



No. 768,053.

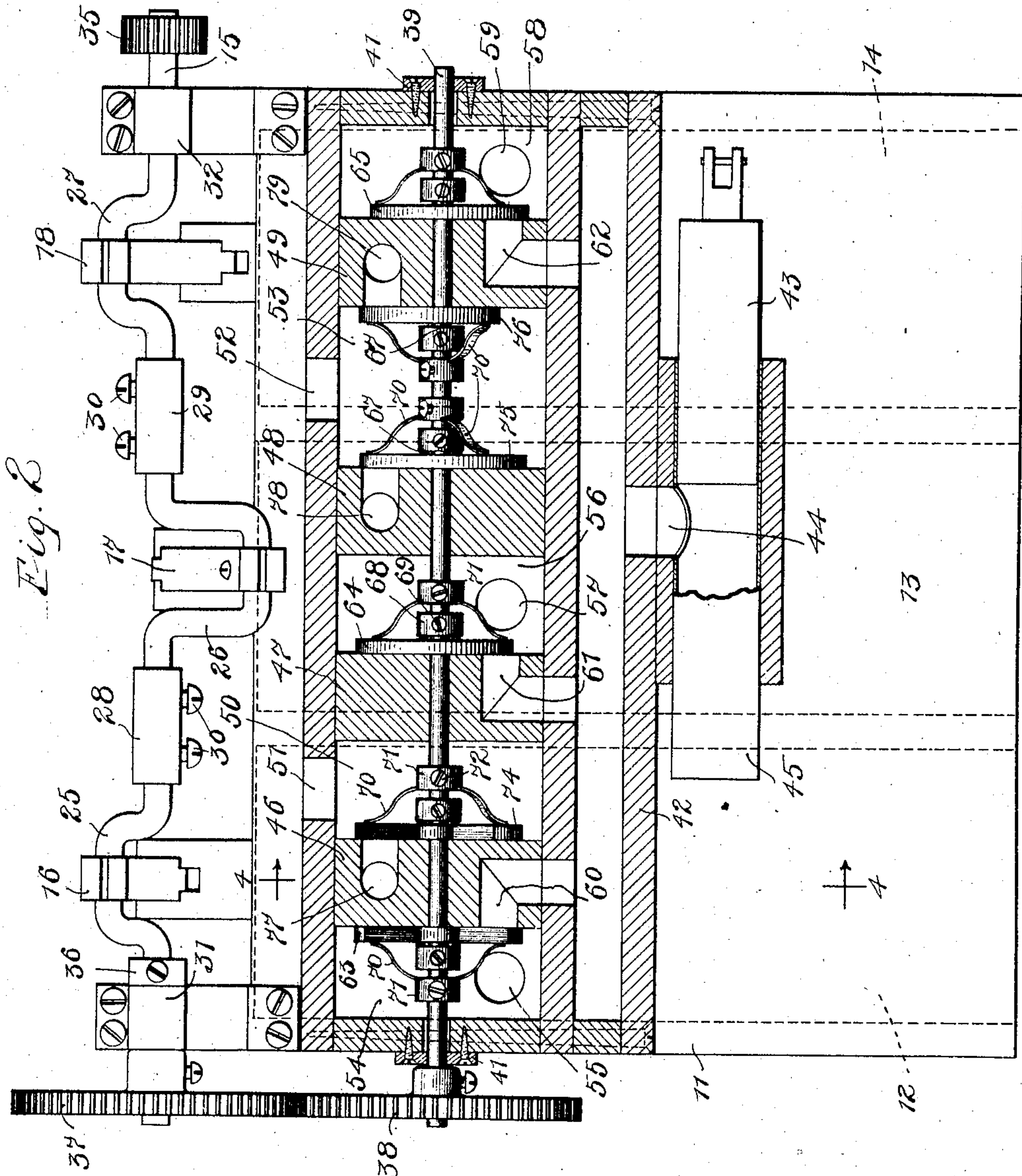
PATENTED AUG. 23, 1904.

A. F. LARSON,  
AIR MOTOR.

APPLICATION FILED JULY 13, 1903.

NO MODEL.

3 SHEETS—SHEET 2.



Witnesses

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Axel F. Larson

By

*Charles A. Brown*  
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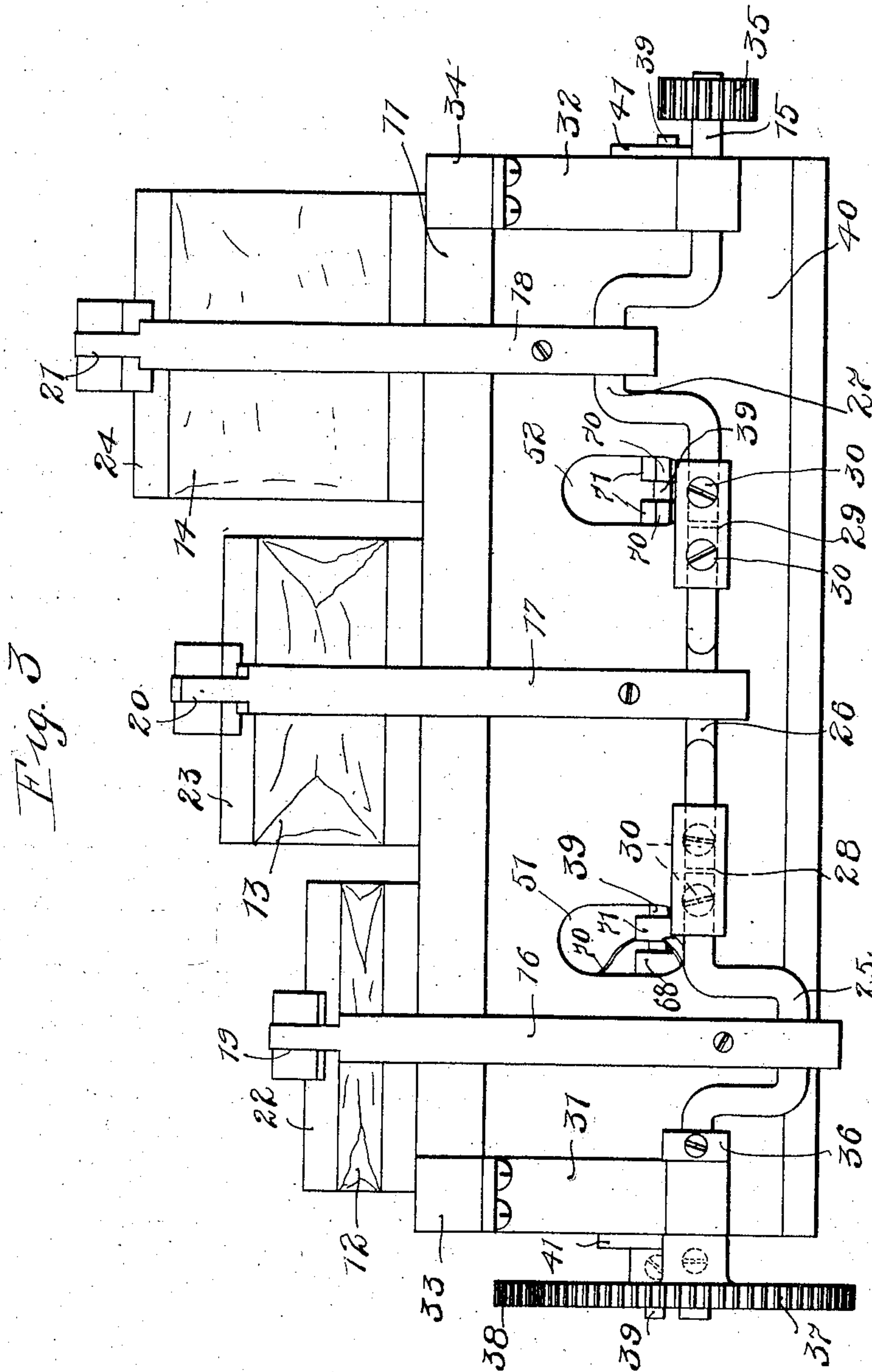
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*Leonard W. Howard*

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# UNITED STATES PATENT OFFICE.

AXEL F. LARSON, OF CHICAGO, ILLINOIS.

## AIR-MOTOR.

SPECIFICATION forming part of Letters Patent No. 768,053, dated August 23, 1904.

Application filed July 13, 1903. Serial No. 165,349. (No model.)

*To all whom it may concern:*

Be it known that I, AXEL F. LARSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Air-Motors, (Case No. 1,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to motor mechanism particularly adapted for operation due to comparatively small differences in air-pressure.

An air-motor constructed in accordance with my invention is particularly useful for the operation of automatic or semi-automatic musical instruments in which the difference in air-pressure necessary for the operation of the motor is brought about by the operation of a suitable bellows.

The particular objects of my invention are to provide an air-motor which shall operate at an absolutely uniform and unvarying speed of rotation, and to provide a motor which shall be of simple and cheap construction, and one which cannot readily get out of order or adjustment.

In many air-motors of the prior art which have been used for the operation of the mechanism of automatic piano-players there have been provided suitable bellows or collapsible chambers associated with suitable valving mechanism whereby the control of a supply of pressure to the bellows is effected. Suitable mechanism has been provided whereby a main shaft may be driven by the bellows. The valving mechanism of such motors has been of such a construction that the valve or valves do not require an absolutely uniform amount of power throughout a complete cycle, and as an appreciable part of the power developed by the motor is necessary for the operation of the valving mechanism this inequality in the power required to operate the valves has given rise to inequalities in the speed of rotation of the main shaft—that is, during any one complete revolution of the main shaft there may be a slight variation in the speed thereof. This slight variation in the speed of operation of the air-motor is particularly ob-

jectionable when such motors are used for the operation of any of the well-known forms of automatic piano-players, it of course being desirable in such cases that the perforated sheet of paper controlling the operation of the keyboard mechanism should be driven at an absolutely constant speed.

The construction of a preferred embodiment of my invention will be apparent from a consideration of the accompanying drawings, in which—

Figure 1 is an end elevation. Fig. 2 is a cross-sectional view taken on line 2 2 of Fig. 1. Fig. 3 is a top plan view. Fig. 4 is a cross-sectional view taken on line 4 4 of Fig. 1. Fig. 5 is a view in elevation of one of the disk-like valves employed. Fig. 6 is a perspective view showing a detail of construction, and Fig. 7 is a detail showing a spring-foot for holding the valves in position upon their seats.

I have illustrated an upright base-board 11, to the back of which are secured three bellows 12, 13, and 14. A common main shaft 15 is adapted to be driven by the bellows through the agency of suitable reciprocating connecting mechanism consisting of connecting-rods 16, 17, and 18, having pivoted connection at 19, 20, and 21, respectively, with the back boards 22, 23, and 24 of the driving-bellows. The connecting-rods connect, respectively, with cranks 25, 26, and 27 upon the main shaft 15. The shaft is broken or divided within the connecting-collars 28 and 29, these collars being provided with set-screws 30 30, by means of which the angular adjustment of the various cranks may be accomplished. In the embodiment of my invention herein shown the cranks are set one hundred and twenty degrees apart. The main shaft is carried in bearings 31 and 32, mounted upon upwardly-extending projections 33 and 34 of the base-board 11. The main shaft is provided at one end with a driving wheel or pinion 35, by means of which the mechanism of an automatic piano-player may be driven. A collar 36 is provided upon the main shaft to prevent the longitudinal movement thereof. A gear-wheel 37 upon one end of the main shaft meshes with a gear-wheel 38 of the same diameter, this gear-wheel 38



being mounted upon a valve-shaft 39, the shaft 39 extending through a valve-case 40, upon either end of which is mounted a vulcanized fiber bearing 41 for the reception of the shaft 39. Directly below the valve-case 40 is fastened a wind-chest 42, the wind-chest and valve-case being practically air-tight. Below the wind-chest is fastened a valve 43, a suitable longitudinal movement of which regulates the size of the opening into the passage 44 from the supply-pipe 45 to the interior of the wind-chest 42.

While an air-motor embodying my invention may be constructed to operate due to the expansion of air at a pressure greater than that of the atmosphere, I prefer to connect with the supply-pipe 45 means for producing a partial vacuum or suction within the wind-chest 42, where the air-pressure is maintained lower than that of the atmosphere. The three bellows which are adapted for successively causing a forward rotative movement of the main shaft are each alternately connected, first with the interior of the wind-chest, where a partial vacuum is maintained, and then with the greater pressure of the atmosphere without.

My present invention has for one of its principal objects the provision of improved valving mechanism for effecting the opening and closing of the passage-way leading to the driving-bellows. The interior of the valve-case 42 is divided into compartments by air-tight partitions 46, 47, 48, and 49, partition 46 being shown in central cross-section in Fig. 4. The space 50 between the partitions 46 and 47 is at all times filled with air under atmospheric pressure on account of the large opening 51 in the upper part of the valve-case. In the same manner the opening 52 connects the chamber 53 with the atmosphere. The chamber 54 is provided with an opening 55, leading to the bellows 12. The chamber 56 is provided with an opening 57, leading to the bellows 13, and the chamber 58 is provided with an opening 59, leading to the bellows 14. A port 60 leads from the left-hand face of the partition 46 to the interior of the wind-chest 42. In a similar manner the port 61 leads from the right-hand face of the partition 47 through this partition to the interior of the wind-chest, while the port 62 leads from the wind-chest to the right-hand face of the partition 49.

The disk-like rotary valves 63, 64, and 65 control the exhaustion of air from the bellows 12, 13, and 14, respectively. These disk-like valves are preferably made of vulcanized fiber or similar material, the faces of the partitions in the valve-case being coated with graphite to prevent wear and to permit the easy rotation of the valves upon their seats.

Each of the disk-like valves is provided near its center with diametrically opposite holes 66

66, within which the driving-pins 67 67 of the chuck 68 project. This chuck is provided with a set-screw 69, by means of which it may be secured in position upon the valve-shaft 39. Except for the fact that each valve-disk must rotate with its associated chuck, and therefore with the valve-shaft, there is considerable freedom of movement between the valve-disks and the valve-shaft. A spring-foot, such as that illustrated in Fig. 7, is desirably provided for each of the valve-disks, this spring-foot serving, by means of its toes 70 70, to press the valve-disk lightly upon its seat. The pressure exerted by the spring-foot may be regulated by properly adjusting the hub 71 along the valve-shaft 39 and securing the same in position by means of the set-screw 72. A suitable sector, as at 73, is cut through each of the valve-disks.

Rotation of the valve-shaft successively causes the cut-out sectors of the valve-disks to be properly registered with the ports 60, 61, and 62. Thus a communication is opened between the wind-chest 42 and the bellows 12 by way of the port 60, the sector-like opening in the disk-like valve 63, the chamber 54, and the opening 55. The vacuum or suction in the wind-chest 42 causes the collapse of the bellows 12, thereby causing a forward impulse to be exerted upon the main shaft 15 through the crank 25. Before the complete collapse of the bellows 12 the sector-like opening in the valve-disk 64 has been brought into register with the port 61, whereby a communication is established between the wind-chest 42 and the bellows 13, whereby the collapse of this bellows is effected to follow the collapse of the first bellows 12. Thereafter the opening through the valve 65 is brought into such a position as to open a communication between the wind-chest and the interior of the bellows 14, whereby this bellows is caused to collapse, the collapse of each bellows in turn causing a forward impulse upon the main shaft 15. Upon the complete collapse of the bellows 14 the bellows 12 and its associated valve are again in position to be actuated, whereupon the cycle of operations is repeated to cause the continuous forward movement or rotation of the main shaft 15.

The valves 63, 64, and 65 may be known as "exhaust-valves," since they control the exhaustion of the air from the bellows with which they are associated.

The bellows are respectively provided with admission-valves 74, 75, and 76, these valves being located one in the chamber 50 and two in the chamber 53, each of which is in open communication with the atmosphere. The port 77 leads from the interior of the bellows 12 to the right-hand face of the partition 46. The port 78 leads from the bellows 13 to the right-hand face of the partition 48, and the port 79 leads from the bellows 14 to the left-hand face of the partition



49. These admission-valves are provided with sector-like openings similar to those in the exhaust-valves. The admission-valves are so placed upon the valve-shaft as each to  
 5 open a communication between the atmosphere and the interior of the associated bellows at the time when the associated bellows is being expanded.

It will be seen that the arrangement of  
 10 valves and ports is such that the only air-pressures brought to bear upon any of the valve-disks are in such a direction as to cause these valves to be seated, this feature being distinguished from the construction employed  
 15 in certain devices of the prior art, in which the wind-pressure tends to lift the valves from their seats against the comparatively strong tension or pressure of suitable spring mechanism. The construction which I have shown  
 20 herein is such that the air-pressures automatically seat the valves and take up any wear of the valve or valve-seat which may occur after long-continued operation of the motor.

It is quite possible to operate a motor constructed in accordance with my invention  
 25 without the use of the spring-feet described, and such spring-feet may be dispensed with, if desired.

It will be seen, furthermore, that the amount  
 30 of power required for the operation of my improved valving mechanism is at all times the same, whereby any variations in the speed of rotation of the main shaft are avoided.

While I have herein shown and described a  
 35 preferred embodiment of my invention, it will be apparent to those skilled in the art that many modifications may be employed without departing from the spirit thereof.

What I claim as new, and desire to secure  
 40 by Letters Patent, is—

1. In an air-motor, the combination with a driving-bellows, of a shaft driven by said bellows through the agency of suitable reciprocating connecting mechanism, a wind-chest  
 45 within which the pressure is maintained less than that of the atmosphere, a valve-shaft driven by gears from the main shaft, a rotary valve on said valve-shaft, adapted periodically to open a communicating passage-way between said bellows and said wind-chest, and a  
 50 spring-foot engaging said valve and tending to hold said valve lightly against its seat, the air-pressure serving to maintain said valve upon its seat.

2. In an air-motor, the combination with a driving-bellows, of a main shaft driven by said bellows through the agency of suitable connecting mechanism, a wind-chest within which the pressure is maintained less than that of  
 60 the atmosphere, a rotary valve driven from said main shaft, adapted periodically to open a communicating passage-way between said bellows and said wind-chest, and a second rotary valve driven from said main shaft, adapted  
 65 intermittently to open a communicating

passage-way between said bellows and the atmosphere, the air-pressure serving to maintain said valves upon their seats.

3. In an air-motor, the combination with a plurality of driving-bellows, of a common  
 70 main shaft driven by said bellows through the agency of suitable reciprocating connecting mechanisms, a wind-chest within which the pressure is maintained less than that of the atmosphere, a valve-shaft driven by gears from  
 75 said main shaft, a rotary valve for each of said bellows on said valve-shaft, adapted periodically to open a communicating passage-way between said bellows and said wind-chest, and a spring-foot engaging said valve and tending  
 80 to hold said valve lightly against its seat, the air-pressure serving to maintain said valves upon their seats.

4. In an air-motor, the combination with a plurality of driving-bellows, of a common  
 85 main shaft driven by said bellows through the agency of suitable reciprocating connecting mechanisms, a wind-chest within which the pressure is maintained less than that of the atmosphere, a rotary valve for each of said  
 90 bellows driven from the main shaft, adapted periodically to open a communicating passage-way between the associated bellows and said wind-chest, and a second rotary valve for each of said bellows driven from said main shaft,  
 95 adapted intermittently to open a communicating passage-way between the associated bellows and the atmosphere, the air-pressure serving to maintain all of said valves upon their seats.

5. In an air-motor, the combination with a plurality of driving-bellows, of a common  
 100 main shaft successively acted upon by said bellows, suitable reciprocating connecting mechanism for connecting each of said bellows with said main shaft, a wind-chest within which the pressure is maintained less than that of the atmosphere, a rotary valve for each of said bellows driven from said main shaft, and adapted periodically to open a communicating passage-way between said bellows  
 105 and said wind-chest, and a second rotary valve for each of said bellows driven from said main shaft, and adapted intermittently to open a communicating passage-way between said  
 110 bellows and the atmosphere, the air-pressure serving to maintain said valves upon their seats.

6. In an air-motor, the combination with a driving-bellows, of a main shaft driven by  
 120 said bellows through the agency of suitable reciprocating connecting mechanism, a wind-chest within which the pressure is maintained less than that of the atmosphere, a valve-shaft driven by gears from the main shaft, a disk-like rotary valve on said valve-shaft, a valve-seat for said valve having a port adapted to afford a communicating passage-way between  
 125 said bellows and said wind-chest when open, said disk-like valve serving periodically to  
 130



open said port, and a spring-foot engaging said valve and tending to hold said valve lightly against its seat, the air-pressure serving to maintain said valve upon its seat.

5 7. In an air-motor, the combination with a plurality of driving-bellows, of a main shaft driven by said bellows through the agency of  
10 suitable reciprocating connecting mechanism, a wind-chest in which the pressure is maintained less than that of the atmosphere, a valve-shaft driven by the main shaft, a pair of disk-  
15 like rotary valves for each bellows driven by said valve-shaft, one of said valves coöperating with a suitable port to control the opening of a passage-way from said bellows to the  
20 atmosphere, and the other valve coöperating with a second port to control the connection of said bellows with said wind-chest, and a spring-foot for each valve tending to hold the  
valve lightly upon its seat, the air-pressure serving to maintain the valves upon their  
seats.

8. In an air-motor, the combination with a driving-bellows, of a main shaft driven by  
25 said bellows through the agency of suitable reciprocating connecting mechanism, a wind-chest in which the pressure is maintained less than that of the atmosphere, a valve for regulating the pressure within the wind-chest, a  
30 valve-shaft driven by the main shaft, a pair of disk-like rotary valves for said bellows driven by said valve-shaft through the agency of suitable chucks having projecting pins engaging openings in said disk-like valves, one  
35 of said valves coöperating with a suitable port to control the opening of a passage-way from said bellows to the atmosphere, and the other valve coöperating with a second port to control the connection of said bellows with  
40 said wind-chest, and a spring-foot for each valve tending to hold the valve lightly upon its seat.

9. In an air-motor, the combination with a driving-bellows, of a main shaft driven by  
45 said bellows through the agency of suitable reciprocating connecting mechanism, a wind-chest in which the pressure is maintained less than that of the atmosphere, a valve for regulating the pressure within the wind-chest, a  
50 valve-shaft driven by the main shaft, a pair of disk-like rotary valves for said bellows driven by said valve-shaft through the agency of suitable chucks having projecting pins engaging openings in said disk-like valves, one  
55 of said valves coöperating with a suitable port to control the opening of a passage-way from said bellows to the atmosphere, and the other valve coöperating with a second port to control the connection of said bellows with  
60 said wind-chest, and a spring-foot for each valve tending to hold the valve lightly upon its seat, the air-pressure serving to maintain the valves upon their seats.

10. In an air-motor, the combination with a  
65 plurality of driving-bellows, of a main shaft

driven by said bellows through the agency of suitable reciprocating connecting mechanism, a wind-chest in which the pressure is maintained less than that of the atmosphere, a valve-shaft driven by the main shaft, a pair of disk-  
70 like rotary valves for each bellows driven by said valve-shaft, one of said valves coöperating with a suitable port to control the opening of a passage-way from said bellows to the atmosphere, and the other valve coöperating  
75 with a second port to control the connection of said bellows with said wind-chest, and a spring-foot for each valve tending to hold the valve lightly upon its seat.

11. In an air-motor, the combination with a  
80 plurality of driving-bellows, of a main shaft driven by said bellows through the agency of suitable reciprocating connecting mechanisms, a wind-chest in which the pressure is maintained less than that of the atmosphere,  
85 a valve-case, partitions in said valve-case containing ports leading from said bellows to said wind-chest and from the bellows to the atmosphere, a valve-shaft driven by the main  
90 shaft extending through said valve-case, a pair of disk-like rotary valves for each bellows driven by said valve-shaft and controlling the ports through said partitions, one of the valves of each pair coöperating with a suitable  
95 port to control the opening of a passage-way from the associated bellows to the atmosphere, and the other valve of the pair coöperating with a second port to control the connection of said bellows with the wind-  
100 chest, and a spring-foot for each valve tending to hold the valve lightly upon its seat, the air-pressure serving to maintain the valves upon their seats.

12. In an air-motor, the combination with a  
105 plurality of driving-bellows, of a main shaft driven by said bellows through the agency of suitable reciprocating connecting mechanisms, a wind-chest in which the pressure is maintained less than that of the atmosphere,  
110 a valve-case, partitions in said valve-case containing ports leading from said bellows to said wind-chest and from the bellows to the atmosphere, a valve-shaft driven by the main shaft extending through said valve-case, and  
115 a pair of disk-like rotary valves for each bellows driven by said valve-shaft and controlling the ports through said partitions, one of the valves of each pair coöperating with a suitable port to control the opening of a pas-  
120 sage-way from the associated bellows to the atmosphere, and the other valve of the pair coöperating with a second port to control the connection of said bellows with the wind-chest, the air-pressure serving to maintain the  
125 valves upon their seats.

13. In an air-motor, the combination with a  
plurality of driving-bellows, of a main shaft  
130 driven by said bellows through the agency of suitable reciprocating connecting mechanisms, a wind-chest in which the pressure is



maintained less than that of the atmosphere, a valve-case, partitions in said valve-case containing ports leading from said bellows to said wind-chest and from the bellows to the atmosphere, a valve-shaft driven by the main shaft extending through said valve-case, a pair of disk-like rotary valves for each bellows driven by said valve-shaft and controlling the ports through said partitions, one of the valves of each pair cooperating with a suitable port to control the opening of a passage-way from the associated bellows to the atmosphere, and the other valve of the pair cooperating with a second port to control the connection of said bellows with the wind-chest, and a spring-foot for each valve tending to hold the valve lightly upon its seat.

14. In an air-motor, the combination with a plurality of driving-bellows, of a main shaft having a corresponding number of cranks by which said shaft is driven through the agency of suitable connecting-rods, means for angularly adjusting said cranks with respect to each other, a wind-chest within which the pressure is maintained less than that of the atmosphere, rotary valves for each of said bellows driven from said valve-shaft, one of said valves adapted to open the communicating passage-way between the associated bellows and said wind-chest, the other of said valves adapted to control a communicating passage-way between the bellows and the atmosphere, the air-pressure serving to maintain said valves upon their seats, and a spring-foot for each valve tending to hold the valve lightly upon its seat.

15. In an air-motor, the combination with a plurality of driving-bellows, of a main shaft having a corresponding number of cranks by which said shaft is driven through the agency of suitable connecting-rods, means for angularly adjusting said cranks with respect to each other, a wind-chest within which the pressure is maintained less than that of the atmosphere, and rotary valves for each of said bellows driven from said main shaft, one of said valves adapted to open a communicating passage-way between the associated bellows and said wind-chest, the other valve adapted to control a communicating passage-way between said bellows and the atmosphere, the air-pressure serving to maintain said valves upon their seats.

16. In an air-motor, the combination with a plurality of driving-bellows, of a main shaft driven by

said bellows through the agency of suitable connecting mechanism, a wind-chest within which the pressure is maintained less than that of the atmosphere, a rotary valve adapted periodically to open a communicating passage-way between said bellows and said wind-chest, a second rotary valve adapted intermittently to open a communicating passage-way between said bellows and the atmosphere, the air-pressure serving to maintain said valves upon their seats, and a valve-shaft for said valves driven by said main shaft through the medium of gears.

17. In an air-motor, the combination with a plurality of driving-bellows, of a main shaft driven by said bellows through the agency of suitable reciprocating connecting mechanism, a wind-chest in which the pressure is maintained less than that of the atmosphere, a valve-shaft driven by the main shaft through the medium of gears, a pair of disk-like rotary valves for each bellows driven by said valve-shaft, one of said valves cooperating with a suitable port to control the opening of a passage-way from said bellows to the atmosphere, and the other valve cooperating with a second port to control the connection of said bellows with said wind-chest, and a spring-foot for each valve tending to hold the valve lightly upon its seat, the air-pressure serving to maintain the valves on their seats.

18. In an air-motor, the combination with a plurality of driving-bellows, of a main shaft having a corresponding number of cranks by which said shaft is driven through the agency of suitable connecting-rods, means for angularly adjusting said cranks with respect to each other, a wind-chest within which the pressure is maintained less than that of the atmosphere, a valve-shaft driven by the main shaft through the medium of gears, and rotary valves for each of said bellows driven by said valve-shaft, one of said valves adapted to open a communicating passage-way between the associated bellows and said wind-chest, the other of said valves adapted to control a communicating passage-way between said bellows and the atmosphere, the air-pressure serving to maintain said valves upon their seats.

In witness whereof I hereunto subscribe my name this 7th day of July, A. D. 1903.

AXEL F. LARSON.

Witnesses:

LYNN A. WILLIAMS;  
HARVEY L. HANSON.