Sept. 20, 1960 R. E. C. BROWN 2,953,779

ELECTROMAGNETIC SOUNDERS OR RINGERS FOR GIVING AUDIBLE CALLING SIGNALS

Filed Oct. 1, 1958 2 Sheets-Sheet 1

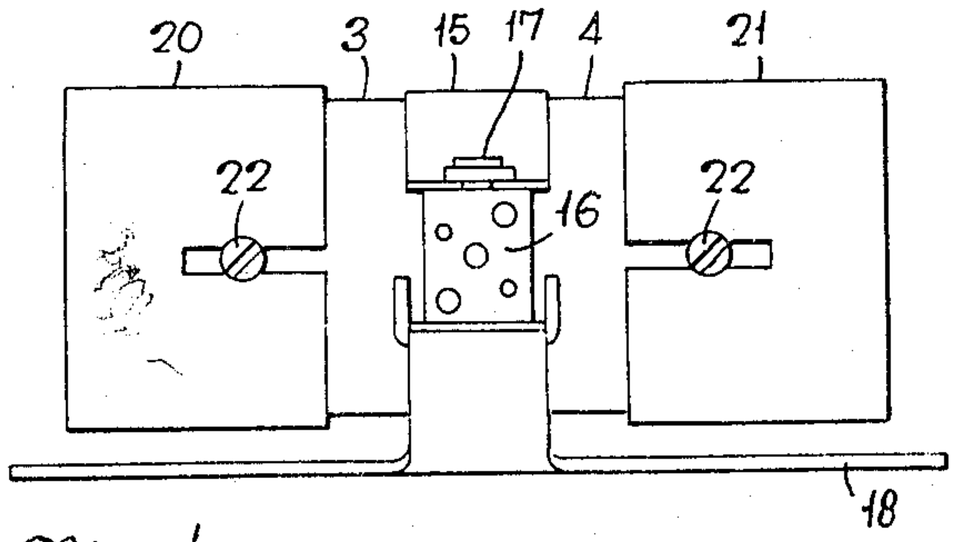

Fig. 1.

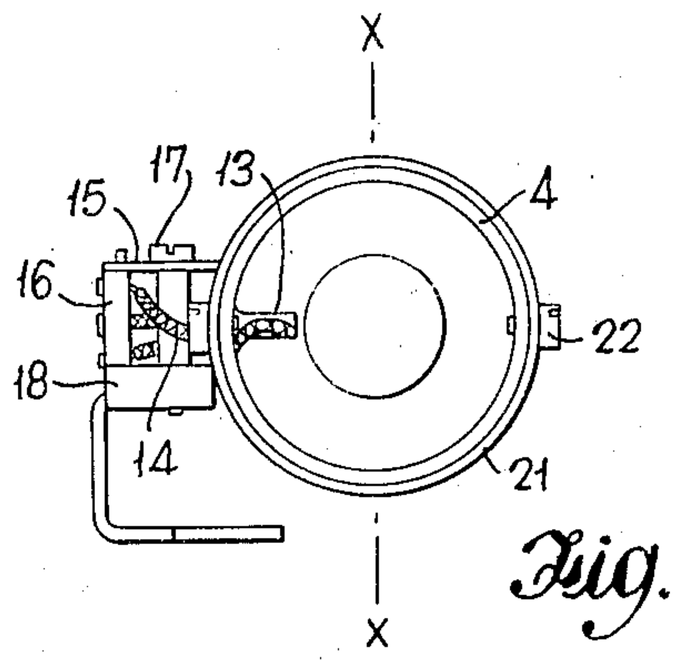

Fig. 2.

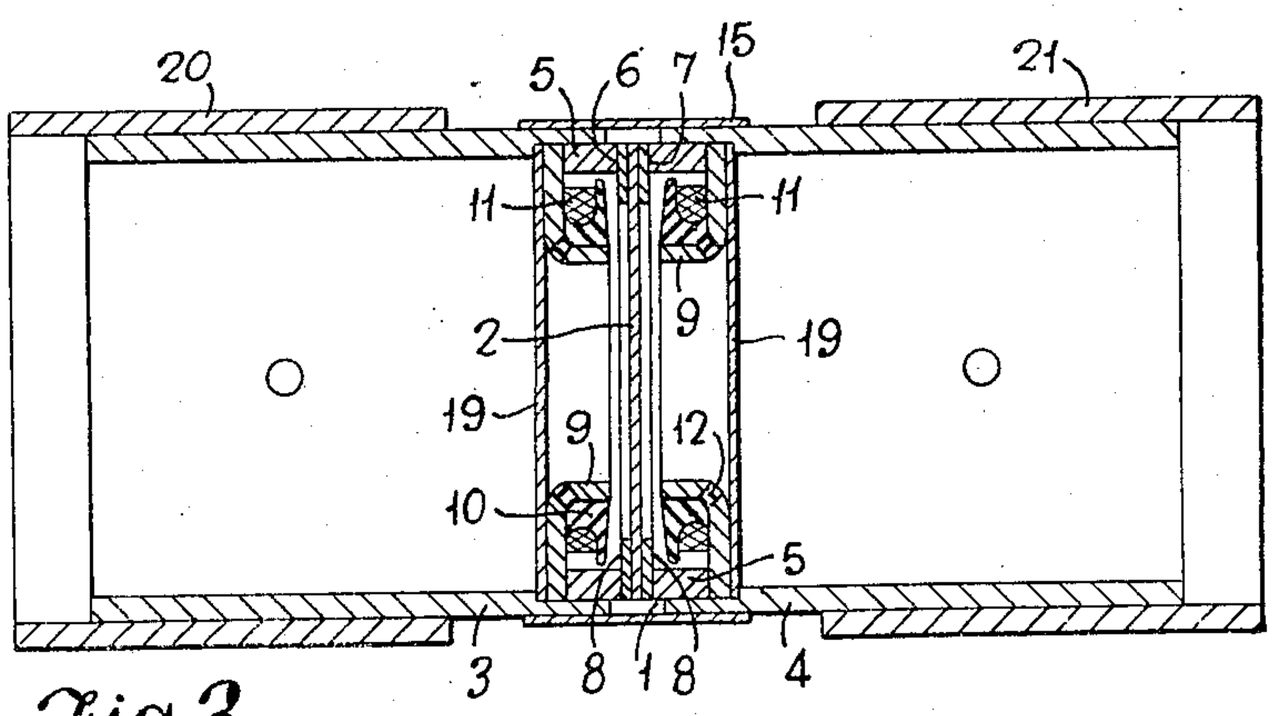

Fig. 3.

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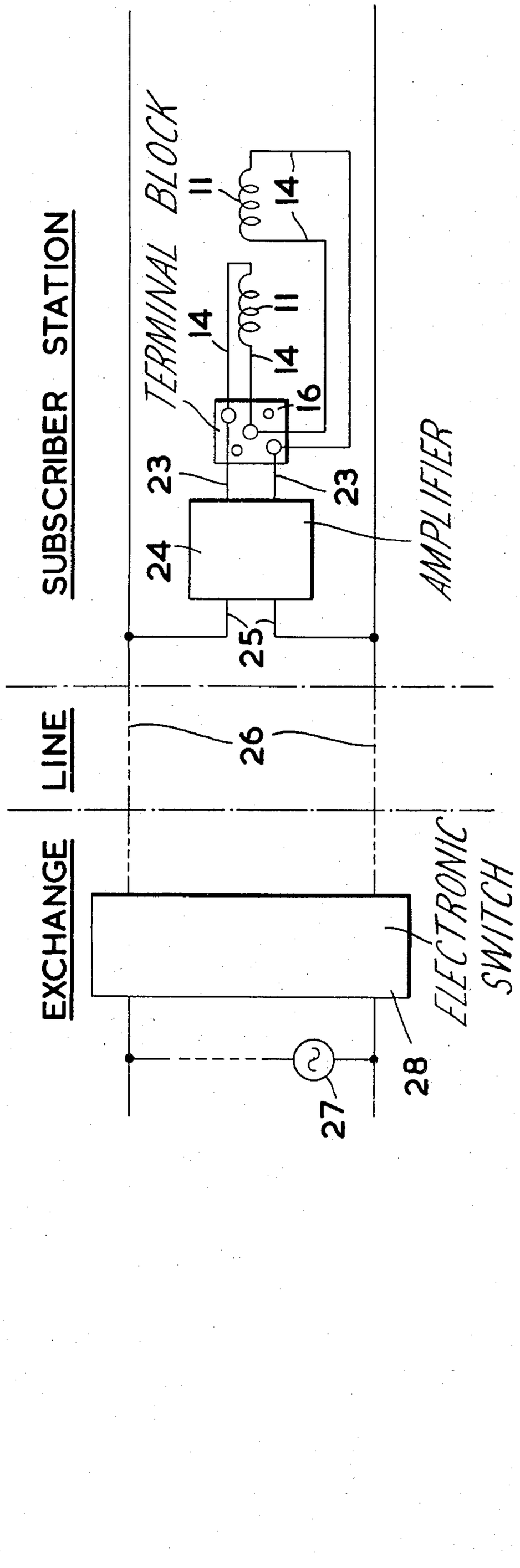

FIG. 4.

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ELECTROMAGNETIC SOUNDERS OR RINGERS FOR GIVING AUDIBLE CALLING SIGNALS

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3 Claims. (Cl. 340—388)

This invention relates to electromagnetic sounders or ringers such as are used for giving audible calling signals in telephone and like systems.

In telephone systems it has been usual to employ, for giving audible calling signals at subscriber stations, polarised ringers (magneto bells) of a type in which a hammer is vibrated in response to low-frequency (e.g. 17-cycles-per-second) alternating ringing current and thereby caused to strike a gong or gongs. This type of ringer has hitherto proved generally satisfactory, but so far as the electronic automatic telephone exchange systems now being developed are concerned it suffers from the disadvantage that the relatively high level of the power required to operate it precludes or renders difficult the transmission of such power through gate circuits or other switching elements of an electronic switching stage.

The object of the present invention is to provide an improved form of sounder or "ringer" which is especially suitable for use in connection with electronic automatic telephone exchanges in that the level of the power required to operate it is relatively low (compared with that required to operate the previously-mentioned type of ringer), and which is of a size and configuration making it readily usable (in place of the previously-mentioned type of ringer) in existing telephone sets without any major rearrangement of component parts.

The electromagnetic sounder or "ringer" provided by the invention is of a kind (hereinafter termed the kind referred to) in which a diaphragm, adapted to be vibrated in response to tone current fed to the winding of the electromagnetic system, is coupled to the external air through the medium of an acoustically resonant system comprising tube or like resonators.

According to the invention, there is provided an electromagnetic sounder or "ringer," of the kind referred to, wherein the electromagnetic system is of the balanced armature ring magnet type comprising pole-pieces on each side of the diaphragm and is such as to leave uncovered by it both sides of a central portion of the diaphragm, and wherein there is on each side of the diaphragm an acoustic resonator of tubular or like form open acoustically at one end to said central portion of the diaphragm and open acoustically at the other end to the external air.

The two acoustic resonators, one on each side of the diaphragm, may conveniently be constituted by a cylindrical tube or tubes coaxial with the diaphragm. In one contemplated form of construction, a telephone-receiver-like unit comprising the electromagnetic system with the diaphragm is located part way along the interior of a cylindrical tube, the portion of the tube on one side of said unit serving to constitute the whole or part of one of the two acoustic resonators, and the portion of the tube on the other side of said unit serving to constitute the whole or part of the other of the two acoustic resonators. In the case of this form of construction, provision may be made for adjusting the

location of the telephone-receiver-like unit in the tube for the purpose of adjusting the resonant frequencies of the two resonators. In another (and at present preferred) contemplated form of construction, a telephone-receiver-like unit comprising the electromagnetic system with the diaphragm lies partly within, and closes one end of, a cylindrical tube coaxial with the diaphragm and constituting the whole or part of one of the two acoustic resonators, and lies partly within, and closes one end of, a further cylindrical tube coaxial with the diaphragm and constituting the whole or part of the other of the two acoustic resonators.

It may be arranged that the two acoustic resonators resonate at different frequencies, which may be different harmonics of a frequency employed for ringing.

The acoustically resonant system comprising the two acoustic resonators may include telescopically arranged cylindrical tubes, the telescopic arrangement of the tubes serving to permit ready adjustment of the resonant frequencies of the resonators.

By way of example, an electromagnetic sounder or "ringer," of a preferred specific form according to the invention, will now be described with reference to the accompanying drawings. Fig. 1 of the drawings shows a side view of this sounder or "ringer," Fig. 2 shows an end view as seen looking from the right in Fig. 1, and Fig. 3 shows a cross-section taken on the line XX in Fig. 2 as seen looking from the left in Fig. 2. Fig. 4 is a circuit diagram showing this sounder or "ringer" connected in circuit at a subscriber station in a telephone exchange system. In the case of this sounder or "ringer," a telephone-receiver-like unit **1** (Fig. 3), comprising the electromagnetic system with the diaphragm **2** and hereinafter for convenience in description termed the receiver unit, lies partly within, and closes one end of, a cylindrical tube **3** coaxial with the diaphragm and forming the main constituent member of the acoustic resonator on one side of the diaphragm, and lies partly within, and closes one end of, a similar cylindrical tube **4** coaxial with the diaphragm and forming the main constituent member of the acoustic resonator on the other side of the diaphragm.

The electromagnetic system is of the balanced armature type. The system includes two permanent magnets **5** of ring form which are magnetised and assembled so that the annular faces **6** and **7** are of opposite polarity, and which are separated by the diaphragm **2** and two annular spacing rings **8**. The two spacing rings **8** are situated one on each side of the diaphragm **2**, and are formed of soft magnetic material. Resting on the outer annular face of each permanent magnet **5**, and projecting radially inwards, is an annular pole-piece **9** of L section. There are thus two annular pole-pieces, one on each side of the diaphragm **2**. The radially-projecting portions of the two pole-pieces **9** form annular air-gaps on each side of an annular portion of the diaphragm **2**. This annular portion of the diaphragm constitutes the armature of the balanced armature system, the diaphragm being formed of suitable magnetic material. The pole-pieces **9** and cheeks **10** of plastic material which are moulded thereon together form channels in which the two sections of the winding **11** of the electromagnetic system are wound. The cheeks **10** are locked securely in position on the respective pole-pieces by portions **12** of the moulded plastic which lie in small holes in the pole-pieces. Each of the two pole-pieces **9** is partly cut away at one place, as seen at **13** in Fig. 2, to provide a passage for the lead-in wires **14** to the two sections of the winding **11**. The two sections of the winding, one on each side of the armature constituted by the diaphragm **2**, are so connected electrically (in series with each other) that they are mutually

assisting in regard to the production of radial fluxes in the plane of the armature.

To prevent ingress of dust or dirt to the receiver unit **1**, thin flexible non-resonant discs **19** formed of polyethylene are provided across each face of this unit. These discs are such as to leave the cylindrical tubes **3** and **4** effectively open acoustically to the central portion of the diaphragm **2**.

Each of the two similar cylindrical tubes **3** and **4** is cut away internally, to increase the internal diameter, for a short part of its length from one end, the portion of increased internal diameter serving to accommodate, and being a tight fit with that portion of the receiver unit **1** which lies within the tube. The two cylindrical tubes **3** and **4** are clamped together in position on the receiver unit **1** by a clamping clip **15** which embraces both tubes where they overlap the unit, and which carries between its ends a small terminal block **16** provided with terminals to which the lead-in wires **14** of the two sections of the winding **11** are connected. The clip **15** is clamped by a clamping screw **17** which engages a threaded hole in a mounting member **18**. This mounting member **18** forms the medium through which the sounder or "ringer" is mounted or suspended within the casing of a telephone set. The acoustic resonator of which the cylindrical tube **3** forms the main constituent member includes a further cylindrical tube **20** which fits telescopically on the tube **3**. Correspondingly, the acoustic resonator of which the cylindrical tube **4** forms the main constituent member includes a further cylindrical tube **21** which fits telescopically on the tube **4**. These telescopic arrangements serve to permit ready adjustment of the resonant frequencies of the two resonators. Each of the tubes **20** and **21** is locked in position on the respective inner tube (when correctly adjusted) by means of a pair of screws **22**. The cylindrical tubes **3**, **4**, **20**, and **21** may be made of brass or other suitable non-magnetic material. The sounder or "ringer" is intended for use in a telephone system in which a tone sounding (ringing) current applied to a subscriber's line to call the subscriber has a frequency which is in effect wobbled about a mean frequency, the mean frequency being in the region of 2000 cycles per second and the extent of the wobble being about 70 cycles per second on each side of the mean frequency. This wobbling of the frequency of the tone sounding current serves to impart a characteristic tone to the sound produced by the sounder or "ringer" in response to the flow of such current through its winding **11**. The internal diameter of the tubes **3** and **4** which form the main constituent members of the two acoustic resonators is about 1.0 inch, and the overall axial length between the outer edges of the tubes **20** and **21**, when these have been set to their proper positions on the tubes **3** and **4**, is about 2.75 inches, these dimensions having been found to give the best response to a tone sounding current of the kind just mentioned.

The requisite series connection of the two sections of the winding **11** (which as already stated is a connection such that the two sections are mutually assisting in regard to the production of radial fluxes in the plane of the armature constituted by an annular portion of the diaphragm **2**) is effected by connecting, in the case of each section, one of the lead-in wires **14** of the section to the central terminal on the terminal block **16** and the remaining lead-in wire **14** of the section to one or the other, depending on the section concerned, of two further terminals on this terminal block, these two further terminals being, as shown in the circuit diagram of Fig. 4, the terminals to which the external connections **23** of the sounder or "ringer" are made. In the circuit diagram, the sounder or "ringer" is represented by the terminal block **16** and the two sections of the winding **11**, and is shown connected for giving audible calling signals at a subscriber station in an electronic automatic telephone exchange system. The external connections **23** just referred to are shown as being the output wires of a transistor amplifier which is represented by the block **24** and which has its input circuit **25** connected across the line wires **26** of the subscriber's line. The details of the transistor amplifier, which is arranged to derive its direct current power supply from the exchange by way of the line wires **26**, do not concern the present invention. The amplifier serves when requisite to amplify, and feed to the two sections of the winding **11**, tone sounding current transmitted from the exchange to the subscriber station over the line wires **26**, and supplied by a source **27** in the exchange. This source is of course only connected to transmit tone sounding current to the subscriber's line when it is required to give an audible calling signal at the subscriber station. The tone current supplied by this source is of the kind previously mentioned having a frequency which is wobbled about a mean frequency, the mean frequency being in the region of 2000 cycles per second and the extent of the wobble being about 70 cycles per second on each side of the mean frequency. In the circuit diagram, the circuit for applying tone current from the source **27** to the line wires **26** is shown schematically as including an electronic switch represented by the block **28**. The detailed arrangements at the exchange do not concern the present invention, which is solely concerned with the constitution and constructional arrangement of the sounder or "ringer."

It has been found that, in the case of a sounder or "ringer" of the prefrred specific form which has been described with reference to the drawings, the sound produced has sufficient carrying power for most purposes if the power supplied to the winding of the receiver unit (in the form of tone sounding current of the kind referred to) is of the order of 2 milliwatts.

What I claim is:

1. An electromagnetic sounder comprising a circular diaphragm and an electromagnetic system and acoustic resonators, said electromagnetic system comprising a magnetic armature constituted by an outer annular portion of said diaphragm, an electrical winding comprising a winding section coaxial with said diaphragm on each side of said armature the two sections being mutually assisting in regard to the production of radial fluxes in the plane of said armature, annular pole pieces on opposite sides of said armature and coaxial with said diaphragm and defining spaces on each side of said armature in which the winding sections of said winding are disposed and forming a pair of air gaps comprising corresponding air gaps on each side of said armature, and permanent magnet means of ring form for producing between said pole pieces on opposite sides of said armature a steady magnetic flux passing across said air gaps and traversing said armature in a direction substantially normal to its plane, and said acoustic resonators comprising on each side of said diaphragm a cylindrical acoustic resonator tube coaxial with said diaphragm and open acoustically at one end to the circular central portion of said diaphragm bounded by said outer annular portion and open acoustically at the other end to the external air, said electromagnetic system and said acoustic resonators leaving said circular central portion of said diaphragm wholly uncovered and unshielded on each side of said diaphragm so far as obscuration by them in an axial direction is concerned.

2. An electromagnetic sounder comprising acoustic resonators and a receiver unit consisting of an electromagnetic system with a circular diaphragm, said electromagnetic system comprising a magnetic armature constituted by an outer annular portion of said diaphragm, an electrical winding comprising a winding section coaxial with said diaphragm on each side of said armature the two sections being mutually assisting in regard to the production of radial fluxes in the plane of said armature, annular pole pieces on opposite sides of said armature and coaxial with said diaphragm and defining spaces on

each side of said armature in which the winding sections of said winding are disposed and forming a pair of air gaps comprising corresponding air gaps on each side of said armature, and permanent magnet means of ring form for producing between said pole pieces on opposite sides of said armature a steady magnetic flux passing across said air gaps and traversing said armature in a direction substantially normal to its plane, and said acoustic resonators comprising on each side of said diaphragm a cylindrical acoustic resonator tube which is coaxial with said diaphragm and within which said receiver unit partly lies to close one end of the tube in a manner which leaves the tube open acoustically at this end to the circular central portion of said diaphragm bounded by said outer annular portion the tube being open acoustically at the other end to the external air, said electromagnetic system and said acoustic resonators leaving said circular central portion of said diaphragm wholly uncovered and unshielded on each side of said diaphragm so far as obscuration by them in an axial direction is concerned.

3. An electromagnetic sounder comprising acoustic resonators and a receiver unit consisting of an electromagnetic system with a circular diaphragm, said electromagnetic system comprising a magnetic armature constituted by an outer annular portion of said diaphragm, an electrical winding comprising a winding section coaxial with said diaphragm on each side of said armature the two sections being mutually assisting in regard to the production of radial fluxes in the plane of said armature, annular pole pieces on opposite sides of said armature and coaxial with said diaphragm and defining spaces on each side of said armature in which the winding sections of said winding are disposed and forming a pair of air

gaps comprising corresponding air gaps on each side of said armature, and permanent magnet means of ring form for producing between said pole pieces on opposite sides of said armature a steady magnetic flux passing across said air gaps and traversing said armature in a direction substantially normal to its plane, and said acoustic resonators comprising on each side of said diaphragm a cylindrical acoustic resonator tube which is coaxial with said diaphragm and within which said receiver unit partly lies to close one end of the tube in a manner which leaves the tube open acoustically at this end to the circular central portion of said diaphragm bounded by said outer annular portion the tube being cut away internally to increase the internal diameter for a short part of its length from this end the portion of increased internal diameter serving to accommodate and fitting closely over that portion of said receiver unit which lies within the tube and the tube being open acoustically at the other end to the external air, the two tubes being clamped in position on said receiver unit by a clamping clip embracing both tubes where they overlap said receiver unit, and said electromagnetic system and said acoustic resonators leaving said circular central portion of said diaphragm wholly uncovered and unshielded on each side of said diaphragm so far as obscuration by them in an axial direction is concerned.

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