Oct. 14, 1930. E. SPIELMANN 1,778,374

ELECTRIC MUSIC INSTRUMENT

Filed Feb. 8, 1928

FIG. 1.

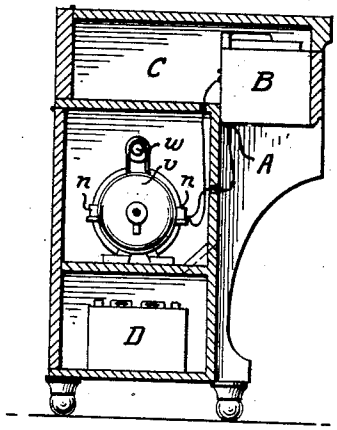


FIG. 2.

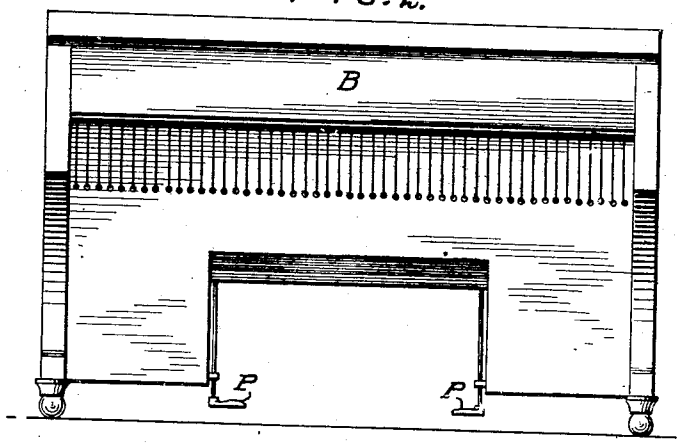


FIG 3

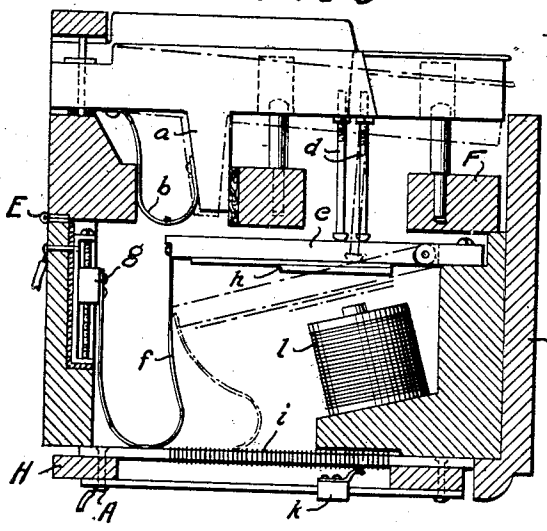


FIG. 4.

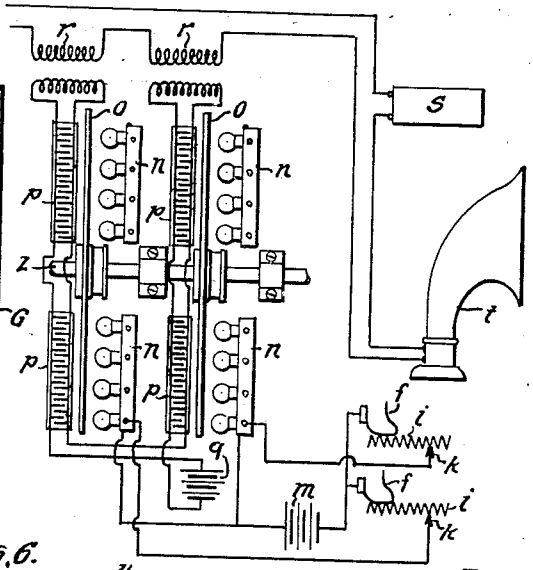


FIG. 5.

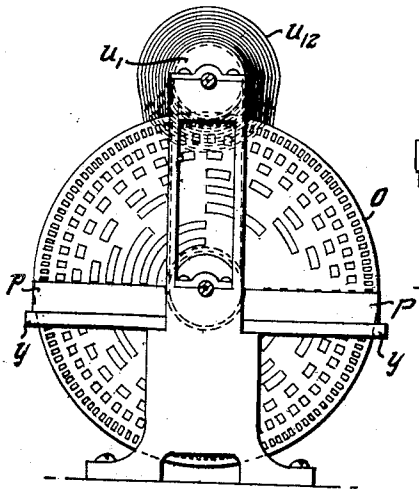
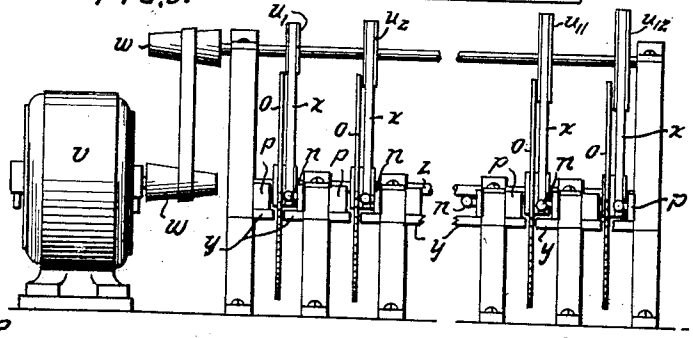


FIG. 6.



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ELECTRIC MUSIC INSTRUMENT

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This invention relates to an electric music instrument in which the current impulses acting onto a telephone receiver (loud speaker) are produced by intermittently exposing to light at sound frequencies of photoelectric cells by means of slotted rotating screens. Such music instruments with release of sounds by a key board have already been suggested but were not fit for artificial purposes since they did not admit tuning of the notes or equalizing the same.

According to this invention the tuning of the notes to arbitrary irrational frequency relations is effected (as f. i. necessitated by the key board of an instrument the octaves of which are as usual subdivided into twelve half-notes) in that each half-note of the gamut of an octave is produced by a separately driven rotating screen commanded f. i. by belt-drives from a common main shaft. By appropriately dimensioning the belt drums any desired speed ratio of the single screens may be obtained which moreover may be corrected if necessary by adjusting the diameters of one or the other drum on turner's lathe.

Since the sound frequencies of the harmonics of a note in the different octaves are in the ratios of the powers of the number two it is a further feature of this invention that all the harmonics of a certain note are produced by one and the same screen which to this purpose bears concentric rows of slots or the like the number of which is doubled from row to row (preferably outwards).

The keys of the music instrument are connected to electric resistances in a manner known as such to partially switch on or off these resistances by more or less pressing down the key and thereby increasing or diminishing the current intensity and consequently the sound intensity. A new feature according to this invention consists in that the efficient length of the resistance means (coils or the like) is regulable by means of a contact slide or the like, so that each note can be regulated individually. Thus it is possible to compensate the unequal light emission of the electric light sources and the unequal sensibility of the photoelectric cells and thereby to obtain equal sound intensity and timbre with all notes and half-notes when equally acted on the respective key.

Further features of the invention will be seen from the following specification and drawings wherein—

Fig. 1 is a side elevation of my electric music instrument, partly in section, Fig. 2 is a front elevation thereof seen from the side of the player. Fig. 3 is a sectional view of the key board mechanism in a side elevation on an enlarged scale as compared with Figs. 1 and 2. Fig. 4 is a diagrammatic view of two of the rotatable screens with adjacent glow lamps and photo-electric cells, showing also the electric connections from the latter to the current sources, loud speaker and key contacts. Fig. 5 is a side elevation and Fig. 6 is a front elevation of the rotatable screens with belt drives and (in Fig. 6 only) of the motor and the master gear. The scale of Figs. 5 and 6 is between that of Figs. 1 and 2 on the one hand and Fig. 3 on the other hand.

In Figs. 1 and 2 A are the flexible current supply lines between the key board B and the glow lamps referred to hereinafter. C is the detachable cover of the music instrument, D is the storage battery serving as source of electric current for the electromotor referred to hereinafter. Parts *n*, *v* and *w* of Fig. 1 will be referred to hereinafter, when describing Figs. 4, 5, and 6. P, P are two pedals for the general regulation of the current intensity for the supply of the glow lamps and for the fixing of the keys which have played on in their low position, respectively.

One of the current supply lines A is also shown in Fig. 3, wherein E, F, G and H are different parts of the key board frame, E being the rear plate, G being the front plate thereof and H being such part of the frame, on which the resistances referred to hereinafter are fixed while part F serves as a rest or stop for the keys. *a* is an extension of the key, *b* is a band spring pressing onto the said extension *a* and onto the part E of the frame. *d* are bolts fixed at the lower

side of the keys. *e* are levers fulcrumed at the key board frame. *f* are band springs connected to the levers *e*, *g* are adjusting screws connected to the springs *f*. *h* are armatures attached at the lower sides of levers *e*. *i* are bare resistance wires, *k* are slide contacts contacting the said resistance wires *i*. *l* are electromagnets arranged opposite the armatures *h* referred to above.

Referring to Fig. 4, *m* is the battery serving as current source for the glow lamps *n*, *o* are rotatable screens, *p* are photoelectric cells, *q* is a storage battery serving as current source for the above photoelectric cells. *r* are low frequency transformers, the secondary coils of which are arranged in the circuit of the valve amplifier *s* and the loud speaker *t*.

In Figs. 5, and 6, u_1, u_2,—u_{11}, u_{12} are pulleys, *v* is an electromotor, *w* are bevelled pulleys of a regulable transmission (master gear), *x* are the belts connecting the pulleys u_1, u_2—to the corresponding pulleys on the discs, *o*, *y* are the supports of the photoelectric cells *p* and the glow lamps *n*, respectively, and *z* are the individual shafts of the different discs *o*.

Hereinafter the different parts of my electric music instrument are described as such as well as their mode of cooperation.

I. Apparatus for the production of a sound frequent intermittent exposure to light of the photoelectric cells

An electromotor *v* (Fig. 6) is connected by means of a regulable transmission *w* to a shaft on which twelve pulleys u_1 to u_{12} are arranged (in the drawing four only being shown). Each of these pulleys makes to rotate by means of a belt *x* one of twelve pulleys preferably of equal diameters each being arranged on a separately fulcrumed shaft *z* and connected to discs *o*, the speed ratios of which corresponds to the twelve sounds of an octave by appropriately dimensioning the pulleys u_1 to u_{12}. The discs *o* are impervious to light. As indicated in Fig. 5 radial slots are provided on eight concentric rings thereon i. e. on the innermost ring one slot, on the second ring two, on the third ring four, and on the following rings always double the number of slots appearing on the preceding one, the outermost ring having 128 slots. Preferably these discs *o* are produced photographically on films, on which the slots appear as translucent strips on a black ground. At both sides of these discs *o* supporting boards *y* are arranged (Fig. 4) on the one side of which eight electric glow lamps *h* are arranged in such a manner that the light of each of these eight lamps passes through a different row of slots of the disc *o*. On the other side of the discs *o* photoelectric cells *p* are arranged opposite to the glow lamps. When the discs *o* rotate each of the glow lamps *n* illuminates the opposite photoelectric cell *p* intermittently with a frequency which differs according to the varying number of slots and the different number of revolutions of the discs: the ratio of intermittence of the glow lamps arranged adjacent one and the same disc is that of one and the same sound in eight succeeding octaves, whilst the ratio of intermittence of the twelve groups of glow lamps is that of the frequencies of the twelve sounds within an octave. By means of this apparatus one may produce light intensity variations corresponding to 84 sounds or eight octaves and the corresponding variations of resistance of the photoelectric cells. Each of these photoelectric cells is connected to a circuit of the battery *q* in series with the primary coils of low frequency transformers *r* the secondary coils of which form part of a circuit in which the loud speaker *t* is arranged besides the valve amplifier *s* (Fig. 4). The variations of resistance in the photoelectric cells which occur when the latter are intermittently exposed to light, produce variations of current force which are transformed into alternating currents and transferred to the circuit of the loud speaker, for conversion into audible sounds.

II. Key board and mechanism

In Fig. 3 an embodiment of the key board and mechanism of the instrument is shown in section. On the frame E F G of the key-board keys are arranged as usual. Each key has on its lower side an extension *a*, which penetrates into a recess of the key board frame. On this extension *a* an **S**-shaped band spring *b* is fixed in such a manner as to force the key into the horizontal position, which is limited by the extension *a* bearing on the key board frame or by the strain of a filament (not shown) the length of which is adjustable by means of screws. At the lower side of each key an adjustable bolt *d* is arranged which transfers the movements of the key (when being played on) onto an one armed lever *e* arranged below each key. To eliminate the difference of angles of motion of the black and white keys the respective adjustable bolts *d* are arranged at different distances from the fulcrums. Every lever *e* is connected with one end of a **V**-shaped band spring *f* the other end of which is connected to adjusting screws *g* which enable the band springs *f* to be lifted or lowered, respectively. The springs *f* bear on insulating strips *i* having bare resistance wires wound thereon, the number of such strips fixed side by side on the frame H being equal to that of the keys. In the state of rest each band spring is adjusted by means of the screw *g* in such a manner as to just not contact with the resistance wires. According to the deepness to

which the key is pressed down when being played on the lever *e* displaces more or less the band spring *f* (see Fig. 3, in dotted lines) so that by the band springs rolling on the respective resistance wire *i* more or less resistance is switched on or off according to the pressure on the key. Each of the band springs is continuously connected to a circuit supplied by the battery *m* and leading from the screw A, slide contact *k*, to the resistance wire *i* and band spring *f*. To each of these circuits one of the above said glow lamps *n* is connected and by means of the arrangement described each glow lamp corresponding to the respective key may be not only switched on and off by pressing down the key but also the intensity of the current supply and thereby the intensity of light thereof may be varied. A particular advantage of the described mechanism is its absolute noiselessness when being acted on, which is an important requirement for each mechanism connected to a music instrument. By means of the slide contact *k* each note can be separately adjusted as to sound intensity and timbre.

III. Assemblage

The outer appearance of the electric music instrument is similar to that of a harmonium both in shape and in size. Provision is made, however, in arranging the key board and the apparatus to enable the instrument to be played simultaneously with a piano. Therefore (Fig. 1) the cover C is detachable and the key board- and mechanism-box B is arranged in such a height above the apparatus that the instrument may be put below the key board of the piano in such a manner that the two key boards fit together. For this purpose also the key board- and mechanism-box B is adjustable in height and therefore the current supply lines leading from the glow lamps *n* to the screws A are flexible.

Fig. 2 shows the two pedals P arranged on the instrument. The left pedal acts on a general regulating rheostat in the circuit of the battery *m*. By pushing this pedal the current supply to the glow lamps is throttled and thereby the force of sound diminished. The right pedal connects the current into a circuit supplied by the current source of the electromotor *v*, which circuit contains the coils of the electromagnets *l* shown in Fig. 3. Armatures consisting of soft iron are fixed on the lower sides of the levers *e*. When the right pedal is pushed down an electric current flows through the coils *l* of the electromagnets so that all the levers *e* having previously been pressed down are maintained in their lowest position by the attraction on their respective armatures *h*. As long as the right pedal is pushed down the sound, corresponding to the keys acted on, endures without continuing to press down the keys. In the casing of the instrument there are further the necessary low frequency transformers *r*, the valve amplifiers *s*, the batteries D and a device for regulating the speed of the electromotor.

The absolute sound pitches which may be produced by this instrument depend—setting aside the dimensions of the apparatus—especially on the number of revolutions of the driving motor. It is therefore necessary before playing the instrument to regulate the number of revolutions of the motor so that the sounds produced are in accordance with the keys of the key board. This regulation is, however, very simple since by correct regulation of a single sound all other sounds are automatically also correct; moreover this instrument has the entirely novel feature, that one may transpose a music piece into any desired pitch by varying the speed of the motor without changing the mode of playing.

The electric music instrument according to this invention may be also used as equivalent for any known music instrument by the following modification:

It is well known to register sounds photographically by arranging in series a telephone and an electric light source by means of a transformer, and to photograph on a moving film the light variations caused by the sound oscillations. This method is utilized in speaking and music playing films, on which language or music is photographically registered in its connection.

The modification of the apparatus consists in utilizing discs *o*, the concentric rings of which do not bear the above said slots but photographic registrations of the single tones of music instruments. The loud speaker of an electric music instrument having such discs produces, when being played, tones having the timbres of the music instrument the tones of which are registered on the discs.

In especial embodiment of the electric music instrument three key boards are provided like those of an organ, corresponding to three apparatus driven by one and the same motor. One of these apparatus comprises discs *o* with photographic sound registrations of string instruments, the second one comprises such of wood wind instruments, and the third that of brass instruments. With such an instrument a single musician is able to play a complete orchestral piece with all timbres and dynamic shades thereof.

I claim as my invention:

1. An electric music instrument comprising in combination electric current sources, a number of electric glow lamps, a key board adapted to individually connect said glow lamps with one of the said current sources, photoelectric cells arranged opposite said glow lamps, a telephone receiver connected to one of the said current sources and to said photoelectric cells, a motor, a series of gear drums adapted to be driven by the said motor,

a series of partially translucent and partially opaque screens arranged between the said glow lamps and the said photoelectric cells, gear drums individually connected to the said screens and adapted to be driven at individual speed from the gear drums of the said series of drums.

2. An electric music instrument as claimed in claim 1 in which the diameter ratios of co-operating gear drums are equal to the sound frequency ratios of the notes and half notes of an octave.

3. An electric music instrument as claimed in claim 1 in which the translucent portions of the opaque screens are arranged in concentric rows of a number doubled from row to row.

4. An electric music instrument as claimed in claim 1 in which the screens are identical and interchangeable.

5. An electric music instrument as claimed in claim 1 in which the motor is adapted to run at regulable speed.

6. An electric music instrument as claimed in claim 1 in which means adapted to vary the ratio of revolutions of the motor and the series of gear drums are provided.

7. An electric music instrument comprising in combination electric current sources, a series of contact springs continuously connected to one of the said current sources, bare resistance means arranged opposite the said contact springs, key mechanisms adapted to make the said contact roll onto the said resistance means, glow lamps connected to the said resistance means, photoelectric cells connected to another current source and arranged opposite to the said glow lamps, partially translucent screens rotating between the said glow lamps and the said photoelectric cells, and a telephone receiver connected with the said photoelectric cells.

8. An electric music instrument comprising in combination a key board mechanism, an electric current source connected to the fixed parts of the said key board mechanism, a series of contact springs rigidly connected at the one end to the said fixed parts and at the other end to the moving parts of the said key board mechanism, bare resistance means arranged opposite the said contact springs and adapted to be touched by the said contact springs, glow lamps connected to the said resistance means, photoelectric cells connected to another current source and arranged opposite to the said glow lamps, partially translucent screens rotating between the said glow lamps and the said photoelectric cells, and a telephone receiver connected with the said photoelectric cells.

9. An electric music instrument comprising in combination a key board frame having adjustable parts, an electric current source connected to the said adjustable parts, a series of contact springs individually connected to the said adjustable parts, bare resistance means arranged opposite the said contact springs and adapted to be touched by the said contact springs, glow lamps connected to the said resistance means, photoelectric cells connected to another current source and arranged opposite to the said glow lamps, partially translucent screens rotating between the said glow lamps and the said photoelectric cells, and a telephone receiver connected with the said photoelectric cells.

10. An electric music instrument comprising in combination a key board frame, keys fulcrumed on the said frame apart from the player's side, levers fulcrumed on the said frame towards the player's side and adapted to be moved by the said keys, a series of springs fixed at one end on the said levers, an electric current source connected to the said contact springs, bare resistance means arranged opposite the said contact springs and adapted to be touched by the same, glow lamps connected to the said resistance means, photoelectric cells connected to another current source and arranged opposite the said glow lamps, partially translucent screens rotating between the said glow lamps and the said photoelectric cells, and a telephone receiver connected with the said photoelectric cells.

11. An electric music instrument comprising in combination a key board frame, longer and shorter keys fulcrumed on the said frame, levers arranged below and adapted to be actuated by the said keys, bolts arranged at the lower sides of the said keys and adapted to touch the said levers at distances of the fulcrums of the said levers inversely proportionate to the length of the said longer and shorter keys, contact springs adapted to be actuated by the said levers, bare resistance means arranged opposite the said contact springs, an electric current source, glow lamps connected to the said current source and to the said resistance means, photoelectric cells arranged opposite the said glow lamps, partially translucent screens adapted to rotate between the said glow lamps and the said photoelectric cells, a telephone receiver connected to the said photoelectric cells and another current source connected to the said photoelectric cells and to the said telephone receiver.

12. An electric music instrument comprising in combination an electric current source, a key board mechanism, contact springs connected to the said current source and adapted to be actuated by the said key board mechanism, bare resistance means arranged opposite the said contact springs, adjustable contact slides being in contact with the said resistance means, glow lamps electrically connected to the said contact slides, photoelectric cells arranged opposite the said glow lamps, partially translucent screens adapted

to rotate between the said glow lamps and the said photoelectric cells, a telephone receiver connected to the said photoelectric cells and another current source connected to the said telephone receiver and the said photoelectric cells.

13. An electric music instrument comprising in combination an electric current source, a key board mechanism, electric glow lamps connected to the said current source and adapted to be switched on and off by the said key board mechanism, a variable rheostat common to all said glow lamps, a pedal connected to the said rheostat and adapted to vary the resistance thereof, photoelectric cells arranged opposite the said glow lamps, partially translucent screens adapted to rotate between the said glow lamps and the said photoelectric cells, a telephone receiver and a current source connected to the said telephone receiver and the said photoelectric cells.

14. An electric music instrument as claimed in claim 1 in which the translucent and opaque portions of the screens are formed by photographic sound records.

15. An electric music instrument comprising in combination more than one key board mechanism, one set of glow lamps connected with each key board mechanism, one set of rotatable screens corresponding to each key board mechanism each of these sets bearing photograms of different timbres, a set of photoelectric cells corresponding to each set of screens, a driving mechanism common to all the said sets of screens and a telephone receiver electrically connected to the said photoelectric cells.

In testimony whereof I affix my signature.

EMERICH SPIELMANN.