Aug. 28, 1945. A. L. W. WILLIAMS 2,383,832

INTERCOMMUNICATION SYSTEM

Filed Jan. 29, 1943 2 Sheets-Sheet 1

FIG. 1

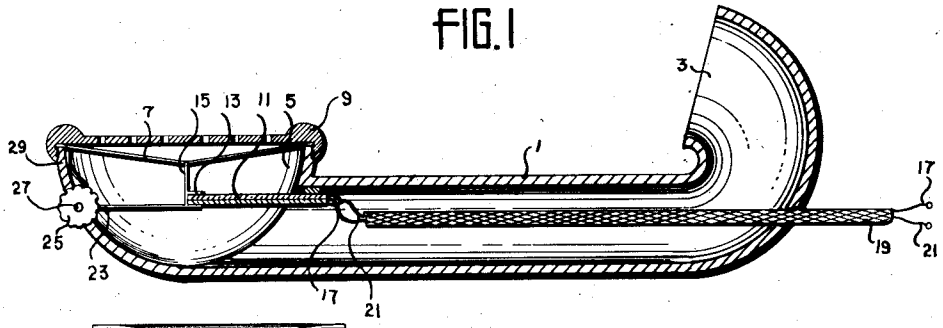


FIG. 2

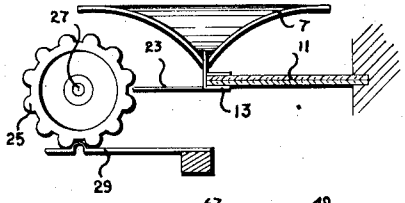


FIG. 3

FIG. 4

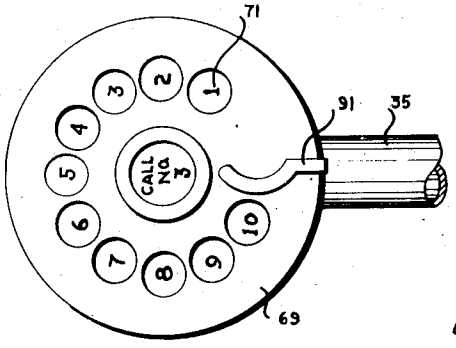
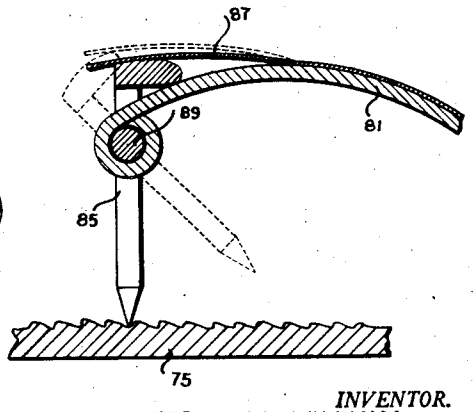


FIG. 5



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INTERCOMMUNICATION SYSTEM

Filed Jan. 29, 1943 2 Sheets-Sheet 2

FIG. 6

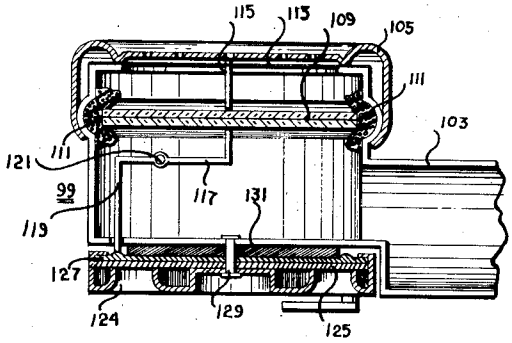


FIG. 7

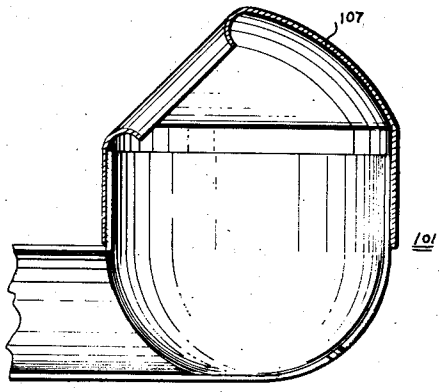
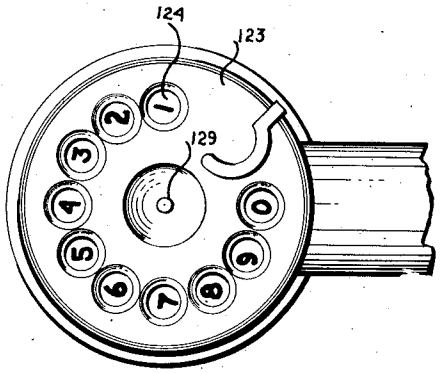


FIG. 8



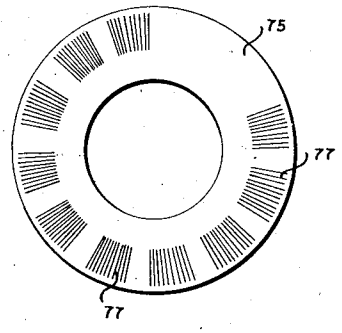
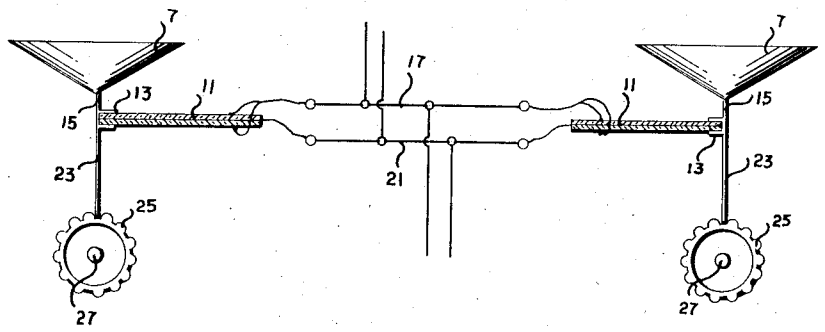


FIG. 9



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UNITED STATES PATENT OFFICE

2,383,832

INTERCOMMUNICATION SYSTEM

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Application January 29, 1943, Serial No. 474,013

19 Claims. (Cl. 179—1)

This invention relates to intercommunication systems and, more particularly, to systems of the "self-powered" type that do not require electric batteries or the like for energizing the telephone transmitters or receivers comprised therein.

As an example of a handset intended for use in communication systems of the type to which this invention pertains, attention may be directed to the United States patent to C. N. Reifsteck, No. 2,098,402. The patented device is constituted by a hollow tube, in the shape of a French handset, in which is disposed an electro-magnetic transducer that functions to generate fluctuating electric currents in response to sound and to generate sound when fluctuating electric currents are supplied thereto.

Handsets of the patented type have given satisfaction, in general, but they have several disadvantages that are overcome by the present invention. The most serious disadvantage is the lack of inherent means for calling the party with whom conversation is desired, which necessitates the addition of an auxiliary buzzer network or the like to communication systems installed in noisy locations, or to systems comprising more than two handsets connected in series or in parallel.

It is, accordingly, an object of the present invention to provide a handset with inherent calling means.

Another object is to provide a self-powered communication system comprising a plurality of stations each of which is adapted to transmit a loud calling-signal to one or more of the others without employing an auxiliary buzzer network or the like.

The foregoing objects and other objects ancillary thereto are attained, in a preferred embodiment of the invention, by providing a handset wherein a transducer comprising a diaphragm connected to a piezoelectric crystal element, or "multiplate flexing element", may be employed either as a transmitter or as a receiver and by providing additional means whereby the piezoelectric element may be extraordinarily stressed or agitated in order to generate calling, or signalling potentials.

For the purpose of stressing the element, one end of a small, flat spring may be connected thereto adjacent to the diaphragm connection and means, manually operable from the exterior of the handset, may be provided for agitating the free end of the spring. Such means may take the form of a knurled wheel, or the like, similar to those employed on cigarette lighters, against the periphery of which bears the free end of the spring. The wheels may be so mounted within the housing, or shell of the handset that a portion of its periphery projects outwardly in a position convenient for operation by the thumb of the user. A resilient detent may be provided for the wheel whereby, in the rest position, the teeth thereof are prevented from making contact with the free end of the spring to interfere with utilization of the transducer for voice transmission.

Alternatively, means analogous to the well-known telephone dial mechanism may be provided for automatically agitating the crystal element a predetermined number of times corresponding to the code number of a given station.

A still further embodiment of the invention may comprise means for automatically agitating the crystal at a definite frequency for a definite period of time in response to a single manipulation of a dial wheel or the like, whereby a musical note is emitted from each of the handsets connected together in the system. In that modification, signalling of a specific station may be accomplished by sequentially operating the dial wheel, or analogous device, the requisite number of times to send the proper code signal.

The novel features characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of certain specific embodiments thereof, when read in connection with the accompanying drawings, in which:

Figure 1 is a sectional view, showing a greatly simplified embodiment of the invention,

Figure 2 is a side view partly in section, considerably enlarged, exemplifying the operative relation between the crystal element, the spring carried thereby, the signal-wheel and a detent therefor;

Figure 3 is a view, partly in elevation and partly in section, exemplifying a commercial embodiment of the invention;

Figure 4 is a view in elevation of the dial, or calling device;

Figure 5 is an enlarged view, partly in elevation and partly in section, of a detail of the device shown in Figure 3;

Figure 6 is a sectionalized view of a toy handset, embodying the invention;

Figure 7 is a side view of the dial-element of the device shown in Figure 6;

Figure 8 is a plan view of an element of the signal-dial shown in Figure 3, and

Figure 9 is a view, partly schematic, exemplifying an interphone system including a plurality of handsets constructed according to the invention.

Referring now to Figure 1 of the drawings, a telephone instrument constructed according to the invention may comprise a cylindrical body 1, one end of which is reversely curved and flared to constitute a sound-receiving orifice 3, and the other end of which merges into a circular opening 5 angularly disposed to the axis of the cylindrical portion. A conical diaphragm 7 is positioned within the circular opening, the flexible periphery thereof being gripped between the edge of the opening and a perforated circular guard 9, or ear piece, which is threadedly or otherwise held to the perimeter of the said opening.

A piezoelectric element 11 is mounted within the device as by cementing one portion thereof to the inner wall of the cylindrical portion or by clamping it thereto in any appropriate manner. The piezoelectric element may be a multiplate flexing element of either the bender or twister type such, for example, as is disclosed in the United States reissue patent to C. B. Sawyer, Re. 20,213, or in the United States patent to A. L. W. Williams, No. 2,222,056.

The free end of the crystal element, if of the "bender" type, or a free corner thereof, if it is of the square "twister" type, may be provided with a cap 13 to which the apex of the diaphragm 7 is connected. A short piece of rigid wire 15 may be employed as the linkage means between the cap and the diaphragm, as illustrated, but it lies within the scope of the invention to directly connect the free end of the crystal element to the apex of the diaphragm, as by cement or the like.

The outer electrodes of the multiple element (not shown) are connected together and to one conductor 17 of a telephone cord 19 that extends outwardly from the handset in the vicinity of the voice opening; the inner electrode (not shown) is connected to the other conductor 21 of the cord. The conductors may extend to one or more similar handsets, as exemplified by Figure 9 of the drawings.

In order that the crystal element may be agitated at abnormal amplitudes for calling purposes, the cap connected to the apex of the diaphragm is provided with a projection 23 of resilient material such as spring steel that extends therefrom into operative engagement with a knurled wheel 25 or the like which is accessible to the user from the exterior of the handset. In the event that the handset body is molded in two pieces, each of which is analogous to the half-portion shown in Figure 1, oppositely located pockets may be provided in the walls of the opening through which the knurled wheel projects, for the purpose of accommodating the shaft 27 of the wheel. If the handset body is formed from a length of tubular metal or plastic by spinning, pressing, or the like, or if it is die-cast, appropriate bearings may be provided for the wheel by any convenient method.

In order that the spring and wheel shall not impede the vibration of the diaphragm in response to sound or to potentials impressed upon the piezoelectric element from a remote source, such as from another similar handset, a resilient detent 29 is provided which so engages the wheel that, in its rest position, it is out of contact with the spring. The inter-relation of the several elements is clearly shown in Figure 2.

Two or more of the handsets may be connected together as indicated by Figure 9, to constitute a self-powered interphone system that is always ready for use. An operator at any station may call any other station, or all of the other stations simultaneously, by manipulating the knurled wheel 25 which, in turn, agitates the crystal element at an abnormal amplitude. Because of the abnormal flexing of the crystal element, the potentials generated thereby are sufficiently high to cause the diaphragms at the called stations to rattle or buzz, thus obviating the necessity of providing a separate calling circuit including a potential source and one or more bells or the like.

After the called station has answered, conversation may be carried on as with the usual telephone handset, the single piezoelectric transducer at each station functioning both as a transmitter and as a receiver. Intelligibility is unusually good—the rising response of the transducer with rising frequency, when utilized as a microphone, so compensating the falling response thereof when it is utilized as a receiver that the overall response is reasonably flat throughout the voice range.

A commercial embodiment of the invention, adapted for interphone use on battleships, submarines or the like, where rough usage is to be expected, is exemplified by Figures 3, 4 and 5 of the drawings. For purposes of convenience, the device will be referred to as being constituted by a transducer-housing, designated in its entirety by the numeral 31, a mouth-unit identified by the numeral 33 and a hollow, cylindrical handle 35 which communicates with the interior of the mouth-unit at one end and with the interior of the transducer housing at the other.

The mouth-unit comprises an intermediate cylindrical element 37 having a side opening into which one end of the handle is cemented or otherwise fastened, and it is provided with an interior circumferential ledge 39 or shoulder adjacent to one end against which the periphery of a mouthpiece 41 abuts. The back of the mouth-unit is closed by a cover-plate 43 having a projecting bead or flange 45 that extends slightly into the intermediate element and fits tightly against the inner wall thereof. All three elements, i. e., mouth piece, intermediate element and cover-plate, may be molded from a thermosetting plastic or the like.

The basic portions of the transducer housing are constituted by an intermediate cylindrical element 47, a front cover-plate 49 and a back cover-plate 51 dimensionally the same as the equivalent portions of the mouth-unit similarly styled. The front cover-plate is provided with a plurality of perforations 53 for the egress of sound and its bead 55 serves to clamp the edge of a diaphragm 57 against the ledge 59 carried by the inner wall of the intermediate element.

The ends of a piezoelectric element 61 of the bender type are supported at diametrically opposite locations within the intermediate element, as by embedding them in two cushions of resilient material 63, such as sponge rubber, that are held in place between a bead 65 on the back cover-plate and the ledge 59. A drive connection 67 extends between the apex of the diaphragm and the center of the piezoelectric unit.

A signalling dial 69, having numbered finger-holes 71, is affixed to a shaft 73 that extends through a central perforation in the back cover-plate, the face of the dial next to the cover-plate carrying a circular disk 75, or the like, provided with ten angularly spaced apart roughened or

corrugated areas 77 corresponding to the finger holes 71, as illustrated in Figure 8. One end of a dial-return spring 79 is affixed to the end of the dial shaft 73 that projects into the housing, the other end of the spring being fastened to the flange 65 on the back cover-plate.

In order that the dial may be utilized for code calling, means are provided whereby each roughened or radially corrugated area on the signalling disk may be utilized to cause the crystal unit to be agitated for a short period of time, the total number of periods depending upon the extent of rotation of the dial away from the "rest" position thereof. Such means include a resilient element in the form of a curved spring 81, one end of which is mounted upon the inner face of the back cover-plate 51 and the other end of which extends outwardly through the plate into operative engagement with the corrugated disk 75. The spring, within the housing, makes contact with a bowed frame 83, the extremities of which are bent over to grip the resiliently supported ends of the crystal unit.

Although not shown in Figure 4, the actual construction of the curved spring is such that the end thereof in contact with the signalling disk is flexible in one direction to permit the corrugations to pass under it as the disk is rotated against the return spring when initiating a call, and it is substantially rigid in the other direction whereby the corrugations, upon return of the dial to the rest position, will cause motion to be transmitted to the crystal unit by way of the bowed frame. The flexibility may be attained by utilizing the equivalent of a pawl 85, pivotally mounted on the end of the spring 81, an additional small biasing spring 87 being provided for urging the pawl into engagement with the disk during return thereof to the rest position. Figure 5, it is to be understood, is suggestive rather than illustrative inasmuch as the spring curves in a plane parallel to the axis of the pivot 89 on which the pawl rotates, rather than in a plane normal thereto, as shown in the drawings.

It will be noted, from an inspection of the drawings, that the handset illustrated in Figure 3 requires the molding of but four distinct elements, i. e., a handle, a mouthpiece, a cylindrical intermediate portion for the transducer housing and the mouth-unit, and four similar cover-plates, two of the latter being perforated after molding to constitute closures for the transducer housing. The said elements may be cemented rigidly together during assembly of the device or they may be press-fitted if desired.

Calling is accomplished as with the usual dial-telephone, by inserting one's finger, sequentially, into pre-selected holes in the dial, moving the finger against the usual stop 91 and thereafter releasing the dial. During return of the dial to the rest position, motion is transmitted to the ends of the crystal unit by way of the curved spring and the bowed frame each time the pawl passes over one of the corrugated areas. The abnormal potentials developed by the unit during its agitation cause the diaphragms of other units connected thereto to rattle or buzz a number of times determined by the extent of the initial rotation of the dial.

The return of the dial to the rest position should take place relatively slowly, in order that the called station may be able to recognize its code number without difficulty. For the purpose of slowing down the dial, friction means, such as a washer or a spring 93 of resilient material through an opening in which the shaft 73 extends, may be interposed between the back cover-plate and the dial.

Alternatively, the entire surface of the disk 75, in the path of the pawl, may be provided with corrugations and a dial having but one finger hole in position 10 may be utilized therewith. In that modification, each time the dial returns to the rest position after manipulation thereof, signalling potentials are generated by the crystal unit at a more or less definite frequency determined by the number of corrugations and the angular velocity of the dial. No illustration is believed to be necessary.

The invention, also may be incorporated into a toy handset, a commercial form of which is shown in Figures 6 and 7 of the drawings. In that embodiment the device comprises complementary right and left half portions which, when joined along a median plane corresponding to the plane of the drawings, provides a cylindrical transducer housing indicated generally by the numeral 99, a bowl-shaped voice-unit designated in its entirety by the numeral 101 and an intermediate tubular handle element 103 which communicates with the transducer housing and the voice unit. The half portions are held together at one end by a perforated earpiece or cap 105, which is spun over the open end of the transducer housing and, at the other end, by a mouthpiece 107 that is telescoped around the opening of the voice unit.

A crystal unit 109 of the bender "multiplate" type is mounted within the transducer housing, the ends of the crystal fitting into diametrically opposite niches, or grooves in the housing wall and being resiliently supported therein by small pieces 111 of sponge rubber or the like. The periphery of a diaphragm 113 is clamped between the rim of the transducer housing and the earcap and a drive-pin 115 connects the center of the diaphragm to an intermediate point on the crystal unit. Preferably, the drive-pin has an offset, U-shape bend that partially encircles and clamps the crystal unit. Below the crystal unit, the pin is bent twice, to provide a portion 117 parallel to the handle and a portion 119 that extends outwardly through an opening provided by two complementary semi-circular channels formed in the bottom wall of the transducer housing. That portion of the drive pin that extends parallel to the handle is pivoted upon a rod 121 that extends transversely across the housing. Openings in the walls of the housing (not visible in the drawings) provide support for the ends of the rod.

The calling device comprises three elements, an outer dial 123 provided with finger holes 124, an intermediate paper disc 125 bearing numerals registering with the finger holes, and an inner roughened or corrugated disk 127. Cement may be employed for holding the disks and the dial together, or the rim of the dial may be spun over the edge of the corrugated disk, as shown.

The calling device is rotatably mounted upon a central stud 129 that is accommodated in an opening provided by two semi-circular channels in the bottom wall of the transducer housing. A fiber washer 131, or the like, is interposed between the corrugated disk and the bottom wall of the housing, for the dual purpose of preventing the dial from wobbling during actuation and of somewhat impeding too rapid rotation thereof.

The protruding end 119 of the drive pin bears on the corrugated inner disk 131 in such man-

ner that motion is transmitted thereto upon rotation of the dial and the crystal unit is agitated violently for calling purposes. No dial-return spring is shown, inasmuch as the device is primarily intended for amusement purposes, although such a spring could be added if desired.

A conical diaphragm may be substituted for the flat diaphragm shown at a slight additional cost.

Excluding the crystal unit itself, the resilient end supports for the crystal, the drive-pin and its shaft and the stud on which the dial is mounted, all of the other elements of the device may be fabricated inexpensively from either plastic or thin metal. Assembly is not complicated process and the factory cost of the handset is surprisingly low when compared with the quality of voice transmission and reproduction that may be obtained therewith.

From a consideration of the foregoing, it will be apparent that the invention offers numerous advantages and, because it permits the elimination of separate calling systems, that it marks an important forward step in the field of interphones of the self-powered type.

It is realized that many other modifications will be apparent to those skilled in the art. The invention, therefore, is not to be limited except insofar as is necessitated by the prior art and by the spirit of the appended claims.

What is claimed is:

1. A telephone instrument comprising a piezoelectric unit adapted to generate electrical potentials when subjected to mechanical stresses and vice versa, a diaphragm operatively connected to the element for translating sounds into electrical potentials, and means for agitating the element to thereby produce potentials higher than those produced by sounds, said means including a manually operable element having an uneven contour and a device for transmitting motion to the piezoelectric element independently of said diaphragm from said contour when the latter is in motion.

2. The invention set forth in claim 1, additionally characterized in this: that the motion transmitting device is in the form of a pawl which is flexible in one direction and relatively rigid in the opposite direction.

3. The invention set forth in claim 1, additionally characterized in this: that the manually operable means includes a knurled wheel portion of which is accessible from the exterior of the instrument.

4. A telephone instrument comprising, piezoelectric element means, means for manually agitating said piezoelectric element means to thereby produce electrical potentials for signaling purposes, and means associated with said agitating means for maintaining clearance between said agitating means and said piezoelectric element means when said agitating means is at rest.

5. A telephone instrument comprising, a piezoelectric element, contactor means connected to said piezoelectric element, means for agitating said contactor means and through said contactor means said piezoelectric element to thereby produce electrical potentials for signaling purposes, and means associated with said agitating means for maintaining clearance between said agitating means and said contactor means when said agitating means is at rest.

6. A telephone instrument comprising, a piezoelectric element, contactor means connected to said piezoelectric element, means for agitating said contactor means and through said contactor means said piezoelectric element to thereby produce electrical potentials for signaling purposes, and means for maintaining clearance between said agitating means and said contactor means when said agitating means is at rest.

7. A telephone instrument comprising, piezoelectric element means, means for manually agitating said piezoelectric element means to thereby produce electrical potentials for signalling purposes, diaphragm means connected to said piezoelectric element means and adapted upon the receipt of sound waves to move the piezoelectric element means, and means for maintaining clearance between said agitating means and said piezoelectric element means when said agitating means is at rest, the clearance maintained between said agitating means and said piezoelectric element means being sufficiently great that movement of said piezoelectric element means by said diaphragm means upon the receipt of sound waves does not cause engagement between said agitating means and said piezoelectric element means.

8. A telephone instrument comprising, in combination, movable means for controlling the establishment of an alternating electromotive force upon being moved, diaphragm means connected to said movable means, and means independent of said diaphragm means for manually moving said movable means to thereby produce electrical potentials for signalling purposes.

9. In a telephone, a housing, a piezoelectric element mounted in said housing, means connected to said piezoelectric element for stressing said element upon movement of said means, and rotatable means pivotably connected to said housing and adapted upon rotation to move said means for stressing said piezoelectric element to thereby produce electrical potentials for signaling.

10. A telephone as set forth in claim 9 further characterized in this: that said rotatable means comprises a dial having holes therethrough corresponding to numerals.

11. A telephone as set forth in claim 9 further characterized in this: that said rotatable means comprises a dial having holes therethrough, and spring means against which said dial may be turned.

12. A telephone as set forth in claim 9 further characterized in this: that said rotatable means comprises a dial having finger holes on one face and corrugations on its other face and it is adapted upon rotation to move said corrugations in contact with and with respect to said means for stressing said piezoelectric element.

13. In a telephone, a housing having a side-wall, resilient means mounted in two oppositely disposed portions of said side-wall, piezoelectric crystal means extending across said housing and having its ends mounted in said resilient means, diaphragm means connected to said piezoelectric means, lever means connected to said ends of said piezoelectric crystal means which are mounted in said resilient means for stressing said piezoelectric crystal means, manually actuatable dial means, means for rotatably mounting said dial means on the outside of said housing and in contact with said lever means whereby upon rotation said lever means stresses said piezoelectric crystal means to thereby produce electrical potentials for signalling.

14. A telephone as set forth in claim 13, further characterized in this: that said dial means has

a corrugated face in engagement with said lever means.

15. A telephone as set forth in claim 13 further characterized in this: that said dial means has a corrugated face in engagement with said lever means and said lever means is spring biased toward said corrugated face for maintaining a portion of said lever means coupled to said dial means.

16. In a telephone, a housing having a side-wall, resilient means mounted in two oppositely disposed portions of said side-wall, piezoelectric crystal means extending across said housing and having its ends mounted in said resilient means, diaphragm means connected to said piezoelectric crystal means substantially mid-way between said mounted ends thereof, lever means pivotably mounted on said housing and connected to said piezoelectric crystal means substantially mid-way between said mounted ends thereof and having a portion extending through said housing, and manually operable means connected to said housing for agitating said lever means.

17. A telephone as set forth in claim 16, further characterized in this: that said manually operable means comprises dial means rotatably mounted on said housing, and said dial means has a corrugated face which is in engagement with said lever means.

18. A device as set forth in claim 4, further characterized in this: that said means for maintaining clearance between said agitating means and said piezoelectric element means is resilient and includes a detent resiliently held in engagement with said agitating means.

19. A device as set forth in claim 8, further characterized in this: that said movable means comprises a piezoelectric crystal and said means independent of said diaphragm means for manually moving said movable means stresses said piezoelectric crystal to produce electrical potentials.

ALFRED L. W. WILLIAMS.

CERTIFICATE OF CORRECTION.

Patent No. 2,383,832. August 28, 1945.

ALFRED L. W. WILLIAMS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 41, strike out the quotation marks before "multiplate" and after "element"; page 2, first column, line 38, for "multiple" read --multiplate--; page 3, second column, line 33, strike out the quotation marks before and after "multiplate"; page 4, first column, line 15, after the word "not" insert --a--; line 52, claim 3, after "wheel" insert --a--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of December, A. D. 1945.

Leslie Frazer

(Seal) First Assistant Commissioner of Patents.