(No Model.)

J. & H. M. GOODMAN.

TELEPHONE TRANSMITTER.

No. 530,412. Patented Dec. 4, 1894.

Fig. 1

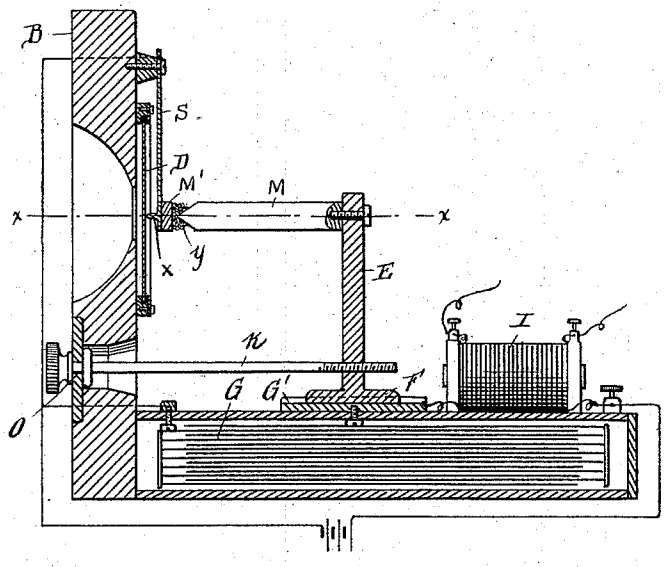


Fig 3.

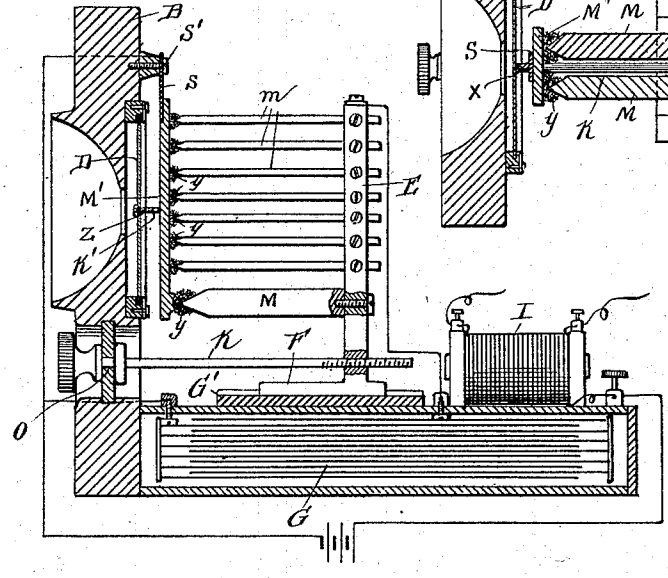
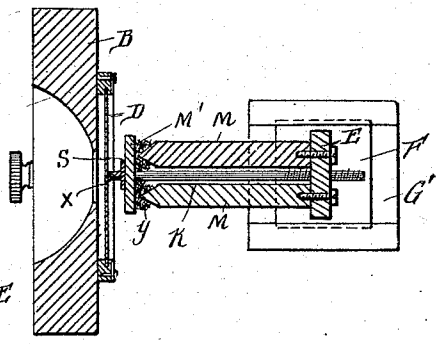
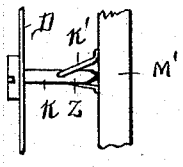


Fig. 2.



Witnesses:
Gr. M. Anderson
Philemasi.

Fig. 4



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UNITED STATES PATENT OFFICE.

JOHN GOODMAN AND HENRY M. GOODMAN, OF LOUISVILLE, KENTUCKY.

TELEPHONE-TRANSMITTER.

SPECIFICATION forming part of Letters Patent No. 530,412, dated December 4, 1894.

Application filed July 3, 1894. Serial No. 516,490. (No model.)

To all whom it may concern:

Be it known that we, JOHN GOODMAN and HENRY M. GOODMAN, citizens of the United States, and residents of Louisville, in the county of Jefferson and State of Kentucky, have invented certain new and useful Improvements in Telephone-Transmitters; and we do declare the following to be 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, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

Figure 1 of the drawings is a representation of a central vertical section of invention, partly diagrammatic. Fig. 2 is a partial section on line *x*—*x*, Fig. 1. Fig. 3 is a sectional view of modification partly diagrammatic. Fig. 4 is a detail of elastic band connection of diaphragm and magnet.

Our invention has relation to certain new and useful improvements in telephones, all as hereinafter fully described and pointed out in the appended claims.

In Patents Nos. 433,505, dated April 10, 1894, and 498,019, dated May 22, 1894, and in applications now pending, Serial No. 497,539, filed January 20, 1894, and Serial No. 509,686, filed May 1, 1894, we have described certain forms of telephone transmitters, in which comminuted magnetic material, between the opposite poles of two magnets, and constituting a part of the electric circuit was the essential agent in varying the strength of the current. We have discovered that the number of magnets, or what is equivalent, the number of magnetic fields, with included magnetic material in a comminuted state, may be multiplied with advantage in the same instrument. The mechanical devices by which this may be accomplished are numerous, but we will only describe such as we have found by experience to be practically useful and sufficient to illustrate the principle.

Fig. 1 and 2 show the simplest form of the instrument.

In Fig. 1 B is the front of the frame having an opening for the mouth piece corresponding with the diaphragm D and a base with a cavity for the accommodation of the condenser G. S is a spring attached to some part of the support of the diaphragm and extending to the central portion thereof upon which it rests by means of the projection X. This spring may be of steel and magnetized and a bar of soft iron M′ affixed at right angles to its free extremity, which will represent a pole of the magnet and the other magnets must approach it with an opposite polarity; or the spring may be of non-magnetic metal, and the bar a magnet, in which case the opposing magnets must present different poles on each side of the middle of the bar magnet. The comminuted magnetic material is represented at *y*. E is the support for the magnets represented by M, which magnets may vary in number and size as well as proximity or adjustment to M′. The support E is provided with a foot F slidable in a groove in the base block G′, the adjustment being made by a screw rod K which engages a threaded opening in said support, and has a bearing at O in the lower front portion of the case, being prevented from longitudinal movement by means of collars or shoulders. The projecting end of said rod may be provided with a head by means of which the rod may be turned, as in the figure, or it may be made angular to receive a key which may be removed after adjustment has been made. In addition to this general adjusting arrangement, each magnet may have an individual adjusting appliance. I is an induction coil which may be placed in any convenient situation within or without the case. This frame is designed to fit into a protecting case and is to be provided with suitable contacts for making connections with battery and line circuits.

Fig. 2 is a horizontal sectional view showing the magnetic cross bar M′ attached at right angles to the spring S and two adjustable magnets M.

Fig. 3 is a more perfect form of the instrument. In general construction it is similar to the first, the difference being in the arrangement and relations of the magnets. Instead of the magnetic bar being at right angles to the spring, its axis here corresponds to the axis of the spring.

M′ is a bar magnet suspended by the spring S from a support above the diaphragm and impinging upon a projection Z from the cen-

ter of the diaphragm through which vibrations may be imparted to it. To this projection it is connected by an elastic band K′ to maintain absolute contact in the event of violent jars. M and *m* are the co-operating magnets the approximated poles of which are different above and below the center of the bar magnet so that they may present an opposite polarity to that portion of said bar magnet with which they correspond.

The adjustable magnets are sharp pointed while the magnetic surface which they approach is either plane or slightly concave. This, we have found to be the best relative shapes for the opposed magnetic electrodes. The finest cambric needle makes an excellent magnet for penetrating the magnetic material. The only objection to it is that such a slender magnet is a bad conductor, but this may be overcome by multiplying their number.

To appreciate the peculiarity of an instrument thus constructed it is necessary to understand the mode of action of iron filings, or its equivalent, in the magnetic field as an agent in modifying the electric current as compared with the other substances in common use for that purpose. Take, for instance, carbon as typical of a certain class. The conductivity of this is increased by pressure, owing to a change thereby effected in its ultimate or molecular constitution, analogous to a molecular change which occurs in selenium when exposed to sunlight. The effecting of this pressure necessarily implies resistance on the part of the material subjected to it, and if the pressure on the material is excessive its molecular integrity is destroyed and it is rendered useless. In the case under consideration the conditions are different. Here the magnetic particles are simply suspended in the magnetic field between the opposing magnetic electrodes in a granular, not molecular condition, each granule, no matter how small it may be, produced by mechanical means, consisting of an infinite number of molecules. These granules, of course, arrange themselves in the lines of magnetic force and constitute the channels of conduction for the electricity. When the electrodes approximate the lines of force and the chains of granules are straightened and the channels of conduction are shortened, again the magnetic granular mass serves more or less under all circumstances as a conductor. When the magnetic electrodes are approximated the route of the current is shortened and its passage facilitated. In this respect the action is similar to what takes place in a water rheostat or telephone transmitter, but differs materially from it in one respect—that in addition to the approximation of the electrodes through a conducting medium, the vibratory magnet during approach brings along with it innumerable small particles of the magnetic material, which, coming in contact with the particles sustained by the stationary magnet—greatly increase the number of channels of conduction, the reverse happening when said magnet recedes. Thus it must be admitted that at no time is there any actual pressure exercised upon the granular mass and consequently no obstacle offered to the free movement of the vibratory electrode bar or magnet. To accomplish fully the object designed the granular magnetic mass, attached to one electrode must be large as compared with the size of the electrode which penetrates it. It should not be confined too strictly in a receptacle but its particles should be allowed space for free movement upon each other, the magnetic influence being sufficient ordinarily to maintain them *in situ*. Nor is any envelope necessary to protect them from atmospheric influence when they are made of material not subject to change in the atmosphere. The points of the penetrating magnets may be of any form so that the liability of subjecting the granules to actual pressure is avoided. When this happens, a disagreeable, grating sound is heard when the diaphragm vibrates and a frying sound when it is at rest, from the simple passage of the current. A conical or wedge shaped point like the end of a chisel or the edge of a knife blade is preferable.

Returning to the construction of the instrument it will be observed that the vibratory bar magnet is arranged upon the principle of the lever (Fig. 3) for which we make no claim *per se* at present, as it is fully set forth in one of our pending applications (Serial No. 509,686, filed May 1, 1894). The fulcrum or fixed point is at S′ and from this down the arc of movement increases until at the lower end the terminal magnet penetrates the mass with quite a plunge. The magnets near the fulcrum give high notes, more perfectly accentuated, and those near the lower end render the base notes loudest. The lowest magnet or magnets, as there may be more than one, facing a transverse bar as in Fig. 1, may be brought into play by a strong current, but ordinarily they only serve as safety valves in the event of an excessive discharge such as may be experienced from currents induced by lightning, &c.

Of magnetic substances, for making the granular mass to be included between the magnetic electrodes, we have used iron, steel, nickel, cobalt, manganese, iron pyrites, oxide of iron, thin iron plates coated with silver copper, or gold, alloys of iron with copper, aluminum and manganese, and various combinations of them.

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

1. In a telephonic instrument, the combination of a diaphragm, a vibratory magnet having contact with said diaphragm, a flexible or spring support for said magnet, a series of opposing magnets approximating said vibratory magnet and having their approxi-

mated poles of opposite polarity to that of the part of the vibratory magnet which they approximate, comminuted magnetic material interposed between the vibratory and the opposing magnets and adjusting devices whereby said opposing magnets may be adjusted with relation to the vibratory magnet, substantially as specified.

2. In a telephonic instrument, the combination with a diaphragm, of a vibratory magnet having contact with said diaphragm, a series of opposing electrodes approximating said vibratory magnet and whose approximated poles are of opposite polarity to that part of the vibratory magnet which each approximates, and masses of magnetic material in a comminuted state constituting the electrical connection between the vibratory magnet and the opposing electrodes, substantially as specified.

3. In a telephonic instrument, the combination with a diaphragm, a spring-supported vibratory magnet making contact with said diaphragm, a series of opposing electrodes approximating said vibratory magnet at right angles and having their approximated poles of opposite polarity to that part of said vibratory magnet which each approximates, and a variable resistance of granular magnetic material between each opposing electrode and the vibratory magnet, substantially as specified.

In testimony whereof we affix our signatures in presence of two witnesses.

J. GOODMAN.
HENRY M. GOODMAN.

Witnesses:
TOM B. MEGLEMRY,
J. SHORT.