LOUD SPEAKING TELEPHONE

T. TOWNSEND BROWN

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Be it known that I, T. Townsend Brown, a citizen of the United States, residing in Zanesville, Muskingum County, Ohio, have invented certain new and useful improvements in loud speaking telephones and do hereby set forth a clear explanation of the same.

The invention relates to loud speaking telephones for use with radio receivers, talking picture projectors or the like, where electrical impulses are transformed into sound waves. Likewise, the invention relates, in counterpart, to microphones or telephone transmitters, where sound waves are made to produce corresponding electrical impulses. More specifically, the invention relates to telephonic devices of the electrostatic type.

SPECIFICATION:

This invention sets forth a method of creating sound waves directly from electrical impulses without the necessity of a vibrating diaphragm or similar moving mechanical element. It is because of this feature and its obvious advantages that the method is considered novel and valuable. The sound waves are generated by air currents rapidly alternating in direction, the air being influenced, due to its dielectric nature, by strong longitudinal and transverse electrostatic fields.

In practice, the longitudinal field is held at a constant strength and the transverse field is modulated. Mechanical forces act upon the mass of air dielectric within the rapidly changing electrostatic field such that the air is moved first in one direction, then in the opposite direction, creating audible waves. The operation of the device makes use of the inductive capacity of air. Inasmuch as other dielectrics possess equal or greater inductive capacity than air it is conceivable that other gasses or fluids could be used or other applications than those suggested could be made without affecting the operativeness of the method of producing motion.

Included in the scope of this invention is the electrostatic microphone which is an application of opposite purpose to that of the loud speaking telephone. When sound waves enter the permanent electrostatic field a reaction takes place which produces a fluctuating transverse electrostatic field. Both the actual movement and changing density are responsible for the reaction. The fluctuating field in turn affects the charge on a collector electrode and the electrical impulses thereby generated are transmitted along a conductor attached thereto.

The advantages of this method of producing sound from electrical impulses or electrical impulses from sound are obvious. Ordinary methods employing moving diaphragms are objectionable because of the distortion introduced by the diaphragm itself. Due to its comparatively great mass and the elastic means of support the diaphragm has a natural period of vibration and a long series of overtones. This results in uneven amplitudes, poor quality and an artificial "canned" character to the emitted sounds. With the diaphragm type of telephones this character is inherent and is unavoidable.

Referring to the attached drawings: Fig.1 is a perspective of the loud speaking telephone showing the electrical connections and a schematic diagram of a high voltage power supply. Fig. 2 is a diagram of the connections of the telephone and the approximate space ratio of the electrodes and component parts. Fig. 3 is a perspective of one dielectric block, cut away to show construction. Fig. 4 is a curve showing the desirable voltage gradient at various points along the dielectric block from one electrode to the other. Fig. 5 is a diagram showing the dielectric block C and electrode D with arrow in the space between to indicate the direction of the force acting on the air separator when the leads are connected according to the polarity shown. Fig. 6 is the same as Fig. 5 with the exception that the polarity of electrode D is now reversed and the direction of force is thereby reversed. Fig. 7 includes a diagram of an amplifying unit in connection with the dielectric block and electrode, suggested as a simple complete circuit illustrating the application of this invention as a microphone. Sound waves enter the microphone and are effective only while traversing axis XY.

Referring more in detail to the attached drawings:
Fig. 1 shows the essential elements of the loud speaking telephone, purposely shown without supporting frame. The dielectric blocks C are formed of molded insulation, thin toward the center and thick and rounded at the sides. Metal rods A and B, firmly inset and held by the molded insulation, constitute the electrodes of each block. The molded material is such that it is a weak conductor of electricity. Each block should conduct not less than 250 microamperes at 10 kilovolts, the specific resistance not exceeding a value approximately 1×10^7 ohms per centimeter cube. This slight conductivity is sufficient to maintain the required voltage gradient and to prevent localized high charges.

The dielectric blocks C are shaped in such a manner, narrow toward the center, as to bring about the greatest voltage gradient at a point midway between the two electrodes A and B. On either side of the midpoint the gradient of voltage decreases because of the increasing width and reaches zero at the electrode faces. The shape of the blocks not only increases the sensitivity of the telephone but serves to reduce brush or point discharge and to prevent electrical breakdown.

Metal reactor electrodes D are spaced between each dielectric block so that the convex faces of the electrodes oppose the concave faces of the blocks. In this way the electrodes are made to match the blocks in shape and the sound channel is kept uniform in width. A one-unit telephone consists of one dielectric blockC and one reactor electrode D. Units may be connected in parallel as shown and the telephone built to any requirement of volume. Electrodes A and B are connected to a source of high potential as illustrated.

In the majority of cases the power to operate the telephone is supplied from a 110 volt 60 cycle line as shown on the diagram. This energizes filament transformers H_1, H_2, H_3, which in turn heat filaments of rectifier tubes G_1, G_2, G_3, G_4. Power is likewise supplied to the high voltage transformer K (110 to 10,000 volts), the center tap of which is grounded, and the high voltage conducted to the tubes for full wave rectification. Chokes F_1, F_2 are inserted ahead of filter condensers E_1, E_2. The high potential, -5000 volts and +5000 volts, is conducted to electrodes A and B of the telephone. This circuit supplies power to what might be termed the "field" of the telephone. It is suggested as a practical means for supplying a steady potential. Other means than that illustrated or a variation of the suggested circuit may be employed to produce the required potential without deviating from the teachings of this specification.

Modulated current is supplied to the telephone from the output of any standard audio frequency power amplifier. The emf., however, must be stepped up to a value approximating that of the "field". The high ratio transformer R is employed for this purpose.

In Fig. 1 the secondary leads of this transformer are connected respectively to the reactor electrodes D and the ground. Maximum volume of sound is created by the telephone when the emf. of the reactor electrodes, relative to the ground, alternates to limits equal to the emf. of the steady field, i.e., in cycles from

-5000 volts to +5000 volts. Correspondingly less volume of sound is emitted as the alternated emf. falls below this value. This feature allows the telephone to respond to voice intonations or rapidly changing amplitude in music or sound.

It is not deemed necessary to illustrate the power amplifier or the initial half of the telephone circuit; first, as it is apparent to those skilled in the art that any one of several circuits may be employed and second, that such circuit is beyond the scope of this invention.

Fig. 2 is a diagram of the loud speaking telephone itself, showing the dielectric blocks C and the reactor electrodes D connected in parallel. Sound channels R to F are formed by the spaces between the respective C members and D members. The efficiency of the telephone depends much upon the proper spacing, i.e., the correct ratio between the size of the members and the distance between members. When the telephone is in operation air is forced in the form of waves in the direction shown by the arrows and in the opposite direction. These waves unite upon reaching the ends of the channels to form a solid wave front travelling outward from the sides of the telephone.

Fig. 3 is a perspective of one dielectric block cut away so as to show the electrode rod B molded in the dielectric material. Electrodes A and B are metal rods running the full length of block C and centering in the expanded portions of the block.

Fig. 4 explains the reason for the odd shape of the dielectric blocks or C members. The curve shows the approximate voltage gradient (in volts per millimeter) at various sections or points along a dielectric block between the two electrodes A and B. At point X, which is the surface of electrode rod A, the voltage gradient is zero. Moving away from the electrode the gradient rises rapidly at first, then more slowly, until at point Y (the midpoint between the two electrodes, where the block is thinnest) the voltage gradient is maximum, reaching a value approximately 1000 volts per millimeter. Moving further toward the opposite electrode B the gradient falls slowly, then more and more rapidly, until it again reaches zero at point Z, the surface of electrode B.

A gradient curve of this type, as an electrical embodiment of the dielectric blocks, is recommended and constitutes an element of this invention. Such must not be construed, however, as essential for the operation of the telephone. It improves the performance of the telephone and allows the following significant advantages; first, higher gradient over the central and more sound-active portions of the dielectric block; second, greater efficiency for lower amplitudes and on lower modulated emfs.; and third, greater resistance to the progressive breaking-down of the dielectric material, greater dielectric strength.

Figs. 5 and 6 are diagrams of single telephone units, comprising one C member and one D member, simplified for the purpose of imparting a clear understanding of the electro-mechanical relation which makes the telephone operative.

In Fig. 5, electrode A is connected to the positive side of the high potential source and the electrode B is connected to the negative side. A steep voltage gradient is made to exist along dielectric block C, especially along the thinner portions, and a strong electrostatic field involves not only the dielectric block but the region immediately adjacent to reactor electrode D in the space between C and D. When electrode D is charged positively (approaching the emf. of A) the field is distorted in such a way as to cause the air (or any other dielectric fluid) to experience a mechanical force and to move in the direction shown by the arrow. The block C experiences a similar but opposite force.

In Fig. 6, the electrical connections to A and B are the same as in Fig. 5. However, the electrical sign of reactor electrode D is now reversed and the charge is made to approach the emf. of B. Under these conditions the physical force is likewise reversed and the air is caused to move in the other direction.

Thus, when an alternating emf. is supplied to reactor electrode D, waves of air are created which move rapidly back and forth in strict accordance with the electrical alternations.

Air waves or sound may be transformed into an alternating emf. by precisely the same means but the process is the direct opposite to that set forth in Figs. 5 and 6. Fig. 7, therefore, is a complete diagram of this invention applied as a microphone or telephone transmitter.

The C and D members are the same as shown heretofore. For the sake of simplicity in this illustration the "field" current is shown as supplied from batteries, the center tap of which is grounded. However, for practical use a high voltage supply such as described in Fig. 1 is more desirable. Electrode D, being now a "collector" electrode, is connected to the primary of an audio frequency transformer T. The secondary is connected to vacuum tube V through condenser S, grid leak L, proper batteries as shown, and thence to electromagnetic headphones P.

Sound waves entering the device along axis XY disturb the constancy and uniformity of the electrostatic field and effect an immediate reaction by changing the space charge in the vicinity of electrode D. This affects the charge on D, resulting in a slight current through the primary of transformer T. The alternating emf., caused by the incoming sound waves, passes through the transformer, is amplified by the vacuum tube circuit and is heard again as sound in the telephones P.

In Fig. 7, as in Fig. 1, a diagram of a standard and well-known circuit is given for the purpose of clearly illustrating the manner of applying this invention in practice. It is not intended that the circuits be represented as elements of this invention or that the structure and application of this invention be limited to any certain type of circuit. It is apparent that many changes in design are possible, and many different applications may be found for this invention, other than those illustrated, without departing from the spirit of this invention as covered by the hereto appended claims.

What I claim is:

1. The means for creating sound waves from electrical impulses comprising a block of dielectric material with a pair of electrodes attached or imbedded at the extremities thereof, a reactor electrode lying to one side of the block of dielectric material, means for supporting the same so that sound channels of the proper width are provided.

2. In a loud speaking telephone the method of producing sound consisting in establishing a constant electrostatic field, a modulated electrostatic field normal to the constant field, and arranging the two fields to react in the presence of a dielectric fluid capable of transmitting the resultant mechanical forces into sound waves.

3. Method of producing motion of a dielectric fluid consisting in immersing in said fluid a partial conductor of electricity with leads attached at the extremities thereof, immersing also and arranging at a short distance to one side of said partial conductor a good conductor or electrode with lead attached, supplying a continuous difference of potential to the extremities of the partial conductor, supplying a continuous or alternating potential to the electrode, and utilizing the movement of the fluid, relative to the conductors, generally in the direction of the alignment of the partial conductor.

4. In a loud speaking telephone the method of creating sound without the aid of a diaphragm consisting in establishing a constant electrostatic field along air-filled channels, producing a modulated or alternated electrostatic field across said channels, and utilizing the mechanical forces arising from the reaction of the two fields on the air dielectric in the channels to create air waves.

5. In an electrostatic loud speaking telephone of the type described the means of creating a concentrated electrostatic field with peaked voltage gradient comprising a dielectric block or material poor conductivity inserted in the electrostatic field, said block being constricted in dimension toward its center.

6. In a telephone of the type described means for reducing brush discharge and for preventing electrical breakdown comprising electrode rods molded into the dielectric material, said material completely enveloping the rods.

7. In a telephone of the type described the method of creating proper electrical conditions for the production of sound from electrical impulses consisting in using dielectric blocks with concave sides, using reactor electrodes with convex sides, and assembling the telephone so that sound channels of uniform width are formed by the spaces between successive sections.

8. The method of creating movement of an air column by electrical energy consisting in setting up a steady electrostatic field longitudinally along the column, setting up a second electrostatic field across said column, and allowing the two fields to interact in said column to produce mechanical forces and movement of said column.

9. In an electrostatic telephone means for producing sound waves comprising a multiplicity of dielectric blocks with electrodes attached, a multiplicity of reactor electrodes arranged between said dielectric blocks, and means of support whereby substantial spacing is maintained between successive dielectric blocks and reactor electrodes to form air channels, open at the extremities, for the synthesis and emission of sound waves.

10. Method of producing force or motion of a dielectric fluid relative to a fixed system made up of an electrode and a high resistance solid consisting in providing said solid with a pair of leads attached at the extremities thereof, providing a reactor electrode spaced to one side of the solid and lying in a position at right angles to the alignment of said extremities, arranging the dielectric fluid to fill a channel the opposite walls of which are formed by the high resistance solid and the reactor electrode, supplying a steady difference of potential to the extremities of the solid, supplying a high potential to the reactor electrode, and utilizing the electro-mechanical forces developed between the high resistance solid and the dielectric fluid generally in the direction of the alignment of the solid to produce movement of said fluid.

11. Method of producing electrical impulses from sound waves consisting in setting up a constant electrostatic field, causing sound waves to pass through said field generally in the direction of the gradient, collecting charges induced by the fluctuating transverse field, and transmitting the resultant electrical impulses over a conductor.

12. Means for transforming sound into pulsating electrical energy comprising a sound-intercepting channel open at the extremities, a poor conductor of electricity forming one side of said channel, a high potential direct current passing along said conductor generally in a direction parallel to the channel, an electrode forming the opposite side of said channel, and a lead attached to said electrode for the purpose of conducting away the pulsating electrical energy.

13. In a microphone means for creating a steady electrostatic field and for collecting the induced charges produced by the sound waves.

14. In a loud speaking telephone or microphone as described means for supplying relatively constant potentials equally above and below the potential of the ground.

15. In a loud speaking telephone of the type described means for supplying a modulated or alternated potential, the alternations of which reach limits equally above and below the potential of the ground.

16. In a microphone of the type described means for collecting, amplifying or using a modulated or alternated potential, the alternations of which reach limits equally above and below the potential of the ground.

17. Method of observing the rate of movement of a dielectric fluid relative to a fixed electrical system consisting in creating in said fluid an electrostatic field the gradient of which is parallel to the direction of movement of the fluid, supplying for the maintenance of said field potentials equally above and below the ground potential, placing a collector electrode to one side of the line of maximum gradient of said field at a point where the field potential is equal to the ground potential when no movement of fluid is present, attaching a lead to the collector electrode to conduct any charges or change of potential to an observing instrument, introducing movement to the fluid, and observing the corresponding change of potential relative to the ground potential.

T. Townsend Brown
Inventor

Witnesses:

Ruth Greiner

C. A. Zinn

COUNTY OF MUSKINGUM
SS.
STATE OF OHIO

Sworn to before me and subscribed in my presence this 2d day of January, 1934 at Zanesville, Muskingum County, Ohio.

C. A. Zinn
Notary Public

C. A. ZINN, Notary Public

T. TOWNSEND BROWN

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3 SHEETS, SHEET 1.

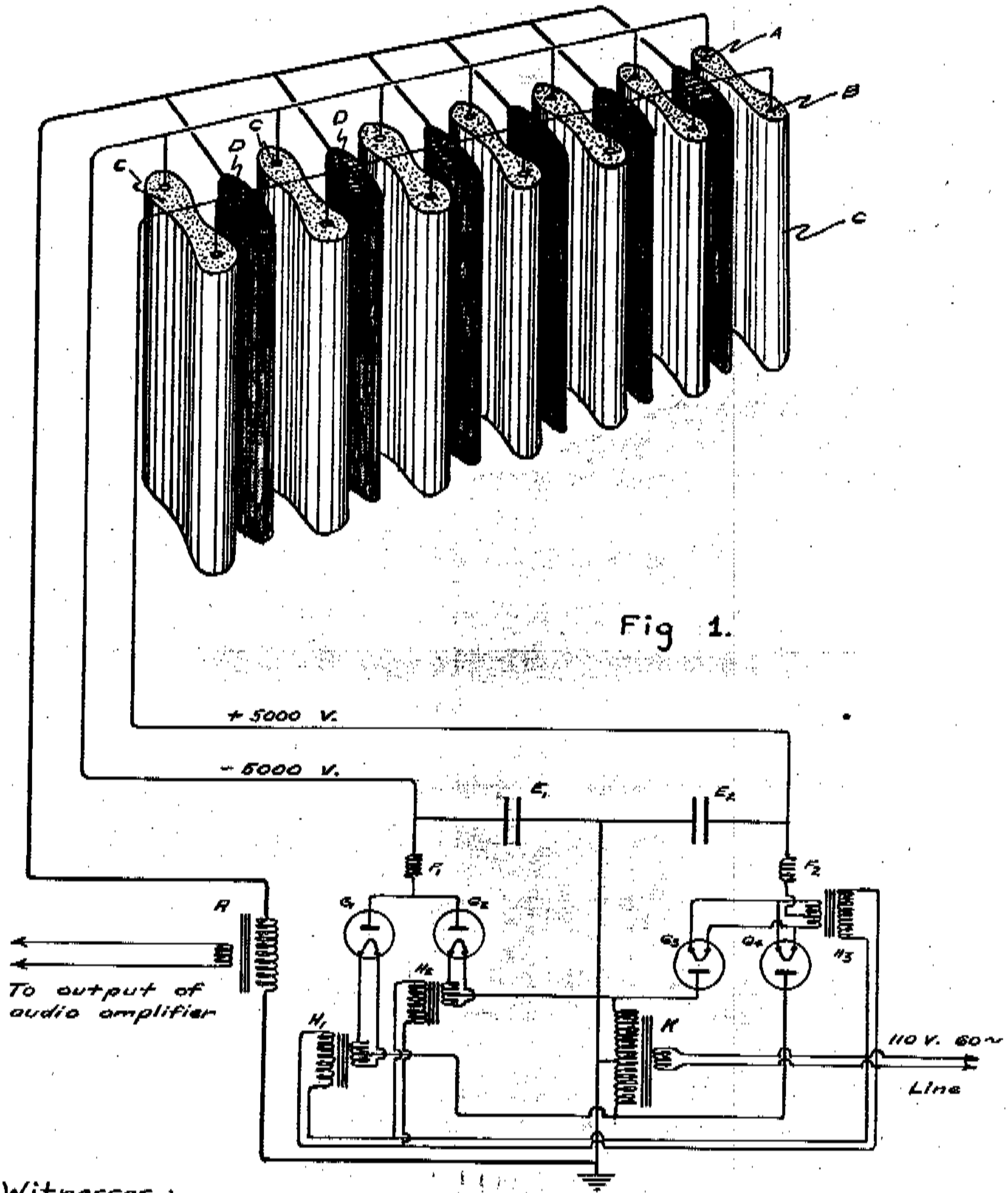

Fig 1.

Witnesses:

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Grace Pedman

Nov. 15, 1933

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His Attorney

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LOUD SPEAKING TELEPHONE

3 SHEETS, SHEET 2.

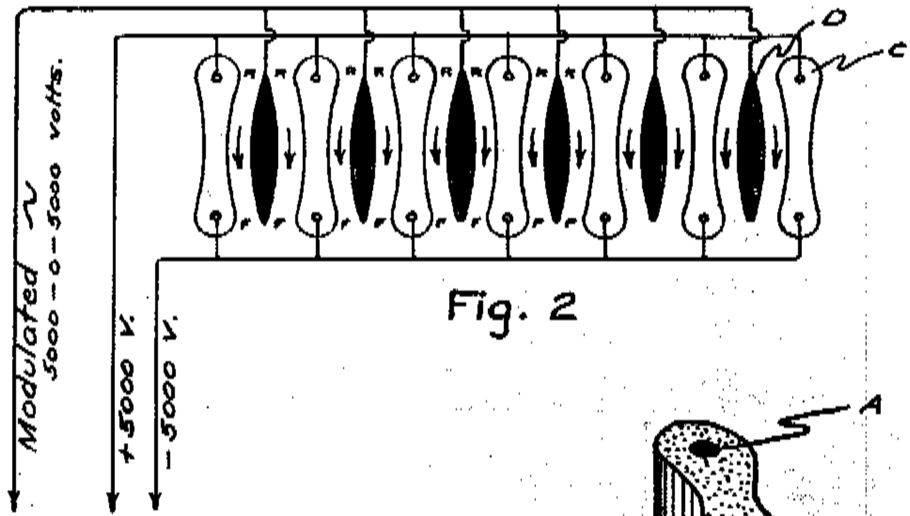

Fig. 2

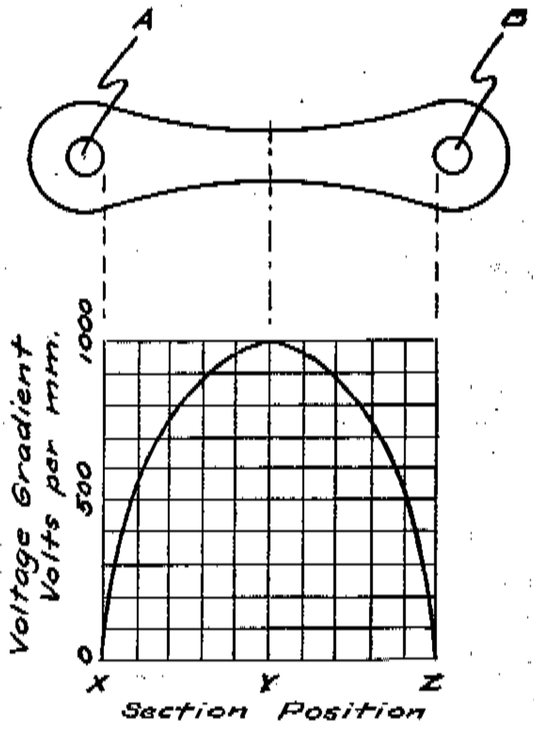

Fig. 4

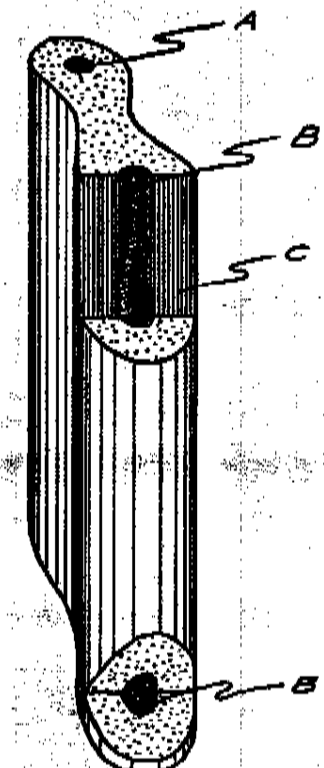

Fig. 3

Witnesses:

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5 SHEETS, SHEET 3.

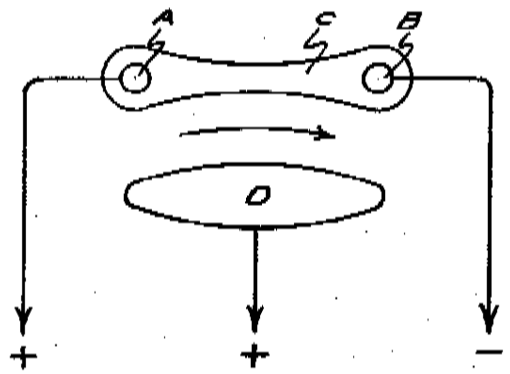

Fig. 5.

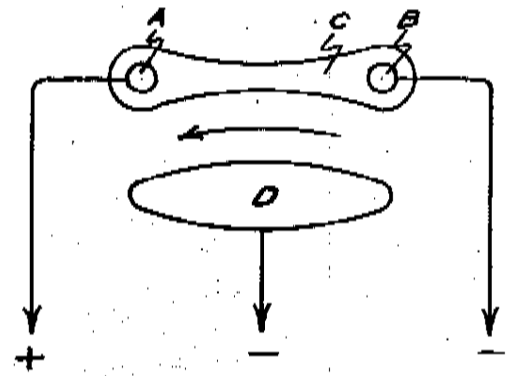

Fig. 6.

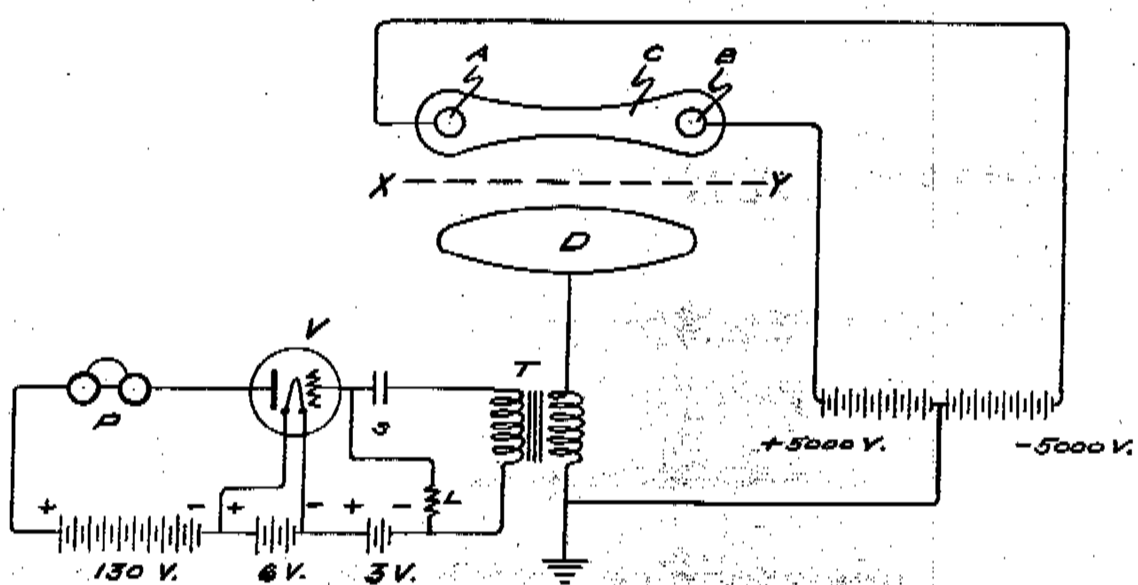

Fig. 7.

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