

(No Model.)

A. E. PAIGE.  
ART OF TELEPHONING.

No. 543,190.

Patented July 23, 1895.

FIG. 1.

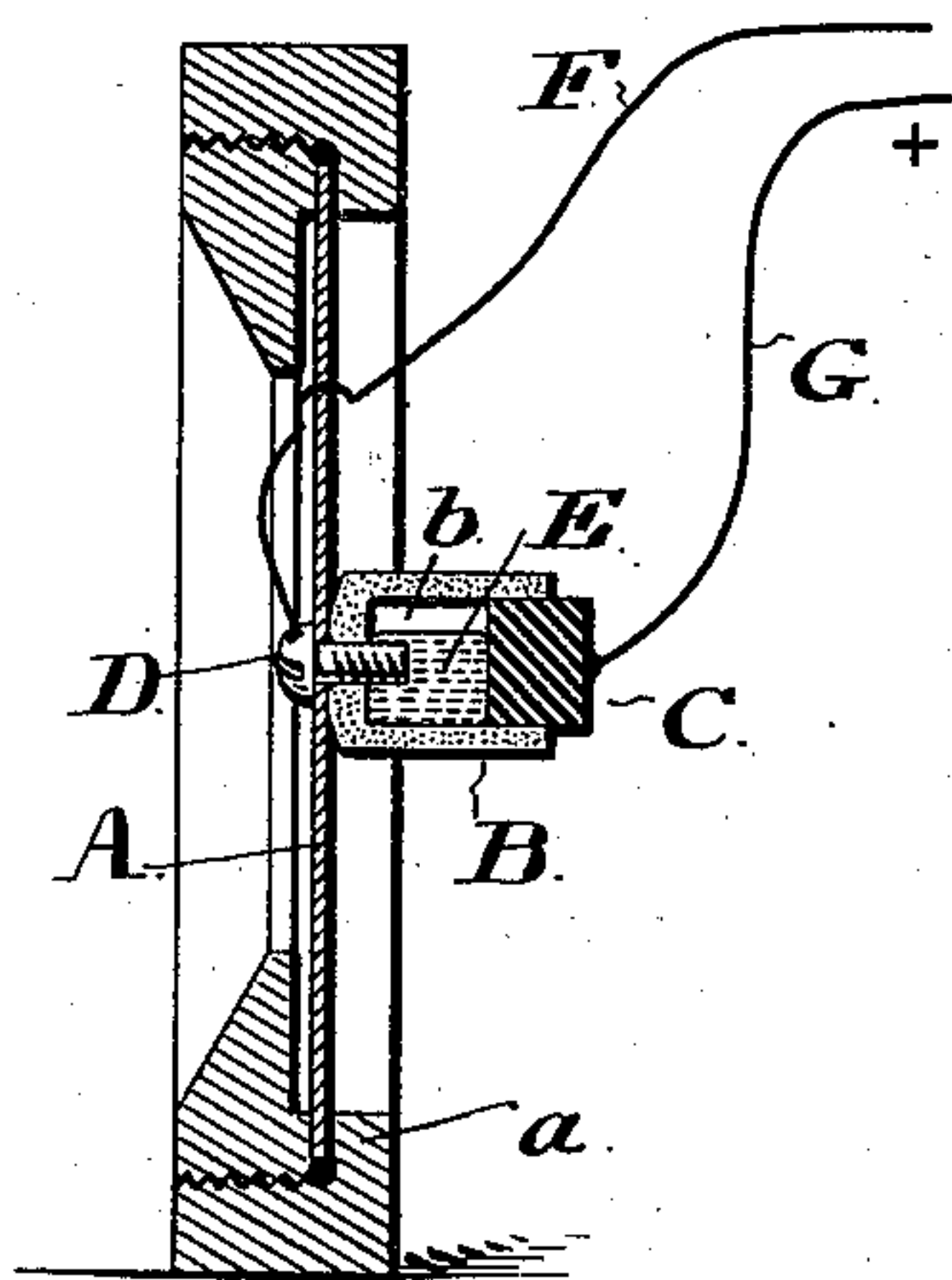


FIG. 2.

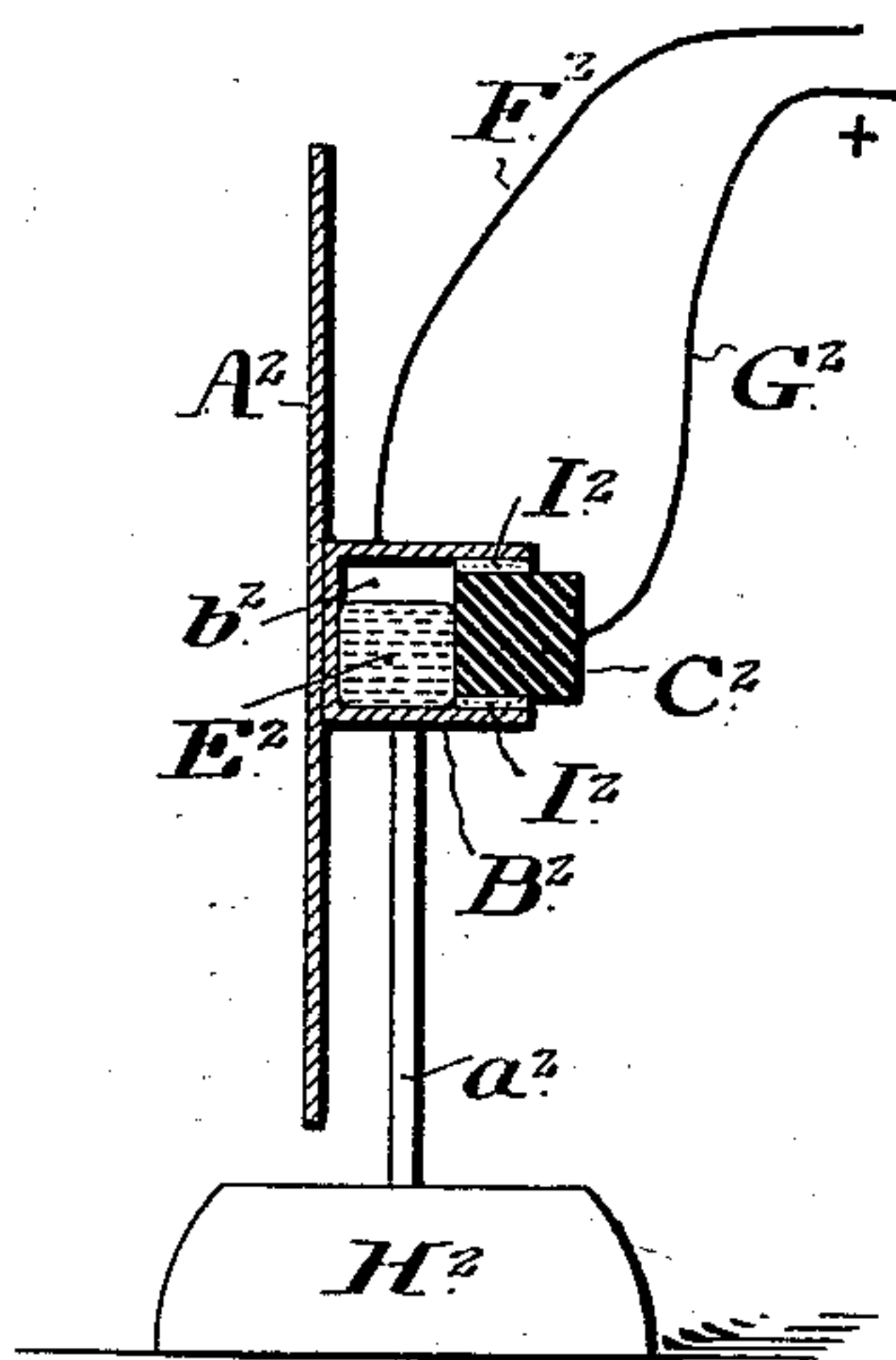
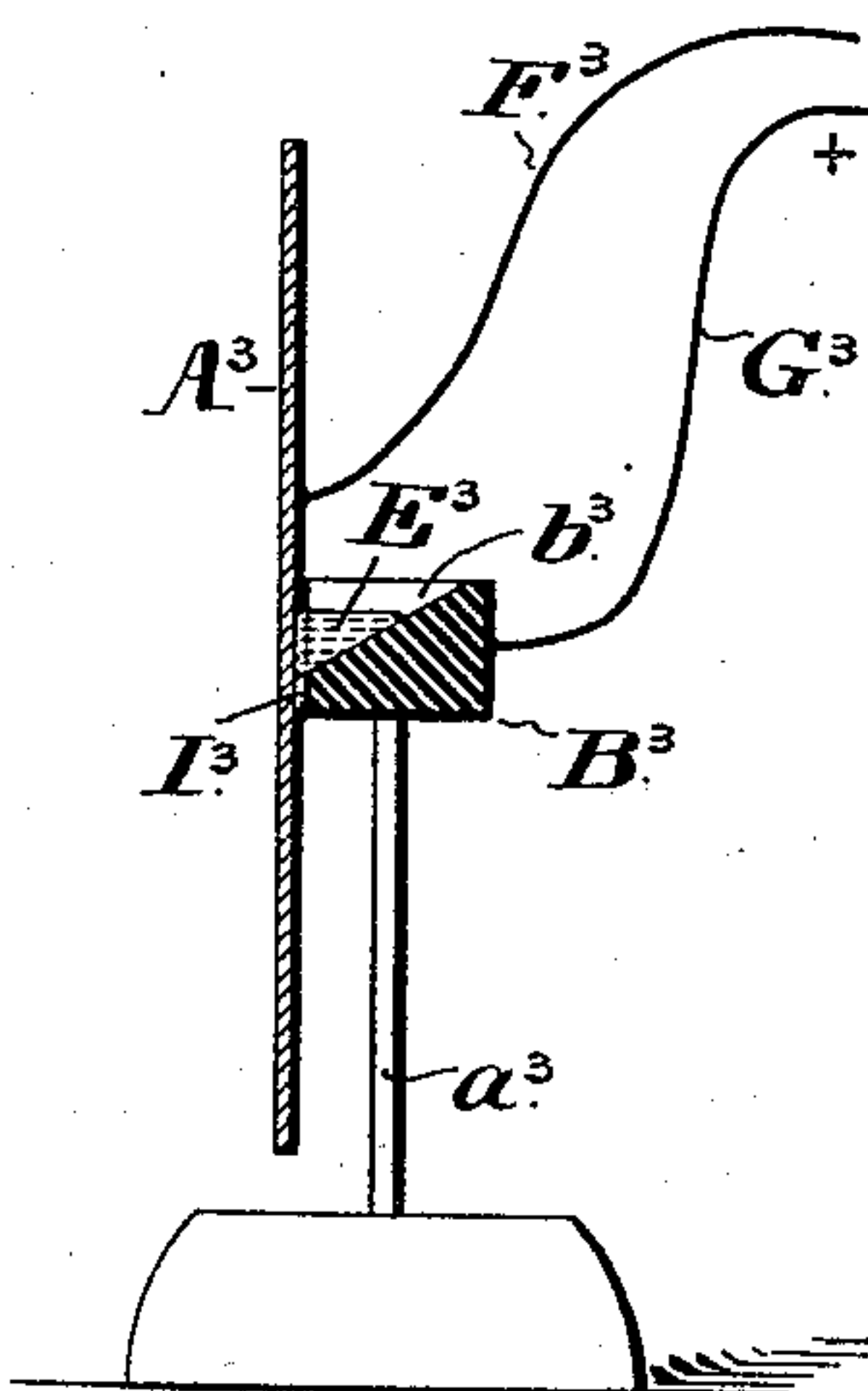


FIG. 3.



WITNESSES:

Sam. Wright  
James Bell

INVENTOR:

Arthur E. Paige



# UNITED STATES PATENT OFFICE.

ARTHUR E. PAIGE, OF PHILADELPHIA, PENNSYLVANIA.

## ART OF TELEPHONING.

SPECIFICATION forming part of Letters Patent No. 543,190, dated July 23, 1895.

Application filed February 25, 1895. Serial No. 539,544. (No model.)

*To all whom it may concern:*

Be it known that I, ARTHUR E. PAIGE, of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Improvements in the Art of Telephoning and in Telephone-Transmitters Adapted to the Practice of said Art, whereof the following is a specification, reference being had to the accompanying drawings.

My invention relates to that class of telephones which under the commonly-accepted theory operate by variations of resistance in an electric circuit, such variation being produced by and conforming to the sound-waves which are to be reproduced at the receiving end of the line. So far as I am aware the variation of resistance in this class of instruments, as heretofore constructed, has been occasioned by the physical movement of an electrode or electrodes toward or from another electrode or electrodes. Where solid substances alone have been employed, either in the form of an electrode or in the form of a plurality of bodies interposed between a moving and a fixed electrode, the necessary variations have, in accordance with the usually-accepted theory, been produced by variations of pressure or in intimacy of contact between the approximate surfaces. Where, on the other hand, liquids or plastic bodies have been interposed between the moving and the fixed electrodes the variations of resistance have been effected by the physical approach or recession of the moving electrode toward or from the fixed one, and the corresponding changes in the length of circuit, extent of immersion, or other consequences of the movement of one electrode relatively to the other.

I have discovered that the necessary modification of the electric current for the reproduction of sound-vibrations can be accomplished by the mere agitation of a liquid conductor, such as mercury, interposed between two separated electrodes, which are maintained in unvarying relation to each other during the transmitting operation.

Among the practical advantages of this improvement in the art are the following: Extreme simplicity of construction, low electrical resistance of the transmitting element as a whole, the avoidance of the necessity

for regulation or adjustment of the parts after they are once organized in working relation, long life of the instrument, the attainment of a maximum of both delicacy and volume in the reproduction of sounds, and the avoidance of disagreeable noises, such as are due to the irregularities of behavior of most of the transmitters heretofore used.

In the accompanying drawings I have indicated three typical forms of transmitter adapted to the practice of my method, the illustrations being in each instance in central vertical longitudinal section through the device, and the details being restricted, as far as possible, to such parts as are directly relative to the transmitting element proper, without attempting to show the adjuncts which in commercial use are found convenient.

I will now proceed to describe the type shown in Fig. 1.

A represents what is commonly called the "diaphragm" in telephone nomenclature—that is to say, a resonator of proper size and shape to receive the sound-vibrations and actuate in accordance therewith the efficient element of the transmitter. The diaphragm may be mounted in any manner which shall not injuriously affect its capacity for vibration—as, for instance, by securing its periphery in an annular two-part frame *a*. The diaphragm A is preferably disk-shaped, and carries at or near its center a cup or receptacle B, which in this instance is made of vulcanite, or other non-conducting material, secured to the diaphragm by means of a metallic screw D which penetrates into the interior chamber *b*, within the cup. A plug C, preferably of carbon, is fitted tightly into the mouth of the cup, so as to form a completely-inclosed chamber *b*. This chamber is partly filled (before the insertion of the carbon plug) with mercury, as indicated at E. The terminal wires F and G of a telephone-circuit are connected respectively to the screw D and the carbon plug C, so that said screw and said plug constitute two solid electrodes or terminals of the circuit, which when once organized and set up at the proper distance remain absolutely fixed in their relation to one another. The circuit across the interspace is of course completed by the mercury E.

The operation of the device in telephoning



is as follows: Sound-waves received upon the diaphragm A, cause it to vibrate, and such vibration shakes the receptacle B, thereby disturbing the mercury E. The disturbances of the mercury effected by the sound vibrations occasion such modifications of the electric current as are required to reproduce the sound upon a receiver at the distant end of the line.

10 In Fig. 2 I have shown a modification of the above type, in that the diaphragm A<sup>2</sup> carries a metallic or conducting receptacle B<sup>2</sup>, in which the chamber b<sup>2</sup>, containing the mercury E<sup>2</sup>, is closed by means of the plug C<sup>2</sup>, preferably of carbon, between whose surface and the adjacent surface of the receptacle B<sup>2</sup> a layer of insulating material I<sup>2</sup> intervenes. The wires F<sup>2</sup> and G<sup>2</sup> are attached respectively to the receptacle B<sup>2</sup> and the plug C<sup>2</sup>. Thus the receptacle B<sup>2</sup> becomes one electrode and the plug C<sup>2</sup> the other electrode, maintained, as above, in separate and unvarying relation to one another, but electrically connected by means of the mercury E<sup>2</sup>. In this instance the apparatus is supported by mounting the receptacle B<sup>2</sup> upon a standard a<sup>2</sup>, of such character as not to prevent the proper disturbance of the mercury by the agitation of the diaphragm, and having a base H<sup>2</sup>.

30 In the type shown in Fig. 3, a block D<sup>3</sup> of carbon with an angular recess in its upper side is cemented or otherwise secured to the diaphragm A<sup>3</sup>, a layer I<sup>3</sup> of insulating material (such as the cement itself) being interposed between the carbon and the diaphragm. The block D<sup>3</sup> is mounted upon a standard a<sup>3</sup> of similar construction to that described in connection with Fig. 2. The mercury E<sup>3</sup> is contained in the receptacle formed by the recess in the top of the block B<sup>3</sup>, which in this instance is shown as open at the top. The terminal wires F<sup>3</sup> G<sup>3</sup> are connected respectively to the diaphragm and to the block, the circuit being completed through the mercury E<sup>3</sup>.

15 By reference to the foregoing typical illustrations, it will be noted that the features which they possess in common are two solid electrodes separated from one another and maintained in unvarying relation; that the circuit between said electrodes is completed by means of a liquid conductor inclosed in a proper receptacle; that this receptacle is so supported that said conductor may be caused to vibrate or be disturbed by sound-vibrations, and that the modification of the electric circuit is directly caused by the disturbance of the liquid conductor itself and without variation of the position or other relations of the solid electrodes toward one another.

60 In the instances described the structure of the receptacle is of such character and so related to the electrodes that when it is agitated or disturbed by sound-vibrations the electrodes themselves are also agitated; but such feature of the structure is merely a matter of convenience, and the agitation of the

electrodes is accidental, and has no bearing upon the essential operation of the instrument. Incidentally, also, a diaphragm or enlarged resonator forms part of the apparatus, 70 and while this is the most convenient device for conveying to the mobile conductor the disturbances due to sound-vibrations, it must be understood that in using the word "diaphragm" in my claims I do not limit myself to this particular device for accomplishing the purpose, nor does the designation of such diaphragm as an element of the combination claimed imply that it must be distinguishable from other elements named. In fact, in the arrangement shown in Fig. 3 of the drawings, the diaphragm itself, or rather a portion of its surface, actually constitutes one electrode. I have specified mercury in these instances as the substance which constitutes the liquid-conductor, completing the circuit between the electrodes, because I believe it to be the best material for that purpose. Its resistance is comparatively low; it is sufficiently mobile to readily undergo the disturbance required, 80 to modify the electric circuit; and, furthermore, it is permanent, or not injuriously affected by anything that occurs under the normal conditions of use. I do not, however, wish to be understood thereby as limiting myself to this particular substance. Furthermore, I have found in operation that the effectiveness of the instrument is enhanced by coating the surface of the mercury by a mere film of certain materials, which are capable of adhering thereto, such as graphite, of the kind ordinarily used as stove-polish or glass, each being in the form of an impalpable powder. From the different electrical characteristics of these two materials it would seem that the modification of the mercury by them must lie in some direction which is not directly cognate to the conducting or non-conducting character of this film. Possibly its presence may modify the surface-tension of the mercury or affect the form or rate of its oscillation; but whatever the principle of its operation may be, the effect is to improve the transmission of speech. In the drawings I have not attempted to show this film, because any graphic representation thereof might be misleading, as it need be of only the most impalpable character. To produce it the merest pinch of the powdered material may be dusted upon the mercury and the surface be then blown upon vigorously until every particle which can thus be removed has been blown away. The surface of the mercury will then appear dimmed or tarnished, and if the mercury be viewed in the form of a globule it will be noted that a very slight change of its normal outline has occurred, the globule being less spherical and more flattened or elongated than when the mercury is pure. I am unable to comprehensively classify the materials of which this film may be composed otherwise than by stating that they appear in all cases where they are 130



used to establish what may be called a definite and apparently coherent skin upon the surface of the mercury.

I have applied to the conductor whose disturbance is utilized for the variation of the electric current the descriptive term "liquid," because said term in its physical as distinguished from its popular sense is the most convenient one wherewith to characterize the said conductor, in that the term implies proper mobility and definite coherence of the substance as a whole. I do not, however, mean by the use of the term liquid to restrict my claim to any absolute degree of mobility or limpidity of the conductor, nor to the use of a pure liquid alone as contradistinguished from a composite liquid—such, for instance, as a sufficiently mobile amalgam, nor as contradistinguished from a liquid incidentally containing solid particles or approaching a jelly-like consistency.

Having thus described my invention, I claim—

1. The hereinbefore described improvement in the art of telephoning, which consists in disturbing, by means of sound vibrations, and in conformity therewith, a liquid conductor interposed and supported between two separated electrodes, without varying the position of said electrodes relatively to one another, said electrodes and interposed conductor constituting a part of a telephone circuit, substantially as described.

2. The combination of a pair of electrodes maintained in unvarying relation to each other and provided with an intermediate receptacle; a liquid conductor contained in said receptacle and completing the circuit between said electrodes; and means substantially as set forth whereby said liquid conductor may be disturbed by, and in conformity with sound vibrations, substantially as described.

3. The combination of a diaphragm; a pair of electrodes maintained in unvarying relation to one another; a receptacle arranged at the interspace between said electrodes; and a liquid conductor contained within said receptacle and completing the circuit between said electrodes, said receptacles being suitably supported to permit disturbance of the liquid conductor by sound vibrations, substantially as described.

4. The combination of a pair of electrodes maintained in unvarying relation to each other and provided with an intermediate receptacle; a liquid conductor coated with a film, substantially as set forth, said coated conductor completing the circuit between said electrodes; and means substantially as set forth whereby said coated liquid conductor may be disturbed by and in conformity with sound vibrations, substantially as set forth.

ARTHUR E. PAIGE.

Witnesses:

JAMES H. BELL,  
G. HERBERT JENKINS.