

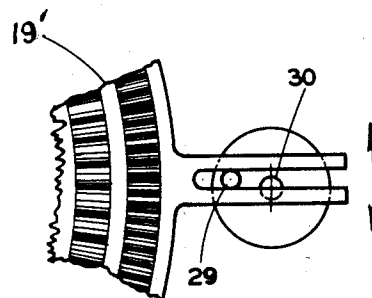
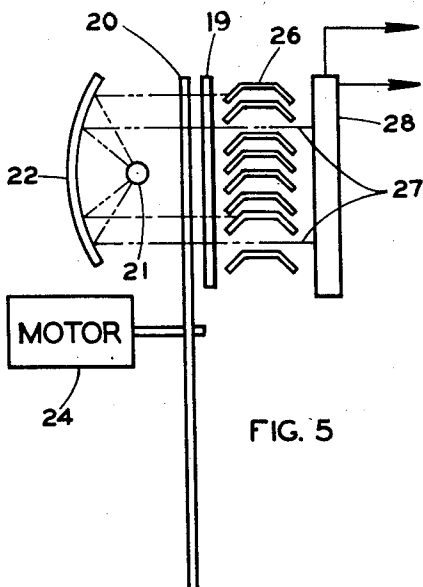
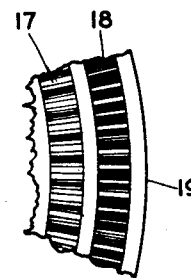
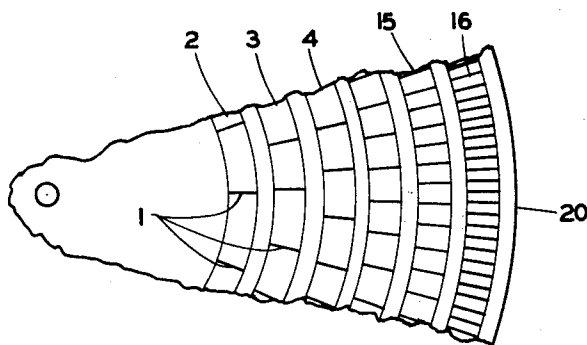
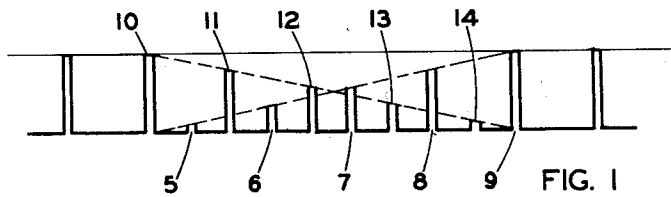
Jan. 7, 1958

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2,819,409

PHOTO-ELECTRIC TONE GENERATOR

Filed Jan. 23, 1951



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2,819,409

PHOTO-ELECTRIC TONE GENERATOR

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Application January 23, 1951, Serial No. 207,286

8 Claims. (Cl. 250—233)

This invention relates to improvements in photo-electric type tone generators in general, and more particularly to those of the type described in my United States Patent No. 2,588,680, granted March 11, 1952.

The type of musical instrument described therein consists of a light source separated from a light-sensitive cell by a tone screen cycling at a natural vibrato rate (about 7 C. P. S.) or sub-multiple thereof. The nature of this screen, which may be in the form of a disc, belt, or cylinder, is such that it varies the light transmitted from the source to the cell in accordance with desired tones or pitches. Opaque shutters controllably masking endless soundtracks inscribed on the screen provide a means of selecting the tone or tones desired, each sound track representing a basic tone. The soundtracks are provided with a representative tone color as well as pitch, so substitution of tone screens can provide changes in both.

The invention disclosed herein provides a permanent cycling pitch screen primarily controlling pitch only, the tone color being provided by a relatively stationary tone color mask which is easily adjusted to vary tone color without removing the tone or pitch screens.

Again, means are described for introducing a frequency vibrato into the tones produced by this type of instrument, which consists of applying an oscillatory motion to a tone color mask.

In addition, means are shown for producing rotating scanning slits of exact relative pitches on a single cycling member of a basic frequency not factorial to the pitches desired.

The foregoing and other objects will manifest themselves as the following description progresses, references being had to the accompanying drawings, in which:

Fig. 1 is an out-of-phase joining of a pulse train of predetermined wave length;

Fig. 2 is a variable density soundtrack recorded from the waveform of Fig. 1;

Fig. 3 is a portion of a pitch screen, showing radial nature and location of the scanning slits;

Fig. 4 is a segment of a typical tone color mask;

Fig. 5 is an assembly capable of producing tones in accordance with pitch wheel and tone mask criteria; and

Fig. 6 is an apparatus for introducing frequency vibrato by tone mask oscillation.

In order to produce an accurate pitch photo-electrically it is necessary to provide means to pulse a light beam a precise number of times each second, the recurrence rate being determined by the frequency of the pitch desired. If a screen, such as that of Fig. 3, had inscribed in it a series of transparent slits 1, and were rotated before a light source, the light would penetrate the screen in a pulsed manner, and the recurrence of the pulses would be dependent upon the cycling rate of the screen together with the number of slits circumferentially placed in it. Unfortunately, where a number of predetermined pitches are desired on discrete endless soundtracks 2, 3 and 4 inscribed on a single rotating screen 20, certain of the endless soundtracks 2, 3, and 4 have phase dis-

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crepancies at the start-end spots, because the cycling speed of the pitch screen 20 cannot normally be a sub-multiple of every pitch desired. If a pitch screen is slowed sufficiently to closely approximate a common sub-multiple, serious difficulty is encountered with speed variations and slit generation.

A simple, but effective remedy for this difficulty is to operate the pitch screen at a natural vibrato rate (about 7 C. P. S.) or a sub-multiple thereof as explained in my U. S. Patent 2,588,680, above referred to. At the start-end spots a procedure such as that graphically shown in Fig. 1 can be used. Here the graph can be considered that of a series of light-producing pulses of predetermined recurrence. The pulses can be considered starting gradually from pulse 5 through 6, 7, and 8 to full amplitude at pulse 9. The pulses then continue at full amplitude to the right, but return eventually from the left after having made a cycle of the tone screen. It will be noticed that pulse 10 which should coincide with the starting pulse 5 is out of phase. The returning pulse series, although out of phase with its start, is caused to decline in amplitude as shown by the pulses 11, 12, 13, and 14, to form a merging overlap.

If these pulses were applied to a light-producing device, and a variable density soundtrack were recorded from it, the overlapped start-end spot shown in Fig. 2 would result. Provided the start-end spot shown were caused to pass a light source at a natural vibrato rate, any discrepancy it could cause would be acceptable to the human ear as a vibrato manifestation. Although a slit-width variation is shown in Fig. 2, it is to be understood that slit density or length variation can be obtained with certain light-producing devices, and that either will function in an essentially similar manner. Methods of actual generation are described in detail in my United States patent application, Serial No. 157,390, filed April 21, 1950.

To cause the start-end spot scanning to recur at a vibrato rate, it is merely necessary to cycle the pitch screen at this rate. Under such operation, exact relative slit frequencies can be used on a single cycling pitch screen.

It must be emphasized that the endless slit train described in detail above is primarily to produce pitches, not tones. Although a tone would be produced by the scan of the pitch screen, it would be extremely acute and undesirable as such. In order to convert the light pulses to those of a pleasing tone color, the cycling pitch screen 20 of Fig. 3 can be masked by a relatively stationary tone screen such as that of Fig. 4. The tone screen 19 is superimposed in stationary fashion over the cycling pitch screen 20 in such manner that the pitch track 15, in Fig. 3, is masked by the tone track 17 in Fig. 4; and the pitch track 16, in Fig. 3, is masked by the tone track 18 in Fig. 4. The basic wave lengths of corresponding tracks are identical, so the tone waveform recorded on the tone tracks 17 and 18 in Fig. 4 serves to vary the light penetrating both screens in accordance with the tone waveform on the stationary tone screen 19. Because the tone screen is relatively stationary, it is comparatively easy to change the tone color while the instrument is operating, for it is necessary only to change tone screen masks. For this purpose the tone screen 19 is made adjustable in a manner which will bring various tone color tracks into operation when desired.

The entire mechanism, then, consists of the assembly shown in Fig. 5 in which a light source 21 with collimating device 22 projects light through a cycling pitch screen 20 driven by suitable means 24. The light continues in a scanning manner through a relatively stationary tone screen 19. Manually operated shutters 26 admit selected tone beams 27 to a light-sensitive cell 28. The voltage

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output from the cell is changed to sound by conventional means such as an amplifier and loudspeaker. Normally the shutters 26 will be connected to keys on a keyboard operable by a musician, and the tone screen 19 will be adjusted for various tone colors by means of manually operated stops.

If desired, a frequency vibrato can be added to the tones produced by the device of Fig. 5 by applying an oscillatory motion at the vibrato rate to the tone screen 19. While the tone screen 19 moves in the direction of movement of the pitch screen 20 the pitch of the tone produced is lowered, while opposing motion raises the effective pitch. The reason for this is that while the motions of the pitch screen 20 and the tone screen 19 are in the same direction, it takes longer for a scanning slit to traverse a tone waveform. This is equivalent to scanning a longer wave length, or a lower pitch. The reverse occurs during opposing motion. A variation above and below pitch at a rate of about seven times a second is a very pleasing frequency vibrato if the deviation is approximately plus and minus 2% in pitch.

An apparatus of obtaining the oscillatory motion, and therefore, the frequency vibrato, is shown in Fig. 6. Here the tone screen 19' is given a reciprocating motion by means of a crank stud 29 eccentrically fixed to a shaft 30 rotating at a vibrato rate. The percentage of vibrato deviation is determined by the distance from the stud 29 to the vibrato shaft 30. The vibrato rate is determined by the vibrato shaft 30 speed.

Although an eccentric crank is one of the simplest methods of obtaining the oscillatory motion necessary, it is to be realized that many methods of obtaining reciprocating motion are well known and would prove applicable. I therefore wish to include within the scope of my claims any such equivalent construction as will produce similar results in essentially the same manner.

What is claimed is:

1. A photo-electric tone generator having a light source, a light-sensitive cell, and a pitch screen having an endless series of transparent slits having a start-end region and a corresponding tone screen having an optical waveform for being scanned by said slits, means mounting said pitch screen and said tone screen with said series of slits and said soundtrack in a scanning beam path in optical alignment between said source and said cell, drive means connected to said pitch screen and adapted to cycle said series of slits past said beam path at a natural vibrato rate in a waveform scanning direction, and drive means for said tone screen adapted to oscillate said waveform in said direction at said vibrato rate.

2. A photo-electric tone generator having a light source, a light-sensitive cell, a pitch screen comprising a series of transparent slits, and a corresponding tone screen having an optical waveform scanned by said slits, means mounting said pitch screen and said tone screen in a scanning beam path in optical alignment between said source and said cell, said pitch screen being mounted for driven movement of said series of slits in a scanning direction through said path during scanning operation, said tone screen being mounted for relative retention of said waveform in said path during scanning operation, and drive means connected to said screens and adapted to impart a scanning relative movement thereto in said direction, said drive means including automatic means for imparting an oscillating movement in said direction at a natural vibrato rate to said tone screen.

3. A photo-electric tone generator having a light source, a light-sensitive cell, and a pitch screen having a series of transparent slits and a corresponding tone screen having an optical soundtrack scanned by said slits, means mounting said pitch screen and said tone screen with said series of slits and said soundtrack in a scanning beam path in optical alignment between said source and said cell, first drive means adapted to move said pitch screen series of slits through said beam path at a constant

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speed in a tone screen scanning direction, and second drive means adapted to impart an oscillatory movement to said tone screen and said soundtrack in said beam path in said scanning direction at a natural vibrato rate.

4. The method of introducing frequency vibrato into the tones produced by a photo-electric tone generator having a soundtrack and scanning means for said soundtrack having a movingly mounted scanning part and comprising a light source and a light-sensitive cell mounted in optical alignment with said soundtrack, which consists of oscillating said soundtrack at a vibrato rate in the direction of movement of the movement of said scanning part.

5. A photo-electric tone generator having a light source, a light-sensitive cell, and a pitch screen having an endless series of transparent slits having one or more regions of sequential slit variations and a corresponding tone screen having an optical soundtrack for being scanned by said slits, means mounting said pitch screen and said tone screen with said series of slits and said soundtrack in a scanning beam path in optical alignment between said source and said cell, drive means connected to said pitch screen and adapted to cycle said series of slits past said beam path at a natural vibrato rate divided by the number of such regions of sequential slit variations in a direction for scanning said soundtrack, and drive means for said tone screen adapted to oscillate said soundtrack in said direction at a natural vibrato rate.

6. A photo-electric tone generator having a light source, a light-sensitive cell, a tone screen having an optical waveform soundtrack, and a pitch screen having an endless pitch track for scanning said soundtrack, said pitch track comprising a series of transparent slits having one or more regions of sequential slit variations, at least one of said variations being a slit spacing discrepancy at a start-end area in the slit series, said pitch track at said start-end area comprising attenuated slits of two groups spaced in order respectively from the slits at each side of said area with the two groups run into each other in interleaved fashion, means mounting said pitch screen and said tone screen with said pitch track and said soundtrack in optical alignment in a scanning beam path between said source and said cell, and drive means connected to said pitch screen and adapted to cycle said pitch track past said beam path at a natural vibrato rate divided by the number of such regions of sequential slit variations.

7. A photo-electric tone generator having a light source, a light-sensitive cell, a tone screen having an optical waveform sound track, and a pitch screen having an endless pitch track for scanning said soundtrack, said pitch track comprising a series of transparent slits having one or more regions of sequential slit variations, at least one of said variations being a slit spacing discrepancy at a start-end area in the slit series, said pitch track at said start-end area comprising slits of two groups spaced in order respectively from the slits at each side of said area with the two groups run into each other in interleaved fashion, means mounting said pitch screen and said tone screen with said pitch track and said soundtrack in optical alignment in a scanning beam path between said source and said cell, and drive means connected to said pitch screen and adapted to cycle said pitch track past said beam path at a natural vibrato rate divided by the number of such regions of sequential slit variations.

8. A photo-electric tone generator having a light source, a light-sensitive cell, a tone screen having an optical waveform soundtrack, and a pitch screen having an endless pitch track for scanning said soundtrack, said pitch track comprising a series of transparent slits having one or more regions of sequential slit variations, at least one of said variations being a slit spacing discrepancy at a start-end area in the slit series, said pitch track at said start-end area comprising attenuated slits of two groups spaced in order respectively from the slits at each side of said area, means mounting said pitch screen and said

tone screen with said pitch track and said soundtrack in optical alignment in a scanning beam path between said source and said cell, and drive means connected to said pitch screen and adapted to cycle said pitch track past said beam path at a natural vibrato rate divided by the number of such regions of sequential slit variations.

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