outer conductor 31 of the coaxial transmission line, insulator 32, and second outer conductor 34 form a transmission line which acts as the second portion of the dipole antenna in assembly 11. This second portion acts to form a substantial ground or reflecting plane, which is necessary in order to provide the desired radiation pattern for the dipole antenna. The physical length L_2 of second outer conductor 34 is selected such that the electrical length of the transmission line formed by conductor 31, insulator 32 and conductor 34 is substantially equal to a quarter wavelength at the resonant frequency of the dipole antenna.

Second outer conductor 34 is electrically connected to outer conductor 31 at first point 53 to form a low impedance feed point for the dipole antenna. The second end of second outer conductor 34, shown at 54 is terminated without connection to other elements in cable 27 in order to provide an open circuit at that end of the dipole. Second end 54 of second outer conductor 34, as it is open circuited or unterminated, acts as a termination for the second portion of the dipole antenna, preventing radiated energy from being conducted along cable 27 towards portable unit 10. The open circuit also prevents undesired radiated energy from being conducted along cable 27 to the antenna from portable unit 10.

As feed point 53 is a low impedance feed point for the dipole antenna, external capacitance, added at or near this point will not substantially degrade the antenna performance. Housing 15 is connected to the feed point of the antenna. A user, holding housing 15 of speaker microphone assembly 11 in his hand will then be holding the dipole antenna, at or near the feed point 53. The user's body capacitance will therefore have a minimal effect upon the radiation characteristics of the

dipole antenna. Components such as microphone **45**, switch **47**, and speaker **46**, particularly speaker frame **48**, because of its mass, can seriously impair antenna radiation characteristics due to their presence in the near field produced by the radiation. By connecting the speaker frame **48** to ground potential at feed point **53**, and the other components to this point, their affects upon the radiation characteristics are minimized.

Helical antenna element **22**, due to its design, has a low input impedance. Transmitters and receivers commonly used in portable radio units, such as unit **10**, have an output impedance of approximately 50 ohms. The transmission line consisting of second outer conductor **34**, insulator **32** and outer conductor **31**, in addition to acting as the ground portion of the dipole antenna, also provides an impedance match for matching the input impedance of antenna element **22** to the output impedance of the radio equipment. This is due to the electrical length of second conductor **34**. By using the grounded portion of the dipole antenna as an impedance matching device, discrete matching components, normally required for matching a transmitter output of one impedance to a radiating element of a different impedance, are no longer required.

Referring to FIG. **4**, antenna element **60** is the same as antenna element **22** in FIG. **3**, except that threaded rod **23** is replaced by an RF connector **61**. Housing **65** has a top wall **66**, a bottom wall **67** and side walls, just as housing **15** in FIG. **3**. Helical antenna **60** is detachably secured to housing **65** by RF connector **69** mounted to top wall **66** of housing **65**. Cable **70** extends through an aperture **71** in bottom wall **67** of housing **65** and provides an electrical connection between the speaker microphone assembly and a portable radio unit such as portable radio unit **10**.

Cable **70** includes a coaxial transmission line consisting of a center conductor **73**, a dielectric insulating material **74**, a braided shield or outer conductor **75** and an outer insulation **76**. Conductors **77**, **78** and **79** are also provided in cable **70** for interconnecting the components located in housing **65** with the equipment in the portable radio unit. A flexible metal tubing **80** commonly known as an armored cable, encases conductors **77**, **78** and **79** and the transmission line. Armored cable **80** is used in order to prevent the speaker microphone assembly from being broken away from the portable radio unit. A plastic tubing **81** encases armored cable **80**.

Housing **65** has mounted therein a microphone **82**, a speaker **83**, a transmitter actuation switch **84**, and a speaker high-low switch **85**. An actuation lever **86** is mounted to the side wall of housing **65**, adjacent transmitter actuation switch **84** for operating this switch. Conductors **77**, **78** and **79** provide electrical interconnections between these components and the portable unit.

Cable **70** enters housing **65** through aperture **71** and is retained by cable clamp **88** secured to the inner and outer surfaces of bottom wall **67**. Center conductor **73** of the coaxial transmission line is connected to RF connector **69** for providing an electrical interconnection between the transmitter and receiver in the portable unit and helical antenna element **60**. Outer conductor **75** of the coaxial transmission line in cable **70** is connected through a connector, such as connector **12** in FIG. **1**, to ground potential in the portable unit, and has its other end terminated at a first point **89** in housing **65**. The first point in this embodiment is the outer shell of RF connector **69**. This first point is connected via conductor **90** to speaker magnet housing **93**, via conductor **91** to point **94** on the inner surface of housing **65**, and via RF choke **92** to one terminal of microphone **82** and speaker **83**.

The inner surfaces of the walls of housing **65** are coated with a conductive metal paint. In the embodiment shown, a conductive silver paint is applied having a thickness of at least **1** mil. A thickness of **1** to **3** mils insures that the painted conductive surface acts as a good conductor over the frequency ranges in which the portable unit operates. The **1** to **3** mil thickness coating will allow efficient operation at frequencies up to and in excess of 470 MHz. At aperture **71** surrounding cable clamp **88** on the inner surface of bottom wall **67**, the conductive paint is not applied for reasons to be explained in a subsequent portion of this application.

Housing **65**, because of the conductive paint applied to the inner surface of the walls, acts in the same manner as second outer conductor **34** shown in FIG. **3**. That is, as it surrounds the coaxial transmission line and is itself conductive at the frequencies of interest, the painted surface along with transmission line outer conductor **75**, forms a second transmission line which acts as the second portion or grounded portion of the dipole antenna. Although not physically as long as second outer conductor **34**, the physical dimensions of the housing in width, height and thickness, cause it to be resonant at the approximate operating frequencies of interest. The conductive inner surface of housing **65** is electrically connected at first point **89** via RF connector **69**, via conductor **91**, and the grounded metal portions of the components in housing **65**, to form a low impedance feed point for the dipole antenna. Aperture **71** through which cable **70** passes, as previously stated, is not provided with a conductive coating. This allows aperture **71** to act in a manner equivalent to the second end of second outer conductor **34** in FIG. **3**. With no silver conductive paint applied, aperture **71** acts to provide an open circuit at the bottom surface of housing **65**. This open circuit is a high impedance and acts as a termination for the second portion of the dipole antenna, preventing radiated energy from being conducted along cable **70** to the antenna from portable unit **10**.

As feed point **89** is a low impedance feed point for the dipole antenna, and the housing is a part of this low impedance feed point, external capacitance added at or near this point will not substantially degrade the antenna performance. A user holding housing **65** in his hand will then be holding the dipole antenna at or near the feed point, and the user's body capacitance will therefore have a minimal affect upon the radiation characteristics of the dipole antenna. As all the components mounted within housing **65** are also connected to the feed point, their affects upon the radiation characteristics are minimized.

Housing **65** also acts to match the impedance of antenna element **60** to the impedance of the transmitter and receiver in the portable radio unit in the same manner as that previously described with respect to second outer conductor **34** in FIG. **3**.

As can be seen, a speaker microphone assembly has been provided which includes a dipole antenna for radiating and transmitting signals. The dipole antenna provides an improved radiation pattern over antennas previously used. By providing a dipole antenna, the reflecting plane constitutes a substantial ground plane for improving the radiation pattern from the radiating element. With the dipole antenna feed point mounted in the speaker microphone assembly housing, body capacitance of the user will not substantially affect or degrade the antenna efficiency. Furthermore, a quarter wavelength coaxial transmission line or its equivalent such as is provided by the housing in FIG. 4, when used as the reflecting portion of the dipole also provides an impedance match so that critical matching components are not required to match the transmitting and receiving equipment to the antenna radiating element. The quarter wavelength coaxial transmission line or its equivalent such as is provided by the housing in FIG. 4, also prevents unwanted RF energy from being conducted to or from the portable unit.

We claim:

1. In a speaker microphone assembly adapted to be held in the hand and for use with a portable radio unit including receiving and transmitting equipment for receiving and transmitting signals, the combination of, a housing having top, bottom and side walls, an elongated antenna element secured to said top wall, said antenna element forming one half of a dipole antenna for radiating signals coupled from said transmitting equipment and coupling radiated signals to said receiving equipment, a cable for coupling the portable unit to said housing, said cable containing a coaxial transmission line having an inner conductor and an outer conductor, said outer conductor terminating at a first point in said housing, circuit means coupling said inner conductor to said antenna element, a second outer conductor surrounding said coaxial transmission line and extending for a predetermined length from said first point along said transmission line, said second outer conductor being connected to said outer conductor of said transmission line at said first point and both conductors forming the other half of said dipole antenna.

2. The assembly of claim 1 wherein said dipole antenna is resonant at a particular frequency, said antenna element and said other half of said dipole antenna each having an electrical length substantially equal to a quarter wavelength at the resonant frequency of said dipole antenna.

3. The assembly of claim 2 wherein said antenna element includes a conductive element having first and second ends, and mounting means secured to one of said ends and adapted to engage said circuit means in said assembly.

4. The assembly of claim 3 wherein said conductive element is formed into a helix for providing a quarter wavelength helical antenna element.

5. The assembly of claim 4 wherein said antenna element includes a tube of nonconductive material surrounding said helical element, said nonconductive material acting to insulate said helical element and maintain the same in a semi-rigid condition.

6. The assembly of claim 4 wherein said circuit means is a connector, said connector being secured to a wall of said housing and having said center conductor coupled thereto, said connector adapted to mate with said antenna element mounting means for mounting said antenna element to said assembly housing.

7. The assembly of claim 6 wherein said cable further includes insulating means surrounding said outer conductor of said coaxial transmission line and between said outer conductor and said second conductor, said insulating means providing an insulated separation therebetween.

8. The assembly of claim 7 wherein said portable unit includes a power source having first and second terminals, one of said terminals forming a reference potential, said reference potential being coupled to said transmission line outer conductor.

9. The assembly of claim 8 further including speaker means, microphone means and unit actuating means mounted in said assembly housing, conductor means coupling said speaker means, microphone means and actuating means to the portable unit for providing electrical connections therebetween, said speaker means including a speaker frame, said speaker means, said speaker frame and said microphone means being coupled to said first point to provide a reference potential thereat.

10. The assembly of claim 9 wherein said outer conductor of said transmission line and said second outer conductor are formed from braided wire conductors.

11. The assembly of claim 9 wherein said second outer conductor is a conductive material secured to said housing walls and coupled to said first point, said housing further including an aperture in said bottom wall, said cable extending through said aperture and said conductive material being isolated from said aperture.

12. The assembly of claim 11 wherein said conductive material is a conductive paint applied to said housing inner walls and having a predetermined thickness.

13. The assembly of claim 12 wherein said conductive paint is a silver conductive paint.

14. The assembly of claim 13 wherein said predetermined thickness is at least 1 mil.

15. A speaker microphone assembly for use with a portable radio unit including receiving and transmitting equipment for receiving and transmitting signals, said portable radio unit having a power source therein with one terminal thereof being a reference potential, said speaker microphone assembly including in combination, a housing having top, bottom and side walls adapted to be held in a user's hand, said bottom wall having an aperture therethrough, transducer means mounted in said assembly housing, a helical antenna element detachably secured to said housing, said antenna element forming one portion of a dipole antenna for radiating signals coupled from said transmitting equipment and coupling radiated signals to said receiving equipment, a connector secured to said housing for detachably securing said helical antenna element, a cable for coupling the portable unit to said housing, said cable containing a plurality of conductors coupling said equipment to said transducer means for providing electrical connections therebetween, and a coaxial transmission line having an inner conductor and an outer conductor, said inner and outer conductor of said coaxial transmission line being connected to said connector, said inner conductor coupling said helical an-

tenna element to said equipment, said outer conductor forming a low impedance point at said connector, said housing further including a conductive material applied to said housing inner walls and connected to said low impedance point, said conductive material being isolated from said aperture in said bottom wall and forming a second outer conductor for surrounding said coaxial transmission line, said transmission line outer conductor and said second outer conductor together forming the other portion of said dipole antenna.

16. A speaker microphone assembly of claim 15 wherein said dipole antenna is resonant at a particular frequency, said antenna element having an electrical length substantially equal to a quarter wavelength at the resonant frequency of said antenna.

* * * * *