Oct. 19, 1926. 1,603,871

H. K. SANDELL

PIANO PLAYING DEVICE

Filed June 14, 1922 4 Sheets-Sheet 1

Fig. 1.

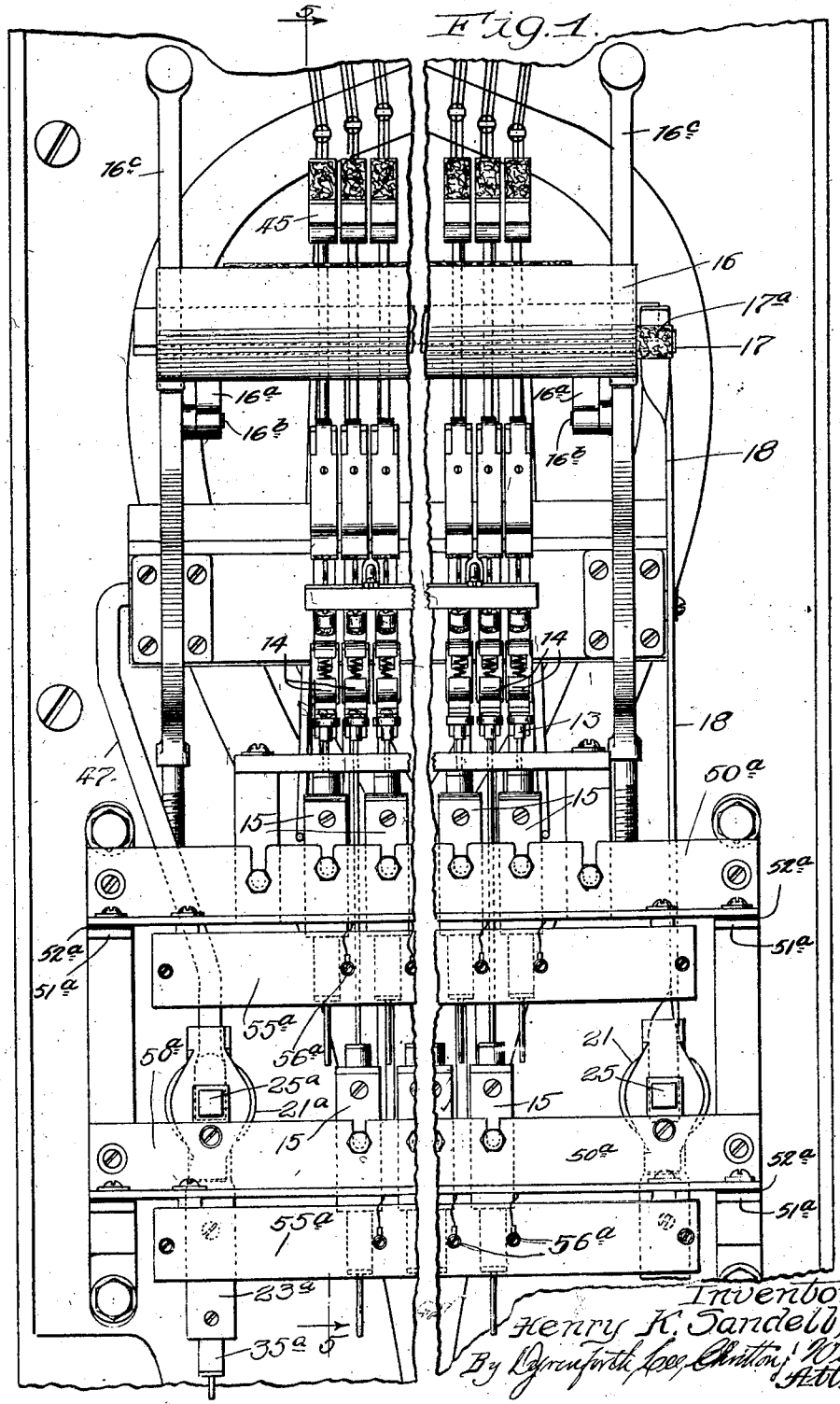

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Fig. 2.

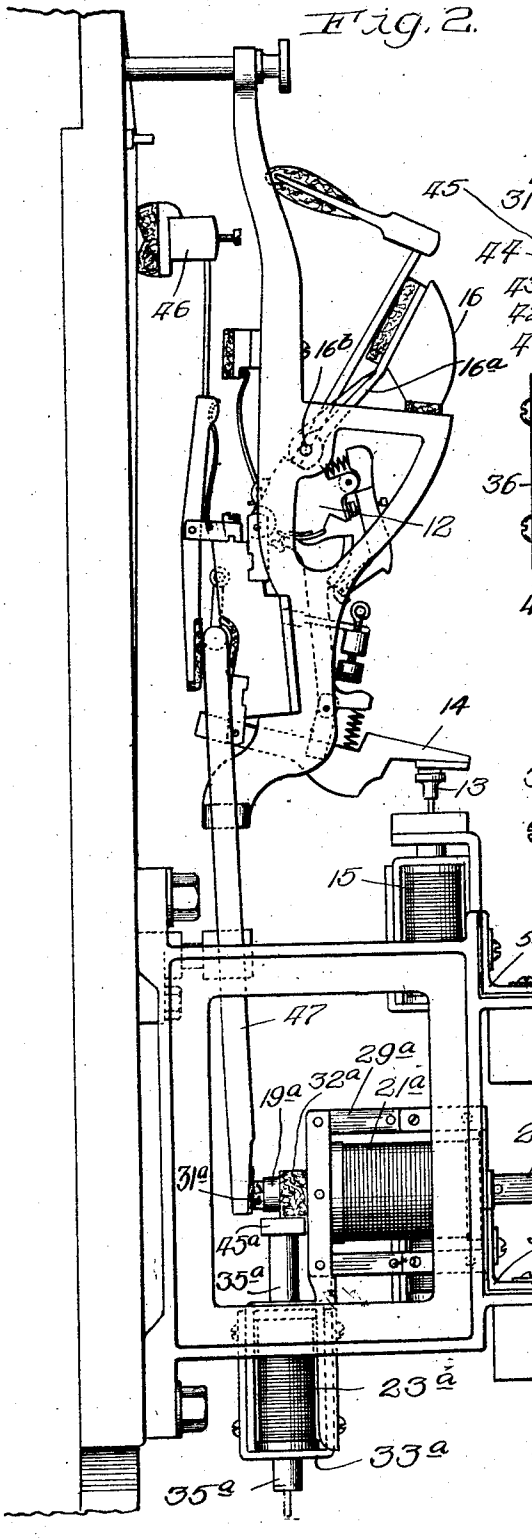

Fig. 3.

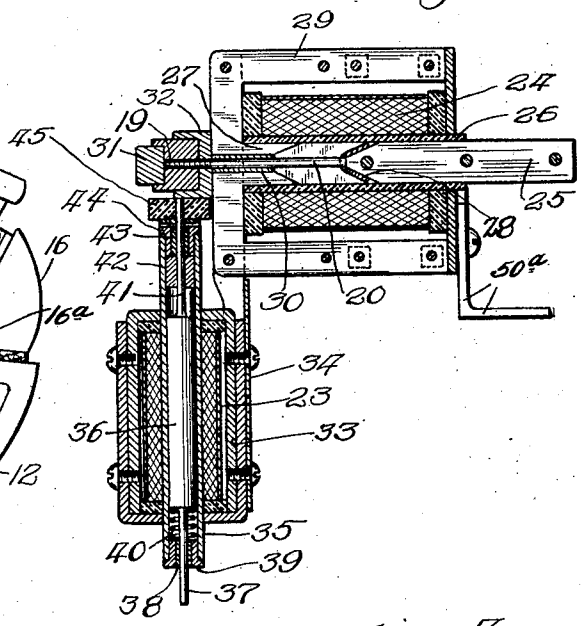

Fig. 4.

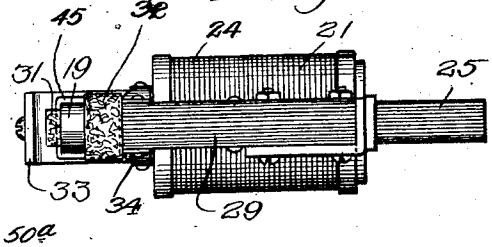

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Fig. 5.

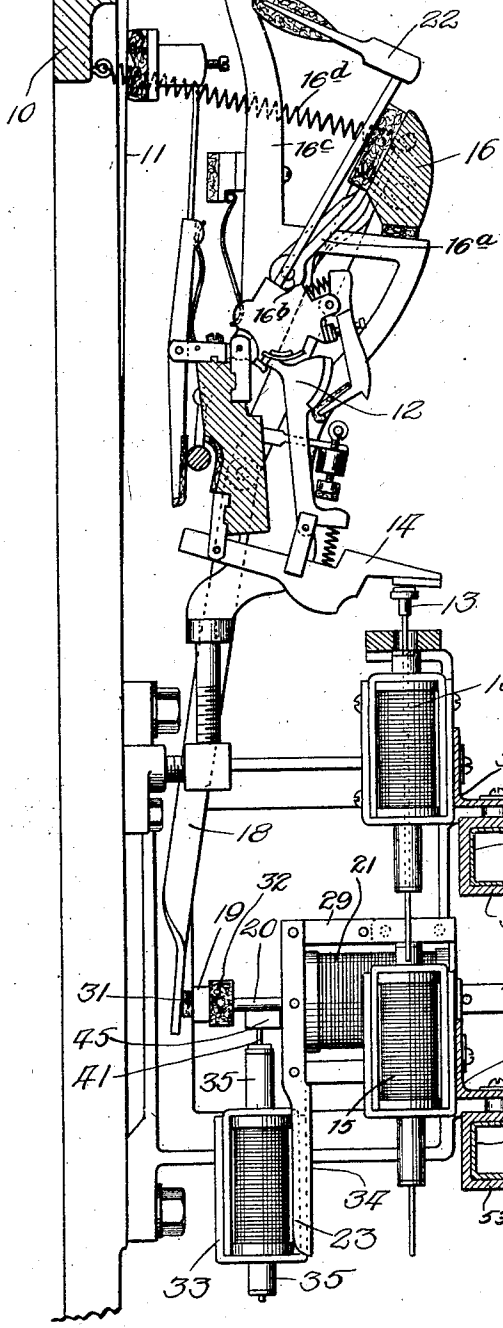
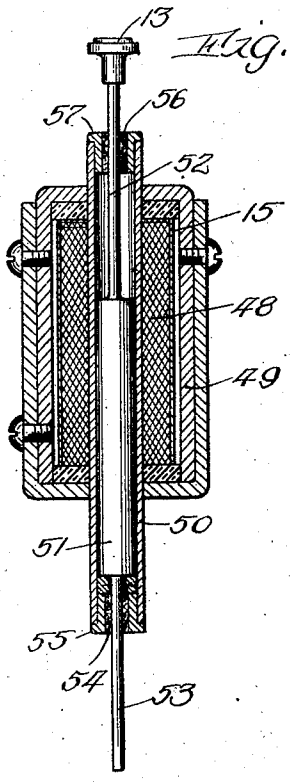


Fig. 6.



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PIANO PLAYING DEVICE

Filed June 14, 1922 4 Sheets-Sheet 4

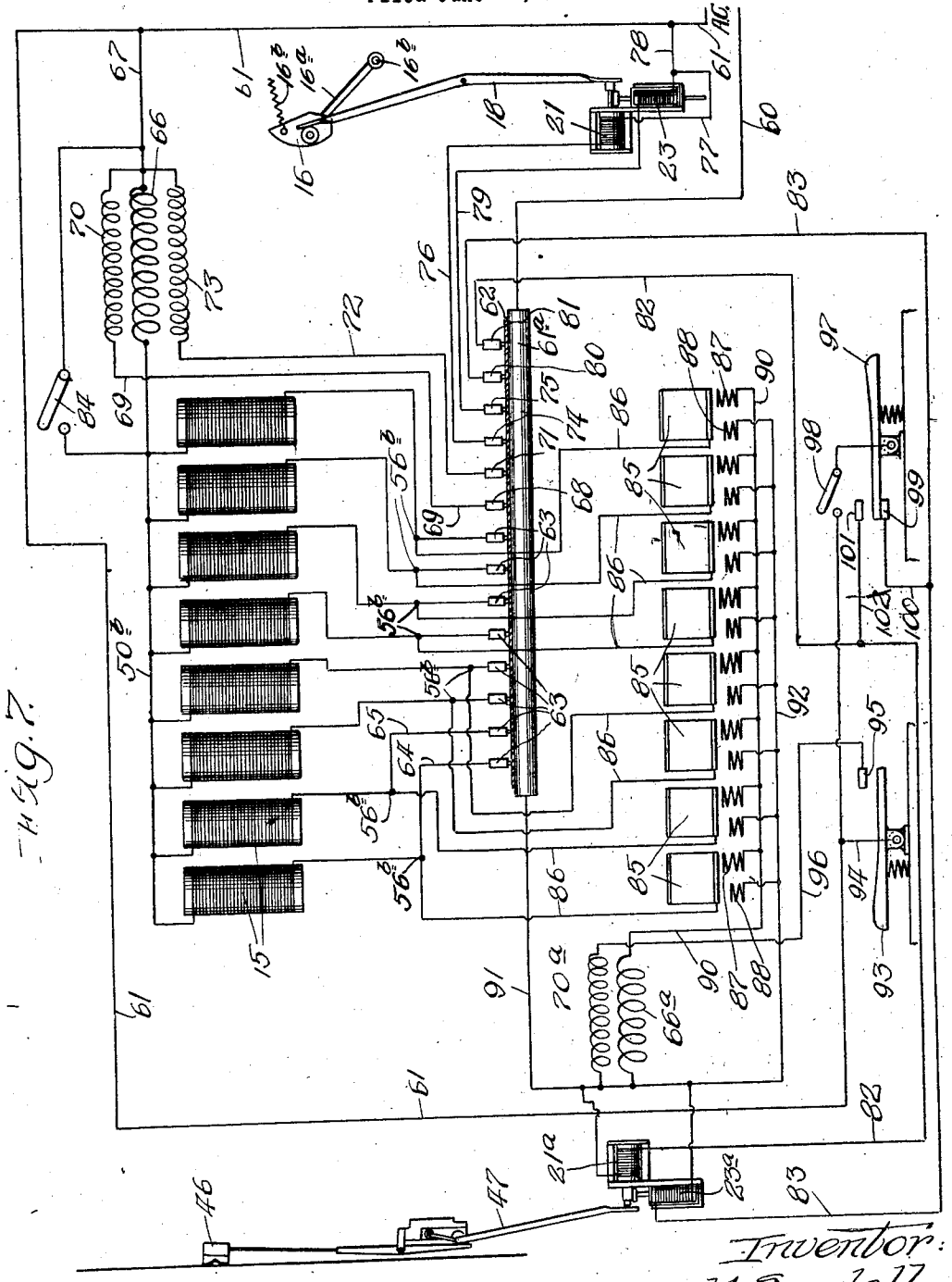

Fig. 7.

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Patented Oct. 19, 1926. 1,603,871

UNITED STATES PATENT OFFICE.

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PIANO-PLAYING DEVICE.

Application filed June 14, 1922. Serial No. 568,226.

The present invention relates to improvements in piano playing devices, and more particularly to such devices operated by means of an electrical current and controlled by perforated note sheets or by manually operated keys, as desired. It will be fully understood from the following description of an embodiment of the invention, illustrated by the accompanying drawings, wherein:

Figure 1 is an elevation of a piano playing device embodying the present invention, the central portion thereof being broken away;

Fig. 2 is an end elevation of the piano playing action illustrated in Fig. 1, showing in detail the operation of a note-playing magnet and of the control magnets for the dampers;

Fig. 3 shows in detail a sectional view through the control magnets for the control of the hammer-rail;

Fig. 4 shows in plan the control magnets of Fig. 3;

Fig. 5 is a sectional view through the action on the line 5—5 of Fig. 1, showing in detail a note-playing action and the control magnets for the operation of the hammer-rail;

Fig. 6 is a sectional view through a note-playing magnet; and

Fig. 7 is a diagrammatic view showing the circuits for the control of the various parts of the piano action both from a perforated note sheet and from manually operated keys and pedals.

Referring more particularly to the drawings, the numeral 10 indicates the string plate of a piano, which may be, for example, of the character described and shown in my prior Patent No. 1,028,496 granted June 4, 1912. The strings are indicated by numeral 11. The actions for the individual keys are designed by numeral 12 and, as they do not form a part of the present invention, are not described in further detail herein. The action of each key is controlled by a riser 13 acting against the jack-butt 14 and actuated by an alternating current note-playing magnet 15, the construction of which will be further hereinafter described.

The length of stroke of the hammers is controlled by the position of the movable hammer-rail 16 carried by arms 16^a mounted on pivots 16^b which are supported on the bracket 16^c. A spring 16^d tends to draw the hammer-rail towards the strings. At one end of the hammer-rail 16 a pin 17 projects, this pin being preferably covered with a felt roller 17^a. The pin 17 engages one end of the hammer-rail operating lever 18, the other end of which is engaged by the felt-covered head 19 of rod 20, operated by the movable core of control magnet 21. By the operation of the control magnet 21, the rod 20 is operated either to force the hammer-rail 16 back to its farthermost position to give a full stroke to the hammers 22, or is permitted to assume an intermediate position, correspondingly reducing the stroke of the hammers.

A second magnet 23 co-operates with the magnet 21 and the rod 20 to hold the rod in its extended position. The mode of operation of this co-operating magnet will be clear from Figures 3 and 5, Figure 3 showing the magnets and their co-operating parts in detail.

Magnet 21 is formed as a coil or spool 24 of suitably insulated wire, in the center of which is the movable core 25. The coil 24 is formed on a cylinder of suitable non-magnetic material 26. At one end of the coil a cylindrical member 27 projects into the opening through the coil, the inner portion of this member being formed to provide a seat for the end of the core 25, which may suitably be provided with a felt bushing 28 to deaden the sound of impact. A laminated iron frame 29 of generally rectangular form completely surrounds the magnet, undue heating thereof being prevented by its laminated construction. The rod 20 is secured to the end of the core 25 and passes through a suitable bore in the member 27 and in the end of the frame 29, a felt bushing 30 being provided to eliminate noise. At the end of the rod 20 the head 19 is mounted, being provided at its end with a felt pad 31, which engages the hammer-rail operating lever 18. Back of the head 19 is mounted a felt washer 32 on the rod 20, the purpose of which will be clear from a consideration of the operation of the co-operating control magnet 23.

Magnet 23 is mounted within an iron frame 33 which is mounted to a suitable depending supporting member 34 secured to the frame 29 of magnet 24. Within the

magnet 23 is mounted a cylinder 35 of suitable non-magnetic material, for example, brass. A core or armature 36 is movably mounted within the cylinder 35. At its lower end the core 36 is provided with a projecting rod portion 37 which passes through a felt bushing 38 in a suitable bore provided in the cap 39 closing the lower end of the cylinder 35. A coil spring 40 in the lower end of the cylinder surrounds the rod-like projection 37 and bears against the end of the core 36, tending to force it upwardly. At its upper end the core 36 is provided with another rod-like projection 41, which passes through a felt bushing 42 in the cylinder 35 and also through a felt bushing 43 in the cap 44 closing the upper end of the cylinder 35. At its upper end the projection 41 is provided with a felt head 45, which normally bears against the felt head 32 mounted upon the rod 20 operated by magnet 21.

The co-operation of the two magnets will be readily apparent from a consideration of Figure 5. When the electromagnet 21 is momentarily energized by alternating current, the solenoid core 25 is forcibly brought to the center of the magnet and the rod 20 is actuated to push the end of the hammer-rail operating lever 18. By this movement the felt pad 32 is brought to such a position as to entirely clear the felt head 45 on the rod 41 operated by electromagnet 23, and the spring 40 in the latter magnet, acting on the end of the core 36, forces the rod 41 and the felt head 45 upwards against the rod 20 between the pad 32 and the frame 29. The elements are then in the position shown in Figure 5. Upon deenergizing the magnet 21, the head 45 then serves as a stop preventing the return of the head 19 of rod 20, and thereby prevent the return of the hammer-rail operating lever 18 to its normal position. A momentary closure of the circuit energizing the magnet 21 consequently results in placing and holding the rod 20 in energized position, its position being maintained even after the magnet 21 has been de-energized. With the parts in this position, energizing the magnet 23 causes a retraction of the core 36 to the center of the magnet. This draws the head 45 back to a position such as to clear the pad 32 on rod 20 and permit the latter to return to its normal position with the magnet 21 de-energized. By means of this arrangement, for example, if the magnets are operated from a perforated music sheet, a single perforation will permit closure of the circuit energizing the magnet 21 and the parts operated by the magnet will be held in the position after the magnet is de-energized until a perforation permitting closure of the circuit through magnet 23 energizes the latter. The hammer-rail lever 18 is then permitted to return to its normal position under the action of its spring 16^d.

Dampers 46 are lifted from the spring to produce the pedaling effect by the lever 47, which is operated by a pair of co-operating magnets 21^a and 23^a of substantially the same type of construction as electromagnets 21 and 23, and co-operating in substantially the same manner. In these electromagnets, as shown in Figure 2, the various elements are indicated by the same numerals that indicate corresponding elements in the electromagnets 21 and 23 in Figures 3 and 5, the suffix "a" being added to the several numerals. It will be apparent that a momentary energizing of the magnet 21^a will operate the lever 47 to lift the dampers 46, and the latter will be retained in the lifted position by co-operation of the magnet 23^a until the latter is momentarily energized.

The cores of magnets 21 and 21^a are preferably of laminated construction, as shown in Figure 4, undue heating thereof being prevented by this laminated construction.

The construction of the individual note-playing magnets 15 will be clear from a consideration of Figure 6. Each of these magnets is formed of a spool 48 of suitable insulated wire mounted in a metallic, preferably iron frame 49. Within the spool is a tube or hollow cylinder 50 of non-magnetic material, preferably brass. Slidably mounted within this tube is the magnetic core member 51, provided at its ends with rod-like projections 52 and 53. The rod-like projection 53 passes through a bushing 54 in the cap 55 in the lower end of the tube 50 and serves as a guide for the movement of the core. The rod-like projection 52 passes through a similar bushing 56 in the cap 57 in the upper end of the tube 50. The rod-like projection 52 is provided at its upper end with a head 13 and acts as a riser for operating the piano action, as shown in Figures 2 and 5.

As will be seen from Figures 1, 2 and 5, the note-playing magnets 15 are arranged in rows, each row of magnets being mounted upon an angle bar 50^a extending transversely across and parallel to the string frame. The angle bars 50^a are insulatably mounted upon the supporting braces 51^a, the insulation being indicated at 52^a. A channel bar 53^a is insulatably suspended from each angle bar 50^a and is lined with insulating material, such as fiber, indicated at 54^a. A panel 55^a of insulating material serves as a cover for this channel bar, which is used as a conduit for the electric cables controlling the individual notes. Terminals 56^a are provided on the panels 55^a, to which are connected one of the terminal leads from each of the note-playing electromagnets, the control lines for the corresponding notes being connected to the cor-

responding terminals inside the channel box or conduit 53a. The opposite terminals of the note-playing electromagnets are directly connected with the angle bars 50a, which serve as a common connecting line for all the electromagnets.

The operation of the various circuits controlling the mechanical devices of the piano will be clear from a consideration of Figure 7. In this figure the various parts are shown diagrammatically, the parts and electromagnets corresponding to those hereinbefore described being indicated by the same reference numerals. Two main connections 60 and 61 are provided for the supply of alternating current for the operation of the instrument. The line 60 is directly connected with the contact roller 61a, over which moves the perforated note sheet 62. Co-operating with the contact roller 61a and the note sheet 62 are a plurality of contact members 63 controlling the note magnets 15. Other contacts controlling the expression devices and the volume of sound are provided, as will be hereinafter described. From each contact 63 a connector 64 leads to a point of connection 56b, with which is connected a terminal line from the corresponding note-playing magnet 15. The other terminals of the note-playing magnets are all connected to a common connector or line 50b, corresponding to the angle bar 50a previously described. The line 50b is connected with a coil 66 which, in turn, is connected through line 67 with the other current supply line 61. The switch 84 is opened in playing by means of a perforation in the note-sheet. It will thus be apparent that when a perforation in sheet 62 corresponding to a given note passes between a contact 63 and contact roll 61, current will pass through that contact to the corresponding note-playing magnet 15, the connector 50b, the inductance 66 and the line 67 to the outlet line 61. The fixed inductance of the coil 66 will determine the force with which the core of the note-playing magnet is centered and consequently will determine the volume of sound of the note.

For varying the loudness of tone additional means closed by circuits through the contact roller 61a are provided. For decreasing the current and for correspondingly decreasing the volume of sound, a contact 68 is provided, which, when it engages the contact roller 61a, closes a shunt circuit through the line 69 and the coil 70 to the line 67. The coil 70 is wound in the same direction as the coil 66 and closure of this circuit consequently increases the inductance and decreases the current through the note-playing electromagnets through which circuits are closed from the circuit through contact 68. For producing a greater volume of sound, a contact 71 is provided, which, when it engages contact roll 61 through a perforation in the note sheet provided for the purpose, closes a shunt circuit through the line 72 and the coil 73 to the line 67. The coil 73 is wound in a reverse direction to the coil 66 and consequently when current is passed through coil 73, the inductance is decreased and the current actuating the electromagnets 15 energized while the current through contact 71 is closed, is greater than the normal current.

The electromagnets 21 and 23 controlling the hammer-rail are energized by the operation of contacts 74 and 75 respectively. When contact 74 engages the contact roll 61a through a suitable perforation in the note sheet, a circuit is closed through the line 76 to the electromagnet 21 and line 77 leading to the line 78 connecting with the main 61. A single perforation in the note sheet, causing a momentary energizing of the electromagnet 21 is sufficient, as has been previously explained, since by co-operation of the core of electromagnet 23, the core of magnet 21 is held in position until magnet 23 is energized. When contact 75 engages contact roll 61a through a perforation in the note sheet, a circuit is closed through line 79 and electromagnet 23, which is energized to retract its core and release the core of its electromagnet 21 in the manner previously described. The damper control magnets 21a and 23a are controlled in similar manner from contacts 80 and 81, respectively. The line leading from contact 80 to electromagnet 21a is indicated by numeral 83 and that leading from contact 81 to electromagnet 23a is indicated by numeral 82.

In Figure 7 circuits are diagrammatically shown for the control of the piano playing devices from keys and pedals such as are in use in ordinary pianos. When it is desired to use the manual and foot operated controls instead of the note-playing keys, the switch 84 is closed, thereby establishing a connection between the line 50b and the line 67 shunting out the inductance 66. The note-operating keys are indicated diagrammatically in end elevation at 85. The base of each key is connected by a line 86 with the terminal 56b of the corresponding note-playing magnet 15. Below each key are mounted two coil springs, a longer spring 87 and a shorter spring 88. The springs 87 and 88 serve as contact members, the spring 87 being engaged by the base of the key on a slight depression of the latter and the spring 88 being engaged on a more forcible depression of the key. Each of the contact springs 87 is directly connected with a common connector 90 leading to a coil or inductance 66a which is in turn connected through line 91 with the contact roller 61a. The inductance 66a plays the same rôle in modulating the sound produced by the electromagnets being

energized as does the inductance 66 in operating with the note sheet.

Forcible depression of the key causes engagement of the base of the key with the contact spring 88 as well as the contact spring 87. The contacts 88 are each connected with the common connector 92, which connects directly with the line 91 and shunts out of the circuit the inductance 66^a. When a circuit through one of the contacts 88 and the base of the key is closed, it is thus apparent that the inductance 66^a is shunted around with a corresponding increase in current through the electromagnet 15 being energized and a resulting increased volume of sound.

To soften the tone during manual operation, the pedal 93 may be employed. This pedal is connected to the main conductor 61 by a connection 94. When the pedal is depressed, it engages a contact 95, closing a circuit through the line 96 and coil 70^a to the line 91. The coil 70^a, being wound in the same direction as the coil 66^a, increases the inductance in the latter and thereby decreases the current passing to the note-playing electromagnet 15 being energized at the moment. The operation of the pedal 93 and the coil 70^a thus corresponds to that of the contact 68 and the coil 70 in operation with the note sheet.

The pedal 97 controls the energizing of the damper operating magnets 21^a and 23^a. With the switch 98 closed, the pedal is connected to the main line 61. Normally the end of the pedal 97 engages contact 99, thereby closing the circuit through the line 100, line 83 and electromagnet 23^a. On depressing pedal 97 circuit through the contact 99 is opened and circuit through the contact 101 is closed. Current then passes through the connecting line 102 and line 82 to electromagnet 21^a, energizing the latter to raise the dampers 46 from the strings. Release of the pedal 97 breaks the circuit through contact 101 and immediately makes the circuit through contact 99, thereby immediately energizing the electromagnet 23^a and releasing the damper.

I claim:

1. In a piano action, in combination, hammer actuating mechanism, a magnet coil, a freely movable core within the coil normally out of central position therein, means for supplying alternating current to said magnet coil, thereby bringing said core to central position, means operated by the movement of the core to operate the hammer actuating mechanism, a coil in the circuit in series with said magnet coil for determining the inductance in said circuit and means for varying the inductance of said second-mentioned coil to vary the current passing through said magnet.

2. In a piano action, in combination, hammer actuating mechanism, a magnet coil, a freely movable core within the coil normally out of central position therein, means for supplying alternating current to said magnet coil, thereby bringing said core to central position, means operated by the movement of the core to operate the hammer actuating mechanism, a coil in circuit in series with said magnet coil for determining the inductance in said circuit, a coil inductively coupled with said second-mentioned coil and wound in the same direction and independently controllable means for passing alternating current through the last-mentioned coil to increase the inductance in the former coil.

3. In a piano action, in combination, hammer actuating mechanism, a magnet coil, a freely movable core within the coil normally out of central position therein, means for supplying alternating current to said magnet coil, thereby bringing said core to central position, means operated by the movement of the core to operate the hammer actuating mechanism, a coil in the circuit in series with said magnet coil for determining the inductance in said circuit, a coil inductively coupled with said second mentioned coil and wound in the reverse direction, and independently controllable means for passing alternating current through the last-mentioned coil to decrease the inductance in the former coil.

4. In a piano action, in combination, hammer actuating mechanism, a magnet coil, a freely movable core within the coil normally out of central position therein, means for supplying alternating current to said magnet coil, thereby bringing said core to central position, means operated by the movement of the core to operate the hammer actuating mechanism, a coil in circuit in series with said magnet coil for determining the inductance in said circuit, coils inductively coupled with said first-mentioned coil, one of said coils being wound in the same direction and the other in the reverse direction, and independently controllable means for passing alternating current through the last-mentioned coils to vary the inductance in the first-mentioned coil.

5. In combination with a piano action, hammer actuating mechanism therefor comprising single electromagnet coils for each hammer of said action, a freely movable core in each of said coils, said cores being normally out of central position, a common connector for one of the terminals of each of said electromagnet coils, a coil in series with said common connection, independent connectors for the other terminals of each of said coils, and independently controllable means for closing the circuits through said

last-mentioned connectors to supply alternating current to the electromagnet coils, to thereby bring their cores to central position, and means operated by the movement of the cores of the magnets to actuate the corresponding hammers of the piano action.

6. In combination with a piano action, hammer actuating mechanism therefor comprising single electromagnet coils for each hammer of said action, a freely movable core in each of said coils, said cores being normally out of central position, a common connector for one of the terminals of each of said electromagnet coils, an inductance coil in series with said common connector, separate connectors for the other terminals of said coils, independently controllable means for closing a circuit through each of said separate connectors to supply alternating current thereto, to thereby bring the cores to central position, means operated by the movement of the cores of the magnets to actuate the corresponding hammers of the piano action, and means for varying the inductance of the coil in series with the common connector to vary the force of movement of the hammers.

7. In combination with a piano action, hammer actuating mechanism therefor comprising single electromagnet coils for each hammer of said action, a freely movable core in each of said coils, said cores being normally out of central position, a common connector for one of the terminals of each of said electromagnet coils, an inductance coil in series with said common connector, separate connectors for the other terminals of said coils, independently controllable means for closing a circuit through each of said common connectors to supply alternating current thereto, to thereby bring the cores to central position, means operated by the movement of the cores of the magnets to actuate the corresponding hammers of the piano action, an additional coil inductively coupled with the coil in series with the common connector, and means for passing alternating current through the last-mentioned coil to vary the inductance in the circuit through the electromagnets.

8. In combination with a piano action, hammer actuating mechanism therefor comprising single electromagnet coils for each hammer of said action, a freely movable core in each of said coils, said cores being normally out of central position, independently controllable means for supplying alternating current to each of said electromagnet coils, to thereby bring the cores thereof to central position, means operated by the movement of the cores of the magnets to actuate the corresponding hammers of the piano action and means for varying the inductance in the circuit of said electromagnet coils to vary the strength of current passing therethrough.

9. In a piano playing device, in combination with a piano action, alternating current magnets for actuating the individual hammers of said action, and a circuit for the control of each of said magnets including a manually operable key, contact means closed by partial movement of said key for closing the circuit and contact means operable on further movement of said key for reducing the inductance in said circuit.

10. In a piano playing device, in combination with a piano action, alternating current magnets for actuating the individual hammers of said action, and a circuit for the control of each of said magnets including a manually operable key, contact means closed by partial movement of said key for closing the circuit and independently controllable means for increasing the inductance in said circuit.

11. In a piano playing device, in combination with a piano action, electromagnet means for actuating the individual hammers of said action, and a circuit for the control of each of said magnets including a manually operable key, contact means closed by partial movement of said key for closing the circuit and contact means operable on further movement of said key for varying the current in said circuit.

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