

July 5, 1949.

E. M. JONES

2,474,847

PHOTOELECTRIC MUSICAL INSTRUMENT

Filed Aug. 5, 1946

2 Sheets-Sheet 1

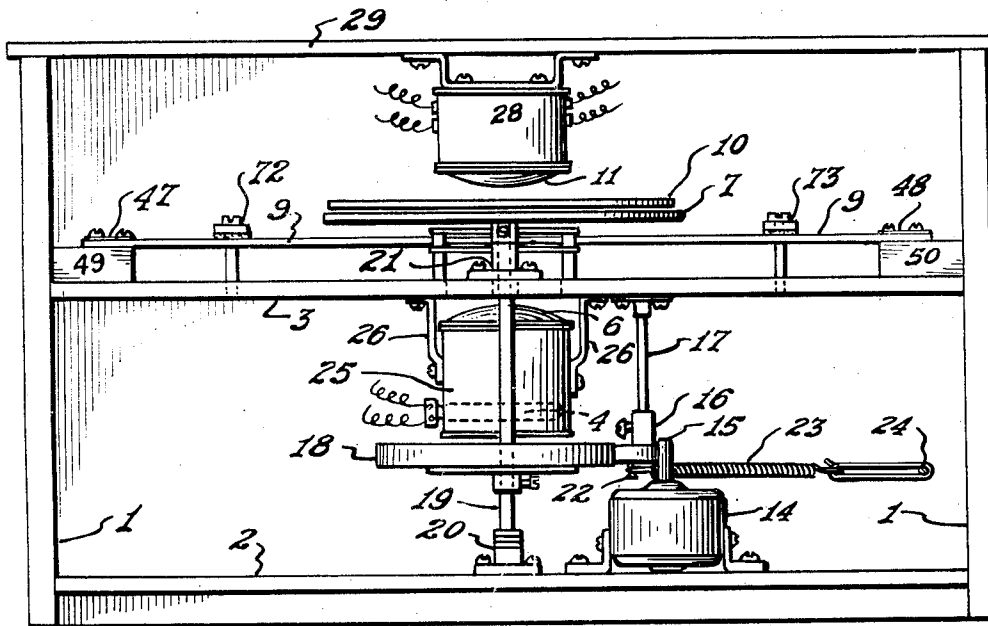
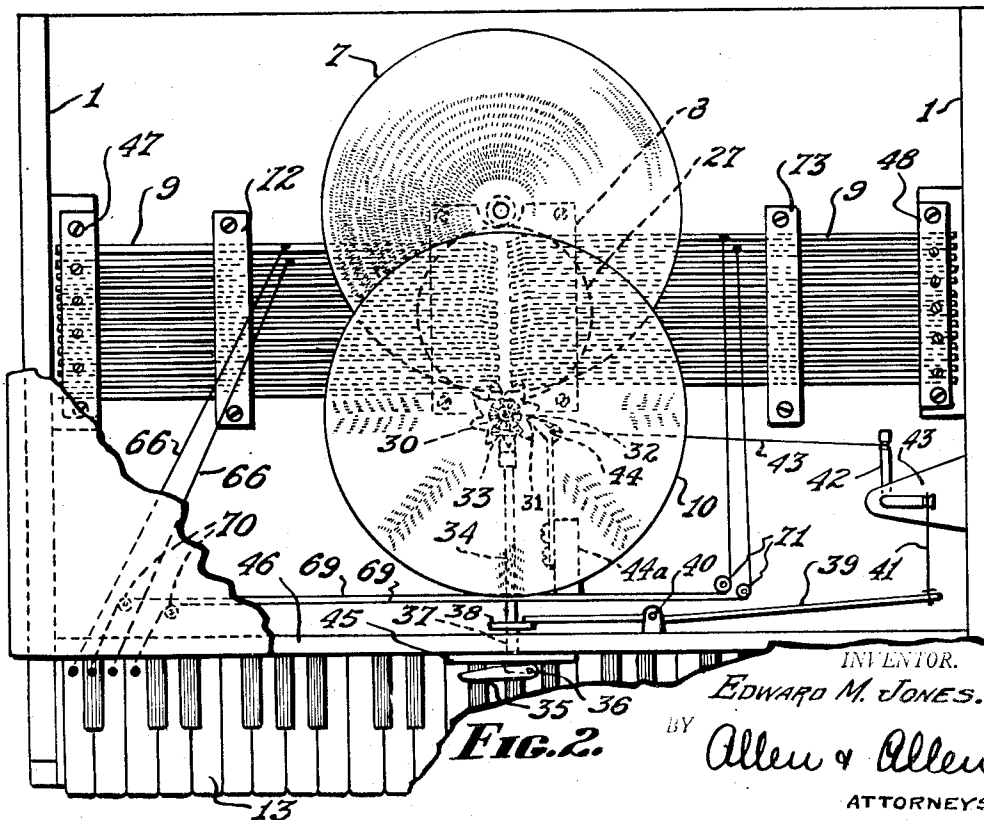


Fig.1.



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2 Sheets-Sheet 2

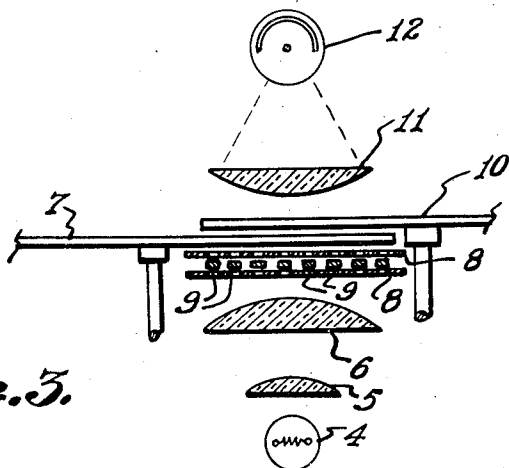


FIG. 3.

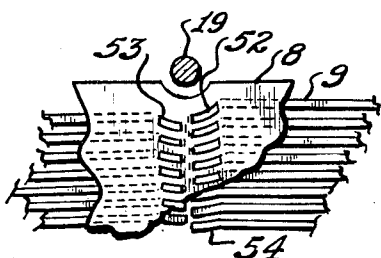


FIG. 4.

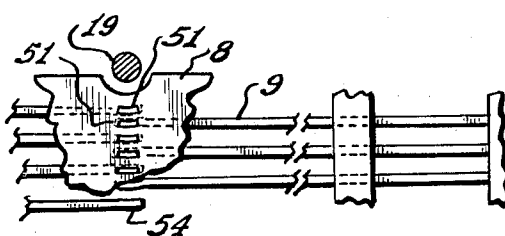


FIG. 5.

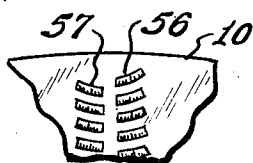


FIG. 6.

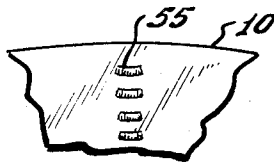


FIG. 7.

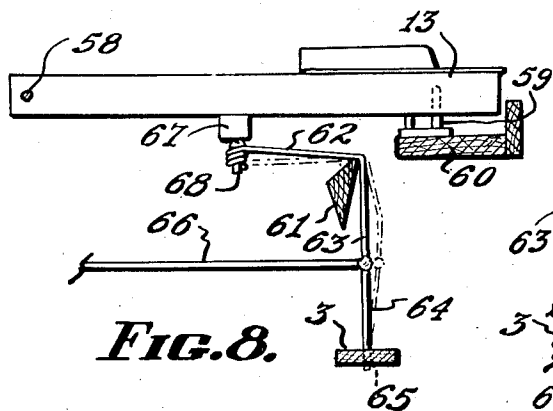


FIG. 8.

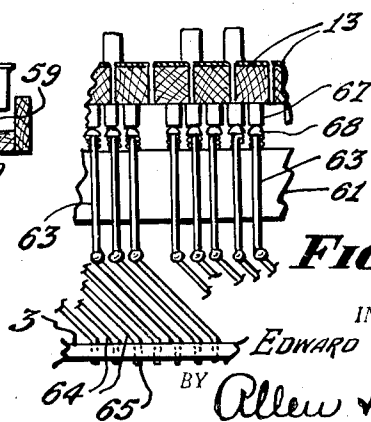


FIG. 9.

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2,474,847

PHOTOELECTRIC MUSICAL INSTRUMENT

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Application August 5, 1946, Serial No. 688,577

22 Claims. (Cl. 250—41.5)

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My invention relates to photoelectric organs or like instruments. It is a common feature of the suggested types that light from a suitable source is divided up into pulsations before impinging upon a photosensitive device which converts the pulsations of light into pulsations of electric energy to be amplified and reproduced. The chief advantage of the photoelectric instrument is its theoretical simplicity both in mechanical devices and in electrical circuits.

Various types of photoelectric instruments have hitherto been suggested, including the one selected herein as the environment for the inventive features hereinafter disclosed. In this type a moving member having opaque and translucent areas serves to cause successive beams of light to traverse the face of a photosensitive means at a desired frequency. This moving means may for convenience be termed an interrupter or pitch disc. The moving beams of light, before reaching the photosensitive device, are further modified by voicing means serving to impart harmonics of desired number and volume, as well as fundamental pulsations. Thus the photosensitive means produces electrical pulsations characterized by a fundamental frequency and harmonics, imparting to the note a desired voice or timbre. My invention is not, however, confined to this particular embodiment.

It will be evident that in the simplest photoelectric organ the interrupter need be the only continuously moving part, which makes for mechanical simplicity. Moreover, the effect of a series of beams of light falling upon a single photocell or group is additive. This obviously greatly simplifies the electrical circuits, especially as compared with instruments of a type in which separate electrical generators are provided for each note of the scale and in which switches must be employed in connection with the keys. Nevertheless, while various types of photocell organs have been suggested in many patents and publications, the theoretical advantages of such systems have not hitherto been attained in commercial practice. The principal object of this invention is the solution of a number of problems inherent in the design of photoelectric organs, which problems have not hitherto been solved in any adequate fashion. The nature of these problems will best be appreciated in connection with description of the invention which follows:

This principal object of my invention and others which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, I accomplish by those

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means and in those constructions and arrangements of parts of which I shall now set forth an exemplary embodiment in the aforesaid exemplary environment. Reference is made to the accompanying drawings, which are semi-diagrammatic in nature, and are designed to illustrate in one operative form the necessary features of the invention as applied to the aforesaid environment. These features may be widely modified as will hereinafter be apparent. In the drawings:

Figure 1 is a vertical elevation of a simplified apparatus.

Figure 2 is a corresponding plan view.

Figure 3 is a diagrammatic representation of the operating elements of the organization.

Figures 4 and 5 are diagrammatic plan views of shutter apparatus.

Figures 6 and 7 are corresponding partial plan views of voicing members for use with the shutter devices of Figures 4 and 5.

Figure 8 is an elevational view with parts in section showing a key mechanism.

Figure 9 is a corresponding partial front elevation with portions in section.

Referring to Figure 1, I have shown a simplified instrument in a case having upright side members 1. In the instrument there is a lower horizontal partition or platform 2 and an upper horizontal partition or platform 3. A motor, drive mechanism and a light source are mounted with respect to the lower platform 2 while above the upper platform I have provided shutters, an interrupter or pitch disc, voicing means and a photocell.

The elements of the optical and mechanical system will be apparent from the diagrammatic representation shown in Figure 3. Here a light source 4 is provided with condensing lenses 5 and 6 so as to produce an upwardly directed beam of parallel light of considerable area, i. e., large enough to cover one useful radial portion of the interrupter disc 7.

The interrupter disc does not require special illustration. It will be understood to bear concentric frequency bands in which opaque and transparent areas alternate in such fashion as to produce spaced beams of light of desired fundamental frequencies which have been mentioned above. The disc may be one of metal stamped or otherwise perforated to provide for the passage of light or it may be a disc of glass or other transparent substance with dark or opaque areas provided photographically or otherwise on its surface.

It will be understood that as respects the tem-

pered musical scale it is possible to arrive at series of whole numbers representative of the desired frequencies for the various notes, in which series the mathematical error is not great enough to be perceptible to the human ear.

The concentric frequency bands on the interrupter disc may be made quite narrow radially, and it is readily possible to provide upon a single disc a series of concentric frequency bands of sufficient number to encompass the entire desired tonal range of the instrument. Nevertheless, it is possible by a duplication of parts which will be apparent to the skilled worker in the art in the light of the teachings herein, to employ two or more interrupter discs and divide the frequency bands between them. A corresponding duplication of light sources and photocells may be made.

I have chosen a disc for the interrupter, as mechanically the simplest contrivance for the purpose; but the alternate opaque and transparent areas may be formed on other bodies such as cylinders, traveling bands and the like.

Between the light source 4 and the interrupter I provide one or more plates 8 having circumferentially elongated apertures therein arranged substantially radially of the interrupter disc in groups. The aperture plate or plates have two functions. The apertures are of carefully controlled length with relation to the opaque and transparent areas of the particular frequency bands to which they appertain; and they act in conjunction with the interrupter to confine the light for any particular frequency band to a circumferential distance equal to a whole number of cycles of the fundamental frequency. In other words the apertures are of such length that a beam of light passing through a transparent area of the interrupter passes also through an aperture, for a length of time equivalent to a whole number of cycles of the given frequency. A new beam starts in its traverse at one end of the aperture just as another beam finishes its traverse at the other end of the aperture. While it is possible to operate with a single beam traversing an aperture at any one time, a smoother result tending to mask roughness of tone due to imperfections in the pitch disc, is obtained if the apertures are made long enough to be traversed by more than one beam at a time. As a second function, the apertures with moving means 9 hereinafter more particularly described, so as to form shutters or valves whereby the particular frequencies producible by the interrupter are selected in accordance with the depression of the keys of the keyboard.

Above the interrupter 7, I have indicated a voice disc 10. This is movable; but for any given voice occupies a stationary position. It is preferably made of transparent material and bears on its surface a series of areas (one for each frequency band on the interrupter 7) of varying translucence, or varying shape. These areas are as long as the apertures in the aperture plates; and they serve to modify the light passing through the shutter and the interrupter to cause pulsations of fundamental and harmonic frequencies in the desired manner. The light beams modified as hereinabove set forth are collected by a condensing lens 11 and brought to bear on the face of a photocell 12. It will be understood that the photocell is connected into a suitable electrical circuit containing amplifying means as desired, and reproducing means such as a loud speaker. Volume control means coupled to a pedal of the instrument may also be provided.

At the front of the instrument as shown in Figure 2 there will be a key board containing a plurality of keys 13 coupled with the shutters as hereinafter described. It will be noted from this figure and from Figure 3 that the interrupter disc 7 and the voice disc 10 are mounted in offset relationship, but in such fashion that a useful radial portion of the one coincides with a useful radial portion of the other.

I have shown herein a single manual instrument; but it will be understood that more manuals including a pedal manual may be provided if desired. The parts outlined herein may be duplicated if desired for each manual; but it will be apparent in Figure 2 that for the reproduction of the notes played upon the illustrated manual, I am employing only one radial portion of the interrupter disc 7. The same interrupter disc may, therefore, be employed for more than one manual (or for other tonal purposes) with the addition of other voice discs similar to the one illustrated, other aperture plates and shutter mechanisms and other light sources and photocells.

While I have illustrated the voicing device in the form of a disc 10, and while the use of a complete disc enables me to provide for a large number of voices or combinations of voices, it will be understood that the voicing means can be less than a complete circular disc or can be an element having, for example, a sliding rather than a rotary motion, and still operate in the manner herein-after described.

Referring to Figure 1, I have shown a motor 14 mounted upon the platform 2. This will preferably be a synchronous motor or other device capable of producing powered rotation at a steady rate. It has a shaft 15 which, through a small friction disc 16 on a jack shaft 17, transmits rotation to a disc 18 which preferably has sufficient mass to act as a fly wheel. The shaft 17 may be made elastic or springy so as to hold the friction disc 16 in contact with the shaft 15 and disc 18, or other means may be provided for the purpose. The disc 18 is mounted upon a shaft 19 which has a bearing 20 on the platform 2 and, extending through the upper platform 3 where it has another bearing 21, is fastened to the interrupter disc 7 at the axis thereof. By these means the interrupter disc may be rotated at a steady rate.

If desired, a pin 22 may be placed eccentrically upon the friction disc 16 and connected by a spring 23 to an abutment means 24. The abutment means is movable, being attached to a manually operated lever or the like (not shown) which may be set at different positions. When the position of the abutment 24 is such as to cause the spring 23 to exert tension on the disc 18, this tension will assist and retard the rotation of the disc 16 as it turns and will thus interrupt the smoothness of its motion. In my instrument the interrupter 7 is designed to be driven at a slow rate, so that the friction disc 16 revolves at a rate corresponding to a suitable tremolo frequency. Hence the modification of its movement as set forth serves as a simple and convenient way of imparting a frequency tremolo or vibrato to the reproduced frequencies. The vibrato effect may be eliminated by moving the abutment 24 to a position in which the spring 23 is not tensioned.

A housing 25 supported by brackets 26 from the upper platform 3 holds the light source 4 and lenses 5 and 6. The partition 3 is cut away as at 27 so that light from the source can pass upwardly through the interrupter disc.

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An upper housing 28 for the lens 11 and photocell 12 may be supported from brackets on the platform 3, or as shown, from a hinged cover 29 for the instrument. The housings 25 and 28 are, of course, in alignment with each other and with the perforation 27. The light source acts to illuminate substantially a full radial portion of the disc 7.

The voicing disc 10 is mounted on a vertical shaft 30 which has a bearing (not shown) on the upper platform 3. The shaft, below the voicing disc, carries a star wheel or other element 31, the function of which will presently be set forth. A bevel gear 32 is also mounted on the shaft 30 above the disc, and meshes with a bevel gear 33 on a horizontal shaft 34 extending through a front board or panel 46 of the instrument. On the end of the shaft beyond the front board, I provide an angular arm to which, as at 36, I pivot a handle member 35. A sleeve 37 on the shaft 34 is spring urged to an outer position, and carries a flange 38 on its inner end.

A lever 39, pivoted as at 40 to brackets on the front board, bears against the flange 38 at one end. The other end of the lever is connected by a rod or link 41 to one arm of a bell crank 42 pivoted in brackets 43 on the side frame member 1. The other arm of the bell crank is connected by a rod or wire 43 to a detent lever 44 which is resiliently bendable and is mounted to a support 44a on the platform 3. The end of the detent lever engages between the teeth of the star wheel 31 excepting when a pull is exerted on the wire 43.

When the handle 35 is grasped for turning the voice disc 10, it will be pushed inwardly, turning on its pivot 36. The result of the operation of the mechanism just described is that the end of the detent lever 44 is withdrawn from the star wheel 31. The voice disc may then be rotated by turning the handle 35. An end of the handle coacts as a pointer with a dial 45 on the front panel of the instrument on which the various voices are indicated. When the voice disc has been turned to a desired position, as indicated by the dial, releasing the handle 35 will result in the end of the detent lever reengaging in the star wheel. This not only effects an accurate positioning of the voice disc 10 for the selected voice, but also locks it against further undesired movement.

It will be understood that while I have indicated a simplified mechanism for controlling the voice disc, other mechanisms may be employed including ones in which particular locations of the voice disc are selected by stop tabs.

Shutter mechanisms for the apparatus thus far described comprise, as indicated, one or a pair of plates 8 having apertures therein and a series of movable shutter members 9. These latter are in the form of elongated rods, the outer ends of which are clamped, as at 47 and 48, to blocks 49 and 50 on the platform 3. The elongated members 9 may be formed by stamping from sheet metal of fairly heavy gauge; and the outer ends of the groups of members 9 may be left undivided where they are clamped or fastened. In my apparatus the shutter elements are preferably moved by flexing, as distinguished from pivoting, for a reason hereinafter set forth.

It will be understood that there is a large number of concentric pitch tracks on the interrupter disc 7; and one of the problems involved is the provision of shutter mechanism of a closely spaced character at its operating end. Consequently, I prefer to divide the movable shutter elements 9 into two groups shown in Figure 4, as

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a right and a left hand group. As shown in Figure 5, the plate or plates 8 may be provided with a single series of radial apertures 51 which are of the required respective lengths and are curved to follow the pitch tracks of the disc 7, the plate or plates 8 being located, of course, to cause the apertures to coincide with the pitch tracks. But since there must be room enough between the apertures to permit the movement of a movable shutter element to uncover them, it will be clear that the arrangement shown in Figure 5 will, to some extent, limit the number and width of the pitch tracks on the disc 7.

As a consequence, I prefer the arrangement of Figure 4, where the two radial groups are indicated at 52 and 53. In this arrangement, the apertures in each group can be separated from each other by the distance between pitch tracks plus the width of a pitch track; and thus the apertures may be caused to respond to pitch tracks which are located very close together on the disc 7 while still providing adequate room for shutter movement.

The ends of the rods 9 are formed into blocking or shutter means 54 responding in shape to and slightly larger in dimensions than the various apertures 51 or 52 and 53. When the blocking portion lies beneath an aperture, light cannot go through the aperture. Since, as has already been indicated, the movable shutter elements 9 are of elongated form and are moved by flexing, it will be seen that the blocking elements 54 move in a direction transverse of or radial to the arcuate slots 51 or 52 and 53. In moving, the blocking elements uncover these slots progressively from side to side.

The wave form screens are representations, diagrammatically indicated at 55 in Figure 7 or at 56 and 57 in Figure 6, formed on the voice disc 10 and responding in size, position and curvature to the pitch tracks on the interrupter disc 7. These representations are areas of varying translucence or transparent areas of varying dimensions, serving in either instance to impart fundamental and harmonic frequency variations to the moving light beams produced by the interrupter disc. The operation of the transparent and opaque areas in the pitch tracks of the interrupter disc 7 is to cause beams of light to traverse the voice screens 55 and 56 or 57 progressively from end to end. I find it necessary for best results that the shutter operate as hereinabove described since, should it operate to uncover the voice screen elements from end to end, the voice or timbre of the tones may vary as the blocking elements move, giving an undesired effect if the blocking element is not moved so as fully to uncover its particular voice screen. When, however, the blocking elements move transversely to voice screen elements of varying translucence, a partial movement of a shutter or blocking element will uncover a portion of the voice screen from end to end, preserving the full harmonic content of the reproduced tone, and varying only its volume in accordance with the degree of opening of the shutter. In this way my instrument may be made to have a certain degree of dynamic quality since the volume of the tones produced can be controlled to a degree by the distance to which the playing keys are depressed.

Since the movable elements 9 of the shutter mechanism are moved by flexing, it will be seen that I have achieved a mechanism which is not of delicate character, but on the contrary, is very sturdy and not liable to come out of adjustment.

A relatively strong pull is required to open the shutters, which is advantageous; but since operating means will be connected to the bars 9 intermediate their ends, it will be understood that the range of movement of said operating means will be quite limited. There are many ways in which the movement of the playing keys 13 can be transmitted to the movable shutter elements 9. One keying mechanism is shown in Figures 8 and 9 where a key 13 is shown pivoted at 58 and guided by the usual pin 59 on the key bed 60. The several keys will be spring pressed to an upward position by means not shown, and the upward position may be determined by the impingement of the key bodies against suitable stop means as desired.

A rail 61 passes across the instrument beneath the keys 13. For each key an element of relatively stiff and resilient wire is provided, bent so as to have a substantially horizontal portion 62 resting at one end on the rail 61, a substantially vertical portion 63 depending from the edge of the rail, and an angularly bent portion 64 extending downwardly to a support (which may be the platform 3) and anchored there in any suitable fashion, as by having its end bent downwardly as at 65 and forced into a hole in the support. Transmission means, such as a wire 66 passing to a movable shutter element, is attached substantially at the juncture of portions 63 and 64.

When a key 13 is depressed, it bears downwardly on the free end of portion 62 of the resilient member. If desired a padded abutment 67 may be provided on the key, and the end of portion 62 may be coiled so as to engage the threads of an adjustment screw 68. Other constructions are equally available at this point. When actuated by the key, the portion 62 pivots on the rail 61, causing the portion 63 also to pivot, acting as a crank arm. The lower end of the portion 63 is permitted to move only a short distance because of the stiffness of the shutter element 9 to which it is connected by the flexible but non-stretchable transmission element 66. The result is that the vertical portion 63 is caused to bend or bow as shown in dotted lines in Figure 8. This bending force is transmitted to the shutter by the element 66. The angularly bent portion 64 prevents transverse motion of the lower end of the vertical portion 63 which would tend to occur when the transmission element 66 runs in a direction non-parallel to the key 13.

The advantage of this sort of mechanical transmission is that a large movement of the end of the key 13 is translated into a small but powerful movement of the transmission member 66. Further, the direction in which the transmission element 66 extends is immaterial. It will be seen in Figure 2 that I may directly connect various keys 13 to various ones of the movable shutter elements 9 by the transmission elements 66 extending in any desired direction. Other transmission elements 68 and 69, which must be carried to the right hand group of movable shutter elements, may, wherever necessary to avoid the other apparatus hereinabove described, be carried around any suitable abutments, rollers or the like 70 and 71. Rollers are not necessary. The pull on the transmission elements is strong enough and the extent of their movement so slight that frictional characteristics may largely be disregarded. I prefer to run the transmission elements in straight lines to the shutter elements wherever possible. It will be understood that added spring means in the shut-

ter mechanism are not required, the resilience of the members 9 serving to return the blocking elements to blocking position when the pull on the transmission elements is released. By choice of metals and gauges for the movable shutter elements 9, their resilience may be controlled as desired.

One other problem presents itself in connection with the shutters, which is the problem of bouncing or vibration. It is desired to have each shutter open positively in response to a pull on its transmission element and close just as positively when the pull is released. Bouncing or vibration at either end of the movement may produce audible imperfections in the tones. As a consequence, I find it necessary to control the movable elements of my shutters by damping means. Such means may take various forms. I prefer to provide damping means indicated at 72 and 73, which comprise bar-like members overlying the shutter elements 9 and carrying on their under sides a frictional or other damping substance engaging the surfaces of the elements 9. It is possible to employ for damping purposes either an elastic material which may be distorted when the shutter elements move or better, a viscous and gummy material which will prevent vibration of the shutter elements.

Hereinabove I have described the essential elements of one form of instrument embodying my invention. It will be understood that, in the light of the claims which follow, the principles of the invention may be applied to other organizations and that the particular organization may be widely modified and elaborated for various purposes. Modifications in the exemplary embodiment may thus be made without departing from the principles of the invention.

Having described the invention in connection with the aforesaid exemplary embodiment, what I claim as new and desire to secure by Letters Patent is:

1. In a device of the character described, having a rotating member with concentric pitch tracks thereon, a shutter mechanism comprising a plate with radially arranged apertures conforming to the several pitch tracks, and shutter elements having radially arranged blocking means movable to cover and uncover said apertures, said blocking means being located respectively on the ends of a series of elongated parallel rod-like members extending parallel to the plane of and in a tangential direction with respect to said rotating member, the other end of said rod-like members being rigidly held, whereby movement of the blocking means may be attained by flexing the rod-like members transverse their length.

2. The structure claimed in claim 1 wherein the apertures are of circumferentially elongated form, wherein the blocking means are of similar form and wherein the movement of said blocking means, as produced by flexing said rods, is a movement transverse to the longer dimensions of said apertures.

3. The structure claimed in claim 1 including damping means engaging said rod-like members.

4. The structure claimed in claim 1 including damping means engaging said rod-like members, playing keys, moving means actuated thereby for converting the movement of said playing keys into limited longitudinal movement of a transmission member, and flexible, strand-like transmission members connecting said last mentioned

means with individual ones of said rod-like members to flex them.

5. The structure claimed in claim 1 wherein the apertures are of circumferentially elongated form, wherein the blocking means are of similar form and wherein the movement of said blocking means, as produced by flexing said rods, is a movement transverse to the longer dimensions of said apertures, playing keys, moving means actuated thereby for converting the movement of said playing keys into limited longitudinal movement of a transmission member, and flexible, strand-like transmission members connecting said last mentioned means with individual ones of said rod-like members to flex them.

6. The structure claimed in claim 1 wherein the apertures are of circumferentially elongated form, wherein the blocking means are of similar form and wherein the movement of said blocking means, as produced by flexing said rods, is a movement transverse to the longer dimensions of said apertures, playing keys, moving means actuated thereby for converting the movement of said playing keys into limited longitudinal movement of a transmission member, flexible, strand-like transmission members connecting said last mentioned means with individual ones of said rod-like members to flex them, and damping means for said rod-like members, said damping means comprising elements including motion retarding means contacting a plurality of said rods in common.

7. The structure claimed in claim 1 wherein the apertures are of circumferentially elongated form, wherein the blocking means are of similar form and wherein the movement of said blocking means, as produced by flexing said rods, is a movement transverse to the longer dimensions of said apertures, playing keys, moving means actuated thereby for converting the movement of said playing keys into limited longitudinal movement of a transmission member, flexible, strand-like transmission members connecting said last mentioned means with individual ones of said rod-like members to flex them, and damping means for said rod-like members, said damping means comprising elements including motion retarding means, contacting a plurality of said rods in common, said motion retarding means including a viscous substance.

8. The structure claimed in claim 1 wherein said apertures are arranged in staggered relation in two rows, and wherein the rod-like members extend inwardly toward said plate in sets from both sides thereof.

9. In combination in a device of the character described, a shaft, means for rotating said shaft, an interrupter disc having concentric pitch tracks mounted on said shaft, a plate located adjacent said disc and having apertures therein positioned respectively in alignment with the several pitch tracks on said disc, and shutter means comprising blocking elements for the several apertures, said blocking means on the ends of elongated rod-like members, the other ends of which are clamped whereby flexing of said rod-like members will move said blocking elements, a series of playing keys and connections between said playing keys and said elongated rod-like members respectively.

10. The structure claimed in claim 9 wherein the apertures in said plate are formed in staggered fashion in two rows, in which there are two sets of said blocking elements and in which each set of blocking elements has its rods extending

in a direction divergent from the direction of the rods of the other set.

11. The structure claimed in claim 9 wherein the apertures in said plate are formed in staggered fashion in two rows, in which there are two sets of said blocking elements and in which each set of blocking elements has its rods extending in a direction divergent from the direction of the rods of the other set, and in which damping means are provided for said rods.

12. The structure claimed in claim 9 wherein the apertures in said plate are formed in staggered fashion in two rows, in which there are two sets of said blocking elements and in which each set of blocking elements has its rods extending in a direction divergent from the direction of the rods of the other set, and in which damping means are provided for said rods, said damping means comprising elements common to the rods in each set, said elements bearing a viscous substance contacting said rods.

13. The structure claimed in claim 9 wherein the apertures in said plate are formed in staggered fashion in two rows, in which there are two sets of said blocking elements and in which each set of blocking elements has its rods extending in a direction divergent from the direction of the rods of the other set, and in which damping means are provided for said rods, in combination with a movable element juxtaposed to said interrupter disc and having wave form representations thereon corresponding with the various apertures of said plate, and means for moving said movable element to various positions in which different sets of wave form representations are made to respond to said apertures.

14. In a device of the character described, a shutter mechanism comprising an apertured plate, an elongated, straight, rod-like member, rigidly mounted at one end and carrying at the other end a blocking means juxtaposed to an aperture of the plate, a pivoted playing key, a flexible resilient member having an end adjacent to said playing key and an end engaged by an external rigid support, an intermediate rigid support over which said member passes in such fashion that depressing said key will result in a resilient bending of said flexible member, and a transmission means connecting said flexible member with said elongated member at a point intermediate its ends whereby to produce flexing of said member.

15. In a device of the character described, a shutter mechanism comprising an apertured plate, an elongated, straight, rod-like member rigidly mounted at one end and carrying at the other end a blocking means juxtaposed to an aperture of the plate, a pivoted playing key, a flexible, resilient member having an end adjacent to said playing key and an end engaged by an external rigid support, an intermediate rigid support over which said member passes in such fashion that depressing said key will result in a resilient bending of said flexible member, and a transmission means connecting said flexible member with said elongated member at a point intermediate its ends whereby to produce flexing of said member, and damping means engaging said rod to prevent vibration thereof.

16. In a device of the character described, a pitch disc having a plurality of concentric pitch tracks thereon, a plate adjacent said disc and having apertures therein of circumferentially elongated form and arcuate shape responding re-

spectively to said pitch tracks, voicing means having wave form screens thereon responding respectively in shape and position to said apertures, and means for uncovering and covering said apertures, said last mentioned means moving in a direction transverse the greatest dimension of said apertures whereby to uncover said apertures from side to side.

17. In a device of the character described, a frame, lower and upper platforms in said frame, a vertical shaft mounted in bearings on said platforms and passing through the upper platform a pitch disc mounted on said vertical shaft above said upper platform, a motor mounted on said lower platform and having means to drive said shaft, a plate having apertures therein responding in position to the pitch tracks on said disc, shutter elements comprising elongated rods having at one end blocking means for individual apertures and being clamped at the other end, said elongated rods divided into groups extending away from said plate in opposite directions, movable means adjacent said disc and bearing wave form representations in a plurality of groups, individual wave form representations of the several groups being so positioned and dimensioned as to be capable of being made to respond in position to said apertures and pitch tracks, a series of playing keys and transmission means connecting said playing keys and individual ones of said elongated rod-like members.

18. In a device of the character described, a frame, lower and upper platforms in said frame, a vertical shaft mounted in bearings on said platforms and passing through the upper platform, a pitch disc mounted on said vertical shaft above said upper platform, a motor mounted on said lower platform and having means to drive said shaft, a plate having apertures therein responding in position to the pitch tracks on said disc, shutter elements comprising elongated rods having at one end blocking means for individual apertures and being clamped at the other end, said elongated rods divided into groups extending away from said plate in opposite directions, movable means adjacent said disc and bearing wave form representations in a plurality of groups, individual wave form representations of the several groups being so positioned and dimensioned as to be capable of being made to respond in position to said apertures and pitch tracks, a series of playing keys and transmission means connecting said playing keys and individual ones of said elongated rod-like members, and damping means engaging said elongated rod-like members.

19. In a device of the character described, a frame, lower and upper platforms in said frame, a vertical shaft mounted in bearings on said platforms and passing through the upper platform a pitch disc mounted on said vertical shaft above said upper platform, a motor mounted on said lower platform and having means to drive said

shaft, a plate having apertures therein responding in position to the pitch tracks on said disc, shutter elements comprising elongated rods having at one end blocking means for individual apertures and being clamped at the other end, said elongated rods divided into groups extending away from said plate in opposite directions, movable means adjacent said disc and bearing wave form representations in a plurality of groups, individual wave form representations of the several groups being so positioned and dimensioned as to be capable of being made to respond in position to said apertures and pitch tracks, a series of playing keys and transmission means connecting said playing keys and individual ones of said elongated rod-like members, damping means engaging said elongated rod-like members, means accessible from a position adjacent said playing keys for shifting said movable member containing the wave form representations, a light source, and a photocell, one of said elements being located above and one below said upper platform, and in alignment with said apertures.

20. The structure claimed in claim 19 in which the apertures in said plate, said blocking means and said movable means containing said wave form representations are confined to one side of said pitch disc, leaving other portions thereof free for use with a duplication of the remaining elements for the generation of tones for other uses in the instrument.

21. In a musical instrument including a rotating tone-frequency determining means and a driven shaft affixed to said means, a disc affixed to said driven shaft, a constant speed drive shaft, a friction disc fixed on a resilient flexible jack shaft, said friction disc being driven by said drive shaft at a rate corresponding to a sub-audio frequency, said friction disc being operative to transmit torque from said drive shaft to said first mentioned disc, and a spring having an end attached eccentrically to said friction disc, whereby a periodic variation is imparted to said torque, the other end of said spring being attached to an abutment.

22. The combination claimed in claim 21 including a vibrato control means for shifting the position of said abutment.

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