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MacDowell et al.

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[45] **Jan. 22, 1974**

[54] **DISCONE ANTENNA**

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[52] **U.S. Cl.** **343/703,** 343/773, 343/861

[51] **Int. Cl.** **H01Q 13/00**

[58] **Field of Search** ... 343/773, 774, 775, 846, 703, 343/861

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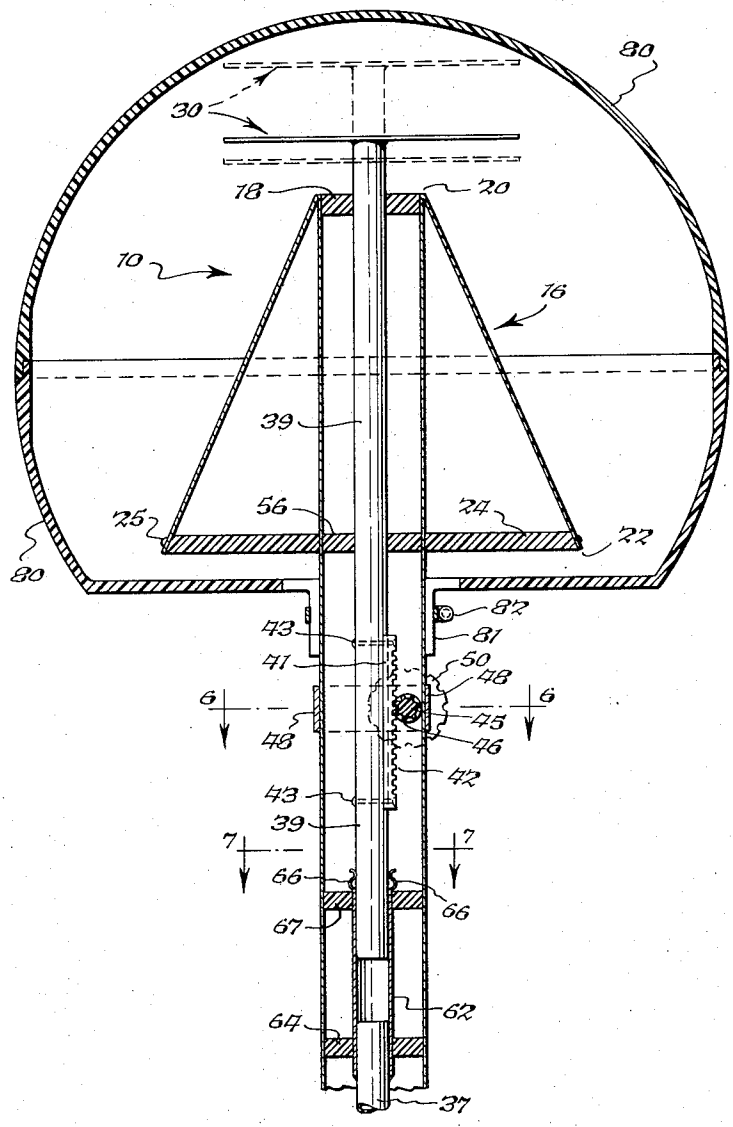
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[57] **ABSTRACT**

An antenna comprising a conical element connected at the apex thereof to the outer conductor of an input transmission line, a disc-shaped antenna element connected to the transmission line inner conductor and positioned adjacent the apex of the conical element, and adjustment means mechanically connected to the line for adjusting the distance between the disc-shaped element and the conical element whereby the impedance match of the antenna to the line can be varied so as to obtain a desired level, preferably a minimum, of the standing wave ratio. The adjustment means can comprise a rack connected to the inner conductor of the line and a pinion engaging the rack whereby rotation of the pinion moves the inner conductor to change the position of the disc-shaped element. A coupling means in the transmission line maintains the electrical transmission path during the relative movement of the conductors. The adjustment means can be automatically operated under control of sensing means connected to the transmission line in response to changes in the standing wave ratio on the line.

12 Claims, 7 Drawing Figures



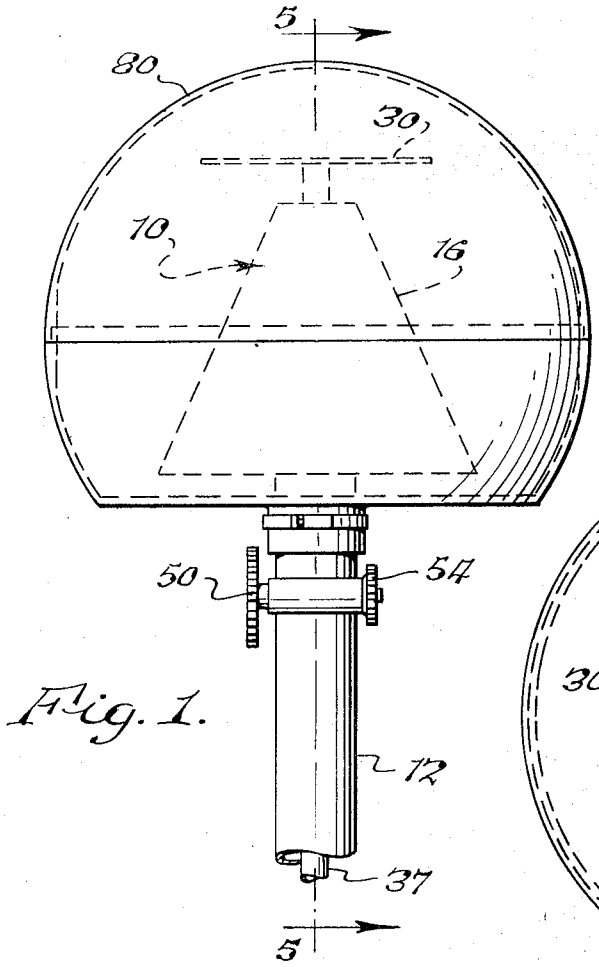


Fig. 1.

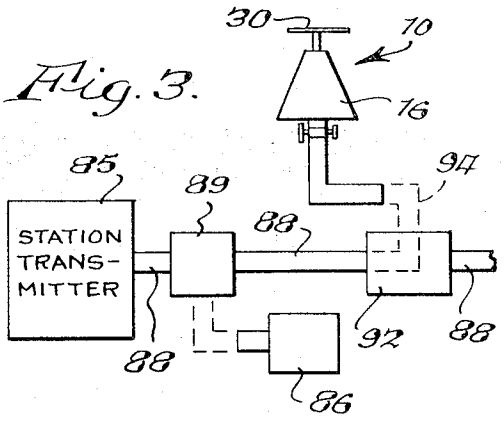


Fig. 3.

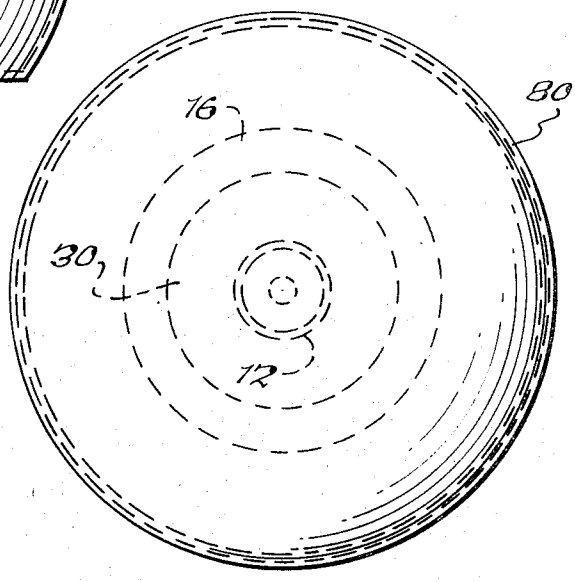
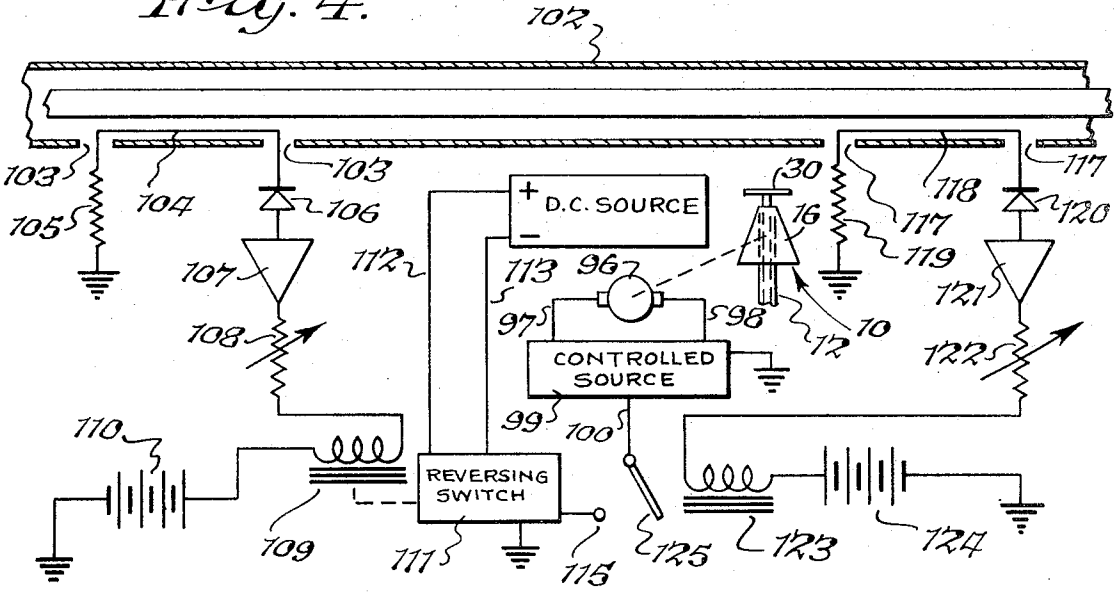


Fig. 2.

Fig. 4.



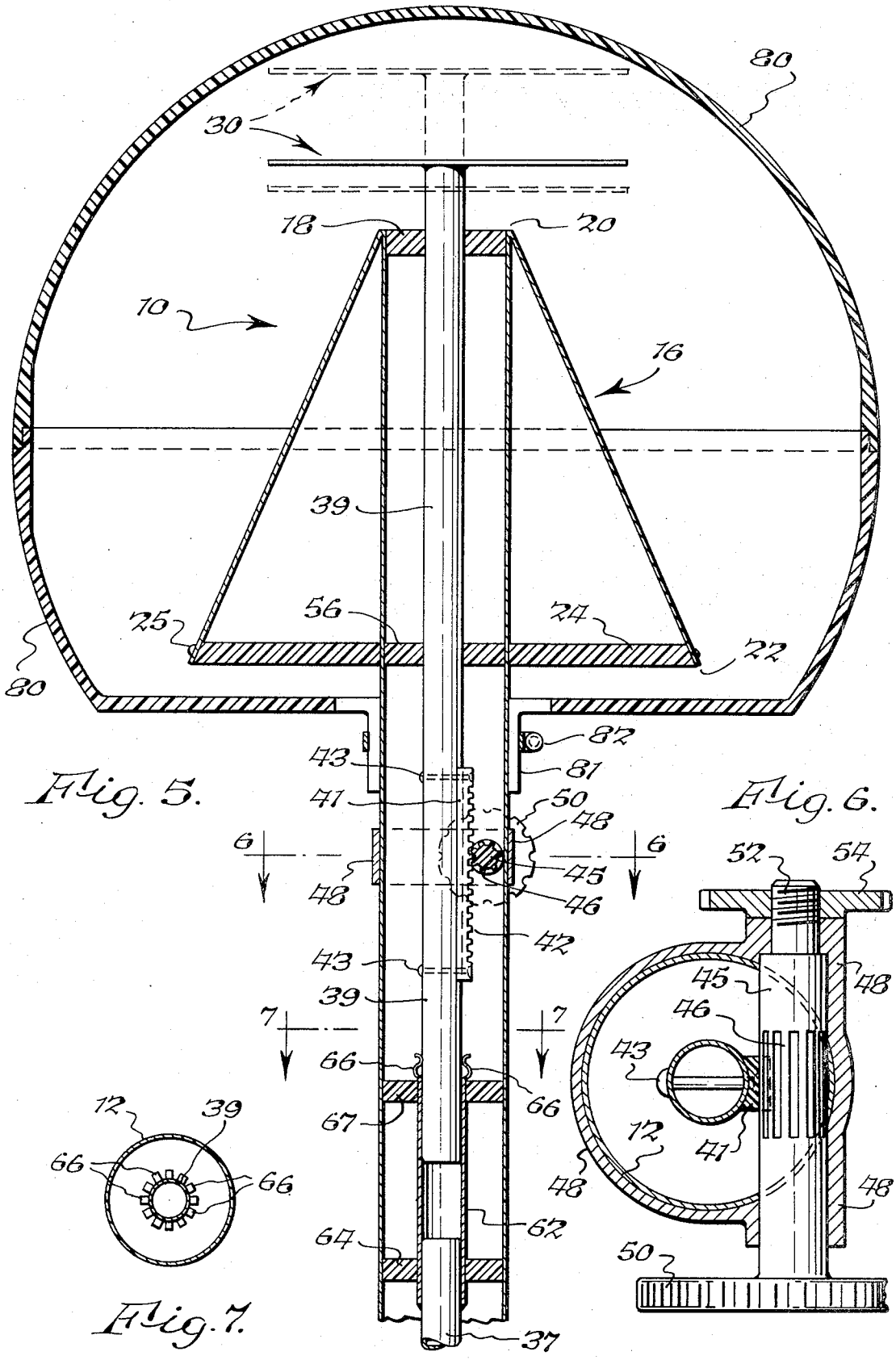


Fig. 5.

Fig. 6.

Fig. 7.

DISCONE ANTENNA

BACKGROUND OF THE INVENTION

This invention relates to the antenna art, and more particularly to a new and improved antenna of the discone type.

One use of the present invention is an auxiliary or emergency antenna for transmission of television broadcasts, although the principles of the invention can be variously applied. Failure of the main antenna at a television broadcasting station can result from severe weather conditions, especially wind, ice and temperature extremes, as well as from electrical and mechanical breakdown. Failure of a main broadcasting antenna is seldom, if ever, repairable without extensive loss of broadcasting time for several reasons, among which are the relative scarcity of antenna repair specialists and the possibility that hazardous conditions can delay repair procedures.

An antenna constructed for emergency broadcasting must satisfy several requirements. It must be capable of handling the electrical power levels associated with broadcasting and it must have a radiation characteristic which will cover the primary broadcast area of the station. The antenna should have few working parts that can fail and must be able to withstand severe weather conditions. To be economically feasible the antenna itself should be relatively inexpensive, compact and easy to install, and require a minimum amount of maintenance and which can be performed by the average technician.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide an antenna for emergency broadcasting which has effective power handling and radiation characteristics.

It is an additional object of this invention to provide a new and improved antenna of the discone type having efficient power handling and radiation characteristics.

It is a further object of this invention to provide such an antenna which is relatively simple in construction and convenient and easy to install and maintain.

The present invention provides an antenna comprising a conical antenna element connected at the apex thereof to the outer conductor of a transmission line, a disc-shaped antenna element connected to the inner conductor of the transmission line and positioned adjacent the apex of the conical element, and adjustment means mechanically connected to the line for adjusting the distance between the disc-shaped element and the conical element whereby the impedance match of the antenna to the line can be varied so as to obtain a desired level of the standing wave ratio. The adjustment means is mechanically connected to the transmission line for moving the inner and outer conductors of the line relative to each other, and there is provided coupling means in the line for maintaining the electrical transmission path during relative movement of the conductors. The present invention also provides sensing means connected to the line and in controlling relation to the adjustment means for operating the adjustment means in accordance with changes in the standing wave ratio on the line.

The foregoing and additional advantages characterizing features of the present invention will become clearly apparent upon a reading of the ensuing detailed description together with the included drawing wherein:

BRIEF DESCRIPTION OF THE DRAWING FIGURES

FIG. 1 is an elevational view of an antenna according to the present invention;

FIG. 2 is a top plan view thereof;

FIG. 3 is a schematic block diagram showing a preferred method of installing the antenna of the present invention as an emergency or auxiliary broadcast antenna;

FIG. 4 is a diagrammatic view of a sensing and control arrangement for the antenna according to the present invention;

FIG. 5 is a sectional view taken about on line 5—5 of FIG. 1;

FIG. 6 is a sectional view taken about on line 6—6 of FIG. 5; and

FIG. 7 is a sectional view taken about on line 7—7 of FIG. 5.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring now to FIGS. 1, 2 and 5 of the drawing, an antenna 10 according to the present invention comprises an input transmission line 12 having an outer conductor and an inner conductor. Transmission line 12 is of the standard three and one-eighth inch type and preferably is made of copper. Antenna 10 further comprises a conical antenna element 16 which is connected at the apex thereof to input transmission line 12 on the outer conductor thereof. In particular, transmission line 12 is provided at one end thereof with an annular or washer-shaped insulator member 18 which fits snugly within the outer conductor of line 12 and surrounds the inner conductor thereof. Member 18 preferably is of Teflon but can be of any other suitable electrically insulating material. Conical element 16 preferably is formed from a sheet of copper cut into the required shape and bent or otherwise formed into the shape of a cone suitably joined along the edge. Conical element 16 is not formed into a peak but rather terminates in an apex edge 20 which is disposed substantially in a plane perpendicular to the axis of conical element 16. Conical element 16 is connected to transmission line 12 by silver soldering or otherwise suitably joining apex edge 20 to the end of the outer conductor of line 12 which is adjacent insulator member 18. Conical element 16 also has a bottom or base edge 22 which lies substantially in a plane perpendicular to the axis of conical element 16. The interior region of conical element 16 is closed by means of an annular or washer-shaped member 24 of suitable electrically insulating material which is joined at the periphery thereof to the inner surface of conical element 16 adjacent base edge 22, and is fixed along the inner surface thereof to the outer conductor of transmission line 12. Member 24 can be joined to conical element 16 by various means such as screws 25 shown in FIG. 5, the heads of which would be substantially flush with the outer surface of member 16, whereby member 24 serves to provide structural rigidity to the conical element 16 as well as to seal the interior of element 16 against adverse environmental conditions. When conical element 16 is connected to input transmission line 12 in the manner shown in FIG. 5, apex edge 20 and base edge 22 lie sub-

stantially in parallel planes each of which is perpendicular to the longitudinal axis of transmission line **12.**

The height of conical element **16** is defined as the measured distance between these two planes including apex edge **20** and base edge **22** along a line perpendicular to both planes. The bottom diameter or maximum diameter of conical element **16** is the diameter of a circle defined by base edge **22** in its plane. The side length of conical element **16** is the straight line distance measured along the outer surface of element **16** between apex edge **20** and base edge **22.** The total length of conical element **16** would be the straight line distance measured along the outer surface of element **16** from base edge **22** beyond apex edge **20** to the point which is known as the vertex of the cone. The base angle of conical element **16,** which also is termed the flair angle, is the angle measured between a plane passing through base edge **22** and perpendicular to the axis of conical element **16** and a plane tangent to the outer surface of conical element **16.** In the conical element **16** of the present invention, this angle is equal to the angle described between a plane passing through apex edge **20** and perpendicular to the axis of cone **16** and a plane tangent to the outer surface of conical element **16** and extending beyond edge **20.**

The antenna of the present invention further comprises a disc-shaped antenna element **30** connected to the inner conductor of transmission line **12** and positioned adjacent the apex of conical element **16.** In particular, disc **30,** which preferably is of copper, is welded or otherwise suitably mounted adjacent the center thereof to an end of the inner conductor of transmission line **12** which extends outwardly beyond insulator member **18.** As a result, disc **30** is positioned to lie substantially in a plane parallel to the plane of apex edge **20** and the plane of base edge **22** and which plane is perpendicular to the axes of transmission line **12** and conical element **16** whereby the center of disc element **30** is substantially on the coincident axes of transmission line **12** and conical element **16.**

Antenna **10** of the present invention further comprises adjustment means mechanically connected to transmission line **12** for moving the inner and outer conductors of transmission line **12** relative to each other to adjust the distance between conical element **16** and disc-shaped element **30** whereby the impedance match of antenna **10** to input transmission line **12** and the transmission line to which input line **12** would be connected during use, can be varied so as to obtain a desired value of the standing wave ratio on the line. As shown in FIG. **5,** the inner conductor of transmission line **12** includes a stationary portion **37** and a movable portion **39** which is axially spaced from stationary portion **37** and extends outwardly beyond the end of transmission line **12** where it is connected or attached to disc element **30.** A rack member **41** having teeth **42** is mounted on movable portion **39** by suitable means such as screws **43.** Rack **41** is disposed so that teeth **42** are spaced linearly along a line parallel to the axis of transmission line **12.** A pinion **45** having teeth **46** is positioned so that teeth **46** of pinion **45** engage teeth **42** of rack **41** whereby upon rotation of pinion **45** rack **41** is moved linearly so as to move portion **39** of the inner conductor of transmission line **12** along the axis of line **12** to vary the distance between disc element **30** and conical element **16.** As shown in FIG. **6,** pinion **45** extends through the outer conductor of input transmission line **12** and at a position spaced from the base of conical element **16,** and pinion **45** is rotatably supported in a housing member **48** surrounding the outer conductor of transmission line **12** and suitably fixed thereon. One end of pinion **45** extends outwardly from housing **48** and is provided with a handle **50** for rotating pinion **45** in both clockwise and counterclockwise directions whereby disc element **30** and conical element **16** are moved towards and away from one another in response to rotation of pinion **45** by handle **50** in both directions. The other end of pinion **45** is in the form of a threaded extension **52** on which is threaded a locking means in the form of a lock nut **54** for maintaining a fixed rotary position of pinion **45** after an adjustment has been made. The movable portion **39** of the inner conductor of transmission line **12** is movably supported within line **12** by insulator member **18** and by a similar insulator member **56** fixedly positioned in line **12** as shown in FIG. **5** to be substantially coplanar with insulator member **24.** Rack member **41,** screws **43** and pinion **45** are of suitable electrically insulating material such as Teflon.

Antenna **10** of the present invention further comprises coupling means designated generally at **60** in FIG. **5** for maintaining the electrical transmission path provided by input line **12** during relative movement of the transmission line inner and outer conductors when an adjustment is made. Coupling means **60** is operatively connected to the stationary and movable portions **37** and **39,** respectively, of the inner conductor of transmission line **12.** In preferred form coupling means **60** comprises a cylinder **62** of electrically conducting material such as copper connected at one end thereof to stationary portion **37** of the inner conductor of transmission line **12.** As shown in FIG. **5,** cylinder **62** snugly fits on conductor portion **37** adjacent one end thereof and is welded or otherwise suitably joined onto conductor portion **37.** A washer shaped insulator member **64** provided in line **12** fits over the end of cylinder **62** surrounding the end of stationary conductor portion **37** to give structural support and rigidity to the combination. Cylinder **62** has sufficient axial length so as to receive at the opposite end thereof the end of the movable portion **39** of the inner conductor of transmission line **12** thereby allowing linear or reciprocable movements of conductor portion **39** within cylinder **62.** Coupling means **60** further comprises a wiper member of electrically conducting material connected to cylinder **62** and positioned so as to be in wiping contact with the movable portion **39** of the inner conductor of transmission line **12.** As shown in FIGS. **5** and **7** a plurality of finger-like wiper members **66** are connected circumferentially around the end of cylinder **62** and resiliently urged against the outer surface of conductor portion **39.** The wiper members **66** preferably are of a phosphor-bronze alloy metal which has sufficient flexibility and are provided with a silver coating to enhance the surface electrical conductivity thereof. The relatively large number of circumferentially spaced fingers **66** provides efficient handling of relatively large operating currents. A washer shaped insulator member **67** identical to insulator member **64** is fixedly positioned within the outer conductor of transmission line **12** and fits over the combination of cylinder **62** and conductor portion **39** adjacent wiper members **66** to enhance the structural rigidity and stability of the combination.

Antenna **10** can be provided with a protective enclosure **80** of relatively thin plastic material generally semispherical in shape comprising two halves suitably joined or assembled together and having a neck portion **81** which fits onto input transmission line **12** below the base of conical element **16** and secured thereof by means of a clamp **82.** Enclosure **80** protects against electrical hazards as well as insulating antenna **10** against the effects of hazardous weather conditions. The interior of enclosure **80** can be filled with nitrogen or a similar gas to prevent corrosion of the antenna components.

FIG. **3** illustrates the manner in which antenna **10** of the present invention is installed to serve as an emergency antenna for replacing the main broadcasting antenna in a television station. Block **85** represents the station transmitter and its associated equipment, and an emergency or auxiliary power source or cavity **86** is available for providing emergency power when needed. A station transmission line **88** connects the output of transmitter **85** to a broadcasting antenna usually on a tower (not shown), and a connector member **89** in line **88** permits connection of emergency source **86** in a known manner to line **88.** Antenna **10** of the present invention would be connected during an emergency to station transmission line **88** at a point between connector **89** and the main broadcast antenna. A connector member **92** is connected in line **88** and normally connects station transmission line **88** to the input of the broadcast antenna. Should the broadcast antenna fail for any reason connector **92** is removed thereby enabling connection of input transmission line **12** of antenna **10** by means of a conventional U patch **94** to station transmission line **88.** It has been determined that the foregoing change from normal operation to emergency operation can be made in less than ninety seconds thereby permitting the television station to begin to return to broadcasting in less than 2 minutes and remain broadcasting through antenna **10** of the present invention while repairs are being made to the main broadcast antenna.

Antenna **10** of the present invention operates in the following manner. Prior to placing antenna **10** into operation, the adjustment means is operated to vary the impedance match of antenna **10** to the transmission line to which it is connected so as to obtain a desired value of the standing wave ratio on the line, preferably the minimum possible standing wave ratio. In particular, when antenna **10** is to be used as an emergency or auxiliary television broadcast antenna in the manner shown in FIG. **3,** the antenna is installed at a convenient location which can be on the roof of the television station, and then during a time when broadcasting is not taking place, antenna **10** can be connected to the main station transmission line, such as transmission line **88** shown in FIG. **3,** and the knob **50** simply is turned to vary the distance between disc **30** and conical element **16** until the standing wave ratio on the line, as measured by a conventional meter or similar equipment, is at the desired minimum value for example about 1.1/1. Then, lock nut **54** is tightened to maintain this particular distance between disc **30** and conical element **16.** The foregoing installation is made easy by virtue of the fact that antenna **10** of the present invention weighs less than 200 pounds and is relatively compact in size, being less than 6 feet high and 6 feet wide. Antenna **10** is easily mounted on the roof of conventional transmitter buildings with no tower or additional height above 20 feet from ground level being necessary unless substantial obstructions exist adjacent the building. After the adjustment has been made, antenna **10** is disconnected from the main transmission line which, in turn, is reconnected to the main antenna tower, whereby antenna **10** is ready for immediate use when required.

When antenna **10** of the present invention is employed for transmitting purposes, the high frequency waves upon reaching the end of input transmission line **12** diverge and travel toward the outer extremities of conical element **16** and disc-shaped element **30** from which the waves spread into space in the form of radiation. Antenna **10** radiates a vertically polarized signal in an omnidirectional radiation pattern. It continuously radiates in a substantially circular pattern and has very broadband characteristics. Antenna **10** of the present invention presents a substantially uniform feed point impedance over the entire television channel for which it is constructed, and it has at least unity gain which varies only slightly over the entire frequency range of the channel.

Antenna **10** of the present invention has the capability of handling at least 25,000 watts of power from the station transmitter. Significantly, the adjustment means of the present invention permits varying of the distance between conical element **16** and disc shaped element **30** to minimize the standing wave ratio on the transmission line to which antenna **10** is connected. A minimum standing wave ratio is important so that there is no reflection of harmful or destructive amounts of power from the antenna back to the station transmitting equipment. The foregoing is provided in an antenna which operates in an effective and efficient manner, which is relatively simple and compact in construction, and which is convenient and easy to install and maintain.

At television broadcast frequencies which are in the VHF range, the useful portion of the signal is that which is radiated at a very low angle with respect to the surface of the earth. Antenna **10** of the present invention, when positioned at average heights, radiates a very low angle of radiation and therefore wastes very little energy at high angles of propogation. Furthermore, its omnidirectional radiation pattern provides maximum coverage from the site of the station transmitter. Although commercial television in the United States has been standardized with horizontal polarization and antenna **10** of the present invention radiates a vertically polarized signal, in an emergency situation the difference would be hardly noticable. Furthermore, two antennas **10** can be fed at 90° angles with respect to each other with a resulting clover-leaf radiation pattern having horizontal polarization.

Input transmission line **12** is of copper, has an outer diameter of 3⅛ inches, and has a characteristic impedance of 50 ohms which is the standard transmission line impedance for television transmitters. By way of illustration, a typical antenna **10** constructed according to the present invention has an approximate height of 22 inches, an approximate width of 15 inches, and weighs about 25 pounds. The power input rating is 25,000 watts, the horizontal circularity is better than ± 2Db, the antenna input impedance is 50 ohms, and the VSWR across a 6 megacycle channel is 1.1/1. In most instances range of adjustment between conical element

16 and disc-shaped element 30 of 3 inches in both directions for a total travel of 6 inches will be sufficient.

When antenna 10 of the present invention is to be used in television or similar broadcasting, it will be constructed with certain electrical dimensions determined by the frequency range of interest. The side length of conical element 16 is determined from the formula:

$$[(5,400)/(\text{lowest frequency})](\tfrac{1}{2}) + 0.75$$

The diameter of disc-shaped element 30 is obtained from the formula:

$$](5,400)/(\text{lowest frequency})](\tfrac{1}{2})\ (0.7) + 0.75$$

In each formula the factor 5,400/lowest frequency is a known relationship for computing a half-wavelength electrical dimension in inches given a frequency in megacycles. The frequency value used is the lowest frequency in the range of interest. The factor of one-half is employed because optimum performance has been determined to result in a discone antenna wherein the side length of the conical element is approximately one quarter wave length of the lowest frequency in the range of interest. In the formula for computing the diameter of the disc-shaped element 30, the factor of 0.7 is employed because optimum results have been determined to arise in a discone antenna when the disc diameter is 0.7 times the cone side length. In each formula the factor of 0.75 is added to lower the cutoff frequency and insure that the desired frequency is passed. This is because each formula without the added additional factor determines the minimum length that can be used for a specific frequency. When the side length of conical element 16 is known, then the remaining cone dimensions of interest can be calculated from known trignometric relationships together with the fact that the distance from the center of the cone to the outer surface of transmission line 12 is one-half the diameter of the transmission line or 1.5625 inches. In television transmission, antenna 10 was found to give optimum results when the maximum diameter of conical element 16 is longer than one-fourth wavelength in free space of the lowest frequency of operation and wherein the diameter of disc element 30 is 0.7 times the maximum diameter of element 16. By way of example, an antenna 10 of the present invention constructed for transmission on television channel 2 in the 54–60 megacycles frequency range would have the following electrical dimensions: Disc element 30 has a diameter of 35.75 inches and conical element 16 has a side length of 50.75 inches, a diameter of the cone base of 50.75 inches, and a flare angle of 62°, 2 mins. Prior to fabrication of conical element 16, the angle at the cone apex between the two side edges which ultimately are joined is 168° 55 mins.

Several properties which cause antenna 10 to be an efficient transmitting antenna also enable it to function advantageously as a receiving antenna. It receives signals in all directions without requiring any rotating of the antenna. It has a three decibel gain in all directions and is physically not large. Although operating with vertically polarized signals, antenna 10 can also receive horizontally polarized signals. The antenna receives signals on a low angle rather than receiving skip signals reflected from the ionsphere. In particular, the circular or doughnut-shaped receiving area provides direct line reception rather than receiving signals reflected from the ionsphere. The adjustment means of antenna 10 of the present invention advantageously permits minimization of the standing wave ratio thereby enabling the antenna to accept the signals in a highly efficient manner.

Antenna 10 of the present invention can be used to transmit and receive signals other than television transmission, for example short wave frequencies, aircraft broadcast signals or commercial and business broadcasts in their particular band. Two or more antennas of the present invention can be combined and operated in various phase relationships to give different radiation patterns in a manner which is well known by those skilled in the art. While conical element 16 and disc-shaped element 30 are illustrated as being in solid form, variations in their construction are possible without departing from the spirit and scope of this invention. For example, conical element 16 can comprise a plurality of wires circumferentially spaced to define a surface of revolution resembling a cone. Disc-shaped element 30 can be formed of a plurality, for example eight, of radially extending wires which, in turn, are connected by a plurality of relatively shorter wires to describe a configuration similar to a spider web. These configurations are especially suitable for international short wave use.

FIG. 4 shows an arrangement according to the present invention whereby the distance between conical element 16 and disc 30 is adjusted automatically in response to changes in the standing wave ratio on the transmission line to which antenna 10 is connected. The adjustment means of the present invention would include reversible electric motor means which, for example, could be connected to pinion 45 for rotating the same. Alternatively, the output of the reversible motor could be connected through a threaded drive section to movable portion 39 of the inner conductor input transmission line 12. In this arrangement a flexible electrical coupling or the equivalent would maintain electrical connection between the movable portion of the inner conductor and the fixed portion of the inner conductor. According to the present invention there is provided sensing means connected to the transmission line for developing an electrical signal having a parameter which varies in proportion to the magnitude of the standing wave ratio on the line together with control means connected to the sensing means and to the reversible drive motor for operating the motor in accordance with changes in the standing wave ratio. Referring to FIG. 4, an electric reversible drive motor, preferably d.c. operated, is connected by lines 97, 98 to a controlled source 99 for energizing and deenergizing the motor 96 and for controlling the direction of rotation of motor 96. In particular, when an electrical input of either positive or negative polarity is applied to input 100 of source 99 motor 96 is energized, and when no input is applied motor 96 is deenergized. Furthermore, the direction of rotation of motor 96 is determined by the electrical polarity of the quantity applied to input 100. The foregoing is representative of various combinations of reversible d.c. motors and control which are readily commerciably available and well understood by those skilled in the art so that a detailed description thereof is believed to be unnecessary.

The transmission line 102 comprising an inner conductor and an outer conductor is representative of the transmission line to which antenna 10 of the present invention is connected during use. A first sensing means is connected to transmission line 102 for providing an

electrical signal when the standing wave ratio reaches a predetermined maximum value. The outer conductor of transmission line **102** is provided with a first pair of apertures **103** spaced apart a distance of about three to four inches for positioning within transmission line **102** a sensing loop **104.** Loop **104** can be of number **12** wire and must be of a length significantly less than one-quarter wave length of the frequency of transmission. One end of loop **104** is connected outside of line **102** to a resistance **105** which in turn is connected to ground. Resistance **105** should equal the characteristic impedance of transmission line **102.** The other end of loop **104** is connected outside of line **102** to the cathode of a diode **106,** the anode of which is connected to the input of an amplifier **107.** The output of amplifier **107,** in turn, is connected through a variable resistance **108** to one terminal of the control coil of a solenoid **109.** The other terminal of the control coil of solenoid **109** is connected to the positive terminal of a battery **110,** the negative terminal of which is grounded. Solenoid **109** is operatively connected to a reversing switch generally indicated at **111** which is connected by lines **112** and **113** to the positive and negative output terminals, respectively, of a d.c. source **114.** Thus, as determined by the operation of solenoid **109** the output terminal **115** of reversing switch **111** will have either a positive or negative polarity.

According to the present invention the outer conductor of transmission line **102** is provided with a second set of spaced-apart apertures **117** through which a sensing loop **118** is positioned within line **102.** Loop **118** is identical to loop **104,** but the distance between the loops **104, 118** along line **102** is not critical. One end of loop **104** is connected outside of line **102** to a resistor **119** having a magnitude equal to the characteristic impedance of transmission line **102.** The other end of loop **118** is connected to the cathode of diode **120,** the anode of which is connected to the input of an amplifier **121.** The output of amplifier **121** is connected through a variable resistance **122** to one terminal of the control coil of a relay **123.** The other terminal of the control coil of relay **123** is connected to the positive terminal of a battery **124,** the negative terminal of which is connected to ground, Relay **124** operates a switch arm **125** whereby input **100** of controlled source **99** is either connected to output **115** of reversing switch **111** or disconnected therefrom depending upon the state of operation of relay **123.** Line **130** represents the mechanical connection between the output of motor **96** and the inner conductor of input transmission line **12** of antenna **10.**

The circuit of FIG. **4** operates in the following manner. The flow of current in the respective circuits including sensing loops **104** and **118** is proportional to the standing wave ratio on transmission line **102.** Resistor **108** is adjusted so that the flow of current in the control coil of solenoid **109** reaches a level sufficient to operate solenoid **109** when the standing wave ratio on line **102** reaches a predetermined maximum value, for example 1.5. Resistor **122** is adjusted so that the flow of current in the control coil of solenoid **123** is of a magnitude sufficient to actuate solenoid **123** when the standing wave ratio on line **102** is equal to or greater than a predetermined minimum value, for example 1.1. Thus, when the standing wave ratio on line **102** is below the predetermined minimum value, switch arm **125** is in the position shown in FIG. **4,** motor **96** is deenergized, and the relative position of disc-shaped element **30** with respect to conical element **16** is fixed or stationary. When the standing wave ratio on line **102** is equal to or greater than the predetermined minimum value, as sensed by loop **118,** a flow of current results which is sufficient to energize solenoid **123** moving switch arm **125** to the left as shown in FIG. **4** to engage terminal **115.** As a result, source **114** is connected to controlled source **99** to energize motor **96** causing movement of disc element **30.** When this movement results in the standing wave ratio being adjusted to a value less than the predetermined minimum value, this is sensed by loop **118** with the result that solenoid **123** is deenergized causing switch arm **125** to the position shown in FIG. **4.**

As motor **96** is operated causing movement of disc **30,** when the standing wave ratio on line **102** reaches a predetermined maximum value as sensed by loop **104,** the flow of current through solenoid **109** as determined by resistor **108** is sufficient to cause operation of reversing switch **111** thereby changing the polarity of the voltage on terminal **115** to reverse the direction of rotation of motor **96.** This, in turn, causes movement of disc **30** in a direction tending to reduce or minimize the standing wave ratio.

It is therefore apparent that the present invention accomplishes its intended objects. The antenna **10** has an effective power handling capability as provided by the adjustment means of the present invention together with effective radiation characteristics arising from its omnidirectional radiation pattern. The antenna **10** has few working parts, is able to withstand severe weather conditions, is relatively inexpensive, compact and easy to install, and requires a minimum amount of maintenance. Several characteristics enable the antenna of the present invention to function advantageously in receiving as well as transmitting signals.

While certain embodiments of this invention have been described with specificity, this is by way of illustration without thought of limitation.

We claim:

1. An antenna comprising:

a. an input transmission line having an outer conductor and an inner conductor, one of said conductors having a stationary portion and a movable portion;

b. a conical antenna element connected at the apex thereof to said outer conductor of said line;

c. a disc-shaped antenna element connected to said inner conductor of said line and positioned adjacent the apex of said conical element;

d. adjustment means mechanically connected to the movable portion of said one conductor of said transmission line for moving said inner and outer conductors of said line relative to each other to adjust the distance between said disc-shaped element and said conical element whereby the impedance match of said antenna to said transmission line can be varied so as to obtain a desired value of the standing wave ratio on the line, said adjustment means comprising rack means on said movable conductor portion, pinion means engaging said rack means for moving said rack means linearly in response to rotation of said pinion means, and means for rotating said pinion means in both clockwise and counterclockwise directions whereby said disc element and said conical element are moved

toward and away from one another in response to rotation of said pinion means in both directions;

e. coupling means operatively connected in said line to said stationary and movable portions of said one conductor for maintaining the electrical transmission path provided by said line during relative movement of said conductors, said coupling means comprising a cylinder of electrically conducting material connected at one end thereof to said stationary conductor portion and positioned to receive at the other end said movable conductor portion for reciprocable movement of said movable portion within said cylinder and a wiper member of electrically conducting material connected to said cylinder at said other end and positioned in wiping contact with said transmission line movable portion; and

f. locking means connected to said adjustment means for maintaining the distance between said disc-shaped element and said conical element after an adjustment has been made.

2. Apparatus according to claim **1,** wherein said adjustment means includes motor means and wherein said apparatus further comprises:

a. sensing means connected to said line for developing an electrical signal having a parameter which varies in proportion to the magnitude of the standing wave ratio on said transmission line; and

b. control means connected to said sensing means and to said motor means for operating said motor means in accordance with changes in said standing wave ratio.

3. Apparatus according to claim **1,** wherein said adjustment means includes electric motor means and wherein said apparatus further comprises:

a. control means connected to said motor means for energizing and deenergizing and controlling the direction of rotation of said motor means;

b. first sensing means connected to said transmission line for providing an electrical signal when the standing wave ratio on said line reaches a predetermined maximum value;

c. means connecting said first sensing means to said control means in a manner such that the direction of rotation of said motor means is changed when the standing wave ratio reaches said predetermined maximum value;

d. second sensing means connected to said transmission line for providing an electrical signal when the standing wave ratio on said line reaches a predetermined minimum value; and

e. means connecting said second sensing means to said control means in a manner such that said motor means remains energized so long as the standing wave ratio is greater than said predetermined minimum value and said motor means is deenergized when the standing wave ratio has said predetermined minimum value.

4. In combination with a television transmitting station including a transmitter having an output, a broadcasting antenna, and a station transmission line connecting the output of said transmitter to said antenna, an emergency antenna for replacing said broadcasting antenna temporarily whenever said broadcasting antenna should happen to fail, said emergency antenna comprising:

a. an input transmission line having an outer conductor and an inner conductor;

b. a conical antenna element connected at the apex thereof to said outer conductor of said input transmission line;

c. a disc-shaped antenna element connected to said inner conductor of said input transmission line and positioned adjacent the apex of said conical element;

d. adjustment means mechanically connected to said input transmission line for moving said inner and outer conductors of said line relative to each other to adjust the distance between said disc-shaped element and said conical element whereby the impedance match of said antenna to said line can be varied so as to obtain the lowest possible standing wave ratio on said station transmission line when said emergency antenna is connected thereto;

e. coupling means in said input transmission line for maintaining the electrical transmission path provided by said line during relative movement of said conductors; and

f. connecting means on said input transmission line for connecting said emergency antenna to said station transmission line when said broadcasting antenna is disconnected from said station line.

5. Apparatus according to claim **4,** wherein the maximum diameter of said conical element is longer than one-quarter wavelength in free space of the lowest frequency of operation and wherein the diameter of said disc is 0.7 times the maximum diameter of said conical element.

6. Apparatus according to claim **4,** wherein said transmission line inner conductor includes a stationary portion and a movable portion, said movable portion being connected to said disc-shaped element, wherein said adjustment means is operatively connected to said movable portion of said transmission line inner conductor, and wherein said coupling means is operatively connected to said stationary and movable portions of said transmission line inner conductor.

7. Apparatus according to claim **4,** further including locking means connected to said adjustment means for maintaining the distance between said disc-shaped element and said conical element after an adjustment has been made.

8. Apapratus according to claim **6,** wherein said adjustment means comprises:

a. rack means mounted on said transmission line inner conductor;

b. pinion means engaging said rack means for moving said rack means linearly in response to rotation of said pinion means; and

c. means for rotating said pinion means in both clockwise and counterclockwise directions whereby said disc element and said conical element are moved toward and away from one another in response to rotation of said pinion means in said both directions.

9. Apparatus according to claim **8,** further including locking means connected to said pinion rotating means for maintaining a fixed rotary position of said pinion means after an adjustment has been made.

10. Apparatus according to claim **6,** wherein said coupling means comprises:

a. a cylinder of electrically conducting material connected at one end thereof to said stationary portion

of said transmission line inner conductor and positioned to receive at the other end said movable portion of said transmission line inner conductor for reciprocable movement of said movable portion within said cylinder; and

b. a wiper member of electrically conducting material connected to said cylinder at said other end and positioned in wiping contact with said transmission line inner conductor.

11. The combination according to claim **4,** wherein said adjustment means includes motor means and wherein said combination further comprises:

a. sensing means connected to said line for developing an electrical signal having a parameter which varies in proportion to the magnitude of the standing wave ratio on said transmission line; and

b. control means connected to said sensing means and to said motor means for operating said motor means in accordance with changes in said standing wave ratio.

12. The combination according to claim **4,** wherein said adjustment means includes electric motor means and wherein said combination further comprises:

a. control means connected to said motor means for energizing and deenergizing and controlling the direction of rotation of said motor means;

b. first sensing means connected to said transmission line for providing an electrical signal when the standing wave ratio on said line reaches a predetermined maximum value;

c. means connecting said first sensing means to said control means in a manner such that the direction of rotation of said motor means is changed when the standing wave ratio reaches said predetermined maximum value;

d. second sensing means connected to said transmission line for providing an electrical signal when the standing wave ratio on said line reaches a predetermined minimum value;

e. means connecting said second sensing means to said control means in a manner such that said motor means remains energized so long as the standing wave ratio is greater than said predetermined minimum value and said motor means is deenergized when the standing wave ratio has said predetermined minimum value.

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