(No Model.)

I. H. FARNHAM.

ELECTRO PHONOMETER AND PHONOSCOPE.

No. 455,815. Patented July 14, 1891.

Fig. 1.

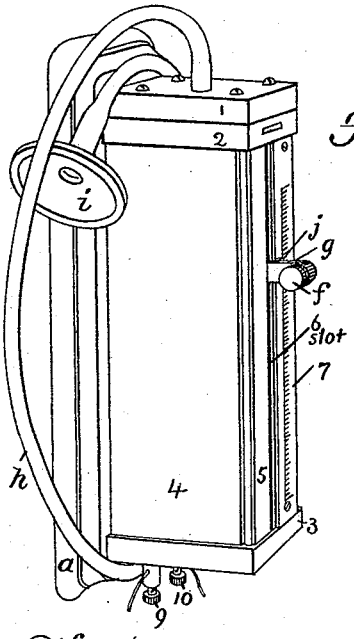


Fig. 5.

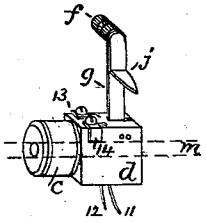


Fig. 4.

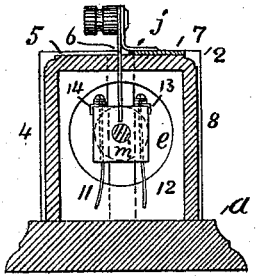


Fig. 2.

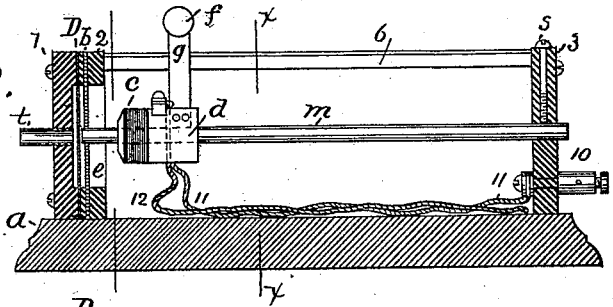
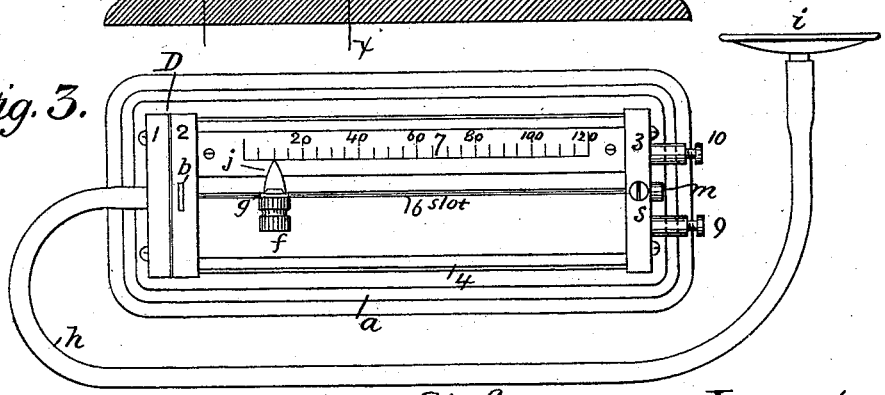
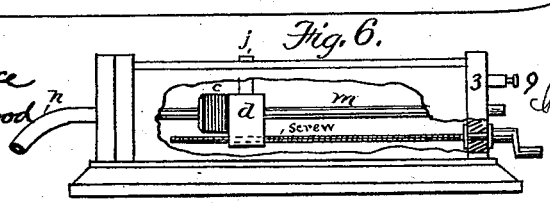


Fig. 3.



Witnesses
Geo. Willis Pierce
Frank C. Lockwood

Fig. 6.



Inventor.
Isaiah H. Farnham

UNITED STATES PATENT OFFICE.

ISAIAH H. FARNHAM, OF WELLESLEY, ASSIGNOR TO THE NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY, OF BOSTON, MASSACHUSETTS.

ELECTRO PHONOMETER AND PHONOSCOPE.

SPECIFICATION forming part of Letters Patent No. 455,815, dated July 14, 1891.

Application filed February 13, 1891. Serial No. 381,365. (No model.)

To all whom it may concern:

Be it known that I, ISAIAH H. FARNHAM, residing at Wellesley, in the county of Norfolk and State of Massachusetts, have invented certain Improvements in Electro Phonometers and Phonoscopes, of which the following is a specification.

This invention is as electro phonometer and phonoscope.

It is well known that the lines of electric circuits extended between different stations are, in addition to their legitimate working-current, traversed by many foreign and intrusive currents of electricity, usually in a state of perpetual variation of strength and often also of direction. Regardless of the character of the invaded electric circuit, these intrusive currents tend to interference with the legitimate current and to distort, retard, or disturb the signals produced thereby. The operative currents ordinarily circulating in telephone-circuits are of minute volume, and for this reason the receiving-telephone requires to be and is an instrument extremely sensitive to electric changes. This being the case, it is evident that in telephone-lines the interfering tendency of the intrusive currents may be expected to manifest itself to a pronounced extent, resulting in noises in the telephone, which vary in degree of intensity from a gentle murmur to a sound which overpowers all others, and which also has a great variety of character. This expectation is fully realized in practice. The interfering currents are due to a great number of causes. They are induced by virtue of the proximity of arc lighting circuits, alternating currents, incandescent lighting circuits, electric railways, and harmonic telegraph circuits. They sometimes occur by conduction or absolute transfer of current from the above agencies and many others unnecessary to mention. Inasmuch as all of the interfering currents are the enemies of and oppose the proper use of the lines, it becomes necessary to cultivate their acquaintance and to study their character and differences, and to determine their comparative values for the purposes of bringing them under control, of suppressing them, if possible, and in any event to diminish their adverse effects. This can best be done practically by studying the disturbances which result from them, and by comparing one kind of disturbance and its effects on the transmission of signals with another.

By means of the instrument which I have invented and which I call an "electro-phonometer," but which is also an electro-phonoscope, the necessary observation, comparison, and standardizing of the disturbances occurring in telephone and telegraph lines can be effected with the greatest convenience.

In the drawings which accompany and form a part of this specification, Figure 1 is a perspective view of one form of instrument embodying my invention which has been found convenient in practice. Fig. 2 is a longitudinal sectional elevation thereof. Fig. 3 is a plan view. Fig. 4 is a cross-section on line $x\ x$ of Fig. 2, and Fig. 5 is a detail. Fig. 6 is a modification.

The essential features of the instrument are respectively a magnet, a diaphragm mounted in front thereof in close proximity thereto, a suitable coil or helix of insulated wire adapted by suitable connections for inclusion in any electric circuit, and capable of being moved or slid along the magnet from one end to the other, suitable means for effecting the said movement, an index or scale properly graduated, and a pointer attached to the movable coil and denoting the advance thereof on the said graduated scale.

As shown in Fig. 1, the inclosing case, which may be made of hard wood, hard rubber, or other similar material, has two sides 4 and 8, and is provided with a base a, to which it is secured. Its ends are respectively closed by end pieces 3 and 1, the latter being centrally perforated, and fitted by means, such as a small rigid tube t, (see Fig. 2,) whereby a flexible tube h, terminated by a convenient ear-piece, may be attached. Binding-screws 9 and 10, constituting the instrument-terminals, are affixed to the rear end piece 3. The top piece 5 is slotted from end to end, and on one side of its outer surface is a graduated scale 7, which may be integral therewith or separate and secured in any desired manner. A lever g projects from the interior through

the slot 6, terminated by a finger piece or button *f*, and provided with the pointer *j*, which is associated with the scale.

In Fig. 1 I have shown the tube *h* as being twisted round the instrument, so as to present a compact appearance when not in use.

The scale 7 is shown as being so graduated that each division represents five units; but it can of course be divided to a much finer degree of graduation, if desired. In Fig. 3 the longer division-marks, each denoting twenty units, are correspondingly designated.

Between the end piece 1 and the end of the casing is a frame-piece 2, forming a seat for the diaphragm D, which is clamped between its front surface and the end plate 1, the said end plate being slightly excavated or otherwise conformed to form a flat vocalizing-chamber. A circular space is cut through the center of the said frame-piece 2, and within the said frame and crossing its central space from the upper to the lower sides is mounted a bar *b*, which in turn is centrally perforated for the admission of the active pole of a magnet *m*, extending from one end of the case to the other, which pole, passing through the said bar, is adjusted in close proximity to the diaphragm D. The magnet can be secured in place by the screw *s*, passing through the back end piece, or in any preferred manner.

An electro-magnetic helix *c* of insulated wire, similar in size and construction to those used in the ordinary hand-telephone, is secured to a block *d*, of non-conducting material, such as hard rubber, and its ends terminate in binding-screws 13 and 14, mounted thereon, and from thence are continued by flexible conductors 11 and 12 (which may, if preferred, be included in a single cord) to the instrument-terminals 9 and 10.

The construction and arrangement of the coil, its supporting-back and moving lever, and its relation to the magnet are more clearly shown in the detail drawing, Fig. 5. The lever *g* being secured to the block *d*, both coil and supporting-block are centrally perforated, and are capable of being slid or moved on the magnet *m* with great facility, the cross-bar forming the front limit and the end piece 3 the back limit of their traverse. Since the bearing-surface upon the magnet is produced by a hole passing through both coil and block, it is sufficiently long to prevent any opposition to the movement of the coil attributable to lateral play and consequent friction. By means of the handle *f* the coil can be moved as desired, and it may be prevented from moving too easily by causing the lever to press elastically against one edge of the traverse slot or by providing an extra spring for that purpose. Other modes of moving the said coil along the magnet may be adopted. For example, I may provide a threaded hole through the block *d*, forming a nut for a screw of suitable pitch and construction, the said screw to be operated by a screw-head at the rear end of the casing. This modification is indicated in Fig. 6.

In the operation of my instrument it is connected with any desired circuit and the coil brought up to its front limit. The observer listens at the ear-piece and notes the amount of disturbance. He then slides the coil backward and finds that the disturbing sound decreases in a regular manner, the reason, of course, being that the coil through which the intrusive currents are circulating as it is moved away from the magnet-pole has a continually-decreasing influence over the magnetism of said pole, which magnetism is therefore maintained more constant, resulting in a more steady attraction of the diaphragm, the vibrations of which, therefore, are diminished directly as the distance the coil is moved, and resulting also in a consequent and proportionate decrease of the disturbing sounds. When the coil is slid back so far that the sounds are normal, there being substantially no disturbance, the position of the index-finger upon the scale is observed and the indication represents the comparative intensity of the disturbance in arbitrary units. By forming a record of these observations I am enabled to compare one line with another, the disturbance on one date with that of the same line on another date, or of a given line at different times of the same day, so as to divide up the amounts of disturbances due to different causes. By my instrument the difference in the severity of disturbance caused by electric railway arc lighting and alternating incandescent lighting systems can be observed and recorded. It is also useful in determining the amount of benefit derived from the use of a return-conductor or other attempts for the suppression of inductive disturbance, in comparing the merits of one transmitter with another, and in determining the talking qualities of different lines and lines having different lengths of cable and underground conductor.

Having now fully described my invention and its mode of operation, I claim—

1. The hereinbefore-described method of comparing disturbing currents in electric circuits, which consists in causing them to vary the field of a magnet-pole exercising attraction upon a vibratory diaphragm, in noting the sounds produced by the said diaphragm under said variation, and then in withdrawing the said currents gradually from said pole until the said sounds cease, and noting the extent of separation, substantially as described.

2. The electro-phonometer described herein, comprising a magnet, a vibratory diaphragm in close proximity to the pole thereof, an electro-magnetic coil or helix adapted for inclusion in an electric circuit mounted on said magnet and adapted to vary the magnetism of its pole, means, as indicated, for moving or sliding the said coil on the said magnet,

whereby its inductive influence thereon may be varied, and a scale and pointer, the latter being attached to said coil and adapted to move over the former and to indicate thereon the extent of movement of said coil.

3. In an electro phonometer or phonoscope, a magnet, a vibratory diaphragm mounted in close proximity to the pole thereof, and a coil or helix of insulated wire adapted for inclusion in an electric circuit mounted on said magnet and capable of being slid or moved thereon from its active pole rearwardly, and vice versa, in combination with an actuating device for moving said coil, and a pointer and scale-indicator, whereby the extent of said motion may be determined.

4. In an instrument for observing and comparatively measuring electrical disturbances in telephone-circuits, a magnet, a vibratory diaphragm mounted in close proximity to the pole of said magnet, a coil or helix of insulated wire and connections for including the same in circuits to be tested, the said coil being loosely mounted on said magnet and adapted to be slid from one end to the other and to vary the magnetism of the active pole thereof in differing degree according to its position, and a lever for moving the said coil on the said magnet, secured at one end to said coil and provided with a handle at the other, substantially as described.

5. The combination, in an instrument for measuring disturbances on telephone-lines, of a vibratory diaphragm, a bar-magnet having one pole in close proximity to and exercising attraction on said diaphragm, and a movable magnetism-varying coil adapted to be included in the circuit to be tested, mounted loosely on said magnet and capable of being slid thereon between its active and inactive poles, the disturbing sounds emitted by the diaphragm being at a maximum when the said coil immediately surrounds the active pole and decreasing as the said coil is slid away therefrom in the direction of the other pole.

6. In an electro phonometer or phonoscope, the combination of an inclosing case, a diaphragm mounted at one end thereof, an ear-piece therefor, a bar-magnet inclosed in said case and having one pole in close proximity to said diaphragm, a movable coil of insulated wire mounted on said magnet and capable of sliding thereon from the active pole rearwardly, and vice versa, a limit-stop for said coil determining its forward position, a longitudinally-slotted cover for said case, a graduated scale mounted thereon, a lever secured inwardly to said movable coil, projecting through the slot in said cover, and provided at its outer end with a handle or finger-piece to move the said coil, and an index-finger carried by said lever, moving therewith over said scale, and indicating thereon the comparative values of disturbing currents, all substantially as described, and for the purposes specified.

7. The combination, in an instrument for comparatively measuring disturbances due to intrusive currents on telephone-lines, of a telephone-diaphragm, ear-piece or ear-tube, and magnet, with a movable coil or helix of insulated wire and connections to place the same in a circuit to be tested, the said coil normally surrounding the active pole of the magnet to produce the maximum manifestation of disturbance, but being capable of sliding rearwardly on said magnet to a point of minimum disturbance, a graduated scale, and a needle or point moving with said coil and indicating on the scale the extent of motion and thereby the degree of disturbance.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 5th day of February, 1891.

ISAIAH H. FARNHAM.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.