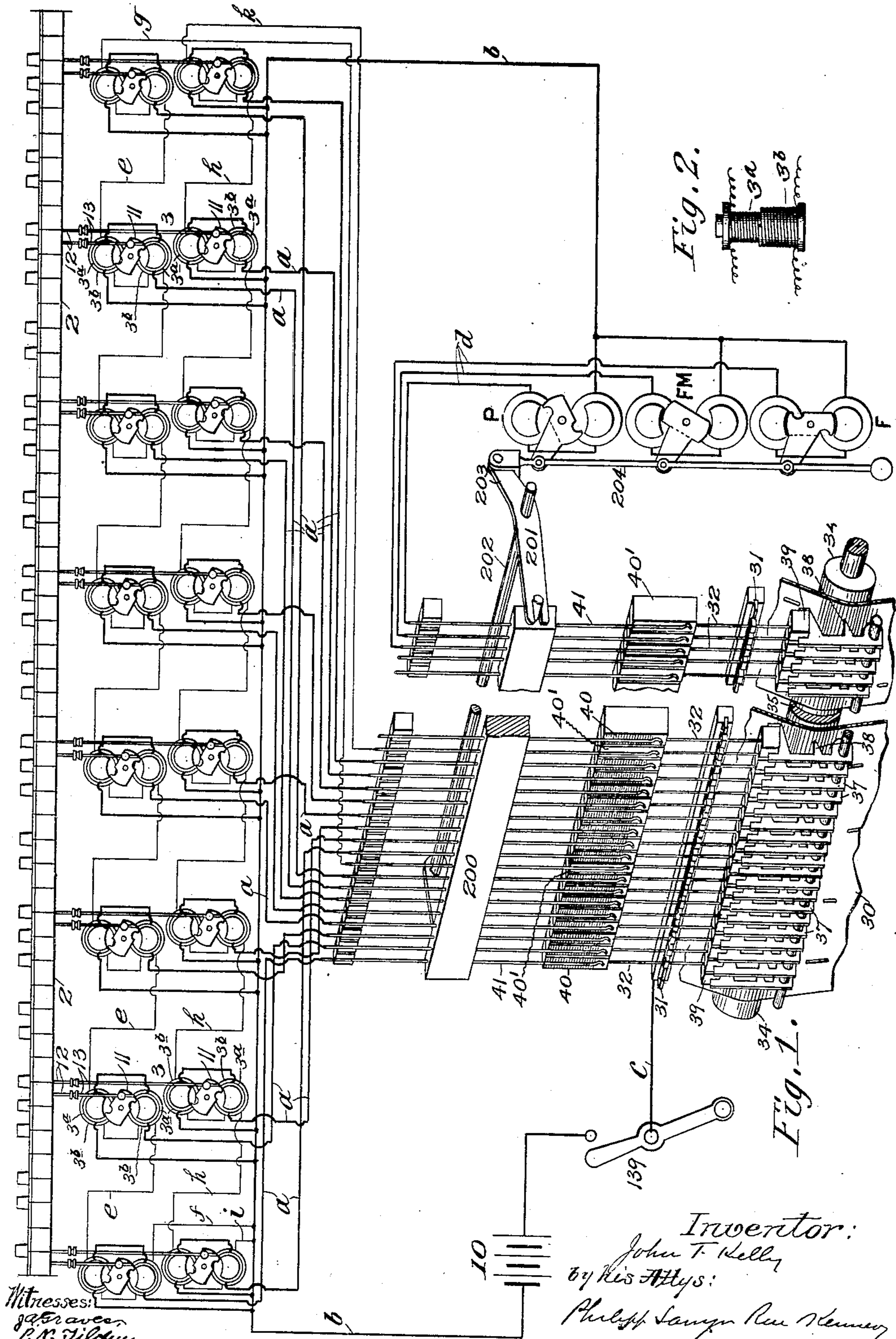


J. F. KELLY.
ELECTRIC PLAYING APPARATUS FOR MUSICAL INSTRUMENTS.
APPLICATION FILED SEPT. 14, 1907.

964,274.

Patented July 12, 1910.



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UNITED STATES PATENT OFFICE.

JOHN F. KELLY, OF PITTSFIELD, MASSACHUSETTS.

ELECTRIC PLAYING APPARATUS FOR MUSICAL INSTRUMENTS.

964,274.

Specification of Letters Patent.

Patented July 12, 1910.

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To all whom it may concern:

Be it known that I, JOHN F. KELLY, a citizen of the United States, residing at Pittsfield, county of Berkshire, and State of Massachusetts, have invented certain new and useful Improvements in Electric Playing Apparatus for Musical Instruments, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to automatically operated musical instruments of that class in which the tone producing devices are actuated by the operation of suitably connected electromagnets, and more particularly to instruments of that class in which the circuits to the electromagnets by which the tone producing devices are actuated are controlled by a so-called music sheet or record sheet on which the various notes are represented by suitable actuating or controlling devices, usually perforations, positioned transversely of the sheet to determine the particular tone to be sounded, and lengthwise of the sheet according to the time and succession of the tones.

The object of the invention is to provide means for producing desired expression in the production or rendering of a musical composition by such an electrically operated automatic playing apparatus by varying the strength or loudness of the different tones which go to make up the composition.

The invention broadly considered may be employed for determining the loudness with which the piece or composition as a whole is played, or for determining the relative loudness of notes played in succession or of successive portions of the composition, but it may also be employed for, and is especially adapted to and includes features relating especially to, the emphasizing of one or more of a plurality of simultaneously sounded tones in accordance with the method and invention described and claimed in my pending application No. 369,520, filed April 22, 1907, by which method the tone producing devices corresponding to tones of the same note name are grouped or connected together and the groups thus formed are controlled so as to determine the strength of action of any particular tone producing device or devices of a group which may be actuated, and as described in detail in said application.

In my said application, I have described

a particular method and means for increasing the strength of action of the operating or key actuating magnets of an automatic playing apparatus similar to that shown in United States Patent No. 753,809, dated March 1, 1904, by increasing the impressed electromotive force of the magnet circuits.

In accordance with the present invention, I provide means for increasing the magnetomotive force affecting the operating magnets without changing the impressed electromotive force of the magnet circuits and with the use of only one electromotive force and without resorting to the use of resistance devices as described in said Patent No. 753,809. This result is secured by providing means for changing the number of turns of the windings of the operating magnets through which energizing current will flow, preferably by providing each of the operating magnets with a supplemental winding or coil not of sufficient size to give enough power to the magnets to cause them to operate the key or tone producing devices, but adapted to act in cooperation with the main winding or coil of the magnet to increase the magnetization of the magnet and hence the force or strength with which its armature will pull on the key or tone producing devices of the instrument.

Such supplemental windings may be connected with the battery or other source of electrical energy in any suitable manner, and may be thrown into circuit by any suitable means for increasing the strength of such operating magnets as may be desired and when desired. For automatic expression control, the circuits to these supplemental windings may be controlled by special contact devices operated or controlled by the music sheet in the same manner as the contact devices for the circuits included in the regular or main windings of the magnets. The supplemental windings are preferably connected in groups according to the method above referred to of my application No. 369,520, the windings of each group being connected in series in a single circuit so that each group of such windings may be controlled by a single contact device the closing of which will connect all the supplemental windings of the group in circuit with the battery.

A full understanding of the invention can best be given by a detailed description of a system or apparatus embodying the

features of the invention in a preferred form, and such a description will now be given in connection with the accompanying drawings.

5 In said drawings:—Figure 1 is a diagrammatic view showing so much as is necessary for an understanding of the invention of an automatic playing apparatus similar to that shown in said Patent No. 10 753,809, provided with controlling devices and electrical connections for giving automatic expression control in accordance with the present invention. Fig. 2 is a detail view showing one method of magnet winding for providing the operating magnets 15 with supplemental coils in accordance with the invention.

The drawing shows at the top a series of finger keys 2 representing the key-board of 20 the piano. These keys are arranged in the usual manner in successive series of seven natural or white keys for striking the A, B, C, etc. to G tones, and with the sharp or black keys for striking the A#, C#, D#, 25 F# and G# tones arranged between the proper natural tone keys. Key operating magnets 3 are located beneath the key-board, a magnet being provided for each key in the actual apparatus. The drawing, to 30 avoid confusion of parts, shows only the magnets for operating the A and A# keys. The key operating magnets, as shown, are of the two-pole form having a pivoted oscillating armature 11 mounted between the 35 poles, and the armature of each magnet is connected with the under side of its corresponding key by connecting rods 12 and 13, whereby when any magnet is energized and its armature rotated the key with which the 40 armature is connected will be drawn downward to cause the operation of the corresponding tone producing device of the piano.

Each of the key operating magnets is provided with a main winding 3^a, and such 45 main winding of each of the key operating magnets is electrically connected through a wire *a* with a contact device of the controlling or transmitting mechanism through which connection may be made with one 50 pole of the battery 10 or other suitable source of electrical energy, and each of said main windings is connected with a wire *b* which connects with the other pole of the battery, the magnets being thus located each 55 in an independent branch circuit controlled by a contact device forming part of the transmitting or controlling mechanism.

The transmitting or controlling mechanism as shown comprises a series of contact 60 fingers or rods 32 adapted to make contact with a contact bar 31 and normally held out of engagement therewith during the operation of the instrument by means of rocking fingers 37 which are controlled for causing 65 or permitting the contact fingers to make

contact with the bar 31 by means of a perforated music sheet 30. The music sheet travels over a bridge 34, and the rocking fingers 37 are supported each by means of a trailing point 38 which engages the sheet 70 on the line of its support by the bridge 34 which is provided with transverse grooves 35 which correspond in position with the trailing points 38, so that when a perforation in the sheet comes beneath a trailing 75 point the point will be allowed to project through the sheet into the groove in the bridge 34, thereby permitting the rocking finger 37 and its corresponding contact finger to make the required movement to 80 bring the contact finger into engagement with the bar 31. The connections from the contact fingers 32 to the main windings of the key operating magnets 3 are through a series of adjustable resistance devices. As 85 shown, each of the contact fingers from which connection is made to the main winding of one of the key operating magnets connects with a resistance coil 40 from which 90 connection is made by one of a series of adjustable contact terminals 41 to the wire *a* leading to the magnet winding. The contact bar 31 is connected to the positive pole of the battery 10 by wire *c* in which is inserted a switch 139. When, therefore, any 95 one of the contact fingers 32 which is connected with the main winding of one of the key-operating magnets is caused to engage the contact bar 31, circuit will be completed to its corresponding magnet winding and 100 the magnet energized to operate the key.

The contact terminals 41 are formed by rods carried by a movable bar 200 and insulated from each other, as by making the 105 bar 200 of suitable insulating material. The resistance coils 40 are also insulated from each other, and the connection between the contact fingers 32 and the rocking fingers 37 is such as to avoid electrical 110 connection between these parts, as by having the ends of the contact fingers inserted in suitable socket pieces 39 of insulating material carried by the rocking fingers. The bar 200 is made movable for the purpose of 115 moving the ends of the contact terminals or rods 41 over the resistance coils 40 so as to simultaneously change the resistance of all the branch circuits leading to the main windings of the key operating magnets, thus providing means for changing or adjusting 120 the effective strength of all such magnets to which circuit may be completed by engagement of their corresponding contact fingers with the contact bar 31. To provide for the desired movement of the bar 200, it is 125 shown as arranged to be moved by a pair of rocking arms 201 extending from a rock shaft 202 which is rocked through an arm 203 by a longitudinally movable operating rod 204. For automatically shifting the 130

bar 200 for controlling the resistance in the circuits to the main windings of the key operating magnets, a plurality of resistance or expression controlling magnets are provided, the circuits to which are controlled by the music sheet. As shown, three such magnets F, FM and P are provided for causing the bar 200 and contact terminals or rods 41 to be moved to the positions of minimum resistance, medium resistance and maximum resistance, respectively. These magnets are shown as of the two-pole form with rotary armatures similar to the key operating magnets, their armatures being connected with the operating rod 204, and the connection between their armatures and the rod 204 being such that when the magnet F is energized, the movement of its armature will cause the bar 200 and contact rods 41 to be shifted to the position shown in which the resistance coils 40 are practically or entirely cut out of the key operating circuits, and when the magnet FM is energized, the other magnets being dead, the movement of its armature will cause the bar 200 and contact rods 41 to be shifted to an intermediate position, and when the magnet P is energized, the magnets F and FM being dead, the movement of its armature will cause the bar 200 and contact rods 41 to be shifted to the position in which all or practically all of each resistance coil will be inserted in its corresponding circuit. The circuits to these magnets F, FM and P are controlled by three of the contact fingers 32, which in turn are controlled by suitably placed perforations in the music sheet 30. These magnets are connected with the negative pole of the battery through the return wire *b*, and each of the magnets is connected by a wire *d* with one of the contact fingers 32 through one of the contact rods 41, so that when the contact finger 32 corresponding to either of these magnets is operated circuit to that magnet will be closed and the resistance devices shifted accordingly. As there is no necessity for providing a variable resistance in these circuits, no resistance coils are provided between the contact rods with which the wires *d* connect and their corresponding contact fingers 32, the ends of the rods, which for uniformity are carried by the bar 200, making sliding contact with suitable contact blocks 40' occupying the same position with relation to these contact rods and the corresponding contact fingers as the resistance coils 40 occupy with relation to the contact rods and contact fingers connected in the circuits to the main windings of the key operating magnets.

The parts of the apparatus as thus far described are substantially similar in their operation to corresponding parts in the apparatus shown and described in said Patent No. 753,809 and in my said application No.

369,520, differing from the apparatus of said patent mainly in the arrangement of the resistance varying means for the key operating circuits so that the resistance coils are stationary and the contact rods or terminals are moved relatively thereto as in my said application, instead of having the resistance coils moved as in said patent, and in having the key operating magnets which cause the production of tones of the same note name connected with adjoining or neighboring contact rods and contact fingers 32, as in the apparatus shown in my said application; and differing from the apparatus of my said application in having a continuous or one piece contact bar 31 as in said patent instead of the sectional contact bar of my said application. It will be understood that the actual apparatus would be provided with pedal operating magnets and controlling devices and connections therefor, with an automatic circuit breaking device and means for controlling the position of the bridge 34, and with a suitable motor for driving winding and rewinding rolls for the music sheet, as in said patent and in my said application.

The additional features and parts and electrical connections shown, and which in the apparatus as shown serve to provide automatic expression controlling means for the emphasizing of individual notes will now be described.

The key operating magnets are each provided with a supplemental winding 3^b which is adapted to be connected in circuit with a suitable source of electrical energy, which may be and preferably will be the battery 10 which supplies current for the main windings 3^a of these magnets. These supplemental windings are for the purpose of increasing the strength of the magnets, and should be of such size, or so proportioned, that when connected with their source of energy the current flowing through them will not sufficiently energize the magnets to cause the armatures 11 to be moved to operate the piano keys, but will be of sufficient size so that the strength of any one of the magnets due to the current flowing through its main and supplemental windings at the same time will be sufficiently greater than the strength of the magnet when energized through its main winding alone as to cause an appreciable increase in the strength of action of the sound producing device operated by the movement of the magnet armature. Because of the fact that the attracting force of a magnet is roughly proportionate to the square of the magnetizing power, a very considerable increase in the strength of action of the magnets may be secured through the use of such supplemental coils or windings without making them of sufficient size, or of such proportions with rela-

tion to the main windings and with regard to the electromotive force of the current supplied to them, that the current flowing through them alone would energize the magnets sufficiently to cause them to operate the sound producing devices. The exact relation between the size or proportions of the supplemental and main windings of the magnets will depend upon the particular increase desired in the strength of the magnets. Fig. 2 shows in detail one spool of one of the key operating magnets showing a preferred way of providing such magnets with the supplemental coils.

To provide for automatic expression control through the use of these supplemental coils or windings they are connected with contact devices of the controlling or transmitting mechanism which are operated or controlled by the music sheet in the same manner as the contact devices for controlling the circuits to the main windings of the key operating magnets; and in order to make use of these supplemental coils in accordance with the method described and claimed in my said application No. 369,520, for emphasizing one or more of a plurality of simultaneously sounded tones, they are, as shown in the diagram, connected in groups, each of which includes the supplemental windings of the magnets which cause the production of tones of the same note name, the supplemental windings of each group being controlled by a single contact device. The supplemental windings of the magnets for operating the A keys will be connected to form one group, those for operating the A# keys will form another group, and those for operating the B keys another group, and so on, the supplemental windings for all the magnets for the entire key-board being thus connected preferably in twelve groups, each group corresponding to the series of tones of the same note name which are produced through the action of the correspondingly named finger keys of the piano.

The connection of these supplemental windings in separate groups in the manner above indicated is preferably effected as shown for the windings of the magnets for the A keys and A# keys by connecting the windings of each group in series in a circuit including one of the contact rods and contact fingers 32 of the transmitting or controlling mechanism. As shown, for example, the supplemental windings of the magnets for operating the A keys are connected with each other by wires *e* and the winding at one end of the series is connected by wire *f* with the common return wire *b* while the winding at the other end of the series is connected by a wire *g* with one of the contact fingers 32 through the corresponding contact rod 41 and a contact block 40'. In a similar manner the supplemental coils for the eight mag-

nets for operating the A# keys are connected in series by wires *h* between the windings, and the winding at one end of the series is connected by wire *i* with the return wire *b* and the winding at the other end of the series is connected by a wire *k* with one of the contact fingers 32 through its corresponding contact rod 41 and contact block 40'. Similar connections will be made from the supplemental windings of each group of key operating magnets corresponding to the differently named keys of the piano so that the supplemental windings of each group will be controlled by one of the contact fingers 32.

In the operation of the apparatus, when any one of the contact fingers 32 which is connected in circuit with the supplemental windings of a group of key operating magnets is caused to engage the contact bar 31, current will be caused to flow through all the supplemental windings of the group the circuit to which includes that contact finger, but on account of the small size of the supplemental windings the magnets will not be sufficiently energized to cause the operation of their armatures and the corresponding tone producing devices. If, however, the circuit is closed to the main winding of any one of the magnets of the group through the supplemental windings of which current is flowing, or if the circuit to such main winding is closed at the same time that the circuit to the supplemental windings of the group is closed, then that particular magnet will be energized so as to operate with a strength greater than if it were energized by the current flowing through its main winding alone. Obviously there is thus provided not only means which may be employed in addition to or in place of the variable resistance devices of the apparatus for varying the relative strength of operation of tone producing devices operated in succession, and therefore the relative loudness of tones sounded in succession, but there is also provided means for emphasizing one or more of a plurality of simultaneously sounded tones by increasing the number of effective turns of the winding of one or more of a plurality of simultaneously energized key operating magnets. For example, if the C and F tones below middle C and the A tone above middle C are to be sounded together and the A tone to be emphasized, then the music sheet will be cut so as to cause the three contact fingers 32 corresponding to the main windings of the magnets which cause the production of these three tones to engage the contact bar 31, and so as to cause the contact finger which controls the circuit including the supplemental windings of all the A magnets to engage the contact bar at the same time, or to engage the contact bar before

and then to be held until the circuits to the main windings of the three magnets have been closed. The three magnets corresponding to the three keys to be operated will thus be energized to operate the keys simultaneously, and while the magnets for the C and F keys will operate with a strength due merely to the current passing through their main windings, the magnet for the A key which is to be actuated will operate with an increased strength due to the combined energizing power of the current flowing through both its main and supplemental windings, and the A tone which is produced simultaneously with the C and F tones will thus be emphasized.

It may happen at times that two tones of the same note name are played together and in this case, of course, if either of such tones were to be emphasized the other would also have to be sounded with equal strength. This would, however, make practically no difference in the musical effect because of the strict consonance of the two tones.

Reference has already been made herein to the fact that the main windings of the key operating magnets which cause the production of tones of the same note name are shown in the drawing as connected with adjoining or neighboring contact rods and contact fingers 32. The object of so connecting the circuits to the main windings of these magnets in this apparatus is to secure the more even distribution of the perforations in the music sheet which results from this arrangement than is the case when the controlling devices with which the perforations in the music sheet co-act are arranged in order corresponding to the succession of tones in the musical scale. The advantage of this manner of connecting the controlling circuits of the key operating magnets with the contact devices of the transmitting mechanism so that the magnets corresponding to tone producing devices for producing tones of the same note name will be controlled by groups of adjacent contact devices of the transmitting mechanism is more fully and particularly pointed out in my said application No. 369,520. It will be understood, of course, that while this manner of connecting the individual controlling circuits with the contact devices of the transmitting mechanism is preferable, it is by no means necessary in an apparatus constructed in accordance with the present invention.

It will be noticed that the contact fingers which control the circuits to the supplemental windings of the key operating magnets are each arranged adjacent to the contact fingers which control the individual circuits for the main windings of the magnets of the group the supplemental windings of which are controlled by such contact

finger. This arrangement is also of advantage in providing for a more even distribution of the perforations in the music sheet than might result if the circuits for the several groups of supplemental windings were connected to a group of adjacent contact fingers.

While the drawing shows a continuous contact bar 31, and while the use of such a continuous contact bar is preferable in an apparatus which is intended to be entirely automatic in its action, it will be understood that the use of such a continuous contact bar is not a necessary feature of an apparatus embodying the present invention, and that the invention is not to be limited to the use of such a continuous contact bar, but that the particular form of contact bar which is to be used will depend upon the requirements of the particular apparatus in which the invention was to be embodied and upon the provision of various devices and attachments providing for control other than the purely automatic control which the apparatus as shown and described herein gives.

It will be understood that the invention is not to be limited to the particular apparatus shown and to which the foregoing description has been mainly confined, but that it includes changes and modifications thereof and departures therefrom within the claims.

What is claimed is:—

1. In an electrically operated musical instrument, the combination with tone producing devices of the instrument, a series of electromagnets for operating the tone producing devices, and means for energizing said magnets, of means for determining the loudness of the tones produced by the operation of said magnets by changing the number of turns of magnet winding through which the energizing current flows.

2. In an electrically operated musical instrument, the combination with tone producing devices of the instrument, a series of electromagnets for operating the tone-producing devices, and means for energizing said magnets, of means for causing one of a plurality of simultaneously sounded tones to be emphasized comprising means for increasing the potential strength of a group of said magnets by increasing the number of turns of magnet-winding through which current will flow when any one or more of the magnets of such group is energized to operate the corresponding tone producing device or devices.

3. In an electrically operated musical instrument, the combination with tone producing devices of the instrument, a series of electromagnets for operating the tone producing devices, and means for energizing said magnets, of expression controlling

means comprising means for varying the potential strength of said magnets by groups by changing the number of turns of magnet winding through which current will flow

5 when any one or more of the magnets of a group is energized to operate the corresponding tone producing device or devices, each group of magnets including magnets for causing the production of tones of the same

10 note name.

4. In an electrically operated musical instrument, the combination with tone producing devices of the instrument, a series of electromagnets for operating the tone pro-

15 ducing devices, and means for energizing said magnets, of expression-controlling means including a plurality of controlling devices each of which is adapted to determine the number of turns of magnet wind-

20 ing through which energizing current will flow when any one of a group of magnets is energized to operate the corresponding tone producing devices.

5. In an electrically operated playing ap-

25 paratus for musical instruments, the combination with tone producing devices of the instrument, a series of electromagnets for operating the tone-producing devices, of means for varying the magnetomotive force of

30 said magnets and the loudness of the tones produced by the operation of said magnets by changing the number of turns of the magnet windings through which the energizing current flows.

35 6. In an electrically operated playing apparatus for musical instruments, the combination with tone producing devices of the instrument, a series of electromagnets for operating the tone producing devices, of means

40 for increasing the potential strength of a group of said magnets by increasing the number of turns of magnet windings through which current will flow when any one or more of the magnets of the group is ener-

45 gized to operate the corresponding tone producing device or devices.

7. In an electrically operated playing apparatus for musical instruments, the combination with tone producing devices of the in-

50 strument, a series of electromagnets for operating the tone producing devices, of means for increasing the potential strength of a group of said magnets which cause the production of tones of the same note name by

55 increasing the number of turns of magnet windings through which current will flow when any one or more of the magnets of a group is energized to operate the corresponding tone producing device or devices.

60 8. In an electrically operated playing apparatus for musical instruments, the combination with tone producing devices of the instrument, of a series of electromagnets for operating the tone producing devices, each

65 having a plurality of windings, and means

for varying the operative strength of said magnets by causing said magnets to be energized by current flowing through one or more of their windings according to the desired operative strength of the magnet.

9. In an electrically operated playing apparatus for musical instruments, the combination with tone producing devices of the instrument, of a series of electromagnets for operating the tone producing devices each

75 having a main winding and a supplemental winding for increasing the operating strength of the magnet, and means for varying the operative strength of said magnets comprising separate means for controlling the flow

80 of current through both the main and supplemental windings of the magnets.

10. In an electrically operated playing apparatus for musical instruments, the combination with tone producing devices of the

85 instrument, a series of electromagnets for operating the tone producing devices, of a plurality of controlling devices each of which controls the potential magnetomotive force of a group of said magnets by changing

90 the number of turns of magnet winding through which energizing current will flow when any magnet of the group is energized to operate the corresponding tone producing device.

11. In an electrically operated playing apparatus for musical instruments, the combination with tone producing devices of the instrument, a series of electromagnets for operating the tone producing devices, of a

100 plurality of controlling devices each of which controls the potential magnetomotive force of a group of said magnets which cause the production of tones of the same note name by changing the number of turns

105 of magnet winding through which energizing current will flow when any magnet of the group is energized to operate the corresponding tone producing device, and means for automatically controlling the operation

110 of said controlling devices.

12. In an electrically operated musical instrument, the combination with tone producing devices of the instrument, of a series of electromagnets for operating the tone pro-

115 ducing devices each having a main winding and a supplemental winding, and means for varying the operative strength of said magnets comprising a series of circuits for the main windings of said magnets, a series of

120 controlling devices for controlling said circuits, a second series of circuits for the supplemental windings of said magnets, and a series of controlling devices for controlling

125 said second series of circuits operated independently of the controlling devices for the first said series of circuits.

13. In an electrically operated musical instrument, the combination with tone producing devices of the instrument, of a series

of electromagnets for operating the tone producing devices each having a main winding and a supplemental winding, a series of circuits for the main windings of said magnets, a series of controlling devices for controlling said circuits, a second series of circuits for the supplemental windings of said magnets, the supplemental windings of a group of magnets being connected in series in each of said circuits, and a series of controlling devices for said second series of circuits.

14. In an automatic electrically operated playing apparatus for musical instruments, the combination with tone producing devices of the instrument, of a series of electromagnets for operating the tone producing devices each having a main winding and a supplemental winding, a series of circuits for the main windings of said magnets, means for supporting and feeding a music sheet, a series of controlling devices adapted to be controlled by the music sheet for controlling said magnet circuits, a second series of circuits for the supplemental windings of said magnets each of which includes the supplemental windings of a plurality of said magnets, and a series of controlling devices adapted to be controlled by the music sheet for controlling said second series of magnet circuits.

15. In an electrically operated playing apparatus for musical instruments, the com-

bination with tone producing devices of the instrument, of an electromagnet for operating a sound producing device having a main winding and a supplemental winding for increasing the operating strength of the magnet, and means for varying the operative strength of said magnet comprising circuit connections and controlling means whereby current may be caused to flow through the main winding alone or through both main and supplemental windings.

16. In an electrically operated playing apparatus for musical instruments, the combination with tone producing devices of the instrument, of an electromagnet for operating a sound producing device having a main winding and a supplemental winding, circuit connections for each winding, and means for separately controlling the flow of current through each winding, the supplemental winding being of such size that the magnetomotive force resulting from the current flowing through it alone will be insufficient to give the magnet strength to operate the tone producing devices.

In testimony whereof, I have hereunto set my hand, in the presence of two subscribing witnesses.

JOHN F. KELLY.

Witnesses:

ELIZABETH G. FARRELL,
GEO. P. REES.