

1,320,366.

Patented Oct. 28, 1919.
2 SHEETS—SHEET 1.

Fig. 1.

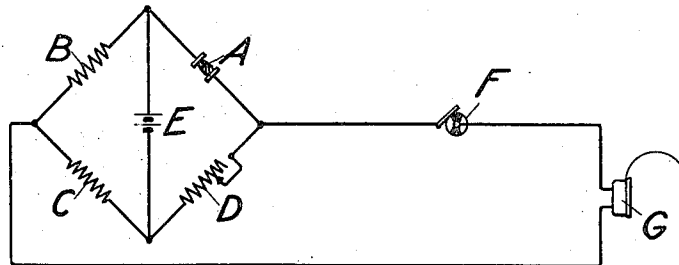


Fig. 2.

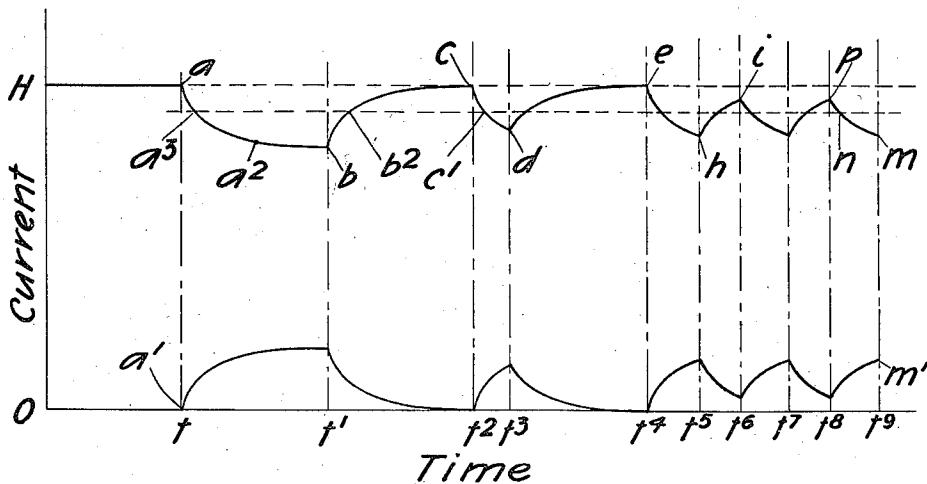
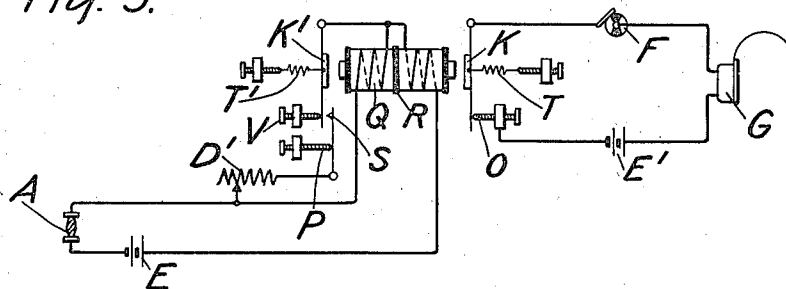


Fig. 3.

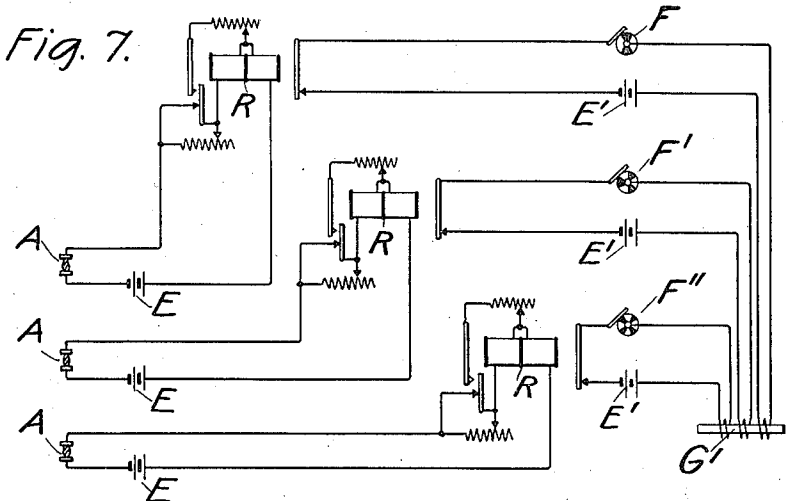
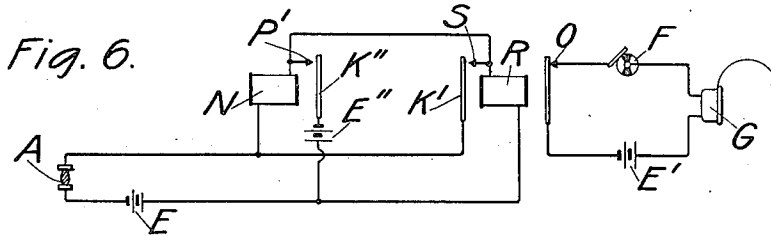
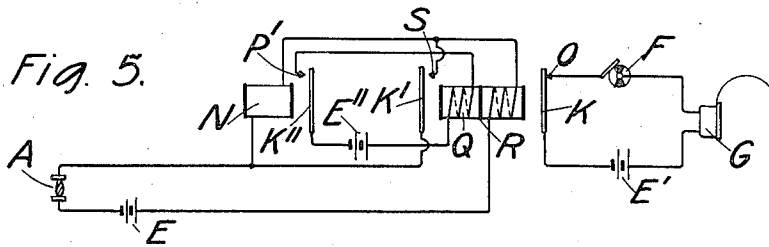
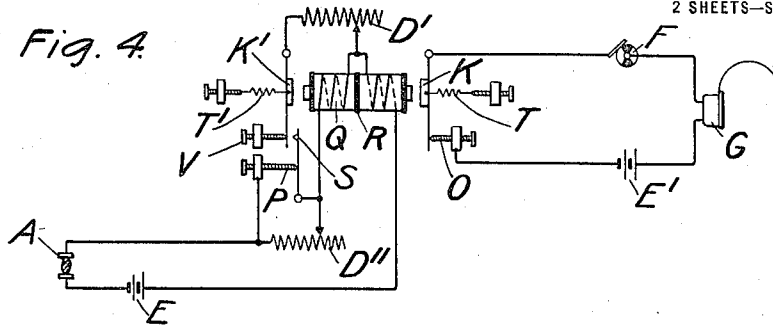


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Patented Oct. 28, 1919.

2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

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OPTIPHONE.

1,320,366.

Specification of Letters Patent.

Patented Oct. 28, 1919.

Application filed October 20, 1917. Serial No. 197,576.

To all whom it may concern:

Be it known that I, WILLIAM G. HOUSKEEPER, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Optiphones, of which the following is a full, clear, concise, and exact description.

This invention has reference to the class of instruments by which the appreciation of the shape of certain characteristics of an object, due to the effect of light either emitted thereby or reflected therefrom or transmitted therethrough, may be obtained from the sense of hearing. One application of this is that a person who is blind may be able to "see" by the aid of the ear or may be enabled to obtain some appreciation of the effect obtained through vision. The name "optiphone" has been given to this type of instrument.

The invention is designed more particularly as an improvement on or substitute for the optiphone described and claimed in the application of F. C. Brown, Serial No. 112,294, filed July 31, 1916, entitled "Optiphone". The invention comprehends a novel apparatus and method for performing the functions of the invention there described.

The optiphone as developed by Brown, consists, in one form, of a plurality of Wheatstone bridges, such as shown in Figure 1 of the accompanying drawing. Each bridge contains a selenium cell or crystal in one arm and a resistance in each of the other arms; a mechanical interrupter and a telephone receiver are placed in series in the indicating circuit so that when the bridge is balanced by adjusting the arms no sound is produced in the telephone receiver. When, however, a black surface, such as that of ordinary black print, is placed in front of the crystal, the bridge is unbalanced, causing a flow of current through the indicator circuit. This circuit is made to produce a continuous sound in the telephone receiver by the action of the interrupter, the note emitted depending upon the number of interruptions per second. When the print is removed, the bridge is again automatically balanced. A series of these bridges is provided, the crystals be-

ing alined and placed close together. The rate of interruption is made different in the different indicator circuits and a single telephone receiver may be used if desired.

If print is passed in front of the crystals of the optiphone in a general direction at right angles to that in which they are alined, one or more distinct tones are produced in the receiver, the pitch and duration of which are an indication of the form of a printed letter, which indication the user soon comes to recognize as characteristic of that particular letter. In this manner the blind are able to read ordinary print. As explained in the application referred to above, this arrangement may be modified in various ways and used for various purposes, but the fundamental principle of operation is that herein set forth.

It has been found that the optiphone has the defect that it becomes inoperative if the print is moved very rapidly past the crystal after the bridge has been thrown out of balance. This is due to the lag in change of resistance of selenium during change of illumination, the interval when the crystal or cell is illuminated by the white background of the print being in this case too brief to allow the resistance to return to normal value. It is the object of this invention to provide a substitute for the bridge circuits which will not present this defect.

The invention will be better understood by reference to the accompanying drawings in which:

Fig. 1 is a simple Wheatstone bridge circuit of the Brown optiphone;

Fig. 2 is a diagram showing the current through the selenium crystal of the Wheatstone bridge of Fig. 1 during changes of illumination and the corresponding current through the indicator circuit;

Fig. 3 shows a simple form of circuit which, according to this invention, it is proposed to substitute for that shown in Fig. 1;

Figs. 4, 5 and 6 are modified forms of the invention; and

Fig. 7 is a complete form of the invention in which a plurality of circuit arrangements as in Fig. 4 are associated.

Referring to Fig. 1, A denotes a selenium crystal or cell which constitutes one arm of

a Wheatstone bridge, the other arms of which contain resistances B, C and D respectively. A battery E supplies the bridge with current and the indicator circuit comprises the telephone receiver G and the interrupter F. This is the Wheatstone bridge arrangement of the Brown optiphone and its operation has been described above. It is necessary, however, to examine the action of the bridge when the rate at which printed matter is passed in front of the selenium cell is changed.

Referring to Fig. 2, H_z represents the current through the cell or crystal A when the bridge of Fig. 1 is balanced, as would ordinarily be the case when the white background of black print is in front of the crystal. If, now, the illumination is reduced, as by bringing a portion of a black letter before the crystal, the resistance of the cell increases, first rapidly and then more slowly, causing a corresponding fall of current through the cell. This change of current is indicated by the section $a b$, Fig. 2. This shows the current condition between the time t and the time t' . If now the original illumination is restored from time t' to time t^2 , the current will rise, as indicated by the portion $b c$ of the curve, the bridge being restored to the balanced condition. The remaining portion of the curve, $c m$, represents similar changes in the current through the selenium but with more rapid and less regular movement of the print in front of the cell. The portions $c d$, and $d e$ of the curve, show respectively the current fall and rise during the relatively short intervals from t^2 to t^3 and t^3 to t^4 . If the illumination is now reduced over the period from t^4 to t^5 and then is increased during the period from t^5 to t^6 , the current will fall from the point e to the point h and will then rise to the point i , the latter interval being too short to allow the current to reach the steady value H, so that the bridge will remain in the unbalanced condition. If now the succeeding intervals are likewise short, as shown by the portion of the curve between i and m , the bridge will remain unbalanced. This is indicated by the curve $a' m'$ (Fig. 2) which shows the changes of current in the indicator circuit corresponding to those through the selenium cell. The bridge is balanced when this current is zero and unbalanced when the current has any other value. It is therefore unbalanced during the interval from t^4 to t^6 , the tone heard in the receiver varying in intensity as the rate of movement of the print is varied.

It is seen, therefore, that if the bridge is thrown into an unbalanced condition as represented at h of Fig. 2 and the print is then rapidly moved past the crystal, the bridge will remain unbalanced and a continuous

tone will be heard in the telephone receiver. A circuit arrangement is shown in Fig. 3 which is adapted to be substituted for the Wheatstone bridge circuit of Fig. 1 and which does not have the above described defect, namely, that a continuous indication may be given in the telephone receiver during the time that the illumination upon the selenium crystal is being reversed. It consists of what may be termed a control circuit containing the selenium cell or crystal A, the battery E and the relay R, and an indicator circuit controlled by the relay R and containing a battery E', a telephone receiver G and an interrupter F. A portion Q of the winding of relay R is shunted through variable resistance D' and a circuit interrupter S also controlled by the relay R. The whole of the winding of relay R may be shunted, rather than the portion Q, if desired. The armatures K and K' are held against adjustable contacts O and V by adjustable springs T and T', respectively. An additional spring carrying a contact S is provided, as shown, though a stationary contact may be used if the fall of current through the relay is sufficiently rapid to prevent "chattering." The position of contact S may be adjusted by means of the adjustable stop P.

The function of the circuit AER is similar to that of the circuit ABCDE of Fig. 1, and the indicator circuit OFGE' performs, in general, the same function as the indicator circuit FG of Fig. 1. There is the difference, however, that the indicator circuit OFGE' is positively made and broken, by properly proportioning the strength of battery E or the number of turns of the relay R, while the indicator circuit FG of Fig. 1 is conductively connected to the control circuit at all times. The moment at which the armature K will be attracted, as the current in the control circuit rises, may be determined by adjustment of the control circuit or by tension of the springs or the size of air gap between armature K and the core of relay R. The curve Hm of Fig. 2 represents the current in the control circuit of Figs. 3 to 6 as well as Fig. 1.

The operation of the arrangement of Fig. 3 is as follows: Suppose that the control circuit is so adjusted that the armature K will be attracted when the point b^2 of the curve, of Fig. 2, is reached. Since the straight line $b^2 n$ intersects each portion of the curve which represents a rising current, the indicator circuit will be opened during each rise of current. If now the indicator circuit is closed whenever the current falls, the sound produced by the telephone receiver will be a proper indication of the reversals of illumination upon the selenium crystal. As the current through the relay R falls, however, the armature K would not

be released until the current reaches a value much lower than that at which the armature was attracted when the current rose, without the provision of special means to accomplish this purpose. This is due chiefly to the fact that the armature K in its circuit-closing position is at some distance from the core of the relay R, and hence the attraction is less than when the armature is in contact with the core of the relay.

Suppose, for example, that the current must fall to a value as low as that indicated by point a^2 , Fig. 2, before the armature K is released. The result will be that the armature will not be released between the points b^2 and m of the current in the control circuit, since the points d , h , m lie above the point a^2 . The purpose of the shunt circuit around a portion or all of the windings of the relay R is to advance the point at which the armature will be released when the current is falling. It is desirable, although not essential, that the resistance D be adjusted until the point of release falls upon the line a^2n , that is, until the value of the current in the control circuit at which the armature releases is the same as that at which the armature is actuated.

In operation, when the illumination upon the crystal A is rapidly changed from a high to a low value or vice versa, as when black or dark print upon a white or light background or light print upon a dark background is moved past the crystal, the resistance of the cell is varied, causing a corresponding rise and fall of the current in the control circuit, as indicated by the curve Hm of Fig. 2. The value of the illumination is normally such as to maintain the armature K in the position to open the indicator circuit and the armature K' in the position to close the shunt circuit D'S. Only a portion of the windings of the relay R, therefore, or a portion of the current in the control circuit, is effective to maintain the armature K in this position. By adjusting the resistance D' the point of release of the armature K can be made anything desired within certain limits. When the current falls to the point a^3 of the curve, Fig. 2, assuming that the apparatus has been adjusted to make this the point of release of the armature K, the indicator circuit is closed and a characteristic tone is heard in the telephone receiver. An instant later the current falls to a value which permits the release of armature K', opening the shunt circuit D'S K'. The tone in the telephone receiver continues until the current in the control circuit again rises and reaches the value b^2 , when the armature K is attracted and the indicator circuit is again opened. This cycle of operations is repeated as long as the illumination upon the selenium is reversed, regardless of the speed of reversal. The con-

tacts O and S, the strength of springs T and T' and the position of stop V may be adjusted to produce the proper sequence of opening and closing of contacts O and S.

The arrangement shown in Fig. 4 is similar to that of Fig. 3, the resistance D' performing the function of resistance D' of Fig. 3, a second resistance D'' being in series with the relay when the same is energized, and a contact P being provided whereby the resistance D'' is shunted when the relay R is deenergized. Contact points S and P are so adjusted that, when the relay is energized, the contact P remains closed until after contact between K' and S is made. The function of the resistance D'' is to compensate for the decrease of resistance in the control circuit brought about by the operation of the shunt about coil Q.

The operation of the arrangement of Fig. 4 is the same as that of Fig. 3, except that immediately after the shunt circuit PSK' is made the resistance D'', normally shunted through the contact P, is thrown into the control circuit. The resistance D'' is in practice adjusted to such a value that the desired compensation will be effected.

Referring to Figs. 5 and 6, alternative arrangements are shown in which an auxiliary relay N and an auxiliary battery E' are used. In each of these figures the relay N is short-circuited through the contact S when the current through the relay R reaches the value which will cause the attraction of armature K'. The relays N control armatures K'' which, in turn, control the auxiliary batteries E''. In Fig. 5 there is provided an auxiliary winding Q upon the relay R, which is included in circuit with the battery E''. In Fig. 6 the battery E'' is connected directly in shunt to the relay R through the contact point P'. In practice the armatures K, K' and K'' of Figs. 5 and 6 are provided with adjustable stops and springs similar to those shown by way of example in Figs. 3 and 4.

The operation of Fig. 5 is as follows: Normally, the relay R is energized, the armatures K and K' being attracted: The relay N is therefore short-circuited and the circuit of battery E'' is opened. If now the illumination upon the selenium crystal A is decreased, the current in the control circuit AER will decrease until a point is reached at which the armature K is released and a tone is produced by the telephone receiver G. At the same instant the armature K' is released, thus causing the closing of the circuit of battery E'' and an energization of the windings Q. The tone continues until the current in the control circuit again rises, due to an increase of illumination upon the crystal A, to the point where the armature K is again attracted. In practice K and K' would ordinarily be the same

moving part, which upon release would first open contact S and upon completion of swing would close contact O.

In Fig. 6 the battery E'' performs the same function as the corresponding battery E'' in Fig. 5, the auxiliary magnetizing effect being produced by current flowing directly through the coils of the main winding of relay R. The operation of this figure will therefore be understood from the description of that of Fig. 5.

While this invention is capable of general use as a relay system, a single selenium cell and control circuit and indicator circuit being used, it is designed more particularly for use with a plurality of these circuits in a manner analogous to the use of a plurality of Wheatstone bridge circuits of the Brown optiphone, which is described above. This arrangement is indicated diagrammatically in Fig. 7, in which the circuits of Fig. 4 are shown as triplicated, by way of example. The three selenium cells A are placed in proximity to each other and aligned. A single telephone receiver G' having three separate coils, one for each indicator circuit, is shown. The interrupters F, F', F'' interrupt their respective circuits at different rates.

In the use of this form of optiphone, as in that of Brown, the apparatus would be assembled in a suitable case adapted, if desired, to be held in the hand of the user. It is sometimes found desirable to employ a lens with the selenium crystals to focus the light thereon, as in the Brown system.

The invention, when applied to relay circuits, is not necessarily limited to the use with a light-sensitive element in the control circuit, since obviously the circuit arrangements disclosed would be of use with any current-varying device.

While various circuit arrangements embodying the broad principles of the invention have been shown and described, it is to be understood that other arrangements besides those specifically shown and described may be employed for accomplishing the same or similar purposes without departing from the spirit and scope of the invention, which is defined in the claims.

What is claimed is:

1. An optiphone comprising a light-sensitive element and means for causing a signal indication for each change of current through the light-sensitive element independently of the rate of change or the duration of illumination upon said light-sensitive element.

2. An optiphone comprising a light sensitive element and means for causing a signal indication for each change of current through the light-sensitive element, said means including a relay having an armature, and means for advancing the point of re-

lease of the relay armature when the current through the light-sensitive element is falling.

3. An optiphone comprising means for causing a signal indication for each change of current through the light-sensitive element thereof, said means including a relay, and means for causing the relay to release its armature when the current through the light-sensitive element falls to the value at which the armature is attracted when the current is rising.

4. In a signaling system, the combination with a light-sensitive resistance element, of a circuit therefor, a source of current and a relay in said circuit, an indicator circuit controlled by said relay, and means associated with said relay for causing it to release when the current in said circuit in falling reaches that value at which the armature is attracted when the current is rising.

5. In a signaling system, the combination with a light sensitive resistance element, of a circuit therefor, a source of current in said circuit, a relay controlled by said circuit, an indicator circuit controlled by the armature of said relay, and means controlled by said relay for shunting a portion of the windings thereof, whereby the point of release of said armature is advanced and the current in the indicator circuit is made to follow the changes of illumination upon said light sensitive resistance element with substantial fidelity.

6. In a signaling system, the combination with a light-sensitive resistance element, of a circuit therefor, a source of current in said circuit, a relay controlled by said circuit, an indicator circuit controlled by the armature of said relay, and means controlled by said relay for hastening the release of said armature when the current through said light-sensitive element is decreasing, the operation of said last-mentioned means affecting the current through said light-sensitive element, and means for compensating in part at least for the change in current thus produced.

7. In a signaling system, the combination with a control circuit, of a source of current therein, means in said circuit for varying the strength of current therein, a relay controlled by said control circuit, the armature of which controls an indicator circuit, means controlled by said relay for hastening the release of said armature when the current through said first-mentioned means is falling, the operation of said last-mentioned means affecting the current through said first-mentioned means, and means for compensating in part at least for the change in current thus produced.

8. In a relay system, a circuit, a relay therein, means including a light-sensitive element and a source of electromotive force

for causing the current to rise and fall in said relay, and means for causing the relay to release when the current in said circuit in falling reaches that value at which the armature is attracted when the current is rising.

9. The method of operating a relay system comprising a circuit, a relay therein, and a light-sensitive element for causing the current in said relay to rise and fall, which method includes causing the relay to release when the current in said circuit in falling reaches that value at which the armature is attracted when the current is rising.

10. The method of operating an optiphone comprising a circuit, a source of current and a light-sensitive resistance element therein, and an indicator circuit controlled by said first-mentioned circuit, which method comprises the moving of characters to be interpreted relatively to the light-sensitive element and adjacent thereto and in such a manner as to prevent the current through said element from returning to its normal value during a plurality of reversals of illumination of said element, and causing the rise and fall of current in the indicator circuit to lag behind the current variation in the first-mentioned circuit.

11. The method of operating an optiphone comprising a circuit, a source of current and

a light-sensitive resistance element therein, and an indicator circuit controlled by said first-mentioned circuit, which method comprises the moving of characters to be interpreted relatively to the light-sensitive element and adjacent thereto and in such a manner as to prevent the current through said element from returning to its normal value during a plurality of reversals of illumination of said element, and causing the time of beginning of current change in the indicator circuit to vary from that in the first-mentioned circuit.

12. The method of operating an optiphone comprising a circuit and a source of current and a light-sensitive resistance element therein, which method includes the moving of characters to be interpreted relatively to the light-sensitive element and adjacent thereto and in such a manner as to prevent the current through said element from returning to its normal value during a plurality of reversals of illumination of said element, and causing each variation of current through the light-sensitive element away from the normal current value therethrough to initiate a signal indication.

In witness whereof, I hereunto subscribe my name this 18th day of October A. D., 1917.

WILLIAM G. HOUSKEEPER.