United States Patent

[11] 3,619,434

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[54] **METHOD OF ADJUSTING THE AIRGAP OF AND FINALLY ASSEMBLING ELECTRICAL TRANSDUCERS OF THE CENTRAL ARMATURE RECEIVER TYPE**
11 Claims, 20 Drawing Figs.

[52] U.S. Cl. **264/40,** 29/593, 29/594, 264/261
[51] Int. Cl. **B32b 31/06,** H04r 29/00, H04r 31/00
[50] Field of Search 264/40, 261, 265, 272, 277, 279; 179/114, 117; 29/594,593

[56] **References Cited**
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ABSTRACT: The airgap adjustment and final assembly of electrical transducers of the central armature type, such as those employed as receivers in telephone sets, is accomplished by adapting the receiver frame to engage frictionally and temporarily support the magnet pole piece assembly during the adjustment of the airgap. Both an AC signal and a selectively variable DC bias, simultaneously applied to the coils of the receiver, are employed in determining the proper airgap spacing which results in the receiver producing an optimum value of acoustic output falling within predetermined minimum limits. After adjusting the airgap, a solidifiable liquid cement or a suitable potting compound is employed to secure the magnet pole piece assembly permanently and rigidly to the frame of the receiver.

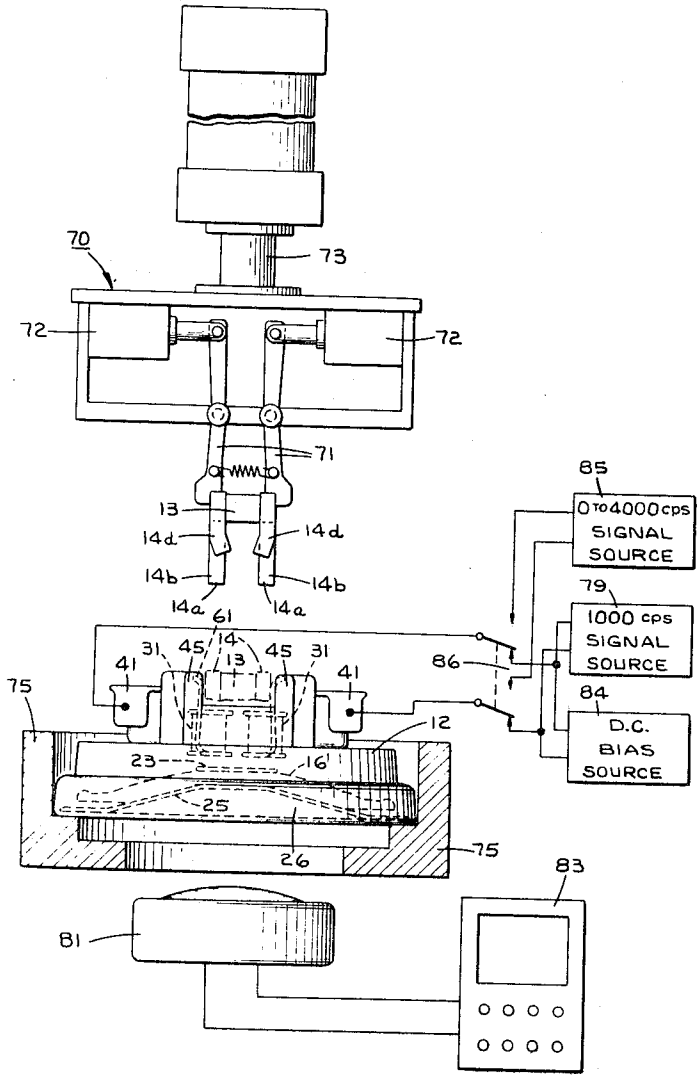


FIG. 1

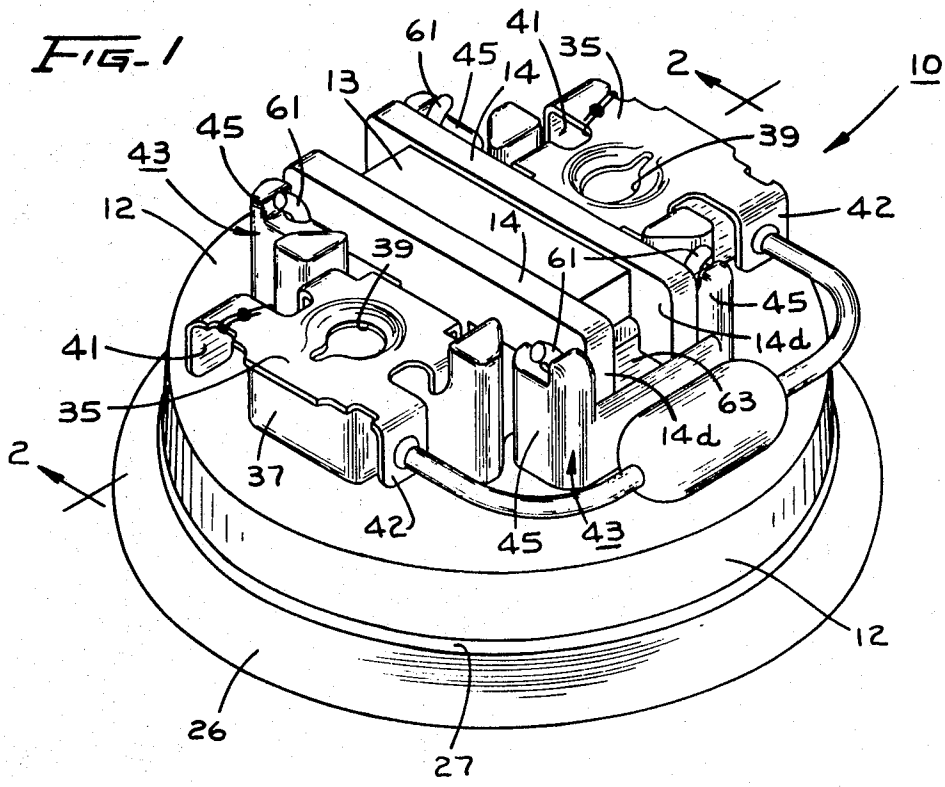
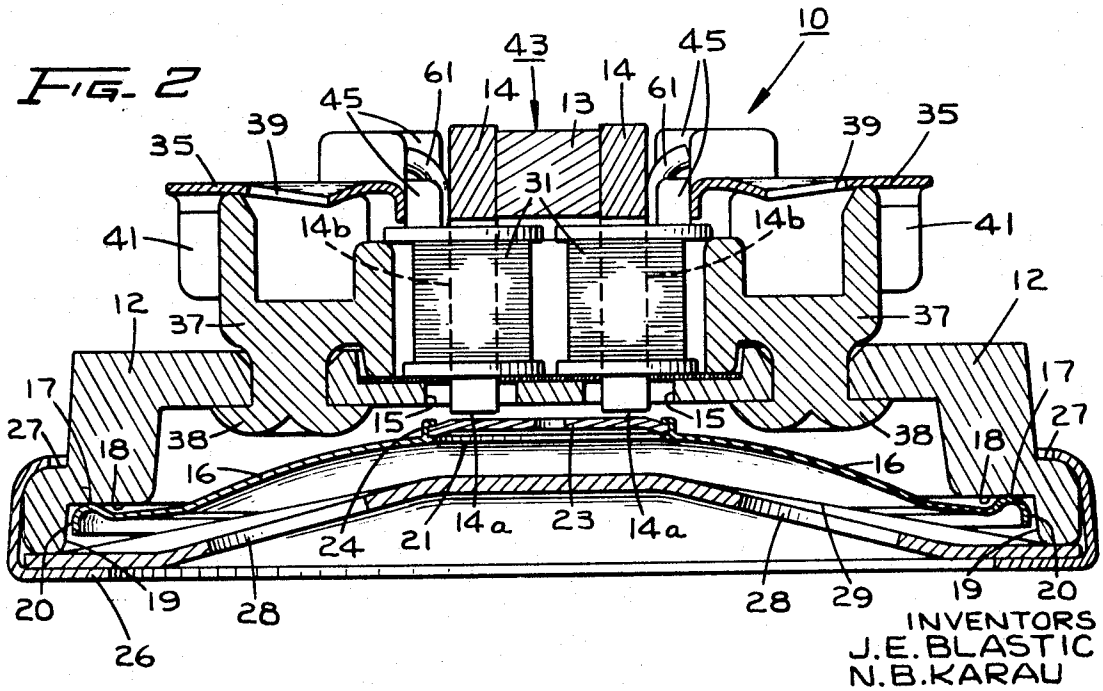


FIG. 2



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FIG. 4

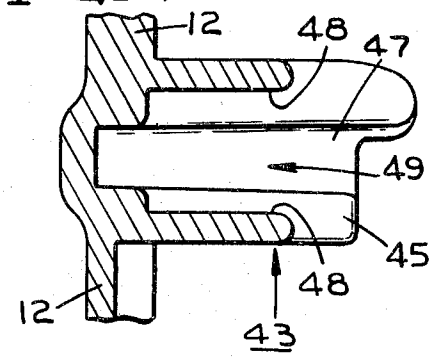


FIG. 3

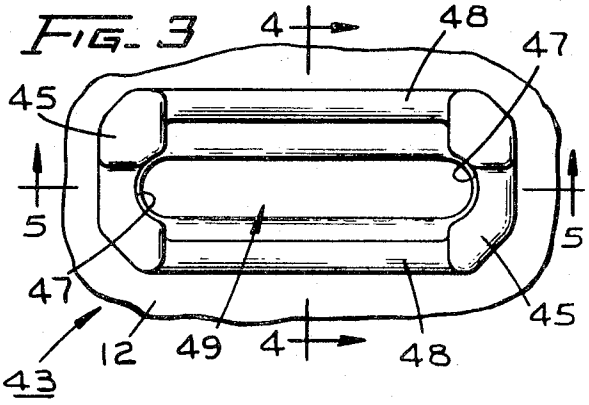


FIG. 5

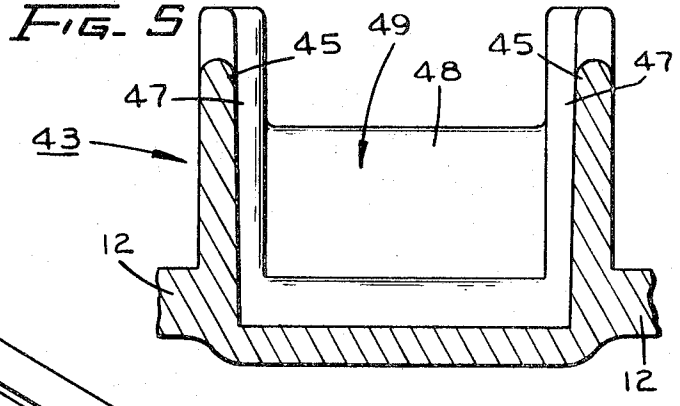


FIG. 6

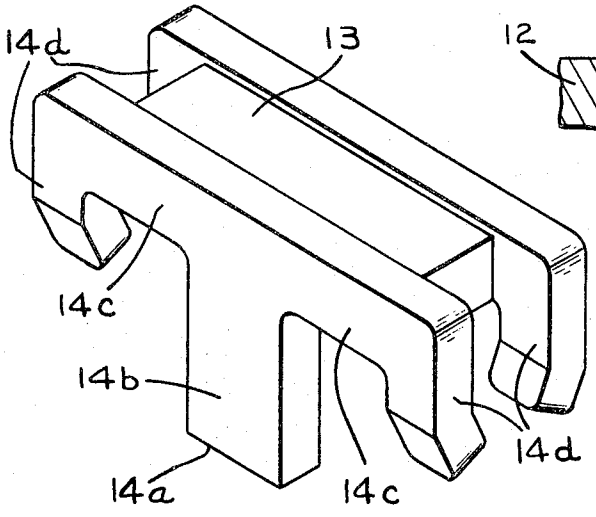


FIG. 7

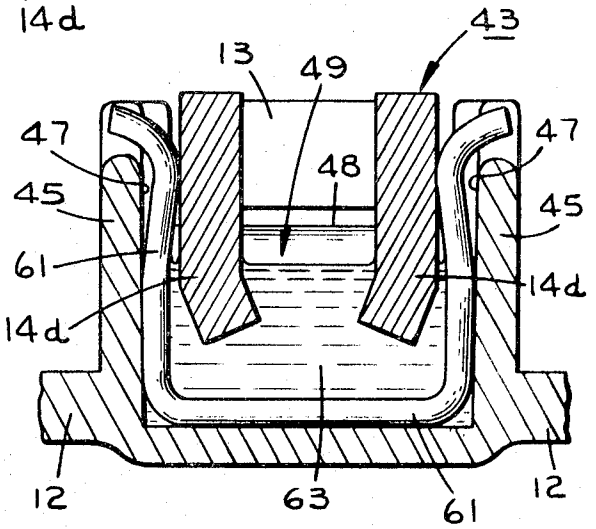
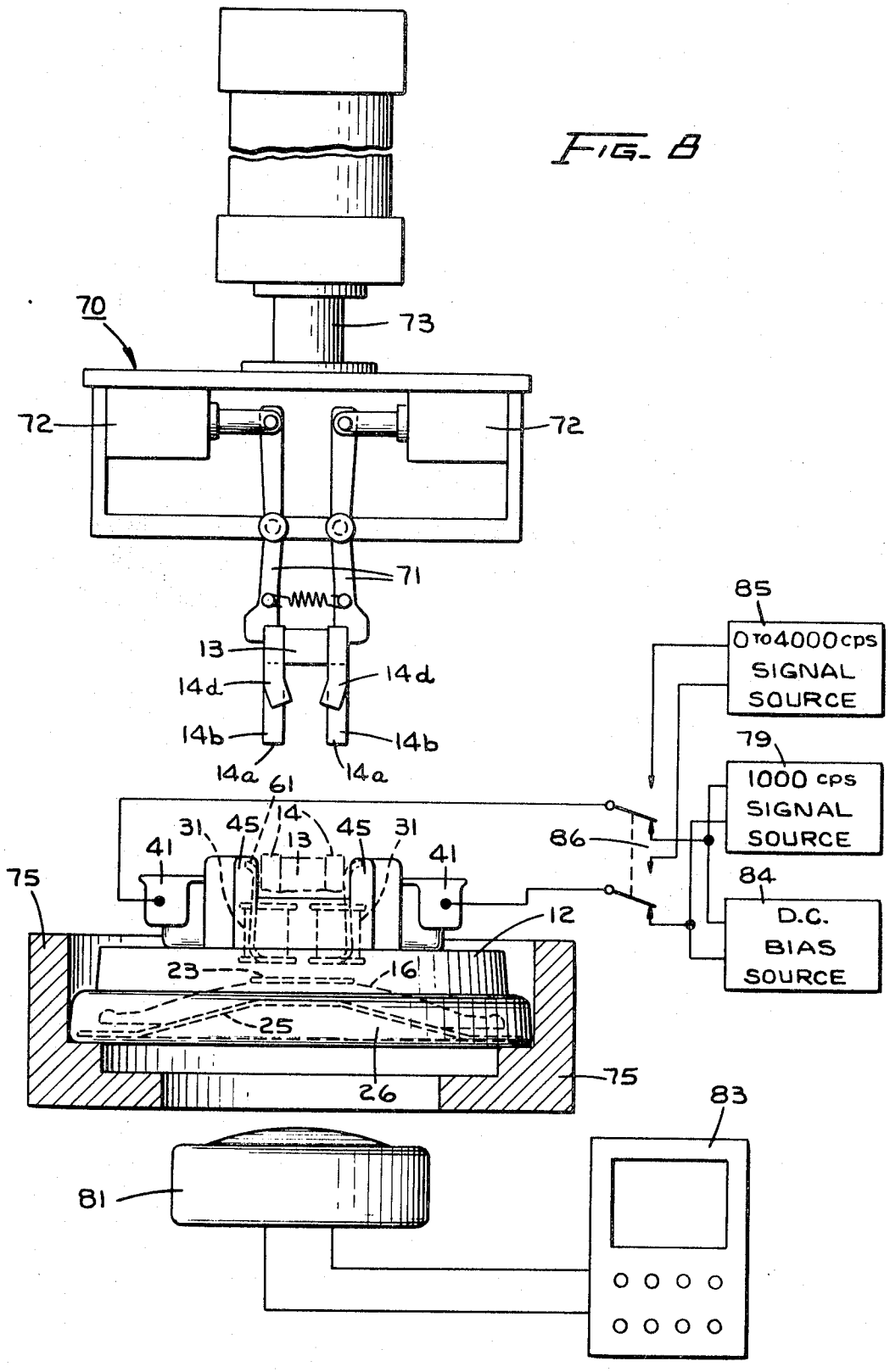


FIG. 8


70
73
72
72
71
13
14d
14d
14b
14b
14a
14a
61
14
31
45
13
45
31
41
41
75
12
23
16
25
26
75
81
83
85
0 TO 4000 cps
SIGNAL
SOURCE
79
1000 cps
SIGNAL
SOURCE
84
D.C.
BIAS
SOURCE
86

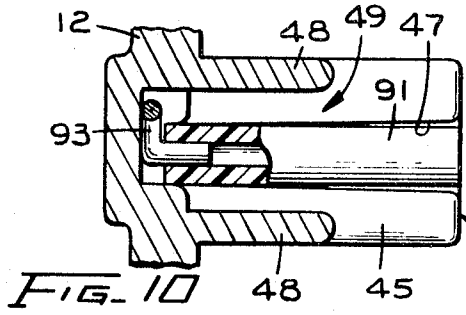


FIG. 10

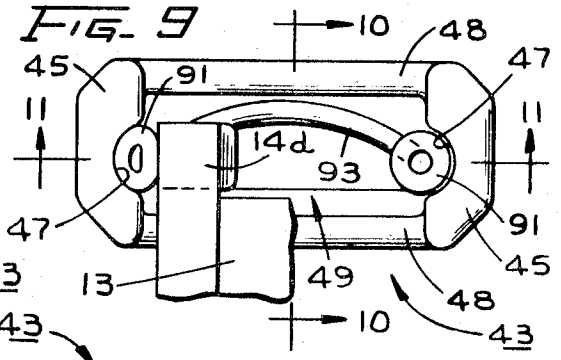


FIG. 9

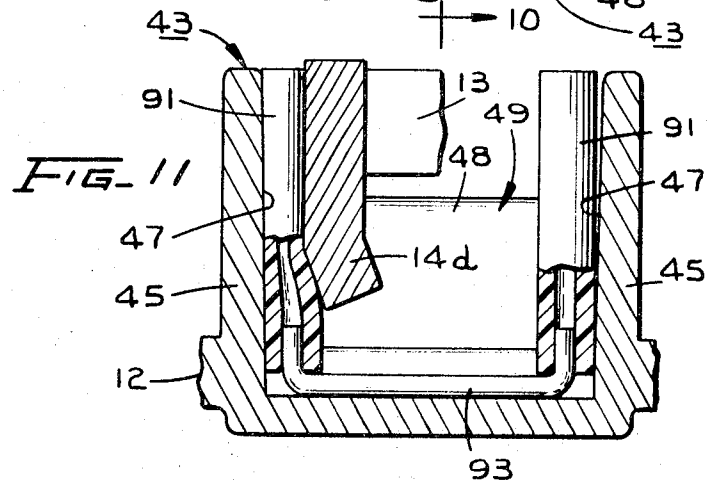


FIG. 11

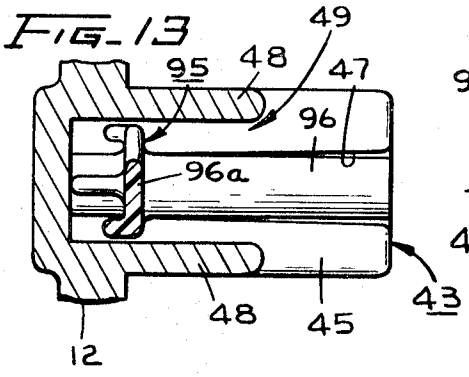


FIG. 13

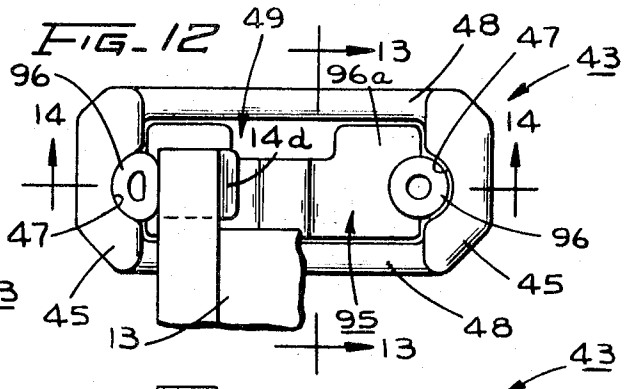


FIG. 12

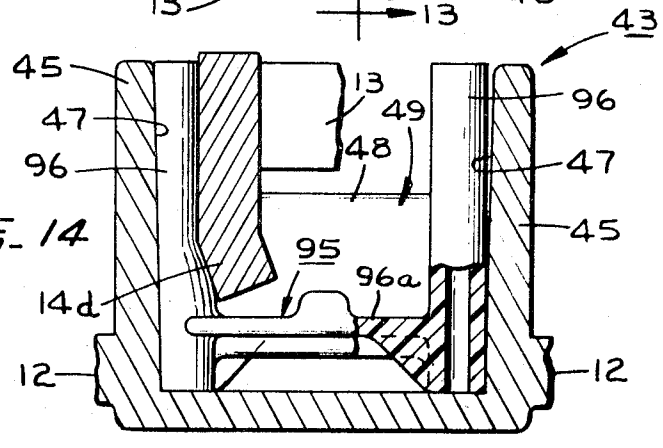


FIG. 14

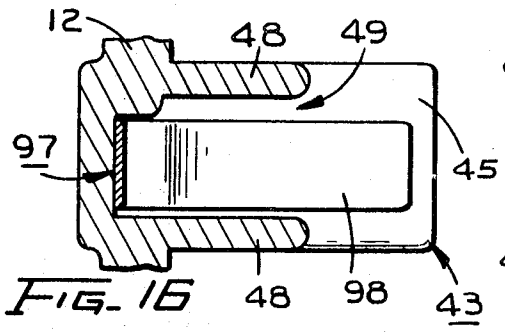


FIG. 16

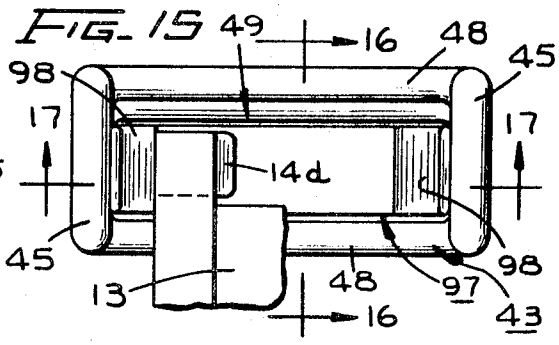


FIG. 15

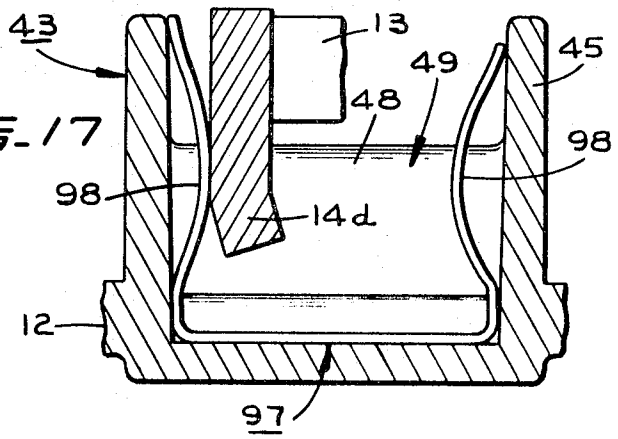


FIG. 17

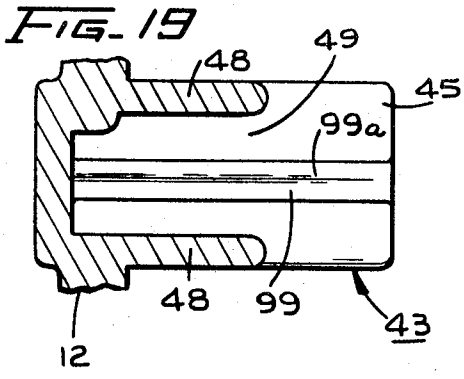


FIG. 19

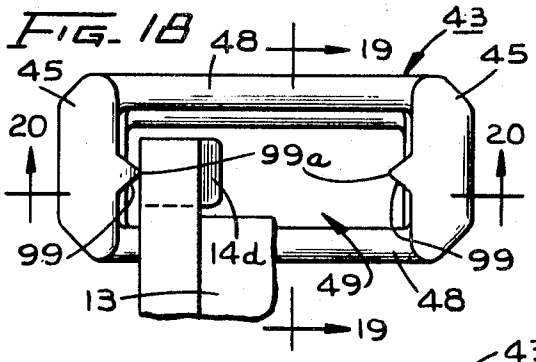


FIG. 18

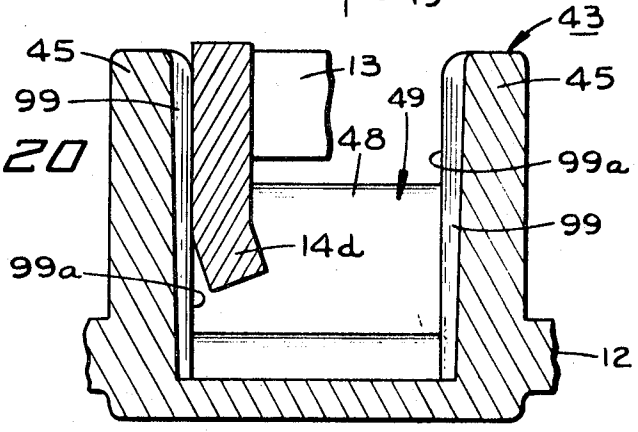


FIG. 20

METHOD OF ADJUSTING THE AIRGAP OF AND FINALLY ASSEMBLING ELECTRICAL TRANSDUCERS OF THE CENTRAL ARMATURE RECEIVER TYPE

The present application is a division of copending application Ser. No. 737,164, filed June 14, 1968, now Pat. No. 3,542,974 Nov. 24, 1970.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is concerned with electrical transducers and, more particularly, with central armature type receiver units, hereinafter generally referred to simply as receivers, and with methods of adjusting the airgap and finally assembling such receivers. These receivers are often employed in performance demanding applications, such as in telephones, for which use considerable care is necessarily required in their manufacture. Particularly is this true with respect to establishing the proper airgap spacing for each receiver, as this parameter has a direct and significant bearing on the level of acoustic output, as well as on the degree of stability attained.

2. Description of the Prior Art

Central armature type receivers used in telephones heretofore have normally comprised a generally cylindrical die cast frame, with a magnet-pole piece assembly secured by weldments to the rearward side of the frame, and a diaphragm-armature assembly supported in substantially free space relationship with respect to the central portion of the frame on the forward side thereof. Induction coils associated with the magnet-pole piece assembly are employed to impart magnetomotive forces to the diaphragm-armature assembly, these forces fluctuating in accordance with the variations in magnitude of the electrical signals applied to the coils. It is the resultant magnetic force-induced movement of the diaphragm-armature assembly, of course, that produces the acoustic output of the receiver.

In order to improve the uniformity and optimize the acoustic output characteristics of the above-described type of central armature receiver, a number of "static" airgap adjusting techniques have been employed heretofore with varying degrees of less than satisfactory success. By "static" is meant an adjusting technique involving only physical displacement of the magnet-pole piece assembly relative to the diaphragm-armature assembly, wherein such movement simultaneously accompanied by acoustic displacement of the diaphragm-armature assembly through signal energization of the coils, will be referred to hereinafter as a "dynamic" airgap adjusting technique.

In all of the prior known airgap adjusting methods, various types of precisely controlled physical displacement of the diaphragm-armature assembly, either by the use of fixed forces, fixed displacements or a combination thereof, have been required, all with the intent of compensating for the troublesome physical variations selectively exhibited by the diaphragms. That such "static" airgap adjusting techniques would not always produce optimum airgap spacings for every receiver is perhaps best understood by initially examining the various characteristics of the diaphragms which lead to variations in the resultant airgap spacings whenever the diaphragm-armature assemblies are subjected to the same type of "static" imparted deflections. The diaphragm characteristics in question pertain to 1 variations in stiffness, 2 nonlinear force deflection characteristics, 3 variations in height, and 4 variations in diaphragm shrinkage resulting from the welding of the magnet-pole piece assembly to the frame during fabrication, such shrinkage causing undesirable variations in or growth of the airgap between the armature and the pole pieces.

With respect to these characteristics, the one relating to inherent stiffness variations encountered in the diaphragms, as manufactured, has proven to be the most difficult to cope with in the assembly of performance demanding central armature type receivers. What compounds this problem is that variations in diaphragm stiffness either directly or indirectly result in: 1 magnetic force variations, 2 force-deflection responses which are not uniform and linear, and 3 nonuniform acoustic power output due to nonuniform airgaps.

In addition, the prior "static" techniques require precision weights and/or threaded members to accurately effect the necessary relative movement between the diaphragm-armature and the magnet-pole piece assemblies so as to establish an air gap spacing falling within the requisite limits. Concomitantly, rather complex and expensive fixturing has also been required heretofore to restrain movement of the diaphragm-armature assembly after having been displaced by the intended amount, as well as during the subsequent movement of the pole tips against the armature, and during the welding of the pole pieces to the frame of the receiver thereafter.

Accordingly, the aforementioned "static" adjusting methods obviously could not be expected to product an airgap for every receiver which would optimize the acoustic output thereof.

In addition, the actual acoustical output efficiencies exhibited by a given receiver heretofore could never be ascertained until the receiver was completely fabricated. As a result, if the acoustic output or stability of the receiver did not satisfy the stringent requirements demanded for a given application, the receiver either had to be discarded or a costly disassembly of the magnet-pole piece assembly from the frame, to which it was welded, was required.

SUMMARY OF THE INVENTION

An object of this invention is to provide new and improved methods of adjusting the airgap of and finally assembling central armature receivers in such a manner that both high stability and optimum acoustic output are realized for each receiver on a production line basis.

It is a further object of this invention to obviate the need of imparting predetermined degrees of physical displacement to the diaphragm-armature assembly relative to the frame during the adjustment of the airgap in central armature receivers.

It is an additional object of this invention to sense the attainment of optimum acoustic output in central armature receivers while the airgap is being dynamically adjusted, with permanent securement of the magnet-pole piece assembly to the frame being accomplished thereafter.

It is still another object of this invention to construct a central armature receiver in a manner which facilitates the airgap adjustment and final assembly thereof in terms of being simple, reliable, inexpensive, and in not requiring any weldments to secure the magnet-pole piece assembly to the frame of the receiver.

In accordance with the invention, central armature receivers, as embodied and claimed herein, utilize a die cast circular frame with a pair of integral, mutually disposed receptacles extending perpendicularly from the rearward, planar side of the frame. The receptacles are each adapted to receive a different one of two laterally disposed and downwardly projecting leg portions of the magnet-pole piece assembly. Each receptacle has resilient protuberances associated with at least two oppositely disposed inner walls thereof. These protuberances are positioned to engage frictionally at all times and temporarily hold the magnet-pole piece assembly after it has been positioned the proper distance from the armature so as to achieve optimum acoustic output for the receiver.

In accordance with the methods of the present invention, a transfer device gradually moves the fully magnetized magnet-pole piece assembly inwardly toward the diaphragm-armature assembly until the pole tips of the former assembly contact the armature of the latter assembly. During this movement, both an AC signal and a DC bias are applied to the coils of the receiver. After contact is made between the pole tips and armature, the transfer device is removed. Thereafter, the DC bias is varied from a predetermined positive value to zero and then from zero to a predetermined negative value while the

acoustic output of the receiver is monitored on a suitable measuring instrument, such as an oscilloscope. If the optimum value of acoustic output falls within minimum acoustic output limits portrayed electronically or otherwise on the screen of the oscilloscope, the partially assembled receiver is tentatively considered acceptable. If the monitored acoustic output response of the receiver should indicate that there is slightly more magnetic flux in the airgap than desired, the magnet is partially de-magnetized so as to effect an optimum acoustic output within the aforementioned limits. Thereafter, a variable frequency AC signal is applied to the coils of the finally adjusted receiver to make sure that the optimum acoustic output still falls within the predetermined limits.

Finally, the magnet-pole piece assembly is permanently secured to the receiver frame, through the receptacles, by injecting or otherwise placing either liquid cement or a potting compound into at least some of the interstices formed therebetween, and curing the cement or potting compound, if necessary.

In accordance with one embodiment of the invention, the resilient protuberances associated with each receptacle are formed by a U-shaped wire insert having two resilient, inwardly bowed leg portions, the latter being partially disposed respectively within two semicircular grooves formed in two mutually disposed inner side walls of the associated receptacle.

In accordance with several other embodiments of the invention, the resilient protuberances associated with each receptacle of the receiver are formed by hollow plastic tubing.

In an additional embodiment of the receiver, the resilient protuberances associated with each receptacle are formed by preformed plastic or metal inserts having mutually disposed planar walls which are bowed to provide resiliency.

In still another embodiment of the receiver, the resilient protuberances comprise integral projections formed along two mutually disposed inner walls of each receptacle.

All of the various receiver embodiments disclosed and claimed herein exhibit the following advantages, which are by no means listed in the order of importance nor are they intended to be all inclusive.

First, the subject receiver construction and methods allow the airgap to be dynamically adjusted for optimum acoustic output in accordance with the peculiar electrical and physical characteristics of each assembly, rather than necessitating adjustment of the airgap based on some empirically derived force and/or fixed displacement values intended to produce a nominal airgap spacing for all receivers.

Secondly, the air gap of the receiver may be readily adjusted for optimum acoustic output, with the armature and pole tips of the receiver thereafter remaining in their normally spaced relationship while the magnet-pole piece assembly is secured to the frame by a suitable cement or resin. This technique makes it possible for unusable diaphragms, and/or magnets, and/or coil assemblies to be discarded before final assembly, which obviously saves considerable time and expense.

Thirdly, there is a substantial reduction in the shrinkage and growth encountered in the diaphragm-armature and magnet-pole piece assemblies during fabrication, by reason of obviating the need for welding the latter assembly to the frame of the receiver. As a result, not only is an optimum initially attained, but permanently retained after final assembly of the receiver.

Fourthly, there is no need for complex and precision airgap adjusting fixtures, including accurately threaded plungers, weights, and locking rings to initially position and subsequently rigidly hold each composite receiver during a welding operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view illustrating a typical central armature type of receiver;

FIG. 2 is a cross-sectional view illustrating the receiver, the airgap of which is adjusted and the magnet-pole piece assembly of which is mounted on the receiver frame in accordance with the principles of this invention;

FIG. 3 is a plan view of one of the two receptacles which form an integral part of the receiver frame and which support the magnet-pole piece assembly of the receiver;

FIG. 4 is a cross-sectional view of one receptacle taken along the lines 4—4 of FIG. 3;

FIG. 5 is a cross-sectional view of one receptacle taken along the lines 5—5 of FIG. 4;

FIG. 6 is a perspective view of the pole pieces and magnet of the receiver illustrated in FIGS. 1 and 2;

FIG. 7 is a cross-sectional view depicting the position of a resilient, U-shaped spring wire within one of the receptacles depicted in FIGS. 3–6, and also depicts the typical position of a portion of the pole pieces of the magnet-pole piece assembly within the receptacle, as well as the manner in which the pole pieces are initially secured by frictional contact with the wire and subsequently and permanently secured to the frame by being embedded within a suitable potting cement or resin;

FIG. 8 is a front elevational view depicting in simplified form apparatus of the type cable of carrying out the method steps involved in adjusting the airgap of and finally assembling a central armature receiver in accordance with the principles of the present invention;

FIGS. 9–11 correspond generally to FIGS. 3–5, but further illustrate the use of plastic resilient tubes which are positioned within associated grooves of the receptacles for frictionally holding the magnet-pole piece assembly temporarily at the proper elevation relative to the diaphragm-armature assembly in accordance with another embodiment of the invention;

FIGS. 12–14 correspond generally to FIGS. 3–5, but further illustrate the use of a substantially H-shaped resilient, one-piece molded plastic insert with hollow leg portions for temporarily holding the magnet-pole piece assembly in accordance with another embodiment of the invention;

FIGS. 15–17 also correspond generally to FIGS. 3–5, but further disclose the use of pre-formed, U-shaped metal insert with inwardly bowed planar leg portions for temporarily holding the magnet-pole piece assembly within each receptacle in accordance with still another embodiment of the invention, and

FIGS. 18–20 likewise correspond generally to FIGS. 3–5, but distinguish therefrom in that an integral, triangularly shaped projection is formed along with mutually disposed inner walls of each receptacle to provide resilient protuberances for frictionally holding temporarily the magnet-pole piece assembly in accordance with still another embodiment of the invention.

DETAILED DESCRIPTION

With particular reference now to FIGS. 1 and 2, there is depicted a central armature receiver unit 10, simply referred to as a receiver hereinafter, comprising a generally circular frame member 12, preferably of die cast aluminum, die cast zinc alloy, or molded plastic material, indirectly supporting on its rearward side a magnet 13, such as one designated Alnico VIII, and a pair of pole pieces 14 made, for example, of 45 percent permalloy, mutually disposed on opposite sides of and secured to the magnet. As best seen in FIG. 6, each pole piece is substantially T-shaped and comprises a pole tip 14*a* at the terminating end of a downwardly extending central leg portion 14*b*, two lateral leg portions 14*c* and two downwardly extending leg portions 14*d* having slightly bent terminating ends. The portion 14*b* of each pole piece extends through an aperture 15 (best seen in FIG. 2) in the frame, with the pole tip 14*a* thereof thus projecting outwardly a short distance from the front side of the frame. The manner in which the magnet-pole piece assembly is secured to the frame of the receiver will be described in greater detail hereinbelow.

A circular, inwardly bowed diaphragm 16 is supported in substantially free space relationship relative to the frame by having a slightly raised outer annular portion 17 resting on a

recessed seating surface **18** of the frame **12**. An inner shoulder **19** associated with the seating surface **18** mates with a rim **20** of the diaphragm and insures that the latter properly seats in the frame **12** and remains axially aligned therewith. The diaphragm **16** has a central aperture **21** in which a slightly formed circular armature **23** is retained, the armature being made, for example of 2 percent Vanadium Peremendur. The armature is formed to permit its central flat area to project above the retaining diaphragm material and, as best seen in FIG. **2**, is supported by a die-formed crimping groove **24** in the diaphragm. Supported in this manner, it is thus seen that the armature is suspended in free-space relationship from the interior of the frame and from the pole tips **14***a* of the pole pieces.

As previously pointed out, it is the airgap spacing between the armature **23** and the pole tips **14***a* that is of critical importance in the assembly of central armature receivers if optimum acoustic output and uniform stability are to be realized.

A protective grid **25** is supported about its periphery by an annular clamping member **26**, which is ferruled over an outer annular shoulder **27** of the frame **12** to protect the diaphragm-armature assembly. The grid has a plurality of apertures **28** formed within the intermediate planar surface area thereof so as not to inhibit or adversely affect the acoustic output response of the receiver. A thin membrane **29**, such as of polyethylene, is clamped between the inner side of the protective grid **25** and the frame **12**, to cover the apertures **28** in the grid so as to minimize foreign materials from collecting on the diaphragm. The membrane is dimensioned and arranged so as to minimize distortion of full frequency response of the receiver.

As also best seen in FIg. **2**, two electrical coils **31** respectively surround central, downwardly extending leg portions **14***b* (see FIG. **6**) of the pole pieces. Electrical connections to the coils are brought out to a pair of terminal strips **35** which are isolated from the receiver frame **12** by a molded plastic block **37**. The block **37** is secured to the frame by a pair of protuberances **38** which are integrally formed in the block. The protuberances are initially inserted through aligned apertures in the frame, with the projecting ends of the protuberances thereafter being flared outwardly so as to wedge against the outer adjacent surfaces of the frame.

As depicted in FIG. **1**, the upper planar surface of each terminal strip includes a die-formed single thread terminal **39** which facilitates making a screw-threaded connection with external circuitry. Additional terminals **41**, **42** are also formed in the terminal strip for connecting the associated coil leads to the terminal strip, and for connecting a click reducing device (not shown) in parallel with the coil leads. It should be understood, of course, that the type of terminals associated with the terminal strip may take any one of a number of different forms, and may comprise separate terminals which are only supported on the terminal strip. Accordingly, the specific terminals described herein are intended to be illustrative only.

As thus far described, the receiver basically resembles prior versions thereof. The additional structure to be described now, however, with specific reference first to FIGS. **1** and **3–5**, departs considerably from the prior versions, as do the methods of airgap adjusting and final assembly involved therewith.

As best seen in FIG. **1**, the opposite, laterally disposed pairs of pole piece leg portions **14***d* are respectively confined within a different one of a pair of mutually disposed and substantially U-shaped receptacles designated generally by the reference numeral **43**. These receptacles, in accordance with the principles of this invention, are formed as an integral part of the receiver frame **12**, and extend perpendicularly outward from the rearward side thereof. As the two mutually disposed receptacles **43** are of identical construction, reference will generally be made hereafter to only one of them in connection with each of the various embodiments thereof to be disclosed and claimed.

As illustrated in FIGS. **3–5**, each receptacle **43** comprises a pair of mutually disposed leg extensions **45**, with semicircular recesses **47** formed in the opposite inner side walls thereof. An intermediate pair of mutually disposed side walls **48** together with leg extensions **45** define a reservoir **49**.

In accordance with one embodiment of the invention, as depicted in FIG. **7**, a substantially U-shaped resilient wire **61** is dimensioned such that the vertically extending and slightly bowed leg sections thereof are respectively positioned within the semicircular grooves **47** of the associated leg extensions **45** of the receptacle. The U-shaped wire may, for example, be made of steel, although other metals and/or alloys may also be used with equal effectiveness.

Regardless of what material the wire insert is made, the purpose thereof, in accordance with the principles of this invention, is to frictionally engage the pole piece leg portions **14***d*, and thereby temporarily support the magnet-pole piece assembly during the airgap adjusting and final assembly of the receiver. The methods involved to this end will be described in greater detail hereinafter. However, attention at this point is directed to the fact that in accordance with the invention, and as disclosed in FIG. **7**, a potting resin or compound **63**, preferably in liquid form initially, is injected or placed in any other suitable manner into at least the base region of the reservoir **49** after the magnet-pole piece assembly has been adjusted to the requisite position within receptacles **43**, which position results in an air gap establishing optimum acoustic output for the receiver. By way of example, any one of a number of commercially available two-part thermosetting resins and hardeners may be employed as a potting medium. Such a potting medium may be cured at either room temperature or at slightly elevated temperatures if a shorter curing time is desired, and when it hardens, the pole piece leg portions **14***d* partially embedded therein results in the entire magent-pole piece assembly being rigidly and permanently secured to the frame of the receiver.

The method of adjusting the airgap and finally assembling a central armature receiver of the type depicted in FIGS. **1–7** will now be described in detail.

As illustrated in FIG. **8**, the magnet **13** and pole pieces **14**, as a soldered or otherwise fastened assembly, is initially mounted within a suitable gripping mechanism **70**, including a pair of pivotally actuated, spring-biased jaws **71**. While a pair of pneumatic cylinders **72** are pictorially shown as the means for actuating the jaws, it is to be understood, of course, that many other types of apparatus, such as cam operated mechanisms, could be utilized with equal effectiveness. The gripping mechanism is supported on a reciprocating device, such as a ram **73**, so as to be positioned above a receiver frame **12**, supported in a suitable stationary nest **75**. At this stage of assembly, the receiver frame has mounted thereon a diaphragm **16**, armature **23**, grid **26**, coils **31** and terminal strips **41**.

Upon the fixture **70** (holding a magnet-pole piece assembly) being lowered so that the pole piece leg portions **14***d* are brought into frictional engagement with the resilient U-shaped wires **61**, which are positioned within the receptacles **43**, an AC signal having a frequency, for example of 1,000 cycles per second is applied to the receiver coils **31** from a source **79**. In addition to the alternating current signal, a direct current bias of approximately 250–300 milliamperes for one particular type of receiver is simultaneously applied to the coils. The polarity of the bias current is chosen so as to aid permanent magnet **13** in attracting the armature **23** toward the pole tips **14***a* of the magnet-pole piece assembly until they are so close that contact is finally abruptly made therebetween due primarily to magnetic attraction. This contact with both the AC signal and the DC bias applied to the coils of the receiver is referred to as the "freeze point."

After the pole tips **14***a* contact the armature **23** of the receiver, previously defined as the "freeze point," the transfer device **70** is removed so as to permit the stressed structural components, including the die-cast frame, to relax and acquire

a normal state. Thereafter, the DC bias is gradually reduced or swept in amplitude from approximately +225 milliamperes down to zero and then from zero to approximately −150 milliamperes. The resulting variable acoustic output energy produced by the receiver is in turn received by a reproducing instrument, such as a sensitive, calibrated microphone **81**. The microphone re-converts the received acoustic energy into electrical energy, with the latter then being fed to a suitable measuring instrument, such as an oscilloscope **83**.

During this time, and with the AC signal of 1,000 c.p.s. still applied to the coils of the receiver, an operator monitors the oscilloscope and ascertains whether or not the optimum value of acoustic output produced by the receiver falls within predetermined limits portrayed by suitable means, electronically or otherwise, on the screen of the oscilloscope. These limits are objectably determined i.e., they are initially established by choosing a permissible lower level of acoustic output for a representative receiver which, if attained when the receiver is finally assembled, will insure that the receiver will normally function satisfactorily in the field, even if subjected to adverse conditions, such as rough handling, stray magnetic fields, etc. Through the use of oscilloscope, the chosen lower level of acoustic output which, by way of example, is 2 *db.* below the peak output for one particular receiver, is readily defined by and visually displayed as the lower one of two spaced 2*db.* limit points derived from an acoustic output response curve representative of all receivers of a given design. The profile of this response curve typically was a bell-shaped distribution.

If upon varying the DC bias current from approximately +225 milliamperes to zero and then from zero to −150 milliamperes an optimum value of acoustic output is established within the aforementioned predetermined limits, the receiver is tentatively considered to be acceptable. However, if the optimum value of acoustic output registers on the oscilloscope beyond that one (higher) of the two predetermined limits which reveals that more biasing current and, thereby more flux in the airgap, is required than can normally be produced by a fully magnetized permanent magnet, then the receiver is considered to be defective. This condition would normally arise as a result of a defective diaphragm-armature assembly, however, other defects in certain of the other components which make up the composite receiver could also produce the same monitored condition.

As for those partially assembled receivers which exhibit an optimum value of acoustic output beyond the other (lower) predetermined limit which reveals that less magnetic flux is required in the airgap than is presently produced by the permanent magnet, the next step is to demagnetize the permanent magnet slightly, such as through the application of an externally applied field, to a degree which results in the optimum acoustic output of the receiver being effectively shifted so as to fall within the aforementioned limits, as indicated on the oscilloscope. During this adjustment, of course, the AC signal of 1,000 c.p.s. is still applied to the coils of the receiver.

After the receiver has been physically and magnetically tested in accordance with the aforementioned steps of the subject method, an alternating current signal which sweeps, for example, from zero to 4,000 cycles per second is applied to the receiver coils **31** from a source **85**, through a suitable electrical switch **86**. The receiver in turn translates the alternating current signal into acoustic output energy which again is picked up by the microphone **81**, reconverted into electrical energy and then fed to the measuring oscilloscope **83**. By observing the conformance of the receiver response characteristics to the predetermined limit requirements portrayed on the screen of the oscilloscope, the acceptance or rejection of the receiver is determined for the last time prior to the final assembly operation.

The final step in the assembly of the receiver involves permanently securing the magnet-pole piece assembly to the receptacles, and thereby to the frame **12** of the receiver. This is accomplished in accordance with the principles of the invention by injecting or otherwise placing either a liquid cement or a potting compound into the reservoirs **49** so as to partially embed the pole piece leg portions **14***d*. This injected material, as previously mentioned, may comprise a two-part thermosetting resin and hardener, and may be cured either at room temperature or at an elevated temperature, depending both upon the time allowed for curing and the nature of the material employed. The resulting receiver structure, with the pole piece leg portions **14***d* being partially embedded in the potting compound, effects rigid and permanent securement of the magnet-pole piece assembly to the frame of the receiver.

Advantageously, the above-described method of adjusting the air gap and finally assembling the composite receiver obviates the need for expensive, precision made threaded plungers and/or weights, permits optimum airgap adjustment based on the peculiar physical, magnetic and electrical characteristics of each receiver, and obviates shrinkage or growth problems associated with the airgap between the armature of the diaphragm-armature assembly and the pole tips of the magnet-pole piece assembly normally caused by the use of welds to secure the magnet-pole piece assembly to the frame. The present method also makes it possible to ascertain whether a given receiver can be adjusted within predetermined acoustic output limits before the magnet-pole piece assembly is permanently secured to the frame of the receiver. This naturally reduces manufacturing costs, reduces the number of defective receivers and facilitates large scale manufacture through the use of manufacturing steps and apparatus which are simpler and more efficient than those required heretofore.

FIGS. **9–11** depict three views of one of a pair of receptacles generally corresponding to the pair depicted in FIGS. **3–5** and **7**, but distinguishing therefrom by the utilization of short, straight sections of hollow tubing **91** which are initially supported within the semicircular grooves **47** of the leg extensions **45** by means of a substantially U-shaped preformed wire base **93**. More specifically, the end of each short, vertically extending leg portion of the wire is inserted into the lower end portion of the aligned hollow plastic tube.

As a modification of this embodiment, short, straight, vertically extending sections of tubing could be used without the interconnecting wire **93** by seating the lower end of each section of tubing, for example, in a bore at the base of the semicircular groove **47** of the associated receptacle. Concomitantly, the hollow tubing could simply comprise one piece formed into a U-shaped configuration in a manner similar to the wire **61** depicted in the receiver embodiment of FIGS. **1–7**, with the possible exception that the vertically extending leg portions would normally be straight.

In all cases, the plastic tubing may, for example, be made of nylon, although other types of resilient plastic material may also be used with equal effectiveness. In all other respects, the receptacle and the function of the tubing depicted in FIGS. **9–11** correspond to the wire counterpart described in detail in connection with FIGS. **1–7**.

FIGS. **12–14** likewise depict a variation of the composite receptacle **43** depicted in FIG. **7**, through the utilization of a one-piece molded plastic insert **95** having hollow, mutually disposed, vertically extending resilient leg portions **96**. Rather than being formed to be substantially U-shaped as the wire **61** in FIG. **7**, insert **95** is essentially H-shaped having an integral, horizontal rib portion **96***a* spaced a short distance from the bottom ends of the vertical resilient leg portions **96** so as to provide greater rigidity to the insert.

FIGS. **15–17** illustrate another variation of the composite receptacle **43** of FIG. **7**, wherein a substantially U-shaped metal insert **97**, having substantial width, is utilized in place of the U-shaped wire **61** depicted in FIG. **7**. The vertically extending and mutually disposed leg portions **98** of the metal insert **97** are slightly bowed inwardly so as to provide the necessary resiliency to frictionally engage and hold the magnet-pole piece assembly during the airgap adjusting and final assembly thereof. Insert **97** could also be made of plastic.

FIGS. 18–20 illustrate still another variation of the composite receptacle 43, wherein a plurality of triangularly shaped projections 99 are integrally formed as a part of each vertically extending leg extension 45 of the channel, wit the substantially sharp protuberances or edges 99*a* providing sufficient resiliency and/or deformation characteristics so as to frictionally engage and temporarily hold the magnet-pole piece assembly by metal-to-metal contact. The integral metal projections 99 thus obviate the need for separate resilient protuberances, such as employed in the various receptacle embodiments described hereinabove. The continuous contacting edges 99*a* disclosed in FIGS. 18–20 could, of course, be formed as a sawtooth or herringbone type edge, or simply comprise a plurality of uniformly or randomly spaced contact protuberances of any other configuration.

It is to be understood that the specific illustrative structural embodiments and associated methods disclosed herein are merely illustrative of the general principles of the present invention. Various other modifications may be devised in light of this disclosure by one skilled in the art without departing from the spirit and scope of this invention.

We claim:

1. A method of adjusting the airgap of and finally assembling electrical transducers of the central armature receiver type, wherein each receiver includes a diaphragm-armature assembly, a magnet-pole piece assembly and induction coil means associated with the magnet-pole piece assembly, all mounted on a common frame, and wherein said frame includes integral receptacle means adapted to receive in frictional engagement therewith at least a portion of said magnet-pole piece assembly and to temporarily support said last-mentioned assembly prior to the permanent securement thereof to said frame, said method comprising:

initially supporting the frame of the receiver with the diaphragm-armature assembly and induction coil means mounted thereon, in spaced relationship from said magnet-pole piece assembly for subsequent relative movement therebetween;

applying a force to impart relative movement between said magnet-pole piece assembly and said frame so as to cause at least a portion of said magnet-pole piece assembly to be received within and frictionally engage the receptacle means, with continued relative movement causing the pole tips of said magnet-pole piece assembly to contact the armature of said diaphragm-armature assembly;

applying an AC signal and a DC bias to said induction coil means during the relative movement between said magnet-pole piece assembly and said frame;

removing the force imparting relative movement between said magnet-pole piece assembly and said frame after said contact is made between said pole tips and armature;

varying the DC bias from an upper predetermined positive value to zero and then from zero to a predetermined negative value;

sensing and measuring the acoustic output response of the partially assembled receiver while said AC signal remains applied to said induction coil means and while said DC bias applied thereto is varied, said sensing and measuring including ascertaining if the optimum acoustic output of the receiver falls within predetermined limits, there limits having been previously established as a minimum acoustic output limits which will insure satisfactory operation of the receiver under normal use conditions, and having been initially derived from a representative acoustic output response curve as upper and lower points defined on either side of the peak of said curve for receivers of the type being assembled;

de-magnetizing the magnet of said magnet-pole piece assembly to establish an optimum value of acoustic output for the receiver in those cases where an optimum output was measured within the predetermined limits, but with a negative DC bias being applied to the induction coil means, this condition indicating that the permanent magnet during the airgap adjustment was producing more flux in the airgap than required to produce an optimum acoustic output within the predetermined limits and with zero DC bias, and

introducing a solidifiable material between at least certain interstices formed between said receptacle means and the adjacent portions of said magnet-pole piece assembly received therewithin, and allowing said material to harden so as to provide permanent and rigid securement of said magnet-pole piece assembly to the frame of said receiver.

2. A method in accordance with claim 1, wherein said AC signal has a frequency of approximately 1,000 cycles per second, and wherein said DC bias is varied from a range of approximately +250–300 milliamperes to zero and then from zero to approximately −150 milliamperes.

3. A method in accordance with claim 2, wherein said DC bias is initially maintained constant at approximately +250 milliamperes during the relative movement of said magnet-pole piece assembly and said frame until contact of the pole tips of said magnet-pole piece assembly is made with said armature of said diaphragm-armature assembly.

4. A method in accordance with claim 1, wherein an oscilloscope is used to sense and measure the acoustic output of said receiver, and wherein said predetermined limits are portrayed electronically on the screen of said oscilloscope.

5. A method in accordance with claim 1, wherein said solidifiable material comprises a thermosetting resin and hardener.

6. A method in accordance with claim 1, wherein said solidifiable material comprises a liquid cement when initially placed in said receptacles.

7. A method in accordance with claim 1, wherein those portions of the magnet-pole piece assembly received within said receptacles make frictional contact with resilient protuberances associated with said receptacles.

8. A method in accordance with claim 7, wherein said resilient protuberances comprise substantially U-shaped inserts with at least the parallel extending leg portions thereof being resilient, a separate insert being positioned within each of said receptacles and oriented so that the leg portions thereof frictionally engage the associated portion of said magnet-pole piece assembly received within each respective receptacle.

9. A method in accordance with claim 1, wherein before the final step of introducing a solidifiable material between certain interstices of the receiver, an AC signal is applied to the induction coils and swept over a frequency range from zero to approximately 4,000 cycles per second, with the acoustic output of the receiver again being measured to ascertain if the optimum value thereof still falls within the predetermined limits.

10. A method of adjusting the airgap of and finally assembling electrical transducers of the central armature receiver type, wherein each receiver includes a diaphragm-armature assembly, a magnet-pole piece assembly and induction coil means associated with the magnet-pole piece assembly, all mounted on a common frame, and wherein said frame includes integral receptacle means adapted to receive in frictional engagement therewith at least a portion of said magnet-pole piece assembly and to temporarily support said last-mentioned assembly prior to the permanent securement thereof to said frame, said method comprising:

initially supporting the frame of the receiver with the diaphragm-armature assembly and induction coil means mounted thereon, in spaced relationship from said magnet-pole piece assembly for subsequent relative movement therebetween;

applying a force to impart relative movement between said magnet-pole piece assembly and said frame so as to cause at least a portion of said magnet-pole piece assembly to be received within and frictionally engage the receptacle means, with continued relative movement causing the pole tips of said magnet-pole piece assembly to contact the armature of said diaphragm-armature assembly;

applying an AC signal of approximately 1,000 cycles per second and a constant DC bias in the range of +200 to +300 milliamperes to said induction coil means during the relative movement between said magnet-pole piece assembly and said frame;

removing the force imparting relative movement between said magnet-pole piece assembly and said frame after said contact is made between said pole tips and armature;

varying the DC bias from an upper positive value in the range of +200 to +300 milliamperes to zero and then from zero to a predetermined negative value of approximately −150 milliamperes;

sensing and measuring the acoustic output response of the partially assembled receiver while said AC signal remains applied to said induction coil means and while said DC bias applied thereto is varied, said sensing and measuring including ascertaining if the optimum acoustic output of the receiver falls within predetermined limits, these limits having been previously established as minimum acoustic output limits which will insure satisfactory operation of the receiver under normal use conditions, and having been initially derived from a representative acoustic output response curve as upper and lower points defined on either side of the peak of said curve for receivers of the type being assembled;

removing said AC signal and said DC bias and de-magnetizing the magnet of said magnet-pole piece assembly to establish and optimum value of acoustic output for the receiver in those cases where an optimum output was measured within the predetermined limits, but with a negative DC bias being applied to the induction coil means, this condition indicating that the permanent magnet during the airgap adjustment was producing more flux in the airgap than required to produce an optimum acoustic output within the predetermined limits and with no external DC bias being applied to the induction coil means;

applying a variable frequency AC signal to said induction coil means and sweeping said signal over a frequency range from zero to approximately 4,000 cycles per second, with the acoustic output of the receiver again being measured to ascertain if the optimum value thereof still falls within the predetermined limits, and

introducing a solidifiable material between at least certain interstices formed between said receptacle means and the adjacent portions of said magnet-pole piece assembly received therewithin, and allowing said material to harden so as to provide permanent and rigid securement of said magnet-pole piece assembly to the frame of said receiver.

11. A method in accordance with claim **10**, wherein an oscilloscope is used to sense and measure the acoustic output of said receiver, wherein said predetermined limits are portrayed electronically on the screen of said oscilloscope, and wherein those portions of the magnet-pole piece assembly received within said receptacles make frictional contact with substantially U-shaped inserts positioned within said receptacles, at least the parallel leg portions of said inserts being resilient and with a separate insert being positioned within each of said receptacles and oriented so that the leg portions thereof frictionally engage the adjacent surfaces of said magnet-pole piece assembly received within each respective receptacle.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,619,434 Dated November 9, 1971

Inventor(s) J. E. Blastic-N. B. Karau-A. F. Kerr

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

Column 2, line 17, "product" should read --produce--. Column 3, line 62, "air gap" should follow "optimum" and precede "initially". Column 4, line 45, "with" should read --two--. Column 5, line 33, "FIg." should read --FIG.--. Column 6, line 36, "magent" should read --magnet--. Column 7, line 22, "the" should precede "oscilloscope". Column 7, line 29, "was" should read --has--. Column 9, line 4, "wit" should read --with--. Column 9, line 61, "there" should read --these--. Column 11, line 28, "and" should read --an--.

Signed and sealed this 13th day of June 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents