Jan. 2, 1923.

1,440,763.

H. BOCKISCH.

AUTOMATIC MUSICAL INSTRUMENT.

FILED APR. 21, 1920.

2 SHEETS—SHEET 1.

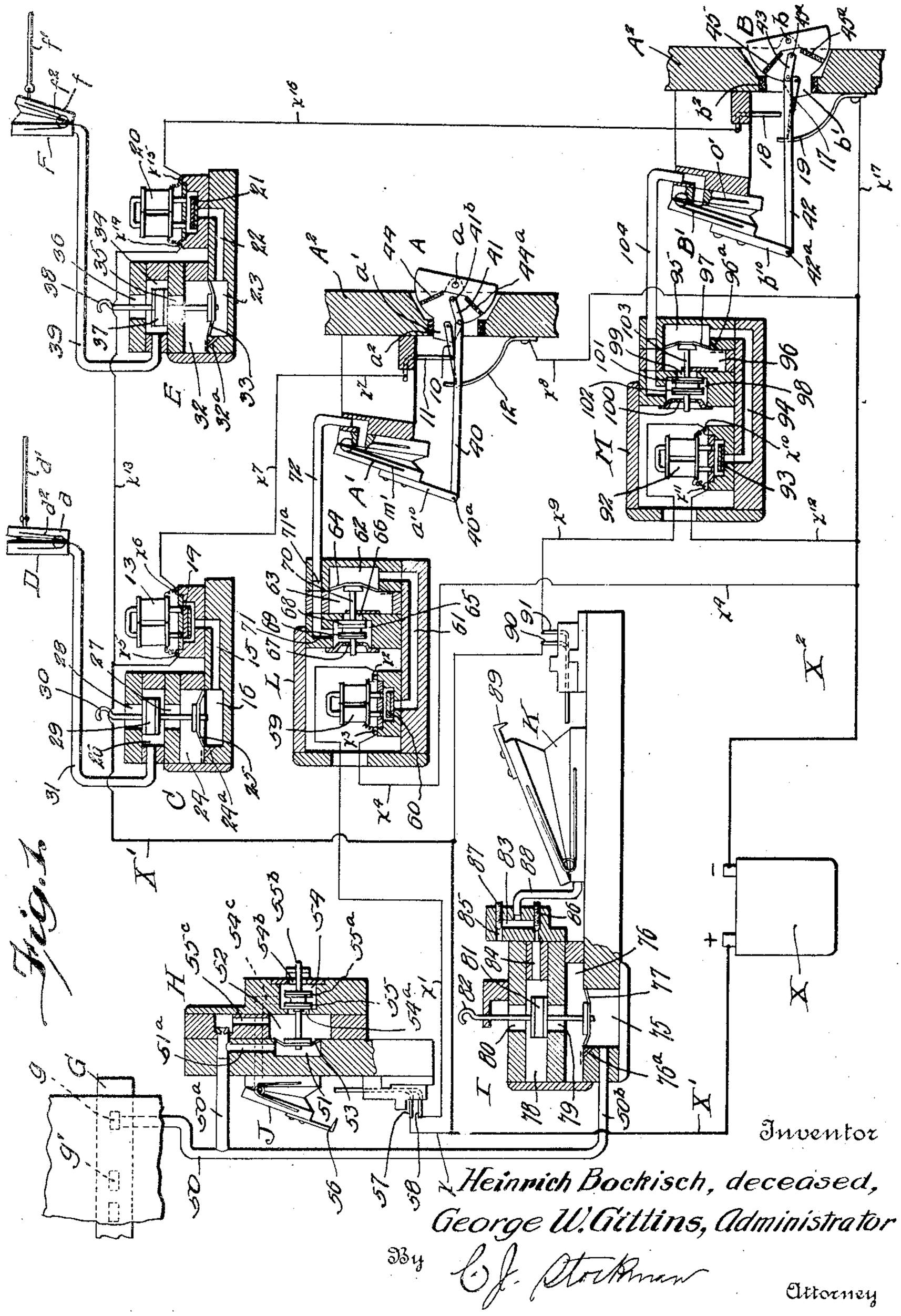

Fig. 1.

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2 SHEETS—SHEET 2.

Fig. 2.

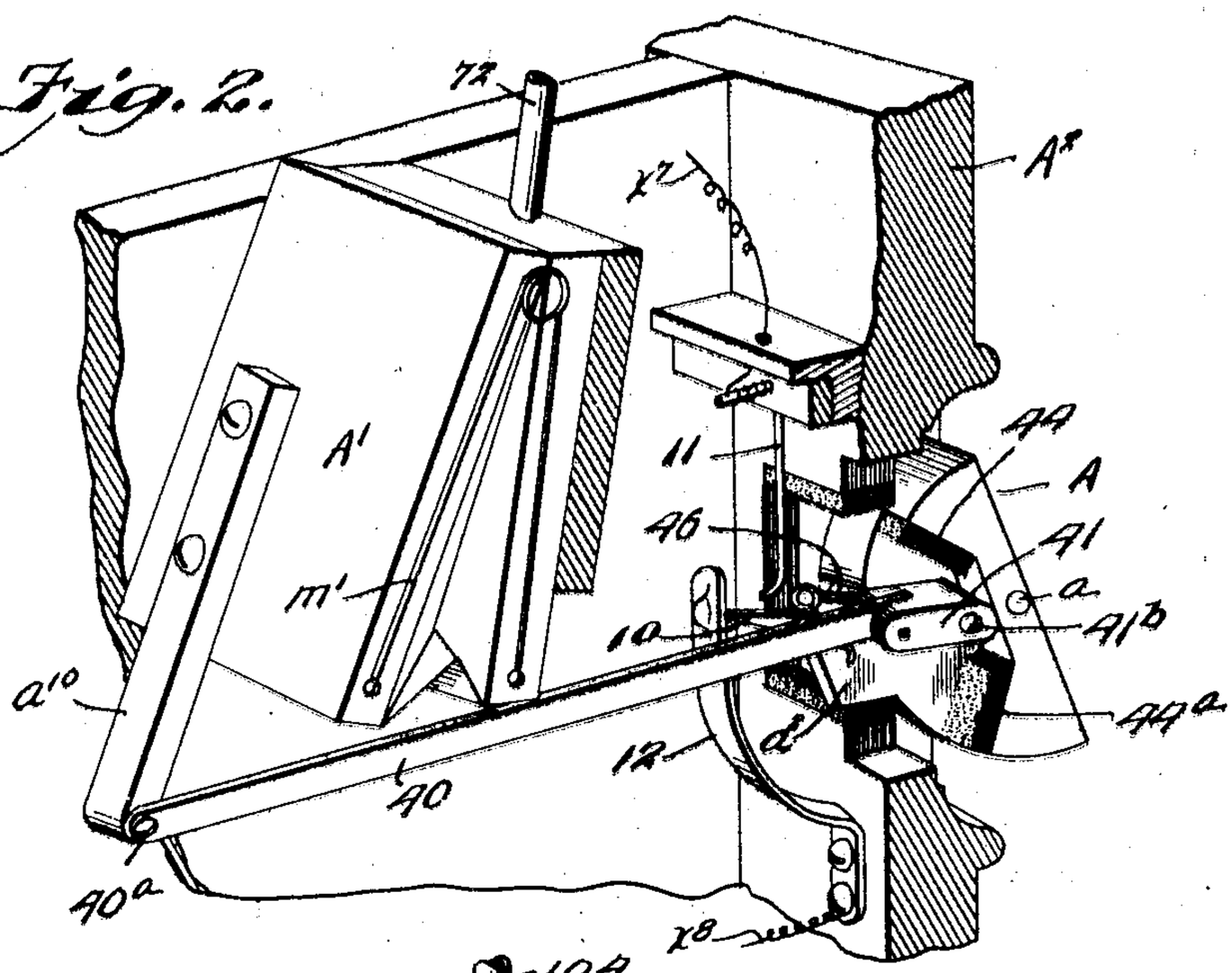
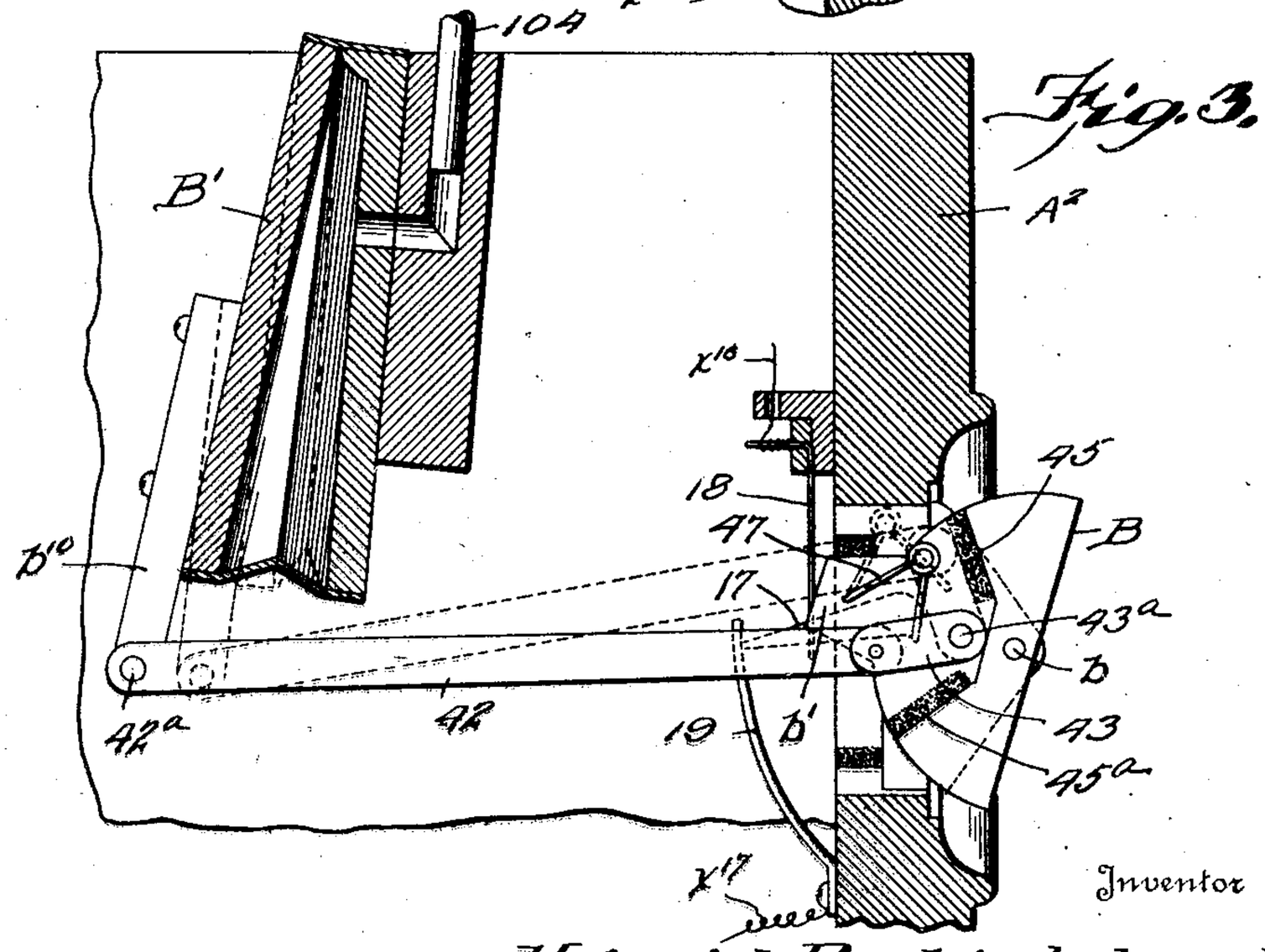


Fig. 3.



Witness

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Inventor

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Patented Jan. 2, 1923. 1,440,763

UNITED STATES PATENT OFFICE.

HEINRICH BOCKISCH, DECEASED, LATE OF POUGHKEEPSIE, NEW YORK, BY GEORGE W. GITTINS, ADMINISTRATOR, OF NEW YORK, N. Y., ASSIGNOR TO WELTE-MIGNON CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

AUTOMATIC MUSICAL INSTRUMENT.

Application filed April 21, 1920. Serial No. 375,576.

To all whom it may concern:

Be it known that HEINRICH BOCKISCH, deceased, late a citizen of the Republic of Czecho-Slovakia, and formerly residing at Poughkeepsie, in the county of Dutchess and State of New York, United States of America, invented certain new and useful Improvements in Automatic Musical Instruments, of which the following is a specification.

This invention has relation to musical instruments of the kinds or styles provided with a plurality of sets, registers or scales of tone elements, each set having a different quality of tone from that of every other set in the instrument. It more particularly relates to stop mechanisms for such instruments. Organs furnish a leading example of instruments of the kind or style referred to and accordingly this invention will be described as applied to organs, but it will be understood that this particular application of the invention is merely exemplary.

It is well understood that in a pipe organ the several sets of pipes—constituting sets of tone elements—are connected to wind passages, respectively, each passage having a stop valve which is opened to admit pressure to the several pipes constituting the set connected thereto, and that in the humanly played organ these valves are opened and closed by the manual manipulation of elements which are arranged adjacent the keyboard and are commonly called "stops" and are so designated in the present application. In other words, whenever the term "stop" is employed in the following description and claims it will be understood to refer to one of these elements which in the humanly played organ is manipulated by the performer to render a set of tone elements operative or inoperative, and not to the set of pipes itself.

One of the important purposes of the present invention is to provide a means whereby a stop of a musical instrument may be moved under control of a record to its "on" and "off" positions to thereby render the corresponding set of tone elements operative and inoperative respectively.

Another of the important purposes of the invention is to provide a manually operable stop with means whereby it may be also operated under control of a record.

A further important purpose of the invention is to provide means whereby a plurality of stops may be selectively operated by record-controlled impulses of different characteristics to render the corresponding tone elements operative alone or together, and which record-controlled impulses of different characteristics for a portion of their course travel a common path, thereby substantially reducing the width of the record which would otherwise be required to control the operation of the stops.

These main purposes of the invention, and others which will be understood without particular mention, are well secured from the construction in the accompanying drawings exemplifying the preferred embodiment of the invention.

In said drawings, wherein like characters of reference denote corresponding parts in the several views:—

Fig. 1 is a diagrammatic view illustrating a very desirable embodiment of the invention, having two stops A and B, and showing the stop A in its on position and the stop B in its off position.

Fig. 2 is a detail view on a larger scale than Fig. 1, showing the stop A in its "off" position, together with a motor for operating said stop and the connections between the motor and the stop.

Fig. 3 is a detail view illustrating the stop B in its "on" position, together with its motor and the connections between it and the motor.

I have considered it to be unnecessary to illustrate the sets of tone elements, or the stop valves, or tone valves, with the wind passages to which the sets of tone elements and stop valves and tone valves are connected, as these may be of ordinary character, such as are well known in the art. In a companion application, executed of even date herewith Serial Number 375,575, to which in many respects the present invention is subsidiary, I have illustrated one ordinary arrangement of sets of tone elements with stop valves therefor, respectively. Reference to that application may be had if necessary for a disclosure of one arrangement of such elements and valves which may be employed.

A and B designate two stops. It will be understood that in practice there may be

any number of these stops. In such case it would be necessary only to duplicate the mechanism illustrated and hereinafter described. It will also be understood that, in practice, the stop A is connected with a stop valve (not shown) to open and close the same to control the pressure to a wind channel to which a set of tone elements (not shown) are connected so that the elements are operative when the valve is open and inoperative when the valve is closed, as is customary. It will further be understood that, in practice, the stop B is connected with a second stop valve (not shown) to control the pressure in a second wind channel (not shown) to which a second set of tone elements (not shown) are connected.

The stops A and B are capable of both manual and automatic manipulation, individually and together, whereby the stop valves similarly may be controlled either manually or automatically.

The stops which I prefer are pivoted at *a* and *b* respectively. The connections between the stops A and B and the corresponding stop valves are preferably each of electro-pneumatic nature.

The accompanying drawings illustrate suitable connections of said nature, but connections of other construction and nature may be employed. The one illustrated between the stop A and the corresponding stop valve comprises a contact element 10 movable with said stop, and adapted to bridge the space between two contact members 11 and 12, and to thereby close an electrical circuit, hereinafter traced, which includes an electro-magnet 13 whose armature 14 opens and closes an atmospheric duct 15 which extends to a chamber 16 in a member C which controls the tension of the air within a pneumatic motor D whose movable board *d* is connected to the corresponding stop valve by a link *d'*. The connection between the stop B and the corresponding stop valve is of similar character, said stop having a contact member 17 to bridge the space between two contact members 18 and 19 to close a circuit through a magnet 20 whose armature 21 opens and closes an atmospheric duct 22 which extends to a chamber 23 in a member E, which member controls the tension of the air in a pneumatic motor F whose movable board *f* is connected to the corresponding stop valve by a link *f'*. The motors D and F are provided with springs d^2 and f^2 respectively, for expanding them when the tension of the air within and without the motors is equal to each other, or, in other words, when both the inside and outside pressures are atmospheric, for example. Stop A has a rearward projection *a'* and stop B has a similar projection *b'*. These projections cooperate with the walls a^2 and b^2 in the board A^2 of the console, to limit the pivotal movements of the stops, said walls preferably having facings of felt or other suitable material to deaden the sound resulting from impact of the stops therewith.

The member C comprises, in addition to the chamber 16, a suction channel 24 which is connected to chamber 16 by a bleed hole 24^a, and is separated therefrom by a membrane 25, a valve chamber 26 having a suction port 27 and an atmospheric port 28, and a valve 29 in the valve chamber, provided with a stem 30 in operative relation with the membrane 25. A duct 31 extends from the valve chamber 26 to the motor D.

The control member E is of like construction: 32 being its suction channel; 32^a the bleed hole, 33 the membrane; 34 the valve chamber; 35 and 36 the suction port and atmospheric ports, respectively; 37 the valve in said chamber; and 38 the valve stem. 39 designates a duct which extends from the valve chamber 34 to the motor F.

It will be apparent, that if either stop be turned pivotally to its "on" position, i. e., in the direction which closes the circuit through the corresponding magnet, air at atmospheric pressure will be admitted to the chamber 16 or 23 of the corresponding member C or E, thereby causing the valve, 29 or 37, of said member to move and uncover suction port 27 or 35, and close atmospheric port, 28 or 36, and that this will result in the collapsing of the corresponding motor D or F and the opening of the corresponding stop valve. It will also be understood that if either of the stops is moved to its "off" position, thereby breaking the circuit to the corresponding magnet 13 or 20, the reverse operation will take place, namely, communication of air at atmospheric pressure with chamber 16 or 23 of the central member corresponding to the stop which has been thus moved, will be cut off; the valve 29 or 37 of said member will be moved to close the suction port and open the atmospheric port of the corresponding central member, thus admitting air at atmospheric pressure to the corresponding motor D or F, whereupon said motor will be expanded by its spring d^2 or f^2 and in expanding will close the corresponding stop valve.

In Fig. 1, stop A is shown in the position it occupies during the first named operation, that is to say, when it is completing the circuit to magnet 13, and stop B is shown in the second named position, namely, when the circuit to magnet 20 is broken. It will be understood that when the parts are in the position illustrated in this figure all of the tone elements of the set controlled by stop A are operative and that any of them will speak, when the corresponding tone valve (not shown) is opened either by pressure upon the corresponding key, as when the instrument is being played manually, or under

control of a record when it is being played automatically. With the stop B in the position illustrated none of the sets of tone elements controlled therefrom will speak because the stop valve controlling the pressure of the air in the wind channel to which said tone elements are connected will be closed.

These stops A and B and the connections thus far described between the stops and stop valves are well adapted for manual operation, as will be apparent, but in order that they may be also adapted for automatic operation, i. e., under control of a suitably prepared record, the invention broadly contemplates mechanism for moving the stops including connections which in either movement of the stop (i. e. to "on" or "off" position as the case may be) are set into position to move the stop in the opposite direction. In the practical embodiment of the invention it is preferred to provide for each stop, a motor and connections between the stop and motor, so organized that the stop will be moved to "on" and "off" positions by successive operations of the motor.

In practice, each stop is preferably under spring tension tending to hold it yieldably in either of its extreme positions and the connections between the respective motors and the corresponding stops are such that each connection is adapted to throw the corresponding stop first to one position (as its on position, for example) and then to its other position (as its off position, for example) by successive operations of the motor. I am aware that connections other than the particular ones hereinbefore described may be employed between the respective stops and stop valves and further that even if the connections include electric circuits provided with circuit making and breaking elements which move with the stops respectively, it is not essential to the invention, considered in its broadest aspects, that the arms 10 and 17 projecting rearward from the respective stops A and B, to bridge the space between the contact members 11, 12 and 18, 19, respectively, be employed. However, such contacts are advantageously employed, inasmuch as the contacts 10 and 17 may be pivoted to the respective stops A and B eccentric to the pivots *a*, *b*, of the latter, and the the contacts 12 and 19 may be resilient and constantly engaged with the otherwise free ends of the contacts 10 and 17, thus utilizing said contact elements 10, 12 and 17, 19 for the performance of a dual function, namely, firstly, as contacting elements of a switch and, secondly, as means by which the stops are yieldably held in their extreme positions.

Moreover, I am aware that the motors employed to operate the respective stops may be of any suitable nature, pneumatic or otherwise, without departing from the spirit of the invention considered in its broadest aspects, yet it is preferred to employ motors of pneumatic nature, such as the bellows A′ and B′ shown in the drawings, and to connect the movable board of each of said pneumatic motors with the corresponding stop A, B, by jointed links. Thus the motor A′ is shown as having its movable board connected to stop A by connected links 40 and 41, the link 40 being pivoted at 40^a to an arm a^{10} carried by the movable board of the motor A and the link 41 being pivoted at 41^b to the stop A, and the motor B′ is shown as having its movable board provided with an arm b^{10} to which one end of a link 42 is pivoted, at 42^a, the other end of the link being pivoted to a second link 43 whose opposite end is pivoted to the stop B at 43^a. The stop A is provided with two spaced shoulders 44 and 44^a arranged on opposite sides of the link 41 and the stop B is provided with spaced shoulders 45 and 45^a on opposite sides of the link 43. Each of these shoulders is preferably faced with a soft material to deaden sound. The link 41 is under tension of a light spring 46, Fig. 2, and the link 43 is under tension of a light spring 47, Fig. 3. One end of each of these springs is connected to the adjacent stop. These springs operate to throw the respective links 41, 43 off dead center position with relation to links 40 and 42 and the respective stops A, B, during the movements of the stops between their "on" and "off" positions. The link 41 oscillates between the shoulders 44 and 44^a and engages the same alternately to throw the stop A into "on" and "off" positions by successive collapsing movements of the motor A′, and, similarly, the link 43 oscillates between the shoulders 45 and 45^a and engages the same alternately to throw the stop B into "on" and "off" positions by successive collapsing movements of the motor B′. In the manual operation of either stop, the stop moves relatively to the link and the latter is not brought into contact with either shoulder on the stops.

It will be understood that when either stop is in "off" position the corresponding contact member 10 or 17 will be out of contact with contact member 11 or 18 and hence the circuits to corresponding magnets 13 or 20 will be broken, and that if either of said stops is now moved to its "on" position, either manually or automatically, the corresponding contact member 10 or 17 will be brought into contact with contact member 11 or 18 and will thereby complete the circuit to the corresponding magnet 13 or 20.

The operating parts of the stops are so correlated that the manual operation of the stops may be effected without disconnecting or otherwise disturbing the record controlled means, the connections being such that after an operation by hand, a subsequent operation by the record controlled de-

vice will always operate the stop to the opposite position. For this reason, care should be taken to have the stops in the "off" position before any piece involving the record control of the stops, is played automatically. Or if the stop is moved to its "on" position, by the operator who wishes to introduce the effect of the stop where it is not called for by the music, care should be exercised to see that it is moved to its off position before the next automatic operation of the stop occurs. The spring contact member 12 pressing on the arm 10 is so arranged that its point of contact with the arm is in a line perpendicular to the stop board face and which passes through the axis of the stop. This construction maintains the stop in one of its extreme positions except when the stop is being moved. The connecting links 40 and 41 from the motor are maintained nearly in alinement with each other by the resiliency of the motor spring m'. The small spring 46, however exerts a side force on the links between their ends and forces them in the direction of the side toward which movement will take place in the next operation of the stop. The small spring 46 being mounted on the stop and eccentric to its pivot, is moved each time the stop is moved by manual or record controlled means. Its other end being connected to the links, as the stop end is moved to one side or the other of the links, this small spring forces the links away from its stop end thus placing the links in set position to permit the motor to operate the stop the next time the power is applied to the motor and in a direction opposite to the last operation.

When power is applied to the motor the link 40 is pressed toward the stop. This movement swings the other link 41 upon its pivot and causes the same to engage the shoulder 44 or 44^a of the stop. Further movement of the motor causes the stop to move until the pivot of the arm 10 passes beyond the line between the point of contact of the contact spring 12 and the pivot of the stop. The spring contact member 12 now presses the arm 10 which in turn forces the stop to its other limit. As the motor releases the compression in the link 40, the links come back to alinement. This is caused by the action of the motor spring m' drawing out on the link 40. As the links approach a position in alinement, the small spring 46 forces the connecting point of the links over the center and in position to operate the stop in the opposite direction when the motor is again operated.

Each time the stop is operated whether by hand or by the record controlled motor, it either makes or breaks the circuit to the magnet 13, depending upon the direction in which the stop is operated, as hereinafter more fully explained.

The motors A′ and B′ are operated by mechanism which selectively utilizes suitable record-controlled impulses having different characteristics, the mechanism being so organized that impulses of one characteristic will cause the motor A′ to be operated while impulses having a different characteristic will cause the motor B′ to be operated. These impulses may be of any suitable nature, pneumatic or otherwise, without departing from the spirit of the invention, considered in its broad aspects, but pneumatic impulses are preferred and the particular mechanism herein illustrated has been designed to use such impulses to the best advantage. This mechanism is as follows:

G designates a tracker bar having tone apertures g' and a stop control aperture g. The present invention is not concerned with the means which are controlled from the tone-apertures g' to control the individual elements of the sets of tone elements and hence such means, which may be of any suitable nature, are not herein disclosed.

A duct 50 leads from the stop control aperture g and has branches 50^a and 50^b which respectively extend to primary stop control members H and I and serve to conduct the operating impulses to said members from the duct 50. These members H and I, respectively, operate pneumatics J and K to make and break circuits hereinafter set forth, which control the operation of secondary control members L and M, as hereinafter explained. As all of these impulses traverse the common duct 50, it is apparent that there must be a selective function exercised in order that either of the motors A′, B′ may be automatically manipulated alone. To this end the controlling members H and I are functionally responsive, respectively, to air impulses having different characteristics, as long and short for example. Thus, member H operates a quick-acting circuit closing pneumatic J and member I operates a relatively slow-acting circuit closing pneumatic K.

The member H has a chamber 51 connected to the branch duct 50^a by a channel 51^a; a channel 52, which is under suction from a suitable source; a membrane, 53, separating the chambers 51 and 52 from each other; a valve chamber 54 having a suction port 54^a and an atmospheric port 54^a, and also having a duct 54^c extending to the interior of pneumatic J, and a valve having two valve members 55 and 55^a, in the chamber 54, and also having a stem 55^b in operative relation with the membrane 53. The member H also has a bleed duct 55^c having communication with the chamber 52 and branch duct 50^a. It

will be apparent that when an air impulse is admitted to chamber 51, member 53 will expand and cause the valve to open suction port 54[a] and close atmospheric port 54[b], thereby placing pneumatic J under suction and causing it to collapse.

The movable board of this pneumatic is provided with a contact member 56 which is adapted to bridge the space between two contact wires 57 and 58. These wires form part of an electric circuit which, when closed, energizes an electromagnet 59, said circuit being hereinafter traced. The magnet 59 has its armature 60 arranged to control an atmospheric duct 61 extending to a chamber 62 in a secondary control member L. This control member has a suction channel 63 which is separable from chamber 62 by a membrane 64, a valve chamber 65 having a suction port 66 and an atmospheric port 67 and a valve having two members, 68 and 69, in the chamber 65, and also having a stem 70 in operative relation with the membrane 64. Accordingly it will be apparent that when the magnet 59 is energized air at atmospheric pressure is admitted to chamber 62, thereby expanding the membrane 64 which acts upon the valve to open the suction port 66 and close the atmospheric port 67. Chamber 65 is thus placed under suction. This chamber is in communication, through a port 71 and channel 71[a], with a duct 72 which has communication with the interior of the motor A′. This motor is provided with a spring m' for expanding it when the tension of the air within the motor is the same as that outside the pneumatic.

The primary control member I includes a chamber 75 to which the branch duct 50[b] extends; a suction channel 76, which is separated from the chamber 75 by a membrane 77 and is connected thereto by a bleed hole 76[a]; a valve chamber 78, having a suction port 79, and an atmospheric port 80; and a valve member 81 mounted in the chamber 78 and having a stem 82 in operative relation with the membrane 77. The member I also has a channel 83 which is connected to the valve chamber, 78, by a port 84 and with the atmosphere by a port 85, and regulating screws 86 and 87 are provided for said ports, respectively, in order that the tension of the air in the channel 83 may be regulated to a nicety. A duct 88 is connected to the channel 83 between the regulating screws and extends thence to the interior of the secondary circuit closing pneumatic K, which has a contact 89 adapted to bridge the space between two contact wires 90 and 91, which form parts of an electric circuit, hereinafter traced, and which circuit energizes an electro-magnet 92 whose armature 93 opens and closes a duct 94 through which air at atmospheric pressure is admitted to a chamber 95 in a secondary control member M. This secondary control member includes, in addition to the chamber 95, a suction channel 96, which is separated from the chamber 95 by a membrane 97, and is connected therewith by a bleed duct 96[a]; a valve chamber 98 having a suction port 99 and an atmospheric port 100; and valve members 101 and 102 in the valve chamber, for closing the ports 99 and 100 respectively, and provided with a stem 103 in operative relation with the membrane 97. A duct 104 has communication with the valve chamber 98, and with the interior of the motor B′. This motor has a spring o' for expanding it when the tension of the air within and without it are equal to each other.

It remains now only to trace the various circuits and set forth the operation in a general way, as follows:—

Assuming that both stops are closed and hence the corresponding sets of tone elements are out of action:

If now it be desired to open stop A, a short pneumatic impulse is admitted to duct 50 and will be conducted to the primary control member H, through branch 50[a]. This impulse will be sufficient to cause pneumatic J to collapse and close the circuit through magnet 59. This circuit is as follows: From the positive pole of a suitable source of electrical potential, indicated at X, by way of a bus bar X′ and wire x to contact wire 57 and thence through contact 56, contact wire 58 and wire x' to the positive terminal x^2 of the magnet 59, through said magnet to the terminal x^3 at its negative side, and back to the negative pole of the battery by way of wire x^4 and negative bus bar X^2. The magnet 59 being thus energized causes air at atmospheric pressure to be admitted to chamber 62 of secondary control member L and this in turn results in the collapsing of pneumatic A′ which through its described connection with stop A, throws the latter to its open or "on" position. This movement of the stop A causes the contact member 10 to engage contact 11 and to bridge the space between said contact 11 and contact 12. This closes the following circuit through magnet 13, namely; from the positive pole of the source X to the terminal x^5 at the positive side of said magnet, thence through said magnet to the terminal x^6 at the negative side thereof, and to contact member 11 by way of wire x^7, and through contact member 10 to contact member 12 and back to the source by way of wire x^8 and bus bar X^2. This causes motor D to collapse and open the corresponding stop valve (not shown) whereupon any of the tone elements of the set controlled by said valve may speak when the corresponding tone valve is opened.

When this operation has taken place duct 50 and branch duct 50[a] will be closed. This will break the circuit to magnet 59 which

being thus de-energized closes atmospheric duct 61. This results in the movement of the valve members 68 and 69 of control member L to position wherein chamber 65 is open to the atmosphere and closed against suction channel 63. The tension of the air in motor A′ is thus changed to atmospheric, whereupon it expands and while expanding merely adjusts the connecting links into such relation to the stop A that the next collapsing movement of the motor will throw the stop to its other or off position. In other words, the stop A is thrown automatically only by the collapsing movement of motor A′, the expansive movement of said motor merely acting to place the connecting links in such relation to the stop A that successive collapsive movements of the motor will throw the stop first to one and then to its other position.

Thus if a short pneumatic impulse is admitted to duct 50 it will collapse the pneumatic J, thereby closing the circuit to magnet 59 and this in turn will cause motor A′ to collapse and throw the stop to its on position, if said stop be in its off position when motor A′ is collapsed. This completes the circuit to stop magnet 13 which in turn operates the stop valve (not shown) and thereby opens up communication of the corresponding wind passage with the several tone elements of the set connected to said passage. This impulse being short, will quickly discontinue whereupon pneumatic J will expand, magnet 59 will be de-energized and motor A′ will expand, thereby adjusting the links to position to throw the stop to the "off" position when the motor A′ is again collapsed, as already explained. Accordingly it will be noted, that the expansion of the motor has not broken the circuit to magnet 13 and that said circuit is not broken until stop A is again thrown, i. e. to its "off" position, by the next collapsing movement of motor A′.

If, instead of a short impulse, a long impulse was admitted to duct 50, the operation already set forth with relation to the collapsing of motor A′ would take place, and in addition thereto, pneumatic K would be collapsed, thereby closing the following circuit to magnet 92, namely:

From the positive pole of the source X, by bus bar X′ and wire x^{18} to contact wire 90; thence through bridge contact 89 and contact wire 91, to wire x^9, thence to positive terminal x^{10} of magnet 92 and through said magnet to the negative terminal x^{11} and back to the source by way of wire x^{12} and bus bar X².

The energizing of the magnet operates through secondary control member M to collapse motor B′, thereby throwing the stop B from its "off" to its "on" position (assuming that it was in "off" position). This movement of the stop carries contact member 17 into operative relation with contacts 18 and 19 and closes the following circuit through magnet 20, namely:

From the positive pole of the source by way of bus bar X′ and wire x^{13} to the positive terminal x^{14} of magnet 20, through said magnet to the negative terminal x^{15}, through wire x^{16} to contact 18; along bridge contact 17 to contact 19 and thence back to the source by way of wire x^{17} and bus bar X².

Magnet 20 being thus energized causes through stop control member E, the changing of the tension of the air in stop motor F from atmospheric to less than atmospheric, thereby opening the corresponding stop valve (not shown) and admitting air under pressure to the corresponding wind passage to permit any of the tone elements connected to said wind passage to speak when the corresponding tone valve (not shown) is opened.

When this long impulse ceases, both motors A′ and B′ expand, and while expanding adjust their connections to the stops into such relation with the stops that the next collapsing movements of the motors will move the stops to their "off" positions, respectively.

Accordingly it will be understood that two short impulses succeeding each other will act upon the motor A′ alone, the first impulse to throw the stop A to its "on" position and the second impulse to throw it to its "off" position and that during the interim between said impulses any of the tone elements corresponding to stop A may speak; while two long impulses succeeding each other, will collapse both motors A′ and B′, and that the first impulse will act to throw both stops A and B to their "on" position and the second will throw both stops to their "off" position, and that in the interim between said impulses any of the tone elements of both sets corresponding to the sets may speak. Similarly a short impulse immediately succeeded by a long impulse will cause successive collapsing movements of the motor A, first by the short impulse and again at the beginning of the long impulse, the remaining portion of the long impulse causing motor B′ to collapse. This makes the set of tone elements corresponding to the stop B operative without the set controlled by stop A. Hence, it is necessary to prepare a record which will control the impulses as desired, in order that the stops may be moved at their proper times into either "on" or "off" positions, singly or together. Such a record has been disclosed in my companion applications numbered serially 375,575 and 375,577, respectively.

Primary circuit closing pneumatic J has been referred to as a quick-acting pneumatic and primary circuit closing pneumatic K has been referred to as a slow-acting pneu-

matic. These terms are relative, it being only necessary that the functional characteristics of the two pneumatics be such that one will require a longer impulse to operate it than the other. The pneumatic K is shown as being longer than the pneumatic J and hence its movable board is required to travel a greater distance in order to close the circuit through magnet 92 than is required of the movable board of pneumatic J in the completion of the circuit through magnet 59.

Having thus described the invention, what I believe to be new and desire to secure by Letters Patent, is:—

1. In mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, means providing a common path for record-controlled impulses of different characteristics, means functionally responsive to the impulses of different characteristics, respectively, and connections between the last named means and the stops, respectively, for operating the latter.

2. In mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, means providing a common path for record-controlled pneumatic-impulses of different characteristics, pneumatically operable-means functionally responsive to the impulses of different characteristics, respectively, and connections between the last named means and the stops, respectively, for operating the latter.

3. In mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, motors for the respective stops, each motor operative to move its stop to "on" and "off" positions, means providing a common path for record-controlled impulses of different characteristics, and operating connections between the latter means and the respective motors, including elements which are functionally responsive to the impulses of different characteristics.

4. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, means providing a common path for record-controlled impulses of different characteristics, and separate operating means between the first named means and the respective stops, each operating means including elements to move the corresponding stop first to one position and then to the other position under control of successive impulses of a characteristic to which the operating means is functionally responsive.

5. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, means providing a common path for record-controlled impulses of different characteristics, and connections between the latter means and the respective stops, including elements which are functionally responsive to the impulses of different characteristics, respectively, motors, connections through which the motors are controlled by said elements, respectively, and connections between the motors and the respective stops, the stops and connections being constructed and arranged with relation to each other to cause the stops to be moved first to one position and then to its other under control of successive impulses.

6. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneumatic motor for each stop, each motor operative to move the corresponding stop to "on" and "off" positions, means providing a common path for record-controlled impulses of different characteristics, and connections between the latter means and the respective motors, the connections including elements which are functionally responsive to the impulses of different characteristics.

7. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a motor for each stop, each motor operative to move the corresponding stop to "on" and "off" positions, means providing a common path for record-controlled pneumatic impulses of different characteristics, and connections between the latter means and the respective motors, the connections including elements which are functionally responsive to the pneumatic impulses of different characteristics.

8. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneumatic motor for each stop, each motor operative to move the corresponding stop to "on" and "off" positions, means providing a common path for record-controlled pneumatic impulses of different characteristics, and connections between the latter means and the respective motors, the connections including elements which are functionally responsive to the pneumatic impulses of different characteristics.

9. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a motor for moving each stop to "on" and "off" positions, means providing a common path for record-controlled impulses of different lengths, and connections between the latter means and the respective motors, the connections including elements which are functionally responsive respectively to the impulses of different lengths.

10. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneu-

matic motor for moving each stop to "on" and "off" positions, means providing a common path for record-controlled impulses of different lengths, and connections between the latter means and the respective motors, the connections including elements which are functionally responsive respectively to the impulses of different lengths.

11. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a motor for moving each stop to "on" and "off" positions, means providing a common path for record-controlled pneumatic impulses of different lengths, and connections between the latter means and the respective motors, the connections including elements which are functionally responsive respectively to the impulses of different lengths.

12. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneumatic motor for moving each stop to "on" and "off" positions, means providing a common path for record-controlled pneumatic impulses of different lengths, and connections between the latter means and the respective motors, the connections including elements which are functionally responsive respectively to the impulses of different lengths.

13. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, means providing a common path for record-controlled impulses of different lengths, means functionally responsive, to the impulses of different lengths respectively, and connections between the last-named means and the respective stops for operating the latter.

14. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, means providing a common path for record-controlled pneumatic impulses of different lengths, means functionally responsive to the impulses of different lengths respectively, and connections between the last-named means and the respective stops for operating the latter.

15. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, means providing a common path for record-controlled impulses of different characteristics, a plurality of primary control members functionally responsive to the impulses of different characteristics respectively, secondary control members connected with the primary control members, respectively, and connections between the secondary control members and the stops, respectively.

16. In a machanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, means providing a common path for record-controlled pneumatic impulses of different lengths, primary control members functionally responsive to the impulses of different lengths respectively, secondary control members connected with the primary control members, respectively, and connections between the secondary control members and the stops, respectively.

17. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a motor for each stop, each motor operative to move the corresponding stop to "on" and "off" positions, means providing a common path for record-controlled impulses of different characteristics, and connections between the latter means and the respective motors, the connections including primary control members which are functionally responsive to the impulses of different characteristics, respectively, and secondary control members having connection with the corresponding primary control members and motors.

18. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneumatic motor for each stop, each motor operative to move the corresponding stop to "on" and "off" positions, means providing a common path for record-controlled impulses of different characteristics, and connections between the latter means and the respective motors, the connections including primary control members which are functionally responsive to the impulses of different characteristics, respectively, and secondary control members having connection with the corresponding primary control members and motors.

19. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a motor for moving each of said stops to "on" and "off" positions, means providing a common path for record-controlled pneumatic impulses of different lengths, and connections between the latter means and the respective motors, the connections including primary control members which are functionally responsive to the impulses of different lengths, respectively, and secondary control members having connection with the corresponding primary control members and motors.

20. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneumatic motor for each stop, each motor operative to move the corresponding stop to "on" and "off" positions, means providing a common path for record-controlled impulses of different characteristics, and connections between the latter means and the respective motors, the connections including primary control members which are

functionally responsive to the impulses of different characteristics, respectively. and secondary control members having connection with corresponding primary control members and motors.

21. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a motor for each stop, each motor operative to move the corresponding stop to on and off positions, means providing a common path for record-controlled impulses of different characteristics, and connections controllable by said impulses and in turn controlling the motors, respectively, said connections including electrical circuits, and means for making and breaking the circuits, the latter means being functionally responsive to the impulses of different characteristics, respectively.

22. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a motor for each stop, each motor operative to move the corresponding stop to on and off positions, means providing a common path for record-controlled pneumatic impulses of different characteristics, and connections controllable by said impulses and in turn controlling the motors, respectively, said connections including electrical circuits and pneumatically operable means for making and breaking the circuits, the latter means being functionally responsive to the impulses of different characteristics respectively.

23. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneumatic motor for each stop, each motor operative to move the corresponding stop to on and off positions, means providing a common path for record-controlled pneumatic impulses of different characteristics, and connections controlled by said impulses and in turn controlling the motors respectively, said connections including control members which are functionally responsive respectively, to the pneumatic impulses of different characteristics.

24. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneumatic motor for each stop, each motor operative to move the corresponding stop to on and off positions, means providing a common path for record-controlled pneumatic impulses of different characteristics, and connections controllable by said impulses and in turn controlling the motors, respectively, each of said connections including primary and secondary control members, the primary control members being functionally responsive respectively to the pneumatic impulses of different characteristics.

25. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a motor for each stop, each motor operative to move the corresponding stop to on and off positions, means providing a common path for record-controlled impulses of different characteristics, and connections controllable by said impulses and in turn controlling the motors, respectively, said connections including electrical circuits, the primary control members being functionally responsive to the impulses of different characteristics, respectively. and the electrical circuits being controlled by the primary control members and controlling the operations of the secondary control members.

26. In a mechanism for controlling the operations of a plurality of sets of tone elements, a stop for each of said sets, a pneumatic motor for each stop, each motor operative to move the corresponding stop to "on" and "off" positions, means providing a common path for record-controlled pneumatic impulses of different characteristics, and connections controllable by said impulses and in turn controlling the motors respectively, said connections including pneumatic primary and secondary control members and electrical circuits, the primary control members being functionally responsive respectively to the pneumatic impulses of different characteristics and each having a circuit making and breaking element and the electrical circuits being opened and closed by said elements and controlling the operations of the secondary pneumatic control members.

27. In a mechanism for controlling the operation of a set of tone elements, a stop, connections controlled by the stop to render the tone elements operative when the stop is in its "on" position and inoperative when the stop is in its "off" position, and record-controlled mechanism for moving the stop, including connections which in either movement of the stop are set into position to move the stop in the opposite direction.

28. In a mechanism for controlling the operation of a set of tone elements, a stop movable to "on" and "off" positions and connections controlled by the stop to render the tone elements operative when the stop is in its "on" position and inoperative when the stop is in its "off" position, and record-controlled mechanism to operate the stop, including a motor and connections between the motor and the stop to transmit movement from the motor to the stop, said connections having an element which is shifted in either movement of the stop to a position in which its next operation by the motor will move the stop to its other position.

29. In a mechanism for controlling the operation of a set of tone elements, a stop,

means operable to render the tone elements operative when the stop is in its on position and inoperative when the stop is in its off position, and record-controlled mechanism for moving the stop, including a motor and connections between the motor and the stop to move the stop to its on and off positions by successive operations of the motor.

30. In a mechanism for controlling the operation of a set of tone elements, a stop, means operable to render the tone elements operative when the stop is in its on position and inoperative when the stop is in its off position, and record-controlled mechanism for moving the stop, including a pneumatic motor and connections between the motor and the stop to move the stop to its on and off positions by successive operations of the motor.

31. In a mechanism for controlling the operation of a set of tone elements, a stop, means operable to render the tone elements operative when the stop is in its on position and inoperative when the stop is in its off position, and record-controlled mechanism for moving the stop, including a motor and mechanical connections between the motor and the stop to move the stop to its on and off positions by successive operations of the motor.

32. In a mechanism for controlling the operation of a set of tone elements, a stop, means operable to render the tone elements operative when the stop is in its on position and inoperative when the stop is in its off position, and record-controlled mechanism for moving the stop including a pneumatic motor and mechanical connections between the motor and the stop to move the stop to its on and off positions by successive operations of the motor.

33. In a mechanism for controlling the operation of a set of tone elements, a stop manually movable to either on or off position, record-controlled means to move the stop to either of said positions, and connections to render the set of tone elements operative when the stop is in its on position and inoperative when the stop is in its off position, the record-controlled means including an element with relation to which the stop is movable to either of said positions and which element is shifted, by movement of the stop, to a position in which its next movement under control of a record will cause it to move the stop to its other position.

34. In a mechanism for controlling the operation of a set of tone elements, a pivotal stop, a valve controlling magnet, and means for energizing and de-energizing the magnet under control of the stop, including spaced electrical contact elements and a contact element movable with the stop and adapted to bridge the space between the first mentioned contact elements to energize the magnet.

35. In a mechanism for controlling the operation of a set of tone elements, a pivoted stop, a pneumatic motor for operating a valve, a magnet, connections between the magnet and motor for controlling the pneumatic forces to the motor, and means for energizing and de-energizing the magnet under control of the stop.

36. In mechanism for controlling the operation of a set of tone elements, a pivoted stop, a pneumatic motor for operating a valve, a magnet, connections between the magnet and motor for controlling the pneumatic forces to the motor, and means for energizing and de-energizing the magnet under control of the stop, including spaced electrical contact elements and a contact element movable with the stop and adapted to bridge the space between the first-mentioned elements to energize the magnet.

37. In a mechanism for controlling the operation of a set of tone elements, a pivoted stop, a motor, and connections between the motor and stop, to operate the stop successively to its on and off positions.

38. In a mechanism for controlling the operation of a set of tone elements, a pivoted stop, a motor for moving the stop to on and off position, mechanism connecting the motor and stop to operate the latter, resilient means controlled by the position of the stop to hold the mechanism in position to operate the stop to the position opposite to that occupied.

39. In a mechanism for controlling the operation of a set of tone elements, a pivoted stop, a motor for operating the same, means holding the stop yieldingly in either its open or closed position, mechanism connecting the motor and stop to operate the latter, and yielding means between the mechanism and stop to hold the former in position to operate the latter to its other position.

40. In a mechanism for controlling the operation of a set of tone elements, a manually and automatically operable stop, a motor, connections between the stop and motor for operating the stop to open and closed position, resilient means between the stop and connections holding the connections in position to operate the stop to its other position when the motor is next operated.

41. In a mechanism for controlling the operation of a set of tone elements, a pivoted stop, an arm pivoted to the stop and eccentric to the stop pivot, a spring pressing on the opposite end of the arm to hold the stop in either its on or off position, connections between the stop and motor, means controlled by the stop when in one position to hold the connections in position to operate the stop

in the direction of the other position when the motor is next operated.

42. In a mechanism for controlling the operation of a set of tone elements, a pivoted stop having shoulders, a motor, means holding the stop yieldingly in either its open or closed position, a pair of links, one of which is pivoted to the stop and the other of which is secured to the motor, the link pivoted to the stop being in position to engage the respective shoulders during the "on" and "off" movement of the stop, and a spring connecting the links and stop and arranged to press the links to a position to operate the stop to the position opposite to that occupied.

43. In a mechanism for controlling the operation of a set of tone elements, a pivoted stop having shoulders, a power pneumatic, means holding the stop yieldingly in either its open or closed positions, connected links, one end of one of which is pivoted on the stop and in position to have the link engage either of the stop shoulders, the opposite end of the other link being connected to the power pneumatic, and resilient means between the connected links and the stop to force the links out of alinement and toward the shoulders not last engaged.

44. In a mechanism for controlling the operation of a set of tone elements, a pivoted stop having shoulders, a power pneumatic, means holding the stop yieldingly in either its open or closed positions, connected links, one end of one of which is pivoted on the stop and in position to have the link engage either of the stop shoulders, the opposite end of the other link being connected to the power pneumatic, resilient means between the connected links and the stop to force the links out of alinement and toward the shoulder, and electric contacts opened and closed by alternate movements of the stop.

In testimony whereof I affix my signature.

GEO. W. GITTINS,
Administrator of the estate of Heinrich Bockisch, inventor, deceased.