Oct. 16, 1934. E. SPIELMANN 1,977,095

PHOTO-ELECTRIC MUSICAL INSTRUMENT

Filed July 23, 1931 2 Sheets-Sheet 1

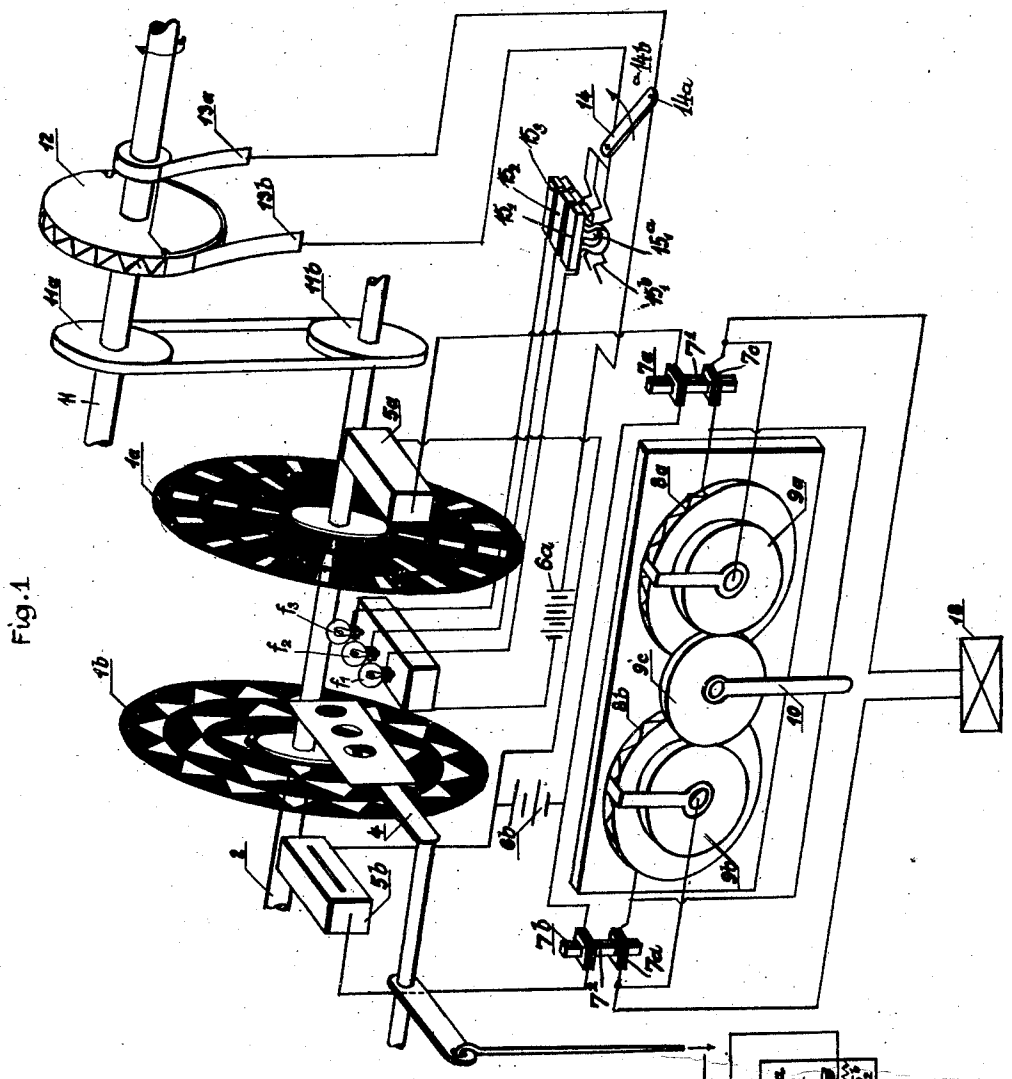

Fig. 1

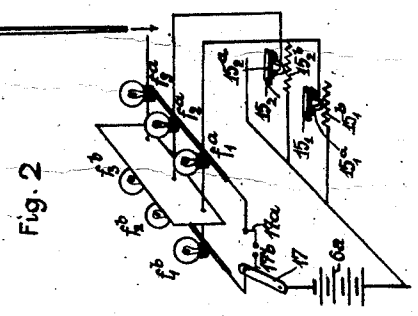

Fig. 2

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Fig. 3

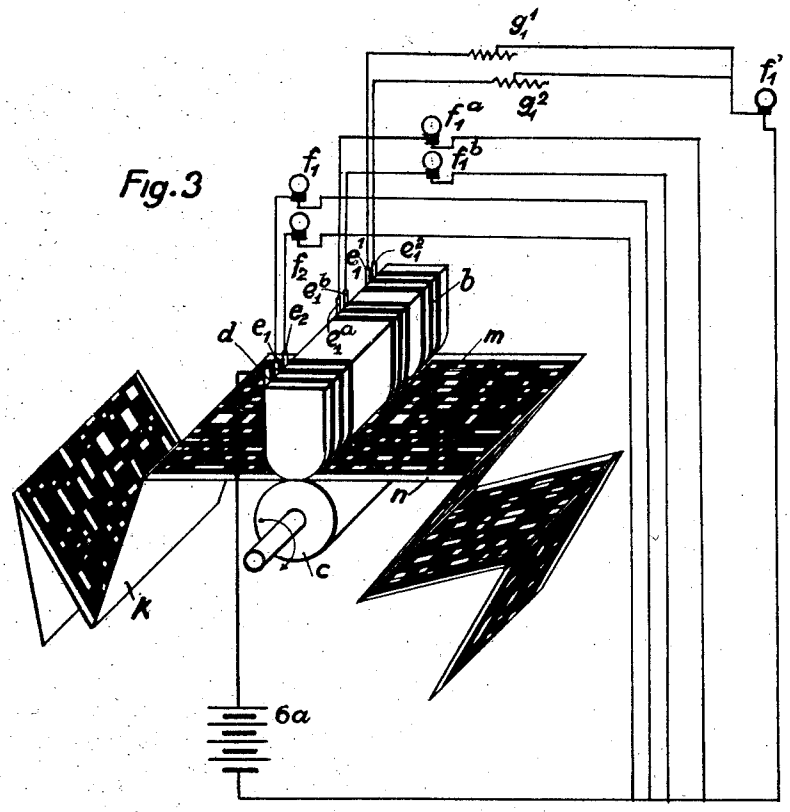


Fig. 4

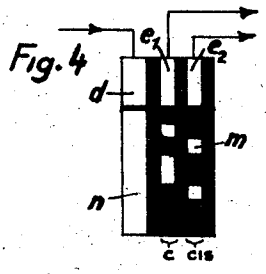
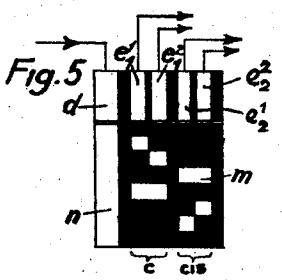


Fig. 5



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UNITED STATES PATENT OFFICE

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PHOTO-ELECTRIC MUSICAL INSTRUMENT

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7 Claims. (Cl. 84—1)

This invention relates to the photo-electric musical instruments of the type described in U. S. Patent No. 1,778,374 and comprises improvements in these instruments.

In these musical instruments the sounds from which are given out through loud speakers or the like to which exciting currents modulated at audible frequency are supplied, the audible frequency modulation is effected by means of rotating circular discs of opaque material in which, preferably in several zones, at regular intervals apertures or the like are provided which are allowed to co-operate as screens with beams of light which are projected from light sources controlled by operating a keyboard to a photo-electric cell. The pitch is then obtained simply from the speed of rotation of each disc and the number of regularly arranged apertures for the annular zone in question. What is commonly referred to as the tone colour of a sound depends on the form or shape of the apertures, which form or shape, therefore, will be shortly referred to in the following as "tone figure". Hitherto, in order to meet the requirements of a variation of tone colour with such musical instruments, several rotating screens or discs with the same tone sequences and differently shaped apertures or the like have been used to be selectively operated as desired. In such electrical musical instruments, moreover, special arrangements are required in order to select and make use of any one of the rotating members, of which there is always a large number. The construction of such electrical musical instruments is obviously complicated and it has also been found to be a disadvantage that even when numerous rotating members are used for each tone sequence the tone colour can only be varied in steps.

The present invention comprises an improved arrangement of such musical instruments, which makes possible quite satisfactory playing and controlling thereof. The arrangement according to the invention consists in this that for automatic playing of photo-electric musical instruments, the circuit of the light source for each tone of this instrument, or the illumination for each tone, is automatically preferably electrically switched on or made effective by one or more contacts or the like for the tone in question being actuated for the period during which the tone is to be sounded by a member which is moved, and is provided with counter contacts arranged according to the tones to be played. In a preferred form of the invention several contacts are provided for each tone which produce different intensities of light or of illumination, or also different sound effects, and which can be operated separately or in different combinations so that the same tone can be produced at different strengths or with different tone quality.

The invention also consists in the manufacture of note bands for automatic playing of photo-electric musical instruments, in which on paper strips or the like provided with a conducting coating, non-conducting surfaces are applied by printing with insulating colours, varnish or the like.

The invention also consists in the variation of the tone quality in photo-electric musical instruments by the introduction of screens which allow the rays from the light source for a particular tone to reach the photo-electric cell either only through the openings or the like of the annular zone of the rotating circular disc corresponding to this tone, or also through the openings of one or several or all of the other annular zones of the same disc.

The invention also consists in the production of a tremolo or vibrato of the tone or sound by periodically interrupting or weakening the light or cell current, for example, by interposing a rotating interrupter or resistance. The tremolo can also be produced automatically by means of a contact space on the automatic playing device provided with suitable interrupting strips, or by constructing one of the resistances of the automatic playing device for regulating the intensity of the sound as rotating interrupter or resistance.

The invention also consists in a device for continuous variation of the tone colour of the sounds to be produced in photo-electric musical instruments, in which at least two synchronously rotating circular discs of opaque material, have their effective zones in the path of beams of light going from a light source to a photo-electric cell, and their corresponding zones have the same number of apertures as operative elements in uniform division, and the shape of the aperture in one disc is different from the shape of apertures in the other disc, and the currents produced by these discs of equal frequency and different modulation are supplied to the reproducing device (loud speaker) which is to be excited by them together, through devices for altering their relative strengths at will between predetermined limiting values.

All the parts which are essential for understanding the invention are illustrated diagrammatically in the accompanying drawings.

Fig. 1 is a diagrammatical perspective view of the whole arrangement with keyboard.

Fig. 2 shows diagrammatically in perspective a part of the arrangement in the case in which sound is to be produced with one or with the other tone colour.

Fig. 3 shows diagrammatically in perspective an arrangement for automatic play of a photo-electric musical instrument, and in the front part shows the contact arrangement in the fundamental simple constructional form, while the rear part shows how the arrangement for varying the sound intensity is used, and the middle part shows how it is employed for varying the tone character of the sounds to be produced. Figs. 4 and 5 are diagrammatic sketches for illustrating the co-operation of the contact arrangement of the first or the second and third constructional forms of Fig. 3.

The two synchronously rotating members 1*a* and 1*b* in Fig. 1 are secured to the shaft 2, and each have in their corresponding annular zones regularly arranged apertures in the same number and different shape, that is, different "tone figure". In the constructional example illustrated, the rotating members are discs of which one contains in three annular zones 16, 8 and 4 triangular, and the other in the corresponding annular zones the same number of elongated holes. With these holes the two rotatable discs 1*a* and 1*b* project into the path of beams of light coming from incandescent lamps *f*1, *f*2, *f*3, if necessary through screens 4 to photo-electric cells 5*a*, 5*b*, which thus are intermittently illuminated when the discs 1*a* and 1*b* rotate. The source of current 6*b* is arranged in common to both photo-electric cells 5*a* and 5*b*, and for each of these photo-electric cells is also arranged the primary winding 7*a* or 7*b* of a transformer 7^1 or 7^2. The secondary windings 7*c*, 7*d* of these two transformers are connected in series and the secondary winding 7*c* is shunted by the regulable resistance 8*a* and the secondary winding 7*d* by the regulable resistance 8*b*. Further, the free ends of the secondary windings 7*c* and 7*d* are connected with the input terminals of an amplifier 18 interposed before the load speaker (not illustrated) of the photo-electric musical instrument.

The regulable resistances 8*a* and 8*b* have a large maximum value and are constructed as sliding contact resistances with rotatable sliding contact arms. The sliding contact arm of the resistance 8*a* is rigidly connected with a toothed wheel 9*a*, and the sliding arm of the resistance 8*b* with a toothed wheel 9*b*. The toothed wheels 9*a* and 9*b* engage with a third toothed wheel 9*c* which is rigidly connected with an operative lever 10. The arrangement is such that the resistances 8*a* and 8*b* are varied in opposite directions without altering the sum of their effective values, that is, in the limiting position of the lever 10 either one or other of the two resistances is used at its maximum value.

In playing the diagrammatically illustrated photo-electric musical instrument by pressure on the keys of the keyboard 15_1, 15_2, 15_3 etc., the desired light source *f*1, *f*2 etc. can be brought into operation. In this case its light always falls together on the effective zones of the two rotating perforated discs 1*a* and 1*b* which thus act as screens, a sound being generated, the tone colour of which is a mixture of two different tone colours. In this way the shape of the apertures in the effective zones of the rotating discs 1*a* and 1*b*, as already mentioned above, may also be referred to as "tone figure". By adjusting the lever 10 the relative strengths of the individual currents supplied to the amplifier 18 from the secondary winding 7*c* and 7*d* and thereby also the total tone colour can be varied as a result of the proportions of the tone colour components produced by the individual rotating discs or their apertures. Experience has shown that such a variation is recognized by the human ear as a constant tone colour variation.

In Fig. 1 also the variation of the tone character in photo-electric musical instruments by the co-operation of screens is illustrated. If, for example, the light source f_1 is switched on by pressing the key 15_1 or the like, its light passes mainly through the sixteen apertures or the like of the outer annular zone which lies nearest to it of the disc 1*b* on to the selenium cell or the like 5*b*, but its light also passes through the inner zones of the disc 1*b* with eight or four openings to the cell 5*b*, so that in the tone or sound produced also the tones corresponding to these zones are heard in the example chosen, that is, tones of a half and a quarter of the frequency of the tone of the marginal zone. If a screen 4 is provided according to the position and size of its holes, the inner zones will be more or less or wholly screened from the light source, for example, f_1, so that the tone character of the tone or sound produced is correspondingly altered.

In order to produce a tremolo or vibrato of the tone or sound by moving the switch 14 from the contact 14*a* to the contact 14*b*, a rotating interrupter or/resistance 12, which is driven from the same shaft 11 as the discs 1*a* and 1*b*, is interposed in the circuit of the lamp, for example f_1, concerned, so that the current supplied from the battery 6*a* is periodically interrupted or weakened, the result of which is a tremolo in the tone produced.

In Fig. 2, two rows of lamps f_1^a, f_2^a etc. and f_1^b, f_2^b etc. separated by an opaque partition 16 are provided, of which the one row f_1^a, f_2^a etc. corresponds to the disc 1*a*, and the cell 5*a* and the other row to the disc 1*b* and the cell 5*b*. By pressing the key 15, the corresponding tone or sound is produced either with the tone figures of the disc 1*a*, or with those of the disc 1*b*, according to whether the switch 17 is turned to the contact 17*a* or 17*b*. If the switch 17 is placed in the middle between the contacts 17*a* and 17*b* and is pressed down on to the lower parts of these contacts, both lamps f_1^a and f_1^b are switched on at the same time when the key 15_1 is pressed and the sound is produced simultaneously with both tone colours.

In the case of Fig. 1, as well as in that of Fig. 2, the sound produced can be varied in strength by the key 15_1 making contact with a resistance 15_1^b by means of a spring 15_1^a, more of the resistance being short circuited when the key is pressed down more strongly so that when the key is pressed more strongly the current in the lamp circuit, and thereby the sound produced, is strengthened.

Figs. 3 to 5 illustrate the automatic playing of a photo-electric musical instrument according to the invention.

In Fig. 3 the light source f_1, f_2 and the like for the different sounds of the photo-electric musical instrument to be played automatically are arranged in circuits, preferably supplied from a single battery 6*a* which leads on one side to a contact *d* and on the other side to a contact

e_1, e_2 etc. The contacts d, e_1, e_2 and so on in the constructional example illustrated, are formed by discs or strips separated from one another by insulated layers which form a comb-like contact block. The closing of the contacts d—e_1, d—e_2 etc. for producing the sound is effected by means of a band k, which can be rolled up or folded together and moved under the contact block which is pressed against the contact block by a roller c of preferably elastic material. This band k consists of a conductive material, or at least a material which is conductive on its surface, for example of so-called silver paper, and is covered on this surface with an insulating layer with the exception of its marginal strips n and the parts m which are arranged according to the sounds to be produced; so that when such a part m passes under the appropriate contact, for example e_2 the circuit of the light source for example the lamp f_2 is closed by the conducting bridge n—m of the band k over the contacts d, e, as is readily seen from Fig. 4 which shows a diagram of the contact arrangement for two tones, for example c and c sharp.

In the constructional example illustrated in the rear part of Fig. 2, two contacts e_1^1 and e_1^2, e_2^1 and e_2^2 etc. are provided for each sound. Each of the two contacts of each sound, for example e_1^1 and e_1^2 is connected with the light source, for example the lamp f_1 for the sound in question through a resistance of different size g_1^1 or g_1^2, so that according to whether the light source circuit for the tone concerned is closed through the contact e_1^1 or e_1^2, the light source acts with less or greater strength of light and consequently also the corresponding sound is produced with less or greater intensity. With a suitably broader contact space m on the band k, both contacts e_1^1 and e_1^2 would be connected simultaneously, in which case on account of the further change of resistance in the light source circuit, a corresponding further alteration of the sound intensity is obtained, as is shown diagrammatically in Fig. 5. The number of contacts arranged for each individual sound with different resistances can of course be increased as desired, and thereby the number of the resistance combinations obtainable in the light source circuit can be increased as desired so that there is a very large possibility of varying the intensity of the sound produced.

In the constructional form illustrated in the middle part of Fig. 3, two contacts e_1^a and e_1^b, e_2^a, e_2^b etc. are provided for each sound. Each of the two contacts of each sound, for example e_1^a and e_1^b is connected with the battery $6a$ through a lamp of the series f_1^a, f_2^a etc. and f_1^b, f_2^b etc., for example f_1^a and f_1^b, so that according to whether the light source circuit for the sound in question is closed through the contact e_1^a or e_1^b, the one or the other light source is switched on and consequently one disc $1a$ or the other $1b$ comes into operation and thereby also the corresponding sound is produced with the one or the other tone colour. With a suitably appropriate contact place m on the band k, both contacts e_1^a and e_1^b can be connected simultaneously, so that the sound concerned can be produced at the same time with the two tone colours corresponding to the different tone colours of the disc $1a$ and $1b$, as is illustrated diagrammatically in Fig. 5 for the contacts e_1^1 and e_1^2, e_2^1 and e_2^2 etc. The number of the contacts provided for each individual sound with the various corresponding lamps and sound discs, can of course be increased as desired and thereby the number of obtainable tone combinations can be increased as desired, so that a very large variability of the tone character of the sounds to be played, that is, a plentiful instrumentation is made possible.

By means of the arrangement for automatically playing photo electric musical instruments the above mentioned tremolo or vibrato of the sound may also be produced automatically according to the indications on the note band, either by the appropriate contact space m being provided with a suitable number of interrupting strips, or by one of the resistances g_1^1, g_1^2 etc. being constructed as a rotating interrupter or rotating resistance like the resistance 12 in Fig. 1.

What I claim is:

1. A photo-electric musical instrument having at least two synchronously rotating circular discs of opaque material, annular zones of perforations in the discs, sources of light, photo-electric cells which the light reaches after passing through the discs, the discs having in their corresponding annular zones the same number of apertures in uniform distribution, and the shape of the apertures in each disc being different from that in the other discs, and means for supplying the currents of equal frequency and different modulation produced by these discs to a reproducing device which is to be excited by them together, and, at the same time, varying their relative intensities within predetermined limits for the purpose for varying the tone colour of the sounds to be produced.

2. A photo-electric musical instrument as claimed in claim 1, in which the means for varying the relative intensities of the differently modulated exciting currents of the reproducing device comprises at least two transformers with their secondaries connected in series, and a regulable resistance connected across each secondary winding.

3. A photo-electric musical instrument as claimed in claim 1, in which the means for varying the relative strengths of the differently modulated exciting currents of the reproducing device comprise at least two transformers with their secondaries connected in series, and regulable resistances connected across the secondary windings, the movable parts of the regulable resistances being connected together in a force-closed manner.

4. A photo-electric musical instrument as claimed in claim 1, in which the means for varying the relative intensities of the differently modulated exciting currents of the reproducing device comprises at least two transformers with their secondaries connected in series, and a regulable resistance connected across each secondary winding, having rotatable sliding contact arms on the regulable resistances, a toothed wheel rigidly connected with each sliding contact arm, and a toothed wheel secured to the adjusting lever engaging with the other toothed wheels.

5. A photo-electric musical instrument as claimed in claim 1, in which the means for varying the relative intensities of the differently modulated exciting currents of the reproducing device comprises at least two transformers with their secondaries connected in series, and a regulable resistance connected across each secondary winding, the resistance being variable together in opposite directions without altering the sum of their effective values.

6. A photo-electric musical instrument an individual light individually operatable for each sound, rotating discs with annular zones of perfo-

rations, the number of perforations in each zone differing from those of its neighboring zone as multiples of two characterized in that there is arranged between lights and perforated discs a movable geared screen which, when engaged, will direct the light of any light only upon one annular zone, while permitting the light to strike all annular zones when disengaged.

7. A photo-electric musical instrument as claimed in claim 1 having for each sound a separate electric lamp which is separately operated, an electric circuit for said lamp, means to close said circuit to light said lamp, and means in said circuit for varying the intensity of light from said lamp.

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