United States Patent

[11] 3,598,923

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[45] Patented **Aug. 10, 1971**

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New Haven, Conn.

[54] **TRANSMITTING ANTENNA SYSTEM FOR AUDIO INDUCTION COMMUNICATION SYSTEM**
16 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **179/82**
[51] **Int. Cl.** **H04b 5/00**
[50] **Field of Search** 179/82; 343/787866; 336/221

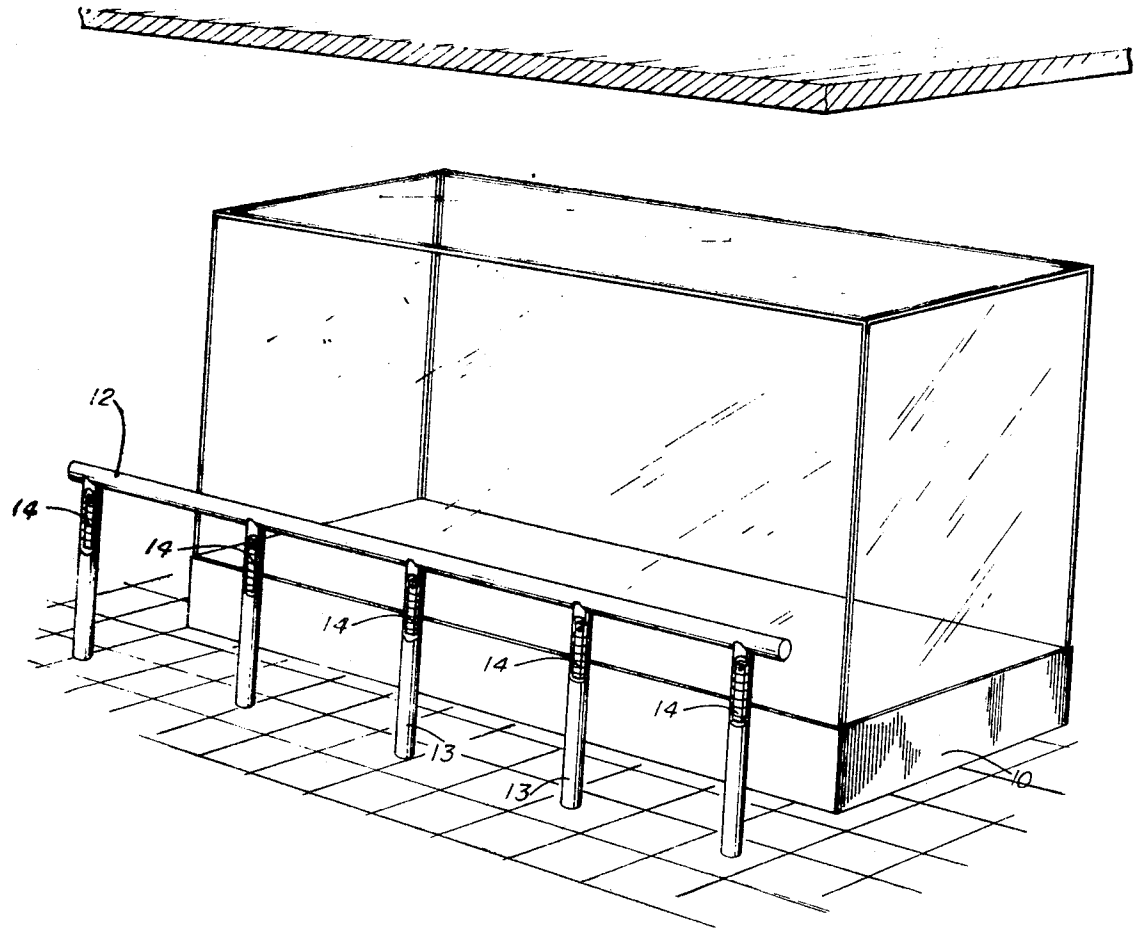
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Primary Examiner—William C. Cooper
Assistant Examiner—William A. Helvestine
Attorney—McCormick, Paulding and Huber

ABSTRACT: A transmitting antenna system for an audio induction communication system provides an active message field within a three-dimensional pickup zone consisting of a magnetic field which varies in frequency directly in accordance with the frequency of the transmitted message. The system comprises a plurality of antennas, each consisting of an elongated core of magnetic material and a winding on the core, located beyond the pickup zone and arranged and energized so that the magnetic field of each antenna within the pickup zone has only one generally vertical direction and so that such one generally vertical direction at any given instant is the same for all of the fields of all of the antennas of said system. By varying the number, the arrangement, the energization and the construction of the individual antennas the shape and size of the pickup zone may be precisely controlled to allow two or more pickup zones to be placed close to one another without mutual interference.



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SHEET 1 OF 4

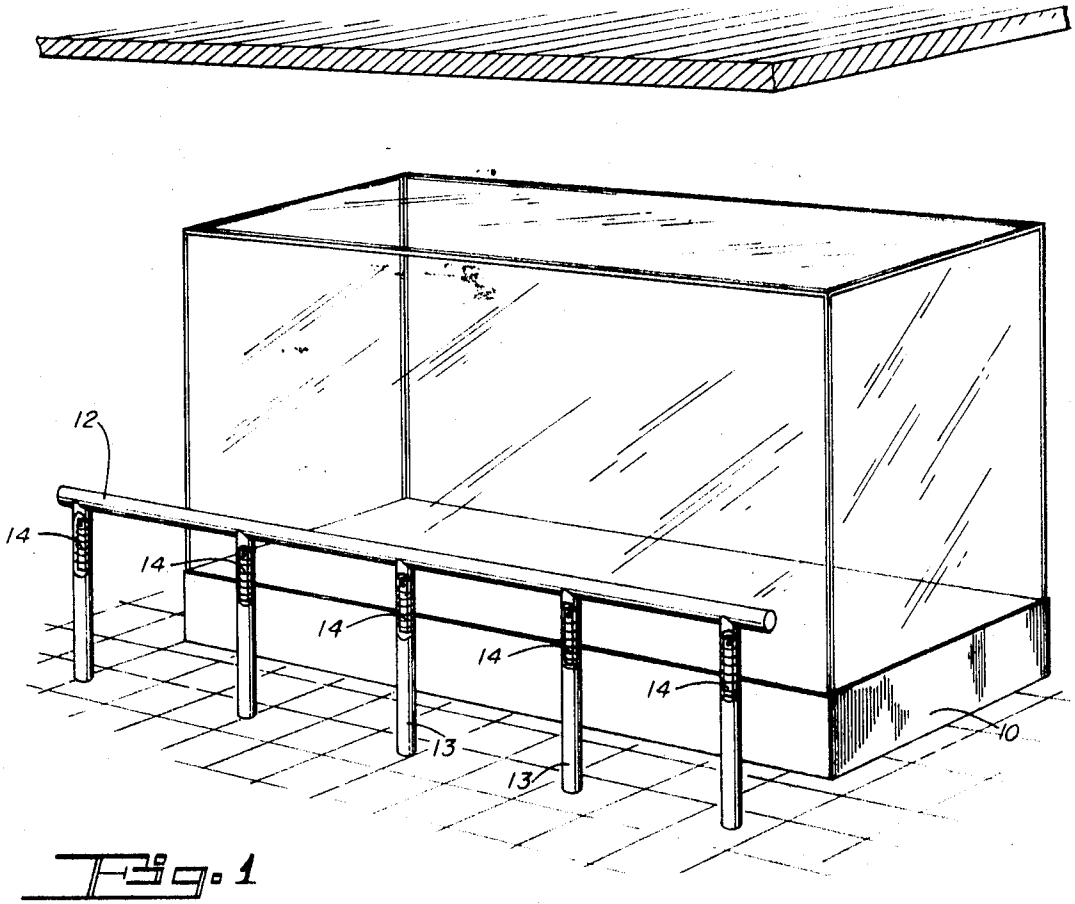


Fig. 1

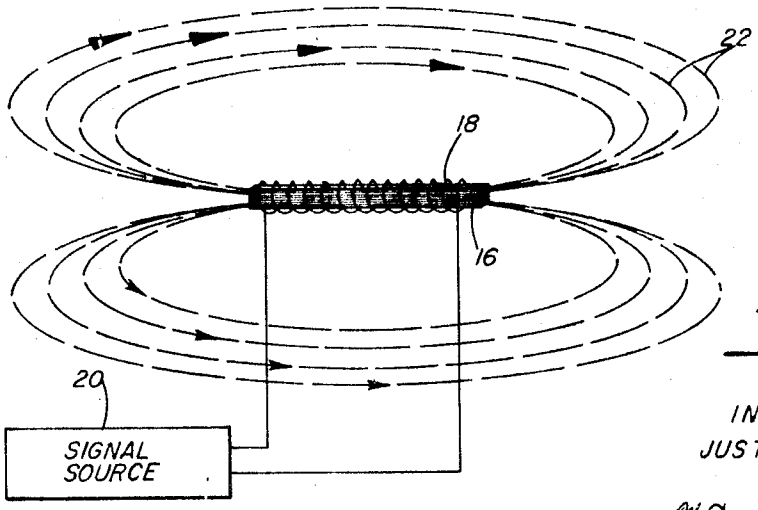


Fig. 2

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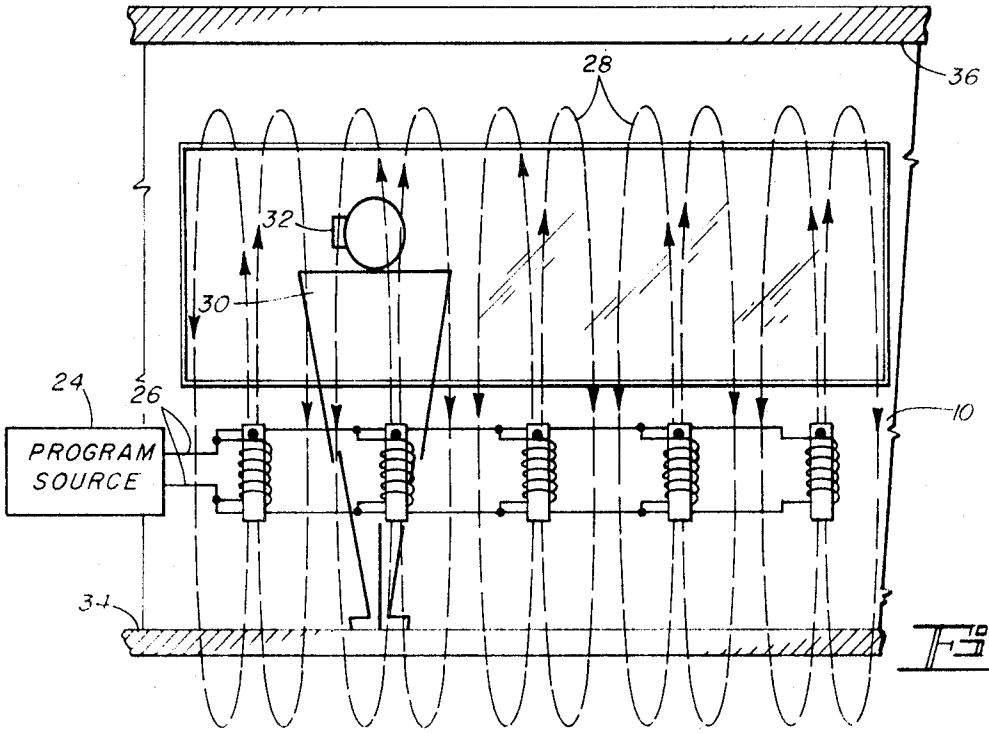


Fig. 3

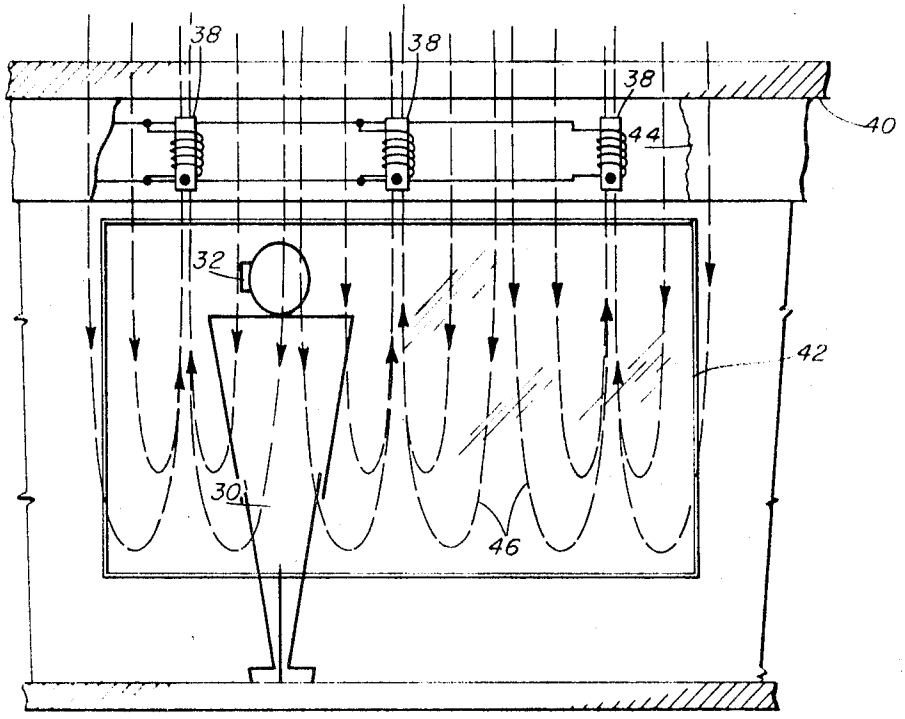
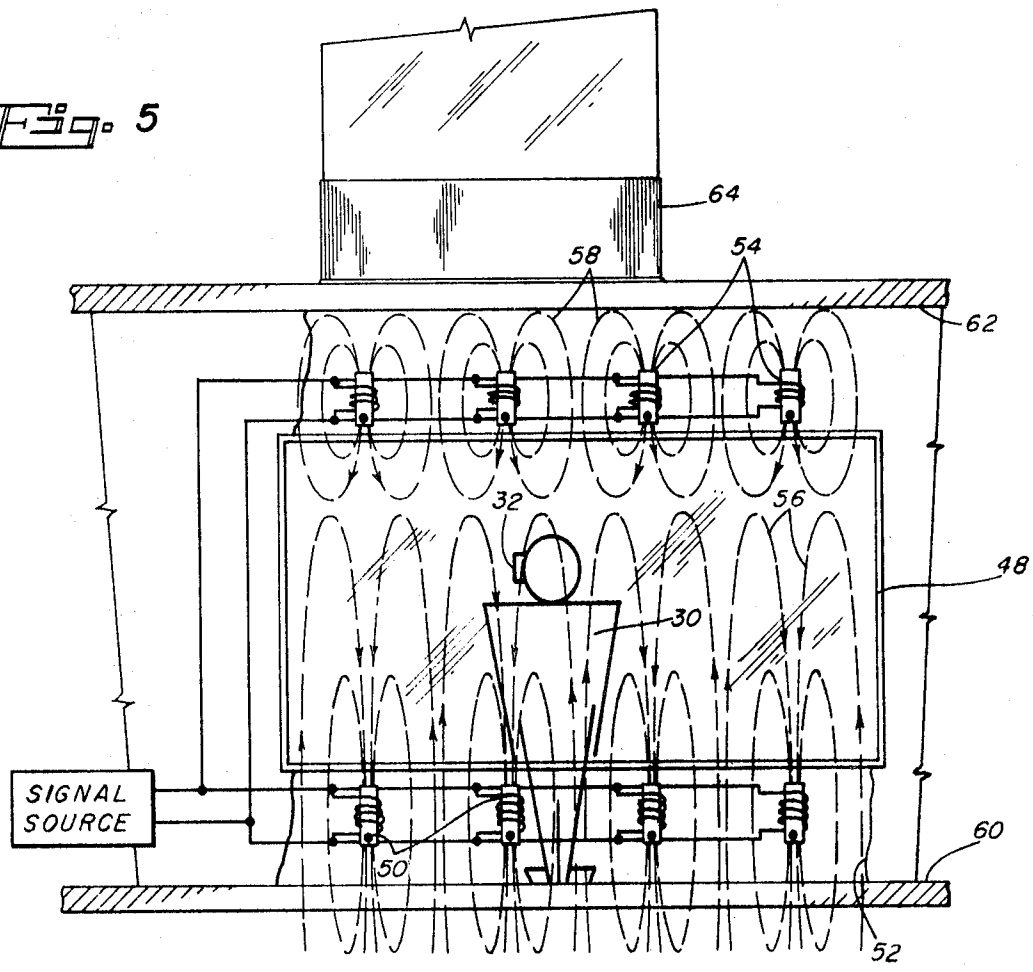


Fig. 4

Fig. 5


64
58
54
62
32
56
48
30
SIGNAL SOURCE
50
60
52

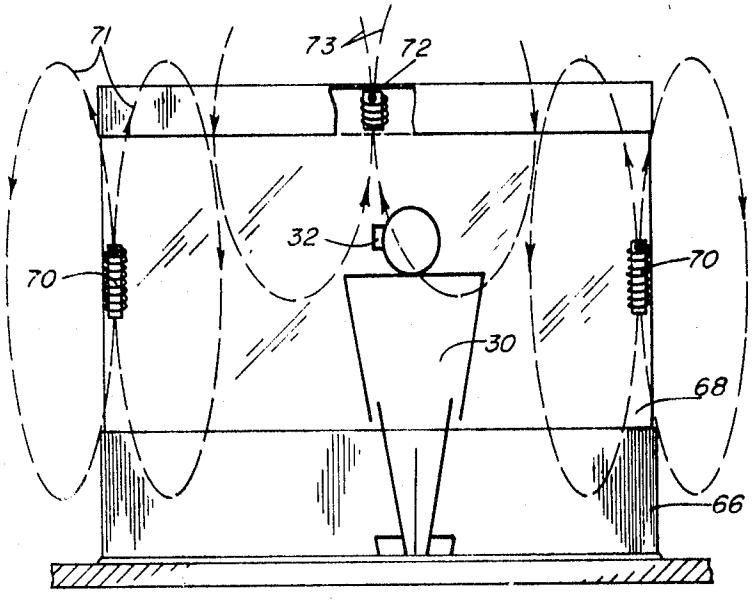

71
73
72
32
70
70
30
68
66

Fig. 6

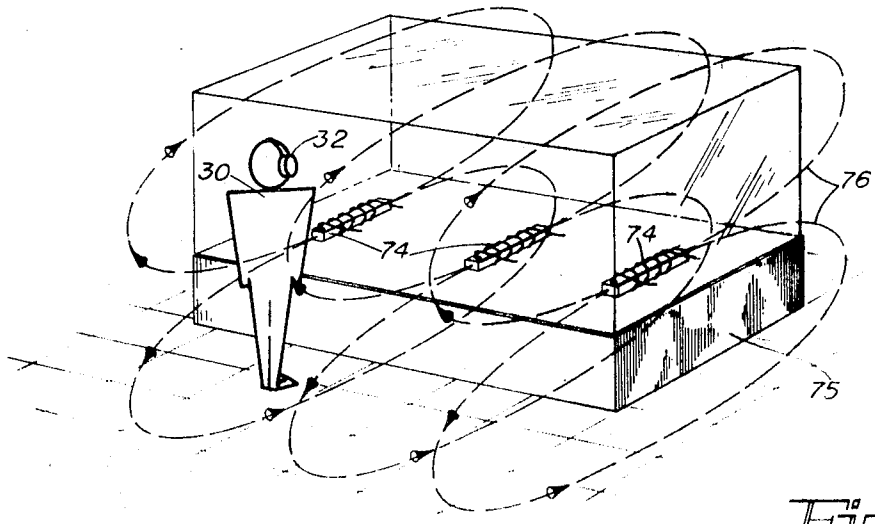


Fig. 7

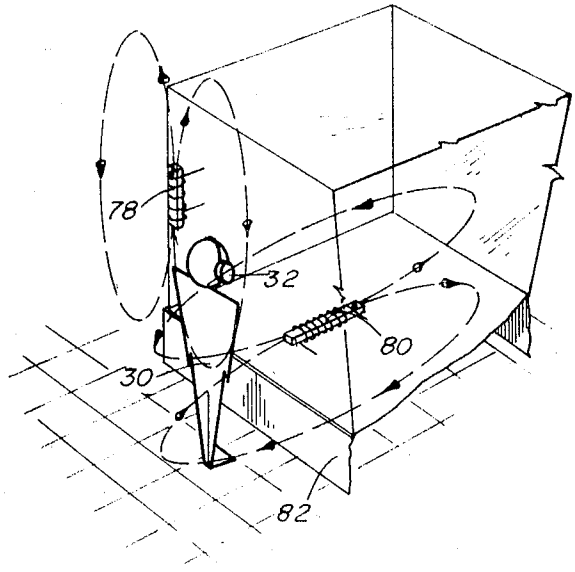


Fig. 8

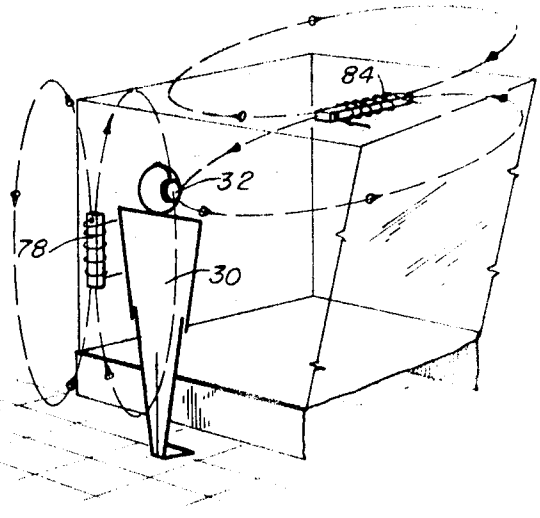


Fig. 9

TRANSMITTING ANTENNA SYSTEM FOR AUDIO INDUCTION COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to audio induction communication systems for use in delivering audible messages to a receiver-equipped viewer or viewers viewing an exhibit in a museum, school auditoriums, class rooms, or the like and wherein the viewers or listeners are free to move from one such exhibit to another at their own pleasure, and deals more particularly with a transmitting antenna system for use in such a communication system for establishing an active message field at a given exhibit or hearing station.

In copending U.S. Pat. application Ser. No. 719,605, filed Apr. 8, 1968 and entitled "Transmitting Antenna for Audio Induction Communication System," is disclosed a transmitting antenna for use with an audio communication system and comprising basically a laminated core of magnetic material wound with a coil of magnet wire. In the use of this antenna the coil is connected to a program source which supplies thereto an audio frequency electrical signal which varies in frequency directly in accordance with the frequency of the message to be transmitted. This energization of the coil sets up a magnetic field passing through the core, and the surrounding space, which similarly varies at a frequency corresponding to the message transmitted. To convert this message field into an audible signal, a viewer or listener is equipped with a receiver which includes a receiving coil preferably wound on a ferrite core or the like. When this coil and core is moved into the message field established by the transmitting antenna, an electrical signal is induced in the receiving coil which is amplified by the receiver and played back through an associated speaker to produce the audible message. Normally, the receiving coil, amplifier and speaker are contained in a small earpiece or other device worn or carried by the viewer so that the receiving coil or antenna is positioned in the area of the viewer's head.

This type of transmitting antenna has various advantages over other types of antennas previously used for audio induction communication systems; however, when a single one of said antennas is used by itself it is often difficult to produce an active message field in and throughout the full extent of a desired pickup or viewing zone without having such field extend substantial distances beyond said zone and cause potential interference with the message fields of other closely associated exhibits or fields. Also, if the desired pickup zone is relatively large it is difficult to obtain, with one antenna, a relatively uniform field throughout said zone with the result that the transmitted message will be reproduced with different intensities depending on the location of the viewer within the zone.

The general object of this invention is therefore to provide an audio induction transmitting antenna system utilizing for each exhibit or transmitted message, a plurality of transmitting antennas similar to that disclosed in the above-identified copending application and arranged so as to produce a relatively uniform active message field within a well defined pickup zone, the size of which may be readily controlled, without the field extending far beyond such zone and interfering with the fields of other transmitted messages.

As used herein, the term "pickup zone," is intended to refer to a three-dimensional zone within which it is desired to be able to pickup and reproduce with acceptable strength, by means of receivers located in such zone, a message transmitted by the associated transmitting antennas, such zone normally including the space occupied by the heads of listeners or viewers viewing the exhibit or the like associated with the transmitted message.

SUMMARY OF THE INVENTION

This invention resides in an antenna system for an audio induction communication system of the type used, for example, in museums, school classrooms and auditoriums for producing an active message field in a three-dimensional pickup zone located in front of a given exhibit or a given listeners area, the zone extending vertically and in both horizontal directions and including the space within which receivers are worn or carried by viewers of the exhibit or listening areas are normally located. The system consists of a plurality of antennas each including an elongated magnetic core and a coil wound on the core. These antennas are spaced from one another along the length of the exhibit and behind the pickup zone so that each produces a magnetic field a portion of which extends forwardly therefrom and passes through the pickup zone and which portion at any given instant has only one general vertical direction. That is, if the field at a given instant and at one point within said zone has a downwardly directed vertical component it also has a downwardly directed vertical component at all other points within said zone, and, at no point, within said zone has any upwardly directed component. The various antennas are additionally so connected to the signal source in such a polar relationship that when excited by the signal source the fields produced by the various antennas within the pickup zone are in generally aiding relation to each other in the vertical direction. That is, if one of the antennas at a given instant and at any point within the pickup zone has a downwardly directed vertical component, the fields of the other antenna or antennas likewise at the same instant has or have a downwardly directed vertical component at all points within said pickup zone so that where the fields of the individual antennas overlap the vertical components aid one another.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a museum exhibit case and an associated set of transmitting antennas for producing an active pickup field in a zone located in front of said exhibit case.

FIG. 2 is a view showing the construction of a transmitting antenna of the type used in FIG. 1.

FIG. 3 is a vertical view showing somewhat schematically the nature of the field produced by the transmitting antennas of FIG. 1.

FIG. 4 is a vertical view showing an arrangement of transmitting antennas comprising another embodiment of this invention.

FIG. 5 is a vertical view showing another arrangement of transmitting antennas comprising another embodiment of this invention.

FIG. 6 is a vertical view showing another arrangement of transmitting antennas comprising still another embodiment of this invention. FIG. 7 is a perspective view showing another arrangement of transmitting antennas comprising still another embodiment of this invention.

FIG. 8 is a fragmentary perspective view showing another arrangement of transmitting antennas comprising still another embodiment of this invention.

FIG. 9 is a perspective view showing another arrangement of transmitting antennas comprising still another embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning first to FIG. 1, this figure illustrates at **10** an exhibit case used to contain a museum display, diorama, or the like intended to be viewed by viewers standing in front of an associated guard rail **12** located in front of the exhibit case. In order to hear a prerecorded message or lecture concerning the material in the case **10**, the viewers are supplied with audio induction receivers each including a receiving coil or antenna adapted to be excited by an audio frequency magnetic field (referred to herein as a message field), an amplifier and a

speaker. These receivers may be made of a relatively small size and customarily are provided in the form of an earpiece or device worn or carried by the viewer with the speaker positioned directly adjacent the viewer's ear so that the message reproduced by the receiver is only heard by the user thereof.

For the purpose of producing an active message field in front of the exhibit case **10** which may be picked up by the receivers of viewers standing in front of the guard rail **12**, a plurality of transmitting antennas **14, 14** are provided and are located in the posts **13, 13** of the guard rail so as to be hidden from view, the posts **13, 13** being of wood, plastic or other nonmagnetic material. These transmitting antennas **14, 14** are each of the general type shown in the aforementioned copending patent application to which reference may be had for further details of its construction. For the present, however, and as shown in FIG. **2** which illustrates the basic components of one such antenna, it is sufficient to note that each antenna **14** includes a core **16** of laminated magnetic material, the core being generally elongated and of a square or rectangular cross section. Surrounding the core **16** is a coil **18** consisting of a large number of turns of magnet wire. In use, the coil **18** is connected to a signal source **20** which supplies to the coil an electrical signal the frequency of which varies in direct relation to the frequency of the message to be transmitted. The signal current flowing through the coil accordingly produces a three-dimensional magnetic field, as indicated by the flux lines **22, 22** which passes through the length of the core **16** and from one end of the core to the other through the surrounding space. The signal source **20** may take various different forms but in one conventional form consists of a tape recorder for playing an endless tape having a message recorded thereon, the message therefore being continually repeated as the recorder is operated, and a suitable amplifier and power transformer for amplifying the signal produced from the recorder pickup and for converting it to a proper level of output power.

The various transmitting antennas **14, 14** of FIG. **1** operate in combination with one another to produce, as mentioned, an active message field in a pickup zone located in front of the guard rail **12** and which zone extends along the length of the rail, for some distance away from the rail, and between two vertical limits which include the level of receivers as normally worn or carried by viewers standing in front of the rail. In this connection, it should be noted that the receivers used with this system, and for all other systems illustrated hereinafter, are ones including receiving coils or antennas arranged so as to be responsive to variations in magnetic flux occurring in a generally vertical direction.

As shown more clearly in FIG. **3** which is a vertical view of the system of FIG. **1**, the antennas **14, 14** are spaced from one another along the length of the exhibit case **10** and are all arranged with the axes of their cores oriented generally vertically. The cores are also located at approximately the same vertical level relative to the exhibit case. The various windings **18, 18** of these antennas are in turn connected to the associated program source **24** by the lines **26, 26** in such a manner chat within the pickup zone the vertical components of all the individual fields produced by the antennas **14, 14** are at any given instant directed in the same direction, that is, either downwardly or upwardly. This is accomplished by connecting the lines **26, 26** to the various coils **18, 18** in such a manner that at any given instant all of the upper ends of the cores **16, 16** are of one polarity and the lower ends of another polarity. In FIG. **3**, and other figures herein, the dots applied to one end of the cores are used to indicate magnetic poles of the same polarity. Likewise, the arrows applied to the various flux lines **28, 28** in FIG. **3** and in other figures hereinafter, are used to indicate the direction of the flux at a given instant.

In considering FIG. **3** therefore, it will be understood that within the desired pickup zone, the fields produced by the various transmitting antennas all have a very substantial vertical component and, at any given instant of time, the vertical components of all such fields are in the same direction throughout the zone and are in aiding relation to one another so as to not anywhere within the pickup zone interfere with one another so as to cause dead areas at which no or only a very weak signal is picked up by the receiver of a person standing at such area. In FIG. **3** and other figures hereinafter discussed a viewer standing within the pickup zone is shown at **30** and his receiver at **32**.

The arrangement of the transmitting antennas **14, 14** as shown in FIG. **3**, not only enables the production of a generally uniform message field within the desired pickup zone but also allows the shape of the zone to be readily controlled so that the message field does not extend far beyond such zone so as to be likely to interfere with the fields of transmitting antennas associated with other close by exhibits. For example, the length of the pickup zone may be readily controlled by increasing or decreasing the number of transmitting antennas. The depth of the field, that is the distance it extends horizontally away from the exhibit case in the direction generally perpendicular thereto, may be controlled by varying the power of the signal supplied to each transmitter as well as by controlling the number of windings of the coil on each core and/or the length to cross-sectional area ratio of each core. That is, as the power of the signal from the signal source is increased or as the number of coil windings is increased, the size of the field tends to increase without much change in general shape; and as the length to cross-sectional area ratio is increased, the shape of the field as viewed on a plane passing through the axis of the core, as in FIG. **3**, tends to take a less rounded and more elongated shape. In FIG. **3**, the floor of the room is indicated at **34** and the ceiling at **36** and normally the transmitting antennas are so designed and excited that the fields produced thereby do not, with any strength, pass appreciably below the floor **34** or the ceiling **36** particularly when other exhibits having their own message fields which might possibly be interfered with are located in other rooms either below the floor **34** or above the ceiling **36**.

In the system of FIGS. **1** and **3**, the illustrated transmitting antennas **14, 14** are positioned at a somewhat intermediate level between the floor **34** and the ceiling **36**. This is made possible because of the presence of the guard rail **12** which allows the antennas to be placed in the posts **13, 13**. When such guard rail is not present the antennas may be otherwise located. FIG. **4**, for example, show three transmitting antennas **38, 38** positioned above the general level of the exhibit which is, in the illustrated case, located behind a window indicated at **42**. In this case, the antennas **38, 38** are located in the front of the exhibit behind a wall **44** located above the window **42**, and they produce fields as indicated generally by the flux lines **46, 46**. These fields are relatively long in the vertical direction and extend downwardly from the transmitting antennas and produce a message field within the desired pickup zone. Of course, parts of the fields produced by these antennas **38, 38** also extend upwardly beyond the ceiling **40** and, therefore, this arrangement may cause interference with the message fields of other exhibits located on the floor above the ceiling **40**. If this is the case, this arrangement should be avoided.

FIG. **5** shows an arrangement of transmitting antennas which may be used when the problem mentioned in the preceding paragraph is present. In this figure, a window **48** is shown behind which an exhibit may be located. A first set of transmitting antennas **50, 50** is located below the window **48** near the front of the exhibit and behind the associated wall **52**, and another set of transmitting antennas **54, 54** is located above the window **48** and also behind the wall **52**. The lower antennas **50, 50** are located in a common vertical plane at a common level and the antennas **54, 54** are located in substantially the same vertical plane and also at a common level with each upper antenna **54** generally vertically aligned with a corresponding one of the lower antennas **50, 50**. The fields produced by the antennas **50, 50** are indicated by the flux lines **56, 56** and the fields produced by the antennas **54, 54** are indicated by the flux lines **58, 58**. The floor of the room containing the exhibit is indicated at **60** and the ceiling at **62**. Above the ceiling **62** is another exhibit contained within a case **64**

which also has other transmitting antennas associated therewith for transmitting a different message field. It will be noted that the fields produced by the upper antennas **54, 54** do not extend appreciably beyond the ceiling **62, 62** and, therefore, do not interfere with the field produced by the antennas associated with the case **64**. These fields do, however, extend below the antennas **54, 54** and within the pickup zone aid the fields of the associated antennas **50, 50**, that is, within the pickup zone the message field is established by the bottom portion of the fields of the upper antennas **54, 54** and by the upper portion of the fields of the lower antennas **50, 50**, and to achieve the aiding relationship of these fields the antennas **50, 50** and **54 54** are connected to the signal source so that all of the bottom ends of the associated cores are of the same polarity at any given time as shown by the dots on the cores. The important point, in FIG. **5**, is to note that by using the two sets of antennas, the vertical length of the fields of both sets may be made substantially shorter than, for example, the fields of the antennas of FIG. **3** or of FIG. **4** so that there is less tendency for the field of the upper antennas **54, 54** to interfere with the fields of other antennas in the room above the ceiling and, likewise, less possibility of the fields of the lower antennas **50, 50** interfering with other antennas located in a room below the floor **60**.

In arranging the transmitting antennas for a particular exhibit, it is, of course, desirable that they as much as possible be hidden from the sight of persons viewing the exhibit. Where the exhibit is located behind a wall, as in FIGS. **4** and **5**, this is easily accomplished, by placing the antennas behind the walls, however, in the case of a standing exhibit case without any guard rail, as in FIG. **1**, the hiding of the antennas may pose some problems, and FIG. **6** illustrates one arrangement of transmitters for overcoming this problem. As shown in FIG. **6**, such an exhibit case is indicated at **66** and has three or four glass sides, the front one of which is indicated at **68**. Such cases normally have corner posts, not shown in FIG. **6**, located at the opposite ends of the front window, and in order to hide the transmitting antennas one such antenna **70** may be located at or behind each such corner post as shown in FIG. **6**. If the exhibit case is of a relatively short length these two corner-transmitting antennas **70, 70** may be sufficient in themselves to produce an adequate signal throughout the full extent of the desired pickup zone. However, in many instances these corner transmitters will not be sufficient to produce an adequate field throughout the entire pickup zone and therefore in order to accomplish this one or more additional transmitting antennas, such as shown at **72**, may be placed in the top of the exhibit case.

The arrangement shown in FIG. **6** also has the advantage that the two corner transmitting antennas **70, 70** may be designed so as to produce a relatively vertically elongated shape of field, thereby sharply defining the end limits of the active message field associated with the exhibit case so that as a viewer moves toward the case from the right or left-hand end thereof, he very quickly moves from a point at which no message is received to a point at which the message is received with satisfactory intensity, this also allowing two exhibit cases to be located relatively close to one another without the danger of the message fields of their associated transmitting antennas overlapping and interfering with one another. As shown in FIG. **6**, the antenna **72** positioned between the two corner antennas **70, 70** is designed so as to have a more circular or rounded field, as shown by the flux lines **73, 73**, which field does not necessarily have the same sharp intensity gradient as the field of the corner antennas **70, 70**, but which adequately fills in the space between the fields of the two corner antennas. The two corner antennas **70, 70** have a length to cross-sectional area ratio substantially greater than the length to cross-sectional area ratio of the antenna **72** so that the fields of the corner antennas **70, 70** are of the generally elongated shape shown by the flux lines **71, 71** whereas the field of the antenna **72** is of the more rounded shape shown.

In all of the preceding arrangements of transmitting antennas, the various antennas of the system have been all arranged with the axes of their cores oriented generally vertically. This, however, is not necessary and if desired one or more of the antennas may have their axes arranged in a different plane. For example, FIG. **7** shows a system wherein three transmitting antennas **74, 74** have their cores located in a common horizontal plane. Referring to this figure, the exhibit with which the antennas **74, 74** are used is contained within an exhibit case indicated at **75**. The antennas **74, 74** are located in a vertical plane which is located near the bottom of the exhibit case and at a level below the desired pickup zone, that is, at a level not normally located. The fields produced by the antennas **74, 74** are indicated by the flux lines **76, 76**, and from them it will be noted that above the level of the antennas, and in front of the case, the individual fields have vertical components which extend in one direction, and below such level the fields have vertical components which extend in the opposite direction. Therefore, as a receiver is moved from a level above the antennas to a level below the antennas, it will pass through a dead zone located at approximately the level of the antennas at which little or no signal will be picked up. It is for this reason that it is desirable that the antennas **74, 74** be located below the pickup zone, as indicated in FIG. **7**, or above such pickup zone, thereby, assuring that within the pickup zone the vertical component of each individual field is at all points in the same direction.

FIGS. **8** and **9** show two arrangements each including one transmitting antenna **78** with its core axis arranged vertically and another transmitting antenna **80** with its core axis arranged generally horizontally. The two antennas **78** and **80** are spaced from one another along the length of the exhibit which is contained within a case **82**, and the axis of the core of the antenna **80** is located at a level below the pickup zone and generally perpendicular to the front of the exhibit. Therefore, within the pickup zone the upper portion of the field of the antenna **80** combines with the front portion of the field of the antenna **78** to produce the desired message field, and in order to achieve an aiding relationship of these two fields, the coils of the two antennas are so connected to the common signal source that the upper end of the core of the antenna **78** and the rear end of the core of the antenna **80** are of the same polarity as indicated by the dots in FIG. **8**.

FIG. **9** is generally similar to FIG. **8** except that the horizontal antenna indicated at **84** is located with the axis of its core above the pickup zone. In this case, therefore, the lower portion of the field of the antenna **84** aids or combines with the front portion of the field of the antenna **78** to produce the desired message field. In order to achieve an aiding relationship of these two fields in the pickup zone, the coil of the antenna **78** and the coil of the antenna **84** are connected to the common signal source so that the top end of the core of the antenna **78** and the front end of the core of the antenna **84** are of the same polarity as indicated by the dots in FIG. **9**.

I claim:

1. An antenna system for use with an audio induction communication system having a signal source for delivering an electrical signal which varies in frequency directly with the frequency of the message to be transmitted and for producing an active message field in a three dimensional pickup zone located in front of an exhibit and which zone extends horizontally along said exhibit, a substantial distance perpendicularly away from said said exhibit and vertically between two limits sufficient to include the levels of receivers as normally worn or carried by persons viewing said exhibit, said antenna system comprising a plurality of antennas each consisting of an elongated magnetic core and a winding on said core, said antennas being spaced from one another along the length of said exhibit and behind said zone so that each produces a magnetic field a portion of which extends forwardly therefrom and passes through said zone and which portion at any given instant has only one generally vertical direction, and means connecting said antennas to said signal source with such a polar relation-

ship to one another that within said zone said fields are in generally aiding relation to each other.

2. An antenna system as defined in claim 1 further characterized by all of said antennas being located at the same vertical level relative to said exhibit.

3. An antenna system as defined in claim 2 further characterized by all of said antennas being arranged with the axes of their elongated magnetic cores being arranged vertically.

4. An antenna system as defined in claim 2 further characterized by all of said antennas being arranged with the axes of their elongated magnetic cores extending generally horizontally.

5. An antenna system as defined in claim 1 further characterized by said antennas comprising two separate groups, the antennas comprising one of said groups being located at one level relative to said exhibit and with the antennas comprising the other of said group being located at a level spaced a substantial distance below said one level.

6. An antenna system as defined in claim 5 further characterized by all of said antennas having the axes of their elongated magnetic cores arranged vertically and with each of the cores of the antennas of said first group being substantially vertically aligned with a corresponding one of the cores of the antennas of said second group.

7. An antenna system as defined in claim 6 further characterized by all of said antennas being located in a common vertical plane.

8. An antenna system as defined in claim 5 further characterized by all of said antennas having the axes of their magnetic cores arranged vertically, the antennas of said first group all having substantially similar cores and the antennas of said second group all having substantially similar cores, the cores of said first group of antennas having a length to cross-sectional area ratio substantially different from the length to cross-sectional area ratio of the antennas of said second group.

9. An antenna system as defined in claim 1 further characterized by all of said antennas being arranged with the axes of their elongated magnetic cores extending vertically, two of said antennas being located respectively near the two front corners of said exhibit at a given vertical level and with a third one of said antennas being located between said first two antennas at a different level.

10. An antenna system as defined in claim 9 further characterized by said third antenna being located at a level above the level of said first two antennas.

11. An antenna system as defined in claim 9 further characterized by said first two antennas having substantially similar cores, and the core of said third antenna having a length to cross-sectional area ratio of said first two antennas.

12. An antenna system as defined in claim 1 further characterized by said antennas including one antenna having its core arranged generally vertically and another antenna having its core arranged generally horizontally.

13. An antenna system as defined in claim 12 further characterized by said antenna with a generally horizontal core being located at a level near the lower one of said two vertical limits of said pickup zone.

14. An antenna system as defined in claim 13 further characterized by said antenna with a generally horizontal core being located at a level near the upper one of said two vertical limits of said pickup zone.

15. An antenna system as defined in claim 13 further characterized by said antenna with a generally horizontal core being located behind said antenna with a generally vertical core.

16. An antenna system as defined in claim 15 further characterized by said antenna with a generally horizontal core being located behind said antenna with a generally vertical core.

PO-1050
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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,598,923 Dated August 10, 1971

Inventor(s) Justin L. Turner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 3, line 57, "chat" should read --that--.
Col. 4, line 43, "show" should read --shows--.
Col. 6, line 65, delete "said" (second occurrence).
Col. 8, line 14, following "ratio" insert --substantially less than the length to cross-sectional area ratio--.

Signed and sealed this 14th day of March 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents