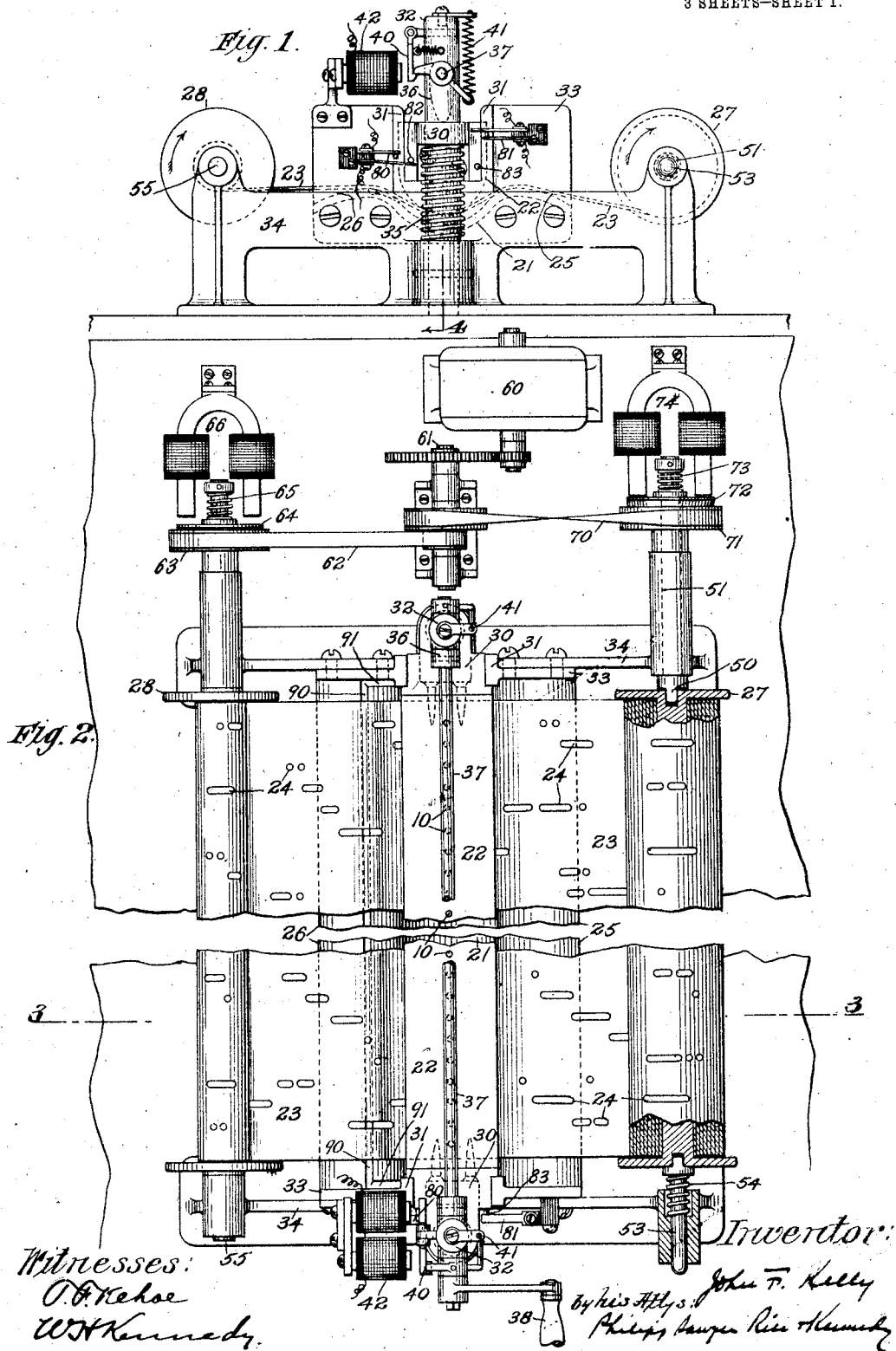


J. F. KELLY.
CIRCUIT CONTROLLING APPARATUS.
APPLICATION FILED AUG. 27, 1910.

1,041,294.

Patented Oct. 15, 1912.

3 SHEETS—SHEET 1.



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3 SHEETS—SHEET 2.

Fig. 3.

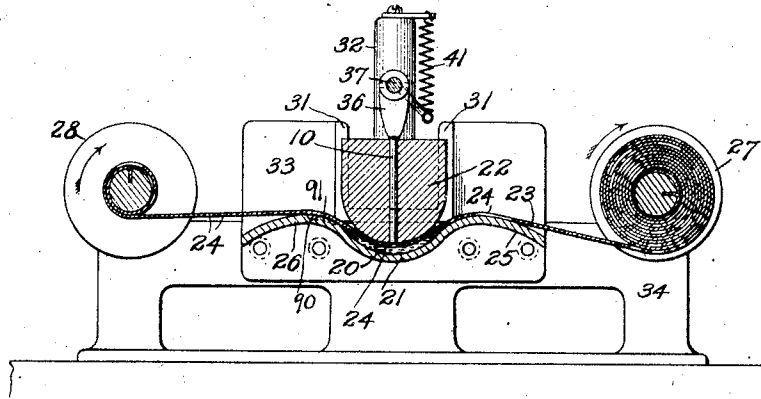


Fig. 4.

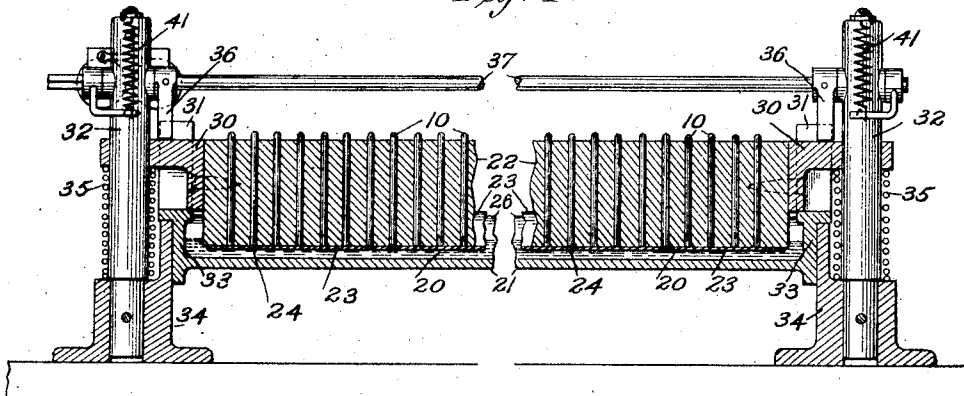
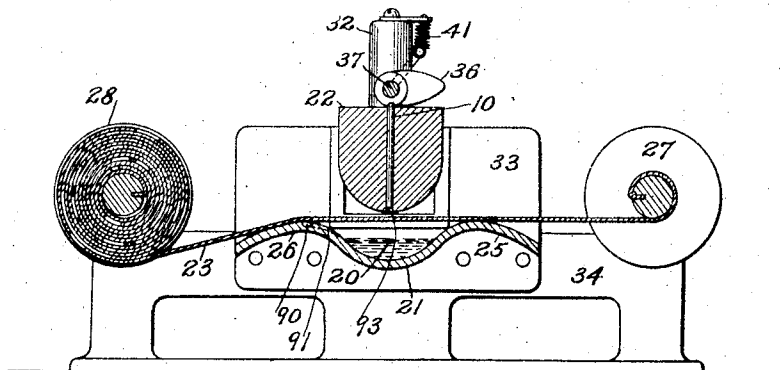


Fig. 5.



Witnesses:
O. F. Kehoe
W. H. Kennedy

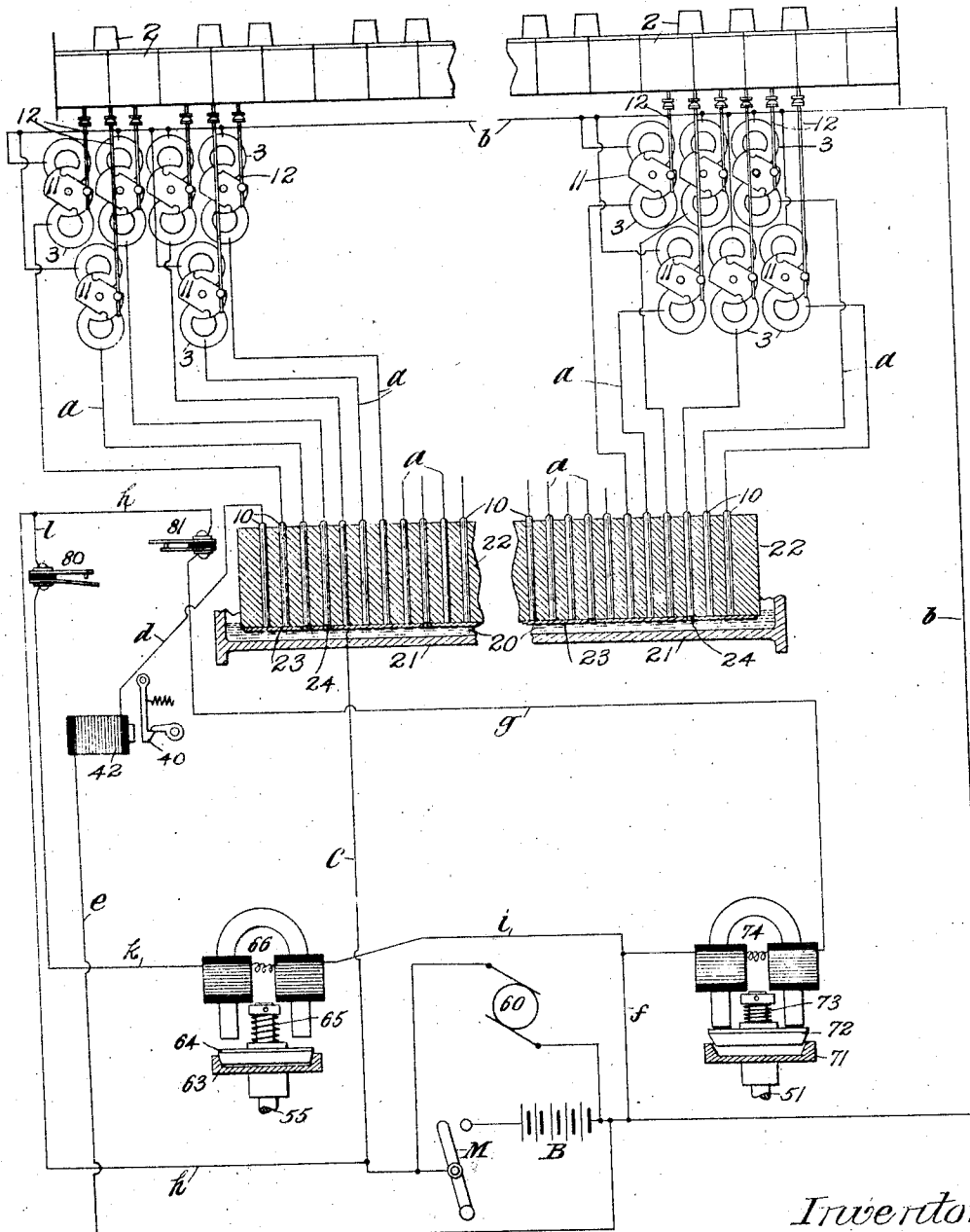
Inventor:
John F. Kelly
By his Attys. Philip Sawyer Rice & Kennedy

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Fig. 6.



Witnesses:
O. A. Kehoe
W. F. Kennedy.

Inventor:
John F. Kelly
By his Attys:
Philip Sawyer Rice Kennedy

UNITED STATES PATENT OFFICE.

JOHN F. KELLY, OF PITTSFIELD, MASSACHUSETTS.

CIRCUIT-CONTROLLING APPARATUS.

1,041,294.

Specification of Letters Patent.

Patented Oct. 15, 1912.

Application filed August 27, 1910. Serial No. 579,218.

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 Circuit-Controlling Apparatus, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to controlling devices for electric circuits, and has been made especially with the idea of providing an improved transmitting or circuit-controlling mechanism for electrically-operated playing apparatus for pianos or other key-board musical instruments, although the invention, broadly considered, will be found useful for other purposes.

The object of the invention is, generally, to provide a circuit-controlling device which shall be reliable and practically instantaneous in action, convenient to use, and simple and inexpensive in construction, the simplicity and cheapness of construction being especially noticeable in the case of circuit-controllers for controlling a large number of branch-circuits from a single main or supply circuit. Because of these advantages, and of others hereinafter referred to, the invention is of especial value in its adaptation to circuit-controlling mechanisms of automatically-controlled electrically-operated playing-apparatus for pianos or other musical instruments.

In accordance with my invention I employ a body of mercury or other suitable liquid conductor as the electrode which moves to make and break contact, and control the movement of the mercury or other liquid conductor by a perforated sheet of paper or other suitable non-conducting material which is moved beneath a guiding surface which is below the surface level of the liquid and which is provided with one or more contact-terminals or electrodes. When the paper sheet intervenes between the liquid and a particular terminal the circuit including that particular terminal is interrupted, but when a perforation comes opposite that terminal the liquid moves into contact therewith and the circuit is closed

and remains closed until the movement of the paper carries the perforation beyond the terminal.

A circuit-closer of preferred construction to embody the invention comprises a receptacle containing mercury, and a guiding device or tracker bar which is movable vertically and which when in its lower or operative position extends down into the receptacle below the surface of the mercury for guiding the perforated strip or sheet of paper or other suitable non-conducting material through the mercury. The guiding device is provided with one or more contact terminals or electrodes in position to be engaged by the mercury when such engagement is not prevented by the interposed sheet. As the sheet is moved beneath the guiding device and between its guiding surface and the mercury, whenever a perforation in the sheet comes opposite a terminal in the guiding device, the mercury will make contact through the perforation with such terminal and close the circuit in which the terminal is connected, and when the sheet is moved to carry such perforation beyond such terminal the body of mercury will be cut off from contact with the terminal and the circuit opened. The closing of the circuit or circuits will thus be controlled according to the movement of the perforated sheet and the location of the perforations therein; and in applying the invention to electrically operated playing apparatus for musical instruments the controlling sheet will be the usual perforated music sheet having the perforations arranged in the usual manner according to the position of the electrodes connected in the operating circuits and according to the tones to be sounded. The apparatus is provided with means for automatically lifting the guiding bar and reversing the movement of the perforated sheet at the end of the forward or operative movement of the sheet, and includes other features of construction, all as hereinafter fully described.

A full understanding of the invention can best be given by a detailed description of a construction embodying the same in the preferred form, and such a description will now be given in connection with the accompany-

ing drawings, which show so much as is necessary to illustrate the invention of a transmitting and playing apparatus for pianos or other key-board musical instruments embodying the various features of the invention.

In said drawings:—Figure 1 is an end view of the circuit-controlling or transmitting apparatus; Fig. 2 is a plan view of the same; Fig. 3 is a section taken on line 3 of Fig. 2; Fig. 4 is a section taken on line 4 of Fig. 3; Fig. 5 is a view similar to Fig. 3, but showing the parts in a different position; Fig. 6 is a diagrammatic view showing the electrical connections of the apparatus shown in the preceding views and showing also a portion of a key-board of a piano and operating magnets for actuating the keys.

Referring to the drawings, Fig. 6 shows at the top a series of finger keys 2 representing a portion of the key-board of a piano. Key-operating magnets 3 are located beneath the key-board, a magnet being provided for each key in the actual apparatus. The key operating magnets, as shown, are of the two-pole form having a pivotal oscillating armature 11 mounted between the poles, and the armature of each magnet is connected with the underside of its corresponding key by connecting rods 12 whereby when any magnet is energized and its armature rotated the key with which the 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 3 is electrically connected through a wire *a* with one of a series of contact terminals 10 of the circuit controlling or transmitting mechanism of the apparatus, through which connection may be made as hereinafter described with a battery B or other suitable source of electrical energy, and each magnet is also connected through a wire *b* with the other pole of the battery, the magnets being thus located in independent branch circuits controlled by the transmitting or circuit controlling mechanism, which will now be described.

A body of mercury or other conducting liquid 20 which forms the liquid electrode is contained in a comparatively long and narrow and preferably shallow trough-like receptacle or holder 21, and is in electrical connection with the battery B or other source of electrical energy through a main or supply wire *c*. Mounted to extend lengthwise of the trough is a guide bar or tracker bar 22, the lower part of which, when it is in operative position, extends downward into the mercury in the trough. The contact terminals or electrodes are formed by rods mounted in openings extending through the tracker bar with their lower ends in a

line in the surface of the tracker bar which is below the surface level of the mercury when the tracker bar is in operative position, and the terminal rods extend downward in the holes to or near to the lower surface of the tracker bar, and as shown in Figs. 3, 4 and 6 they extend down flush with the lower surface of the bar.

The lower surface of the tracker bar extends horizontally lengthwise of the mercury holder and the lower part of the bar is semi-cylindrical or of other suitable shape in cross-section to provide a convexly curved guiding surface against which the perforated controlling music sheet 23 runs as it is moved through the mercury beneath the bar. The controlling sheet is the so-called music sheet having note perforations 24 which are arranged crosswise of the sheet according to the position of the contact terminals 10 and their arrangement with respect to the operating magnets and according to the tones to be sounded, and lengthwise of the sheet according to the time and succession of the tones, and which perforations vary in length according to the time value of the notes which they represent. The sides of the mercury holder as shown extend upward and curve outward to form spreading or smoothing surfaces 25 and 26 against which the music sheet may run as it passes to and from the tracker bar. The music sheet is drawn in its playing movement from a let-off or carrying spindle or roller 27 over the first spreading or smoothing surface 25, thence under the tracker bar 22 and between it and the mercury, and thence over the spreading or smoothing surface 26 to a wind-up roller 28.

It will be seen that the path of the music sheet is practically a sinuous one in its movements to and from the tracker-bar as it passes over the spreading or smoothing surface 25 down into the mercury under and in contact with the lower surface of the tracker-bar, and up over the other spreading or smoothing surface 26 to the winding roller 28.

The tracker bar is mounted to have an upward and downward movement which is preferably a vertical one in the same plane, being for this purpose formed or provided at its ends with end pieces 30 which are shaped to slide in vertical guide-ways 31 and which also have outwardly extending collars which receive and slide on vertical posts or standards 32. The guide-ways 31 in the construction shown are formed in plates 33 which form the ends of the mercury trough and which are secured to the main supports 34. The tracker bar normally stands in its elevated position, as shown in Fig. 5, in which position its lower surface is preferably above the plane of the crests of the spreading and smoothing surfaces 25 and 26,

so as to permit of the ready passing of the music sheet beneath the tracker bar in threading the sheet into the apparatus, and of its movement beneath the bar out of engagement therewith in rewinding. The tracker bar is held in its normal or raised position by suitable springs 35, and is moved downward against the pressure of the springs into operative position by means of cam levers 36 which are carried by and secured to turn with a rock-shaft 37 journaled in the standards 32 and which may be turned by means of a handle 38 which is removable from the rock-shaft 37. When the shaft is turned to move the cams 36 from the position shown in Fig. 5 to that shown in Figs. 3 and 4, the tracker bar is moved downward to bring its lower curved surface in which are located the ends of the terminal rods 10 below the surface level of the mercury in the trough, and when moved to this position the shaft and cams are locked against return movement by a spring latch 40, which thus serves to lock the tracker bar in its operative position. When the latch 40 is retracted, the shaft 37 is rocked by springs 41 to return the cams to the position shown in Fig. 5, and the tracker bar being thus released is then returned by its springs 35 to its normal or raised position.

For effecting the automatic raising of the tracker bar at the end of the playing movement of the music sheet, means controlled by the music sheet are provided for retracting the latch 40, and for this purpose a magnet 42 is provided which is connected in a circuit including one of the contact terminals 10 with which the mercury comes into contact through a special perforation in the music sheet. The circuit to this magnet as shown in Fig. 6 is from the battery B through the main switch M by wire *c* to the mercury in the trough 21, thence through terminal 10 at the left in Fig. 6 and wire *d* to the magnet, and thence back to the opposite pole of the battery by wire *e*.

The music sheets used in the apparatus are rolled for transportation and for introduction into the apparatus onto a carrying reel or roller in the usual manner, such rolls serving as the let-off and rewinding roll when introduced into the apparatus. As shown, the carrying roll 27 is formed with axial recesses or sockets in its ends, the socket at one end being formed to receive a key stud 50 of flat or other suitable form on the end of a shaft 51, and the socket in the other end of the roll being formed to receive the end of a spindle 53 which is movable endwise against the pressure of a spring 54 to permit the roll to be placed in position in the usual manner, said shaft 50 and spindle 53 being journaled in bearings in the supporting frame 34 at one side of the tracker bar. The winding roll 28 is carried by a

shaft 55 journaled in bearings in the supporting frames 34 at the opposite side of the tracker-bar from the carrying or let-off reel. The winding roll is driven for drawing the music sheet past the tracker bar by means of an electric motor 60 geared to a countershaft 61 from which the roll shaft 55 is driven through a belt 62 running on a pulley on the countershaft and on a pulley 63 mounted to run freely on the shaft 55, and which is clutched to the shaft to drive the same by a clutch disk 64, which is mounted to turn with and is free to slide on the shaft and has a tapering peripheral face to engage a corresponding tapered inner face of the flange of the pulley 63 and is normally held in its driving position, as shown in Figs. 2 and 6, by means of a spring 65. A magnet 66, having preferably a U or other suitable shaped core, is mounted in position so that when energized it will attract the clutch disk 64 and withdraw it from engagement with the pulley 63, thereby unclutching or disconnecting the pulley 63 from the shaft 55 and interrupting the driving of the shaft by the motor. For rotating the carrying roll 27 for rewinding the music sheet thereon, the roll shaft 51 is driven from the shaft 61 by a belt 70 running on a pulley on the shaft 61 and also on a pulley 71 mounted free to rotate on the shaft 51. For clutching the pulley 71 to the shaft 51, a clutch disk 72 similar to the clutch disk 64 is mounted to rotate with and free to move endwise on the shaft, and is pressed by a spring 73 to move into its clutching or operating position and is retracted to the position shown in Figs. 2 and 6 to disconnect the shaft 51 from the pulley 71 by a magnet 74 similar to the magnet 66.

The circuits to the clutch magnets 66 and 74 are controlled automatically so that when the main switch M is closed and the tracker bar is in its lower or operative position the magnet 74 will be energized to disconnect the shaft 51 from its driving pulley 71 and the circuit to the magnet 66 will be open so that the shaft 55 of the winding roll 28 will be driven by the motor; and when the tracker bar is in its raised position the magnet 66 will be energized and the circuit to the magnet 74 will be open, so that the shaft 55 will be unclutched from its driving pulley 61 and the shaft 51 will be driven to rotate the carrying roll 27 for rewinding the music sheet thereon. For thus automatically controlling the circuits to the clutch magnets, normally-closed circuit-breaking devices 80 and 81 are provided in the circuits to the magnets 66 and 74, respectively, such circuit-breaking devices being formed and located, as shown in Figs. 1 and 2, so that when the tracker bar is moved to its lower or operative position the device 80 will be engaged by a projection or pin 82 on

one of the end pieces 30 of the tracker bar and operated to break the circuit to magnet 66, and when the tracker bar moves upward to its normal or raised position, the circuit breaking device 80 is first allowed to close the circuit to clutch magnet 66, and then as the tracker bar reaches its upper position a pin 83 projecting from the end piece 30 engages the circuit breaking device 81 and operates the same to open the circuit to the clutch magnet 74.

Referring to the diagrammatic view, Fig. 6, the circuit of the magnet 74 as shown is as follows:—Starting from one pole of the battery B, wire *f* leads to the magnet coil, and from the magnet coil wire *g* leads to the circuit breaking device 81 from which wire *h* leads back through the main switch M to the other pole of the battery. The circuit of the magnet 66 extends from the battery through wires *f* and *i* to the magnet coil and thence through wire *k* to the circuit breaking device 80 and thence by wires *l* and *h* back through the main switch to the other pole of the battery. The motor circuit is also controlled by the main switch M, the motor being preferably, as shown, supplied by the same battery or other source of electrical energy which supplies the key operating magnets 3, the clutch magnets and the magnet 42 which releases the tracker bar catch.

In the operation of the apparatus, a music roll comprising the roller 27 and a music sheet wound thereon is placed in position, supported by the key stud on the end of the shaft 51 and by the spindle 52, and the free end of the music sheet is threaded through between the tracker bar and the mercury and secured in any usual or suitable way to the winding roll 28, the tracker bar being in its normal raised position, as shown in Fig. 5, and the main switch M being open. The handle 38 is then turned to depress the tracker bar to its operative position, as shown in Figs. 3 and 4, thereby forcing the music sheet downward and bringing the lower surface of the tracker bar and the portion of the music sheet beneath it below the surface level of the mercury in the trough. The main switch being then closed, the roll 28 will be driven by the motor to draw the sheet beneath the tracker bar, and the circuits to the different key operating magnets will be closed according to the arrangement of the controlling slots or perforations in the music sheet in the following manner: As the sheet runs underneath the curved surface of the tracker bar, it will be held in close contact with such surface in the line of and for a distance on either side of the line of the contact terminals 10, and will, therefore, so long as a solid portion of the sheet is passing beneath the bar prevent the mercury, which is under pressure beneath the bar and thereby tends to move into contact

with the contact terminals, from reaching and making contact with the contact terminals. When, however, any perforation in the music sheet comes beneath any one of the contact terminals, a portion of the mercury which had already filled the perforation will immediately make contact with such contact terminal to close circuit to the operating magnet which is connected with such contact terminal through one of the branch lines *a*, and such magnet will thereby be energized to operate the corresponding sound producing device of the piano to cause the sounding of the tone represented by that particular perforation in the music sheet. The circuit to this particular operating magnet will then remain closed through the contact terminal and the mercury so long as this particular note perforation in the music sheet is passing beneath the contact terminal, and as the perforation with its portion of mercury, is carried forward by the continued movement of the music sheet, and passes beyond the contact terminal access of the mercury to the contact terminal will be cut off and the circuit to the operating magnet suddenly broken. In the same manner, as each note perforation in the music sheet crosses the line of the contact terminals at the bottom of the tracker bar, circuit will be completed to the corresponding operating magnet to cause the sounding of the tone represented by such perforation and will remain closed for a time corresponding to the whole or full length of the perforation.

When the music sheet has been given its full movement and the last note perforation has passed beyond the line of the contact terminals in the tracker bar, the circuit to the releasing magnet 42 will be closed by a special perforation provided in the sheet for that purpose as hereinbefore explained, and by the action of this magnet the tracker bar will be released and will then be immediately returned by its lifting springs to its normal or raised position, and by the upward movement of the tracker bar the winding roll will be disconnected from the motor and the carrying or rewinding roll 27 connected to be driven by the motor, thus reversing the movement of the music sheet and causing it to be rewound on its carrying roller 27. During such rewinding movement the sheet will run freely between the mercury and the tracker bar and preferably out of engagement with both. At the end of the rewind, the main switch will be thrown to stop the motor, and the operative parts of the apparatus will be in position to permit the removal of the music roll which has just been played and the insertion of a new roll.

The electrodes or contact terminals must be insulated from each other, of course, and for this purpose the tracker bar

may be made of a suitable insulating material, such as wood. The receptacle or holder 21, as well as the contact terminals 10, will usually be made of metal, and when mercury is used for the liquid electrode these parts must be made of a metal that will not readily form an amalgam with the mercury. As the perforated music sheet leaves the mercury and runs up over the spreading or smoothing surface 26 it tends to lift mercury in its perforations. To prevent the waste and diffusion of mercury, by restoring to the trough any mercury so lifted, a riffle or minor trough 90 is formed near the crest of the guiding surface 26 over which the music sheet passes in leaving the mercury during its playing movement. The riffle or minor trough drains back into the main trough through end channels 91. Any mercury lifted by the music sheet will thus be caught in the riffle and will drain back into the main trough.

Instead of having the contact terminals 10 extend down flush with the lower guiding surface of the tracker bar, they may be arranged with their lower ends extending downward sufficiently so that they will be below the surface level of the mercury when the tracker bar is in its lower or operative position but above the lower ends of the holes in the tracker bar, as shown in Fig. 5. There will thus be left a hole or recess 93 in the tracker bar beneath each contact terminal which is open to the under side of the tracker bar. The operation is the same as when the contact terminals extend down flush with the surface of the tracker bar except that the recesses beneath the ends of the terminal rods will become filled with mercury which will remain in the recesses when an imperforate part of the sheet is beneath them, and be filled at other times when the perforation registers therewith.

The music sheet may be made of any suitable material, but I preferably use a sheet of strong flexible paper which is treated with a substance, such as a suitable oil or varnish, which will make the paper less hygroscopic and increase its dielectric strength without depriving it of the requisite flexibility. I prefer to treat the paper for this purpose with a soft or semi-fluid paraffin, such as vaseline.

From the foregoing description it will be seen that an apparatus constructed in accordance with the present invention, in addition to the general advantages and good qualities hereinbefore referred to, possesses certain important advantages contributing to the reliability and practically instantaneous action of the apparatus, and avoids difficulties met with in the use of other circuit controllers or transmitters employing a perforated controlling sheet or tape. All

such perforated-sheet controllers or transmitters, so far as applicant is aware, make use of reading fingers or brushes which co-operate with the perforations in the sheet, either to make contact directly through the perforations or to control other contact devices. This makes the tracking of the sheet rough and irregular, the friction being very variable, and the fingers are liable to tear the perforated paper. With the apparatus of the present invention, on the other hand, the tracking is perfectly smooth and regular. There is also much less danger from sparking with this apparatus, and oxidation by sparking is largely prevented by the fact that the break takes place below the surface of the mercury or other conducting liquid so that the paper is not to any considerable degree subject to the action of the air; and direct heat from the spark is largely obviated by the presence of a large metallic mass. Then, again, the break being below the surface of the mercury, a fresh clean contact surface is always available, inasmuch as all impurities in the mercury tend to rise to the surface. Another advantage of the present invention, as compared with an apparatus employing the reading fingers, is that the full length of the slot or perforation in the controlling sheet is available. Where a reading finger is employed, the effective length of the slot is reduced by an amount equal to the breadth of the point or part of the reading finger that projects through the slot. In applicant's apparatus, the circuit is closed practically instantaneously when the front of the slot reaches the contact terminal, and the circuit remains closed until the end of the slot passes the contact terminal. The full length of the slot is thus fully available, and in fact the apparatus will operate to maintain the circuit closed for a time corresponding to the length of the slot plus the extent of the contact terminal longitudinally of the direction of movement of the perforated sheet. The necessary length of the slots in the controlling sheet is thus very considerably reduced, and the weakening of the sheet correspondingly lessened. This feature of making the full length of the slot available, as well as other advantages here referred to, is of special value in the application of the invention to transmitting or controlling mechanism for playing apparatus for musical instruments, since the length of the perforations or slots in the music sheet become more nearly proportional to the true time of the notes.

It will be seen from my construction that it is not necessary for the operator, in re-threading the controller, to bring the hands into contact at all with the mercury in the trough. With the tracker-bar 22 in the elevated position shown in Fig. 5, the sheet

may be readily passed below the lower surface of the bar from the unwinding roll 27 to the winding-roll 28. It will be further noticed, from Fig. 3, after the tracker-bar has been depressed, and considering the sheet 23 as moving from left to right, that the upper surface of the mercury is a curved one; or, in other words, I have a curved contact surface which conforms to, and accurately fits, the under curved surface of the perforated sheet. The top contact surface of the mercury is, therefore, a curved one. It should also be observed that on account of the upward pressure of the mercury on the lower side of the music sheet there is absolutely no danger of the mercury working between the sheet and the tracker-bar 22. By the term "guiding" surfaces, as applied to the parts 25 and 26, I intend to describe them or refer to them as a spreading and smoothing surface for the music sheet, and not strictly as a guide. It will be seen that during the re-winding movements the perforated sheet, as shown in Fig. 5, is out of contact with the mercury, or conducting liquid, and runs free from the roll 27 to the roll 28, and barely touches the lower curved surface of the tracker-bar 22. The spreading or smoothing surfaces 25 and 26 serve to hold the sheet elevated from the liquid.

What is claimed is:—

1. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a single guiding surface facing downward in the receptacle below the surface level of the liquid, a contact terminal in said guiding surface, and means for moving a perforated sheet of non-conducting material against the downwardly facing guiding surface.

2. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a guiding member in the receptacle having a guiding surface below the surface level of the liquid, a contact terminal in said guiding surface, and means for moving a perforated sheet of flexible non-conducting material beneath said member and against said guiding surface.

3. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a single guiding member in the receptacle having a downwardly facing, curved guiding surface below the surface level of the liquid, a plurality of contact terminals arranged in said guiding surface, and means for moving a perforated sheet of non-conducting material beneath said member and against said guiding surface.

4. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a guiding member in the receptacle having a curved guiding surface below the surface level of the liquid and

having holes open to the guiding surface, contact terminals in said holes extending downward to below the surface level of the liquid but above the lower ends of the holes, and means for moving a perforated sheet of non-conducting material beneath said member and against said guiding surface.

5. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a guiding member having a downwardly facing, curved guiding surface, a fixed contact terminal in an opening in said guiding surface, guide-ways in the receptacle to permit said guiding member to move from a position above the liquid vertically downwardly to carry its guiding surface below the surface level of the liquid, and means for moving a perforated sheet of non-conducting material beneath said member and against said guiding surface.

6. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a single guiding member having a guiding surface, a contact terminal arranged in said guiding surface, means for moving the guiding member to carry its guiding surface into the liquid and for retracting it to withdraw its guiding surface from the liquid, and means for moving a perforated sheet of non-conducting material against said guiding surface.

7. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a guiding member having a guiding surface, a contact terminal arranged in said guiding surface, means for moving the guiding member to carry its guiding surface into the liquid and for automatically retracting the guiding member, and means for moving a perforated sheet of non-conducting material against said guiding surface.

8. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a guiding member having a guiding surface, a plurality of contact terminals arranged in said guiding surface, means for moving a perforated sheet of non-conducting material past said guiding surface, and means for moving the guiding member downward to depress its guiding surface and the portion of the perforated sheet adjacent thereto into the liquid.

9. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a guiding member having a guiding surface, a plurality of contact terminals arranged in the guiding surface, means for moving a perforated sheet of non-conducting material past said guiding surface, means for moving the guiding member downward to depress its guiding surface and a portion of the perforated sheet adjacent thereto into the liquid, and means controlled by the perforated sheet for

lifting the guiding member to raise its guiding surface above the liquid.

10. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, spreading or smoothing means at opposite sides of the receptacle for supporting a perforated sheet of non-conducting material, and a guiding device having a guiding surface and a plurality of contact terminals in the guiding surface, said guiding device being mounted to move downward between said guides to carry its guiding surface and the portion of the perforated sheet adjacent thereto downward into and below the surface level of the liquid.

11. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a tracker bar having a curved under guiding surface and a plurality of contact terminals arranged therein, means for moving a perforated sheet of non-conducting material past the guiding surface of the tracker bar, means for moving the tracker bar downward to depress its guiding surface and the portion of the perforated sheet adjacent thereto into the liquid and for raising the tracker bar to lift its guiding surface above the liquid, and means controlled by the movement of the perforated sheets for controlling the movement of the tracker-bar.

12. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a tracker bar having a plurality of contact terminals arranged in its guiding surface, means for moving a perforated sheet of non-conducting material past the guiding surface of the tracker bar, means for moving the tracker bar downward to depress its guiding surface and the portion of the perforated sheet adjacent thereto into the liquid and for raising the tracker bar to lift its guiding surface above the liquid; and means controlled by the tracker bar on its upward movement for reversing the direction of the movement of the perforated sheet.

13. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a tracker bar having a plurality of contact terminals arranged in its guiding surface, means for moving a perforated sheet of non-conducting material past said guiding surface, means for moving the tracker bar downward to depress its guiding surface and the adjacent portion of the perforated sheet into the liquid, means controlled by the perforated sheet for raising the tracker bar, and means controlled by the movement of the tracker bar for reversing the direction of movement of the perforated sheet.

14. In a circuit controlling apparatus, the combination of a receptacle containing a

conducting liquid, a tracker bar having a plurality of contact terminals arranged in its guiding surface, a carrying roll, a winding roll for drawing a perforated sheet of non-conducting material from the carrying roll past the guiding surface of the tracker bar, means for moving the tracker bar downward to depress its guiding surface and the adjacent portion of the sheet into the liquid and for raising the tracker bar to lift its guiding surface above the liquid, driving means for rotating the winding roll for causing the forward movement of the perforated sheet and for rotating the carrying roll for rewinding the sheet thereon, and means for controlling said driving means to cause the winding roll or the carrying roll to be driven according to the position of the tracker bar.

15. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a tracker bar having a plurality of contact terminals arranged in its guiding surface, supporting rolls for a perforated sheet of non-conducting material, driving means for rotating said rolls to move the perforated sheet past the guiding surface of the tracker bar, means for moving the tracker bar downward to depress its guiding surface and the adjacent portion of the perforated sheet into the liquid, means for automatically raising the tracker bar to lift its guiding surface above the liquid at the end of the forward movement of the perforated sheet, and means controlled by the movement of the tracker bar to cause one or the other of the carrying rolls to be driven by the driving means to cause the sheet to be driven forward or backward according to the position of the tracker bar.

16. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a tracker bar having a plurality of contact terminals arranged in its guiding surface, a carrying roll, a winding roll for drawing a perforated sheet of non-conducting material from the carrying roll past the guiding surface of the tracker bar, means for moving the tracker bar downward to depress its guiding surface and the adjacent portion of the perforated sheet into the liquid, a driving motor, means for connecting the motor with the winding roll for causing the forward movement of the perforated sheet, and means for disconnecting the driving motor from the winding roll and for connecting it with the carrying roll for causing the sheet to be rewound on the carrying roll.

17. In a circuit controlling apparatus, the combination of a tracker bar, a carrying roll, a winding roll for drawing a perforated sheet of non-conducting material from the carrying roll past the tracker bar, a driving motor, driving connections between the motor and the winding roll and the carrying

roll, means for moving the tracker bar into and out of operative position, and electrically operated means controlled by the movement of the tracker bar for controlling said driving connections to determine which roll shall be driven by the motor.

18. In a circuit controlling apparatus, the combination of a tracker bar, means for moving a controlling sheet past the tracker bar, means for moving the tracker bar into operative position, means controlled by the controlling sheet for returning the tracker bar to its non-operative position, and electromagnetic means controlled by the movement of the tracker bar for effecting reversal of the direction of movement of the controlling sheet.

19. The combination with a receptacle containing a conducting liquid, of a tracker bar 22 having a convexly curved under guiding surface, contact terminals 10 arranged in openings in the tracker bar open to the guiding surface of the bar, spreading or smoothing surfaces 25 and 26, and means for feeding a perforated sheet of non-conducting material over the surfaces 25 and 26 and beneath and against the guiding surface of the tracker bar and between said guiding surface and the liquid.

20. In a circuit controlling mechanism, the combination of a receptacle containing a conducting liquid to be electrically connected with a source of electrical energy, a tracker-bar having a curved under guiding surface for guiding a perforated sheet through the liquid, a series of contact terminals in said guiding surface, each to be connected with one of a series of electrically operated operating devices.

21. In a circuit controlling mechanism, the combination of a receptacle containing a conducting liquid to be electrically connected with a source of electrical energy, a tracker bar having an under guiding surface, a series of contact terminals in its guiding surface each to be connected with one of a series of electrically operated devices, means for moving a perforated sheet past the tracker bar, and means for moving the tracker bar downward to depress its guiding surface and the adjacent portion of the sheet into the liquid and for raising the tracker bar above the liquid.

22. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a guiding surface in the receptacle below the surface level of the liquid, a contact terminal in an opening in said guiding surface, means for moving a perforated sheet of non-conducting material against said guiding surface, a stretching and smoothing surface for the perforated sheet as it leaves the liquid, and a minor trough draining into the main receptacle for receiving and returning to the

main receptacle liquid carried out of the main receptacle in perforations in the sheet.

23. In a circuit controlling apparatus, the combination of a receptacle containing a conducting liquid, a tracker-bar, terminals therein, means for elevating and depressing the bar above the surface of and into the liquid, a perforated sheet of insulating material located below the tracker-bar whereby when the sheet is depressed by the bar into the liquid the latter will flow through the perforated sheet into contact with the terminals in the tracker-bar.

24. In a circuit controlling apparatus, the combination of a receptacle for containing a conducting liquid, the sides of which are curved away from the bottom portion of the receptacle, a tracker-bar provided with contact terminals, means for elevating and depressing the bar above and into the liquid, a perforated sheet located below the tracker-bar and movable therewith down into the liquid to close the circuit from the liquid to the contact terminals.

25. In a circuit controlling apparatus, the combination with a receptacle for receiving a conducting liquid, the opposite sides of the same being provided with curved surfaces to support a perforated sheet, a tracker-bar, an electrical terminal therein, means for depressing said bar into, and raising it from, the liquid, rollers for receiving the sheet and adapted to permit the same to move from one to the other in rewinding, and out of contact with the liquid when the tracker-bar is elevated.

26. A circuit controlling apparatus having in combination, a mercury terminal to receive a perforated insulating sheet, winding and rewinding means for the sheet, means to depress the sheet below the normal surface of said terminal when the controller is in use, and means to elevate the sheet for rewinding.

27. In a circuit controlling apparatus, the combination with a receptacle for containing a mercury terminal to receive a perforated insulating music sheet, a tracker-bar having terminals therein for closing an electric circuit from the mercury terminal, means for elevating the bar above the mercury electrode to permit the insertion of the sheet without immersion, and means to depress the bar and carry the sheet into contact with the mercury electrode.

28. An electric circuit controlling device comprising a receptacle, a conducting fluid in the receptacle, a tracker-bar, means for reciprocating the bar, a perforated music sheet of insulating material interposed between the bar and the conducting fluid in the receptacle, whereby the movement of the bar toward the conducting fluid will move a portion of the music sheet into contact with the conducting liquid.

29. In an electric circuit-controller, the combination of a trough containing an electric conducting fluid therein, a perforated sheet of insulating material, winding and
5 rewinding rolls between which said sheet travels, means for depressing a portion of the sheet into the conducting fluid and below its normal surface to close the circuit and comprising a terminal to cooperate with

the conducting fluid and the perforated 10 sheet, and means for elevating the terminal.

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

JOHN F. KELLY.

Witnesses:

A. L. KENT,
P. F. KEHOE.