(No Model.) 3 Sheets—Sheet 1.

A. RETTIG.

TELEPHONE.

No. 481,284. Patented Aug. 23, 1892.

Fig. 1.

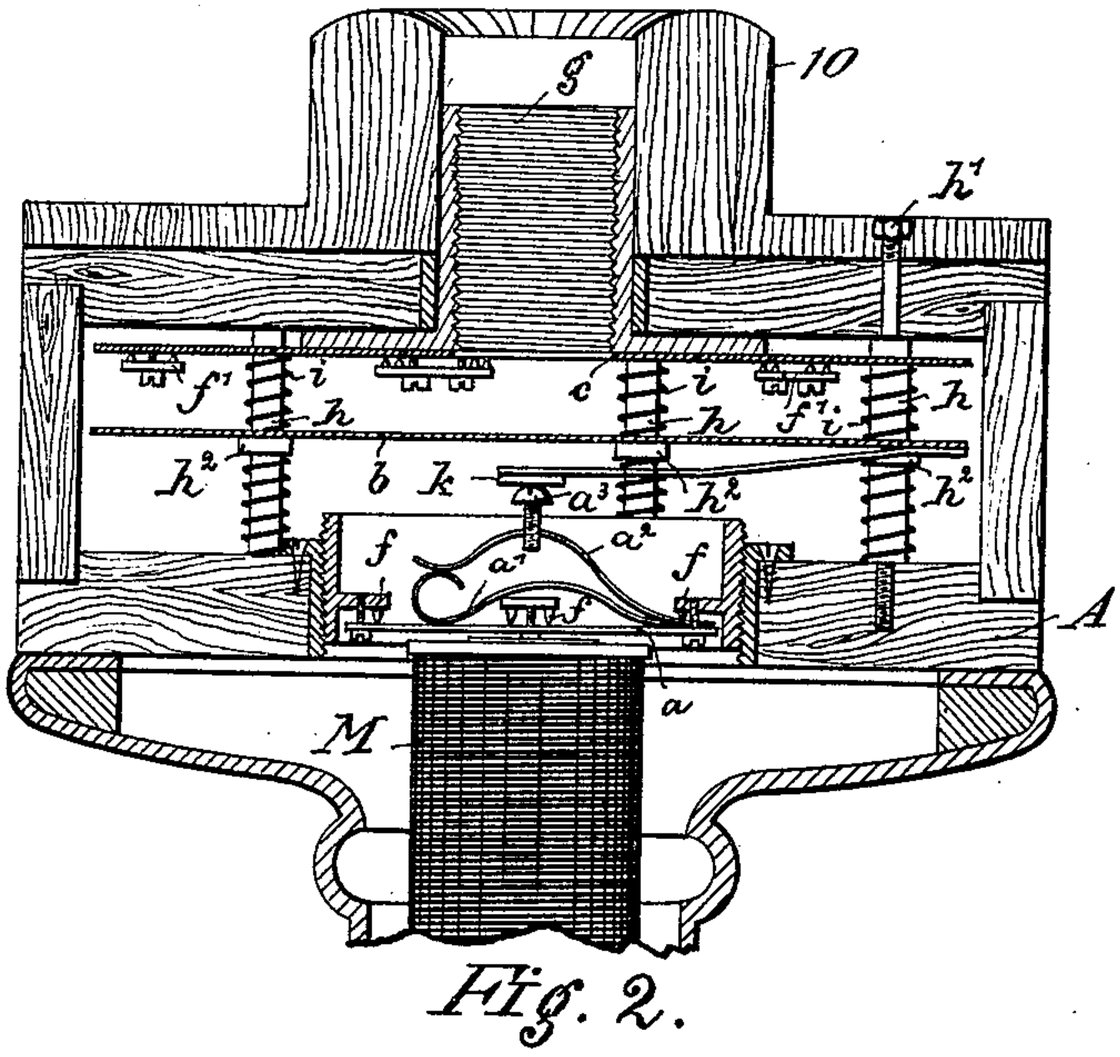
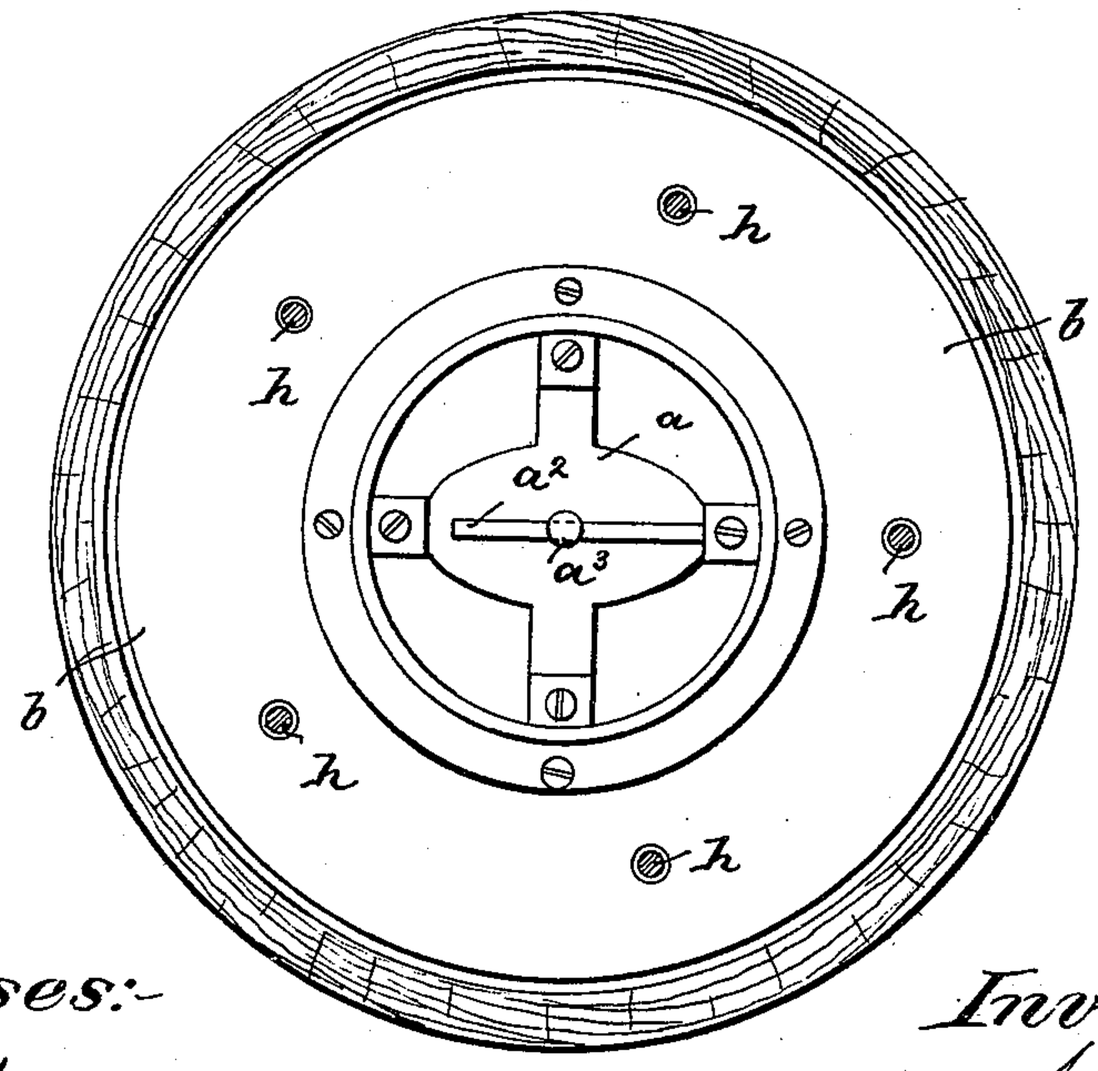


Fig. 2.



Witnesses:-
Fred'k Haynes
D. H. Hayward

Inventor:-
Adolf Rettig
by Attorneys
Brown & Seward

(No Model.) 3 Sheets—Sheet 2.

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Fig. 3.

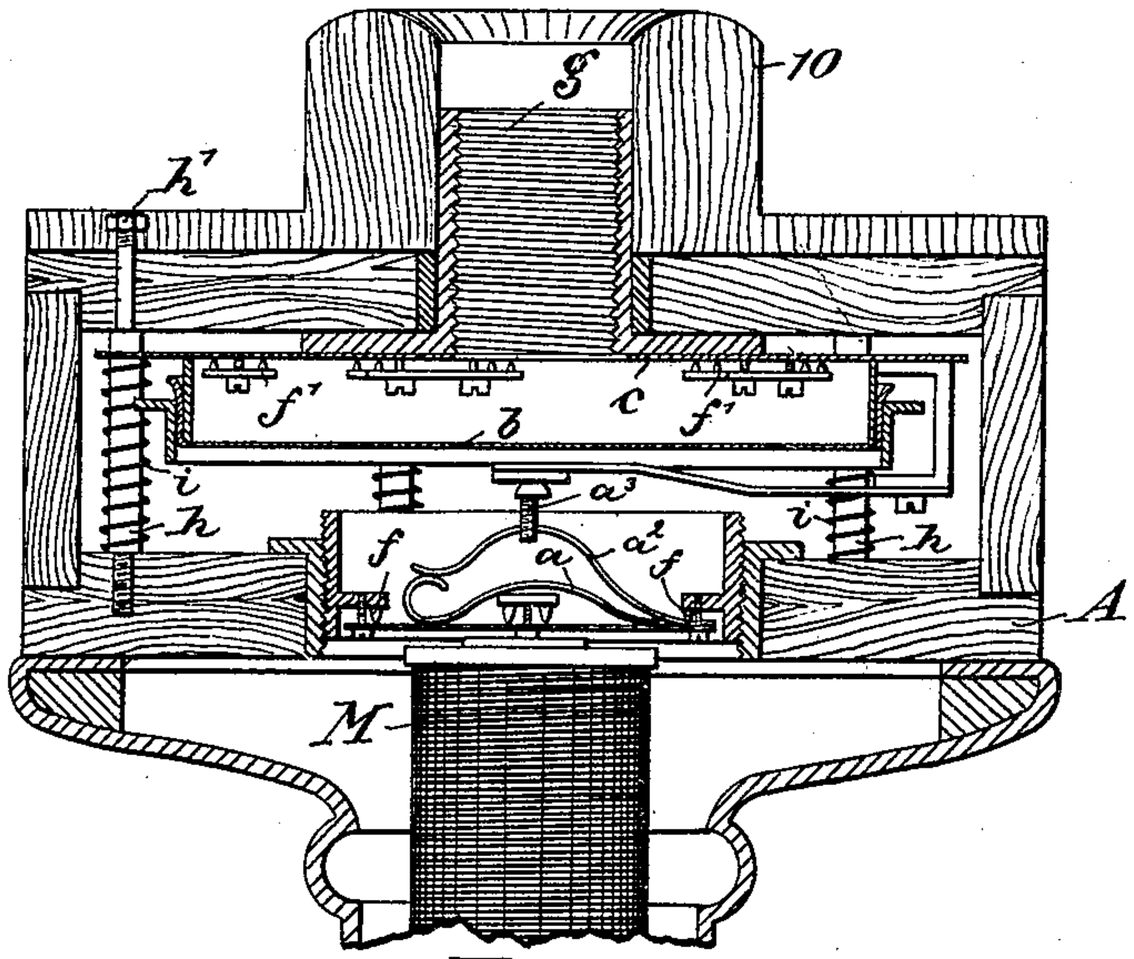
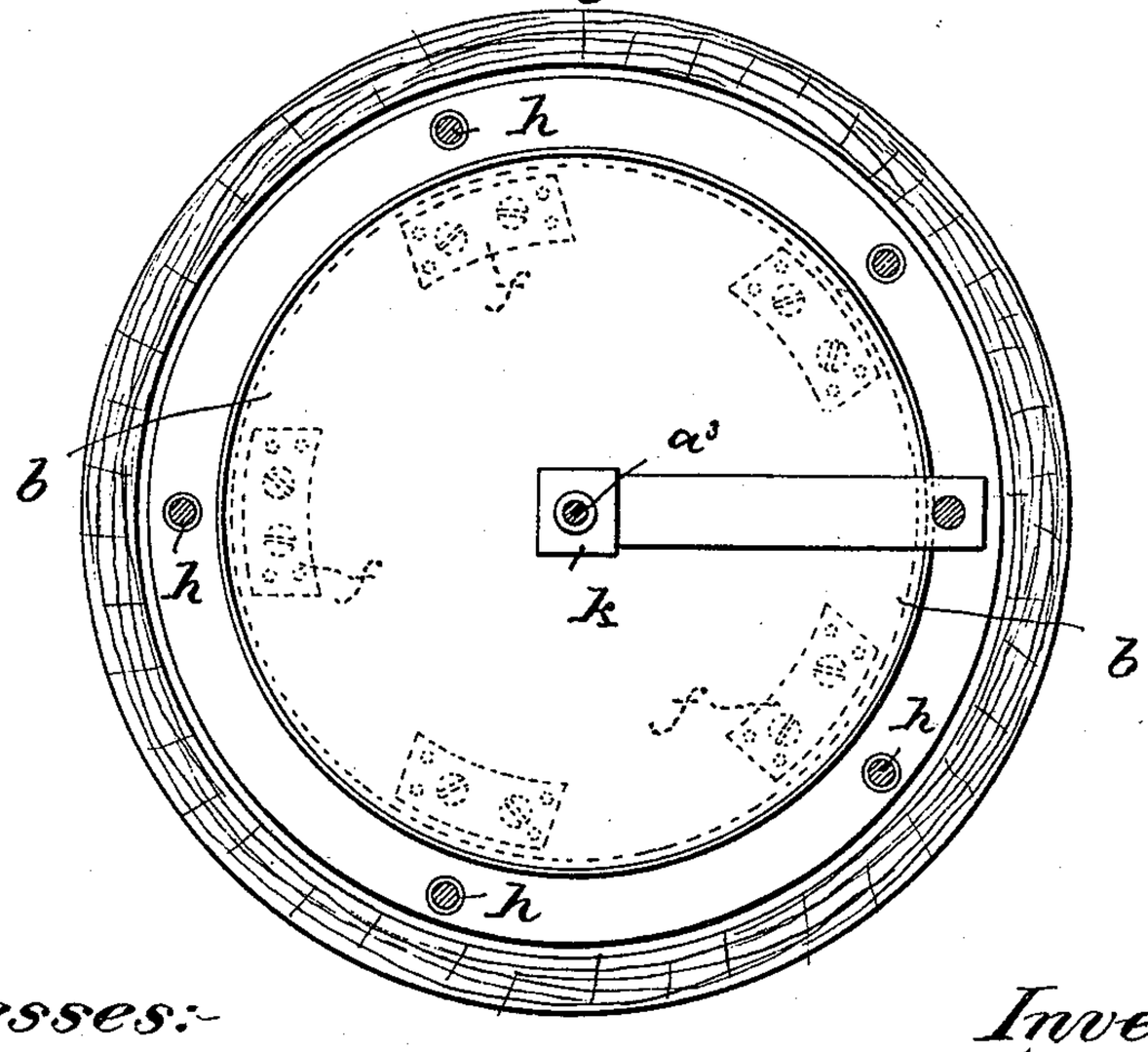


Fig. 4.



Witnesses:-

Fred^k. Haynes

D. F. Hayward

Inventor:-

Adolf Rettig

by attorneys

Frank T. Seward

(No Model.) 3 Sheets—Sheet 3.

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Fig. 5.

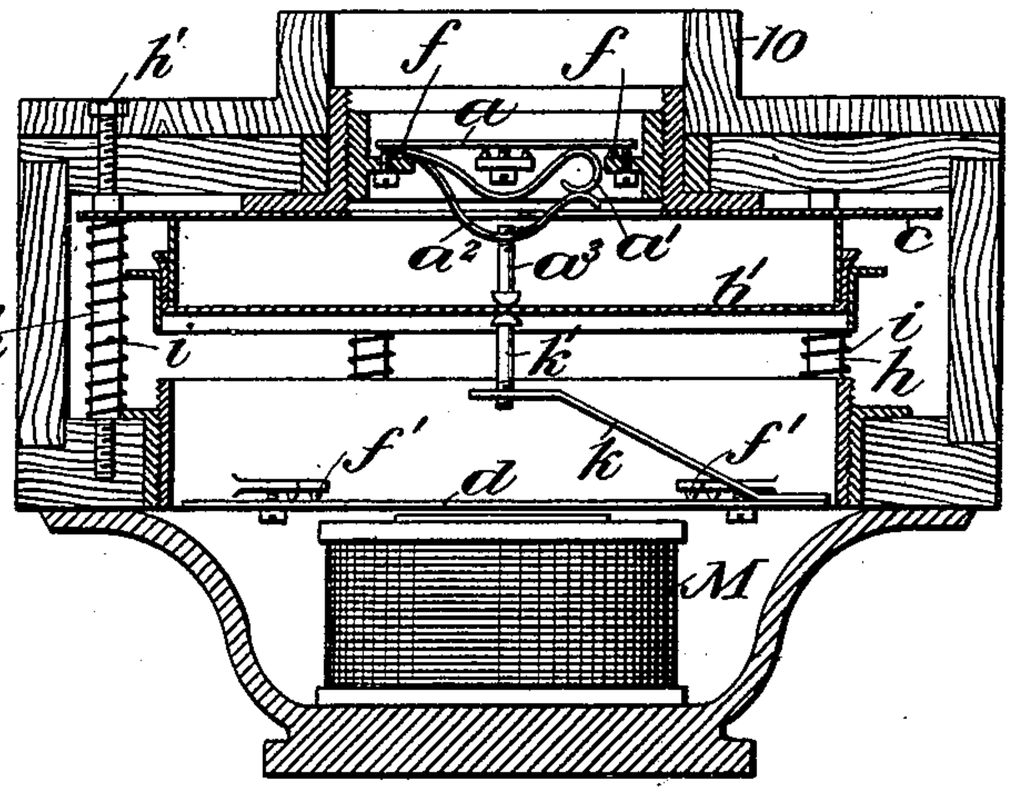


Fig. 6.

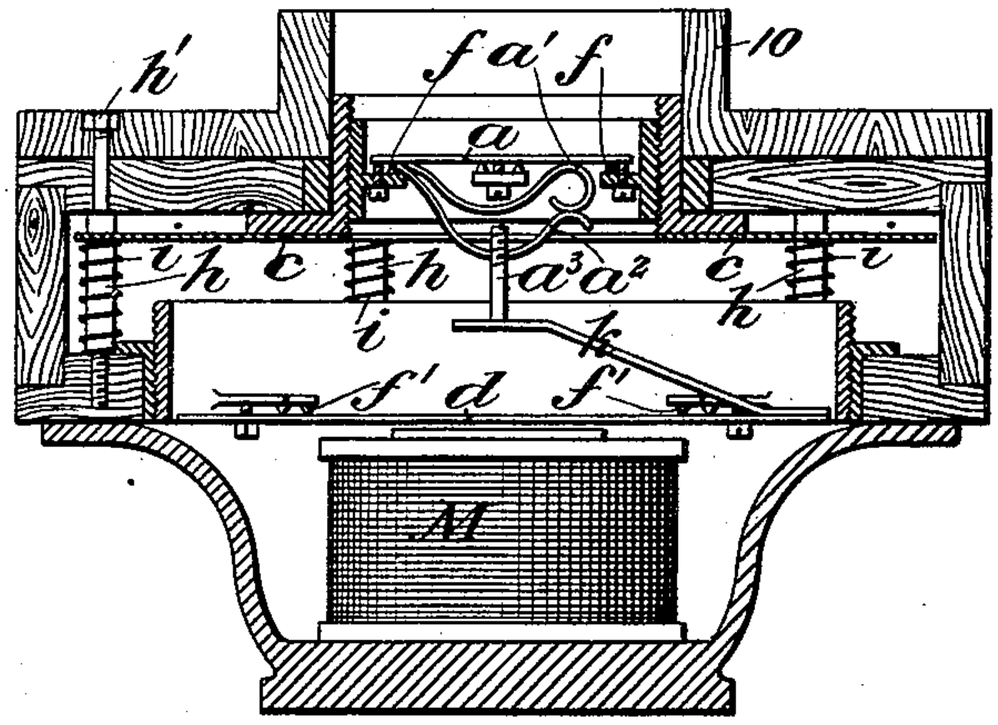
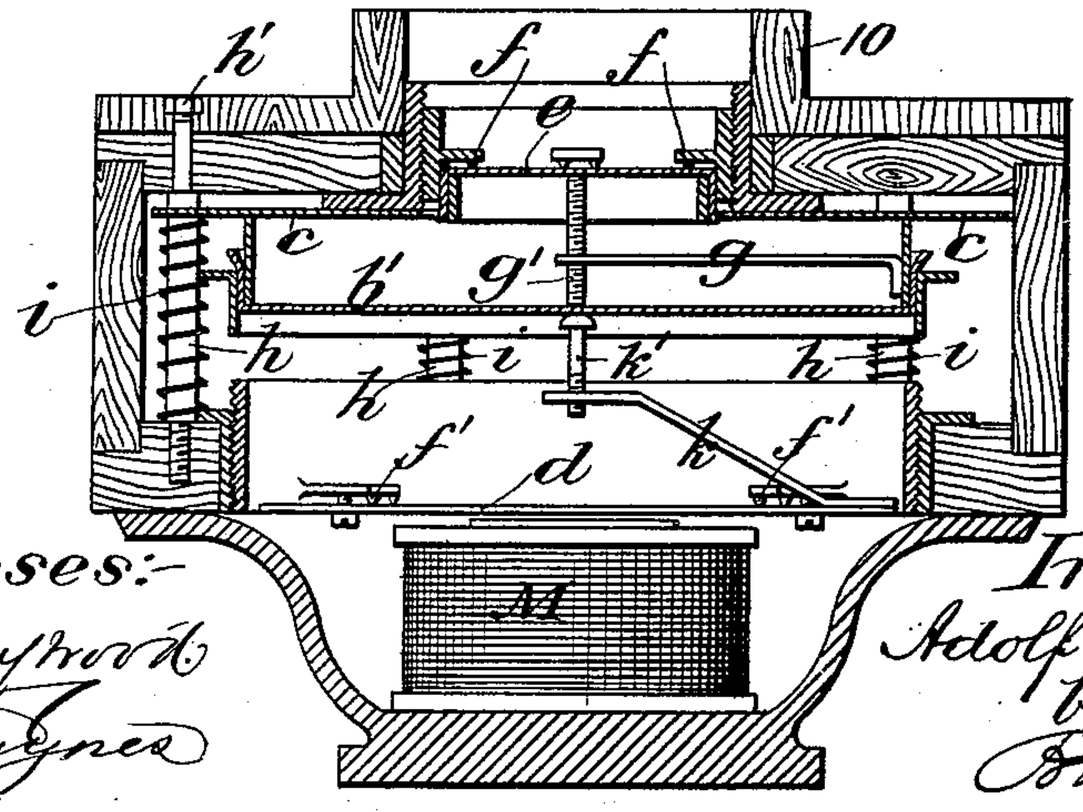


Fig. 7.



Witnesses:-
O. H. Haywood
Fred'k Haynes

Inventor:-
Adolf Rettig
by attorneys
Brown & Lewis

UNITED STATES PATENT OFFICE.

ADOLF RETTIG, OF SAARBRÜCKEN, GERMANY.

TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 481,284, dated August 23, 1892.

Application filed February 17, 1892. Serial No. 421,909. (No model.)

To all whom it may concern:

Be it known that I, ADOLF RETTIG, a subject of the Emperor of Germany, and resident at Saarbrücken, Germany, have invented new and useful Improvements in Telephones and Microphones, of which the following is a specification.

This improvement relates to the means for the closure of the circuit in telephones and microphones. Heretofore these have not satisfied the demands which must be made upon them. They still possess many faults, which must be corrected in order to bring telephony to a state of perfection. By the present invention this art is brought considerably nearer to that desideratum.

My improvement is founded in the main on the utilization of several diaphragms of the same or of different materials considerably varying in size, on the advantageous utilization of the sound-conducting property of the wooden portions of the case of the instrument, and on artificial regulation of resonance.

In carrying out my invention the arrangements at the back of the receiving-plate or back of the telephone-head remain unchanged. As all changes in the telephone may be applied, *mutatis mutandis*, to the microphone, it may suffice if the same are explained here specially in the telephone. I sometimes make use of metal diaphragms only, sometimes of metal diaphragms in combination with diaphragms of other acoustically-active materials, such as rubber membranes, animal membranes, wooden disks, &c. For the transmitter and the receiver special constructions may be used. Each apparatus, however, can, as heretofore, be also used for both purposes.

In the accompanying drawings various constructions for receiving-instruments and transmitters are represented.

Figure 1 represents a central section of a transmitter in which only metal diaphragms are used, and Fig. 2 a transverse section of the same. Fig. 3 represents a central section of a transmitter in which metal and rubber diaphragms are used, and Fig. 4 a transverse section of the same. Fig. 5 represents a central section of a receiver in which metal and rubber diaphragms are used. Fig. 6 represents a central section of a receiver in which only metal diaphragms are employed. Fig. 7 represents a central section of a receiver on which, besides the middle diaphragm, the small diaphragm is also made of rubber.

In the two transmitters represented in Figs. 1, 2, 3, and 4 three diaphragms *a b* or *b′* and *c* are employed. The diaphragm *b′* is of rubber and the diaphragms *a b c* are of metal.

The metal diaphragm *a*, which in the drawings has an oval form, advantageous here, is placed immediately in front of the magnet M. The same can be brought closer to the magnet or removed from the same by the screwing up or down of the socket to which it is fastened from below. The pins *f*, inserted in the arms of this socket with their rounded heads projecting downward therefrom, serve as dampers for regulation of resonance. These pins, through their contact, divide the metal diaphragm *a*, pressed against them, into smaller vibrating parts. The shortening of the vibrations thus produced has the effect of producing a clearer, purer, and more distinct and consequently a more audible tone.

The metal diaphragm *a* is used in all transmitters embodying my invention, whether only metal diaphragms are employed or metal diaphragms in combination with a rubber diaphragm or the like. Over the metal diaphragm *a* there is in the example Figs. 1 and 2 a metal diaphragm *b* and in the example Figs. 3 and 4 a rubber diaphragm *b′*, both considerably larger than the metal diaphragm *a*. This has the resultant advantage that the vibrations of great amplitude and less power which move the large diaphragm *b* or *b′* are changed by the transmission to the so-much-smaller diaphragm *a* into vibrations of smaller amplitude and greater force. Over the diaphragms *b* and *b′* there is a third diaphragm *c*, always consisting of metal, with a short upright flanged metal socket or junction-tube *g* for a mouthpiece. This diaphragm *c* lies close against the flange of its socket *g*, which lies close against the wooden cover of the instrument, while the diaphragm is otherwise free on its upper side. All the three diaphragms are connected with each other and with the wooden portions of the telephone-head.

On the wooden bottom or back of the box A, into which the small metal diaphragm *a* is

sunk, there stand screw-studs *h* in suitable number, of brass or bronze. These serve for connecting the diaphragms lying over the metal diaphragm *a* and also for connecting the wooden top of the head or case with the bottom or back, and, through the medium of the latter, with the metal diaphragm *a*. To the latter diaphragm there are transmitted, by means of the back or bottom A of the case, all vibrations imparted to this latter by the screw-studs and increased by the bottom as a sounding-board. For furthering this purpose, as well as for furthering the proportions of vibrations generally, the screw-studs at all points where they are free within the head or case are surrounded by very elastic fine-wire spirals *i*. The screw-studs *h* reach through the wooden cover. After the interior construction of the telephone-head has been set upon the bottom or back A and the other wooden portions of the case have been placed thereon all are secured together by means of nuts *h'*, screwed onto the ends of the screw-studs. The telephone-head thus closed is fixed to the neck of the telephone. The wooden back, in which lies the metal diaphragm *a*, is cut lengthwise of the fiber in consideration of its solidity. The metal bushing or lining in the center of said back, however, makes it possible that instead of a simple conduction of the vibrations across the wood fiber (which has only about one-third of the strength of the conductivity along the wood fiber) the conduction of the vibrations along the wood fiber becomes effective practically by the roundabout way through the metal bushing referred to.

The vibrations of the large diaphragms *b* and *b'* are imparted to the small metal diaphragm *a* directly by a lever *k*, in combination with a spring device on the small metal diaphragm *a* itself in the manner illustrated in the drawings, Figs. 1 and 3. If the middle diaphragm of the transmitter—as the diaphragm *b* in Fig. 1—is of metal, then the lever is fastened to its lower side or back close to its edge between two of the screw-studs *h*. The said lever *k* is represented in the form of a plate-spring inclined obliquely downward and bent horizontally at its free end. The position of the diaphragm *b* is adjusted from below by nuts h^2 on the screw-studs *h*, so that after regulation the relative position of the lever is subject to no undesired changes. From above the said diaphragm *b* is pressed against the nuts h^2 by the wire spirals between it and the third diaphragm, or, as it may be termed, the "cover-diaphragm." If the diaphragm *b* vibrates toward the small diaphragm *a* on being subjected to a sound vibration from above, then its center sinks and its edges rise, from which it results that the free end of the lever *k* sinks toward the small metal diaphragm *a*. If the diaphragm *b* vibrates upward, then its center rises, while its edges sink, and in consequence the free end of the lever rises.

The lever is intended to transmit the vibrations of the middle diaphragm *b* directly to the small metal diaphragm *a*, and that in a measure of increase corresponding to the power of the lever. For the purpose of this transmission a spring device is affixed to the upper side of the small metal diaphragm *a* itself. This device consists, in the first place, of a fine plate-spring *a'*, fastened to one arm of the metal diaphragm *a*, bent upward over the center of the same, then bent downward without fastening onto the other end of the same, and there terminating in an upwardly-directed coil. On the fastened end of the said spring *a'* there is affixed one end of a second upwardly-bent plate-spring a^2, which at its other and free end, curved somewhat upward, lies loosely on the coil of the spring *a'*. Through the apex of the spring a^2, affixed to the metal diaphragm *a* over the center of the said diaphragm, there is screwed a pin a^3, which has a rounded head of brass or bronze and which is adjustable by screwing to bring its head in light contact with the free end of the plate spring or lever *k*, affixed to the lower side of the diaphragm *b*. When the lever *k* swings downward, its free end presses on the pin a^3, and the vibration of the diaphragm *b* is thus, through the medium of the spring device *a' a²*, imparted directly to the small diaphragm *a*. If the lever swings upward, the contact is broken.

In order to prevent a disturbing metallic noise, it is advisable to cover the lever *k* at the point of contact of the pin a^3 with a very fine piece of membrane or the like. The circumstance that the lower one of the two springs *a' a²*, fastened to the metal diaphragm *a*, is fastened only at one end to the said diaphragm, while its other end only lies loosely on the said diaphragm is the cause of brisker vibrations of the diaphragm *a*. On the under side of the metal cover-diaphragm *c* small plates with resonance-regulating pins or dampers *f'* are tightly fitted, the rounded heads of the said pins lying against the said metal diaphragm. The vibrations of the metal cover-diaphragm are very strong, especially when a paraboloid hearing and speaking tube on the Rettig system or a single "tone-bringer" is connected with the socket *g*, the like also even if the mouth of the speaker be brought near the said socket. These vibrations are imparted by the screw-studs *h*, with their wire spirals *i*, to the middle diaphragm *b*, and through this directly to the metal diaphragm *a*, while at the same time the said vibrations are by the screw-studs and the flange of the socket *g* on the cover-diaphragm *c* imparted, also, to the wooden parts of the telephone-head, and through these again to the diaphragm *a*. Altogether the whole construction is so calculated that every vibration which occurs is effectively utilized as regards the metal diaphragm *a* and the magnet.

As regards the wooden parts of the telephone-head, this is assured in such manner that everywhere, practically, either directly

or indirectly—as, for instance, in the bottom or back A—the vibrations are rendered effective lengthwise of the fiber. The side walls of the telephone-head are placed with the longitudinal fiber running perpendicularly.

If the vibrative parts consisting of the wooden portions are to be entirely utilized, the wooden cover must be made of two boards or layers united, of which the under one is cut lengthwise of the fiber, but is tightly bushed by a metal ring, while the upper one, having on it the junction-boss 10, is so placed that the wood fiber stands perpendicularly. The circular opening in the middle of the cover is to be made so large that the socket *g* passes freely within it. The flange of the said socket must lie closely against the metal bushing-ring of the lower board of the wooden cover. If the advantages offered by the vibrations of the wooden parts of the telephone-head are not desired to be completely utilized—say on account of simplification of labor—then the side wall, with the wooden cover and junction-disk, may also be made of one piece with perpendicular running fiber. As the flange of the socket or junction tube *g* is pressed from below tightly against an area equal to that of the whole of the junction-boss 10, the most important vibrating parts are even then brought into communication with each other.

In large telephone-heads, which develop very strong power of resonance, it is advisable to fully utilize all advantages offered by the vibrations offered by the wooden portions. The junction-boss 10 must in every case show perpendicular fiber. The same must have the form and size of the ear-piece of the medical stethoscope. The ear-pieces hitherto used in telephones are acoustically very unfavorably constructed as regards form and size. The area of the skull around the outer auditory-canal, which is favorable to the conduction of vibrations, is small. It does not extend beyond the usual size of the ear-piece of the medical stethoscope.

In the telephone-heads hitherto used the wood fiber, not to speak of anything else, lies so that transverse conduction must take place. The consequence of this is that the influence of the sound-vibrations is in the main limited to the direct influence of the sound-waves on the receiving-plate, while the very effective vibrations of the wooden parts are utilized only in a very slight measure. If a paraboloid hearing and speaking tube on the Rettig system or a single tone-bringer is connected with the socket or junction tube *g* of the transmitter, the same act automatically, with considerable increase of tone, to lead to the telephone the tone even from a distance. If the middle diaphragm of the transmitter is a rubber diaphragm, as in the example, Figs. 3 and 4, a short tin cylinder is connected with the cover-diaphragm *c*, and over the lower opening of this tube the rubber diaphragm is stretched by means of a ring with projecting edges, which is drawn up to the cover-diaphragm by screws. The resonance regulation is adjusted either on the cover-diaphragm inside or outside of the cylinder or on the tin cylinder. The plate-spring *k*, acting as a lever, is so adjusted in this example that it lies free under the rubber diaphragm. The said spring is fastened either to the cover-diaphragm or to the tin cylinder, or to the contrivance for stretching the diaphragms. The plate spring or lever *k*, bent upward and then horizontally at its free end, is so adjusted with its horizontal bent end to the center of the rubber diaphragm that it only just touches the latter quite lightly. The head of the pin a^3 on the spring device lying over the small metal diaphragm *a* is brought up to the under side of the lever *k*, and that in such a way that it only just touches the said lever quite lightly. In order to avoid any disturbing metallic noise upon the touching of this head by the plate-spring, the latter is here, also at the point of contact, covered with a very fine membrane or the like.

The vibrations of the rubber diaphragm *b'* are much stronger than those of the metal diaphragm *b*. The effect of the transmitter with a rubber diaphragm is therefore correspondingly greater.

Instead of the rubber diaphragm any other similar acoustically-effective diaphragm—for instance, an animal membrane—may also be used.

The diaphragms *b b'* and *c* may be made as large as desired, and the force of the vibrations increased correspondingly. The increase in the size of the diaphragms will be accompanied by a correspondingly-greater increase of the vibrations through the so-much-larger telephone-heads.

In the receivers shown in Figs. 5 and 6 the same acoustic principles are utilized as in the transmitter, only the construction appears reversed here and somewhat modified in accordance with the special purpose.

In the bottom of the telephone-head a larger round metal diaphragm *d* is here fastened adjustable by screws in a similar manner to the small metal diaphragm *a* in the transmitter. Instead of this, however, a metal diaphragm, as usual hitherto, may be laid on the neck of the telephone, only in such a case the diaphragm cannot without danger of catching be brought so near to the magnet M as when the metal diaphragm is screwed into the bottom. Instead of the bottom board a wooden ring must then be placed over the diaphragm. The said ring in order to avoid transverse conduction must be made so that the fiber runs parallel with the faces of the diaphragms. To this wooden ring the screw-studs *h* are then affixed.

As regards the regulation of resonance with the diaphragm *d*, it is advisable here to limit it to four resonance-regulating pins *f'* or dampers a quarter of a circle apart from each other, as in such a regulation of resonance

the maximum of force is developed. The resonance-regulating pins *f'* or dampers are to be fastened when the diaphragm is screwed into the wooden plate in the same manner as with the small metal diaphragm *a* of the transmitter.

If the diaphragm is only laid loosely on the neck of the telephone, the regulation of the resonance is effected by means of small plates with resonance-regulating pins or dampers, as with the cover-diaphragm *c* on the upper or on the under side of the diaphragm. The sound-wave which causes the middle diaphragm of the transmitter to sink in its center is continued into the receiver, and consequently causes the metal diaphragm *d* in front of the magnet to rise upward in its center. In consideration of this the lever *k* is to be placed on the upper side of this diaphragm. The small metal diaphragm *a* is here adjusted in a socket screwing into the flanged socket of the cover-diaphragm *c*, the said diaphragm *a* having its spring device a' a^2 underneath. The contact of the lever *k* and the pin a^3 on the spring device at the diaphragm *a* takes place, if only metal diaphragms are used, as it does in the transmitter in such a case, only here the lever acts from below, while in the transmitter it acts from above. If a rubber diaphragm is also used, Fig. 5, it is adjusted between the large metal diaphragm *d*, placed before the magnet, and the cover-diaphragm *c* in a similar manner as in the transmitter. It then lies between the lever *k* on the large metal diaphragm *d* in front of the magnet and the spring device of the small metal diaphragm *a*. The contact of the lever *k* and the rubber diaphragm is here effected as follows: In the free horizontal bent end of the lever under the center of the rubber diaphragm there is tapped a perpendicularly-placed screw-pin *k'*, adjustable longitudinally by screwing, the said pin having a spherically-rounded head, which is brought so close to the rubber diaphragm from below as just to touch it quite lightly. On the other side of the rubber diaphragm the head of the screw-pin a^3 of the spring device of the small metal diaphragm *a* is adjusted in the same manner to the rubber diaphragm.

The effect of the receivers in which only metal diaphragms are used is inferior in force to the effect of the apparatus in which a rubber diaphragm is also employed.

The firm fastening of the metal diaphragm *d*, which can of course, if indicated, be made to more than four arms, permits of the use of a larger metal diaphragm in front of the magnet than hitherto.

The rubber diaphragm *b'* and the metal diaphragm *c* may be made as large as desired and the tone be increased in proportion to the so-much-greater resounding force of the larger telephone-head. Of course in that case the resonance regulation is to be intensified in proportionate manner.

Tone-bringers of lesser focal distance may be connected with their front opening to the socket on the cover-diaphragm *c*. On the drawings, Figs. 5 and 6, the adjustment of the front opening of a tone-bringer of 0.4 millimeter focal distance is supposed.

In connecting a flat tone-bringer the fitting of the same takes place in the same manner as in the transmitter. If in the receiver a tone-bringer of lesser focal distance is used, the same may be made divided in such manner that a portion of the same near the apex can be screwed off. The hearer can thus hear from a greater distance than otherwise. One always hears in the focus. If the noises of the room in which it is desired to hear are to be kept away, a conduction-tube with insertion-heads at the end, as in my tone-bringer, is to be adjusted to the flanged socket of the cover-diaphragm *c*, or if a tone-bringer of lesser focal distance is used, then to this or to its conduction-tube. In this manner the observing ear may without annoyance be hermetically shut off, if necessary. If on the adjustment of tone-bringers the outside noises are to be kept out, only a very flat tone-bringer must be used, as in the transmitter. Here also the telephone is most advantageously so connected that the middle diaphragm is placed in the focus of the paraboloid, and only a small surface of the same lies free to the outside.

In place of the small metal diaphragm *a* in the receiver a small round rubber diaphragm *e* may likewise be fastened in the adjustable interior socket, to which the metal diaphragm *a* is adjusted. For this purpose the arms of the said socket are retracted somewhat and the rubber diaphragm *e* is so pushed against the resonance-regulating pins *f* by means of an exactly-fitting small tin cylinder that it is tightly stretched and at the same time touches the heads of the said pins. In case no other rubber diaphragm is adjusted in the receiver, nothing else is necessary. If, however, a rubber middle diaphragm *b'* is employed in the receiver, a little change in construction is necessary, a simple lever *g* being affixed to the inner side of the tin cylinder, on which the rubber diaphragm *b'* is stretched, the said lever having in its free end a screw-pin *g'*, which projects above and below and is adjusted over the center of the rubber diaphragm *b'*, the said pin being spherically rounded off at both ends. The end of the said pin *g'*, which is directed against the rubber diaphragm *b'*, is brought to the said diaphragm in such manner that its lower end just barely touches the said diaphragm quite lightly. Thereupon the small rubber diaphragm *e* is also, by means of screwing from above, brought so toward the upper end of the said pin that the said pin only just barely touches the latter diaphragm quite lightly.

Fig. 7 shows the construction in case of the employment of two rubber diaphragms. The tone is stronger when two rubber diaphragms are employed than when only one rubber dia-

phragm is used. What holds good for the telephone holds good, also, *mutatis mutandis*, for the microphone. If a thin disk of wood is used as a receiving-plate, the same must be bordered at its edge with metal and fastened in the front plate of the microphone as a bottom plate in the same manner as the small metal diaphragm *a* in the transmitter of the telephone or the larger metal diaphragm *d* in the receiver of the telephone. The resonance regulation is then to be so adjusted that the heads of the resonance-regulating pins touch the metal border of the wooden disk.

The hereinbefore-specified constructions considerably exceed, even without the employment of tone-bringers, the other known constructions in naturalness, clearness, distinctness, and strength of tone, as also in regard to distance of speaking and hearing. On adding tone-bringers all these advantages are increased in a considerable measure. Quite remarkable, among other things, is the extension of the speaking distance. In my experiments telephones of acknowledged excellent construction, after removal of their former telephone-head, as also of their receiving-plate, were used as a base for the new telephone-heads, while unchanged telephones of the same construction were used for comparison.

On comparison with the unchanged telephones it was shown that for distance the unchanged transmitter allowed of a speaking distance of only twenty-five to thirty centimeters. On using a transmitter provided in a rude extemporized way with my improvements the speaking distance was at once so extended that without speaking toward the apparatus every word could be clearly and distinctly understood at a distance of four miles, whether the speaker spoke in the same room or in the adjoining rooms, in the hall, on the stairs, or in another room adjoining the hall.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The improvement in telephones and microphones, consisting in the combination, with a wooden case or head, of a plurality of diaphragms of different area, lever and spring devices connecting the said diaphragms with each other, and screw-studs and spiral springs thereon connecting the said diaphragms with each other and with the wooden case, substantially as and for the purpose herein set forth.

2. The construction of the wooden head of a telephone or microphone transmitter with the grain of the wood running across the back, substantially as and for the purpose herein specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ADOLF RETTIG.

Witnesses:
FRANZ HASSLACHER,
FRIEDRICH CORRELL.