Oct. 18, 1949. E. M. SPIELMAN 2,484,914

PHOTOELECTRIC KEYBOARD INSTRUMENT

Filed Feb. 7, 1947 2 Sheets-Sheet 1

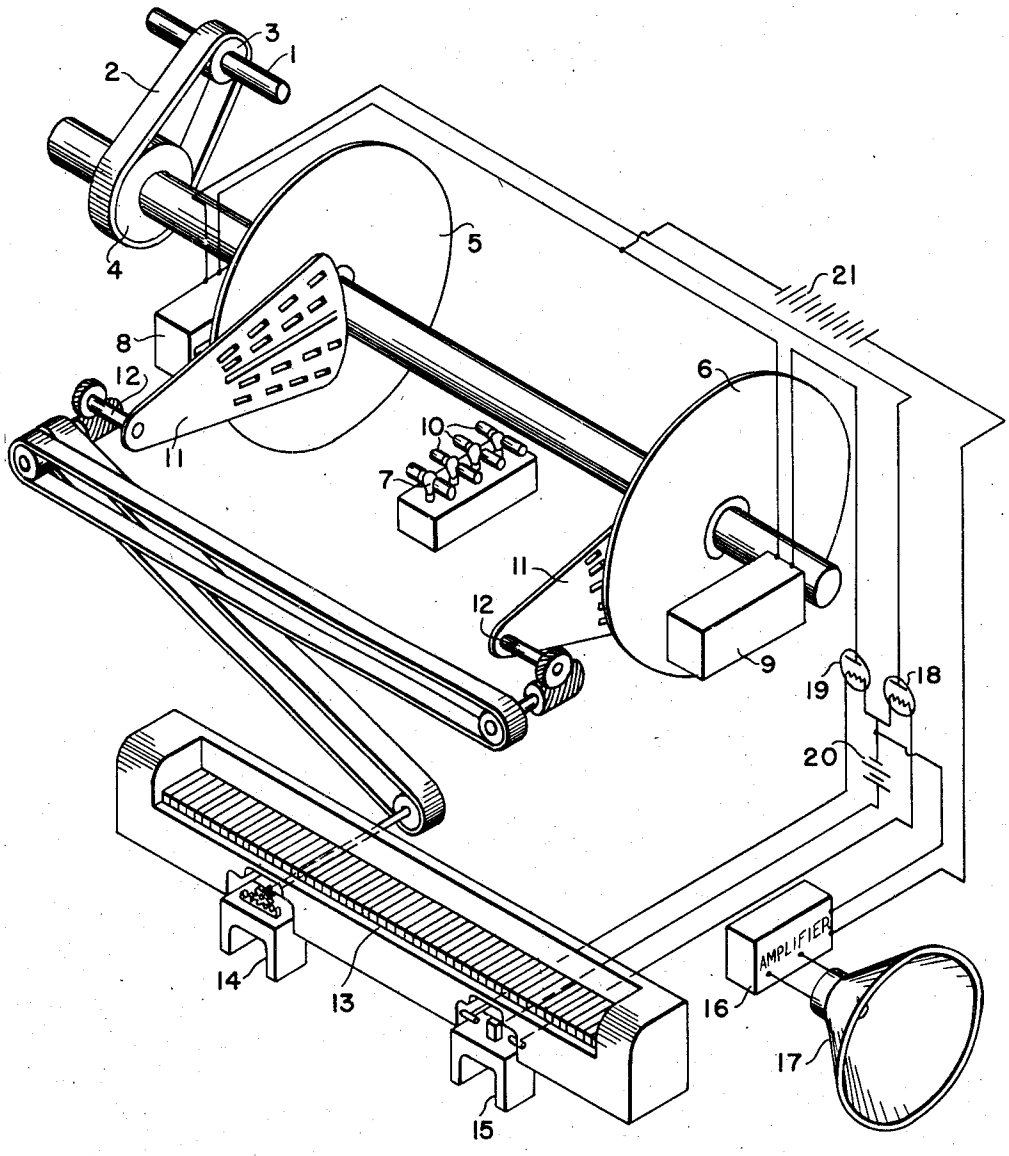


Fig-1-

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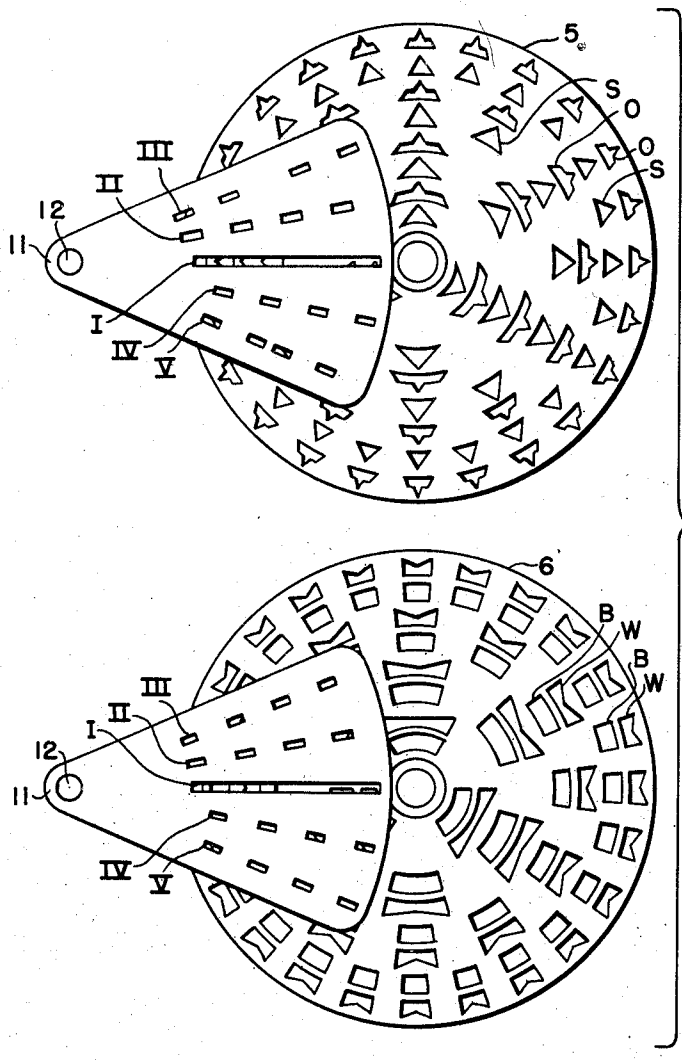


Fig-2-

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Patented Oct. 18, 1949

2,484,914

UNITED STATES PATENT OFFICE

2,484,914

PHOTOELECTRIC KEYBOARD INSTRUMENT

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Application February 7, 1947, Serial No. 727,237

2 Claims. (Cl. 84—1.18)

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The invention relates to a photoelectrical musical instrument producing orchestral effects. It is a continuation-in-part of my copending patent application Serial No. 526,408, filed on March 14, 1944, now Patent No. 2,469,850 issued on May 10, 1949.

The production of an orchestral effect generally requires a plurality of musicians playing different instruments.

However, a single musician can produce orchestral effect also playing upon a theatre organ with a plurality of keyboards. Each keyboard sounds with distinct timbre representing different types of orchestral instruments.

The theatre organ is a universal instrument; but it can never become a home instrument, even if it should be possible to reduce its size and its costs. The proper operation of a plurality of keyboards requires much more skill than average players can acquire. This difficulty is eliminated by a musical instrument which produces orchestral effect using a single keyboard. Four characteristics dominate the sounding of music played by an orchestra.

1. An orchestra performs music which mainly sounds with sustained tones.

2. An orchestra executes the single voices of the polyphony with different volume.

3. An orchestra alternately performs the entire polyphony in one of three fundamental timbres, viz. the timbre of stringed, woodwind and brass instruments, or in any combination thereof.

4. An orchestra stresses a leading voice by a timbre contrasting to the timbre mixture of the other voices.

Any music made audible with these characteristics has orchestral effect. In order to produce orchestral effect by playing on a single manual a suitable keyboard instrument has first to sound with sustained tones; secondly to achieve a volume differentiation of each single voice among the polyphony, i. e. to enable volume control of each single tone by adequate pressure of the coordinate key; thirdly, to produce a variety of timbres in connection with means to make them alternately sound single or in any combination; fourth, to enable a leading voice to sound with a timbre contrasting to the timbre mixture of the other voices.

The present invention comprises a photo-electric musical instrument which complies with the above stated four requirements and produces an orchestral effect with a single keyboard. The operation of the musical instrument embraced by the invention will now be described in detail and with reference to the attached drawings.

In the drawings,

Fig. 1 is a perspective view of the essential parts of the instrument, and

Fig. 2 shows a couple of tone discs equipped with screens in conformity with this invention.

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In my Patent No. 1,778,374 I have already described a photo-electric keyboard instrument which fulfills two conditions of orchestral effect creation; it produces sustained tones and enables volume control of each tone by key pressure. The same method and means are used in the present invention describing the additional devices which realize the compliance with the two remaining conditions; those details of the instrument which are disclosed in my former patent have been omitted, as they do not contribute to a better understanding of my improved instrument.

The motor driven shaft 1 rotates tone discs 5 and 6 of which twelve are actually provided, but not shown, with varying speed. The rotation of each couple is effected by means of belt 2 driven over pulleys 3 and 4. The change of speed is effected by a change of the size of pulley 3. Twelve of these pulleys, not shown in the drawing, are provided, one for each couple of tone discs; the diameters of these pulleys increase at the same ratio as the frequencies of the twelve consecutive notes within a chromatic octave.

In the drawing only one tone disc couple is shown; the other eleven tone disc couples are equally constructed and arranged, as hereafter described in connection with the one shown. The tone disc couple 5 and 6, the row of glow lamps 7 situated in the middle between the tone disc and the photo-sensitive cells 8 and 9 located at the outer sides of the tone discs are combined in a group which I have already described in my Patent No. 1,977,095 as a means for getting one and the same photo-electrically generated note sounding in one of two different timbres or in a mixture thereof. A keyboard instrument built on the principles of the above referred to patent fulfills the first two conditions of producing orchestral effect, but the third insufficiently, and the fourth not at all. The invention eliminates these shortcomings of my prior invention in the following way.

Each tone disc contains instead of one, at least two sound tracks. The light beams of each glow lamp penetrate the two sound tracks of each tone disc, four sound tracks on both tone discs for one and the same note.

Fig. 2 shows schematically the arrangement of the sound tracks on tone disc 5 and 6 for the same note in four consecutive octaves. The application of multiple sound tracks opens many possibilities of sound track designing which will produce the following timbres. The outer track of each note O will create on disc 5 the specific timbre of the instrument, the inner track of each note S the timbre of stringed instruments on disc 6 the outer track W the timber of wood wind instruments and the inner track B the timber of

brass instruments. In order to concentrate the light beams of each glow lamp on the coordinated four sound tracks each lamp 7 has a filament forming a light line in combination with two optical systems 10 which project the picture of the light line in such a manner that they exactly cover the width of the two coordinate sound tracks. In general any four designs of sound tracks will serve the purpose if they produce four timbres characterized by a different number of harmonics. Accordingly timbre O demands tones without harmonics, timbre W tones poor in harmonics and timbre S and W tones rich in harmonics.

In order to produce one of the two timbres by one tone disc sounding separately means are provided which prevent the light beams from covering both sound tracks. Each tone disc is combined with a sector-shaped, perforated screen 11 which can be turned about an axle 12 into five positions marked I, II, III, IV and V.

I signifies the normal position having a slit throughout the screen which makes the light beams accessible to all sound tracks; each note sounds in a mixture of two timbres.

In position II the screen has as many perforations as to give the light beams of each glowlamp way to penetrate one of the two sound tracks coordinate to each note.

In position III the same number of perforations is so situated as to direct the light beams to the other of the two sound tracks. The photo-sensitive cell 8 responds to the modulated light beams passing through the rotating disc 5, the cell 9 responds to the light beams passing through the rotating disc 6. In Patent No. 1,977,095 I have already described means to connect one of the cells or both together to the input of the amplifier by knee movement. Moving the screens into different positions is also effected by knee movement.

If orchestral effect has to be produced with all its sudden changes of timbres on a single keyboard there is no time available to manually push or pull buttons. The combination of the described tone discs and movable screens and the means to select and mix timbres by a knee movement, described hereinafter, are adapted to effect the third characteristic of orchestral effect. These devices render it possible to play four fundamental timbres in nine combinations, namely,

All screens 11 in position I:
Photo-cell 8 is connected to amplifier—timbre mixture OS
Photo-cell 9 is connected to amplifier—the timbre mixture WB
Both photo-cells are connected to amplifier—timbre mixture OSWB

All screens in position II:
Photo-cell 8 is connected to amplifier—timbre S
Photo-cell 9 is connected to amplifier—timbre B
Both photo-cells are connected to amplifier—timbre mixture SB

All screens in position III:
Photo-cell 8 is connected to amplifier—timbre O
Photo-cell 9 is connected to amplifier—timbre W
Both photo-cells are connected to amplifier—timbre mixture OW.

In position I, II and III the screen perforations are distributed in such a manner that the light beams of all glow lamps are alike directed to the same sound tracks; thus all notes over the entire keyboard sound with the same chosen timbre.

In position IV and V the screen perforations direct the light beams of some glow lamps to one sound track and of other glow lamps to another sound track; thus some notes of the keyboard sound with one and some other notes with another chosen timbre. This selectiveness renders the instrument capable to meet with the fourth characteristic of orchestral effect, i. e. to stress a leading voice by a timbre contrasting to the timbre mixture of the other voices.

A standard keyboard usually comprises at least seven octaves. A leading voice can sound in any octave. Theoretically a pattern for the distribution of perforations can be designed which makes one of the four fundamental timbres the timbre of the leading voice, sounding in only one chosen octave, whereas the other octaves sound in contrasting timbre mixture. Practically two patterns will be sufficient, one which enables stressing a leading voice in treble and another one which allows the stress of a leading voice in bass.

The screen 11 at the side of the tone disc 5 shows in position IV a slit extended over the four inner sound tracks (timbre mixture in bass) and two perforations for the sound tracks S (leading voice in treble) and in position V the same slit and two perforations for the sound tracks O. The screen 11 at the side of tone disc 6 shows in position V a slit extended over the four outer sound tracks (timbre mixture in treble) and two perforations for the sound tracks B (leading voice in bass) in position V the same slit and two perforations for the sound tracks W. By these positions six timbre combinations are added to the nine timbres and timbre mixtures enumerated above. Therefore, the player has to effect the control of fifteen possibilities of instrumentations. The controlling means are illustrated in Fig. 1.

On the instrument case beneath the keyboard 13 two frames 14 and 15 are arranged, one to be operated and sidewardly moved by the left, the other by the right knee of the player, the frames sliding parallel to the keyboard within a short distance. All axles 12 are operatively connected with frame 14 by a device which converts the sliding movement of the frame 14 into a rotation of the screens 11. These movements are controlled in such a manner that all screens 11 stay in position V when frame 14 reaches its left end position, and all screens 14 stay in position III when frame 14 reaches its right end position. Three catch springs properly distributed along the path which the frame travels from the left to the right end position denote the points where the screens 11 assume position IV, I or II.

Frame 15 activates either tone disc 5 or tone disc 6 or both together by connecting photo-cell 8 or 9 or both with the amplifier 16 and the speaker 17.

Connecting and disconnecting the high voltage generally used with photo-sensitive cells causes clicks which must be eliminated with a musical instrument; this can be effected by known methods. The above described method secures noiselessness and undistorted timbres. The twelve photo-sensitive cells 8 connected in parallel and the twelve cells 9 connected in parallel are each located in a separate circuit of the battery 21. The voltage undulations photo-electrically generated in these circuits supply the grid of the first amplifier stage. The circuit of the photo-cell 8 passes a diode 18, the circuit of the photo-cell 9

passes a diode 19. The battery 20 delivers the necessary filament current for the diodes.

When the filament current in one of the diodes is cut off the coordinate photo-cell is disconnected from the amplifier and vice versa connected when the filament current has been turned on. Switching on or off the filaments of the diodes causes no click. Frame 15 has the task to effect this operation by a movement of the knee. The frame 15 is furnished with a device which in one end position of the sliding frame turns off the filament of diode 18 in the other end position the filament of diode 19, whereas in the middle position of the frame both filaments are turned on. Moving the frame 15 by the right knee into three positions enables selecting the timbres generated by the photo-cells 8 and 9 separately or together.

It is also possible to use one tone disc with four sound tracks for the same note instead of using two types of tone discs as described with two sound tracks for the same note. In this case the coordinate screen has to be provided with fifteen rows of differently arranged perforations to be turned by frame movement into fifteen different positions in order to obtain the same number of different timbres and timbre combinations. Moving a sliding frame into fifteen different positions in quick change is not practicable, but it is not difficult to move a sliding frame into three or even five positions. For this reason two types of tone discs are used with the invention.

The photo-electric instrument according to this invention is provided with other customary means, for instance pedals, for volume control, drum sound, sforzando, sustaining notes vibrato devices, and so forth.

I claim:

1. In a photo-electric keyboard instrument means to produce a note sounding in several eligible timbres and mixtures thereof, at least one tone disc having a plurality of concentric sound tracks for producing one and the same note

in several timbres, a photo-sensitive element on one side of said tone disc, a source of light on the other side thereof projecting a light-line across the said sound tracks, a movable sector-shaped screen coordinated to said tone disc, said screen being provided with a center slot extending radially over the entire width of the sound tracks to make the light-line accessible to all sound tracks and radially extending rows of perforations located on both sides of said center slot to make part of the light-line accessible to selected sound tracks.

2. In a photo-electric keyboard instrument means to produce a note sounding in several eligible timbres and mixtures thereof, at least two cooperatively coupled tone discs each having a plurality of concentric sound tracks, photo-sensitive elements on the one side of said tone discs and a source of light to project a light-line across the said sound tracks of each disc, sector-shaped screens coordinated to each of said tone discs, said screens being provided with a center slot extending radially over the entire width of the said sound tracks to make the light-line accessible to all sound tracks and radially extending rows of perforations located on both sides of said center slot to make part of the light-line accessible to selected sound tracks, an amplifier and means to alternately connect said photo-sensitive elements with said amplifier.

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