

H. BOCKISCH,

MECHANISM FOR SYNCHRONIZING THE OPERATIONS OF MOVING PARTS.

APPLICATION FILED DEC. 15, 1917.

Patented Dec. 16, 1919.

5 SHEETS—SHEET 1.

1,324,779.

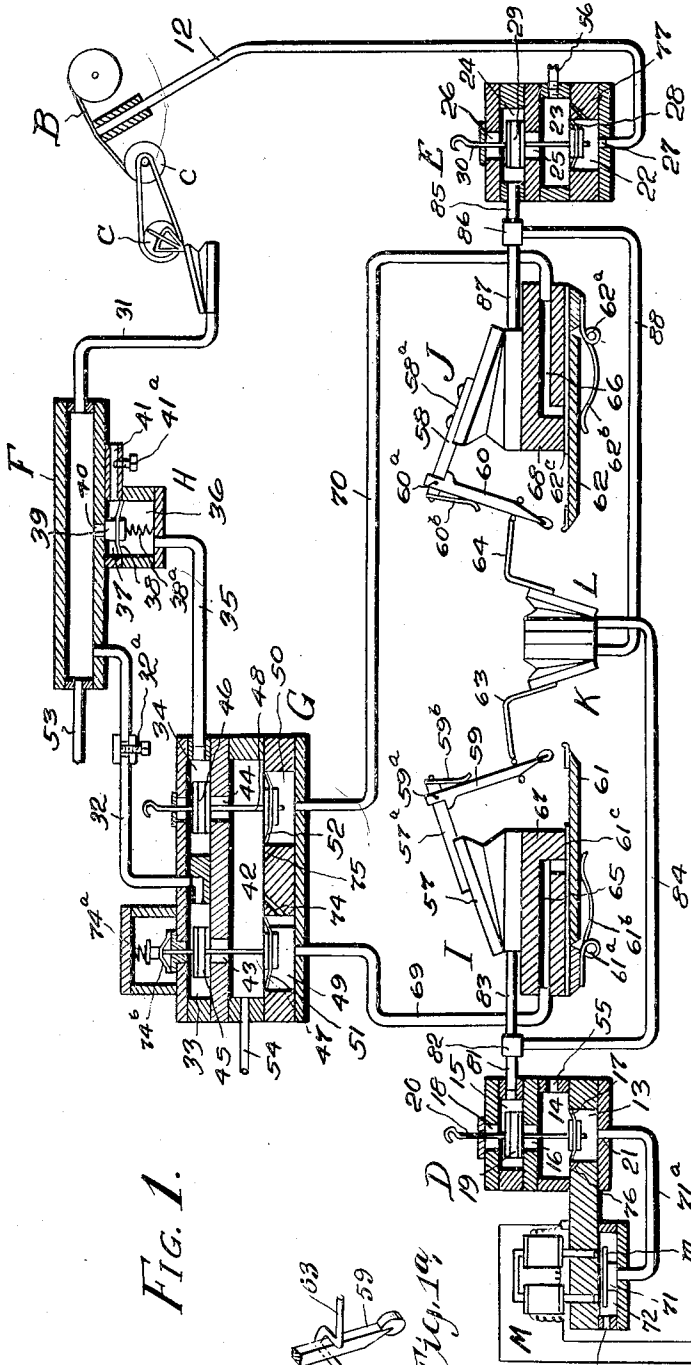


FIG. 1.

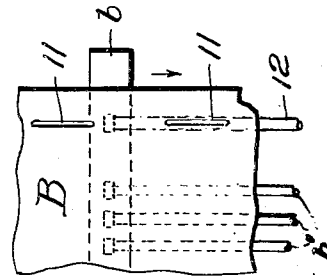
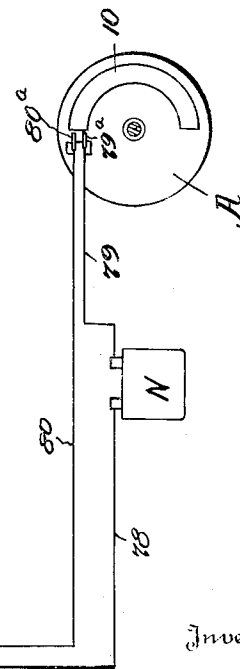


FIG. 2.



Inventor

Heinrich Bockisch,

C. J. Stockman

Attorney

Witnesses

J. M. Lyle

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FIG. 3.

FIG. 4.

Inventor
Heinrich Bockisch,

J. N. Lykes

Heinrich Böckisch,

By C. J. Stockman
Attorney

Attorney

H. BOCKISCH.

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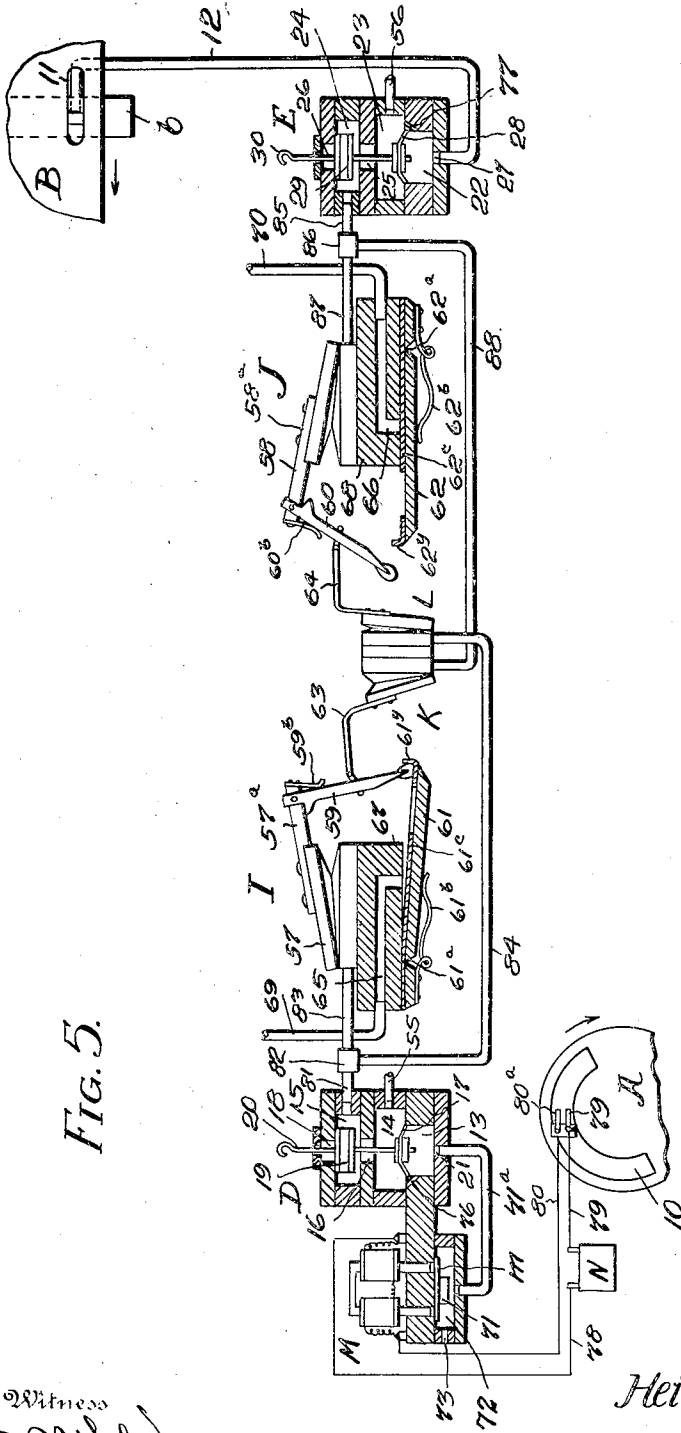


FIG. 5.

FIG. 11.

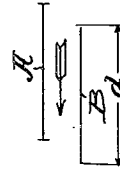


FIG. 10.

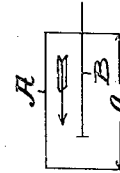


FIG. 9.

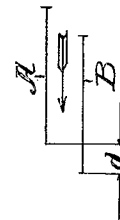
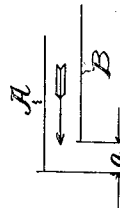


FIG. 8.



Inventor

Heinrich Bockisch,

C. J. Stockman

Attorney

Witness
J. M. Lufes

H. BOCKISCH.

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5 SHEETS--SHEET 4.

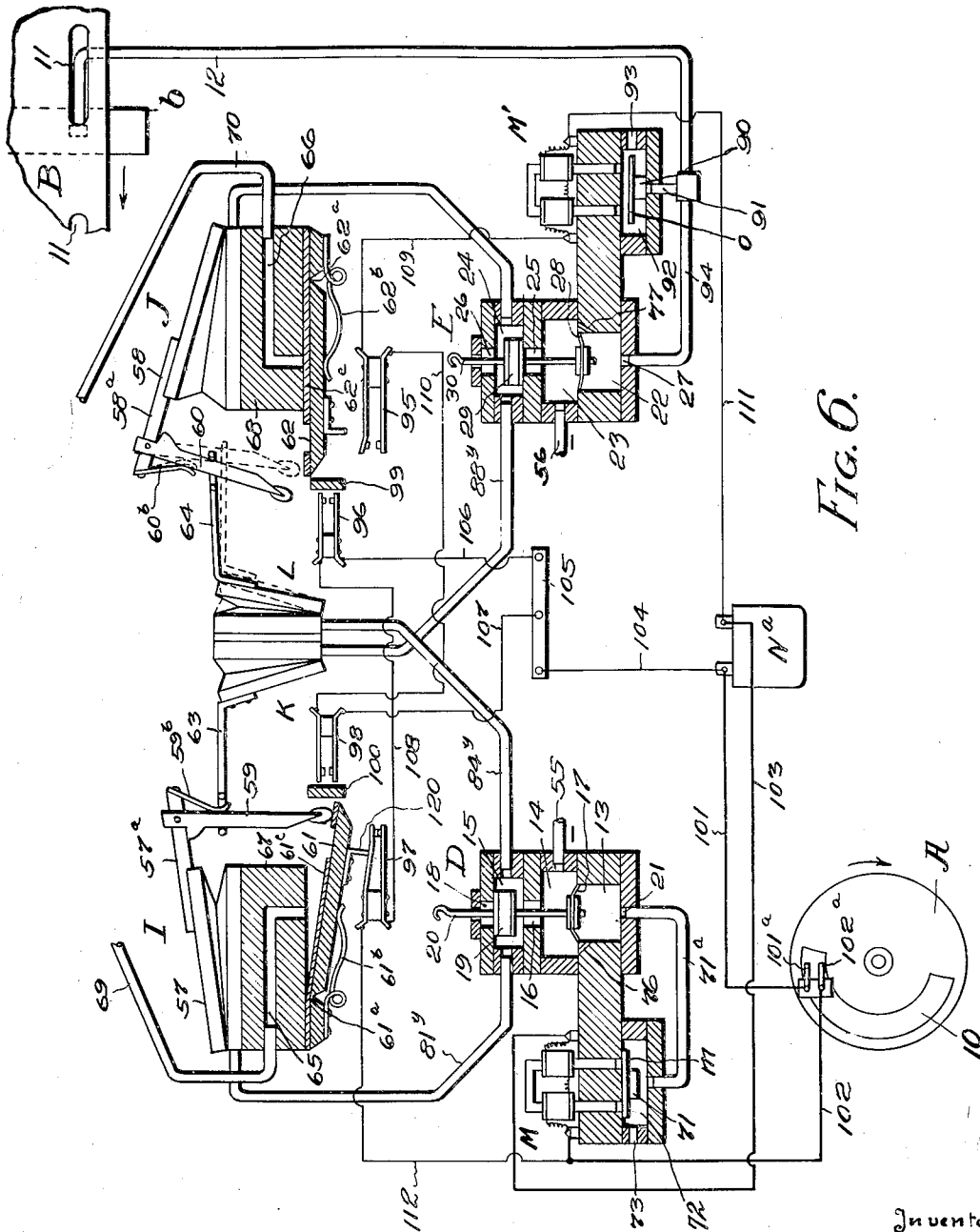


FIG. 6.

Inventor

Heinrich Bockisch,

By *C. F. Stockman*
Attorney

Witness
M. Lyles

H. BOCKISCH.

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5 SHEETS—SHEET 5.

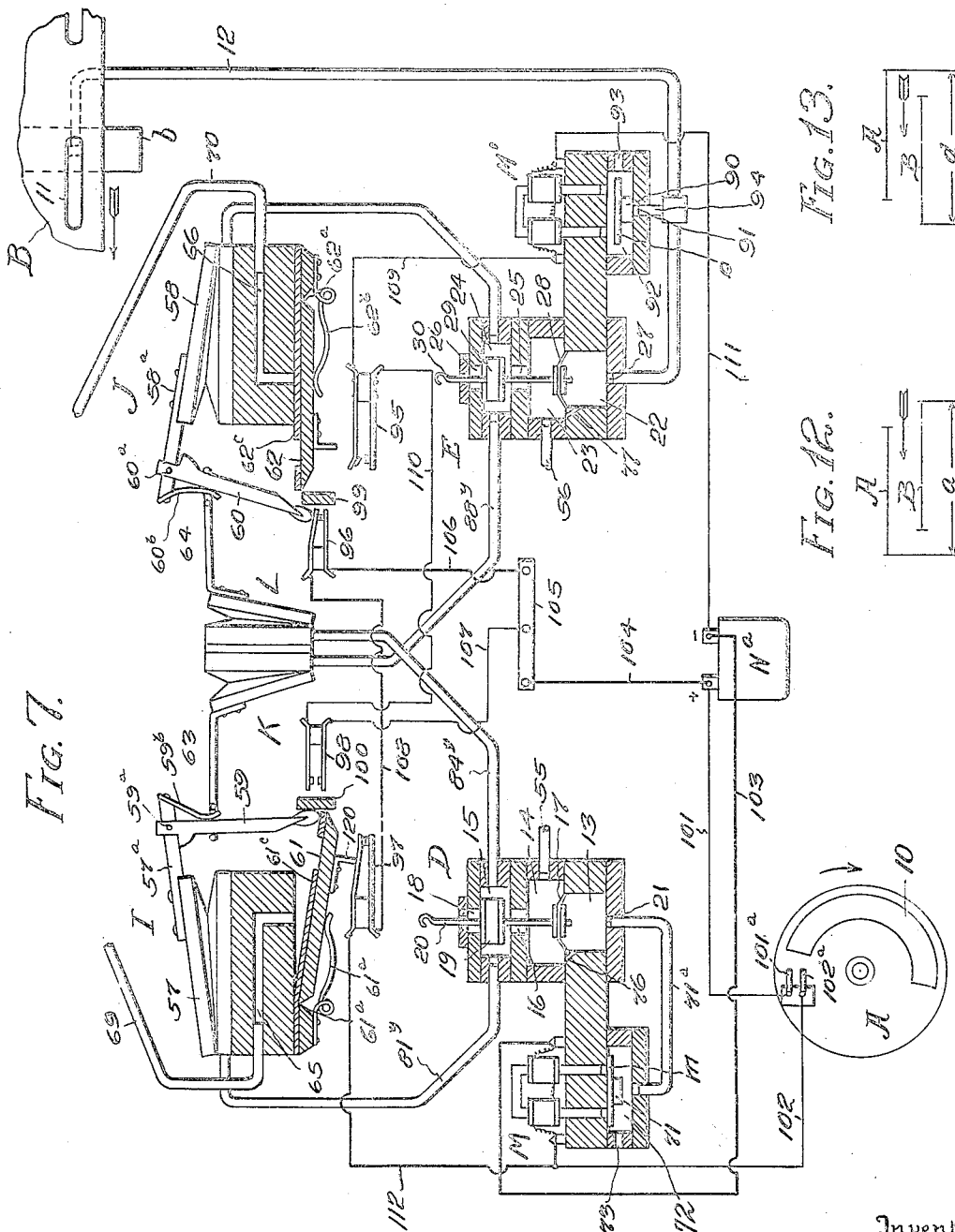
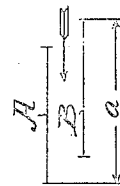
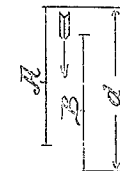


FIG. 7.

FIG. 13.

FIG. 12.



Witness
J. M. Lyle

Inventor
Heinrich Bockisch,

By C. J. Stockman

Attorney

UNITED STATES PATENT OFFICE.

HEINRICH BOCKISCH, OF POUGHKEEPSIE, NEW YORK, ASSIGNOR TO M. WELTE & SONS,
OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

MECHANISM FOR SYNCHRONIZING THE OPERATIONS OF MOVING PARTS.

1,324,779.

Specification of Letters Patent.

Patented Dec. 16, 1919.

Application filed December 15, 1917. Serial No. 207,352.

To all whom it may concern:

Be it known that I, HEINRICH BOCKISCH, a subject of the Emperor of Austria-Hungary, residing at Poughkeepsie, in the county of Dutchess and State of New York, have invented certain new and useful Improvements in Mechanism for Synchronizing the Operations of Moving Parts, of which the following is a specification.

10 This invention relates to improvements in mechanisms for synchronizing the operations of moving parts, and particularly for the synchronization of a pneumatically-operated record-controlled instrument with another instrument or means of appropriate character. It may be very desirably employed to synchronize the operations of a phonograph and an automatic piano, organ, orchestrion, or the like, and hence I have shown preferred embodiments of the invention when employed for this particular purpose, but it will be understood that this is merely exemplary, as the invention considered in its broadest aspects, may be applied to many different classes of machinery, apparatus or instruments by suitable modification of elements which are more or less immaterial to the real invention here involved, the said modification having reference principally to the substitution for the hereinafter described "primary controlling elements," which are peculiarly appropriate to a phonograph and a self-playing piano, organ or orchestrion, of other primary controlling elements more especially adapted for the particular class or style of machines, apparatus or instruments which are to be synchronized.

40 In the accompanying drawings, wherein like characters of reference designate corresponding parts in the several views:

Figure 1 is a schematic sectional representation of one embodiment of my invention applied to the synchronization of the operations of a phonograph and an instrument played by a perforated note sheet or record. In this particular embodiment the period of acceleration or retardation of one instrument commences when one primary controlling element comes into operation and terminates when the operation of the other primary controlling element commences.

Fig. 1^a is a fragmentary representation of

a part of the element 59 (or 60) and a part of the element 63 (or 64) preferably employed in the various forms of the invention, and is particularly intended to show the slidable connection of these elements with each other.

Fig. 2 is a detail representation of part of a perforated note sheet, which form of record is preferably employed to control the operation of the piano or the like, and part of a tracker board associated with such record, showing the primary controlling element of the piano or the like formed as a part of the note sheet and with special apertures to successively open a special duct in the tracker board.

Fig. 3 is a schematic sectional representation of certain parts and shows their several positions when the speed of the record of the piano or the like is being accelerated.

Fig. 4 is a like view of the same parts but shows the positions when the period of acceleration has been terminated and before the parts have been returned to their original positions: in other words, while both primary controlling elements are in operation.

Fig. 5 is a view similar to Fig. 3 of the same parts shown in said figure, but modified to effect an acceleration of the speed of the record throughout the entire period of the operation of the primary controlling element of the other instrument when the latter is traveling faster than the former, or the retardation of the speed of the record of the first named instrument throughout the entire time a perforation of the primary controlling element thereof is in registration with the special duct in the tracker board.

Figs. 6 and 7 are schematic sectional representations showing different operative positions of the parts in an embodiment of the invention wherein the period of acceleration or retardation initiated by one primary controlling element is continued by the other primary controlling element.

Figs. 8 and 9 are diagrammatic views to illustrate respectively the periods of acceleration and retardation of the speed of the piano with the construction shown in Figs. 1 to 4, inclusive.

Figs. 10 and 11 are similar views to illus-

trate the periods of acceleration and retardation when the form illustrated in Fig. 5 is employed; and

Figs. 12 and 13 are similar views to illustrate said periods when the form illustrated in Figs. 6 and 7 is employed.

In all the figures of the drawings: A and B designate two movable or traveling parts whose movements are to be synchronized by the present mechanism. In this particular application of the invention the part A is the table of a phonograph of any approved or suitable kind and the part B is a perforated note sheet such as is commonly employed as the record for controlling the operation of actuating pneumatics in player pianos, piano players, automatic organs, orchestrions or other suitable musical instruments. It is well known that in practice the table A is rotated at a regulated speed by a suitable motor, and hence it is not necessary to illustrate or further refer herein to the mechanism for driving said table. It is also understood that the note sheet or record B is caused in practice to travel at a regulated speed over a tracker board *b*, and that it is perforated and in its travel over the tracker board opens and closes ducts *b'*, (Fig. 2), formed in the latter, these ducts respectively communicating with certain pneumatics (not shown) of a player action whose nature is such that it controls the operation of the sound emitting elements of the instrument by acting directly on appropriate elements of a piano action, as is usual in player pianos, or upon the keys of the piano, as usual in piano players, or by opening air passages to reeds or pipes or other sound producing elements, as is common in organs or orchestrions for example. It is apparent that any means adapted to open and close the several ducts *b'* of the tracker board, when the latter is employed, in a predetermined succession, may be utilized in lieu of the perforated note sheet B, and hence I would have it understood that the term "record" wherever herein used is intended to comprehend any such device or means.

The record B in operation is wound onto a take-up roll *c* which, as shown in Fig. 1, derives motion from a wind motor, illustrated conventionally at *e*. As it is common in instruments of this class to connect such motors with the take-up roll of the instrument for the purpose stated, and as a particular connection of the motor with such roll is in no wise a part of my present invention, I shall not undertake to illustrate or describe any particular connection in detail.

Moving with the table A and record B respectively are what I have elected to call "primary controlling elements," which will be presently more particularly described. They control the operation of the synchronizing mechanism.

The synchronizing mechanism comprises elements so correlated and combined as to bring about the correction of the speed of one instrument when it is traveling faster or slower than the other, and to do this promptly and with such certainty that there is no noticeable lack of synchronization in the operation of the two instruments or machines: it being understood that the record B and the phonograph record have been properly prepared with reference to each other in the first instance and that the defects to be corrected are those due to friction and other conditions which influence the two instruments differently and make it advisable to force one instrument to follow every fluctuation in the speed of the other.

The present invention aims to secure a practically perfect synchronization of the instruments by mechanism of very simple nature.

In practice it is preferred to so arrange the synchronizing mechanism that the speed of one machine or instrument will be directed or controlled by the other. When the mechanism is arranged to synchronize a phonograph and a player piano or the like, it is preferred to control the speed of the piano or the like from the phonograph, and each of the herein illustrated embodiments of the invention exemplifies such an arrangement.

Each of said embodiments includes a system of pneumatically operated valves and motors. The present day practice being in favor of the utilization of suction in the operation of automatic pianos and the like, (*i. e.* the difference in pressure between air at atmospheric, or normal, pressure and air at less than atmospheric, or subnormal, pressure) I prefer such arrangement and have illustrated the same and will describe the invention exclusively with relation thereto, without, however, intending to restrict the invention to such arrangement, as by well understood changes the mechanism may be easily adapted to utilize the difference in pressure between air at atmospheric pressure and air above atmospheric pressure.

In each of the several forms of the invention herein exemplified, the primary controlling element associated with the table A, is an arcuate metallic strip 10 which is suitably secured to the underside of the table and is insulated therefrom: and the primary controlling element associated with the record B may be regarded as that part of the record adjacent to the longitudinal edge of the latter, the said part having, as shown, a series of spaced special apertures 11 arranged to open a special duct 12 connected to the tracker board B, intermittently.

Each of the illustrated embodiments of the invention includes two valved members

marked D and E respectively. The member D preferably includes three chambers, respectively marked 13, 14 and 15. Chamber 15 has a port 16 through which it has communication with the chamber 14 and said chamber 14 is separated from the chamber 13 by a membrane 17. The chamber 15 further has a port 18 and is provided with a valve having a stem, 20, connected to the port 21 through which it is supplied with air at atmospheric pressure. The chamber 14 contains air under suction, and when the port 16 is opened the chamber 15 similarly contains air under suction. At other times, the chamber 15 contains air at atmospheric pressure, supplied thereto through the port 18. The member E is of similar construction: its chambers are marked 22, 23 and 24; its ports are marked 25, 26 and 27; its membrane is marked 28; its valve is marked 29; and the stem of the valve is marked 30. The valves 19 and 29 form primary valves in the herein exemplified forms of the invention.

Each form of the invention also contemplates the use of an air conduit F having connection with the wind motor C through a duct 31, and valved members G and H by which the tension of the air in the conduit F is changed under control of other parts of the synchronizing mechanism. The conduit F and the members G and H are shown only in Fig. 1. It will be noted that the conduit F is connected by a duct 32 with a chamber 33 of the member G and that said member G has another chamber marked 34, which is connected by a duct 35 with a chamber 36 of the member H. The member H also has a chamber marked 37, which is separated from the chamber 36 by a membrane 38 provided with a valve 39 which opens and closes a port 40 between the conduit F and the member H. The chamber 37 has a duct 41 to the atmosphere and the membrane 38 has a spring 38^a which acts upon it in opposition to the pressure of air in the chamber 37. The openings through the duct 32 may be adjustably regulated by any suitable means, as the screw 32^a, for example, and the duct 41 similarly may be adjustably regulated, as by the screw 41^a, for example. The chambers 33 and 34 of the member G have communication with a common conduit 42 in said member, through ports 43 and 44 and these ports are opened and closed by secondary valves 45 and 46, respectively mounted in the chambers 33 and 34 and provided with stems 47 and 48. The conduit 42 is separated from other chambers, marked 49 and 50 respectively, by membranes 51 and 52 and these membranes are connected to the stems 47 and 48 of the valves 45 and 46.

The conduit F is provided with a duct 53

by which it has connection with a suitable source of supply of regulated suction, while the conduit 42 of the member G is suitably connected with a source of unregulated or stronger suction, through the duct 54. The chamber 14 of the member D and the corresponding chamber 23 of the member E similarly have communication with a suitable source of air under suction, the connection being exemplified by the ducts 55 and 56.

In each of the several herein exemplified forms of the invention there are two motors I and J. These motors are in the form of bellows whose movable boards 57 and 58 carry elements 59 and 60 which act to open valves 61 and 62 under certain conditions hereinafter explained. These elements 59 and 60 are fulcrumed at 59^a, 60^a to projections 57^a and 58^a which are secured to the movable boards 57 and 58 and substantially form parts thereof. K and L designate another pair of motors, preferably in the form of ordinary bellows. Bellows K has a connection, shown at 63, slidably engaged with the valve opener 59 and when collapsed adjusts said valve opener into position where its path of movement toward the valve 61 will be such that it will not engage the valve 61. The bellows L has a similar connection, shown at 64, to the valve opener 60, whereby the collapsing of the bellows will move said valve opener into position wherein it will not engage the valve 62 when the bellows J is collapsed. The valve openers 59 and 60 have springs 59^b and 60^b for holding them yieldably in engagement with the respective adjusting connections 63 and 64.

The valves 61 and 62 in all of the exemplified forms of the invention are hinged at 61^a and 62^a respectively and close the mouths of channels 65 and 66 formed in suitable members 67 and 68. The channel 65 is connected by a duct 69 with the chamber 49 of the member G and the channel 68 is connected by a duct 70 with the chamber 50 of said member G. These channels 65 and 66 when uncovered are open to the atmosphere. The valves 61 and 62 are pressed yieldably to their closed positions by springs 61^b and 62^b.

The motors I and J, openers 59 and 60, motors K and L and devices 63 and 64 constitute a very desirable form or embodiment, whose employment therefor is preferred, of a means by which the valves 61 and 62 are selectively operated. This operation is controlled in accord with the movements of the parts to be synchronized, preferably by the means now to be described:

In all of the herein exemplified forms of the invention, the motors I and L have communication, through suitable ducts hereinafter more particularly referred to, with the valve chamber 15 of the member D: and the

motors J and K similarly have communication through appropriate ducts, with the valve chamber 24 of the member E. Moreover, in each of the herein exemplified forms of the invention, the operation of the valve 19 in the member D is controlled primarily by the member 10 which intermittently closes a circuit, hereinafter described, through an electro-magnet M whose armature *m* is provided with a valve 71 which opens and closes a duct 71^a extending from a chamber 72 to the port 21 of the member D. The chamber 72 has an atmospheric port 73 and hence when the duct 71^a is opened atmospheric air is admitted to the chamber 13. This duct 71^a is opened when the magnet M is energized and is closed when said magnet is de-energized, under control of the primary controller 10 and the circuits hereinafter to be explained.

I have thus described the several parts which are or may be common to the several particular embodiments illustrated in the drawings and hence bear the same reference characters throughout the drawings: and it will be apparent in each of these embodiments that whenever the duct 12 is opened air will be admitted to the chamber 22 of the member E, whereupon the membrane 23 will be raised, thus moving the valve 29 to the position in which it opens the port 25 and closes the port 26. Suctional force accordingly is communicated to the bellows J and K, and the latter thereby collapsed, through ducts which will be later more particularly referred to as they appear to differ somewhat from each other in the diagrammatic representations of the different embodiments. Obviously, when the bellows J is collapsed it moves the valve opener 60 toward the valve 62 and if the bellows L be expanded at this time, the valve 62 will be opened, thus admitting air to the channel 66, which air will flow thence to the chamber 50 of the member G, whereupon the membrane 52 will rise, thus moving valve 46 and opening communication of the chamber 34 with the conduit 42. The unregulated suctional force in the conduit 42 accordingly will be communicated to the membrane 38 in the member H, whereupon this membrane will be forced downward against the tension of the spring 38^a thus opening the port 40 between the conduit F and the chamber 37. As the chamber 37 is in communication with the atmosphere through the duct 41, it follows that the attenuation of the air in the conduit F is lessened and the speed of the motor C will be correspondingly reduced. This occurs when the valve 29 is moved to open port 25 in the member D before the valve 19 is moved to open the port 16 in the member D.

The latter valve (19) is opened when the port 21 is opened to the atmosphere. This

occurs whenever a circuit through the magnet M is closed by the arcuate member 10. When the port 21 has been opened to the atmosphere, the membrane 17 in the member D will be raised, thus moving the valve 19 and thereby opening the port 16 and closing the port 18. Air under suction will thus be communicated to the bellows I and the latter will collapse and move the valve opener 59 toward the valve 61. It will be remembered, however, that when the duct 12 was opened and the valve 29 raised, the bellows K was collapsed and hence it moved the valve opener 59 to position in which its movement toward the valve 61 does not bring it into contact with the valve 61. Accordingly it follows that the collapsing of the bellows I has no effect upon the valve 61 provided the valve 29 is open.

On the other hand, it will be apparent that when the table A is traveling ahead of the record B, the valve 19 will be opened first. In such case, the bellows I and the bellows L will each be collapsed first. The collapsing of the bellows I will now cause the valve 61 to be opened and the collapsing of the bellows L will adjust the valve opener 60 to a position in which its path of movement will be outside the valve 62. The opening of the valve 61 admits air at atmospheric pressure to the chamber 49 of member G, thus causing the membrane 51 to rise and move the valve 45 to position in which the unregulated-suction conduit 42 is in communication with the member F through port 43, chamber 33 and duct 32. This effects a further attenuation of the air in the conduit F and, it follows that the motor C will now be speeded up.

When the valve 61 has been closed the entrance of air at atmospheric pressure into the chamber 49 ceases whereupon the valve 45 automatically returns to its position in which it closes the port 43 and hence acts to close communication of the conduit F with the conduit 42. The return of the valve 45 to the position just described is expedited by the provision of a bleed hole 74 and may be further expedited by a spring 74^a. The stem of this valve is preferably connected to a pulpette 74^b whereby a substantially air tight connection is maintained around the same.

Similarly when the valve 62 has been closed, the chamber 50 no longer has communication with the atmosphere and hence the valve 46 returns to the position in which it closes the port 44 and thereby cuts off communication of the chamber 36 into the suction conduit 42. This action of the valve 46 is expedited by the provision of a bleed hole 75. The spring 38^a plus the force of whatever air at atmospheric pressure enters the chamber 36 by way of the chamber 34 and duct 35 now acts upon the membrane 38

and presses the valve 39 to its seat adjacent the port 40, and hence cuts off communication of the conduit F with the atmosphere.

Of course it will be understood that the closing of the valve 61 will follow the closing of the duct 71^a, and the closing of the valve 62 will follow the closing of the duct 12. It will also be understood that the duct 71^a is closed when the magnet M is deenergized and that when it has been closed atmospheric pressure no longer enters chamber 13 whereupon the primary valve 19 will fall and will close port 16 and open port 18. This action is expedited by connecting the chamber 13 with the chamber 14 by a bleed hole 76. Air at atmospheric pressure now passes to the bellows I and L which thereby resume their expanded conditions. Similarly, it will be understood that the duct 12 is closed when the aperture 11 which opened it has passed out of registration with said duct, and when thus closed the primary valve 29 falls very promptly (there being a bleed hole 77 connecting chambers 22 and 23) and closes port 25 and opens port 26, whereupon air at atmospheric pressure is admitted to the bellows J and K and the latter are again extended to their original forms. Further, it will be understood that each of the bellows employed in the mechanism will preferably be provided with springs which are under tension when the bellows are collapsed and aid in expanding them promptly, as is usual in the pneumatics and motors of this type.

It will also be understood that the parts 61 and 62 which I have hereinbefore termed "valves" and which open and close the channels 65 and 66 may desirably consist of wooden strips having a suitable facing 61^c and 62^c for making an air-tight connection with the members 67 and 68 adjacent to the mouths of said channels.

Having now described the elements common to the several herein exemplified forms of the invention, I will next describe the parts which differ in the several forms exemplified by the drawings premising this portion of the description with the statement, which also applies in substance to the preceding description, that the illustrations are largely of a diagrammatic nature and while for the sake of clearness of illustration they show particular relative positions of the parts and an arrangement of ducts appropriate to such position yet in actual practice these may, obviously, be varied.

N, (Figs. 1, 3, 4 and 5) designates a suitable source of electrical potential from the positive terminal of which a wire 78 extends to the positive terminal of the magnet M. From the negative terminal of the magnet a wire 79 extends to a place adjacent to the table A and terminates in a terminal 79^a. Another conductor, 80, extends to a place

adjacent to the table A from the magnet M, and terminates in a terminal 80^a, which is adjacent to and spaced from the terminal 79^a. The gap between the terminals 79^a and 80^a is closed by the arcuate member 10 on the table A and hence the circuit through the magnet M is closed intermittently in the rotation of the table A and remains closed for a time determined by the length of the arcuate member 10 and the speed of rotation of the table.

The chamber 15 of the member D in these figures is provided with a duct 81 to which is connected, at 82, a duct 83 extending to the bellows I and another duct 84, extending to the bellows L. Similarly, the chamber 24 of the member E is provided with a duct 85 to which is connected, at 86, a duct 87 which leads to the bellows J and another duct, 88, which leads to the bellows K.

It will be remembered that when the primary controlling element associated with the table A acts to open the duct 71^a to the member D and the primary valve 19 in said member is thereby moved to open port 16, before the primary controlling element associated with the record B acts to open the duct 12 to the member E, the bellows I is collapsed and the valve opener 59 is brought into engagement with and opens the valve 61, thus bringing about a further attenuation of the air in the conduit F and speeding up the motor C and also that the bellows L is simultaneously collapsed and valve opener 60 thereby adjusted (see Fig. 3) so that in its movement toward the valve 62 which occurs when the duct 12 is opened and the bellows J thereby collapsed, it will travel past said valve 62 without touching the same: and similarly that when the duct 12 is opened before the duct 71^a, the bellows J and K are collapsed first, and the valve opener 60 is thereby brought into engagement with and opens the valve 62 thus bringing about a lessened attenuation of the air in the conduit F and slowing down the motor C, and simultaneously therewith the valve opener 59 is adjusted so that it will not make contact with the valve 61 when the port 21 is opened and the bellows I is collapsed. Accordingly, it follows that the two valves 61 and 62 are opened alternately and selectively, the particular one opened first depending upon whether the record B is traveling ahead of or behind the relation predetermined for the record B and table A. It also follows that when the ducts 12 and 71^a are opened simultaneously, which occurs when the record B and table are traveling in synchronism with each other, all of the bellows are collapsed simultaneously and hence neither valve 61, 62 is opened and no change in the degree of attenuation of the air in the conduit F takes place. This is shown in Fig. 4 and is substantially true

with respect to all of the several herein exemplified forms of the invention, and what has been said with relation to the selective opening of the valves 61 and 62 also applies to all of the forms exemplified.

It has not however been definitely stated thus far that if the duct 71^a is opened first and the opener 59 has been moved and has opened the valve 61, the tendency upon the opening of the duct 12 is to withdraw said opener from its engagement with the valve; and similarly if the duct 12 is opened before the duct 71^a has been opened and the opener 60 has been moved and has opened the valve 62, the tendency upon the opening of the duct 71^a is to withdraw said opener from its engagement with the valve. If this tendency be unresisted and if the valve be allowed to close, it will follow that the action of speeding up the motor C when the duct 71^a is opened first, will terminate the instant the duct 12 is opened; and, on the other hand, the action of slowing down the motor C when the duct 71^a is opened first will terminate the instant the duct 71^a is opened.

But if the tendency be resisted, or if the valve be held against closing when its opener has been withdrawn from engagement therewith, the speeding up or slowing down of the motor will not be terminated instantly upon the opening of the second opened duct but, by appropriate means, may be made to terminate at a predetermined later period. With this in mind, I have exemplified different arrangements. In one of these arrangements (Figs. 1, 3 and 4) the action, brought about by the opening of the first opened duct and the consequent opening of the corresponding valve 19 or 29, is terminated the instant the second-opened duct is opened, as it will be noted that either valve opener 59 or 60 is free to be moved off the end of the corresponding valve 61, 62 and the valve when thus released is free to be returned to its seat by its spring (61^b, 62^b). The period of speeding up or slowing down of the motor is then determined by the time elapsing between the opening of the two ducts (see Figs. 8 and 9). The second arrangement (Fig. 5) exemplifies a means by which the period of speeding up or slowing down of the motor extends throughout the entire period that the first opened duct is opened (see Figs. 10 and 11). This may be accomplished by the addition of a suitable stop to each valve, as shown. These stops are designated 61' and 62'. It will be noted that each is so related to the path of movement of the corresponding openers 59, 60, that the latter cannot be disengaged from its valve as long as its bellows (I, J) is collapsed. Hence the collapsing of the bellows I, J, is necessary to permit the valves 61, 62 to close.

In the construction exemplified by Figs.

6 and 7, the acceleration or retardation extends throughout the period of time commencing with the opening of the first opened duct and ending with the closing of the second opened duct. This is accomplished by the provision of means operable to hold the first opened valve 61, or 62 in its open position until the valve 19 or 29 second opened has been closed. The means herein exemplified are as follows:

An electro-magnet M' additional to the magnet M is employed. This magnet M' is operatively related to the member E, and its armature *o* carries a valve 90, which opens and closes a port 91, in a chamber 92 having an atmospheric port 93. The port 91 is connected by a duct 94 with the duct 12. There are also added four sets or pairs of spring contactors, marked 95, 96, 97 and 98, respectively, and blocking strips or stops 99 and 100, respectively and suitable circuit connections between the same, the magnets and a suitable source of electric potential, marked N^a in these figures. It will be noted that one circuit, shown by heavier lines is formed as follows:

From the positive terminal of the source N^a a wire 101 extends to the table A and has a terminal 101^a adjacent to the member 10 on the latter. A second wire, 102 having a terminal 102^a adjacent to but spaced from the first, extends to the positive terminal of the magnet M, and a third wire, 103 extends from the negative terminal of the magnet M to the negative terminal of the source N^a. The second circuit, shown in lighter lines, is formed as follows: from the positive terminal of the source N^a a wire 104 extends to a bus bar from which a wire 106 leads to one member of the contact 96 and a second wire 107 leads to one member of the contact 98. The other member of the contact 96 is connected by a wire 108 to a member of the contact 97. The other member of the contact 95 is connected by a wire 109 to a terminal of the magnet M' and the other terminal of said magnet is connected by a wire 111 with the negative terminal of the source of electrical potential. A wire 110 connects the remaining member of the contact 95 with the remaining member of the contact 98 and the remaining member of the contact 97 is connected by a wire 112 with the positive pole of the magnet M, through a part of the wire 102 to which the wire 112 is connected.

The correlation of the parts is such that the operation will be as follows:

When the phonograph table A is traveling faster than the record B the gap between the contacts 101^a and 102^a is bridged by the segment 10 before the duct 12 is opened. This bridging of the gap referred to instantly closes a circuit which traverses the following course from the positive pole of

the source of electrical potential N^a , wire 101, terminal 101^a, controller 10, terminal 102^a, and wire 102 to magnet M, and by wire 103 back to the negative pole of the source.

5 The magnet M being now energized attracts its armature and opens the valve 72. This as has been already explained, acts through the member D and the ducts connecting said member to the bellows I (which duct is marked 81^v in Figs. 6 and 7) to cause the bellows I to collapse and open the valve 61 whereupon air at atmospheric pressure acts upon the membrane 51 in the member G (Fig. 1) and opens the valve 45, thereby

10 subjecting the wind motor C to the strong, unregulated suction in the conduit 42, and speeding up the record B. The valve 61 has a projection 120 which engages one member of the contactor 97 and presses the

20 same into engagement with the other member thereof when said valve is opened.

At the same time bellows L is collapsed by suction from conduit 14 through port 16, chamber 15, and duct 84^v. This collapsing

25 of the bellows L pulls the valve opener 60 into position wherein in its downward movement, which occurs when bellows J is collapsed, as hereinafter described, it will pass by the valve 62 and press one member of contact 96 into engagement with the other. It will be understood that bellows J is collapsed when the duct 12 has been opened after the gap between the terminals 101^a and 102^a has been bridged by the mem-

35 ber 10. A shunt circuit operative to hold the valve 61 open after member 10 no longer bridges the gap between terminals 101^a and 102^a and until duct 12 is again closed is now established, this circuit being

40 as follows:—from negative pole of the source of electrical potential, through wire 103, magnet M, wire 112, contact 97, wire 108, contact 96, wire 106, positive bus bar 105 and wire 104 to positive pole of the

45 source. This circuit is shown in Fig. 7, the heavy lines representing the shunt circuit which is now energized.

It will be noted that when communication of the bellows J with the suction conduit 23 was established by the opening of the duct 12 and the raising of the valve 29, the bellows K was also placed under suction from said conduit 23 through port 25, chamber 24 and duct 88^v. The bellows K

55 while thus subjected to suction is only slightly collapsed because the stop 100 is in such relation to the valve opener 59 as to prevent its moving out of engagement with valve 61.

60 This period of acceleration thus continues until duct 12 is closed, whereupon all parts return to their positions ready for another operation.

If the music roll or record is traveling too

65 fast, in which case the duct 12 is opened be-

fore the gap between the terminals 101^a and 102^a is bridged by the member 10, the primary valve 29 is raised to open port 25 and close port 26, thus placing bellows J and K in communication with the suction conduit 23. The collapsing of the bellows J opens valve 62 and engages one member of contact 95 with the other member thereof by means of the projection 121. The collapsing of the bellows K pulls the valve-opener 59 out of operative relation with the valve 61 and places it in position in which its movement downward will press one member of contact 98 in engagement with the other member thereof.

80 The opening of the valve 62 also established communication of chamber 50 in member G with the atmosphere, thus raising valve 46 and opening communication of chamber 36 of member H with the strong, unregulated, suction in conduit 42. The valve 38 is thus withdrawn from port 40, whereupon communication of conduit F with the atmosphere is established and the attenuation of the air in said conduit is thereby reduced and the motor C slowed down, all as hereinbefore explained.

When now the gap between the terminals 101^a and 102^a is bridged by the member 10 the magnet M is energized and the valve 72 is raised, and the bellows I is collapsed, all as before. At this time, however, the valve opener 59 having been previously moved into position wherein it will not engage the valve 61 and will engage the contact 98, will, when the bellows I, is collapsed bring about an engagement of the members of the contact 98 and another shunt circuit will be established as follows:—from the negative pole of the source by wire 111, through magnet M', wire 109, contact 95, wire 110, contact 98, wire 107, bus bar 105 and wire 104, to the positive pole of the source.

Thus in the form exemplified by Figs. 6 and 7 the operation of one primary valve 19 or 29 in advance of the other not only acts through the mechanism described to accelerate or retard the movement of the motor C, as the case may be, but further prepares a circuit which becomes operative when the other of said primary valves is opened to continue the acceleration or retardation until the second-opened valve has been closed.

Having now described the invention what I believe to be new and desire to secure by letters patent, and what I, therefore, claim is:—

1. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the operations of the motor in accord with the movements of the parts to be synchronized, said

means comprising connections between said parts and the motor, including a plurality of valves, and operating means therefor, the valve-operating means having openers for the valves and devices for rendering either

2. Mechanism for synchronizing the operations of moving parts, comprising in combination, a motor for driving one of the parts and means for governing the operations of the motor in accord with the movements of the parts to be synchronized, said means comprising connections between said parts and the motor, including a plurality of valves and operating means therefor, the valve-operating means having openers for the valves and devices for rendering either opener inoperative with respect to its valve according to which part is traveling in advance of the other and for rendering both inoperative with respect to the valves when the parts are traveling in synchronism.

3. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a pneumatic motor for driving one of the parts and means for governing the operations of the motor, said means comprising connections between the said parts and the motor, including an air conduit, a plurality of valves, connections between the valves and the conduit to vary the force of the air in the latter to accelerate or retard the speed of the motor according to which valve is opened first, openers for the valves, devices for rendering either opener inoperative with respect to its valve, and elements by which said openers and devices are operated in accord with the movement of the parts to be synchronized, respectively.

4. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the operations of the motor, said means comprising connections between said parts and the motor, including atmospheric ducts, valves for controlling said ducts, openers for said valves, devices for rendering either opener inoperative with relation to its valve, and elements by which said openers and devices are operated selectively in accord with the movements of the parts to be synchronized.

5. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the operations of the motor, including a plurality of valves, openers for the valves, devices for rendering either opener inoperative with relation to its valve, means for operating said openers and devices in accord with the movements of the parts to be synchronized and connections between said valves and the motor, said connections including valves respectively controlled by the first-mentioned

valves and serving to cause the speed of the motor to be accelerated or retarded according to which of them is operated first.

6. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a pneumatic motor for driving one of the parts and means for governing the operations of the motor, including an air conduit having connection with the motor, a plurality of valves, openers for the valves, devices for rendering either opener inoperative with respect to its valves, elements by which said openers and devices are operated selectively in accord with the movements of the parts to be synchronized, atmospheric ducts controlled by said valves, and valved connections between said ducts and the conduit for varying the force of the air in the latter to increase or reduce the speed of the motor, respectively.

7. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts, primary valves, means for operating the primary valves in accord with the movements of the parts to be synchronized, respectively, secondary valves, connections between the secondary valves and the motor for accelerating or retarding the speed of the motor according to which valve is opened, and connections between the primary valves and the secondary valves, the latter connections including valves and operating means therefor having elements for opening the valves and devices for rendering either of said elements inoperative with relation to its valve, said elements and devices being controlled by the primary valves and selectively controlling the operations of the secondary valves.

8. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts, primary valves, means for operating said valves in accord with the movements of the parts to be synchronized respectively, secondary valves, and connections between the primary valves and secondary valves, including intermediate valves, elements for opening the intermediate valves and devices for adjusting either of said elements out of operative relation with its valve when the other element is moved to open its valve.

9. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts, primary valves, means for operating the primary valves in accord with the movements of the parts to be synchronized, respectively, secondary valves, connections between the secondary valves and the motor for increasing or decreasing the speed of the motor according to which valve is operated, and connections between the pri-

mary and secondary valves, the latter connections being controlled by the primary valves and in turn controlling the secondary valves, and including atmospheric ducts, valves for controlling said ducts, respectively, openers for said valves, devices for rendering either opener inoperative with relation to its valve and means for operating said openers and devices from the primary valves.

10. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, primary controllers operating in accord with said parts respectively, and connections between the primary controllers and the motor, including valves, valve operating elements periodically actuated under control of the primary controllers and devices under control of the controllers for rendering one or the other of the valve operating elements inoperative with relation to its valve.

11. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, primary controllers operable in accord with said parts, respectively, a plurality of valves, an actuating element for each of said valves, devices for rendering the actuating elements operative or inoperative with relation to the respective valves, connections between one primary controller and one of the actuating elements and between said primary controller and the device which renders the other actuating element inoperative with relation to its valve, connections between the other primary controller and the remaining actuating element and device, and connections between the valves and the motor, whereby the speed of the motor is accelerated or retarded according to which of the valves is actuated.

12. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, primary controllers operable in accord with said parts respectively, and connections between the primary controllers and the motor, including valves, valve operating elements periodically actuated under control of the primary controllers, and devices under control of the primary controllers for rendering one or the other of said operating elements inoperative with respect to the corresponding valve according to which primary controller first becomes active, the connections further including valves which are respectively controlled by the first mentioned valves, and in turn control the forces to the motor to accelerate or retard the speed of the latter, respectively.

13. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a pneumatic motor for driving

one of said parts, a pair of pneumatically operable valves, elements between the same and the motor through which the speed of the motor is accelerated or retarded according to which of the valves is opened, valves for controlling the pneumatic forces to operate the first mentioned valves, respectively, pneumatically operated elements for opening the second named valves respectively, pneumatically operated devices connected to the valve-opening elements for moving the latter severally into inoperative relation with the respective valves, primary controllers operable in accord with the parts to be synchronized, respectively, and means connecting one primary controller with the element for opening one of the second named valves and the device for moving the opener of the other of said valves out of operative relation with its valves, and for connecting the other primary controller with the remaining opening element and device.

14. Mechanism for synchronizing the operations of moving parts comprising, in combination, a motor for driving one of the parts to be synchronized, an air conduit connected to the motor, and means for varying the force of the air in said conduit, including pressure operable valves, air connections between the valves and the conduit, said connections being controlled by the valves; primary controllers operable in accord with the movements of the parts to be synchronized, and means intermediate the primary controllers and said valves including movable elements selectively operated under control of the primary controllers and in turn controlling the pressures to which said valves are subjected, respectively.

15. In a mechanism for synchronizing the operations of moving parts, the combination with a pneumatic motor for driving one of the parts and an air conduit having communication with the motor and provided with means by which the force of the air therein may be varied to increase the speed of the motor when it is traveling too slow and decrease the speed of the motor when it is traveling too fast, of valves for controlling said means to increase or decrease the speed of the motor, respectively, and means for controlling said valves, the latter means including valves and elements for opening the latter valves selectively in accord with the operations of the parts to be synchronized.

16. In a mechanism for synchronizing the operations of moving parts, the combination with a pneumatic motor for driving one of the parts, of means for subjecting the motor to suctional forces of varying intensities, comprising a conduit having communication with said motor and provided with means through which the air therein is further attenuated and means through which the attenuation when the motor is traveling too

slow of the air is reduced when the motor is traveling too fast, said means having controlling valves and mechanism for selectively operating the latter valves in accord with the movements of the parts to be synchronized.

17. In a mechanism for synchronizing the operations of moving parts, the combination with a pneumatic motor for driving one of the parts, of means for subjecting the motor to suctional forces of varying intensities comprising a conduit having communication with said motor and provided with means through which the air therein is further attenuated, and means through which the attenuation of the air is reduced, said means having pneumatically operable valves, air connections to said valves, valves for controlling said connections, and elements controlled by the parts to be synchronized for selectively operating the latter valves to operate the first mentioned valves in accord with the movements of the parts to be synchronized.

18. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts, and means for governing the operations of the motor, including valves, connections to the motor controlled by the valves, a pair of pneumatics for each valve, a valve-opener connected to one pneumatic of each pair, connections between the other pneumatics and the openers, and means for operating the pneumatics to move either opener to open its valve and the other opener out of operative relation with its valve in accord with the movements of the parts to be synchronized.

19. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts, and means for governing the operations of the motor, a pair of valves, connections to the motor controlled by the valves, an operating pneumatic for each valve, a pivoted valve-opener connected to each operating pneumatic, additional pneumatics, devices connected to the latter pneumatics and slidably engaged with the openers to move the latter into inoperative relation with the valves, and means respectively controlled by the movements of the parts to be synchronized for controlling said pneumatics to open the valves in accord with the movements of said parts, one of said means being connected to the operating pneumatic of one valve and the additional pneumatic for the other valve and the other of said means being connected to the other operating pneumatic and additional pneumatic.

20. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the opera-

tions of the motor, including a conduit having connection with the motor, valves, valved connections controlled by the first mentioned valves for varying the force of the air in the conduit to accelerate or retard the speed of the motor according to which of the first mentioned valves is operated, a pair of pneumatics for each of the first-mentioned valves, a valve-opener connected to one pneumatic of each pair, connections between the other pneumatics and the openers, and means for operating the pneumatics to move either opener to open its valve and the other opener out of operative relation with its valve in accord with the movements of the parts to be synchronized.

21. Mechanism for synchronizing the operation of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the operations of the motor, including a conduit having connection with a source of regulated suction and the motor, said conduit also having an atmospheric port and a valve for controlling said port, ducts having communication with a source of unregulated suction, valves for controlling said ducts, respectively, one of said ducts also, having communication with the conduit, means controlled by the other duct for operating the valve of the atmospheric port, and means for selectively operating the valves which control said ducts in accord with the movements of the parts to be synchronized, to thereby increase or reduce the degree of attenuation of the air in the conduit according to which valve is operated.

22. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the operations of the motor, including a conduit having connection with a source of regulated suction and the motor, said conduit also having an atmospheric port and a valve for controlling said port, ducts having communication with a source of unregulated suction, valves for controlling said ducts, respectively, one of said ducts also having communication with the conduit, means controlled by the other duct for operating the valve of the atmospheric port, a pair of valves, atmospheric ducts controlled by the latter valves, means for opening the valves of the first mentioned ducts when the atmospheric ducts are opened, respectively, and means for opening the valves of the atmospheric ducts selectively in accord with the movements of the parts to be synchronized.

23. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the operations of the motor, including a conduit

having connection with a source of regulated suction and the motor, said conduit also having an atmospheric port and a valve for controlling said port, ducts having communication with a source of unregulated suction, valves for controlling said ducts, respectively, one of said ducts also having communication with the conduit, means controlled by the other duct for operating the valve of the atmospheric port, a pair of valves, atmospheric ducts controlled by the latter valves, means for opening the valves of the first mentioned ducts when the atmospheric ducts are opened, respectively, a pair of pneumatics for each of the valves of the atmospheric ducts, a valve-opener connected to one pneumatic of each pair, connections between the other pneumatics and the openers, and means for operating the pneumatics to move either opener to open its valve and the other opener out of operative relation with its valve in accord with the movements of the parts to be synchronized.

24. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the operations of the motor, including valves, connections between said valves and the motor for accelerating the speed of the motor when one valve is opened and retarding it when the other is opened, a pair of pneumatics for each valve, a valve opener connected to one pneumatic of each pair, the latter pneumatics constituting operating pneumatics for the openers, respectively, connections between the other pneumatics and the openers, by which the openers are moved into inoperative relation with the respective valves, an air connection with the operating pneumatic of one opener and with the other pneumatic of the other opener, a second air connection with the other pneumatics, valves for controlling said air connection, respectively, and means whereby the last mentioned valves are operated in accord with the movements of the parts to be synchronized, respectively.

25. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts and means for governing the operations of the motor, including valves, atmospheric ducts controlled thereby, valved connections between the atmospheric ducts and the motor for accelerating the speed of the motor when one of the first mentioned valves is opened and retarding it when the other is opened, a pair of pneumatics for each first mentioned valve, a valve opener connected to one pneumatic of each pair, the latter pneumatics constituting operating pneumatics for the openers, respectively, connections between the other pneumatics and the open-

ers by which the openers are moved into inoperative relation with the respective valves, an air connection with the operating pneumatic of one opener and with the other pneumatic of the other opener, a second air connection with the other pneumatics, valves for controlling said air connections, and means whereby the last mentioned valves are operated in accord with the movements of the parts to be synchronized, respectively.

26. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, primary controllers movable in accord with said parts respectively, and connections between the primary controllers and the motor, including a pair of pneumatically operable valves, the movement of one of which effects an increase of the speed of the motor and the movement of the other of which effects a decrease of the speed of the motor, a second pair of valves for controlling the pneumatic forces upon the first-named valves, pneumatically operable actuating means for the respective last named valves, comprising valve-opening elements adapted to engage the valves or to be moved to inoperative position with respect to said valves, and means between the primary controllers and the actuating means whereby each primary controller controls the actuating means of one to move one element to open said second pair of valves and to move the other element out of operative relation with the other of said valves.

27. In a synchronizing mechanism, a pair of valved members, a pneumatic for each of said members, valve openers moved by the pneumatics respectively, and a pneumatically operated device for rendering each opener inoperative with respect to its valve.

28. In a synchronizing mechanism, the combination with a pair of valved members, a pneumatically operable means mounted upon each of the members and serving to actuate the valve thereof, and selectively operated devices for making said means inoperative with relation to their valves, respectively.

29. Mechanism for synchronizing the operations of moving parts, comprising in combination, a motor for driving one of the parts, and means for governing the operation of the motor in accord with the movements of the parts including primary controllers for the moving parts, respectively, valves, valve openers, a pair of pneumatics connected to each opener, one pneumatic of each pair serving to operate the opener to open its valve and the other pneumatic of each pair serving to adjust the opener out of operative relation with its valve, means for simultaneously controlling the forces effective upon the operating pneumatic of one pair and the adjusting pneumatic of the

other pair to operate one opener to open its valve and to adjust the other opener out of operative relation with its valve under control of the primary controller of the moving part which is in advance of the other, and means for rendering ineffective upon the opener which has been moved to open its valve, the tendency of the adjusting pneumatic connected to said opener to disengage the latter from its valve when the primary controller of the other moving part comes into action.

30. Mechanism for synchronizing the operations of moving parts, comprising in combination, a motor for driving one of the parts and means for governing the operation of the motor in accord with the movements of the parts to be synchronized, including a pair of valves, valve openers, pneumatics for operating the openers to open the valves, respectively, pneumatics for moving the openers into inoperative relation with their respective valves, and stops operatively related to the valves to engage the openers.

31. Mechanism for synchronizing the operations of moving parts, comprising in combination, a motor for driving one of the parts and means for governing the operation of the motor in accord with the movements of the parts to be synchronized, including a pair of primary valves, a second pair of valves, openers for the latter valves, pneumatics connected to the openers for moving the same to open the valves, respectively, pneumatics connected to the openers for adjusting the same out of operative relation with their respective valves, connections through which the pneumatics are controlled by the primary valves to open one or the other second valve according to which moving part is in advance of the other, and stops operatively related to said second valves to engage the openers.

32. Mechanism for synchronizing the operations of moving parts, comprising in combination, a motor for driving one of the parts, a pair of primary controllers operable in accord with the movements of said parts, respectively, and connections between the primary controllers and the motor, including a pair of valves respectively operative to retard or accelerate the speed of the motor, openers for said valves respectively, pneumatics connected to the openers for moving the same to open the valves, respectively, pneumatics connected to the openers for adjusting the same out of operative relation with their respective valves, means under control of the primary controllers for controlling the forces effective upon the pneumatics to open one or the other of the valves according to which moving part is in advance of the other, and stops operatively related to said valves to engage the openers.

33. Mechanism for synchronizing the op-

erations of moving parts, comprising in combination, a motor for driving one of the parts, an air conduit connected to the motor, and means for varying the force of the air in the conduit to accelerate or retard the speed of the motor, including air connections to the conduit, pneumatically operable valves for controlling the connections, valves for controlling the pneumatic forces to the valves of said connections, openers for the second mentioned valves, pneumatics connected to the openers for moving the same to open said second mentioned valves, pneumatics connected to the openers for adjusting the same out of operative relation with their valves, means operable in accord with the movements of the parts to be synchronized for controlling the forces effective upon the pneumatics to open one or the other of the second mentioned valves according to which moving part is in advance of the other, and stops operatively related to said second mentioned valves to engage the openers.

34. Mechanism for synchronizing the operations of moving parts, comprising in combination, a motor for driving one of the parts, and means for governing the operation of the motor in accord with the movements of the parts to be synchronized, including a pair of primary valves operable in accord with said moving parts respectively, a pair of secondary valves, and connections between the primary valves and the secondary valves for operating the secondary valves from the primary valves, respectively, said connections including additional valves for controlling the secondary valves, respectively, openers for the additional valves, pneumatics connected to the openers for moving the same to open their valves, respectively, pneumatics connected to the openers for adjusting the same out of operative relation with their respective valves, means under control of the primary valves for controlling the forces effective upon the pneumatics to open one or the other of the additional valves according to which moving part is in advance of the other, and stops operatively related to said additional valves to engage the openers.

35. Mechanism for synchronizing the operation of moving parts comprising in combination a motor for one of said parts and means for effecting an increase or decrease in the speed of the motor comprising a plurality of valves, means for actuating the valves under control of the moving parts respectively, devices under control of the moving parts for determining which of the valves is to be operated according to which moving part is in advance of the other, and means for continuing the actuation of said valve throughout the corresponding cycle of the other moving part.

36. Mechanism for synchronizing the operation of moving parts comprising in combination a motor for one of said parts and means for effecting an increase or decrease in the speed of the motor comprising a plurality of valves, motors for actuating the valves under control of the moving parts respectively, openers moved by the motors for engaging the valves to move the same, devices under control of the moving parts for moving the openers out of operative position with respect to the corresponding valves, one of the moving parts controlling the motor of one of the valves and the opener of the other of said valves, and means for preventing the selecting mechanism from moving the openers to inoperative position between the time of action of a motor upon its valve and the cessation of the action of said motor thereon.

37. Mechanism for synchronizing the operation of moving parts comprising in combination a motor for one of said parts and means for effecting an increase or decrease in the speed of the motor comprising a plurality of valves, motors for actuating the valves under control of the moving parts respectively, openers moved by the motors for engaging the valves to move the same, pneumatic devices under control of the moving parts for moving the openers out of valve operating position, one of the moving parts controlling the motor of one of the valves and the opener of the other of the valves, and stops for preventing said pneumatic devices from moving the openers out of valve engaging position between the time of action of a motor upon its corresponding valve and the cessation of the action of said motor thereon.

38. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, a pair of valves, means for operating said valves in accord with the movements of the parts to be synchronized, including an operating element for each of the valves, means for rendering the operating element second actuated inoperative with respect to its valve, means for preventing the first actuated operating element from ceasing to exert its effect upon its valve throughout the cycle of operation of the moving part that travels behind the other moving part, and connections between the valves and the motor for accelerating the speed of the motor when one valve is operated and retarding it when the other valve is operated.

39. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, primary controlling elements movable in accord with the parts to be synchronized, respectively, a pair of valves, connections between the valves and the motor for ac-

celerating the speed of the motor when one valve is operated and retarding it when the other valve is operated, operating elements for said valves, connections for controlling said operating elements from the primary controlling elements, devices likewise connected with the primary controlling elements for adjusting either operating element out of operative relation with its valve when the other operating element is moved to actuate its valve, and stops for preventing disengagement of the engaged valve and its operating element from each other until the cycle of operation of both controlling elements is completed.

40. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, primary controlling elements movable in accord with the parts to be synchronized, respectively, a pair of valves, connections between the valves and the motor for accelerating the speed of the motor when one valve is operated, and retarding it when the other valve is operated, operating elements for said valves, pneumatics with which the operating elements have pivotal connection and which move the same bodily, other pneumatics having devices connected to the valve operating elements to move the latter pivotally into inoperative relation with the valves, respectively, connections between the pneumatics which move one operating element bodily and the other pivotally and one primary controlling element, connections between the other pneumatics and the other primary controlling element, and stops to prevent disengagement of the engaged valve and its operating element from each other until the cycle of operation of both primary controlling elements has been completed.

41. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, and connections periodically operative in accord with the moving parts respectively and respectively effecting an increase and decrease of the speed of the motor, said connections including valves, operating elements for the valves, electric motors, elements for operating the valve-operating elements under control of the motors respectively, devices for rendering either valve-operating element inoperative with respect to its valve according to which moving part is in advance of the other, electric circuits in which the motors are included, and circuit breaking means therein, one of which is closed when the first-operated valve is moved, to partially complete the circuit, and the other of which is closed to complete the circuit upon movement of the operating element of the other of said valves.

42. Mechanism for synchronizing the op-

erations of moving parts, comprising, in combination, a motor for driving one of said parts, and connections periodically operative in accord with the moving parts respectively and respectively effecting an increase and decrease of the speed of the motor, said connections including a pair of valves, valve-operating elements movable into and out of operative relation with the valves, respectively, electric motors, means under control of said motors whereby when either of the motors is energized, the corresponding valve is operated and the operating element for the other valve is moved out of operative relation with the latter, a main circuit in which the energized motor is included, said main circuit being controlled by one of the parts to be synchronized, and a shunt circuit in which said motor is included, having circuit closers therein, one of which is closed when one of the valves is moved and the other of which is closed under the influence of the valve operating element of the other valve.

43. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, and connections periodically operative in accord with the moving parts respectively and respectively effecting an increase and decrease of the speed of the motor, said connections including a pair of valves; an actuating means for each of said valves, each actuating means comprising an element capable of being moved to inoperative position with respect to its valve, electric motors controlling the actuating means respectively, main circuits for the motors controlled from the moving parts, respectively, and a shunt circuit for each of said motors, each of said shunt circuits being under control of one valve and the inoperative element of the other valve.

44. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of the parts, a pair of valves, connections between said valves and the motor, including valves, elements to engage the latter valves and open the same, and devices to selectively move said elements into inoperative relation with their valves, said elements and devices being controlled by the first-mentioned valves, and means for operating the first-mentioned valves in accord with the movements of the parts to be synchronized, including electric motors therefor, respectively, a source of electrical potential and main and shunt circuits in which the motors are included, the shunt circuits including contactors to be engaged with each other when the second-mentioned valves are opened respectively, and other contactors to be engaged with each other by movement of the valve-operating

elements which have been adjusted into inoperative relation with their valves.

45. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, and connections periodically operative in accord with the moving parts respectively and respectively effecting an increase and decrease of the speed of the motor, said connections including a pair of valves, means controlled by said valves respectively for varying the effective strength of the forces exacted upon the motor, an operating element for each of the valves, actuating means for the operating elements, devices for moving the operating elements to such position as to render them inoperative with respect to their corresponding valves, electric motors controlling the actuating means of the operating elements and the devices aforesaid, means for energizing the electric motors under control of the moving parts respectively, and means for continuing the energizing of the motors after the effect of the moving part which initially energized them, ceases.

46. Mechanism for synchronizing the operations of moving parts, comprising, in combination, a motor for driving one of said parts, and connections periodically operative in accord with the moving parts respectively and respectively effecting an increase and decrease of the speed of the motor, said connections including a pair of valves, means controlled by said valves respectively for varying the effective strength of the forces exacted upon the motor, an operating element for each of the valves, actuating means for the operating elements, devices for moving the operating elements to such position as to render them inoperative with respect to their corresponding valves, electric motors controlling the actuating means of the operating elements and the devices aforesaid, means for energizing the electric motors under control of the moving parts respectively, and means for continuing the energizing of the motors after the effect of the moving part which initially energized them, ceases, and throughout the effective cycle of the operation of the moving part which is traveling behind the other.

47. Mechanism for synchronizing the operations of moving parts comprising, in combination, a motor for driving one of said parts, a pair of valves, connections between the valves and the motor, through which an increase or decrease in the speed of the motor is effected according to which of said valves is operated, pneumatic motors, elements moved by said pneumatic motors to actuate said valves, devices engaged with said elements to move one or the other to inoperative position with respect to the

corresponding valve, a pair of electric motors, main circuits in which said electric motors are included, said circuits being under control of the moving parts respectively, 5 shunt circuits in which said electric motors are included, each shunt circuit being under the joint control of the pneumatic motor of one valve and the device which renders the element of the other valve inoperative, and 10 means controlled by the electric motors respectively, for causing the energizing of one of the electric motors to actuate the pneumatic motor of one of the valves and the device which renders the operating element 15 of the other valve inoperative.

48. Mechanism for synchronizing the operations of moving parts comprising, in combination, a motor for driving one of said parts, a pair of valves, connections between 20 the valves and the motor through which an increase or decrease in the speed of the motor is effected according to which of said valves is operated first, operating means for said valves respectively, comprising movable elements capable of being shifted out of 25 operative relation with respect to the corresponding valves, devices for so shifting said elements, electric motors, under control of the moving parts respectively, and a circuit 30 for each of said motors including two circuit closing elements one of which is closed when one of the elements is moved to actu-

ate its valve and the other of which is closed when the other element is moved to inoperative position, and stops for preventing the 35 devices from moving the elements to inoperative position with respect to said valves throughout the effective cycle of movement of the moving part that travels behind the other. 40

49. Mechanism for synchronizing the operations of moving parts comprising, in combination, a motor for driving one of said parts, a pair of valves, connections between the valves and the motor through which an 45 increase or decrease in the speed of the motor is effected according to which of said valves is operated first, operating means for said valves respectively, comprising pneumatics, elements moved by said pneumatics 50 for engaging the valves to actuate the latter, pneumatic devices for shifting said elements to positions in which they are inoperative with respect to the corresponding valves, electric motors, energized under control of 55 the moving parts respectively, each of said electric motors controlling the operating means of one valve, and the pneumatic device of the other of said valves, and stops for preventing the pneumatic device last 60 operated from moving the corresponding element out of valve engaging position.

In testimony whereof I affix my signature.

HEINRICH BOCKISCH.