No. 766,821. PATENTED AUG. 9, 1904.

A. GAMACHE.

TELEPHONE TRANSMITTER.

APPLICATION FILED JUNE 21, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

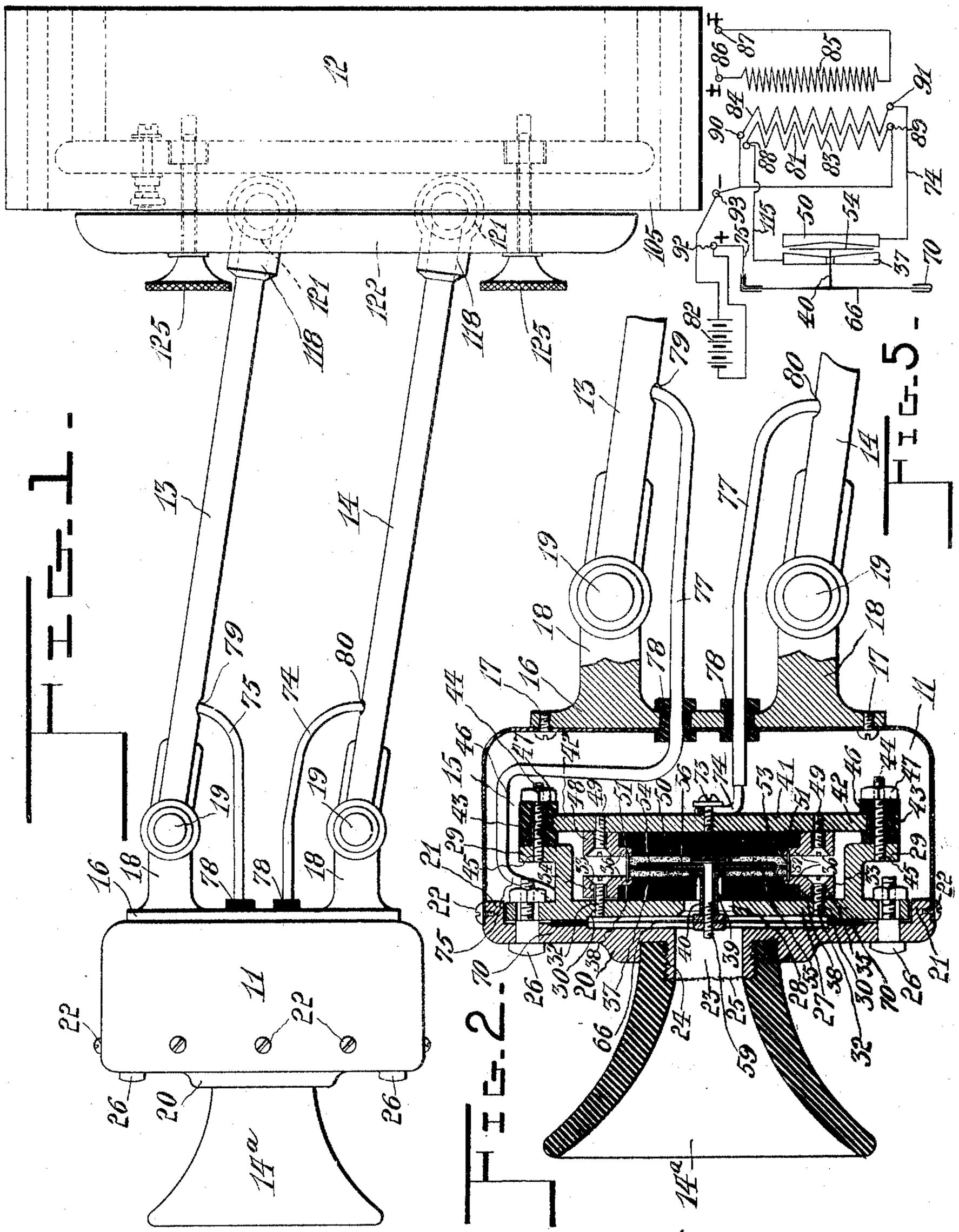

FIG. 1.

FIG. 5.

FIG. 2.

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NO MODEL. 2 SHEETS—SHEET 2.

FIG. 4.

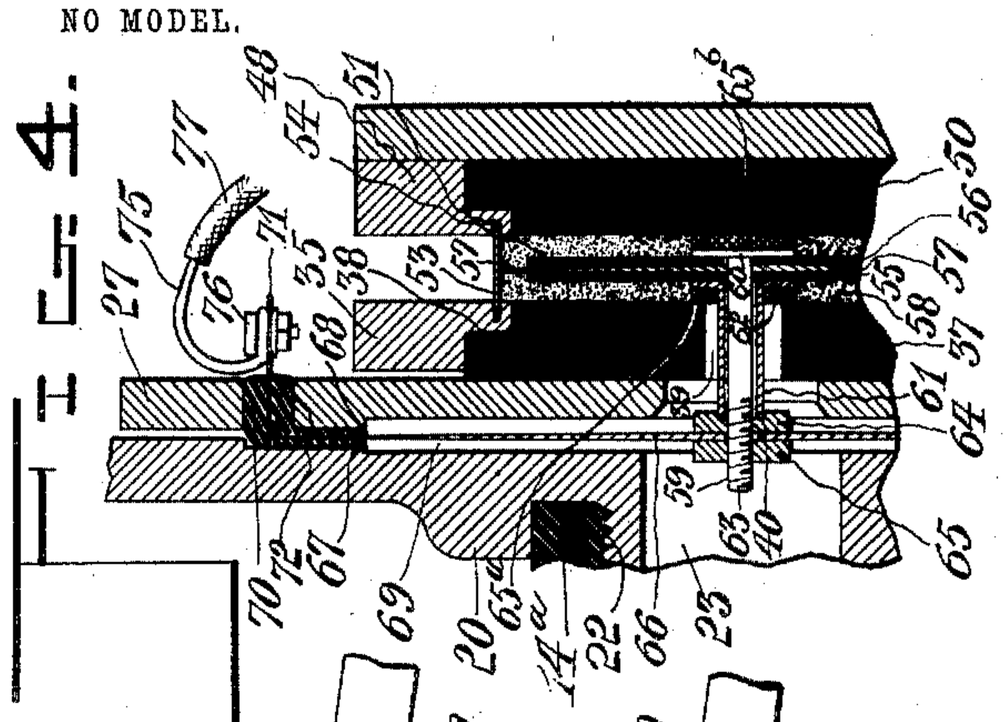

FIG. 8.

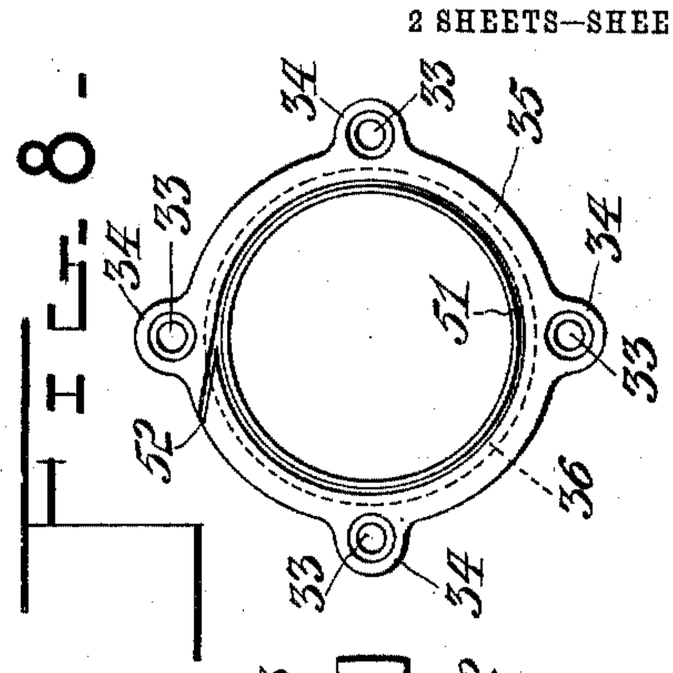

FIG. 3.

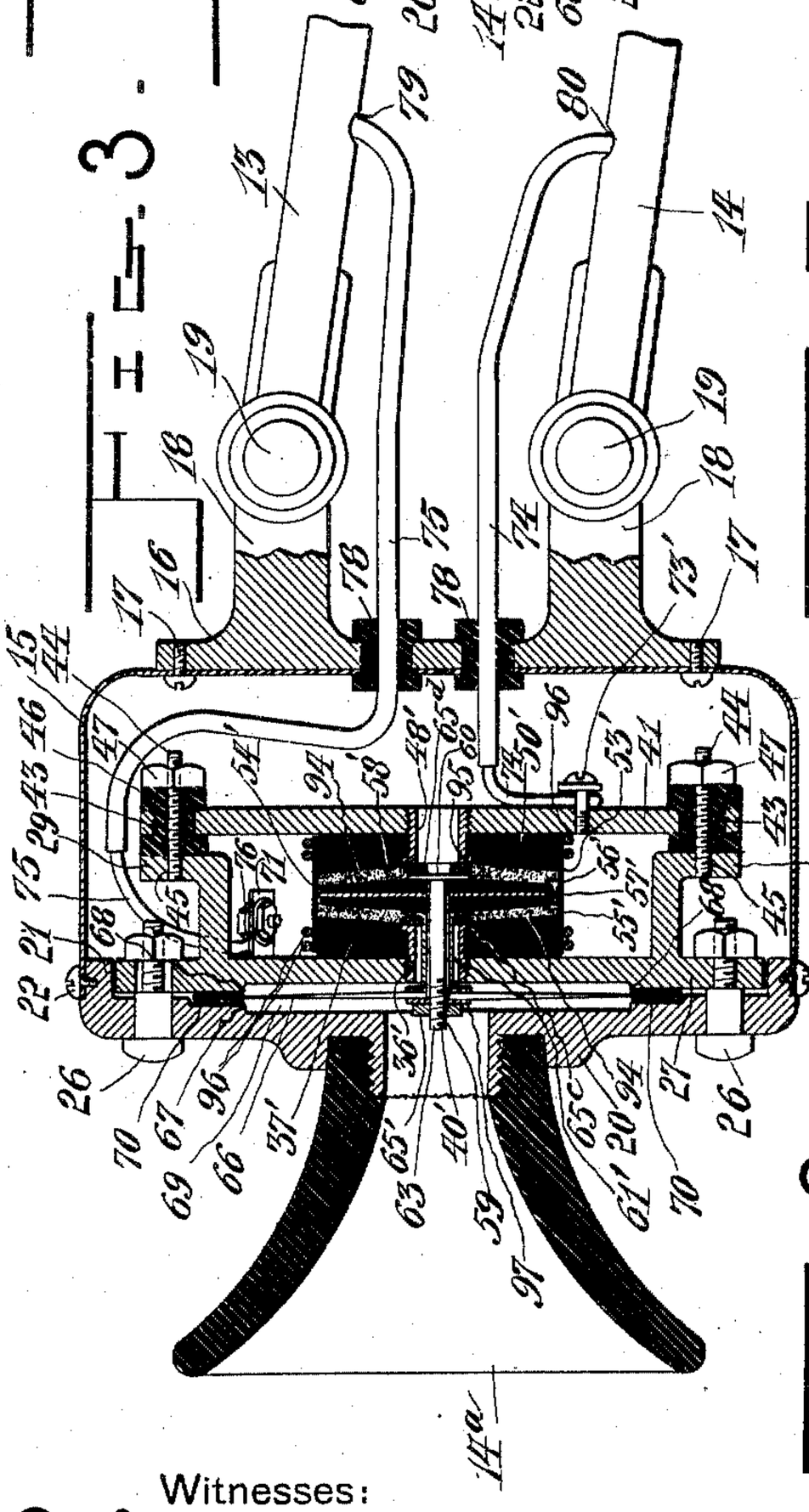

FIG. 7.

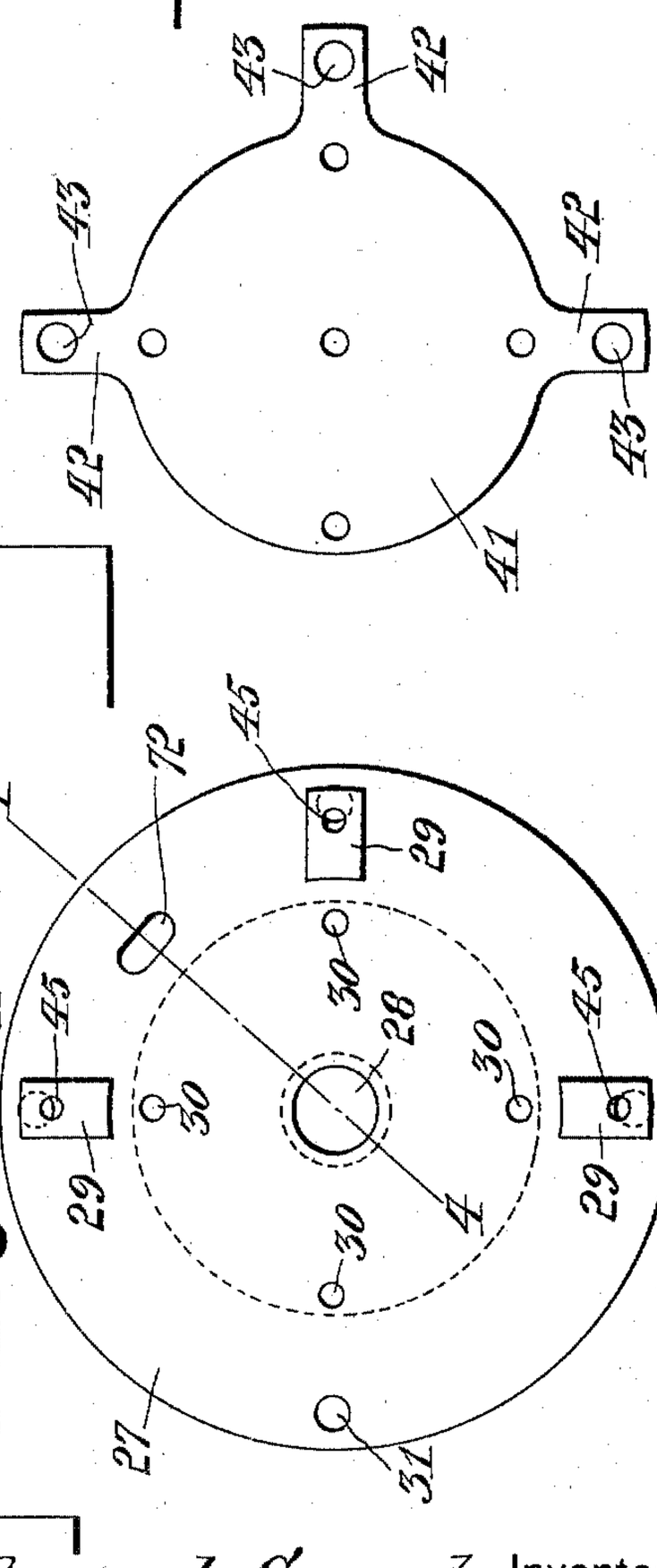

FIG. 6.

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No. 766,821. Patented August 9, 1904.

UNITED STATES PATENT OFFICE.

AUGUSTE GAMACHE, OF EAST CLIFTON, CANADA.

TELEPHONE-TRANSMITTER.

SPECIFICATION forming part of Letters Patent No. 766,821, dated August 9, 1904.

Application filed June 21, 1902. Serial No. 112,625. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTE GAMACHE, a subject of the King of Great Britain, residing at East Clifton, county of Compton, Province of Quebec, Canada, have invented certain new and useful Improvements in Telephone-Transmitters; and I do hereby declare that the following is a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to a compound microphone-transmitter especially adapted for long-distance-telephone connections.

The object of my invention is to produce a transmitter which shall more fully utilize the battery-current, as well as the vibrations of the diaphragm, than in those hitherto invented, which shall more than double the intensity and clearness of the sound produced, which shall be absolutely free from any vibrations produced in the line from sources external to the diaphragm mechanism which operates it—such, for instance, as making and breaking of the battery-circuit caused by the hook-switch—and, finally, to produce all of these effects without injuring the telephone in any material way or impairing its efficiency or increasing its cost of construction substantially.

My invention involves the use of a peculiar species of induction-balance or induction-coil having a pair of primaries wound in opposite directions and coacting with a single secondary which forms a member of the line-circuit or long-distance wires.

By my peculiar mode of connection both sides of the diaphragm are enabled to be used, and instead of the usual means—providing a single pair of contacts, one of which is stationary and the other vibrated with the diaphragm and electrically connected with the stationary electrode by a chamber filled with loose granulated carbon—I provide two stationary electrodes on opposite sides of the vibratory electrode, which is divided into two sections or faces facing, respectively, the two stationary electrodes and connected with the respective electrodes by two chambers, each filled or partially filled with granulated carbon. The vibratory electrode may be divided into two parts by an intermediate insulating-washer, which forms a partition separating the chamber in which said vibratory electrode vibrates into two portions, each of which contains granulated carbon and whose opposite surface is formed by one of said double stationary electrodes, and while the said vibratory electrode is connected directly to one pole of a local battery the two stationary electrodes are connected to independent primary wires of the induction-coil, which are wound in opposite directions thereon and their opposite ends connected together and to the opposite pole of the battery. The effect of this novel mode of connection is such that the vibration of the diaphragm causes a simultaneous widening of one of the granulated-carbon chambers and a narrowing of the other, and the resistance of one of the two alternative inductive paths of the current is consequently diminished at the same time that the other is increased, while at the same time the current through the main battery-circuit remains substantially unchanged. Now as the said primary wires are wound in opposite directions the two effects in the respective wires caused by increasing the current in one and decreasing it in the other will be just double the effect that a single wire would produce in producing an inductive current in the secondary wire; but one notable effect is that inasmuch as the two primaries are wound in opposite directions a direct increase or decrease of the battery-current produces no effect on the secondary wire and induction-coil, and thereby the effect of jars, breaks, or partial breaks in the circuit and other external disturbances produces no effect either in the transmitter or in the receiver at the distant end.

My invention further consists in the peculiar construction and combination of parts hereinafter described and more particularly pointed out in the claims accompanying this specification.

I have shown and illustrated in the accompanying drawings two preferred forms of the transmitter proper, together with the preferred mode of mounting the transmitter and

other necessary views to illustrate the principle of my invention, and herein—

Figure 1 is a side elevation of a complete transmitter constructed according to my invention, together with the mounting thereof. Fig. 2 is a vertical longitudinal section through the mechanism of the transmitter proper, or rather through one of the forms herein illustrated. Fig. 3 is a similar view of the other preferred form. Fig. 4 is a detail fragmentary view, on an enlarged scale, of some of the parts shown in Fig. 2 to illustrate more clearly the arrangement thereof, this section being taken on the line 4 4 of Fig. 6. Fig. 5 is a diagram of the connections to illustrate the principle of my invention. Fig. 6 is a rear face view of one of the castings forming the framework which supports the electrodes, as shown in the form illustrated in Fig. 2. Fig. 7 is a similar view of the other casting. Fig. 8 is a similar view of one of the ring collars which hold the electrodes in position.

The same numerals of reference denote like parts in all the figures of the drawings.

Referring first to Fig. 1, 12 designates the base, which is adapted to be affixed to the wall, and 11 the transmitter-box, which is connected to the base 12 by a pair of parallel swinging arms 13 14 and has at its forward side a funnel-shaped mouthpiece 14ª of any ordinary pattern. The parallel arms 13 and 14 may have cross-arms 121 secured at their stationary ends and at right angles thereto by means of connecting-T's 118. These cross-arms 121 are arranged to oscillate in semicircular recesses formed between the sides 105 of the base 12 and a pair of cleats 122, which are operated by clamping-screws 125 to frictionally secure the cross-arms and to hold the transmitter in projected position. The features of the base not being herein claimed need not be more specifically described.

I will first describe that form of the transmitter illustrated more particularly in Figs. 2, 4, 6, 7, and 8 and afterward describe its manner of operation and the modified form shown in Fig. 3. The transmitter-box 15 is a cup-shaped metallic member, which may be of spun brass, aluminium, or any suitable material or may be drawn into shape by suitable dies, and this member is secured to the rigid base 16 by means of screws 17, which base 16 has a pair of rearwardly-projecting lugs 18, having at their extremities suitable bearing-apertures forming sockets for pivot-pins 19, which connect the lugs 18 with the swinging arms 13 and 14 and enable the transmitter to be supported thereby. The forward side of the transmitter-box 15 is closed by a cover-plate 20, which has an annular marginal flange 21, interlocking with the edge of the member 15 and secured thereto by radial screws 22. The cover-plate 20 is pierced centrally by an aperture 23, around which is formed the threaded boss 24, which enables the mouthpiece 14ª to be secured thereto, and, as usual, there may be clamped between the two a screen or perforated metal plate 25 to protect the diaphragm against injury; but the parts thus far described form no part of my invention, these being substantially the same as in the ordinary form of transmitter.

Around the margin of the cover-plate 20 are formed a series of holes, herein shown as four in number, through which project four shouldered bolts 26, which are for the purpose of clamping the frame-plate 27 (shown on an enlarged scale in Fig. 6) to the inner face of the cover-plate. This frame-plate 27 is pierced centrally by an aperture 28 and has a series of three upstanding lugs 29 at distances of ninety degrees from each other, while the fourth quadrant—that is to say, the quadrant opposite the central lug 29—is left open. This plate 27 is also provided with a series of four screw-holes 30 on the same radii as the lugs 29 and bolt-holes 31 for the bolts 26, but within the latter, these holes being provided with internal threads, with which engage a set of screws 32, which project through countersunk holes 33, formed in a series of radial ears 34 on a ring collar 35. (Illustrated in detail in Fig. 8.) This ring collar has an overlapping inwardly-projecting annular flange 36, the purpose of which is to secure in position one of the carbon electrodes, herein termed the "front" electrode, (designated 37,) which has an annular groove 38 around its periphery adapting it to interlock with the flange 36, so that the latter sits flush with the face of said electrode when the ring-collar is clamped up into its position, as illustrated in Figs. 2 and 4. This electrode 37 has also a central aperture 39, which is considerably smaller than the aperture 28 in the frame-plate 27 and just sufficient to allow the free passage of the compound connecting-rod 40, which will be presently referred to.

Mounted opposite to the frame-plate 27 there is a back plate 41 of circular form, as shown in Fig. 7, and having three radial ears 42 at distances of ninety degrees from each other and arranged to coact with the upstanding lugs 29, formed on the frame-plate 27. These ears 42 are pierced by enlarged holes 43, through which pass three studs 44, which are secured in threaded sockets 45, formed in the lugs 29, and are insulated from the back plate 41 by collars 46, of hard rubber or other suitable insulating material, and the studs 44, coupled with the insulation 46, enable the back plate to be securely clamped to the frame-plate 27 by means of nuts 47 in the manner shown in Fig. 2. This back plate 41 has also clamped thereto a ring collar 48 of precisely similar form to the ring collar 35 and secured to the plate 41 by means of screws 49, and within the same is clamped a back electrode, also of carbon, (designated 50,) which is flush with the surface of the ring collar 48

in the same manner as is the case with the front electrode 37. The two annular flanges 36 on the ring collars 35 and 48 have each formed in their opposing faces an annular groove 51, which is connected with the exterior of the collar by means of a tangential groove 52, the purpose of this tangential groove being to enable the insertion of a strip of insulating material 53, such as celluloid, preferably of the same kind as is commonly used in photographic films, this strip 53 being inserted through the tangential grooves 52 and pushed round through the groove 51 until it closes the same, this operation being performed after the two plates 27 and 41 have been bolted together and all the parts adjusted relatively to each other. The strip of celluloid 53 thus coacts with the carbon electrodes and the ring collars to form a diaphragm-chamber in which is mounted and which is transversely divided by a compound diaphragm-electrode 54, the parts of which are made up in the manner which will now be described. This diaphragm-electrode 54 may be made of any metal, gold-plated to prevent corrosion and to secure a perfect contact, and can also be made of thin carbon, in either case the diameter being somewhat smaller than the surfaces of the carbon blocks 37 and 50. In the present case I have shown the diaphragm-electrode 54 as made up of three parts—to wit, two thin carbon plates 55 and 56, which are mounted, respectively, at the front and rear sides of a thin washer 57, of mica or other like insulating material, which extends from side to side of the strip 53, and thus divides the diaphragm-chamber into two equal portions, each of which is filled or partially filled with very fine granulated carbon 58. Both the two carbon plates 55 and 56 and the insulating-washer 57 are centrally pierced and mounted on a metal spindle 59, which has at its rear end a head 60, contacting with the rear carbon plate 56, while a metal sleeve 61 is mounted on the spindle 59 and has a flanged head 62, which contacts with the opposite or front carbon plate 55. The front end of the spindle 59 is threaded, as shown at 63, and has mounted thereon two nuts 64 and 65, the former of which is screwed down over the sleeve 61 and clamps the same firmly in place, so as to secure the three plates 55, 56, and 57 firmly in position, while the other nut, 65, is adapted to be put on after the threaded end of the spindle 59 has been inserted through the central aperture in a sound-diaphragm 66 and to clamp it thereto. It will thus be seen that the compound connecting-rod 40, made up of the parts 59, 61, 64, and 65, supports the compound diaphragm-electrode firmly in its position parallel to the sound-diaphragm 66 and coaxially therewith and also that the two plates 55 and 56 of the diaphragm-electrode are electrically connected with one another through the medium of the compound connecting-rod 40. The front half of the diaphragm-chamber, which is otherwise open at the center, is closed by a felt washer 65[a], so as to prevent the granular carbon filling the chamber from becoming spilled or getting into the sound-diaphragm chamber, and I also prefer to cushion the back motion of the diaphragm-electrode in like manner by means of a felt pad 65[b].

The sound-diaphragm 66 is made of conducting material, preferably aluminium, and is also, preferably, formed, as shown, of lenticular shape, being of gradually-tapering thickness toward its periphery, at which point it is clamped between the cover-plate 20 and the frame-plate 27, which have projecting annular lugs 67 and 68 thereon, so as to form a narrow circular chamber 69, in which the diaphragm is free to vibrate without coming in contact with any of the stationary parts. This conducting-diaphragm 66 is thoroughly insulated from the parts of the frame by an insulating-band 70, of hard rubber or other material, which is of U-shaped cross-section and bent around the edge of the diaphragm, so as to separate it on all sides from the plates 20 and 27; but at one point thereof the diaphragm 66 has a radial tab 71 projecting therefrom, which is bent at right angles and inserted through a hole 72, formed in the frame-plate 27, which hole is also surrounded by insulating material, as shown in Fig. 4, so that the tab 71 is also completely insulated from the plate 27.

The back plate 41 may have any suitable binding-screw, as 73, screwed thereinto, so as to enable the attachment of one of the wires 74 of the battery-circuit, while the tab 71 of the diaphragm 66 is likewise operatively connected to another wire 75 by means of a binding-screw 76. These wires are covered with insulating material 77 and extend through transverse apertures in the back of the cup 15 and base-block 16, which apertures are preferably surrounded by insulating-collars 78, and from thence the wires are led through lateral apertures 79 and 80 into the swinging arms 13 and 14, which are interiorly tubular, so as to permit the wires 74 and 75 to be protected on their way to the battery and induction-coil. The front carbon block 37 is not connected to any wire, but is electrically connected, as shown, to the framework of the transmitter, which itself forms the conducting means to conduct the current between this electrode and one of the poles of the induction-coil, as will presently be set forth.

We may at this point best pause to consider the mode of operation of the apparatus as illustrated diagrammatically in Fig. 5. In this diagram the parts represented diagrammatically, in particular the two carbon electrodes 37 and 50, the diaphragm-electrode 54, the connecting-rod 40, and the sound-diaphragm 66, are represented by the same nu-

merals as in the other figures of the drawings. In addition are illustrated diagrammatically the elements of an induction-coil 81 and a battery-circuit 82, both of which are operatively connected to the parts of the transmitter. The induction-coil 81 is made up of three elements—that is to say, two primary coils 83 and 84 of a few turns each and a secondary 85 of many turns, which latter is connected in series with the line-circuit, represented in the diagram by terminals 86 and 87. The first primary coil 83 has terminals 88 and 89, and the second primary coil 84 has likewise terminals 90 and 91, it being supposed that the direction from 88 to 89 is the same direction around the magnetic core of the induction-coil as the direction 90 to 91 of the second primary. The battery-circuit 82 is represented as having two terminals 92 and 93, herein represented as respectively positive and negative, to the former of which the conductor 75, which is connected with the diaphragm 66, is connected. The front carbon 37 is connected by the metallic framework of the instrument and by any suitable conducting means 115 with the terminal 88 of the first primary 83, while the back carbon 50 is represented as connected by the conductor 74 to the terminal 91 of the second primary 84, while the opposite terminals 89 and 90 of the two primaries 83 and 84 are connected together and to the negative pole 93 of the battery. Now the current of the battery will normally flow from the terminal 92 through the sound-diaphragm 66 and the diaphragm-electrode 54, whence the current divides and, passing through the granular carbon 58 in each half of the diaphragm-chamber, reaches the two carbon electrodes 37 and 50. From the carbon electrode 37 the current will flow through the first primary coil 83 in one direction, while the opposite branch of the current from the back carbon 50 will flow through the second primary coil 84 in the opposite direction, both branches joining together again at the battery-terminal 93. Now assuming that the two branch currents are equal and that the two primaries have equal inductances—that is to say, an equal number of turns around the common core of the induction-coil—the first feature of this connection to be observed is that the inductive effect of any disturbance in the main circuit of the battery will be *nil*, so that no sound is produced in the receiver of the telephone nor any current transmitted through the secondary 85 of the coil in this case; but now suppose the diaphragm 66 to be vibrated by a person speaking into the telephone. Thereupon the diaphragm-electrode 54 is caused to vibrate between the two carbon electrodes 37 and 50, whereby the approach of the electrode toward either of the carbon blocks causes the resistance of the corresponding branch of the circuit to be diminished, while the resistance of the opposite branch is increased, and accordingly the current in the first branch is increased, while that in the opposite branch is diminished. The simultaneous effect of a vibration is therefore to cause an increased current to pass through one of the primaries—as, for instance, the primary 83—in one direction, while at the same time the branch current through the other primary, 84, in the opposite direction is diminished. The consequent effect of this is that the balance is disturbed and the two branch currents no longer neutralize each other; but their variations are conjoined to double the inductive effect relatively to what it would be if only one primary were present and only one carbon block—as, for instance, the carbon block 50—as is the case with the ordinary transmitter in common use. Hence a double current is produced in the secondary coil 85 and transmitted over the line-wire, and hence the sound heard in the receiver is necessarily double in magnitude; but this is not the only effect and advantage of my construction, because it is to be observed that a battery of much less power may be employed, and the current being divided between two branches of the circuit the consequent heating is reduced to a multiple ratio of something like the third or fourth power in proportion to the decrease of the strength of the current, and hence the fatigue effect of the granular transmitter is practically eliminated, thus enabling the power of the transmitter to be practically constant in all positions of the diaphragm-electrode, and hence increasing the uniformity of the vibrations in the receiver and causing them to resemble more closely the vibrations originally produced in the original transmitter.

In Fig. 3 is shown a somewhat modified mechanical arrangement of the parts of the transmitter constituting the electrodes and diaphragm-chamber, enabling the latter to be condensed into a considerably smaller and more compact space, although the electrical arrangement of the parts is identical with that just described. In this case the parts constituting the transmitter-box, the mouthpiece, the frame-plates 27 and 41, and the sound-diaphragm and its insulation are the same as above described; but the remaining parts are altered slightly in their conformation as follows: I here employ two carbon blocks 37′ and 50′, the equivalents of the blocks 37 and 50, and these are smaller in external diameter and exteriorly cylindrical. These blocks are identical in form and have preferably concave spherical surfaces 94, which are highly polished, as I have found this conformation gives a considerably improved result. These carbon blocks 37′ and 50′ are secured fast in place to their respective plates 27 and 41 by tubular bolts 36′ and 48′, which have central bores sufficient to permit in the case of the bolts 36′ the free passage of the connecting-rod 40′

without contacting therewith, and they are secured firmly in central apertures formed in the plates 27 and 41 by having screw-threaded engagement therewith. These bolts have on their inner ends flanged heads 95, which are flush with the inner surfaces of the carbon blocks, these latter being recessed or annularly mortised, so as to permit the heads 95 to be countersunk therein as shown. With these blocks coöperates the diaphragm-electrode 54′, which is made up in a similar manner to the diaphragm-electrode 54, consisting of a central mica disk 57′ and carbon plates 55′ and 56′, these latter being, however, in this case, of plano-convex or lenticular conformation to correspond with the spherical concave surfaces 94 of the carbon blocks. The diaphragm-chamber is closed in this case by a cylindrical strip of celluloid, paper, or like insulating material 53′, which is wrapped around the carbon blocks and secured in place by a winding of cord or fine wire 96. The diaphragm-chamber is, as in the former case, partially filled with a quantity of finely-granulated carbon 58′, which is confined within the chamber to prevent it from issuing from the central apertures by central felt washers 65^c and 65^d. The connecting-rod 40′ is herein also slightly different from that shown in the former form of transmitter. The central stem or spindle 59 having the flanged head 60 and the threaded end 63 are the same as previously described, but the surrounding sleeve 61′ is formed with an annular radial flange at each end, which flanges press, respectively, against the opposing faces of the sound-diaphragm plate 66 and the carbon plate 55′, and the parts are clamped up in place by a washer 97 and a nut 65′. The conductor 74, leading from the back carbon 50′, is attached, preferably, at one side of the tubular bolt 48′ by a binding-screw 73′. The greater compactness of this form of transmitter, together with the central tubular apertures in the hollow bolts 36′ and 48′, by permitting greater freedom of vibration present several advantages over the construction shown in the other figures, as will be readily understood.

While I have shown in the accompanying drawings the preferred form of my invention, it will be understood that I do not limit myself to the precise form shown, for many of the details may be changed in form or position without affecting the operativeness or utility of my invention, and I therefore reserve the right to make all such modifications as are included within the scope of the following claims or of mechanical equivalents to the structures set forth.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a compound microphone-transmitter, the combination of a compound vibratory electrode comprising a disk of insulating material and electrically-connected plates of conducting material on either side of said disk, a chamber within which said electrode vibrates, pulverulent conducting material partially or wholly filling said chamber, a pair of stationary electrodes located opposite to and at a short distance from the said vibratory electrode, and means for vibrating said electrode in accordance with sound-waves.

2. In a compound microphone-transmitter, the combination of a compound vibratory electrode comprising a disk or diaphragm of mica and a pair of electrically-connected carbon plates on either side of said disk and within the edge thereof, a quantity of pulverulent conducting material on either side of said electrode, a pair of stationary electrodes located opposite to and at a short distance from the said vibratory electrode, and means for communicating to said electrode a vibratory movement in accordance with sound-waves.

3. In a compound microphone-transmitter, the combination of a metallic sound-diaphragm, a compound diaphragm-electrode having conducting material on either side thereof, and a compound connecting-rod securing together the parts thereof and consisting of a bolt having a flat disk-head and a threaded stem passing through central apertures in said sound-diaphragm and electrode, a flanged sleeve surrounding said bolt between said diaphragm and electrode, and a nut over the threaded end of said bolt adapted to clamp the parts solidly together.

4. In a compound microphone-transmitter, the combination of an aluminium sound-diaphragm, a compound vibratory electrode comprising a central insulating-disk and a pair of carbon plates on opposite sides thereof, and a compound electrical and mechanical connection comprising a headed bolt, flanged sleeve, and a nut, securing said diaphragm and electrode centrally and coaxially together and connecting the said carbon plates electrically with said diaphragm.

5. In a transmitter, the combination of a lenticular sound-diaphragm clamped at its edges to a stationary frame and insulated therefrom, an electromechanical connection secured at the center of and perpendicular to said diaphragm, and a vibratory electrode secured at the opposite end of said connection.

6. In a transmitter, the combination of a lenticular sound-diaphragm secured around its periphery to a stationary frame, a post secured perpendicularly to said diaphragm at its center, and an electrode carried by the opposite end of said post.

7. In a transmitter, the combination of a lenticular sound-diaphragm secured around its periphery to a stationary frame, a post secured perpendicularly to said diaphragm at its center, a vibratory diaphragm-electrode carried by the opposite end of said post in a plane parallel to said diaphragm, a closed chamber

within which said electrode vibrates, pulverulent conducting material partially or wholly filling said chamber, and a pair of stationary electrodes insulated from each other and forming opposite sides of said chamber.

8. In a compound microphone-transmitter, the combination of a transmitter-box, a cover-plate therefor having a central aperature therethrough, a frame-plate having a central aperture rigidly clamped to said cover-plate and having upstanding lugs, a back plate clamped to said lugs and insulated therefrom, a pair of stationary electrodes secured respectively to said frame-plate and back plate, an inclosing wall connecting the parts held by said frame-plate and back plate and forming an inclosed diaphragm-chamber, a vibratory electrode adapted to vibrate in said chamber, a sound-diaphragm connected to said vibratory electrode, and a coherer such as granulated carbon located in said chamber.

9. In a compound microphone-transmitter, the combination of a transmitter-box comprising a cup-shaped member and a cover-plate secured thereto and having a central opening therethrough, a mouthpiece on the outer side of said cover-plate, and a frame-plate rigidly clamped to said cover-plate and having a central aperture, a metallic sound-diaphragm having its periphery clamped between said cover-plate and frame-plate and insulated therefrom, a stationary electrode secured to the rear face of said frame-plate, a back plate rigidly clamped to said frame-plate and insulated therefrom, a secondary stationary electrode secured to said back plate on its forward face and opposite said first-named stationary electrode, a strip of insulating material such as celluloid inclosing the chamber between said electrodes, a vibratory electrode located in said chamber and dividing the same into two portions, an electromechanical connection between said sound-diaphragm and said vibratory electrode, a coherer such as granulated carbon in each portion of said closed chamber, a main conductor electrically connected to said sound-diaphragm and a pair of branch conductors respectively connected to the stationary electrodes.

10. In a compound microphone-transmitter, the combination of a transmitter-box comprising a cup-shaped body member and a cover-plate rigidly clamped thereto and having a central aperture, a mouthpiece secured around said central aperture, a screen clamped between said mouthpiece and cover-plate, a frame-plate rigidly clamped to the inner face of said cover-plate, a lenticular metallic sound-diaphragm having its periphery clamped between said cover-plate and frame-plate, each of the latter being recessed around the central portion of said diaphragm to form a diaphragm-chamber, an insulating-ring of U-shape section surrounding the periphery of said sound-diaphragm, a tab or ear formed on the edge of said sound-diaphragm and arranged to project from said frame-plate to form an electric terminal and insulated from said frame-plate, a back plate rigidly clamped to said frame-plate on the inner face thereof and insulated therefrom, said back plate and frame-plate being separated from each other by suitable intervening members, a pair of carbon electrodes secured to the opposing faces of said frame-plate and back plate, a pair of ring-collars having flanges projecting over the edges of said carbon electrodes, said collars being secured respectively to the frame-plate and back plate, a strip of laminar insulating material such as celluloid forming an annular ring inclosing the chamber between said electrodes, a compound vibratory electrode of laminar form located within said chamber and adapted to divide the same transversely, an electromechanical connection rigidly connecting said electrode to said sound-diaphragm and also electrically connecting it therewith, a coherer such as granular carbon within said diaphragm-chamber on either side of said electrode, and a pair of insulating-cushions such as felt on opposite sides of said electrode at the center so as to give resiliency to the vibration thereof and also to close the chamber at the center.

11. In a transmitter, the combination of a disk-shaped vibratory electrode, means for causing the same to vibrate, a pair of stationary electrodes located opposite to and at a small distance from said vibratory electrode, and a coherer such as pulverulent carbon located between said electrodes, one of said electrodes having a slightly-convex and the adjacent electrode a corresponding opposed concave surface, substantially as described.

12. In a transmitter, the combination of a disk-shaped vibratory electrode of lenticular form, means for causing the same to vibrate, a pair of stationary electrodes located on opposite sides of said vibratory electrode and having their faces formed with corresponding curvature, and a coherer such as pulverulent carbon located between said electrodes, the opposing faces of said electrodes being highly polished.

13. In a transmitter, the combination of a lenticular electrode of hard carbon, means for vibrating the same, a pair of hard-carbon stationary electrodes located opposite to said vibratory electrode and having each a curved face of form corresponding to that of the latter, and a coherer such as pulverulent carbon located in the space between said electrodes.

14. In a transmitter, the combination of a disk-shaped lenticular vibratory electrode of hard carbon having a highly-polished spherical face, means for causing the same to vibrate, a pair of hard-carbon stationary electrodes having highly-polished spherical concave faces corresponding to the convex faces of said vibratory electrode and opposite there-

to, and a coherer such as pulverulent carbon located in the spaces between said electrodes.

15. In a compound microphone-transmitter, the combination of a double-convex lenticular vibratory electrode, means for vibrating the same, a pair of correspondingly-concave stationary electrodes on either side of the same, and a coherer such as pulverulent carbon between said vibratory electrode and each of said stationary electrodes.

16. In a compound microphone-transmitter, the combination of a double-convex lenticular vibratory electrode of hard carbon having highly-polished spherical faces, a pair of plano-concave lenticular stationary electrodes also of hard carbon and mounted on either side of said diaphragm-electrode, the opposing faces of said stationary electrodes being highly polished and spherically concave to correspond with the convexity of the opposing faces of said vibratory electrode, and a quantity of pulverulent granular carbon located in the spaces between said vibratory electrode and each of said stationary electrodes.

17. In a compound microphone-transmitter, the combination of a compound disk-shaped double-convex lenticular vibratory electrode composed of a central circular insulating-plate and a pair of plano-convex conducting-plates on either side thereof, means clamping the parts thereof in position and electrically connecting them one to the other, a pair of plano-concave circular stationary electrodes mounted on either side of said vibratory electrode and of approximately the same diameter therewith, the opposing faces of said stationary and vibratory electrodes being highly polished, a cylinder of insulating material inclosing said electrodes and forming a closed chamber within which said vibratory electrode vibrates, means for vibrating said vibratory electrode, and a coherer such as pulverulent carbon located within said chamber on either side of said vibratory electrode and between it and the stationary electrodes.

18. In a compound microphone-transmitter, the combination of a compound disk-shaped double-convex lenticular vibratory electrode composed of a central circular insulating-plate and a pair of plano-convex conducting-plates on either side thereof, means clamping the parts thereof in position and electrically connecting them one to the other, a pair of plano-concave circular stationary electrodes mounted on either side of said vibratory electrode and of approximately the same diameter therewith, the opposing faces of said stationary and vibratory electrodes being highly polished, a cylinder of insulating material inclosing said electrodes and forming a closed chamber within which said vibratory electrode vibrates, a coherer such as pulverulent carbon located within said chamber on either side of said vibratory electrode and between it and the stationary electrodes, a vibratory sound-diaphragm, means connecting said diaphragm rigidly to said vibratory electrode at the center thereof and in a parallel plane therewith, the parts forming said diaphragm-chamber having a central bore therethrough, and a pair of washers of resilient insulating material such as felt on each side of said vibratory electrode separating it from said central bore.

19. In a compound microphone-transmitter, the combination of a frame-plate, a stationary electrode having a central aperture secured thereto on the inner face thereof, a tubular bolt passing through said central aperture and screwed into a central aperture of said frame-plate and having a flanged head seated in a recess around the central aperture of said electrode, a back plate rigidly clamped to said frame-plate and separated by an open space therefrom and also insulated therefrom, a second stationary electrode formed in like manner to said first-mentioned electrode and secured centrally to the front face of said back plate, a second tubular bolt formed in like manner to said first-mentioned bolt and securing said second electrode in like manner to said back plate, a vibratory electrode located between said stationary electrodes, a strip of insulating material inclosing the chamber between said electrodes, and a quantity of pulverulent material such as carbon located in said closed chamber.

20. In a compound microphone-transmitter, the combination of a frame-plate having a central aperture and a set of lugs projecting from its inner face, a back plate secured to said lugs and insulated therefrom, said back plate being parallel to said frame-plate, a pair of circular carbon electrodes secured opposite one another on the opposing faces of said frame and back plates, said electrodes having central apertures and annular recesses around the inner ends of said apertures, a pair of flanged headed tubular bolts passing through said apertures and engaged in threaded apertures in the frame and back plates respectively so as to secure said electrodes to their respective plates, a metallic sound-diaphragm parallel to said front plate and mounted exteriorly thereof and insulated therefrom, a strip of insulating material such as plate-celluloid surrounding said stationary electrodes and secured in place thereon so as to form a closed chamber therebetween, a circular carbon vibratory electrode mounted intermediately of said closed chamber and arranged to vibrate therein, an electromechanical connection rigidly connecting said vibratory electrode and said sound-diaphragm at their centers and passing through the center of one of said tubular bolts without contacting therewith, a quantity of pulverulent carbon on each side of said vibratory electrode within said closed chamber, and a pair of felt washers closing the central apertures of said chamber formed by said tubular bolts.

21. In a transmitter, the combination of a disk-shaped vibratory electrode, means for causing the same to vibrate, a pair of stationary electrodes located opposite to and at a small distance from said vibratory electrode, and a coherer such as pulverulent carbon located between said vibratory electrode and each stationary electrode, the adjacent faces of the vibratory and stationary electrodes being correspondingly convex and concave, substantially as described.

22. In a transmitter, the combination of a disk-shaped vibratory electrode of lenticular form, means for causing the same to vibrate, a pair of stationary electrodes located on opposite sides thereof and opposite to the respective lenticular faces of said vibratory electrode and having their faces formed with a corresponding curvature, and a coherer such as pulverulent carbon located between said electrodes, the opposing faces of said electrodes being highly polished.

23. In a compound microphone-transmitter, the combination of a metallic sound-diaphragm, a disk-shaped vibratory electrode, and a compound connecting-rod electrically and mechanically securing said diaphragm and electrode in coaxial relation without solder or other permanent fastening and comprising a bolt, a nut on the end thereof, and a sleeve mounted on said bolt between the diaphragm and electrode, said diaphragm and electrode being clamped between either end of said sleeve and the head and nut of said bolt respectively.

24. In a compound microphone-transmitter, the combination of a compound vibratory electrode comprising a disk of insulating material and electrically-connected plates of conducting material on either side of said disk, a chamber within which said electrode vibrates, conducting material within said chamber on both sides of said electrode, a pair of coöperating electrodes, and means for vibrating the compound electrode in accordance with sound-waves.

25. In a telephone-transmitter, the combination with a diaphragm thereof, of two relatively stationary electrodes, an intermediate electrode, a stem passing through one of said relatively stationary electrodes and mechanically connecting said diaphragm with said intermediate electrode, a tube of insulating material inclosing said intermediate electrode, connecting said relatively stationary electrodes and forming therewith an electrode-chamber, a flexible mica diaphragm interposed between the periphery of said intermediate electrode and the walls of said tube of insulating material, the periphery of said mica diaphragm being secured to the tube-walls, said diaphragm dividing the electrode-chamber into two compartments, and adapted to permit a movement of said intermediate electrode with respect to said relatively stationary electrodes and granular carbon interposed between the electrodes in each of the compartments of said electrode-chamber.

26. In a telephone-transmitter, the combination with a diaphragm thereof of two relatively stationary electrodes, an intermediate electrode, a stem passing through one of said relatively stationary electrodes and mechanically connecting said diaphragm with said intermediate electrode, a tube of insulating material inclosing said intermediate electrode, connecting said relatively stationary electrodes and forming therewith an electrode-chamber, a flexible mica diaphragm interposed between the periphery of said intermediate electrode and the walls of said tube of insulating material, the periphery of said mica diaphragm being secured to the tube-walls, said diaphragm dividing the electrode-chamber into two compartments, and adapted to permit a movement of said intermediate electrode with respect to said relatively stationary electrodes, granular carbon interposed between the electrodes in each of the compartments of said electrode-chamber, and an induction-coil having two differentially-connected primary windings, each connected in an electrical circuit including said intermediate electrode, one of said relatively stationary electrodes, the intervening granular carbon, and a source of current.

27. In a telephone-transmitter, the combination with a diaphragm thereof, of two relatively stationary electrodes, an intermediate electrode, a mechanical connection between said intermediate electrode and said diaphragm, a tube of insulating material surrounding said intermediate electrode and connecting said relatively stationary electrodes to form therewith an electrode-chamber, a flexible mica diaphragm upon which said intermediate electrode is mounted, the periphery of said mica diaphragm being secured to the walls of said tube, said flexible diaphragm dividing the electrode-chamber into two compartments and permitting movement of said intermediate electrode with respect to said relatively stationary electrodes, and granular carbon interposed between the electrodes in each of the compartments of said electrode-chamber.

28. In a telephone-transmitter, the combination with a diaphragm thereof, of two relatively stationary electrodes, an intermediate electrode, a mechanical connection between said intermediate electrode and said diaphragm, a tube of insulating material surrounding said intermediate electrode and connecting said relatively stationary electrodes to form therewith an electrode-chamber, a flexible mica diaphragm upon which said intermediate electrode is mounted, the periphery of said mica diaphragm being secured to the walls of said tube, said flexible diaphragm dividing the electrode-chamber into two compartments and permitting movement of said

intermediate electrode with respect to said relatively stationary electrodes, granular carbon interposed between the electrodes in each of the compartments of said electrode-chamber, and an induction-coil having two differentially-connected primary windings each connected in an electric circuit including said intermediate electrode, one of said relatively stationary electrodes, the intervening granular carbon and a source of current.

In witness whereof I have hereunto set my hand in the presence of two witnesses.

AUGUSTE GAMACHE.

Witnesses:

J. W. MACKIE,

M. C. MELINDA MACKIE.