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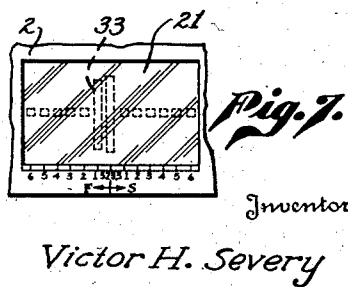
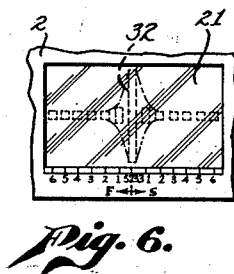
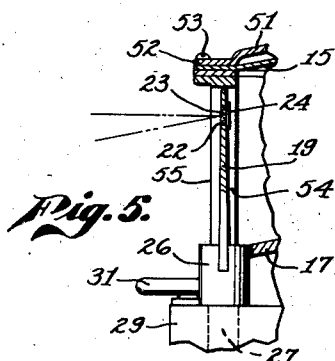
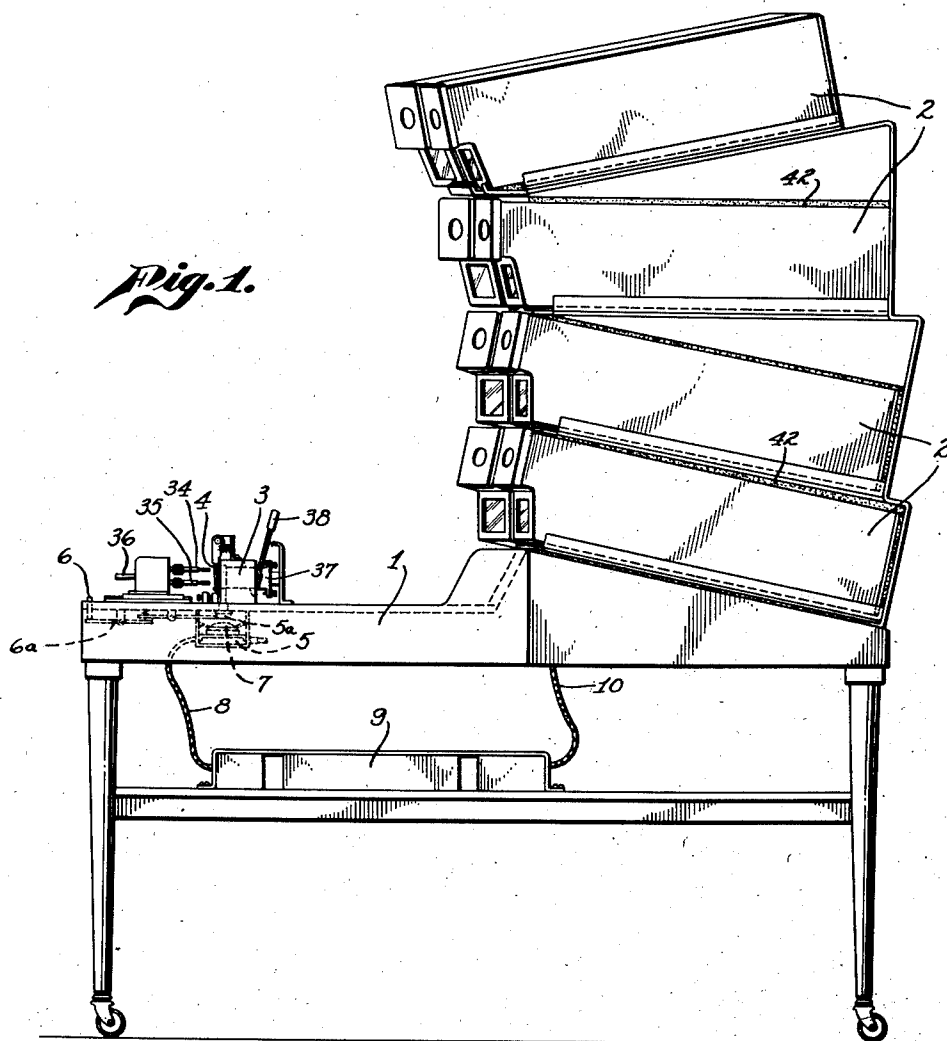
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2,070,867

TUNING APPARATUS

Filed Dec. 4, 1935

5 Sheets-Sheet 1



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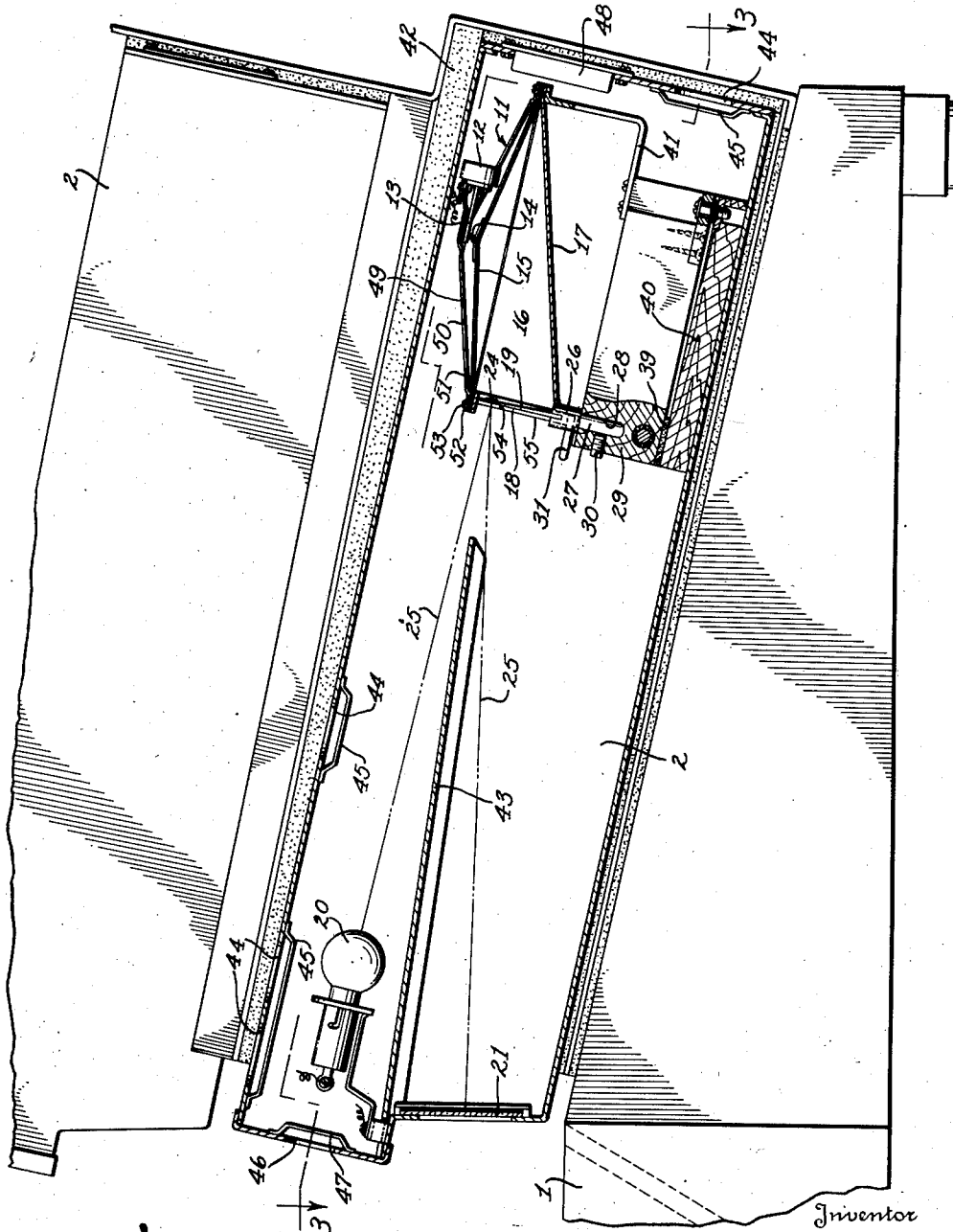


Fig. 2.

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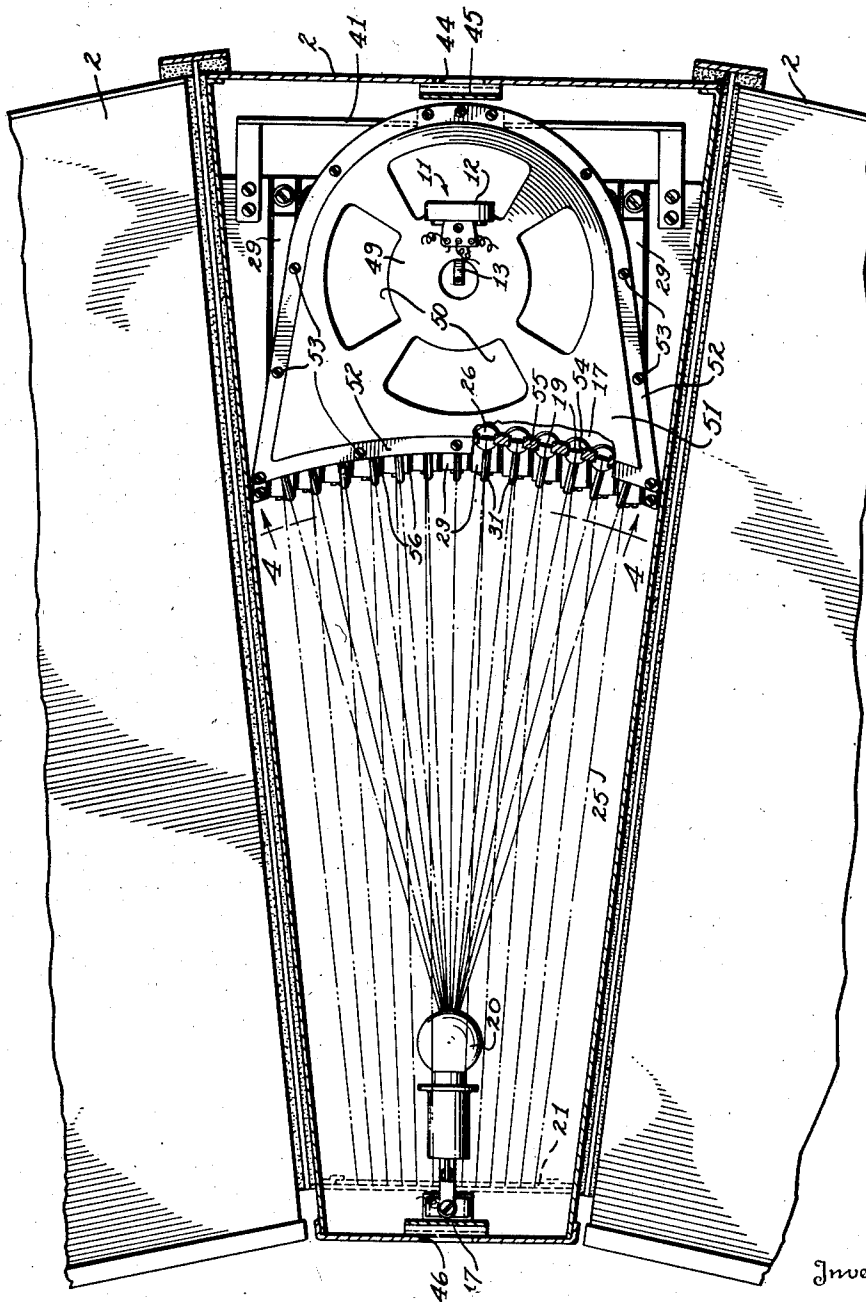


Fig. 3.

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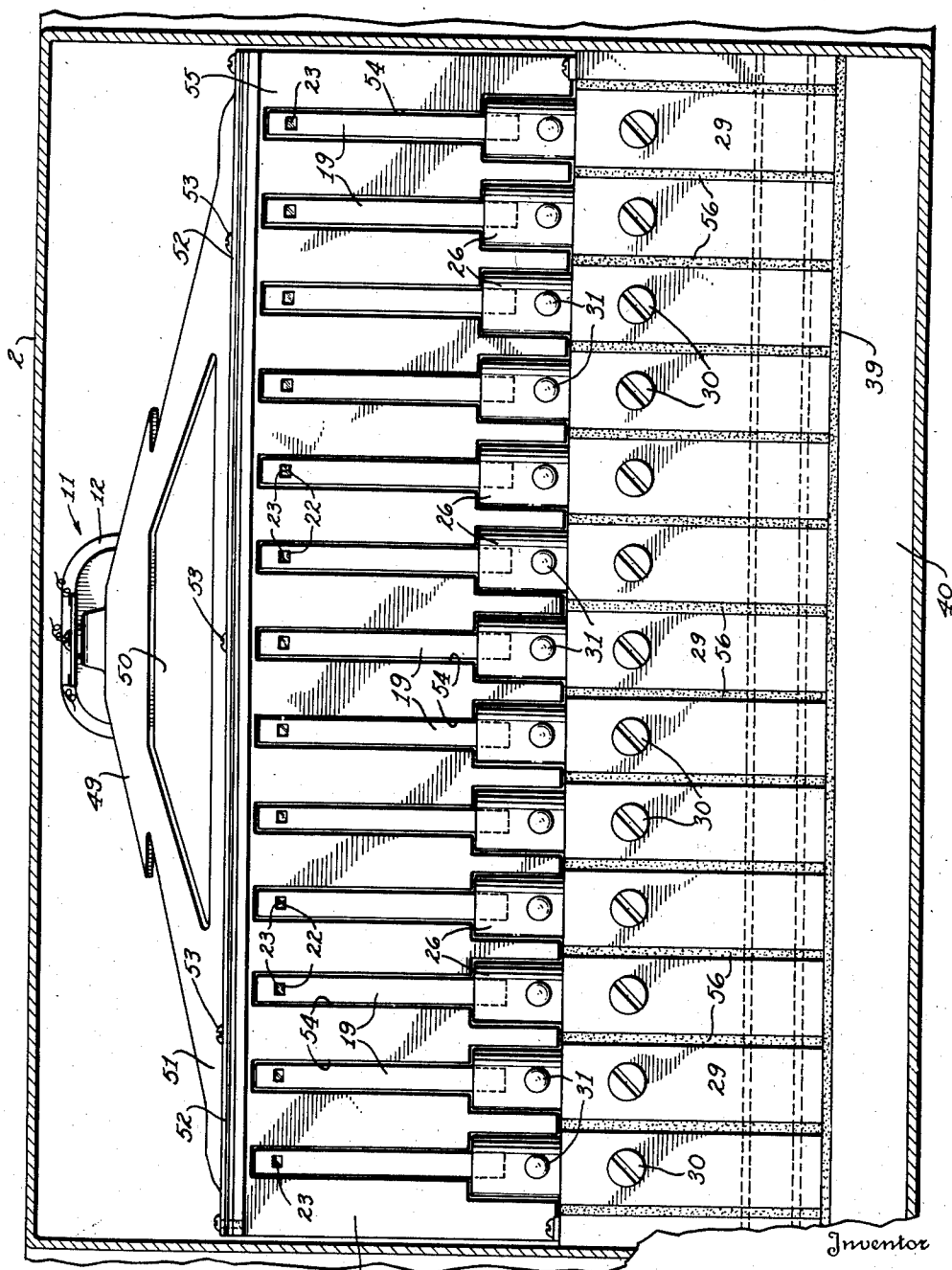
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5 Sheets-Sheet 4



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TUNING APPARATUS

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5 Sheets--Sheet 5

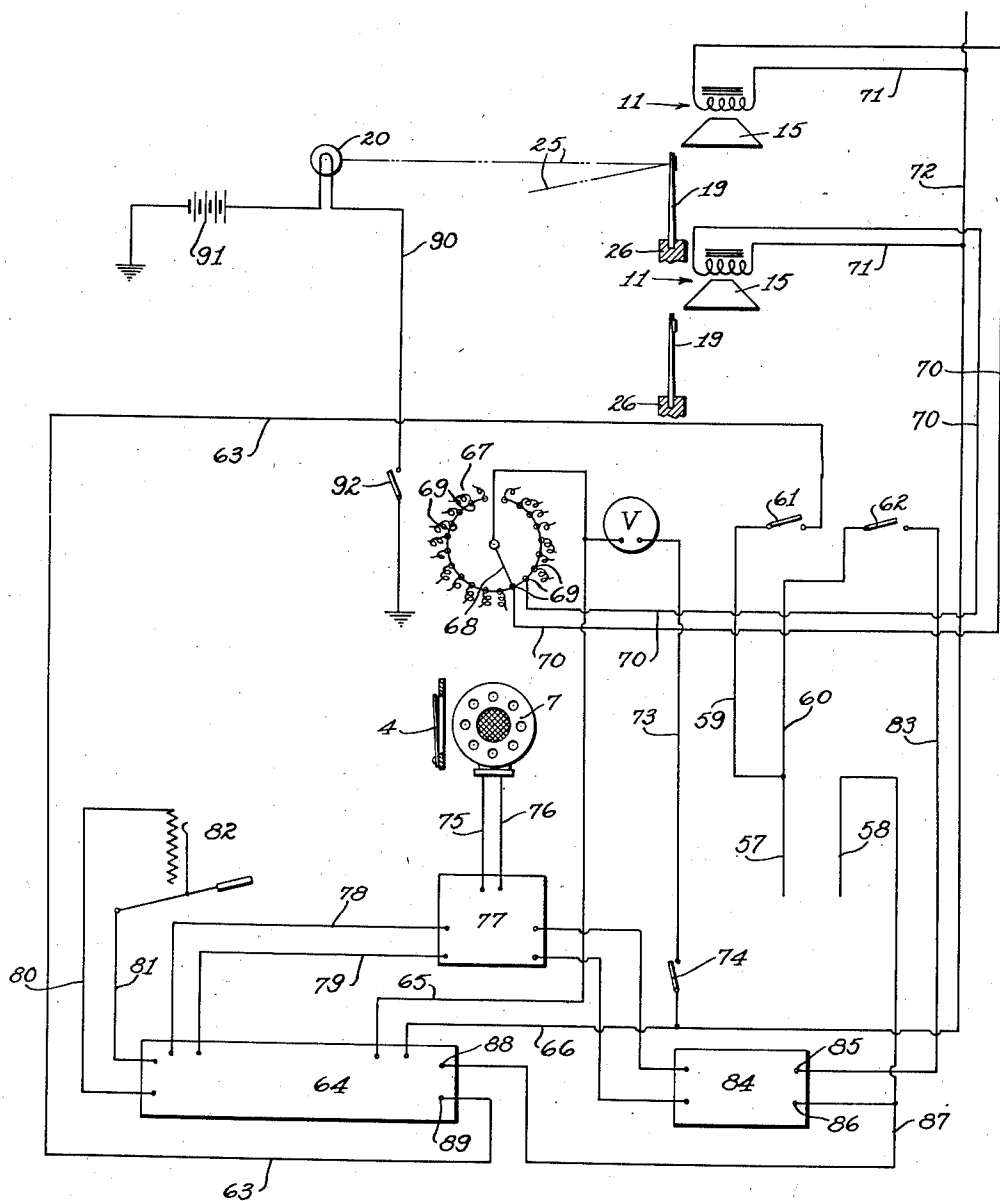


Fig. 8.

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UNITED STATES PATENT OFFICE

2,070,867

TUNING APPARATUS

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Application December 4, 1935, Serial No. 52,794

10 Claims. (Cl. 84-454)

This invention relates to tuning apparatus, and while features of the invention may be employed for tuning musical instruments of different kinds, the invention is intended to be particularly useful in tuning reed instruments. In the present specification the invention is described as applied to the tuning of harmonicas. At present, the tuning of harmonicas is accomplished with considerable difficulty, and requires the services of a highly paid expert.

The general object of this invention is to provide tuning apparatus of simple construction, which can be employed for tuning harmonicas or similar instruments, or for voice testing.

In the preferred form of the apparatus, it involves the use of a gang of test vibrators, which are graduated to vibrate at slightly different frequencies individually, one of the test vibrators having a natural frequency which is the same as that of the reed of the instrument that is to be tuned. The other test vibrators are in two sets, one set of which is graduated individually to vibrate at slightly higher frequencies, and the other set of which has its individuals constructed to vibrate at slightly lower frequencies than that of the reed that is to be tuned.

One of the objects of this invention is to provide simple means for effecting the vibration of these test vibrators, and for indicating the relative activity of the same as induced by the vibration of the reed that is to be tuned; also to provide a test box of simple construction and involving the use of simple means for effecting the vibration of the test reeds, and for adjusting the same so as to indicate clearly to the tuner whether the reed being tuned is flat or sharp.

Further objects of the invention will appear hereinafter.

The invention consists in the novel parts and combination of parts to be described hereinafter, all of which contribute to produce an efficient tuning apparatus.

A preferred embodiment of the invention is described in the following specification, while the broad scope of the invention is pointed out in the appended claims.

In the drawings:

Figure 1 is a side elevation of the table carrying the apparatus, and also illustrating two adjacent banks of test boxes, but omitting the banks of test boxes beyond the banks illustrated.

Fig. 2 is a longitudinal section through one of the test boxes illustrated in Fig. 1, and further illustrating details of its construction, and also the construction of a means for effecting the

vibration of the test vibrators as induced by the vibration of the reed that is to be tuned. In this view certain parts are broken away and shown partially in elevation.

Fig. 3 is a longitudinal section taken about on the line 3-3 of Fig. 2, and particularly illustrating the translating device for effecting the vibration of the test vibrators and the arrangement of the test vibrators, which enables them to cooperate with a screen to indicate visually to the tuner whether the reed being tuned is flat or sharp.

Fig. 4 is a diagrammatic view of the forward end of the gang of test vibrators as viewed in elevation from the curved line 4-4 of Fig. 3. In other words, this view, as far as the test vibrators are concerned, is a developed elevation. This view also illustrates a portion of the electro-mechanical translating apparatus that cooperates with these test vibrators.

Fig. 5 is a vertical section taken in the same plane as Fig. 2, but upon an enlarged scale, and this view is a fragmentary one, which particularly illustrates the manner of mounting the test vibrators for effecting their adjustment to enable them to cooperate on a screen operating as a visual indicator.

Fig. 6 is a front elevation of one of the screens employed in tuning the reed, and indicating the location of reflected light beams on the screen when the reed is in perfect tune.

Fig. 7 is a view similar to Fig. 6, but indicating the relation of reflected light beams on the indicator screen when the reed is flat; that is to say, when the period of vibration of the reed is too low.

Fig. 8 is a diagrammatic view indicating the wiring arrangement and the general relation of the apparatus embodied in the invention.

In employing the apparatus embodying this invention, to tune the reeds of a harmonica the reed plate is mounted in a suitable holder, and the reed to be tuned is set in vibration. Through the agency of the vibrating reed, impulses are developed in a circuit having the same frequency as the frequency of the reed in its natural vibration. This impulse current is then amplified to produce an amplified current, which is in circuit with a translating device operating to produce sympathetic vibrations in a test vibrator device. This test vibrator device includes a gang of test vibrators, which are graduated to vibrate at frequencies slightly above and slightly below the frequency of the reed that is being tuned. One of the test vibrators, preferably the one in the mid-

die of the gang of test vibrators, has a period of vibration or frequency the same as that of the reed if in tune. In front of the tuner a screen is placed, upon which beams of light are reflected from the test vibrators, and the light projected on the screen becomes more elongated when the reed reflecting the light is vibrated. In this way the screen operates as a visual indicator to indicate which test vibrator in the gang is vibrated in harmony with the reed that is to be tuned. In this way the tuner determines whether the reed to be tuned is flat or sharp, and he then performs an operation upon the reed to reduce its frequency or to increase its frequency, as the case may be, to bring the reed into tune.

In the present instance, the vibration of the reed to be tuned is preferably effected through the agency of pneumatic means preferably including a suction box in which a partial vacuum is maintained. The means for holding the reed plate and the suction box, forms the subject matter of my copending application, Serial No. 51,369, filed November 25, 1935, and that application also includes a detailed description of the means for removing a slight amount of material from the reed to change its frequency.

Referring more particularly to the parts, I indicate a table for supporting the apparatus, and toward the rear of this table a plurality of test boxes 2 are provided, said test boxes being arranged in vertical banks and horizontal tiers. The reed plate, the reeds of which are to be tuned, is set up in a holder 3 near the front of the table, and the reeds, such as the reed 4 indicated in Fig. 1, are exposed at the forward face of this holder. Beneath the holder 3 a suction box 5 is provided, and associated with the suction box there is a valve 5a corresponding to each reed 4, which can be opened by depressing a button 6 and actuating lever 6a to apply suction to the reed 4 to effect its vibration. The suction box also includes a pick-up diaphragm 7 that becomes vibrated by the vibrating air in the suction box, and this develops impulses in a circuit 45 within a cable 8 that leads to amplifying apparatus 9. From this amplifying apparatus 9 a cable 10 leads off to carry circuits leading to the test boxes 2. Referring particularly to Figs. 2 and 3, each test box is provided at its rear end with a translating device 11, including electro-mechanical means 12 actuated by amplified electric impulses to vibrate a tongue 13 that is in contact at its end with a tip 14 on a diaphragm 15, which may be of the usual conical form. In this way, the conical diaphragm 15 is caused to vibrate at the same frequency as the impulses in the circuit passing into the electro-mechanical means 12. The diaphragm 15 is preferably located in a substantially horizontal position, but slightly inclined upwardly to correspond with the inclination of the test box (see Fig. 2). The space under the diaphragm 15 constitutes an air chamber 16 having a bottom wall 17 that forms an angle with the "plane" of the diaphragm, so as to form an opening 18 facing toward the opposite end or forward end of the test box. In this opening 18 a gang of test vibrators 19 are mounted, said vibrators being preferably mounted in an arc as indicated in Fig. 3, the center of which is located toward the front end of the box and preferably at the location of a source of illumination, such as an electric lamp 20. These test vibrators are provided with means enabling them to reflect a beam of light onto a screen 21 at the front of the box (see Figs. 6 and 7). For this purpose each

vibrator, as indicated in Fig. 5, is provided with an opening 22 in the upper end of the same, to which a small reflector or mirror 23 is mounted. This mirror is preferably mounted in place by means of a shim 24 of cork, which is secured to the mirror and to the vibrator by Canada balsam, or similar material.

There is a test box corresponding to each reed that is to be tuned, and by reason of the adjustability of the reeds 19 individually, they can all be placed in a position such that the beams of light indicated by the lines 25, will be thrown alongside of each other on the screen 21. This screen may be made of translucent paper, but preferably is made of frosted glass or similar material. In order to enable the test vibrators to be individually adjusted in this way, I prefer to mount each vibrator securely in a head 26 formed on the upper end of a rotatable spindle 27 mounted in a socket 28 in a base or block 29, and each spindle 27 is provided with a set screw 30 for rigidly securing it in place. Each head 26 is provided with a short handle 31 for rotating it into its proper adjusted position.

The middle test vibrator of the vibrators 19, has a predetermined frequency of vibration, which is the same as the true note that should be produced by the reed that is being tuned. When the diaphragm 15 vibrates at a certain frequency, the reed in the gang of reeds that has the same frequency of vibration, will be more activated by the vibrations of the air in the air chamber 16 than its adjacent reeds. The effect of this is illustrated in Figs. 6 and 7. If the reed is in perfect tune, the middle beam of light on the screen will be greatly elongated, as illustrated by the dotted lines 32 in Fig. 6. Each screen has a scale such as illustrated in Figs. 6 and 7, with the letter F toward the left, and the letter S toward the right. If the reed being tuned is flat, for example, the appearance of the longest beams of light on the screen will not be as illustrated in Fig. 6, but will have the appearance indicated by the dotted lines 33 in Fig. 7, indicating that the vibrator to the left of the middle vibrator is being vibrated in sympathy with the diaphragm 15, and this would indicate that the reed being tuned is slightly flat. The tuner will then remove some of the material from the reed to increase its frequency of vibration. For this purpose, at the front of the table, abrading or cutting tools 34 and 35 are provided, which are mounted just in front of the reed 4. By operating the handle 36, either one of these tools 34 or 35 may be advanced to remove a small quantity of material from the face of the reed. When applying these tools to the reed, the reed is backed up by a slide 37 controlled by a handle 38. All of this mechanism is illustrated in detail in my prior application, Serial No. 51,369, filed November 25, 1935. The base or blocks 29 are all mounted on insulation 39 on a base rail 40, and the back end of the translating device 11 is supported on a suitable bracket 41. In addition to this, each test box is insulated from all the other test boxes by means of insulation 42 (see Fig. 2), thereby preventing interference.

In order to prevent direct light from the lamp 20 from impinging on the screen 21, each test box is provided with a shield 43 projecting rearwardly from the forward wall, as indicated in Fig. 2.

The walls of each test box are provided with ventilating openings 44 covered by guards 45, and the upper portion of each forward wall of

each test box is provided with a ventilating opening 46 communicating with the atmosphere and also covered by a guard 47. The interior of the test box at the rear may be provided with a thermostat 48 for automatic temperature control by means not illustrated, and which forms no part of this invention.

The translating device 11 includes a cover 49 in the form of a conical plate or "spider" having a plurality of openings 50 through it (see Fig. 3), and this cover has a forward extension 51 which extends out to the opening 18 at the forward side of the air chamber 16. This cover is formed with a flange 52 extending around its margin, which is secured in place in any suitable manner, as by means of screws 53.

One of the advantages of vibrating the test vibrators 19 through the agency of the air in the air chamber 16, is that great accuracy is possible in the frequency of the test vibrators, due to the fact that they are not under the influence of magnetism. It has been found that such vibrators which are under magnetic influence, tend to change their pitch slightly, due to magnetostriction. When such test vibrators are vibrated through the use of electromagnets, it is found that magnetism loads the vibrator if the magnet is placed near the center or lower part of the vibrator, which naturally lowers the pitch. Vibrating the test vibrators through the agency of the air remains invariable, and the slight adjustments of the test vibrators that are necessary for casting the beams of light on the screen 21, do not substantially affect the frequency of the vibrator. In this connection, attention is called to Fig. 4, which illustrates the test vibrators 19 mounted in slots 54 in the grating or face plate 55 of the air chamber 16. In order to prevent any possibility of the vibration of one test vibrator affecting any other vibrators in the gang, their bases 29 are separated from each other by vibration insulation 56, such as soft rubber, cork, or similar material.

In Fig. 8 I illustrate diagrammatically the general arrangement of the apparatus and wiring. In this diagram 57 and 58 indicate the power circuit wires, and the wire 57 connects up with two conductors or wires 59 and 60 leading respectively, to an amplifying switch 61 and a power switch 62. From the amplifying switch 61 a conductor 63 leads over to an amplifier 64, and output conductors 65 and 66 lead off from this amplifier, the wire 65 passing over to a multiple switch 67 with a rotatable arm 68 capable of making contact with any one of twenty contacts 69. Each of these contacts 69 corresponds to a test box. From each contact 69 a wire 70 extends over to a corresponding test box to connect up with the translating device 11 of the same. The return wires 71 from the translating devices connect up to a return trunk wire 72, which is connected to the wire 66. Between the wire 66 and the wire 65 a voltmeter V is connected by a shunt 73 including a switch 74. The wires 75 and 76 that connect the diaphragm 7 into the circuit, lead to a preamplifier 77, one side of which is connected by wires 78 and 79 to one end of the amplifier 64 to cooperate with a balancing circuit at this end of the amplifier carried through wires 80 and 81, and including a variable resistance 82. When the power switch 62 is closed, current flows through the wire 83 to a converter 84, being connected at a terminal 85 cooperating with the terminal 86 that is connected to the wire 87 that leads off from the line

wire 58. The wire 87 connects to the terminal 88 at one end of the amplifier 64, and the cooperating terminal 89 is connected to the aforesaid wire 63 that leads to the amplifier switch 61. The lamp 20 is connected up into a lamp circuit 90, including a battery or source of E. M. F. 91, and the switch 92 for lighting the lamp whenever desired.

The general mode of operation of the apparatus will now be described. The reed plate of the harmonica that is to be tuned, is set up in the holder 3 so that the reeds 4 are in the position indicated in Fig. 1. The tuner then depresses a plunger 6, which opens a valve 5a to draw air into the suction box 5 past the reed 4. This causes the reed to vibrate, and the reed of course, vibrates at its own natural frequency. The vibration of this reed sets the air in the suction box 5 in vibration, and causes the diaphragm 7 to vibrate at the same frequency as the air. The vibration of the diaphragm 7 causes impulses in the circuit wires 75, 76, at the same frequency as the reed. These impulses are preamplified in the preamplifier 77 and amplified in the amplifier 64, so that amplified impulses pass through the translating device 11, which has been put into the circuit by means of the multiple switch 67. The activating of the translating device causes vibrations of its diaphragm 15, and the vibrations of this diaphragm are imparted to the air in the air chamber 16. The vibration of the air in this air chamber 16 imparts vibrations to the test vibrators 19 and, of course, the test vibrator that is most nearly in tune with the reed, will become most active in its vibration, and if it happens to be in tune, this will be indicated to the tuner by looking upon the screen 21, where the conditions illustrated in Fig. 6, will occur; that is to say, the light bands of maximum length will be at the middle of the scale of the screen. If the reed is not in tune, a band of light having the most elongation, will be to one side or the other of the middle of the screen. If it is to the right, it will indicate that the reed is sharp, and if it is to the left, it will indicate that the reed is flat. For example, as indicated in Fig. 7, the elongation of the band just to the left of the central band as indicated in dotted lines, would indicate that the reed is flat. Having ascertained whether the reed is flat or sharp, the tuner then uses the abrading or cutting tools 34 or 35 to bring the reed into tune. If the reed is flat, it will be necessary to take off a small amount of material toward the free end of the reed by using the cutting or abrading instrument 34, and vice versa.

It is understood that the embodiment of the invention described herein is only one of the many embodiments this invention may take, and I do not wish to be limited in the practice of the invention, nor in the claims, to the particular embodiment set forth.

By reason of the insulation 56 for the individual test vibrators, it will be evident that no interference can occur between them.

It is evident that this apparatus can be employed for testing the trueness of a vocal note by having the singer sing the note so as to vibrate diaphragm 7.

What I claim is:

1. In tuning apparatus for tuning a musical instrument having vibrators, means for vibrating the vibrator that is to be tuned, an electric circuit, means for developing impulses in the electric circuit at the same frequency as that of the

vibrator to be tuned, means for developing an electric current from the first-named circuit in which the said impulses are amplified, a translating device receiving said current for translating the impulses of the amplified current into audible notes, a gang of graduated test vibrators vibrated sympathetically by the said audible notes, and having predetermined natural frequency, said test vibrators including one whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned and including other test vibrators having natural frequency respectively, above and below that of the said note, and means for indicating the relative activity of the test vibrators actuated through the agency of the translating device.

2. In tuning apparatus for tuning a musical instrument having vibrators, means for vibrating the vibrator that is to be tuned, an electric circuit, means for developing impulses in the electric circuit at the same frequency as that of the vibrator to be tuned, means for developing an electric current from the first-named circuit in which the said impulses are amplified, a translating device receiving said current for translating the impulses of the amplified current into audible notes, said translating device having an air box, the air in which is vibrated at a frequency the same as that of the translating device as induced by the amplified electric current, a gang of test vibrators having predetermined natural frequency including one whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned and including other test vibrators having natural frequency respectively, above and below that of the said note, and means for indicating the relative activity of the test vibrator actuated through the agency of the translating device.

3. In tuning apparatus for tuning a musical instrument having vibrators, means for vibrating the vibrator that is to be tuned, an electric circuit, means for developing impulses in the electric circuit at the same frequency as that of the vibrator to be tuned, means for developing an electric current from the first-named circuit in which the said impulses are amplified, a translating device receiving said current for translating the impulses of the amplified current into audible notes, said translating device including a diaphragm vibrated by the impulses of the amplified current to reproduce the note corresponding to the frequency of the vibrator that is to be tuned, an air chamber adjacent the diaphragm, the air in which is vibrated at the same frequency as the note from the diaphragm as induced by the said amplified current, a gang of graduated test vibrators having predetermined natural frequency to be vibrated sympathetically by the air vibrations in the air chamber, said test vibrators including one whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned, and including other test vibrators having natural frequencies respectively, above and below that of the said note, and means for indicating the relative activity of the test vibrators actuated through the agency of the translating device.

4. In tuning apparatus for tuning a musical instrument having vibrators, means for vibrating the vibrator that is to be tuned, an electric circuit, means for developing impulses in the electric circuit at the same frequency as that of the vibrator to be tuned, means for developing an electric current from the first-named circuit in

which the said impulses are amplified, a translating device receiving said current for translating the impulses of the amplified current into audible notes, said translating device including a diaphragm vibrated by the impulses of the amplified current to reproduce the note corresponding to the frequency of the vibrator that is to be tuned, an air chamber adjacent the diaphragm having a wall inclined to the plane of the diaphragm so as to form an opening into the air chamber located toward one edge of the diaphragm, a gang of graduated test vibrators mounted in the said opening and having predetermined natural frequency, to be vibrated sympathetically by the air vibrations in the air chamber, said test vibrators including one whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned, and including other test vibrators having natural frequencies respectively, above and below that of the said note, and means for indicating the relative activity of the test vibrators actuated through the agency of the translating device.

5. In tuning apparatus for tuning a musical instrument, the combination of means for vibrating the vibrator that is to be tuned, an electric circuit, means for developing impulses in the electric circuit at the same frequency as that of the vibrator to be tuned, means for developing an electric current from the first-named circuit in which the said impulses are amplified, a test box corresponding to the vibrator of the instrument that is to be tuned, a translating device receiving said amplified current for translating the impulses of the amplified current into audible notes, said translating device including a diaphragm located adjacent one end of the test box, and including an air chamber adjacent the diaphragm, a gang of graduated test vibrators vibrated sympathetically by the said audible notes and each having a predetermined natural frequency, said test vibrators disposed in an arc having its center adjacent the other end of the test box, said test vibrators including a test vibrator whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned, and other test vibrators having natural frequencies respectively, above and below that of the said note, a screen located at the end of the test box remote from the translating device, reflectors on the test vibrators, and a source of light for reflecting beams from the said reflectors onto the said screen to indicate the relative activity of the test vibrators induced through the agency of the translating device.

6. In tuning apparatus for tuning a musical instrument, the combination of means for vibrating the vibrator that is to be tuned, an electric circuit, means for developing impulses in the electric circuit at the same frequency as that of the vibrator to be tuned, means for developing an electric current from the first-named circuit in which the said impulses are amplified, a test box corresponding to the vibrator of the instrument that is to be tuned, a translating device receiving said amplified current for translating the impulses of the amplified current into audible notes, said translating device including a diaphragm located adjacent one end of the test box, and including an air chamber adjacent the diaphragm, a gang of graduated test vibrators vibrated sympathetically by the said audible notes and each having a predetermined natural frequency, said test vibrators disposed in an arc having its center adjacent the other end of the

test box, said test vibrators including a test vibrator whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned, and other test vibrators having natural frequencies respectively, above and below that of the said note, a screen located at the end of the test box remote from the translating device, reflectors on the test vibrators, a source of light for reflecting beams from the said reflectors onto the said screen to indicate the relative activity of the test vibrators induced through the agency of the translating device, and means for mounting each test vibrator to enable the same to be adjusted to regulate the position of the light beam from the same on the screen.

7. In tuning apparatus of the kind described for tuning a musical instrument having vibrators, a translating device including a diaphragm with electrical means for vibrating the same to produce musical notes, a gang of graduated test vibrators vibrated at the frequency of the note produced by the diaphragm, said test vibrators each having a predetermined natural frequency, said vibrators including one whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned and including other test vibrators having natural frequencies respectively, above and below that of the said note.

8. In tuning apparatus of the kind described for tuning a musical instrument having vibrators, a translating device including a diaphragm with electrical means for vibrating the same to produce musical notes, a gang of graduated test vibrators vibrated at the frequency of the note produced by the diaphragm, said test vibrators each having a predetermined natural frequency, said vibrators including one whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned and including other test vibrators having natural frequencies respectively, above and below that of the said note, said test vibrators being disposed in an arc and carrying reflectors.

9. In tuning apparatus of the kind described

for tuning a musical instrument having vibrators, a translating device including a diaphragm with electrical means for vibrating the same to produce musical notes, a gang of graduated test vibrators vibrated at the frequency of the note produced by the diaphragm, said test vibrators each having a predetermined natural frequency, said vibrators including one whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned and including other test vibrators having natural frequencies respectively, above and below that of the said note, said test vibrators being disposed in an arc and carrying reflectors, and means for mounting the individual test vibrators for rotation about an axis extending in the same general direction as the plane in which the test vibrator extends to enable the direction of a reflected beam from the reflector to be regulated.

10. In tuning apparatus for tuning a musical instrument having vibrators, a translating device having a diaphragm with electrically operated means for vibrating the same to develop vibrations in the diaphragm corresponding to the frequency of electrical impulses imparted to the same, an air chamber formed adjacent the diaphragm and having a wall in a plane inclined to the plane of the diaphragm so that an opening in the air chamber is formed adjacent one edge of the diaphragm, a gang of test vibrators mounted in the said opening and disposed along an arc having its center remote from the translating device, said gang of test vibrators being graduated to vibrate at predetermined natural frequency and including one whose natural frequency is that of the note to which the vibrator of the instrument is to be tuned, and including other test vibrators having natural frequencies respectively, above and below that of the said note, a reflector carried by each test vibrator, and means for mounting each individual test vibrator to enable the same to be adjusted to regulate the direction of a beam reflected from its reflector.

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