May 10, 1966 H. F. RIETH 3,250,844

PHOTOELECTRIC ORGAN

Filed May 17, 1965 3 Sheets-Sheet 1

Fig. 1

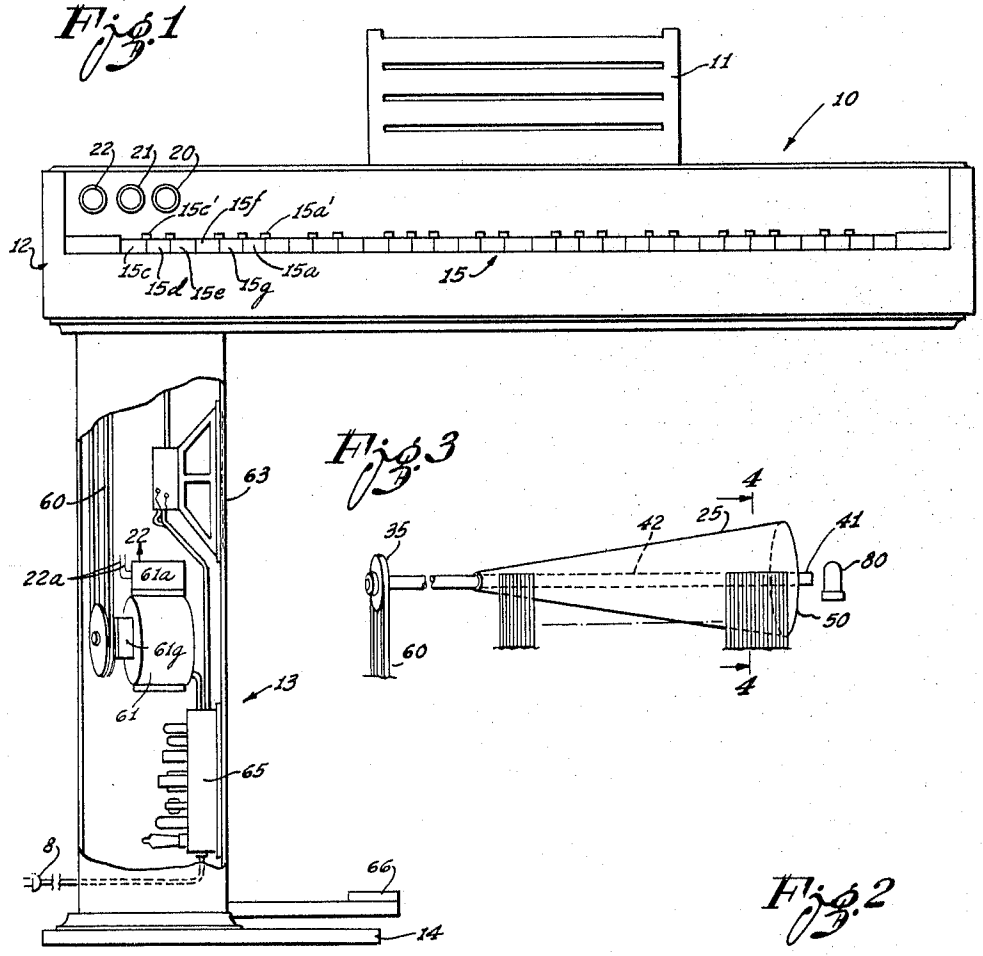
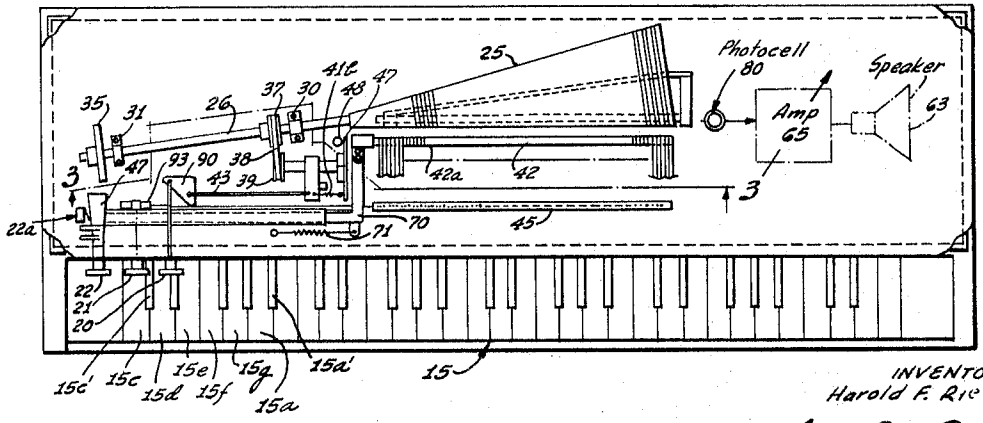


Fig. 3

Fig. 2



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Fig. 4

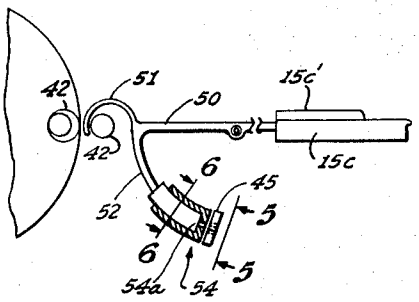


Fig. 5

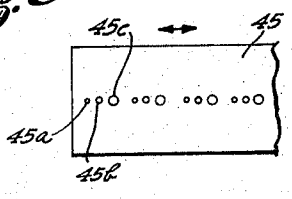


Fig. 6

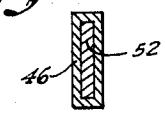


Fig. 8

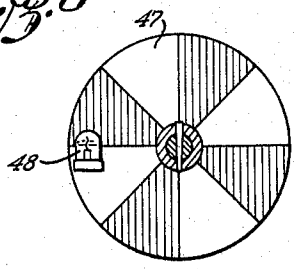


Fig. 9

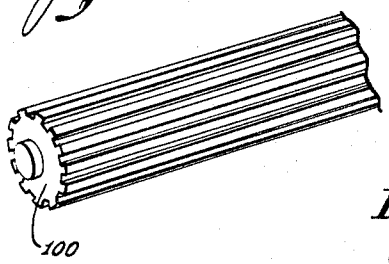
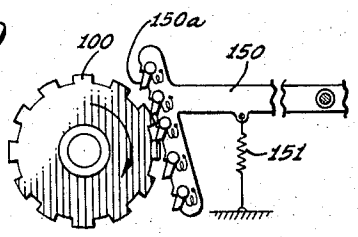


Fig. 10



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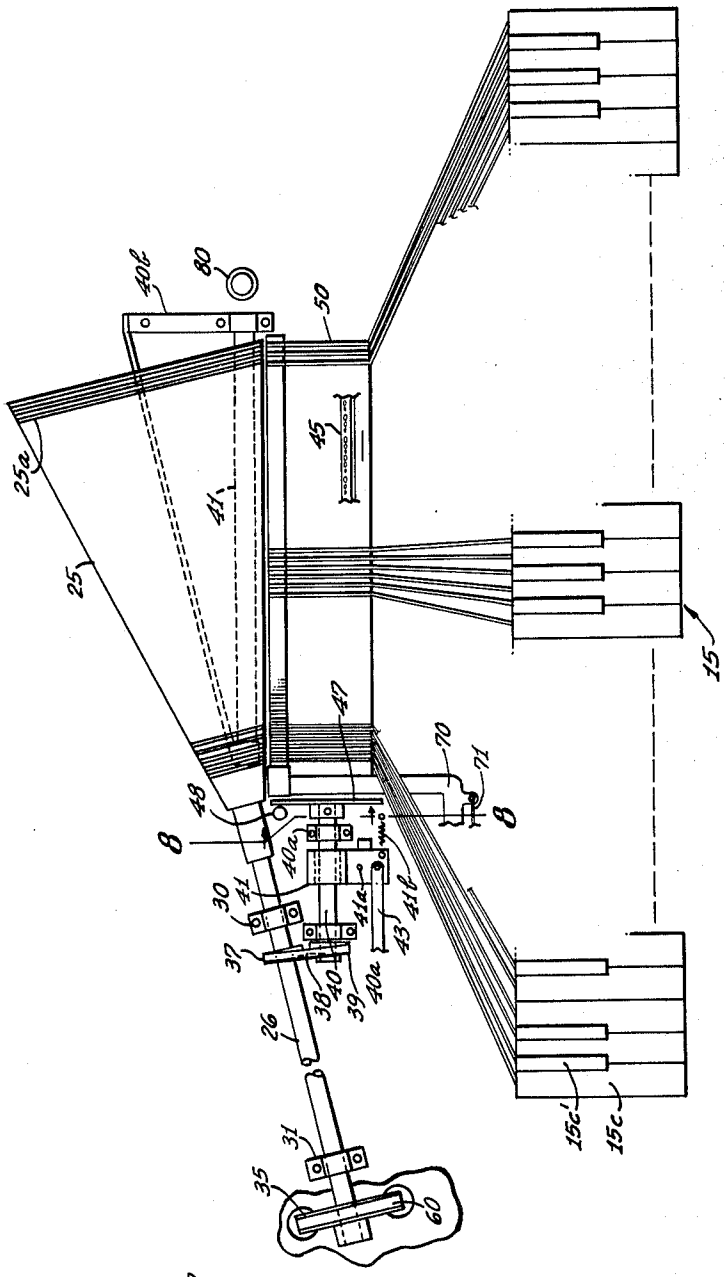


Fig. 7

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United States Patent Office 3,250,844 Patented May 10, 1966

3,250,844

PHOTOELECTRIC ORGAN

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Filed May 17, 1965, Ser. No. 456,046
11 Claims. (Cl. 84—1.18)

This is a continuation-in-part of my copending application, Serial No. 848,660, filed October 26, 1959, entitled "Photoelectric Organ."

This invention relates to photoelectric musical instrument and, more particularly, to a photoelectric key-operated instrument for the production of complex sounds.

Attempts have been made to duplicate the tonal qualities of an organ, piano or other musical instrument without the use of bulky and expensive apparatus inherent in pipe organs. These attempts utilize either electrically vibrated reeds or electronic oscillators, the outputs of which are combined in various proportions to produce the desired note or tonal chord. These instruments, however, do not adequately duplicate the tones of the organ and are moreover complicated and expensive. Though perhaps less bulky than pipe organs, these instruments are also somewhat bulky as well.

In addition to these disadvantages, each note of instruments utilizing electronic oscillators or vibrating reeds is separately adjustable. Though the instruments may be accurately calibrated in the factory, the pitch of many of the notes is changed in shipment and as the instrument is used. Though the instruments, therefore, are theoretically adjustable to a high level of accuracy, as a practical matter, they seldom reach the consumer in such a condition and after little use, the accuracy further deteriorates. The instruments accordingly require continuous adjustments.

In a specific illustrative embodiment of this invention, a small and simple photoelectric key-operated musical instrument is provided which retains its accuracy level during shipment and with subsequent use by the consumer. The instrument includes a rotatable record member which has a number of endless recording tracks in the form of transparent sound tracks. Each of the tracks is a recording of a particular tone with the recording being continuous in that the track has no beginning or end. No tone discontinuity or distortion is provided regardless of what portion of the track is reproduced. Each of the tone tracks includes a predetermined number of identical patterns of the tone. The tone continuity is achieved because only complete tone patterns are utilized.

The record member is rotated at a constant speed and the duration for scanning the various tones is the same. The length of the tracks, however, increases from the lowest note to the highest to prevent crowding because the number of tone patterns is successively greater for the higher notes. To provide for the different lengths, the record member may be in the form of a truncated cone with the tracks being circular tracks at successive axial positions of the cone.

In order to provide for the conventional equally tempered scale, the semi-tones are frequency spaced by a factor of 1.059463. If the ratio of the number of patterns in successive tracks is also 1.059463, all the notes of the instrument are accurately spaced with respect to each other. Providing an uninterrupted tone, however, necessitates complete, not fractional, tone patterns so that utilizing the exact equal tempered halftone ratio of 1.059463 is impossible if an uninterrupted tone is necessary.

Features of this invention relate to the provision of tracks having only complete patterns with the maximum error of the number of patterns being less than a predetermined small value. This maximum error is built into the instrument and does not vary in shipment or with use because the tracks all rotate together as part of a single rotating record member.

As the record member rotates, the tracks are moved adjacent a light gate arrangement which includes a light spreader and a number of light inhibiting elements. The light inhibiting elements are controlled by the keys on the keyboard of the instrument. When a key is operated, an associated inhibiting element is moved to permit the passage of light from the light spreader to a sound track associated with the key. Photoelectric means are included in the record member for receiving the light through the moving sound track and for coupling the received light to amplifier and speaker means. The transmission patterns of the tracks may be photographically produced so that a fairly exact reproduction or organ tones, piano tones, bells or any combinations thereof may be provided.

Other features of this invention relate to the provision of an axially movable elongated light spreader having alternate opaque and transparent portions. Light from a transparent portion is provided to an associated one of the sound tracks when the associated inhibiting element of the light gate is moved. A number of sound tracks are associated with each transparent portion of the light spreader and the axial position of the light spreader determines which track provides the output tone. The sound tracks associated with one transparent portion of the light spreader may provide for tones of the same pitch but different quality as from different instruments.

The relative accuracy of particular notes, for example those used often in chords, may be changed utilizing one of the axial positions of the light spreader. One of the sound tracks associated with particular transparent portions of the light spreader may be for the same note as respectively adjacent tracks but having a different number of patterns. The speed of the motor is automatically adjusted at the same time that the light spreader is moved to scan these tracks.

Other features of this invention pertain to the provision of adjustable delay means for each of the keys on the keyboard to maintain the light gate enabled after pressure is removed from the key. Means are also provided for introducing a tremolo in the form of light modulation with the light to the light spreader being modulated to provide the tremolo. The means for providing the modulation tremolo is adjustable from the keyboard so that the frequency of the tremolo is readily changed.

Further features and advantages of this invention will become apparent upon consideration of the following description when read in conjunction with the drawing wherein:

FIGURE 1 is a front view of the electronic organ of this invention with a portion of the support leg removed;

FIGURE 2 is a top view of the electronic organ of this invention with the top panel of the body of the organ being partially broken away to illustrate various members including a record drum and a light spreader in some detail, particular members being illustrated schematically and only some of the tracks on the record disc and the light spreader being shown;

FIGURE 3 is a sectional view, taken substantially on the line 3—3 of FIGURE 2, of the record drum and some associated components which are utilized in the electronic organ of this invention, certain components not being shown to present other components in clear detail;

FIGURE 4 is an enlarged fragmentary sectional view taken on lines 4—4 of FIGURE 3;

FIGURE 5 is an enlarged front elevational view of a portion of the delay means taken along lines 5—5 of FIGURE 4;

FIGURE 6 is an enlarged sectional view taken substantially on the lines 6—6 of the delay means in FIGURE 4;

FIGURE 7 is an enlarged cutaway top plan view of the keyboard and the components associated therein which are included as part of the body of the electronic organ of this invention;

FIGURE 8 is an enlarged sectional view taken substantially on the lines 8—8 in FIGURE 7 and illustrating a front view of the tremolo disc utilized in the electronic organ of this invention;

FIGURE 9 is a fragmentary perspective view of a gear which is utilized in another embodiment of delay means which may be utilized in the electronic organ of this invention; and

FIGURE 10 is an enlarged side elevational view of the gear and associated components utilized in the other embodiments of the delay means.

Referring to FIGURES 1 through 8, and in particular to FIGURE 1, the electronic organ **10** includes a body **12** which is supported by the support leg **13** on the base **14**. The body **12** includes a keyboard **15** and a music stand **11**. The body **12** is maintained in horizontal alignment on the support leg **13** due to a substantially large weight of the various components in the leg **13**. The leg **13** includes an amplifier **65**, a motor **61** and a speaker **63** all of which have considerable weight.

The keyboard **15**, which may be conventional, illustratively includes 54 keys forming 4½ octaves. The key arrangement of the keyboard **15** is conventional in that the equally tempered scale is utilized with each octave being divided into 12 equal intervals. Two tones are separated by one octave when the frequencies are in the ratio of 2 to 1. The twelve equal intervals are represented by the seven diatonic notes and the five flats and sharps therebetween. A diatonic note is provided when a white key is depressed and a flat or sharp is provided when a black key is depressed.

In the equally tempered scale, if any frequency is multiplied by approximately 1.0595, it is raised by one semitone and if multiplied by 1.2225, it is raised by one tone. All conventional musical instruments follow the equally tempered scale. The frequency of all tones is determined by the pitch, and the pitch of middle C of the conventional piano keyboard has a frequency of 256 cycles per second.

When a power plug **8** in FIGURE 1 is inserted in a power socket, the motor **61** and the amplifier **65** in the leg **13** become energized. The motor **61** rotates a tapered record drum **25** illustrated in FIGURES 2, 3 and 7 by means of a gear box **61***g*, a belt **60**, a pulley **35** and a shaft **26**. The shaft **26** is supported by two brackets **30** and **31** (FIGURE 7) on the body **12**. The drum **25** includes a number of transparent sound tracks **25***a* illustrated particularly in FIGURE 7. Each of the tracks **25***a* is continuous about the surface of the record drum **25** and may be photographically produced. Each of the tracks **25***a* is a sound track providing for a number of individual sound patterns of a particular tone. Illustratively, some of the sound tracks **25***a* may provide for the same pitch but for reproductions of tones from different instruments. One track may illustratively provide for an organ note and its adjacent track may provide for a piano note of the same pitch. Each of the sound tracks may be formed by providing a dark line representing the sound on a light background or by providing a light line representing the sound on a dark background. The line may be provided with a variable axial width at progressive distances circumferentially around the track in accordance with the characteristics of the sound to be produced.

The record drum **25** is continuously rotated by the motor **61** during the operation of the electronic organ **10** but the speed of rotation is adjustable as is hereinafter described. The keyboard **15** controls a number of light gates for coupling light through the sound tracks **25***a* of the record drum **25**. The light gates comprise a light spreader **42** shown in FIGURES 2, 3, 4 and 7. The light spreader **42** may be in the form of a Lucite rod which is illuminated by a lamp **48** or it may be an elongated lamp, not shown. The light from the lamp **48**, positioned at one end of the light spreader **42**, is provided through a rotating chopper disc **47** to the Lucite rod **42**. The chopper disc **47**, which is shown particularly in FIGURE 8, includes a number of alternate opaque and transparent sectors for successively interrupting the light from the source **48** to the light spreader **42**. The frequency of the light interruption is determined by the speed of rotation of the chopper disc **47**.

The disc **47** is rotated with a shaft **40** (FIGURE 7) through a coupling including the pulleys **37** and **39** and a belt **38**. The shaft **40** is supported on the body **12** by two bearing brackets **40***a*. The pulley **37** is mounted on the shaft **26** which, as described above, is driven by the motor **61**. The speed of the shaft **40** and the chopper disc **47** is changed under control of a brake **141**. When the brake **141** is rotated about a pivot **141***a* against a spring **141***b*, it decreases the rotating speed of the shaft **40**. The brake **141** is rotated by a link **43** which is connected to a rotatable member **90** illustrated in FIGURE 2. The rotatable member **90** is positioned by a knob **20** which is mounted above the keyboard **15**. When the knob **20** is pushed in, moving upward in FIGURE 2, the tremolo frequency is decreased due to the braking action by the brake **141**. Variations in the braking action of the brake **141** do not affect the rotational speed of the drum **25** since the disc **47** is relatively light in weight compared to the drum **25**.

The body **12** includes three knobs **20**, **21** and **22** with the knob **20** controlling the tremolo, the knob **21** controlling the return delay for the keys in the keyboard **15** and the knob **22** controlling the axial position of the light spreader **42**.

The light spreader **42** may illustratively have two axial positions for selecting the quality of the tone in accordance with the particular instrument which is to be duplicated and a third axial position utilized for chords. The light spreader **42**, which as indicated above may be a Lucite rod, has a fairly rough surface for dispersing the light introduced thereto from the source **48**. The surface of the Lucite rod has a number of successive opaque bands **42***a* (FIGURE 2) and transparent bands **42***b* formed in the opaque bands **42***a*. The successive opaque bands **42***a* and transparent bands **42***b* may be attained by painting the surface of the Lucite rod with black paint and thereafter removing the paint to form the transparent bands or slits. One transparent band **42***a* is provided on the Lucite rod for each three sound tracks **25***a* on the record drum **25**. The transparent bands **42***b* of the Lucite rod **42** are located adjacent every third successive sound track **25***a* of the record drum **25**. As the drum **25** rotates, therefore, only one-third of the sound tracks **25***a* pass adjacent transparent band **42***a* of he light spreader **42**. The light spreader **42** is moved axially to position the transparent bands **42***a* adjacent either of the other two-thirds of the sound tracks **25***a*.

Light from the light spreader **42**, however, is not coupled to the transparent sound tracks **25***a* due to the inhibition or gating of each of the transparent bands **42***a* of the light spreader **42** by extensions **50** of each of the keys of the keyboard **15**. For example, the extension **50** shown in FIGURE 4 is gated to the key **15***c* of the keyboard **15**. As shown particularly in FIGURE 4, each of the extensions **50** has a semi-cylindrical gate portion **51** which is normally interposed between the light spreader **42** and a cylindrical light receiving member or rod **41**. The light

receiving member or rod **41** is also preferably formed from a suitable material such as Lucite to couple the light received from the light spreader **42** to a photoelectric cell **80** (FIGURE 7) which is located at one end of the Lucite rod **41**. The rod **41** is disposed within the drum **25** as may be best seen in FIGURES 4 and 7. The light receiving means may also be in the form of a photoelectric selenium cell having an extended shape which runs along the inside surface of the drum **25**. Photoelectric cells with such shapes are manufactured by the International Rectifier Corp.

When a key of the keyboard **15** is depressed, the light gate is opened to couple light from the light spreader **42** through the transparent band **42***b* associated with the depressed key and through the adjacent one of the sound tracks **25***a* to the Lucite rod **41**. The amount of light passing through the sound track **25***a* to the Lucite rod **41** at each instant is dependent upon the axial width of the track **25***a* at the position adjacent to the transparent band **42***b* which is passing the light. As previously described, the drum **25** is rotated at a substantially constant speed to dispose successive annular positions on the track **25***a* in contiguous relationship to the transparent band **42***b* which is passing the light. Successive annular positions on the track **25***a* also become disposed in adjacent relationship to the rod **41** since the rod **41** is fixedly positioned by a bracket **406** in FIGURES 2 and 7. The extension **50** of each key is connected to delay means which, in the embodiment shown in FIGURES 4 through 6, is in the form of a dash pot **54** (see FIGURE 4). The dash pot is connected by an extension **52** to the extension **50** of the key. The dash pot **54** includes an adjustable member **45** which is illustrated somewhat schematically in FIGURE 5 for controlling the delay provided by the dash pot **54**. As shown in FIGURE 5, the member **45** includes three different shaped holes **45***a*, **45***b* and **45***c* for each of the keys. The dash pot **54** also includes a piston **46** which is disposed within the member **45** and which is moved outwardly from the member **45** at a rate dependent upon the operative selection of one of the holes **45***a*, **45***b* and **45***c* to return the associated key **15***c* to its normal position on the keyboard **15**. There is one dash pot **54** for each of the keys in the keyboard **15**. The position of the member **45** determines which one of the three holes **45***a* through **45***c* is positioned adjacent a hole **54***a* at the bottom of the dash pot **54**. The hole **54***a* may be at least as large as the hole **45***c*. The amount of air, therefore, which is drawn through the opening **54***a* is determined by which one of the three holes **45***a* through **45***c* is positioned adjacent thereto.

The position of the member **45** is determined by an adjustment of the knob **21** shown in FIGURE 2. By rotating the knob **21**, a gear arrangement **93** is adjusted to move the adjustable member **45**. The knob **21** may include four stops, not shown, one of which provides for a maximum delay with none of the three holes **45***a* through **45***c* being adjacent the opening **54***a*.

In the embodiment shown in FIGURES 9 and 10, dash pots are not utilized but a long gear **100** is positioned under each of the extensions **150** of the keys of the keyboard **15** to replace the dash pot **45** in FIGURE 4 in controlling the position of the gate **51** relative to the light spreader **42** and the drum **25**. In this embodiment, the extensions **150** include means for readily permitting the movement of the extension **150** in an upward direction against the gear **100**. The means may include a number of fingers **150***a* which are spring biased against the gear **100**. When the operator releases the key, however, it does not return to its light gating position under control of the spring **151** until the gear **100** permits it. The gear **100** rotates in a clockwise direction as viewed in FIGURE 10 to permit the extension **150** to rotate back to its normal position, thereby returning the associated key to its normal position in the keyboard **15**. When a gear **100** is utilized, a continuously variable delay may be provided instead of a step variable delay as illustrated by the embodiments of FIGURES 4 through 6.

The modulated light received at the photoelectric cell **80** is coupled, as shown in FIGURE 2, to the amplifier **65** and therefrom to the speaker **63** for conversion to sound. The amplifier **65** and speaker **63** which are illustrated in phantom, are actually located in the support leg **13** but are shown in FIGURE 2 for convenience. As illustrated by the diagonal line extending through the amplifier **65** in FIGURE 2, the amplifier **65** is adjustable to control the volume of the sound from the speaker **63** by operating a foot pedal **66** (FIGURE 1). The electrical signal from the photoelectric cell **80** is a reproduction of the signal photographically recorded in the selected sound track **25***a* on the record drum **25**. If a number of keys of the keyboard **15** are simultaneously depressed, the light wave in the Lucite rod **41** is a composite signal including a number of tones and the output sound provided from the speaker **63** is a chord.

The dimensions of the record drum illustratively may be a length of 14 inches, a maximum diameter of 8 inches and a minimum diameter of 1 inch. The lowest note which may be at a frequency of 64 cycles per second is provided when a key **15***c* is depressed. The sound track for the key **15***c* is recorded at the smaller end of the record drum **25**. The diameter of the sound track for the 64 cycle per second note is, therefore, substantially 1 inch.

In the embodiment being described, two sound tracks **25***a* are provided on the drum **25** for each of the keys to provide for the duplication of the sound of both an organ and a piano, and a third sound track is provided which may be utilized as part of particular chords. The first sound track, therefore, has a diameter of 1 inch but the sound track adjacent thereto corresponding, for example, to the piano tone, has a slightly greater diameter. The speed of rotation of the drum **25** is the same for both the first and second sound tracks, and the pitch of the sound from the two tracks is the same because they each include the same number of sound patterns. The actual peripheral distance for each pattern in the two adjacent tracks are different but each is scanned in the same time by the light from the light spreader **42** so that identical pitched tones are provided. The number of patterns in the third track associated with each of the keys is different than the number on the other two but a substantially similar tone is provided therefrom because as is hereinafter described, the motor speed is adjusted when the third track is scanned. As will be described in detail subsequently, only a particular one of the three tracks **25***a* is disposed relative to the associated track **42***a* on the light spreader **42** to receive light from the associated track **42***a* when the associated gate **51** in FIGURE 4 is operated by the actuation of the associated key on the keyboard **15**.

In order to provide for the conventional equally tempered scale, the semi-tones should be frequency spaced by the factor of 1.059463. If the ratio of the number of patterns for the tracks associated with adjacent keys is 1.059463, the notes provided by the instrument are accurately spaced with respect to each other. Providing a continuous uninterrupted tone, however, requires that partial patterns should not be utilized so that providing for the exact ratio between the number of patterns for adjacent half tone keys is impossible. For example, if the first track **25***a* for the key **15***c* has 116 patterns and provides for a tone having a frequency of 128 cycles per second (note C), the first track for key **15C'** (for note C sharp) should have 116 times 1.059463 or 122.897708 patterns. Only a portion (.897708), therefore, of the last pattern would be utilized to provide for the exact ratio of 1.059463.

In order to avoid partial patterns, the nearest full number of patterns is utilized. For example, for the note C sharp corresponding to key **15C'**, 123 patterns are utilized

instead of 122.897708. The error of the tone provided by the 123 pattern track is

$$\left(\frac{123-122.897708}{123}\right)\times 100=0.083 \text{ percent}$$

A small error of this magnitude is generally undetectable by the human ear. In fact, errors less than 0.20 percent are generally undetectable. The following table illustrates the fractional number of patterns required to maintain the ratio of 0.059463, the number of patterns actually utilized on the tracks of the drum **25**, the notes and keys to which they correspond and the percentage errors.

X 1.059463	Patterns	Note	Key	Percent error
116	116	C	15C	.000
122.897708	123	C#	15C′	.083
130.205592	130	D	15D	.158
137.948012	138	D#	15D′	.037
146.150836	146	E	15E	.103
154.841440	155	F	15F	.103
164.048824	164	F#	15F′	.030
173.803612	174	G	15G	.113
184.138516	184	G#	15G′	.073
195.087988	195	A	15A	.045
206.688452	207	A#	15A′	.151
218.978884	219	B	15B	.010

The particular patterns selected, starting with 116 for the lowest note, provide for smaller errors than any other set of patterns starting with any other number from zero to 150. The largest tone error which is 0.158 percent for the note D, is undetectable by human ears. The relatively small errors are achieved by rounding off the fractions, either up or down to the nearest round number. The fractional number 122.897708, for example, is rounded off to 123 and the fractional number 130.205592 is rounded off to 130.

The particular set of patterns selected starting with 116 is, of course, not the only operable set and this invention is not restricted to the particular set. Other sets may be utilized but the percentage of errors are greater so that for the most accurate set, a lowest pattern number of 116 is utilized. The motor speed for sets starting with different pattern numbers would, of course, differ in order to provide for the same pitches. In order to provide for a frequency of 128 cycles (note C below middle C), the drum **25** rotates at a speed of 1.103 revolutions per second or 66.18 revolutions per minute.

As described above, there are three tracks **25***a* associated with each of the keys **15**C, etc. of the keyboard. For each of the keys, the first two of these tracks have the same number of tone patterns. For example, for key **15**C, the first two tracks each have 116 patterns and for the key **15**C′, the first two tracks each have 123 patterns. The third track in each trio, however, has a different number of patterns. The different number of patterns is utilized for the same note to reduce its error. Suppose, for example, in particular chords it is necessary that the note A sharp corresponding to key **15**A′ should be more accurately spaced from the note C corresponding to the key **15**C. The accuracy can be improved by utilizing a different set of patterns in which the accuracy of the note A sharp is better than the accuracy achieved in the 116 pattern set. By shifting the light spreader **42** with the knob **22**, any one of the three sets of tracks are positioned for scanning. For the first two positions, one or the other of the two sets starting with 116 patterns, is positioned and for the third position, a set starting with a different number is positioned. The first two sets illustratively are utilized for duplicating different instruments. The corresponding notes in these two sets provide for identical pitches and are, therefore, of similar accuracy.

When the knob **22** is pulled, it provides for the longitudinal or axial movement of the light spreader **42** as briefly indicated above. The linkage between the knob **22** and the light spreader **42** includes a shaft **72** (FIGURE 2) and a link **70** which are movable as a unit. The link **70** is affixed to the end of the light spreader **42** and is resiliently restrained by a spring **71**. When the knob **22** is pulled downwardly in FIGURE 2 a particular distance less than the complete distance to which it can be pulled, a wedge-shaped portion **47** at the upper end of the knob **22** forces the shaft **72** and the link **70** to the right against the restraining force of the spring **71**. The link **70**, in turn, moves the light spreader **42** by a slight amount toward the right to a second position displaced from its position of rest. When the light spreader **42** is moved to the right, it registers the transparent bands **42***b* of the light spreader **42** adjacent the 54 piano sound tracks **25***a* instead of adjacent the 54 organ sound tracks **25***a*. There is one piano sound track and one organ sound track for each of the 54 keys of the keyboard **15**. The output signal developed, therefore, when any key of the keyboard **15** is depressed after the operation of the knob **22**, corresponds to a piano note instead of an organ note.

If the knob **22** is pulled the maximum distance toward the left, it shifts the light spreader **42** to a third position and it operates a microswitch **22***a*. With the light spreader **42** at its third position, the third set of tracks on the drum are aligned with the transparent areas **42***b* for scanning. The microswitch **22***a* operates a control unit **61***a* (FIGURE 1) associated with the motor **61** to change the motor speed. The motor speed is adjusted so as to provide the same note for key **15**C as is provided with the light spreader **42** in its first position. If the set of patterns in the third set of tracks **25***a* starts with 58 patterns, for example, instead of 116, the motor speed is doubled so that the same number of patterns are scanned during each second.

For the first of the three tracks of the successive half tones, the diameters of the organ sound tracks **25***a* may be at a ratio of 1.0595 as follows: 1.0000; 1.0010; 1.0595; 1.1225; 1.189; 1.260; 1.335; 1.414; 1.498; 1.587; 1.682; 1.782; 1.888; and 2.000. A diameter of 2.000 would be provided for the next note C, which is at the beginning of the next octave, and which has a frequency of 256 cycles per second. The successive dimensions may be obtained by multiplying each succeeding diameter by 1.0595 which is substantially the same factor utilized between semi-tones of the equally tempered scale.

The drum **25** is tapered in this manner from a narrow diameter for the track with the least number of patterns to the track with the most number of patterns so that the actual peripheral distances of the patterns in the successive tracks are substantially of the same length. The larger pattern tracks are, therefore, not more crowded than the smaller pattern tracks.

Though only three sound tracks **25***a* are provided for each key of the keyboard, it is obvious that any number may be provided. If, for example, five instead of two instruments are to be duplicated, five sound tracks are provided for each key, and the knob **22** has at least 5 positions. The axial position of the light spreader **42** is determined by the position of the knob **22**. Similarly, any number of tracks having different numbers of patterns may be provided for each key, with the motor speed accordingly being varied by the knob **22**. Though each of the tracks **25***a* is described with reference to a single note, it is apparent that a chord may be recorded in one track. The chord, if so recorded, should consist of individual notes of similar accuracy as the individual notes in the other tracks **25***a*.

Although this invention has been disclosed and illustrated, therefore, with reference to particular applications, the principles involved are susceptible of numerous other applications which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

What is claimed is:

1. A photoelectric musical instrument, including,

a rotatable member provided with a particular configuration and having a plurality of endless transparent sound tracks, each of the sound tracks defining a recording of a different pitched tone in accordance with the particular configuration of the rotatable member and with the tone being provided continuously without interruption having no recording discontinuity at any position around the track, the number of sound tracks being at least equal to the number of notes in the scale of the instrument,

means coupled to the rotatable member for providing a rotation of the rotatable member,

means optically coupled to said endless transparent sound tracks on the rotatable member for selectively providing light through any one of said sound tracks as said rotatable member is rotated,

means coupled to said rotatable member for collecting the light provided from said optical means through said one sound track,

means coupled to said collecting means for converting the collected light to electrical signals representing the tone recorded in said one track, and

means optically coupled to the rotatable member for varying the tremolo of the tune.

2. A photoelectric musical instrument, including,

a rotatable member having a plurality of endless transparent sound tracks, the number of sound tracks being at least as great as the number of notes in the scale of the instrument, said endless tracks being disposed in groups with the different tracks in each group having patterns simulating the same tone for different musical instruments, said rotatable member being tapered and being provided with a shape of a truncated cone with the sound tracks being located at different diametric positions along the cone;

means optically coupled to said endless transparent sound tracks on the rotatable member for selectively obtaining the passage of light through any one of the sound tracks;

means coupled to said endless transparent sound tracks on the rotatable member for collecting the light coupled through said sound tracks and modulated in accordance with the selected sound track, said light providing means including a light source having a transparent and an opaque portion for each of the sound tracks;

a plurality of selectively operable light gates being disposed relative to the light source to normally block the light from the transparent portions of said light source to the adjacent sound tracks on the rotatable member;

means operatively coupled to the light gates for selectively operating said light gates to couple the light in a particular one of the groups of sound tracks from the associated transparent portions of said light source through the adjacent sound tracks of said rotatable member to said collecting means; and

means for shifting the position of the light source relative to the rotatable member in an axial direction to couple the light from the transparent portions through the individual ones of the light tracks in the particular groups on the rotatable member.

3. A key-controlled, photoelectrically operated musical instrument, including,

a rotatable transparent member having inscribed thereon groups of endless sound tracks, the tracks in any one group being of the same pitch but of different tone qualities, the number of groups being equal to the number of notes in the scale of the instrument and the tracks in each individual group representing a different note from the tracks in the other groups, said member being tapered in the shape of a truncated cone with the successive groups of tracks being recorded from the lowest notes at the smaller diametric end of the transparent member to the highest notes at the larger diametric end of the transparent member;

means optically coupled to the rotatable transparent member for selecting a particular one of the groups of endless sound tracks at each instant;

means optically coupled to said transparent member for selectively providing at each instant light through any one of the sound tracks in the particular one of the groups inscribed on said transparent member;

means coupled to said transparent member for collecting the light coupled through said transparent member and modulated in accordance with the selected sound track; and

means coupled to the light-collecting means for converting the light collected by the light-collecting means to sounds having characteristics corresponding to the characteristics of the collected light.

4. A key-controlled, photoelectrically operated musical instrument, including,

a rotatable transparent member having inscribed thereon groups of endless sound tracks, the tracks in any one group each having a different number of sound patterns to represent the sounds of different musical instruments, the number of groups being equal to the number of notes in the scale of the instrument and each group representing a different note in the scale, said member being tapered in the shape of a truncated cone with the successive groups of tracks being recorded from the lowest notes at the smaller diametric end of the transparent member to the highest notes at the larger diametric end of the transparent member;

means operatively coupled to said transparent member for selecting a particular one of the groups of endless sound tracks at each instant;

means optically coupled to said transparent member for selectively providing light through any individual one of the sound tracks in the particular one of the groups inscribed on said transparent member;

means coupled to said transparent member for collecting the light coupled through said transparent member and modulated in accordance with the selected sound track;

means operatively coupled to the light-collecting means for converting the light collected by the light-collecting means to sounds having characteristics corresponding to the characteristics of the collected light, and

tremolo means operative upon the light passing to the tracks in the transparent member for modulating the light at a variable rate to provide a tremolo in the sounds produced by the last-mentioned means where the tremolo has variable characteristics in accordance with the variable modulation of the light.

5. A key-controlled photoelectrically operated musical instrument in accordance with claim 4 wherein said light providing means includes an adjustably positioned rod having a number of transparent and opaque bands, one transparent band being provided for each of the groups of endless tracks on said rotatable transparent member;

means for introducing light at one end of said rod; and

means coupled to said rod for adjustably positioning said rod relative to the rotatable transparent member in the axial direction of the rotatable transparent member to couple light through any individual one of its transparent bands to any individual one of the sound tracks in the group associated with said one transparent band.

6. A key-controlled photoelectrically operated musical instrument in accordance with claim 5 wherein said tremolo means interrupts the light introduced to said rod at a variable frequency to provide a tremolo effect.

7. A key-controlled photoelectrically operated musical instrument, including,

a rotatable transparent member having inscribed thereon groups of endless sound tracks, the tracks in any one group each having a different number of sound patterns to represent different musical instruments, the number of groups being equal to the number of notes in the scale of the instrument and each group representing a different note, said member being tapered in the shape of a truncated cone with the successive groups of tracks being recorded from the lowest notes at the smaller diametric end of the transparent member to the highest notes at the larger diametric end of the transparent member, the ratio between the diameters of the smaller diametric tracks of adjacent groups being substantially equal to the ratio between adjacent notes in the scale of the instrument;

means coupled to said transparent member for selecting a particular one of the groups of endless sound tracks at each instant,

means optically coupled to said transparent member for selectively providing light through any individual one of the sound tracks in the particular one of the groups inscribed on said transparent member;

means coupled to said transparent member for collecting the light coupled through said transparent member and modulated in accordance with the selected sound track; and

means synchronously operated with said light providing means for adjusting the speed of rotation of said rotatable transparent member to a speed dependent upon the selection of the individual one of the tracks in the individual group.

8. A photoelectric musical instrument, including,

a rotatable member having a plurality of endless transparent sound tracks, the number of sound tracks being at least as great as the number of notes in the scale of the instrument, each sound track having characteristics to produce a different note on a continuous basis;

means optically coupled to said endless transparent sound tracks on said rotatable member for selectively providing light through any one of the sound tracks;

means coupled to said endless transparent sound tracks on said rotatable member for collecting the light coupled through said rotatable member and modulated in accordance with the selected sound track;

said light providing means including a light source having a transparent and an opaque portion for each of the sound tracks;

a plurality of selectively operable light gates being disposed relative to the light source to normally block the light from the transparent portions of said light source to the associated sound tracks;

means operatively coupled to the light gate for selectively operating said light gates to couple the light from the associated transparent portions through the associated sound tracks to said collecting means, each of said light gates including adjustable delay means for extending the duration of operation of the light gate for a variable interval of time after the operation of the selectively operable means in accordance with the adjustment of the delay means; and

means operatively coupled to the light-collecting means for converting the light collected by the collecting means into sounds having characteristics corresponding to the characteristics of the collected light.

9. A photoelectric musical instrument, including,

a rotatable member having a plurality of endless transparent sound tracks, the number of sound tracks being at least as great as the number of notes in the scale of the instrument and each sound track being provided with a pattern representing a different note,

said rotatable member being tapered and being provided with a shape of a truncated cone with the sound tracks being located at different diametric positions along the cone,

means optically coupled to said rotatable member for selectively providing light through any individual one of the sound tracks,

means coupled to said rotatable member for collecting the light coupled through said rotatable member and modulated in accordance with the selected sound track, said selective operating means including a plurality of keys individually associated with said sound tracks,

means operatively coupled to said keys and disposed relative to the sound tracks and responsive to the operation of any individual one of said keys for providing light to said sound tracks associated with said individual keys, and

adjustable means coupled to each of said keys for delaying the restoration of the coupled key upon the actuation of the key and for providing such delay for a period of time dependent upon the adjustment of the adjustable means to continue the provision of light to said associated track for an interval after the coupled key is operated.

10. In a musical instrument including,

a rotatable drum member having a first group of annular transparent sound tracks spaced axially therealong with each of said sound tracks having a pattern representing a recording of an individual note with first characteristics of sound whereby all of said sound tracks will provide a complete scale;

a second group of annular transparent sound tracks spaced axially therealong and interspersed between said first sound tracks, each of said sound tracks in said second group having a pattern representing a recording of an individual note with second characteristics of sound whereby said second group of sound tracks will provide the complete scale, the diameter of the tracks in the first group having a particular ratio different from unity relative to the diameter of the tracks in the second group;

a translucent rod extending axially of said drum adjacent the surface thereof, said rod having alternate translucent and opaque portions positioned so that each of said translucent portions can register only with the individual tracks representing an individual note in the first and second groups;

control means operatively coupled to the translucent rod for moving said rod axially relative to the rotatable drum member into a first position whereby said translucent portions will register with the sound tracks in said first group and for moving said rod into a second position whereby said translucent portions will register with the sound tracks in said second group; and

motor means operatively coupled to the drum member for rotatably driving said drum member, said motor means being operatively connected to said control means for driving said drum at a first particular speed with said rod in said first position for driving said drum and at a second particular speed with said rod in said second position in accordance with the particular ratio of the diameters of the tracks in the first and second groups.

11. A musical instrument, including,

a rotatable member having a first plurality of endless sound tracks each having a particular number of individual sound patterns to provide for the production of different notes simulating a first musical instrument, the number of sound tracks in said first plurality being at least equal to the number of notes in the scale of the instrument, the rotatable member also having a second plurality of endless sound

tracks each having a particular number of sound patterns to provide for the production of substantially similar notes as the tracks in said first plurality of tracks but simulating chords, the sound patterns of each of the tracks in said second plurality being different than the sound patterns in the corresponding one of said tracks in said first plurality of tracks;

means coupled to the rotatable member for individually selecting a particular one of the tracks in the first and second pluralities;

means coupled to said rotatable member for reproducing the sound recorded in the selected one of the tracks of said first and said second pluralities of tracks; and

means coupled to said rotatable member for rotating the member at a first particular speed when the pattern of sound on one of said tracks in said first plurality of tracks is being reproduced and for rotating the member at a second particular speed when the pattern of sound on one of said tracks in said second plurality of tracks is being reproduced.

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