S. G. BROWN.

TELEPHONY OR TELEGRAPHY.

APPLICATION FILED DEC. 28, 1908.

1,048,443.

Patented Dec. 24, 1912.

2 SHEETS—SHEET 1.

Fig. 5.

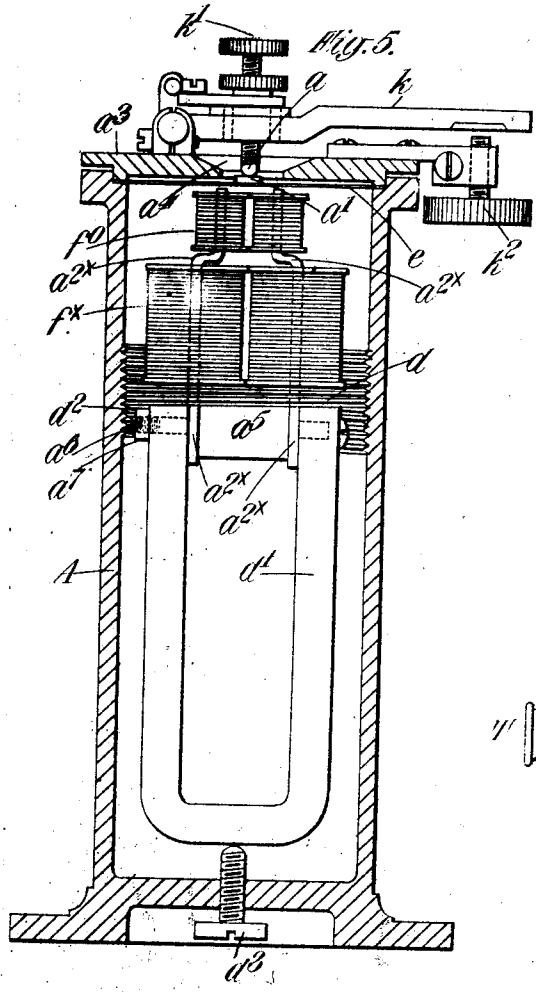


Fig. 6.

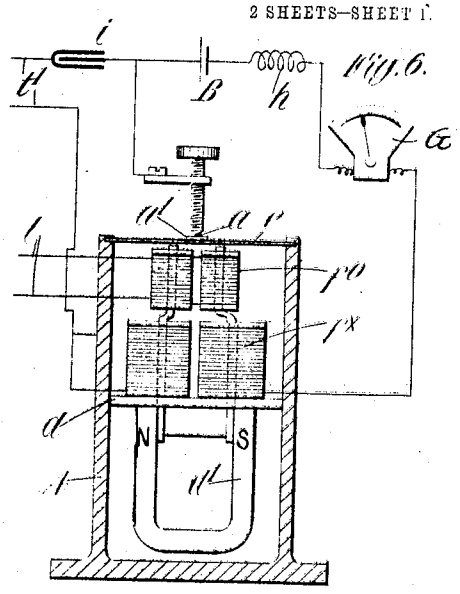


Fig. 1.

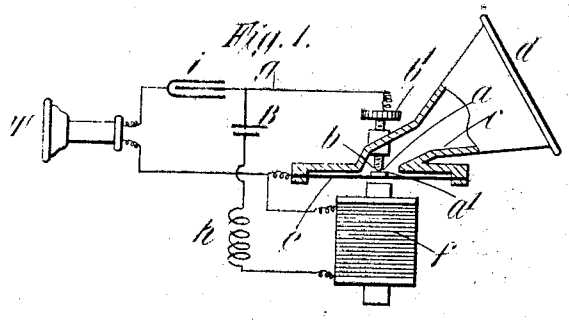


Fig. 2.

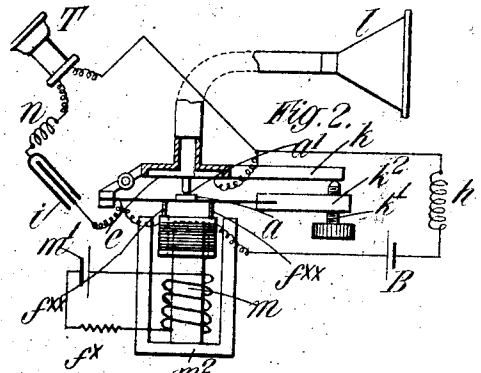
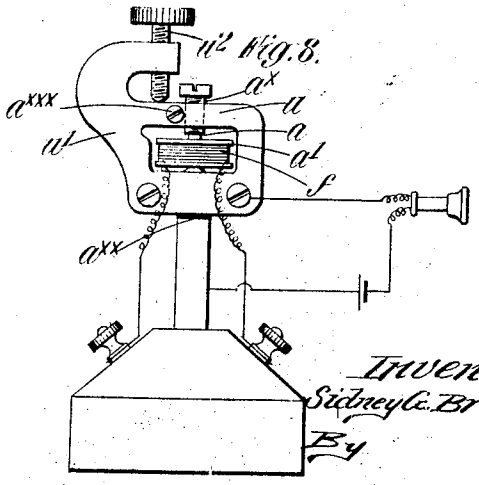


Fig. 8.



Witnesses

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S. G. BROWN.

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2 SHEETS—SHEET 2.

Fig. 1.

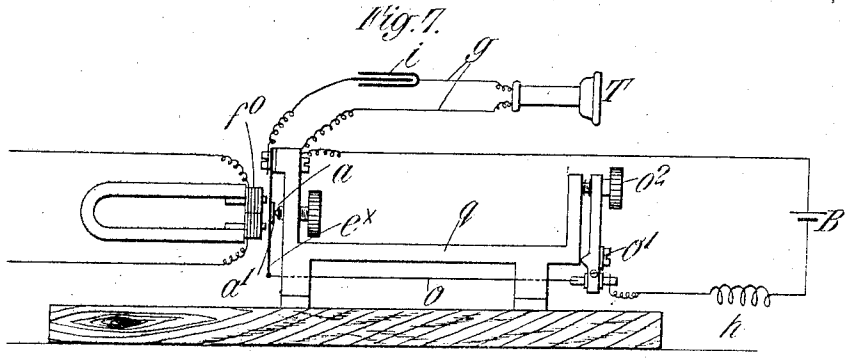


Fig. 3.

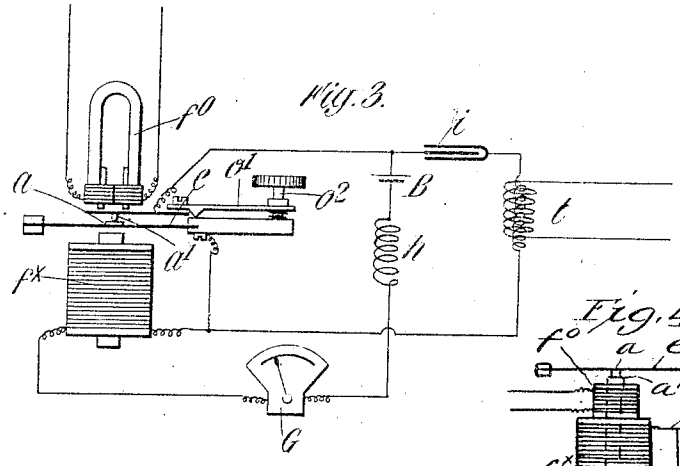


Fig. 4a

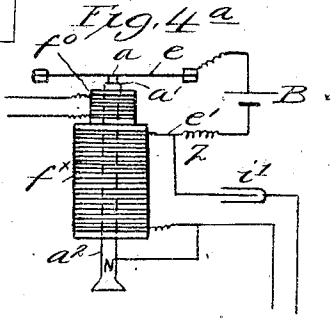
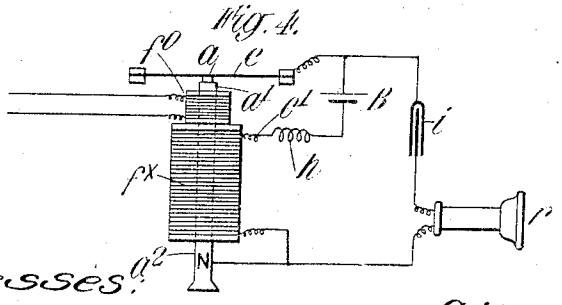


Fig. 4.



Witnesses:

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UNITED STATES PATENT OFFICE.

SIDNEY GEORGE BROWN, OF LONDON, ENGLAND.

TELEPHONY OR TELEGRAPHY.

1,048,443. Specification of Letters Patent. Patented Dec. 24, 1912.

Application filed December 28, 1908. Serial No. 469,651.

To all whom it may concern:

Be it known that I, SIDNEY GEORGE BROWN, a subject of the King of Great Britain, residing at 4 Great Winchester street, in the city and county of London, England, have invented certain new and useful Improvements in or Relating to Telephony or Telegraphy, of which the following is a specification.

This invention relates to systems for the electrical transmission and reception of signals particularly telephonic systems, and has for its chief object to increase the amplitude of the sound waves or signals so as to render the same more distinct and defined and to enable minute or imperfect sounds or signals to be transmitted and received or recorded with greater precision, certainty and clearness than by the methods heretofore practised.

The present invention is based on the result of investigations in connection with separated "contacts" or conductors and the voltage of current necessary for producing sparking across the space between such conductors. When the distance of separation between the contacts or conductors is very small or of molecular dimensions, such for instance, that comparable with a wave length of sodium light, conduction takes place, such conduction seeming to vary according to Ohm's law.

The invention therefore consists essentially in utilizing the aforesaid conducting space for the purpose of magnifying signals or sound waves; the contacts or conductors being arranged in such a manner that by means of an electric current the said conducting space is formed and maintained and adjusted and the requisite degree of conduction between the contacts is insured.

According to this invention, the aforesaid conduction space is formed by employing two or more conducting pieces or contacts of suitable material, one of which contacts is adapted to be moved by electromagnetic or other suitable force so as to form and maintain and regulate the molecular distance between the contacts against the resistance of a counteracting force. As the resistance to the current traversing this predetermined space varies rapidly with any slight variation that may be brought about in the distance between the contacts, a very sensitive detector of the minute relative movements which take place between the said contacts is obtained, the same being rendered particularly suitable for producing a very efficient magnifier or relay for use in telephony.

The sensitiveness of the present method of operation depends upon the smallness of the distance between the contacts and consequently any metals that oxidize under ordinary atmospheric conditions are likely to affect the sensitiveness owing to the oxid intervening between the contacts. Although the contacts may be composed of any suitable metal they are for the reasons above mentioned preferably composed of any of the non-oxidizable metals, such as those belonging to the platinum group, or of gold. Iridium has been found to give the best results in practice, and, for this reason, is preferred, but silver or steel may be used, although for the purpose of the present invention the latter should possess a highly polished surface; other metals may also be found suitable. Carbon may be employed if possessing good conductive or metallic properties. If iridium (highly polished) be used for the contacts the local battery may have a voltage of approximately half a volt, but if steel be used a local current of about two volts will be required. Where steel is employed for the contacts, the sensitiveness may be increased by coating the same with, or working the contacts under, oil or paraffin. With iridium contacts, however, it is best to work them dry, the paraffin having the effect of reducing the sensitiveness. Carbon contacts would also result in a diminution of the sensitiveness.

As a means of producing a variation in the distance between the contacts or of maintaining the conduction space, it will be understood that any means suitable for the purpose of the present invention may be used. For example I may employ a coil suspended in a magnetic field, a heated wire, expansion or contraction of an iron core or the like; in fact any means adapted to effect the requisite adjustment of the conducting space by means of the current passing between the contacts is applicable to the present invention. It may further be stated that any mechanical vibration whatever would

have the effect of varying the conducting space and so vary the current passing across the same, the said variations being indicated by the telephone shunting the contacts, or the variations may be retransmitted.

In order that the said invention may be clearly understood and readily carried into effect, I will proceed to describe the same more fully with reference to the accompanying drawings which represent diagrammatically several exemplary arrangements or embodiments of the invention.

Figure 1 is a partial sectional elevation of a telephonic transmitter embodying the invention; Fig. 2 shows the invention employed in connection with a stethoscope; Fig. 3 shows the invention applied to a telephone relay, the conduction space between the contacts being varied and controlled respectively by electromagnets arranged in the line and local circuits. Fig. 4 shows a similar device in which the line and local electromagnets are superimposed; Fig. 4ª shows a modified form of arrangement of the line connections with the line electromagnet. Fig. 5 is a sectional elevation of a modified form of relay; Fig. 6 is a diagrammatic view showing the electrical connections therefor; Fig. 7 is a view of a relay, in which the conduction space between the contacts is varied and maintained respectively by a line electromagnet and a current carrying wire in the local circuit. Fig. 8 shows a telephone relay which is sensitive to vibrations either mechanically or electrically produced.

According to the arrangement of the improved system shown in Fig. 1, *a a'* are two contacts or conductors, the one *a* being carried by a screw *b* capable of fine adjustment by means of the head *b'* and the other *a'* being mounted upon a disk or diaphragm *e* supported at its periphery and capable of vibrating under the action of the sound waves entering the mouthpiece *d*. The contact *a'* is also capable of moving under the influence of an electromagnet *f* which is arranged in series with the contacts *a a'* in the local circuit of the battery B; the electromagnet being energized by the current in the said local circuit, so as to effect the separation of the contacts *a a'* and thereby form the aforesaid conduction space; the latter being maintained by the action of the said electromagnet. Any variation in the conduction space or the degree of separation of the contacts produced by the variations in the voice will have the effect of correspondingly varying the resistance in the local circuit, the sound waves being magnified in the local circuit and transmitted through the main line to the receiver or telephone T. It will be seen that the current from the battery B passes by way of the electrodes or contacts *a a'* through the vibratory disk or diaphragm *e* into the winding of the electromagnet *f* then through the inductance coil *h* back to the battery B. Thus by the energization of the electromagnet the contacts are opened by the local current, the said magnet acting to open the contacts until the included resistance of such opening cuts down the local current to prevent further action of the magnet the latter then maintaining the conduction space. Upon the local current being switched off the contacts will become closed owing to the relaxation of the force which has held them open. In order to prevent buzzing, as in the case of a bell, the vibrations of the adjustable electrode or contact are regulated by means of the inductance coil *h*; the latter having the effect of preventing currents in the telephone circuit T from flowing into the electromagnet *f* which acts slowly to maintain the conduction space. Or the voltage of the local current may be regulated or reduced in any suitable manner to suit the particular metal employed for the contacts. A dashpot device may moreover form part of or be carried by the disk or diaphragm *e* whereby the aforesaid regulation may be effected. The inductance *h* may be replaced by a resistance (not shown) arranged in series with the electromagnet *f* and serving to counteract any tendency to vibration or to vary the time period; a capacity arranged across the winding of the electromagnet *f* would have a like effect. The condenser *i* in the telephone circuit T acts to normally prevent the current in the local circuit from passing into the line.

In the arrangement shown in Fig. 2, the vibratory contact *a'* is superimposed on the non-vibratory contact *a*. The contact *a'* is mounted on the disk *e* which is carried by a hinged frame *k* capable of fine adjustment by means of the screw *k'* which is arranged to work through the stationary frame k^2 and to engage, by its extremity, the aforesaid hinged frame *k*. By these means the adjustment of the contact *a'* is obtained but in working, when the vibratory contact is subjected to movement, as, for instance, in a manner such as described with reference to Fig. 1, the local current actuates the magnet $f^\times$ so as to maintain and regulate the conduction space. A mouthpiece, as at *d*, Fig. 1, may be arranged in connection with the vibratory contact *a'* but in the figure under description, the utility of the invention is exemplified by its connection with a stethoscope *l*. It will be seen that the contacts *a a'* are arranged in the local battery circuit, the battery being indicated at B. The inductance *h* in this circuit, is for preventing currents in the telephone circuit T from flowing into the magnet coil $f^\times$ which is suspended by the connections $f^{\times\times}$ from the disk *e* pertaining to the contact *a* and which

magnet coil is also arranged in the circuit of the battery B. The said magnet coil f^x acts slowly to maintain the conduction space. The magnet m is constantly energized by the current from the battery m' and tends to maintain the magnetism of the core m^2. In order to prevent any self vibratory movement of the winding f^x, the latter may be provided with a lining of copper or other conducting metal or material. The inductance n in the telephone circuit T is for the purpose of tuning.

Referring to Fig. 3, the conduction space between the contacts a a' is varied and controlled by the line magnet f^0 and the local magnet f^x respectively. The upper contact is carried by the arm o' which may be capable of fine adjustment by means of the screw o^2. The current from the local battery B passes to the upper contact a' and from thence to the lower contact a, the disk or diaphragm e and the electromagnet f^x through the galvanometer G or other indicating instrument and self-induction coil h back to the battery B. The electromagnet f^0 is energized in correspondence with the variations of the signals or sound waves and this variable energization of the aforesaid electromagnet produces corresponding variations in the conduction space between the contacts a a'; the resistance to the passage of the local current being thereby varied. The electromagnet f^x will, as in the previously described arrangements, tend to maintain the conduction space. The electromagnet f^0 therefore has the effect of varying the conduction space while the electromagnet f^x tends to maintain the said space. The transformer t (Fig. 3) is shown for retransmitting the signals, the primary of the said transformer being shunted across the contacts a, a' and having arranged in series therewith a condenser i. This arrangement being general, needs no further description.

Figure 4 shows an arrangement in which the line electromagnet f^0 and the local electromagnet f^x are superimposed. The vibratory contact a is mounted upon the diaphragm e the contact a' being mounted upon the core a^2 of the aforesaid electromagnets. The current flows from the local battery B to the contact a, then to the contact a', core a^2, electromagnet winding f^x, induction coil h back to the battery B. Across the contacts a and a' the receiver r and condenser i are shunted as in the previously described arrangements. The action of the magnet f^x in this arrangement is to release the upper contact and allow the latter to move away from the lower contact which is mounted on the core a^2. The coil f^0 carries the currents that vibrate the contact a which is mounted on the diaphragm e. Instead of arranging the line connections with the magnet f^0 in the manner shown in full lines they may be arranged as shown in Fig. 4^a, a condenser being placed in series therein as shown at i'. If desired, the magnets f^0 f^x may constitute one and the same magnet.

According to the construction illustrated in Fig. 5, the apparatus comprises an outer metallic casing A having a cover plate a^3 carrying the hinged member k for the contact a. The cover plate a^3 is provided with an opening a^4 through which the contact a projects to engage the vibratory contact a' carried by the disk or diaphragm e. A very sensitive adjustment of the contact a is obtained by means of the screws k' and k''. The lower contact a' is influenced by the electromagnets f^0 and f^x which are mounted upon the support d carrying the depending portion or permanent magnet d', the latter being secured to the soft iron cores a^{2x} a^{2x} of the electromagnets f^0, f^x. The electromagnets f^0 f^x are thus polarized by the permanent magnet d'. A distance piece a^5 of non-magnetic material is placed between the cores a^{2x} a^{2x} and the arms of the depending member or permanent magnet, and the parts are secured together by a bolt a^6 and nut a^7. By screwing the support d up or down in the screw threaded part d^2 of the casing A, the parts carried thereby may be adjusted vertically, so that the ends of the cores a^{2x} a^{2x} may be arranged nearer to or farther away from the disk or diaphragm e; the said parts being retained in the adjusted position by means of the jam screw d^3. The electrical connections pertaining to this construction will be understood from the diagrammatic view thereof shown in Fig. 6. In this figure, B indicates the local battery, h the induction coil, t the receiving lines and t' the retransmitting lines; i is the condenser in the latter. G is the galvanometer or other indicating instrument which shows the amount of current that flows through the conducting space and thus indicates the normal resistance between the contacts. When signals or sound waves are being transmitted along the line t the magnet f^0 is energized and vibrates the lower contact a' thereby varying the conduction space which is maintained by the local magnet f^x. The variations produced in the local circuit will be transmitted along the line t' to the distant station. The induction coil h, which may have an iron core and be of 5 to 20 henries induction, is placed in series with the conduction space adjusting electromagnet f^x so as to give the electromagnet a slow period of electrical vibration. Thus the adjusting electromagnet is not affected by the quick vibrations produced on the circuit by telephone currents flowing in the electromagnets f^0, at the same time the tendency for it to produce a vibration on the contact is prevented. It

will be understood that the electromagnet f^x acts to open the contacts until the included resistance of such opening cuts down the local current to prevent further action of the magnet, at which point the action of the magnet maintains the conduction space. Instead of arranging the coils f^0 f^x as shown and described they may constitute one and the same coil. The coils may be differently arranged. For instance they may be disposed separately on the same side or on opposite sides of the disk or arm.

According to Fig. 7, the degree of separation of the contacts is regulated or the conduction space maintained by means of a wire o, of metal, which is connected at one end to a disk or spring strip e^x, which may be of steel, carrying the vibratory contact a', and at the other end to an arm o' capable of fine adjustment by means of the screw o^2. The frame or supporting part q of the device is preferably of the same metal or of metal having the same co-efficient of expansion as the wire o so as to avoid any ill-effects as the result of unequal expansion. The current from the battery B passes to the contact a thence to the contact a' and along the strip e^x and the wire o, through the induction coil h back to the battery B. The passage of the current through the wire o has the effect of heating the latter and causing the same to expand and lengthen and so bring about the separation of the contacts a a', and the forming and maintaining of the conduction space between them. When the telephone transmitter (not shown) is spoken into, the sound waves produce variations in the energization of the main line polarized electromagnet f^0, producing corresponding variations in the resistance of the aforesaid conduction space and thus operating the telephone T.

Although I have not shown a galvanometer or indicating instrument in connection with each arrangement herein described it will be readily understood that such or a similar suitable instrument may form a part of any equipment for the purpose of my invention.

In the above described examples, the conduction space is adjusted and maintained by means of electromagnets and also by means of an electrically heated wire; it will however be obvious that the said space may be maintained by direct mechanical means, and in Fig. 8 I have shown a method of working in which the arrangement is sensitive to vibrations either mechanically or electrically produced.

a a' are the contacts, which are insulated from one another by the insulation shown at a^{xx}, the contact a being rendered adjustable relatively to the contact a' by being mounted at the extremity of the iron screw a^x. The contact a' is carried by the core of the polarized electro-magnet f which is arranged in the local battery circuit as shown. The contact a is further carried in a cross piece u of the metallic frame u'; the cross piece is sufficiently elastic to be capable of very fine adjustment through the varying pressure exerted by the screw u^2. The screw a^x may be held securely in its adjusted position by the screw a^{xxx}. The conduction space thus formed is sensitive to vibration which vibration may be caused by the telephone current flowing in the magnet winding f.

When constructed for working as a relay in connection with telephony, the instrument is sensitive to variations in temperature if constructed of materials which expand with heat. This may be overcome by inclosing the instrument in a suitable heat and sound proof casing having the adjusting means brought outside or by constructing most of the instrument of "Invar" metal, which is not affected by heat or variations in temperature, or of metal or metals having the same co-efficient of expansion. The sensitiveness of the instrument when arranged to act as a telephone relay may be increased for any particular tone or rate of vibration by making the natural period of vibration of the movable contact or conductor in resonance with any particular note or rate of movement for rendering the relay operative.

It will be understood that a switch or equivalent device may be inserted in the local circuit, for the purpose of economy in working, the switching off of the local current causing the contacts to touch each other and the switching on of the said current causing the contacts to open as hereinbefore described. The contacts may be of any suitable conformation but for efficient working the form of the contacts shown in the accompanying drawings when constructed of iridium highly polished and having as to the one contact a flat surface and as to the other a curved or ball termination have been most satisfactory.

The contacts or conductors may be worked in a vacuum or an insert gas with a view to preventing chemical changes taking place.

The invention is applicable to telephony, as hereinbefore described, but it is also applicable to the branch of telegraphy which deals with minute currents, similar to those pertaining to telephony.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In a system for the electric transmission and reception of signals, the combination of a pair of contacts, a source of current in circuit therewith, and means energized by the current traversing said con-

tacts, adapted to form and adjust and maintain a minute conduction space between said contacts.

2. In a system for the electric transmission and reception of signals, the combination of a pair of contacts, a source of current in circuit therewith, and means energized by the current traversing said contacts, for maintaining a minute predetermined conduction space between the said contacts.

3. In a system for the electric transmission and reception of signals the combination of a pair of contacts, a source of current in circuit therewith, means energized by the current traversing said contacts for maintaining a minute conduction space between the said contacts and means for varying the aforesaid conduction space.

4. In a system for the electric transmission and reception of signals, the combination of a plurality of contacts, a source of current in circuit therewith, means energized by the current traversing said contacts, for maintaining a minute conduction space between the same and means for varying the aforesaid conduction space.

5. In a system for the electric transmission and reception of signals, the combination of a pair of contacts a source of current in circuit therewith, means energized by the current traversing said contacts for maintaining a minute conduction space between the same and means for varying the aforesaid space in accordance with the variations of the signals.

6. In a system for the electric transmission and reception of signals, contacts, a source of current in circuit therewith, a local electric circuit containing the contacts, and means, energized by the current traversing said contacts, adapted to open the said contacts and adjust and maintain a minute conduction space between the contacts.

7. In the electrical transmission and reception of signals, the combination of contiguous contacts, a source of current in circuit therewith, a telephone circuit, means energized by the current in said telephone circuit, for forming and adjusting and maintaining a minute conduction space between the said contacts and means for varying the said conduction space.

8. In the electrical transmission and reception of signals, the combination of two contacts, a magnetic force for forming and maintaining and adjusting a minute conduction space between the said contacts by adapting the said force to act on one of the contacts and means for producing a counteracting force for varying the conduction space, the electromagnetic force being dependent on the value of the current which passes through the contacts and across the said conduction space.

9. In a system for the electric transmission and reception of signals, the combination of a pair of contacts composed of non-oxidizable metal, a source of current in circuit therewith, means energized by the current traversing said contacts for forming and adjusting and maintaining a minute conduction space between the same and means for varying the said conduction space.

10. In the electrical transmission and reception of signals, the combination of a pair of contacts whereof one is adapted to be vibrated, a source of current in circuit therewith, and means energized by the current traversing said contacts, for adjusting the vibratory contact so as to form and maintain a minute conduction space between the said contacts.

11. In the electrical transmission and reception of signals, the combination of a pair of contacts, mechanical means for adjusting one of the contacts and electrical means for forming and adjusting and maintaining a minute conduction space between the contacts.

12. In the electrical transmission and reception of signals, a pair of contacts, mechanical means for adjusting one of the contacts, and electrical means arranged in a local circuit and adapted to be traversed by the local current so as to form and adjust and maintain a minute conduction space between the contacts, and means adapted to vary the conduction space between the contacts traversed by the local current.

13. In the electrical transmission and reception of signals, the combination of a pair of contacts, a source of current in circuit therewith, an electromagnet, a current carrying wire adapted to form and adjust and maintain a minute conduction space between said contacts, a frame carrying said current carrying wire and means for connecting said wire to one of the contacts.

14. In the electrical transmission and reception of signals, the combination of a plurality of contacts, a source of current in circuit therewith, means energized by the current traversing said contacts, for forming and adjusting and maintaining a minute conduction space between the contacts, means for varying said conduction space to increase the amplitude of the signals, means for transmitting the said signals and means for receiving the same.

15. In the electrical transmission and reception of signals, the combination of a pair of contacts, means for mechanically adjusting one of the contacts relatively to the other, means for rendering the other contact capable of vibration, a local battery circuit in which the said contacts are included, means energized by the current flowing in said local circuit, for forming and adjusting and maintaining a minute conduction space

between the said contacts, and means for varying the conduction space.

16. In the electrical transmission and reception of signals, the combination of a pair of contacts, a source of current in circuit therewith, local means comprising an electromagnet energized by the current traversing said contacts for forming and adjusting and maintaining a minute conduction space between the contacts, an electromagnet in the line for varying the conduction space and means adapted to regulate the period of vibration of the said local electromagnet.

17. In a system for the electrical transmission and reception of signals, the combination of a plurality of contacts working under oil, a source of current in circuit therewith and means energized by the current traversing said contacts for maintaining a minute conduction space between the same.

18. In a system for the electrical transmission and reception of signals, a relay comprising in combination a plurality of contacts, a source of current in circuit therewith, means in circuit with said source of current adapted to form and adjust and maintain a conduction space between said contacts, and means for varying the aforesaid space in accordance with the variations of the signals.

19. In the electrical transmission and reception of signals, the combination of a vibratory contact, a non-vibratory contact in juxtaposition to the vibratory contact, means for effecting the adjustment of the non-vibratory contact relatively to the vibratory contact whereby more or less current is allowed to traverse the contacts, and local electrical means adapted to control the minute conduction space which is formed and maintained by said local means.

20. In the electrical transmission and reception of signals, the combination of a vibratory contact, a spring strip carrying the said vibratory contact, a non-vibratory contact, means for adjusting the said non-vibratory contact relatively to the vibratory contact, and local electrical means adapted to control the microphonic space between the said contacts and which is formed and maintained by the said local means.

21. In the electrical transmission and reception of signals, the combination of a vibratory contact, a reed for carrying the said vibratory contact, a non-vibratory contact, mechanical means for effecting the adjustment of said contacts whereby more or less current is allowed to traverse the same, and local electrical means for controlling the microphonic space which is formed and maintained by the said local means.

In testimony whereof I affix my signature in presence of two witnesses.

SIDNEY GEORGE BROWN.

Witnesses:

T. SELBY WARDLE,

WALTER J. SKERTEN.