March 4, 1930. T. F. CHEEK 1,749,413

EXPRESSION DEVICE FOR AUTOMATIC MUSICAL INSTRUMENTS

Filed Jan. 4, 1924 6 Sheets-Sheet 1

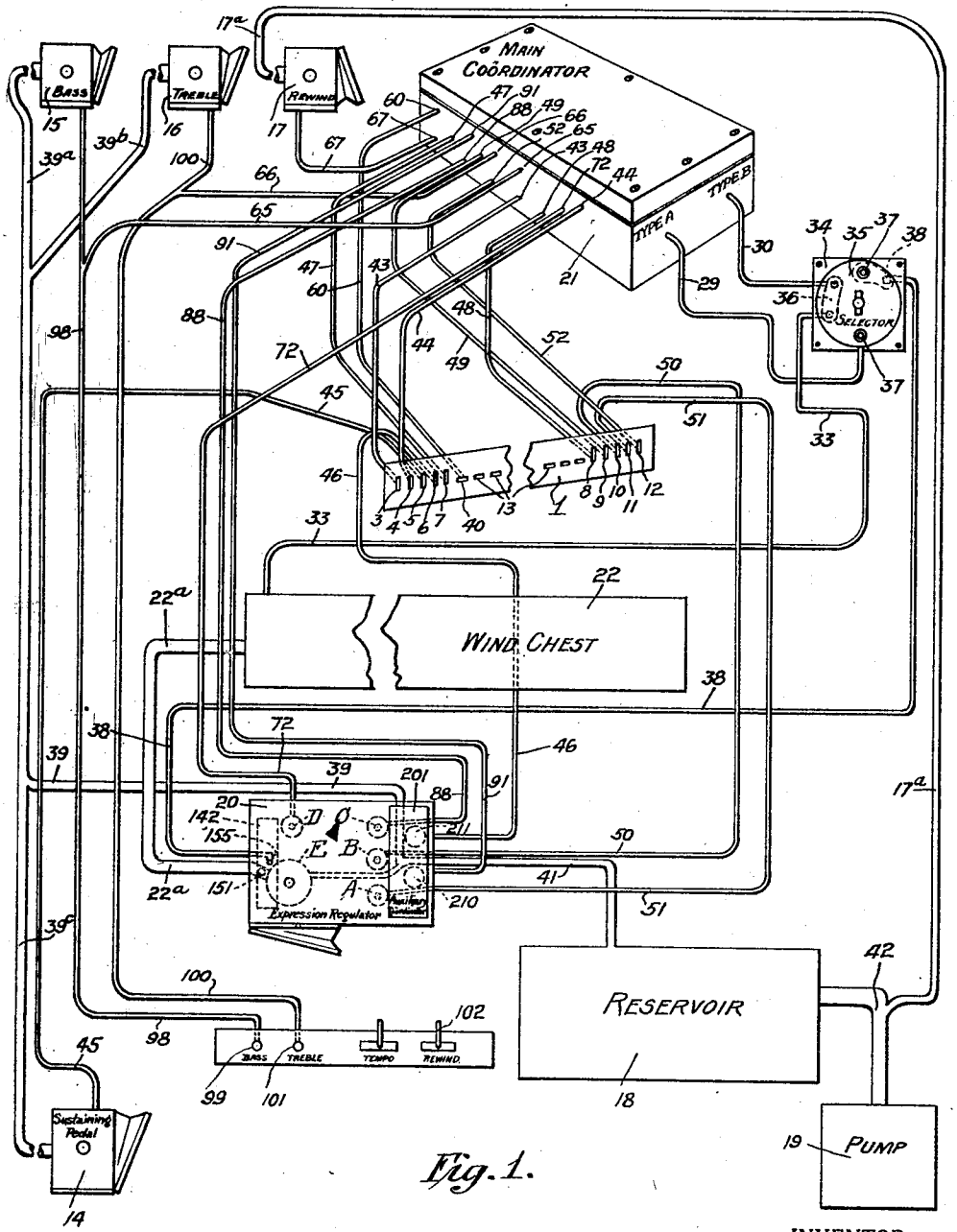


Fig. 1.

INVENTOR
Tolbert F. Cheek
BY Otis W. Holmgren
his ATTORNEY

March 4, 1930. T. F. CHEEK 1,749,413

EXPRESSION DEVICE FOR AUTOMATIC MUSICAL INSTRUMENTS

Filed Jan. 4, 1924 6 Sheets-Sheet 2

Fig. 2.

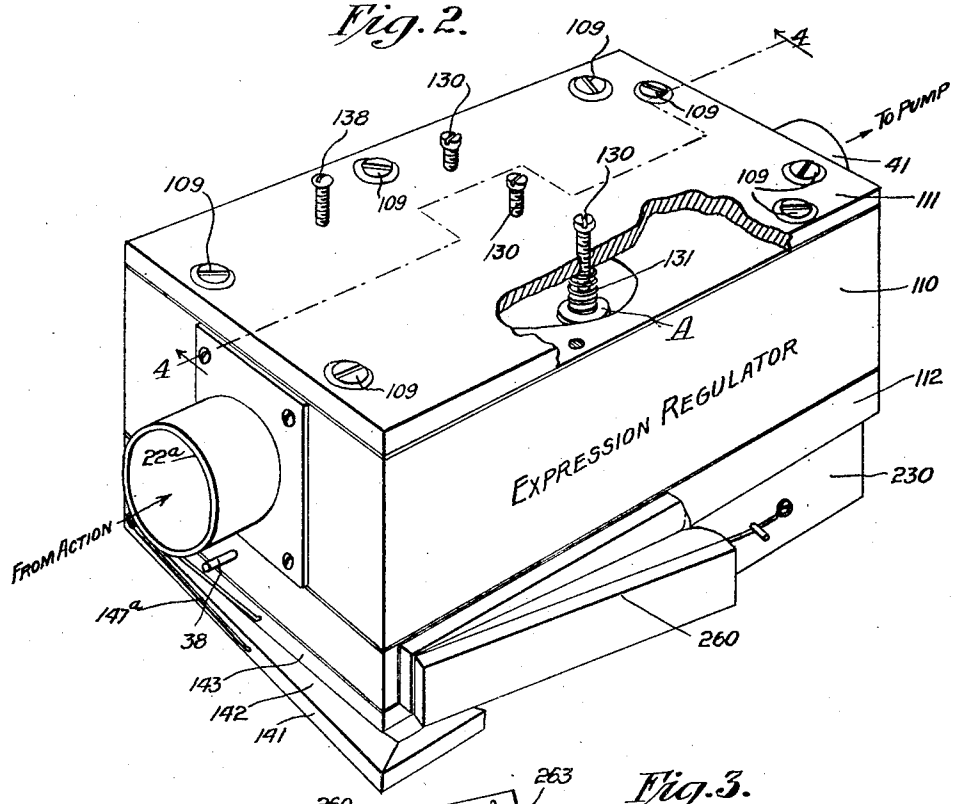
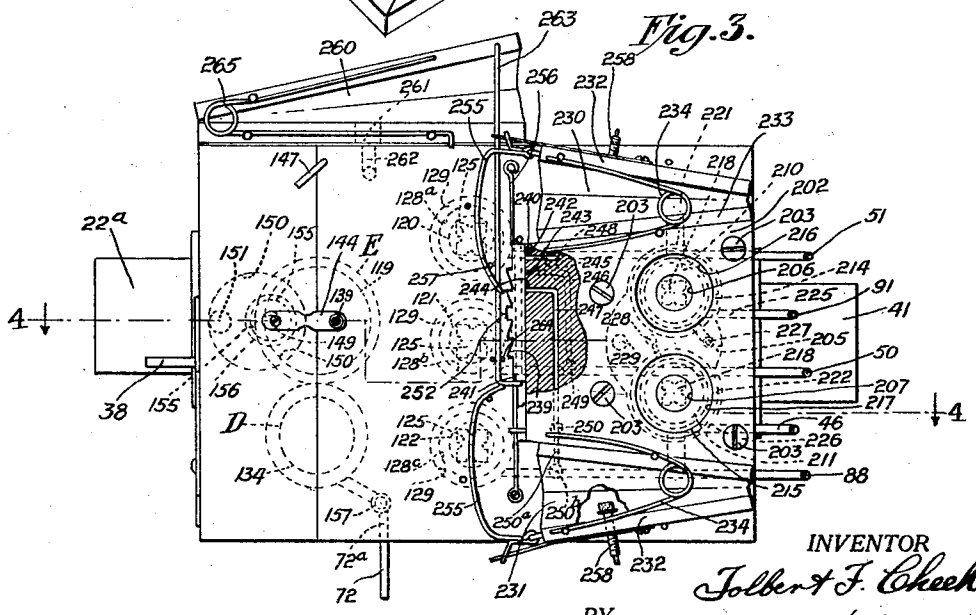


Fig. 3.



INVENTOR
Tolbert F. Cheek
BY
Otis M. Hollingsworth
his ATTORNEY

March 4, 1930. T. F. CHEEK 1,749,413

EXPRESSION DEVICE FOR AUTOMATIC MUSICAL INSTRUMENTS

Filed Jan. 4, 1924 6 Sheets-Sheet 3

Fig. 4.

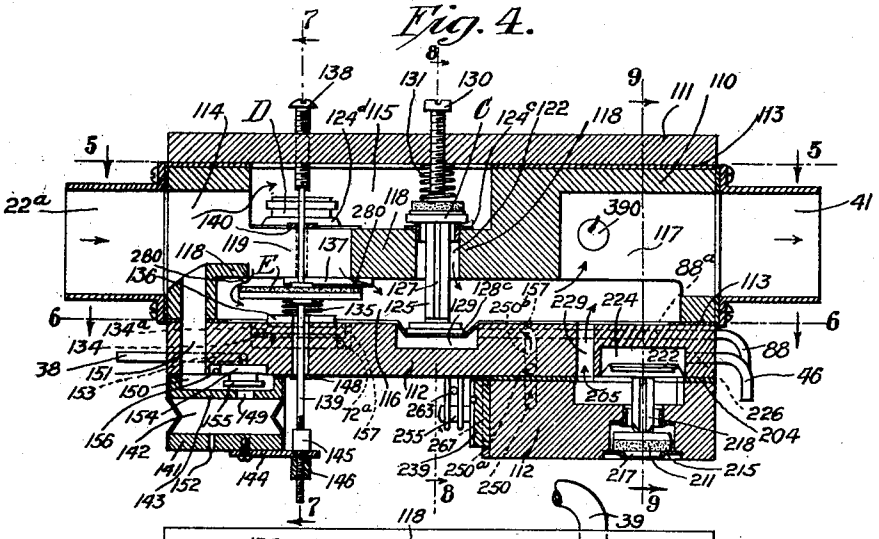


Fig. 5.

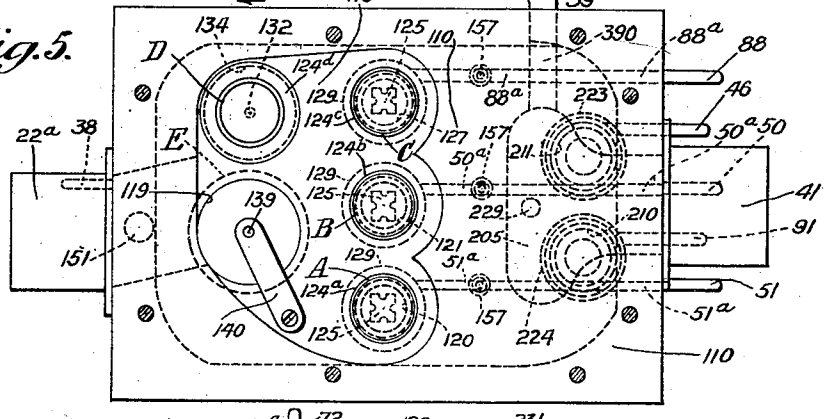
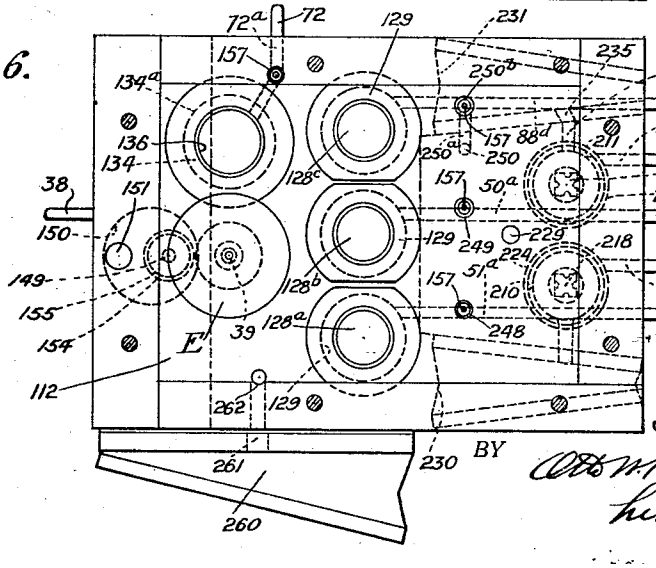


Fig. 6.



INVENTOR
Tolbert F. Cheek
BY
Otto M. Holmgren
his ATTORNEY

March 4, 1930. T. F. CHEEK 1,749,413

EXPRESSION DEVICE FOR AUTOMATIC MUSICAL INSTRUMENTS

Filed Jan. 4, 1924 6 Sheets-Sheet 4

Fig. 7.

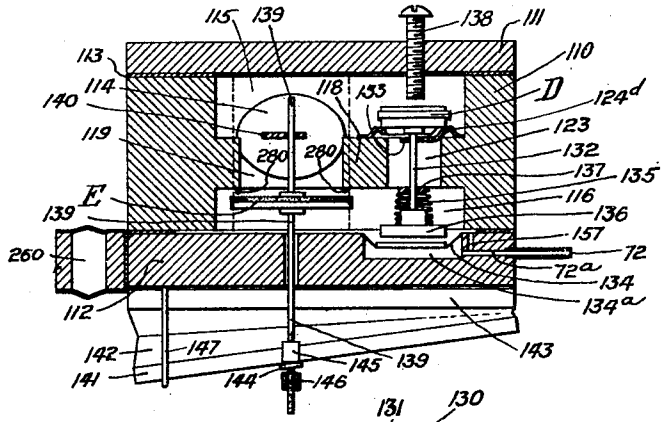


Fig. 8.

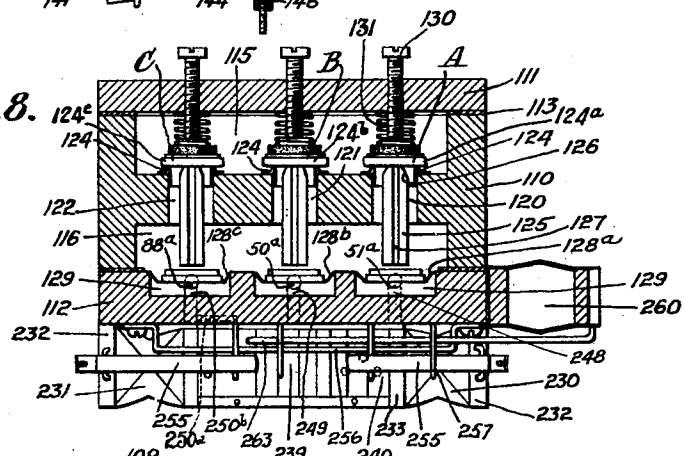
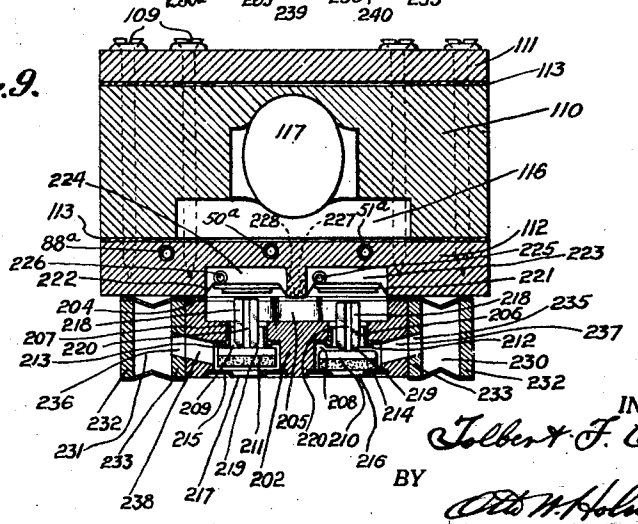


Fig. 9.



INVENTOR
Tolbert F. Cheek
BY
Otto M. Holmgren
his ATTORNEY

March 4, 1930. T. F. CHEEK 1,749,413

EXPRESSION DEVICE FOR AUTOMATIC MUSICAL INSTRUMENTS

Filed Jan. 4, 1924 6 Sheets-Sheet 5

Fig. 10.

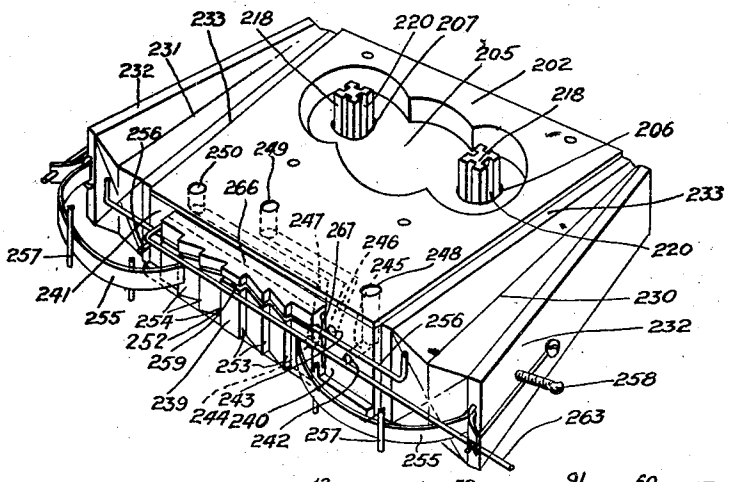


Fig. 11.

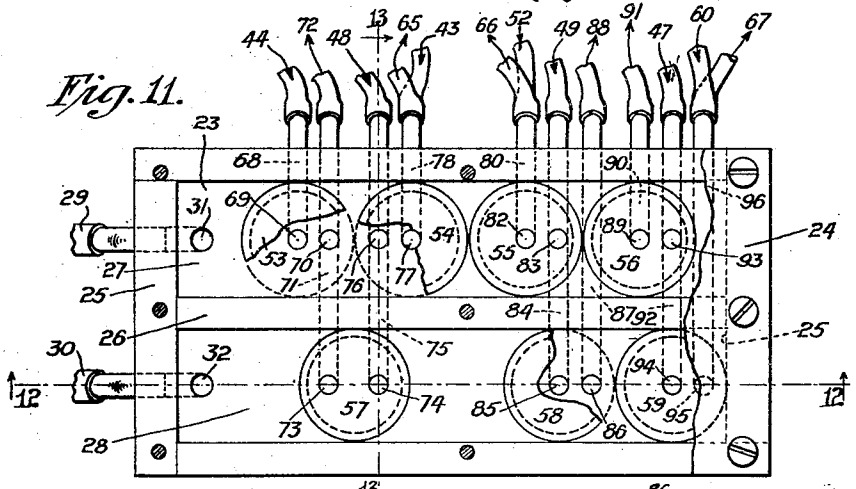


Fig. 12.

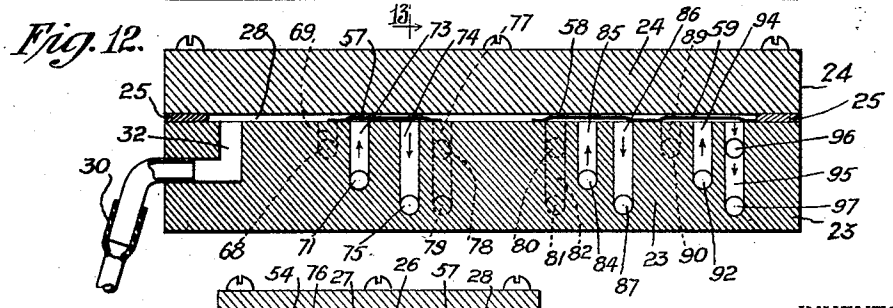
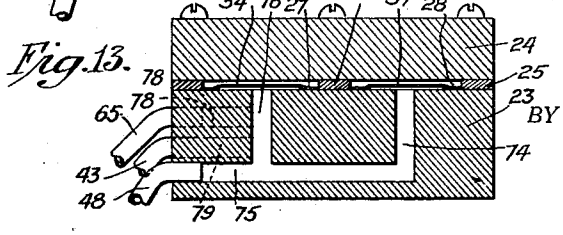


Fig. 13.



INVENTOR
Tolbert F. Cheek
BY
Otto N. Holmgren
his ATTORNEY

March 4, 1930. T. F. CHEEK 1,749,413

EXPRESSION DEVICE FOR AUTOMATIC MUSICAL INSTRUMENTS

Filed Jan. 4, 1924 6 Sheets-Sheet 6

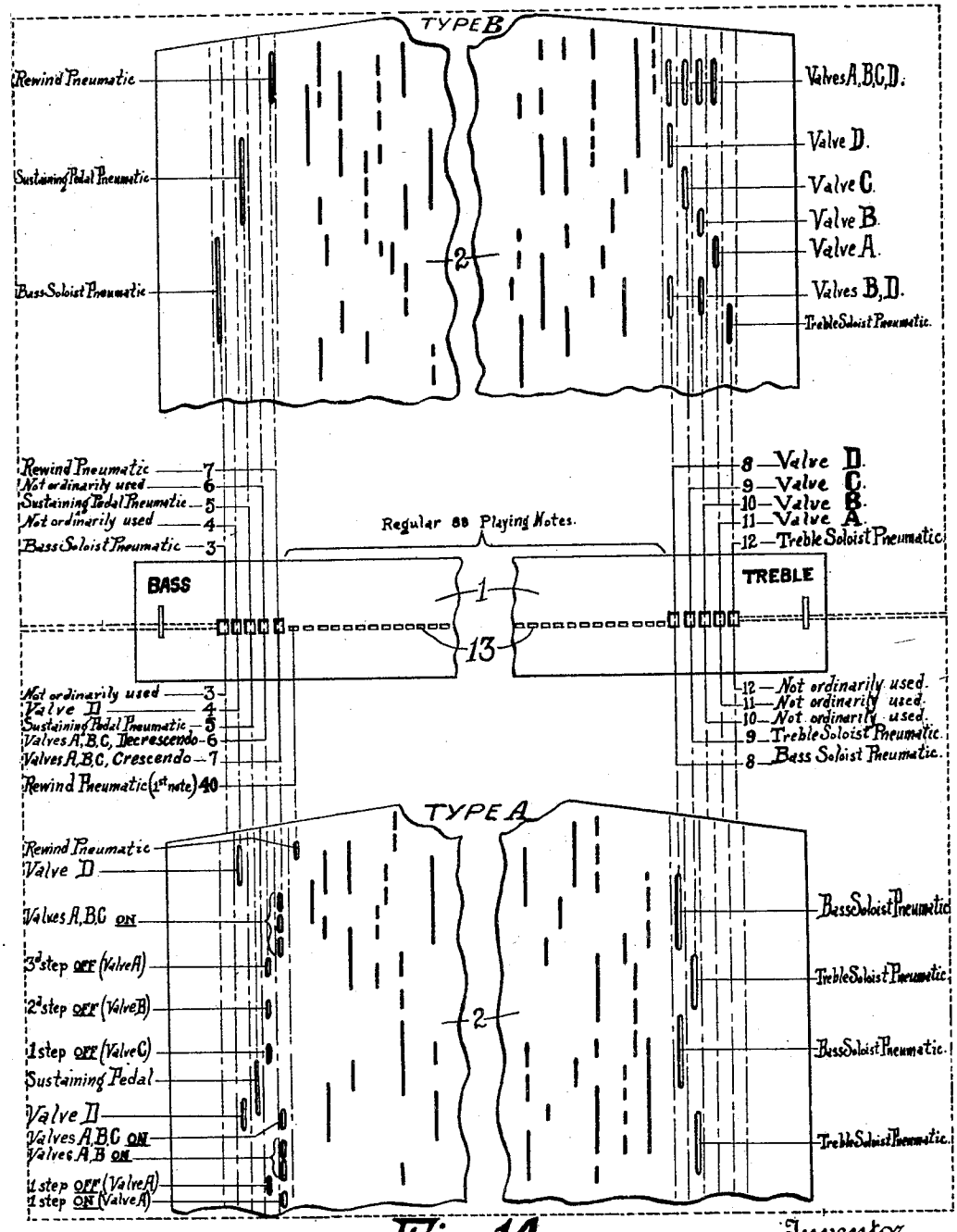


Fig. 14.

Inventor
Tolbert F. Cheek

By his Attorney
Otis W. Holmgren

Patented Mar. 4, 1930 1,749,413

UNITED STATES PATENT OFFICE

TOLBERT F. CHEEK, OF NEW YORK, N. Y., ASSIGNOR TO THE AEOLIAN COMPANY, A CORPORATION OF CONNECTICUT

EXPRESSION DEVICE FOR AUTOMATIC MUSICAL INSTRUMENTS

Application filed January 4, 1924. Serial No. 684,352.

This invention relates to expression devices for automatic musical instruments, and more particularly to an expression device for such instruments which is adapted to function automatically in accordance with the expression perforations or other indicia of any one of a plurality of note sheets or other records.

The note sheets or records used in playing automatic musical instruments of various kinds are usually provided with expression perforations or other indicia or marks in addition to the usual marks corresponding to the playing notes, such expression indicia being indicative of the degrees of tonal intensity of expression with which the composition is to be played by the instrument. The expression marks are either observed by the operator of the instrument and the instructions conveyed thereby are complied with through manual actuation of the parts of the player mechanism which will produce the results called for or the expression marks or indicia are caused to automatically actuate the player mechanism through the interposition of so-called automatic expression devices. Such automatic expression devices usually consist of intermediate mechanism, more or less elaborate in character, initially controlled through the tracker bar, and adapted to function in accordance with the expression indicia or perforations of a single particular type of note sheet which is adapted to be used with an instrument equipped with such expression device.

For instance, there are several standard types of perforated music rolls on the market at the present time, known by various trade designations, which may be designated A, B and C expression rolls, each of which types differs from the others in the arrangement of the perforations or other marks employed to designate the degrees of playing intensity, as well as in the number of steps or degrees of expression with which the compositions or selections recorded on such standard types of rolls are to be played. Proper production of the playing recorded on such differently perforated or marked note sheets can ordinarily only be accomplished by the provision of a particular expression device or mechanism adapted to function in accordance with the perforations of the particular note sheet. Attempts to use a "type A" music roll on an instrument equipped with a type "B" expression device, for instance, would result in confusion and failure, at least so far as producing the prescribed degrees of playing intensity is concerned and for this reason cut-off devices or other means are usually provided for rendering the automatic expression device inoperative when using a music roll with which the expression device is not coordinated so that either no expression whatever is produced, or the expression is produced manually by the operator. Certain player rolls, commercially known as standard 88-note non-expression rolls, have no expression marks and the degrees of playing intensity are limited to the use of the sustaining pedal and soloist pneumatics.

The primary object of the present invention is to enable an automatic musical instrument to produce the playing recorded on a plurality of different types of note sheets or records as indicated on such note sheets or records, including production of the degrees of expression or playing intensity indicated on the note sheets or records by the makers thereof.

A further object is to effect coordination of the differently indicated expression regulating perforations or marks appearing on different types of note sheets or records so that the perforations in registry with the tracker bar openings will cause the expression device to operate in accordance with the expression perforations on the note sheet used regardless of the character or arrangement of such perforations.

A still further object is to enable a single set of expression valves to be operated through the expression perforations or marks of any one of a plurality of differently perforated or marked note sheets or records, so that any desired type of roll may be used with the instrument and the instrument will be caused to correctly produce the degrees of playing intensity called for by the note sheet or roll used.

A still further object is to enable the expression device to operate in accordance with a plurality of note sheets differing in the arrangement of the expression perforations.

A still further object is to enable the expression device to operate in accordance with note sheets which differ in the manner of effecting operation of the expression valves.

A still further object is to enable the expression device to operate to correctly produce the degrees of playing intensity prescribed by a plurality of note sheets which differ in the arrangement of the expression perforations as well as in the manner of effecting operation of the expression valves.

A still further object is to provide a simple, positive, direct acting expression regulator adapted to function in a dual capacity to operate a single set of expression valves by either one of a plurality of different means according to the note sheet played.

A still further object is to enable the expression device to function in an additional capacity to provide different degrees of air tension when playing non-expression note sheets.

A still further object is to provide a simple means for coordinating the functions or effects to be performed or produced through the tracker bar perforations in accordance with a plurality of dissimilarly perforated expression note sheets.

A still further object is to provide a novel selector mechanism adapted to regulate the functions of the coordinator and the expression regulating valves as well.

A still further object is to provide an auxiliary coordinator adapted to cause expression valve actuating impulses of one order to effect operation of expression valves designed for operation through impulses of another order.

A still further object is to provide translating mechanism for converting valve operating impulses of one order into valve operating impulses of another order.

A still further object is to effect translation of intermittently acting valve operating impulses into constantly acting valve operating impulses.

A still further object is to provide a unitary mechanism adapted to correctly produce the degrees of expression prescribed by note sheets of the "B" and "A" types, as well as non-expression note sheets, on the same automatic musical instrument.

Other objects of the invention will hereinafter appear, and to all these ends I have devised the expression device one particular embodiment of which is shown in the accompanying drawings, forming a part of this specification.

In the drawings, Figure 1 is a diagrammatic view of the several essential parts of the playing and expression control mechanism as used in an automatic musical instrument;

Figure 2 is a perspective view partly broken away of the expression regulator proper, in operating position;

Figure 3 is a plan view partly in section of the under side of the expression regulator shown in Figure 2;

Figure 4 is a longitudinal sectional view taken substantially on the line 4—4 of Figures 2 and 3, looking in the direction of the arrows;

Figure 5 is a plan view of the expression regulator with the top removed, taken on the line 5—5 of Figure 4, looking in the direction of the arrows;

Figure 6 is a plan view of the bottom of the expression regulator, taken on the line 6—6 of Figure 4, looking in the direction of the arrows;

Figure 7 is a transverse sectional view through the expression regulator taken on the line 7—7 of Figure 4;

Figure 8, is a transverse sectional view, partly in elevation, through the expression regulator, taken on the line 8—8 of Figure 4, looking in the direction of the arrows;

Figure 9 is a transverse section partly in elevation through the expression regulator on the line 9—9 of Figure 4 looking in the direction of the arrows;

Figure 10 is a perspective view of a preferred form of auxiliary coordinator mechanism for effecting translation of valve operating impulses of one order into impulses of another order, to effect operation of the expression valves in accordance with the expression perforations of a particular type of roll, seen in detail in Figures 3, 4 and 9;

Figure 11 is a top plan view of the tube junction box or main coordinator, the top of which has been removed to more clearly show the parts below;

Figure 12 is a longitudinal sectional view through the main coordinator on line 12—12 of Figure 11, looking in the direction of the arrows;

Figure 13 is a transverse sectional view through the main coordinator taken on the line 13—13 of Figure 11; and

Figure 14 is a diagrammatic view illustrating the particular functions of the main coordinator in effecting coordination of the differently located expression perforations of two particular types of music note sheets or rolls adapted to be used with the same tracker bar of the instrument to cause the expression device to produce the result desired regardless of the individual characteristics of the roll being played.

In the present showing I have illustrated my expression mechanism in detail. This expression mechanism is a separate unitary piece of apparatus adapted to be installed in practically any automatic musical instru-

ment, particularly player pianos, and is also used as an integral part of expression player piano actions manufactured commercially for installation in any standard grand piano or so-called straight or upright pianos. The player piano mechanism for actuating the playing notes of the piano in which it may be installed operates in all respects as it would without the inclusion of my expression device, which operation is well understood.

Referring to the drawings, the invention includes, in its general concept, a tracker bar 1 of an automatic musical instrument, such as a player piano, across which tracker bar 1 a note sheet 2 is adapted to travel. The tracker bar is provided with a plurality of expression apertures 3, 4, 5, 6 and 7 at the bass end and 8, 9, 10, 11 and 12 at the treble end in addition to the apertures 13 which correspond with the playing notes. These expression apertures are adapted to register with perforations located at the respective sides of the note sheet and usually indicate the different degress of expression or tonal effects to be produced in the rendering of the selection recorded on the note sheet, as well as indicating and effecting performance of certain specific functions by various parts of the player mechanism.

In a standard player piano certain of the expression apertures of the tracker bar are caused to communicate more or less directly with certain specific parts of the player mechanism such as the sustaining pedal pneumatic here indicated at 14, the bass soloist pneumatic, indicated at 15, the treble soloist pneumatic 16 and the rewind pneumatic shown at 17. These pneumatics are usually connected to a vacuum supply, such as a bellows or reservoir here indicated at 18, connected to a suitable pump 19. The pneumatics are adapted to be actuated when the proper aperture of the tracker bar is uncovered by a corresponding perforation appearing in the note sheet. In this instance the bass and treble soloist pneumatics 15 and 16 respectively and the sustaining pedal pneumatic 14 are put in communication with the source of power supply by a tube 39 having branches 39^a, 39^b and 39^c leading to the respective pneumatics. This tube 39 communicates with a bore 390 in the expresison regulator 20 and while the instrument is being played the bore 390 and a chamber 117 to which it leads are under air tension communicated from the reservoir 18 through a duct 41. The reservoir 18 in turn communicates with a main power duct or conduit 42 leading to the pump 19. The wind chest 22 is connected to the source of power supply through a conduit or tube 22^a leading to a portion of the expression regulator 20 which is under tension supplied through the duct 41 during the operation of the instrument. The rewind pneumatic in this instance is connected directly to the main power duct 42 by a tube 17^a.

If the player action is adapted to produce different degrees of tonal intensity indicated on a particular note sheet other apertures of the tracker bar are caused to communicate more or less directly with expression valves or other devices for producing the result desired. If a note sheet is used bearing expression perforations which are not arranged to correspond with the nomenclature of the tracker bar apertures improper expression production would result and other unsatisfactory effects would be produced as is well known.

In a broad concept the present invention provides for the coordination of the expression producing elements so that the same expression producing mechanism may be employed to produce the proper expression called for by any one of a plurality of note sheets bearing different arrangements of the expression perforations or no expression perforations at all. To this end I have devised the expression device illustrated herein which is adapted to form part of the player mechanism, interposed between the source of power supply 19 and the tracker bar 1 for production of the results desired and between the source of power supply 19 and the wind chest 22 for actual performance of the functions incidental to such results, and is adapted to function in accordance with any note sheet or music roll desired to be played. My expression device is adapted to correctly produce the different degrees of expression or tonal effects called for by practically any standard player roll or music sheet at present made or any desired number of them in the same instrument. In the present case, however, I have for illustration shown the device as adapted to produce the expression called for by two particular types of expression player rolls in which the arrangement of the perforations as well as the manner in which the expression valves are caused to operate are radically different, as "types A and B," and, in addition, the ordinary non-expression roll. I have effected coordination of the expression producing elements so that the same results called for by the roll being played will be produced regardless of its type or make and substantially the same results will be produced with one roll as with another, except that when a non-expression roll is being played no expression will be produced automatically.

In effecting coordination of the expression producing elements I utilize my expression regulator, indicated at 20, and a coordinator or junction box 21. The expression regulator includes a series of expression valves A, B, C and D adapted to regulate the tension in the wind chest 22 to produce the degrees of playing intensity, designated, technically, pianis-

simo, piano, poco forte, mezzo forte, forte and forzando, as well as intermediate steps or degrees, and a regulating or low tension valve E, all of which will be described in detail at a later point in this specification.

The coordinator 21 is arranged to effect proper juncture of the different expression apertures of the tracker bar which are adapted to produce a similar result in accordance with differently located perforations on a plurality of note sheets, so that the effect of the expression perforations of a particular note sheet are communicated to the proper valves of the expression regulator 20 to produce the proper degree of playing intensity called for by the perforations of that note sheet and none other, or to other parts of the player mechanism. To this end the tube leading from an aperture of the tracker bar which is employed for different purposes in different note sheets is directed to the coordinator 21 and is there caused to be placed in communication with the expression valve or other device which is to be actuated in accordance with the perforation of the particular note sheet used.

In the case which I have chosen for illustration, the expression perforations of the two types of expression player rolls besides being differently arranged, are adapted to control the expression producing mechanism in a different manner. For instance, as seen in Figure 14, the "type B" roll is adapted to effect operation of the expression valves independently and to produce any desired combination of the valves regulating the air tension in the wind chest corresponding to a greater or lesser tonal power than that produced through any one of these valves alone or any combination thereof. The "type A" roll is designed to effect operation of the expression valves A, B and C successively, in a prescribed order of regular crescendo or decrescendo steps, and the valve D independently. With both rolls the sustaining pedal and soloist pneumatics are operated independently. From this it will be seen that the expression device must be adapted to cause the expression valves to operate in accordance with the manner in which the respective note sheets are designed to effect such operation. The embodiment of my invention described and shown herein accomplishes this result.

It will be understood that coordination will only be required in respect of the apertures of the tracker bar which differ in nomenclature and are employed for different purposes with different types of note sheets. Where an aperture is utilized to effect the performance of the same function in all note sheets, or the performance of one function in one sheet and none in the others, such aperture is placed directly in communication with the particular part of the player mechanism which it affects.

Coordinator

Referring to Figures 1, 11, 12 and 13 the main coordinator 21 comprises in the present instance a base 23 and a cover 24, with an air-tight spacer 25 between the meeting portions of the outer sides and ends, and a central longitudinal spacer 26, whereby are formed a plurality of longitudinal channels 27 and 28. Two longitudinal channels are shown in this instance because the invention is illustrated in connection with two different types of expression player rolls, "type A" and "type B," one channel being used for effecting coordination with each type of roll, but the coordinator may be divided and arranged so that any number of longitudinal channels are formed to accommodate any desired number of different types of expression rolls, and the coordinator may take other forms as well.

In this instance the portion of the coordinator having the channel 27 may be termed the "type A" and the portion having the channel 28 the "type B". When in use the channel corresponding to the type of expression roll being played is under air tension, the other channel being open to atmosphere. Air tension is supplied from the wind chest 22 by a tube 33 and is communicated to the respective channels 27 and 28 by tubes 29 and 30 leading to ports 31 and 32 in the respective channels. The tubes 29 and 30 are adapted to be alternately placed in communication with the tube 33 through any suitable valve or switch mechanism. In this instance I utilize a selector mechanism 34, into which the tubes 29, 30 and 33 lead, having a rotatable valve member 35 provided with a chamber or groove 36 on its under side of sufficient length to place the tubes 30 and 33 in communication with each other when the valve 35 is turned in one position and the tubes 29 and 33 when turned in another position. The valve 35 is also provided with through ports 37 and when either of the tubes 29 or 30 is in communication with tube 33 the other will be in communication with atmosphere through one of the ports 37. The valve 35 is also adapted to be turned to a further position to close off the entrances to the tubes 29, 30 and 33 and to place one of the open ports 37 in communication with a tube 38 which leads to the expression regulator 20 when a non-expression roll is being played, and also, under certain conditions, when expression rolls are used. The valve member 35 may in addition be turned to a still further position to close off the ends of all the tubes 29, 30, 33 and 38. The operation of the device when a non-expression roll is used will be described at a later point. The selector 34 may be located at the spool

box, or in the key slip of the instrument, or in any other desired place.

In Figure 14 I have illustrated with clarity the correspondence and non-correspondence of the expression apertures of the tracker bar with the functions or effects sought to be performed or produced through registry of the expression perforations of the two expression note sheets here selected for illustration with said tracker bar apertures. As already explained coordination is required in all cases where non-correspondence exists. The coordinator is therefore of importance in obtaining the desired results.

The tubes leading from the tracker bar expression apertures 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 are designated 43, 44, 45, 46, 47, 48, 49, 50, 51 and 52. The tube leading from the first playing note aperture 40 at the bass end of the tracker bar, used to operate the rewind in "type A" playing, is designated 60. Certain of these tubes, viz, 43, 44, 47, 48, 49 and 52 lead to the main coordinator, and others, for the reason already stated, to the parts of the player mechanism directly affected. Tube 45 leads to the sustaining pedal pneumatic, 46 directly to "type A" decrescendo actuating mechanism, 50 to expression valve B, and 51 to the expression valve A. The tubes leading into the main coordinator are combined or caused to communicate therein with the proper tube leading out of the main coordinator to produce the proper result or effect. For this purpose the channels contain a plurality of inverted pouches, designated 53, 54, 55 and 56 on the "type A" side, and 57, 58 and 59 on the "type B" side. The tubes entering the main coordinator communicate with transverse and vertical ports and the pouches are adapted to cover the upper ends of adjacent vertical ports so that communication of adjacent vertical related ports with each other is effected through the pouch when the channel 27 or 28, as the case may be, is under air tension, at which time the pouches in such channel will be inflated or elevated. As the opposite channel will at such time be opened at atmosphere through one of the ports 37 of the selector, the pouches in such channel will be depressed, closing the ends of the adjacent vertical ports in that channel and preventing communication one from the other, thus nullifying the effect of the channel. Any air tension which may be communicated to the pouches in what I term the inactive channel will but serve to effect tighter closing of the pouch.

The two sides of the main coordinator are thus adapted to operate each independently of the other. However, in some cases it is desirable to utilize some of the transverse and vertical ports in the inactive side while the opposite side is under air tension to effect through communication for certain of the tubes into and out of the main coordinator and this is accomplished without affecting the pouches in the inoperative channel.

The functions performed by the main coordinator will be apparent from a combined reading of Figures 1 and 14, but the arrangement of the tube courses in said coordinator will nevertheless be outlined in detail.

Tube 44, leading from the tracker bar aperture 4 communicates with a transverse passage 68 which joins the vertical port 69 leading to the pouch 53 at the "type A" side. The vertical port 69 is adapted to communicate, through the pouch 53, with a vertical port 70 leading to a transverse passage 71, this passage 71 communicating with a tube 72 leading from the main coordinator directly to the expression valve D. The passage 71 also communicates with a vertical port 73 leading to the pouch 57 at the "type B" side, and this port 73 is adapted to communicate, through the pouch 57, with a vertical port 74 leading to a transverse passage 75, which passage 75, in turn, joins the tube 48 which initiates at the tracker bar opening 8, and also a port 76 leading to the pouch 54. The port 76 is adapted to communicate with a vertical port 77, and this port 77 in turn joins transverse passages 78 and 79 leading, respectively, to the tube 65 which communicates with the bass soloist pneumatic and the tube 43 which initiates at the tracker bar aperture 3.

Tube 66 which leads from the treble soloist pneumatic and tube 52 leading from aperture 12 of the tracker bar communicate respectively with transverse passages 80 and 81, both of which lead to a vertical port 82 terminating beneath the pouch 55. The port 82 is adapted to communicate with a vertical port 83 leading to a transverse passage 84 and this passage 84 communicates at one end with the tube 49 which has its inception at the tracker bar opening 9 and at the other end with a vertical port 85 beneath the pouch 58. The port 85 is there adapted to communicate with a vertical port 86 leading to the transverse passage 87, and this passage 87 communicates directly with a tube 88 which leads to the expression valve C of the expression device 20.

A vertical port 89 beneath the pouch 56 at the "type A" side communicates with a transverse passage 90 leading to the tube 91 and this tube 91 runs directly to the auxiliary coordinator or crescendo actuating portion of the "type A" expression valve operating mechanism forming part of the expression device 20.

Tube 47 leads from tracker bar aperture 7 into a transverse passage 92 and from passage 92 vertical ports 93 and 94 lead to the pouches 56 and 59 respectively. At the pouch 56 the port 93 is afforded access to the port 89 and from thence to the passage 90 and tube

91, while at the pouch 59 the port 94 is adapted to communicate with a vertical port 95 which effects a juncture of two transverse passages 96 and 97 respectively with the tubes 60, leading from the first playing note 40 at the bass end of the tracker bar, and 67, leading directly to the rewind.

To illustrate the operation of the main coordinator in connection with each of the particular types of rolls for which it is adapted to function, a detailed description will be given of the manner in which operation of the expression valves is accomplished to provide the different degrees of tonal power or intensity prescribed by the note sheet as well as the manner in which the sustaining pedal, bass, treble and rewind pneumatics are automatically actuated.

Playing "type B" roll

In using a "type B" player roll the rotary valve 35 is turned to the position indicated in Figure 1 to place the channel 28, representing the "type B" side of the main coordinator under air tension through tube 33 and tube 29 in communication with atmosphere. The vertical ports 69, 70, 76, 77, 82, 83, 89 and 93 of the "type A" side will thus be closed at their upper ends by depression of the pouches 53, 54, 55 and 56, and the pouches 57, 58 and 59 over the ends of the ports 73, 74, 85, 86, 94 and 95 of the "type B" side will be elevated, affording communication between adjacent ports.

Valve A, regulated to give a degree of intensity slightly greater than the set regulation or fixed intensity regulated by the low tension valve E as will be later described, is operated through tracker bar aperture 11 which communicates directly with the A valve through tube 51.

Expression valve B, giving a degree of intensity slightly greater than A, is operated through tracker bar aperture 10 which communicates directly with the B valve through tube 50.

Expression valve C, affording a still greater intensity, is operated through tracker bar aperture 9 which leads through tube 49 to passage 84 and thence through ports 85 and 86 and passage 87 to tube 88, and thence to the C valve.

Valve D, termed the "quick accent" or "crash" valve, is operated through tracker bar aperture 8 from which tube 48 leads to passage 75, through ports 74 and 73, to passage 71 and tube 72, and from thence to the D valve.

The sustaining pedal is controlled by tracker bar aperture 5 which leads directly to the pneumatic 14 through tube 45.

The bass soloist pneumatic which actuates the bass half of the hammer rail to produce solo effects is controlled by tracker bar apertures 3 from which tube 43 leads to passage 79, to port 77, passage 78 and tube 65, and thence to tube 98 communicating with the pneumatic 15. The tube 98 is also adapted to be connected to the usual soloist button 99 located in the key slip of the instrument or elsewhere for manual operation. The same result would be produced if the tubes 65 and 43 were simply T'd together as indicated in Figure 11.

The treble soloist pneumatic is operated through tracker bar aperture 12 from which tube 52 leads to passage 81, port 82 and passage 80 in the "type A" side to tube 66, and from thence to tube 100 communicating with pneumatic 16. The same result will be produced if the tubes 52 and 66 are T'd together as indicated in Figure 11. Tube 100 is also connected to treble soloist button 101 for manual operation.

The rewind pneumatic is operated through tracker bar aperture 7, from which tube 47 leads to passage 92, communicating with ports 94 and 95 through the pouch 59 and from thence to passage 97 which communicates with tube 67 leading directly to pneumatic 17. The rewind is also adapted to be manually actuated by the lever 102 through connections not shown.

Tracker bar apertures 4 and 6 are not ordinarily used in playing "type B" music rolls but if desired these apertures may be employed to control a mandolin rail, an automatic selector, a repeat switch, or for other purposes, the proper connections therefor where necessary being arranged in the main coordinator.

Assuming for example that the low tension valve E is set at a fixed regulation giving air tension which will register substantially eight inches vacuum on a water column gauge, and the valves A, B and C set to regulate the air tension to different predetermined degrees above E as follows: A, four inches; B, six inches; C, seven inches; and D, five inches; the air tension for the instrument may be regulated to different degrees up to the maximum for which the power plant is regulated through different combinations of the valves, and substantially the following results are obtainable:

Valves	Inches vacuum	Playing tension
E	8	P. P.
E+A	12	P.
E+D	13	P. (crash)
E+B	14	P. F.
E+C	15	P. F.
E+A+D	17	P. F. (crash)
E+A+B	18	M. F.
E+A+C	19	M. F.
E+B+D	19	M. F. (crash)
E+C+D	20	M. F. (crash)
E+B+C	21	M. F.
E+A+B+D	23	F. (crash)
E+A+C+D	24	F. (crash)
E+A+B+C	25	F.
E+B+C+D	26	F. (crash)
E+A+B+C+D	30 or over	F. F. (crash)

All the valves are capable of being manually regulated independently of each other

to give different degrees of air tension above the set regulation so that practically an unlimited number of combinations are possible within the normal range, which is equivalent to thirty inches on water column gauge or slightly thereabove, and the above specified range of expression tension is only cited as a specific illustration and does not represent the only range of which the regulator is capable.

The selector is constructed so as to provide for communication of tube 38 with atmosphere while tube 30 is connected to tube 33 and in this case the valve 155 will, as hereinafter described, operate to close off the suction from pneumatic 142 which adjusts the valve E and the valve E will be caused to assume a set regulation corresponding to, say, twelve inches of vacuum on a water column gauge, which will give increased air tension. If the valve E is regulated to low tension corresponding to eight inches vacuum on a water column gauge and high tension corresponding to substantially twelve inches of vacuum, through operation of the valve 155, all the valves A, B, C and D will in this case operate at regulated degrees above twelve inches instead of eight inches as above mentioned, and louder playing will result throughout.

Playing "type A" rolls

In using a "type A" player roll the selector valve 35 is turned to cause the tubes 29 and 33 to communicate with each other and tube 30 to atmosphere, thus placing the "type A" side of the main coordinator under air tension. The vertical ports 73, 74, 85, 86, 94 and 95 of the "type B" side will thus be closed at their upper ends by depression of the pouches 57, 58 and 59 and the pouches 53, 54, 55 and 56 over the ends of ports 69, 70, 76, 77, 82, 83, 89 and 93 will be elevated.

In "type A" expression production tracker bar aperture 7 is adapted to effect operation of certain mechanism of the expression regulator 20 later to be described to cause the valves A, B and C, producing different degrees of playing intensity, to be actuated successively in crescendo order, by successive impulses transmitted by the valve actuating mechanism under the influence of successive perforations of the music sheet passing over the tracker bar aperture 7. The valves are opened in a prescribed order of successive steps, each perforation producing one additional step of playing intensity until all the valves A, B and C are in operation.

The valves A, B and C are thrown out of operation in inverse or decrescendo order by the same valve actuating mechanism under the influence of successive note sheet perforations passing over tracker bar perforation 6.

Valve A is operated by one step on, or "up"; valve B by an additional step up, and valve C by a further step up. The same effects are produced in inverse order by successive steps off, or "down".

In operation the crescendo tracker bar opening 7 communicates through tube 47 with the passage 92, port 93, port 89, passage 90 and tube 91 and this tube 91 runs directly to the auxiliary coordinator or "type A" crescendo actuating mechanism of the expression regulator. The decrescendo tracker bar opening 6 communicates through tube 46 directly with the "type A" decrescendo actuating mechanism of the expression device 20. The quick accent or "crash" valve D is operated through tracker bar opening 4 from which tube 44 leads to passage 68, port 69, port 70 and passage 71 to tube 72 and thence directly to valve D.

The sustaining pedal pneumatic is operated through tracker bar opening 5, which communicates through tube 45 directly with the pneumatic 14, as in "type B" playing. The bass soloist pneumatic is operated through tracker bar aperture 8 from which tube 48 leads to passage 75, port 76, port 77 and thence through passage 78 to tube 65 which runs to the tube 98 communicating with pneumatic 15. The treble soloist pneumatic is operated through tracker bar aperture 9 from which tube 49 leads to passage 84, port 83, port 82 and passage 80 to tube 66 which in turn communicates with tube 100 running to pneumatic 16. The rewind in "type A" expression production is operated through the tracker bar aperture 40 which corresponds with the first playing note at the bass end, which is the one least used in playing. This aperture 40 communicates with tube 60 which leads to transverse passage 96 of the main coordinator, which passage 96 leads through to the "type B" side and meets port 95, which port 95 joins passage 97 leading to tube 67 and from thence directly to the rewind pneumatic. The same result would be accomplished if the tube 60 were simply T'd to the tube 67 as indicated in Figure 11.

Assume, for example, that the low tension regulator valve E is set to regulate for tension registering eight inches of lift on a water column vacuum gauge and that the valves A, B, C and D are set to give air tensions above valve E equivalent to four inches, six inches, seven inches and five inches, respectively, the range of expression tension obtainable will be substantially as follows:

Valves	Inches vacuum	Playing tension
E	8	P. P.
E+A	12	P.
E+D	13	P. F.
E+A+D	17	M. F. (crash)
E+A+B	18	M. F.
E+A+B+D	23	F. (crash)
E+A+B+C	25	F.
E+A+B+C+D	30 or over	F. F. (crash)

Different results will be obtainable accord-

ing to the manual setting of the valves A, B, C and D for the degree of tension which each is adapted to permit above the set low tension.

The selector 34 may also be utilized to set the regulator valve E to alter the basic low tension as mentioned in connection with type B playing, which will have the effect of stepping up all the valve combinations.

Playing non-expression rolls

In playing an ordinary 88 note non-expression roll having no expression perforations, and with which any desired expression is imparted by actuating the bass and treble soloist pneumatics either automatically or by the buttons 99 and 101, the rotary selector valve 35 is turned so that the ends of tubes 30, 29 and 33 are closed and the atmospheric ports 37 either closed or one of them placed in registry with the end of tube 38 in accordance with the playing tension desired as will hereinafter appear in detail. Tube 38 leads to what I term the "cut-off" of the expression regulator. If the tube 38 is not open to atmosphere, or if the tube 38 and the valve 155 to be hereafter described are entirely eliminated, which I have done in cases to simplify the construction, the valve E will be allowed to move to its regulated position for the minimum low playing tension. If the tube 38 is open to atmosphere the regulating valve E will be caused to open to an extent permitting a greater minimum playing tension.

Non-expression note sheets usually have unperforated margins, except generally for perforations adapted to register with aperture 5, the third hole at the bass end of the tracker bar, which is used with practically all music rolls for operation of the sustaining pedal pneumatic. The unperforated margins cover the expression apertures of the tracker bar and the expression producing valves are not actuated.

The valve E is manually adjustable to fix or regulate the amount of opening of the valve within certain limits affording means for setting the low tension at any desired degree to produce the tonal power desired for this degree of playing. It is a set regulator when adjusted and when playing "type A" or "type B" rolls the valves A, B, C and D will produce successive degrees of greater air tension than that fixed by the low tension regulator E.

Expression regulation

The manner in which coordination of the expression perforations of various types of music sheets is accomplished having been described, the automatic action of the expression regulating mechanism under the influence of the results of such coordination transmitted to it will now be set forth in detail.

The expression regulator 20 is a small, compact unit of but a few inches in each dimension and is installable at any desired location within the piano case. It is connected with the reservoir 18 at one end and with the wind chest 22 at the other. It is of the type which operates on what is technically termed the "direct system" in contradistinction to the "bleed system."

Referring particularly to Figures 2 to 10 inclusive, the expression regulator in this instance includes a body portion 110, and top and bottom portions 111 and 112, respectively, suitable packing 113 being interposed between the top 111 and bottom 112 and the body 110. The top, body and bottom are secured tightly together, as by the screws 109 which pass through the top and body and into the bottom.

The body 110 has an entrance chamber 114 leading from the conduit 22^a at one end of the body 110, which conduit is in communication with the wind chest 22, an upper valve chamber 115 of preferably greater volume, a lower chamber 116 of preferably still greater volume, hereinafter termed the "main pressure channel", and an exit chamber 117 which leads to the conduit 41 at the opposite end of the body 110, which conduit is connected to the source of power supply, in this instance the pump 19, through the reservoir 18 as already described.

The entrance chamber 114 is at all times in communication with the upper valve chamber 115 and in fact forms part thereof and may be dispensed with per se if desired. The exit chamber 117 similarly forms part of and is at all times in communication with the main pressure channel 116. A partition 118 is thus formed in the body portion substantially centrally thereof. A vertical port 119 in the partition 118 is adapted to afford communication between the upper valve chamber 115 and lower chamber or main pressure channel 116, passage through this port 119 being regulated by the regulator valve E.

Ports 120, 121, 122 and 123 are also adapted to afford communication between the upper chamber 115 and lower chamber 116, and passage through these ports is regulated by the valves A, B, C and D, respectively.

The valves A, B and C are substantially alike in construction and rest on valve seats 124^a, 124^b, and 124^c. The stems 125 of these valves are here shown as square in cross section, with tapering upper ends 126 where they are secured to the valves, and provided with grooves 127 at each longitudinal side, all to afford a free passage through the ports 120, 121 and 122 when the respective valves are opened. The stems 125 are located over suitable pouches 128^a, 128^b and 128^c, respectively, enclosing small pouch chambers 129,

by the elevation of which pouches the valves A, B and C are adapted to be raised from their seats. The height of lift of the valves is regulated by any suitable means. In the present instance I have provided suitable manually adjustable means in the form of regulating screws 130, so that the lift of the respective valves may be adjusted independently of each other to provide the desired specific degree of opening when the valves are actuated. I have also used more or less flexible regulating means in the form of small pneumatics which are manually adjusted to provide the desired degree of opening and yet at the same time afford a certain degree of latitude and flexibility in regulating the tension of the wind chest. These pneumatics enable the valves to operate with somewhat greater finesse but form part of the disclosure of a copending application Serial No. 703,018, filed March 31, 1924, and will therefore not be described herein.

In this instance I have interposed suitable cushioning means in the form of springs 131 located between the valve and top 111 for guiding the valves in their movement and assisting in normally holding the valves to their seats, but such cushioning means is not essential and may be dispensed with without any deleterious effects resulting.

The valve D is of a somewhat different construction. The port 123 for the valve D is of slightly greater area than the ports 120, 121 and 122 because this valve is the quick accent or "crash" valve and its stem 132 is preferably of considerably smaller diameter than the stems 125. The seat 124^d is in this case provided with an upper bridge 133 for guiding the stem 132 and the stem rests upon the pouch 134 enclosing a chamber 134^a when this pouch is inflated. Resilient closing means are preferably used for this valve for the purpose of sharply closing it to produce the necessary quick accent. In this instance I have provided a spring 135 secured between the base 136 of the stem and a lower guide bridge or leaf 137 secured to the under side of the partition 118, the purposes of which are obvious.

The height of lift of the valve D is regulated by suitable means, as for instance, by a regulating screw 138, though I may also use the manually adjusted pneumatic means hereinabove referred to.

Low tension regulator

The valve E I have termed a "low tension regulator" or regulating valve. It is the valve which regulates the normal air tension for the wind chest of the player mechanism for non-expression or ordinary soft playing as well as the minimum air tension desired in expression playing. The ordinary tension and the minimum expression tension may be the same, or the former may be greater than the latter, the mechanical actuating means for this valve, now about to be described, being capable of accomplishing either result.

The low tension valve E regulates the passage of air through the port 119 and in this instance is in the form of a relatively flat disk with a stem 139 of considerable length which extends through the valve (see Figs. 4 and 7). The portion of the stem above the valve is guided by a suitable bridge or leaf 140 secured to the upper side of partition 118, and the portion below the valve extends through the bottom 112 to the lower movable leaf 141 of a regulating pneumatic 142, the upper leaf 143 of which is rigidly secured beneath the bottom 112. The connection of the valve E with the movable leaf 141 may be effected in any desired manner, and in the present instance I have provided a toe-piece 144 secured to the under side of the movable leaf 141, which toe-piece is suitably secured to the lower end of stem 139. The stem 139 is threaded at the lower end and suitable nuts 145 and 146 are located on the threaded portion above and below the toe-piece 144 for the purpose of adjusting the effective length of the stem 139 and hence fixing the relation between the valve E and the movable leaf 141 of the pneumatic 142. A stop 147 may also be provided for limiting the opening movement of the pneumatic 142 as well as any suitable means, here shown as a spring 147^a, for urging the leaves apart and inflating the pneumatic when air tension is removed. Suitable packing 148 may also be provided at the under side of the bottom 112 around the stem 139.

Pneumatic 142 is in communication with the main power channel 116 through a port 149 located in the upper leaf 143 and this port 149 communicates with a small chamber 150 in the upper leaf leading to a passage 151 which joins the chamber 114. This chamber 114, as already described, communicates with the main power channel through port 119.

The amount of opening of the valve E to regulate the low tension is mechanically adjusted by the pneumatic 142. When playing an expression roll on the instrument the valve E is adapted to be moved upward to a point whereby the size of the opening will afford the minimum air tension desired for expression playing by the substantially complete collapse or closing of the pneumatic 142 under the influence of the vacuum pull through port 149, chamber 150, passage 151, upper chamber 114, port 119 and main pressure channel 116.

When playing a non-expression roll, the air tension of the wind chest may be regulated by the opening of valve E to a point to supply either the same air pressure or minimum tension as that employed for expression playing through the operation of the pneu-

matic 142, or, the upward movement of the valve may be limited to that afforded by but partial closing or collapse of the pneumatic 142. When it is desired to play a non-expression roll under the minimum air tension referred to the selector valve 35 is turned to a position so that the ends of vacuum tube 33 and cut-off tube 38 are both closed. The pneumatic 142 will then be adapted to collapse to substantially its fullest extent, in the same manner as when playing an expression roll. Should it be desired to play a non-expression roll under a somewhat greater tension, producing louder playing of the instrument, the air pressure in the wind chest may be further reduced by limiting the upward movement of the valve E to increase the effective size of port 119 by causing the pneumatic 142 to only partially collapse.

Expansion of the pneumatic 142 is brought about by turning the selector 35 so that the atmospheric vent 37 registers with the end of tube 38 and allows this tube 38 to communicate with atmosphere. Atmospheric pressure is then communicated through tube 38 to a passage 153 in the bottom 112, which passage 153 leads to a pouch 154 directly over the port 149. A suitable valve 155 is secured to the pouch 154. Admission of atmospheric pressure to the pouch 154 will cause it to inflate, carrying with it the valve 155, and the valve 155 will seat over the port 149. Vacuum will thus be closed off from the pneumatic 142 and atmospheric pressure entering the pneumatic through the bleed 152 will cause the pneumatic to open and remain in open position during the playing. The valve E will thus be in its downward or rest position and a wide and free air passage is provided through the port 119 and past the valve E. The pouch 154 is provided with a small bleeder port 156 leading to vacuum, in this instance to chamber 150. Whenever atmospheric pressure is cut off from pouch 154 the pull of the vacuum through the bleed 156 will cause the pouch 154 to collapse, withdrawing the valve 155 from port 149 and maintaining it in such withdrawn position. The pneumatic 142 may then deflate to bring the valve E to its regulated position for minimum tension.

For a single set low tension regulation of the valve E I locate stops 280 at the under side of partition 118 (see Fig. 7) against which the valve E may abut, the length of the stops being fixed to afford the proper degree of opening. This provides a simple arrangement eliminating adjustment of the stem 139 as well as the cut off valve 155 and enabling the stem to be rigidly, or non-adjustably, secured to the pneumatic 142.

The valves A, B, C and D are all operated in an identical manner, viz, by elevation of the pouches over which they are located, brought about by admission of atmospheric pressure to the pouches from the tracker bar apertures with which they correspond. The pouch 134 beneath valve D and the pouches 128^a, 128^b and 128^c for the valves A, B and C are each provided with a small vent or bleed 157 leading to the main pressure channel 116 at any desired location so that the suction will normally maintain the pouches in collapsed position. The bleed for pouch 134 for valve D runs from the passage 72^a which communicates with the tube 72 at one side of the expression regulator. The bleeds for the pouches of valves A, B and C are in this instance located in longitudinal passages 51^a, 50^a and 88^a which connect the pouches 128^a, 128^b and 128^c with the tubes 51, 50 and 88, respectively, at one end of the pressure regulator. The tubes 51 and 50 lead direct to tracker bar apertures 11 and 10, respectively, while tube 88 runs into the main coordinator where communication is afforded with tracker bar aperture 9.

The expression regulating mechanism as a whole so far described is adapted to operate the valves A, B and C and valve D, as well as valve E, directly and independently in accordance with the determination of the main coordinator when such determination is the resultant of the junction of means for conveying the forces or expression valve operating impulses from different tracker bar apertures, which apertures may represent the same function or effect in different types of note sheets. The regulating mechanism is also designed to accomplish the same result when the impulses or forces are transmitted through the same aperture of the tracker bar representing different functions or effects in a plurality of note sheets where such forces are intended to be exerted or manifested in a like manner.

For instance, there are several commercial expression note sheets or rolls which while they differ from the "type B" or "type C" in respect of the functions or effects to be produced through the various expression apertures of the tracker bar, they are designed to effect production or performance of such effects and functions in substantially the same manner, i. e., by independent action of the several expression valves or other devices whereby the valves may be operated individually, or any two or more of them may be associated in any desired air tension regulating combination. The regulator 20 as thus far described is adapted to function in accordance with the determination of the main coordinator in all such cases without any substantial change or modification in construction.

There are also other types of expression note sheets or rolls more or less similar to the "type A" sheet, in accordance with which the expression valves are not adapted to be dissociated to function independently or in independent combinations, but some or all of

them are designed to be operated in certain specified order, or in certain prescribed associated relationships; for example, in ascending (crescendo) or descending (decrescendo) order, whereby a prescribed number of steps of tone intensity or degrees of expression tension are produced.

Therefore, in order that the valves of the regulator may be adapted to function for expression note sheets of the last mentioned type it will be necessary to effect still further coordination or junction of the forces for effecting operation of the valves. To this end I have devised an auxiliary coordinator which is adapted to operate in conjunction with the expression regulator 20, as well as the main coordinator, to cause the valves thereof to effect correct production of the results prescribed by the expression perforations of such different types of note sheets.

Auxiliary coordinator

The auxiliary coordinator comprises means for coordinating expression valve operating impulses of one order with expression valve operating impulses of another order. It also comprehends the association and cooperation of intermittently acting expression valve operating means with continuously acting valve operating means. It still further comprises means for translating intermittently acting expression valve operating impulses into constantly acting expression valve operating impulses.

It will be seen that operation of the valves A, B, C and D is accomplished by the ingress of atmospheric pressure through the passages 51, 50, 88 and 72 to elevate the pouches 128[a], 128[b], 128[c] and 134, and that upon failure of such pressure the valves will close. The expression impulses for operating said valves may therefore be said to be of the order herein referred to as "constantly acting". The expression valve operating apertures of note sheets of the type of which the "type B" or "type C" is representative are arranged in a manner to effect such constantly acting expression valve operation.

On the other hand, note sheets of the type of which the "type A" is representative are adapted to effect operation of the expression mechanism by intermittent impulses, one impulse for effecting opening of an expression valve, whereupon it will remain open, and another impulse for causing it to close. Note sheets of this type may therefore be said to be of the order according to which the expression valve operating impulses are "intermittently acting."

In order to cause a single set of expression valves or a single expression device to function in a dual capacity in accordance with both constantly acting and intermittently acting expression valve operating impulses it will be necessary, by one means or another, to effect translation of the intermittently acting expression valve operating impulses into constantly acting expression valve operating impulses. In the present instance I have effected such translation and coordination in a simple device which receives the intermittent impulses and instead of causing such impulses to directly actuate the expression valves, the impulses are utilized to actuate certain mechanical means, which mechanical means has the capacity of effecting the production of a different constantly acting impulse corresponding to each intermittent impulse when such intermittent impulse is designed to bring about or produce a certain result or effect, such, for example, as the opening of a valve, as well as the capacity of effecting the discontinuance or cessation of a constantly acting impulse upon receipt of an intermittent impulse designed to produce or bring about an opposite result or effect, thus restoring the status quo.

The auxiliary coordinator, designated 201, may form an integral part of the expression regulator body, but preferably includes a separate body 202 which is adapted to be secured to the expression regulator 20, in this instance to the bottom 112 thereof, adjacent to the end contiguous to the source of power supply, by a plurality of screws 203, suitable packing 204 being interposed to provide an air tight joint between the bottom 112 and body 202.

The top of the body is bored out, as seen at 205, to form a transverse chamber, hereinafter called the suction chamber, and this chamber 205 is provided with two opposite vertical ports 206 and 207 communicating with valve chambers 208 and 209 located at the bottom of the body 202. A pair of suitable double-acting valves 210 and 211, termed the auxiliary valves, are located in the valve chambers 208 and 209, respectively. In their upward position the auxiliary valves 210 and 211 are adapted to seat on suitable inner circular valve seats 212 and 213 located in the valve chambers 208 and 209 over the ends of the ports 206 and 207. In their downward position the auxiliary valves are adapted to seat against suitable outer circular valve cups or seats 214 and 215 which enclose the lower ends of the valve chambers 208 and 209, respectively, and are provided with atmospheric openings or ports 216 and 217. In this instance, merely for convenience, valve 211 is shown in the upward position and valve 210 in the downward position. When the auxiliary valves are in their upward position the valve chamber is open to atmosphere through the ports 216 and 217 and communication is cut off from the suction chamber 205. When the auxiliary valves are in their downward position, the valve chambers 208 and 209 are open to the

suction chamber 205 and atmospheric pressure is cut off.

The valves 210 and 211 are provided with stems 218 which traverse the ports 206 and 207. The stems 218 are in this instance square in cross section, with tapered securing ends as seen at 219, and have grooves 220 on each longitudinal side to insure a free passage through the ports. Superposed above the stems 218 are pouches 221 and 222. These pouches enclose the ends of pouch chambers 223 and 224 in the under side of the bottom 112 of the regulator 20, and are put in communication with the tubes 91 and 46, respectively, through passages 225 and 226. The passages 225 and 226 are provided with small vents or bleeds 227 and 228 which lead into the suction chamber 205. The suction chamber 205 is at all times in communication with the main pressure channel 116 of the regulator through a vertical port 229 which extends completely through the bottom 112 of the expression regulator 20.

A pair of pneumatics 230 and 231 are secured at opposite sides of the auxiliary coordinator body 202. These pneumatics include movable leaves 232 and stationary leaves 233. Suitable resilient means, here shown as springs 234, tend to normally maintain the pneumatics in inflated position. The stationary leaves of pneumatics 230 and 231 are provided with ports 235 and 236 which are adapted to communicate with the valve chambers 208 and 209 through passages 237 and 238 in the body 202.

Rarefaction of air in the main pressure channel acts through port 229, chamber 205, bleeds 227 and 228, and pouch chambers 223 and 224 to hold the pouches 221 and 222 in retracted or deflated position. Under this condition, which exists while the player mechanism is under air tension, air tension in the suction chamber 205 will also act to hold the auxiliary valves 210 and 211 against the upper valve seats 212 and 213, which will leave the valve chambers 208 and 209 open to atmosphere through the lower valve seat openings 216 and 217. This will permit admission of atmospheric pressure to the pneumatics 230 and 231 and the pneumatics will remain inert and inflated under the influence of the springs 234. This condition exists when the auxiliary coordinator is not in operation and will prevail until a note sheet perforation uncovers either one of the tracker bar apertures 6 or 7 which will cause one or more separate atmospheric pressure impulses, depending upon the number of note sheet perforations passing over the tracker bar aperture, to be transmitted through the tubes 46 or 91 and passages 225 or 226 to the pouch chambers 223 or 224, respectively, as the case may be.

Admission of an impulse of atmospheric pressure to the pouch chamber will result in inflation of the pouch so that the pouch will engage the valve stem 218 and effect movement of the auxiliary valve to its outer seat. The pneumatic will then be in communication with the suction chamber, and deflation will result. When the impulse has ceased the pouch will be deflated, the auxiliary valve will immediately resume its normal position against the upper seat and atmospheric pressure will be admitted to the pneumatic which will thereupon return to its inflated position.

The pneumatics and auxiliary valves form part of the mechanical impulse translating mechanism, the function of which is to alternately translate the intermittent crescendo expression valve operating impulses transmitted through an aperture of the tracker bar into continuous expression valve operating impulses for operating the valves A, B and C and to effect cessation of said continuous impulses in accordance with intermittent decrescendo expression valve operating impulses also transmitted from another aperture of the tracker bar.

Translating valve

The translating mechanism may take various forms. In the present instance the translating mechanism includes a sliding translating valve 239 which is adapted to cooperate with an auxiliary tracker bar 240 formed in the forward end face 241 of the body 202. This auxiliary tracker bar is provided with a plurality of small apertures, in this instance three, designated 242, 243 and 244, which communicate with horizontal passages 245, 246 and 247, respectively. The passages 245, 246 and 247 join vertical ports 248, 249 and 250, the port 250 having a short branch or cross port 250^a and a vertical port 250^b, and these vertical ports lead through the body 202 and partly into the bottom 112 of the regulator 20 until they effect juncture with the passages 51^a, 50^a and 88^a leading, respectively, to the pouches 128^a, 128^b and 128^c which operate the expression valves A, B and C.

The translating valve 239 is in this instance in the form of a rectangular sliding disk which is adapted to reciprocate across the end face 241 of the body 202 to successively uncover and cover the apertures 242, 243 and 244. This valve may, however, be circular, or in any other desired form, suitable means being provided for moving the valve to open and close the apertures. In this case the translating valve is adapted to reciprocate, and any preferred means may be employed to effect such reciprocation, such, for instance, as providing the valve with a rack 252 on its outer surface. This rack 252 may comprise two series of teeth 253 and 254, the teeth of each series corresponding in number to the apertures which the translating valve is de-

signed to successively cover or uncover. The teeth of the rack are preferably adapted to be engaged by suitable pawls 255, which may be secured to the movable leaves 232 of the pneumatics 230 and 231, or suitably mounted on the auxiliary coordinator body so that the movable leaves engage and actuate the pawls. The translating valve 239 is preferably held in seating engagement and guided in its reciprocatory movement by a suitable guide 256 secured to the under side of the bottom 112, and this guide 256 may rest in a groove 259 formed in the rack. Suitable guide pins 257 may also be provided for the pawls, and the pneumatics 230 and 231 may have regulating screws 258 for limiting the movement of the movable leaves 232 during deflation of the pneumatics so that the pawls 255 will properly engage the teeth of the rack and move the translating valve an amount equal to the distance between two adjacent teeth which corresponds with the distance between the apertures 242, 243 and 244 upon each movement of the leaves 132 in either direction.

In operation of the translating valve, assuming the parts to be in the position shown in Figure 3, an intermittent crescendo regulating valve operating impulse of atmospheric pressure through tube 91 will cause the corresponding pneumatic 230 to collapse and the movable leaf 232 will cause the pawl 255 to engage the innermost tooth of rack series 253, moving the translating valve to a position uncovering the aperture 242. This will cause a constantly acting impulse of atmospheric pressure to enter passage 245 and thence pass through the course already outlined to the pouch 128^a, inflation of which will open the regulator valve A and hold it open. A second intermittent impulse through tube 91 will cause the pawl to engage the central tooth of rack series 253, uncovering aperture 243 and opening regulator valve B; and a third impulse through tube 91 will cause the pawl to engage the outermost tooth of the series 253 uncovering aperture 244 and opening regulator valve C.

An intermittent decrescendo regulating valve operating impulse of atmospheric pressure through tube 46 will effect operation of the opposite pneumatic 231 in like manner, the pawl 255 acting on the teeth of rack series 254, moving the translating valve back one step to close one port and thereby effecting cessation of the constantly acting valve operating impulse and closing the last valve opened. A second intermittent impulse will cover another port and effect closing of another valve; and a third impulse will cover the remaining port, effecting closing of the regulator valve first opened.

The translating valve is adapted to reciprocate back and forth in any prescribed order, one step at a time, so that any particular part of the selection being played on the instrument may be emphasized by increased tension supplied by valve A alone, giving one step or degree of air tension and tonal expression; by valves A and B together, giving an increased degree of air tension; or by all three valve A, B and C, giving a further increased tension. The valve D, as already described, is operated independently, or in combination with either or all of the valves A, B and C, for quick accent of the expression, or "crash" effects.

In some cases a "type A" roll selection may terminate with loud expression, in which case the translating valve will be open. In order that all the apertures 242, 243 and 244 may be closed so that the playing of the next selection may commence with proper expression, I have provided automatic mechanical restoring means for restoring the translating valve to its closed position when the power has been shut off from the instrument. This means comprises in this instance a pneumatic 260 secured to one side of the bottom 112 of the expression regulator and having a port 261 communicating with a passage 262 leading to the main pressure channel 116. The movable leaf of the pneumatic 260 is provided with suitable means adapted to engage the valve, in this instance a hook 263, suitably guided, as by the pins 264. The hook is of such length that when the pneumatic is collapsed, in which position it is maintained during the playing of the instrument by constant suction from the main pressure channel, the translating valve will not be impeded by the hook 263. When the power supply fails or the air pressure in the main pressure channel approximates atmospheric pressure, a spring 265 secured between the leaves of the pneumatic 260 will cause the pneumatic to assume its inflated position and the hook 263 will draw the translating valve back to its initial position to close the apertures 242, 243 and 244.

The inner surface of the translating valve 239 which engages the face of the auxiliary tracker bar 240 is provided with a channel 266 so that the top and bottom of the translating valve only will bear against the face of the auxiliary tracker bar. I also preferably insert suitable air tight sealing material in the channel 266, such as a strip of skin or soft leather 267 and allow a portion of the strip which normally covers the apertures 242, 243 and 244 to be loose, in the form of a flap. This provides an air tight closure for the apertures because the apertures are normally under air tension, being in communication with the passages 51^a, 50^a and 88^a which lead to the pouches 128^a, 128^b and 128^c and have the small bleeds 157 which communicate with the main pressure channel. The suction tends to tightly seat the flap over the

apertures, thus positively shutting off atmospheric air.

Figure 14 exhibits a comparison of the expression indicia of the "type B" and "type A" note sheets, showing the arrangement of the expression perforations, with several arbitrary examples of the manner in which the expression valves are operated, and illustrating, as well, the nomenclature of the tracker bar expression apertures with respect to each particular type of note sheet, the expression perforations of both sheets being aligned with the tracker bar apertures with which they correspond. The examples given are self-explanatory.

It will be seen that in playing a "type B" note sheet tracker bar apertures 4 and 6 are not ordinarily used. In playing a "type A" note sheet tracker bar apertures 3, 10, 11 and 12 are also normally inactive. Occasionally a selection on either type of roll may be perforated to correspond with either of these apertures, for some specific purpose. As already stated, I may make use of such inactive apertures for any desired purpose, but an illustration of the effects produced, if any, if they are not so used and either of such apertures should "come on" during the playing of a selection might be apropos.

If in playing a "type B" note sheet tracker bar aperture 4 should come on through a note sheet perforation, no effect whatever would be produced, because tube 44 communicates with the main coordinator passage 68 leading to vertical port 69 which comes to a dead end at the closed pouch 53. If aperture 6 should come on it would be the same as if a "type A" note sheet were being played, because tube 46 leads direct to the decrescendo or expression valve closing mechanism, and the effect would be nil.

On the other hand, if a "type A" note sheet were being played and aperture 3 should come on, the effect would be to operate the bass soloist pneumatic, because tube 43 leads to passage 79, vertical port 77, passage 78 and tube 65, which runs to pneumatic 15. Access would also be afforded to vertical port 76 which communicates with passage 75 and to vertical port 74, but this can produce no further effect because the pouch 57 would be closed. If aperture 10 should come on, the effect would be the same as with the "type B", because tube 50 leads direct to the valve B, and the only effect would be to produce a little louder playing of the instrument. If aperture 11 should come on, the effect would be the same as in the case of a "type B" note sheet, because tube 51 leads direct to the A valve, and slightly louder playing would be the only result. If aperture 12 should come on the effect would be to operate the treble soloist pneumatic, because tube 52 leads to passage 81, vertical port 82, passage 80 and tube 66, which runs to pneumatic 16. Access would in this case also be afforded, through pouch 55, to vertical port 83 which communicates with passage 84 and to vertical port 85, but this can produce no further effect because the pouch would be closed.

From this it will be seen that the modification of the expression mechanism shown herein is free from any destructive consequences and practically proof against any confusion due to the functioning of additional tracker bar apertures, which additional apertures are only used in remote cases, being more or less "special" note sheets. The slightly louder playing or solo effects which would follow with a "type A" note sheet under such conditions would in fact be a satisfactory substitute for the mandolin attachment or other device prescribed by such apertures, and the instrument may, moreover, not be provided with such attachment or other devices, and the difference in playing, if any, would ordinarily not be noticed.

It is to be understood, however, that all these apertures can be taken care of so that absolutely no effect would be produced if either of them should come on during the playing by providing additional ports and passages in the main coordinator. The apertures in question are very seldom used and the modification which I have illustrated has given entire satisfaction under practically all conditions.

It will be seen that while the main coordinator is designed to effect coordination of the nomenclature of apertures of the tracker bar to effect production of certain results or effects, the expression device as herein described is also adapted to effect dissociation of the nomenclature of certain of the tracker bar apertures, either by direct connection of certain of the tracker bar apertures with valves or pneumatics or other parts, as, for instance apertures 5, 6, 10 and 11; or by tubes being T'd to each other, as for instance tubes 65 and 43, 52 and 66, and 60 and 67; or by coordination of one aperture having different significance in the case of different types of note sheets with one or more apertures indicative of a like function or effect in the case of a particular note sheet, as for instance tracker bar apertures 3, 7 and 9; or by coordination of apertures not ordinarily used with one type of note sheet, as for instance aperture 4 with the corresponding aperture employed in the case of a note sheet of another type; or otherwise, so that the expression valves or other parts of the mechanism are actuated through such apertures in accordance with the particular note sheet used.

It is to be understood that my expression regulator is adapted to be used with any automatic musical instrument and is not limited in its adaptation to sheet controlled musical instruments but may be used as well with in-

struments employing records of different types; that the expression regulator 20 may take different forms and is not limited in operation to the use of valve mechanism but any desired air tension regulating elements, such as bellows, reservoirs, or other devices, may be substituted therefor; that the auxiliary coordinator, similarly, need not necessarily have valves for receiving the intermittent impulses but other elements, such for instance as are ordinarily used in expression devices adapted to operate for the "type A" note sheet alone may be employed; that any desired mechanical or other means may be used for operating the impulse translating mechanism, and the translating valve herein shown is merely a preferred form and other devices may be substituted therefor; that the terms "forces" or "impulses" as used herein are intended to mean any desired forces or impulses, electrical, mechanical, fluid, pneumatic, atmospheric, or otherwise, and the tracker bar may be any element adapted to be interposed between the indicia or perforations of the record or note sheet for the purpose of initially effecting communication between the record or note sheet and the expression regulating mechanism; that the selector may be constructed in different forms to suit particular conditions; and that the main coordinator may be any desired means for effecting coordination of the expression indicia or perforations of a plurality of records or note sheets and the auxiliary coordinator may be any auxiliary means for effecting coordination of forces or impulses of different character or any auxiliary means necessary or desirable to enable the expression mechanism to operate in accordance with one or more records or note sheets which are themselves different in character from other records or note sheets adapted to be used with the expression regulating mechanism or in which the expression indicia or perforations are of different character or designed to effect operation of the expression regulating mechanism in a manner different from that of other note sheets or records adapted to be used on the instrument; all to the end that I do not desire to be limited strictly to the modification herein shown and described, but that other forms and modifications of the several parts are included within the spirit and scope of the invention as expressed in the appended claims.

What I claim is:

1. Expression regulating mechanism for automatic musical instruments comprising the combination with a tracker bar and a source of power supply, of a unitary expression regulator adapted to operate in accordance with the expression perforations of any one of a plurality of different note sheets, means for effecting coordination of the nomenclature of expression apertures of the tracker bar in accordance with said different note sheets, means for rendering said expression regulator operative in accordance with the particular note sheet used, said expression regulator being adapted to be directly operated initially through tracker bar expression apertures in the case of a note sheet of one type, and an auxiliary coordinator forming part of said expression regulator, said auxiliary coordinator being directly actuated initially through expression apertures of said tracker bar, and means for causing said auxiliary coordinator to effect operation of said expression regulator in accordance with a particular note sheet.

2. In an automatic musical instrument, an expression regulator, a main coordinator, a selector, a tracker bar, a wind chest, an auxiliary coordinator and suitable tubes connecting said parts so that by manually adjusting the selector any of several kinds of note sheets may be passed over the tracker bar and will correctly govern the action of the expression regulator.

3. In an automatic musical instrument, an expression regulator having a number of expression regulating devices therein and means for rendering said expression regulating devices inoperative, consisting of a valve which may be opened so as to permit a free flow of air therethrough and around the expression regulating devices, a pneumatic connected to said valve and manually controlled means governing the action of said pneumatic.

4. In an automatic musical instrument, an expression regulator having a number of expression regulating devices, a valve which may be opened to render said devices inoperative, a pneumatic connected to said valve and controlling the action of the same, a bleed in said pneumatic for admitting atmospheric air, an exhaust from said pneumatic which may be operated to close the same and a manually controlled valve adapted to close said exhaust.

In testimony whereof, I have signed this specification.

TOLBERT F. CHEEK.