A. L. HAHL.

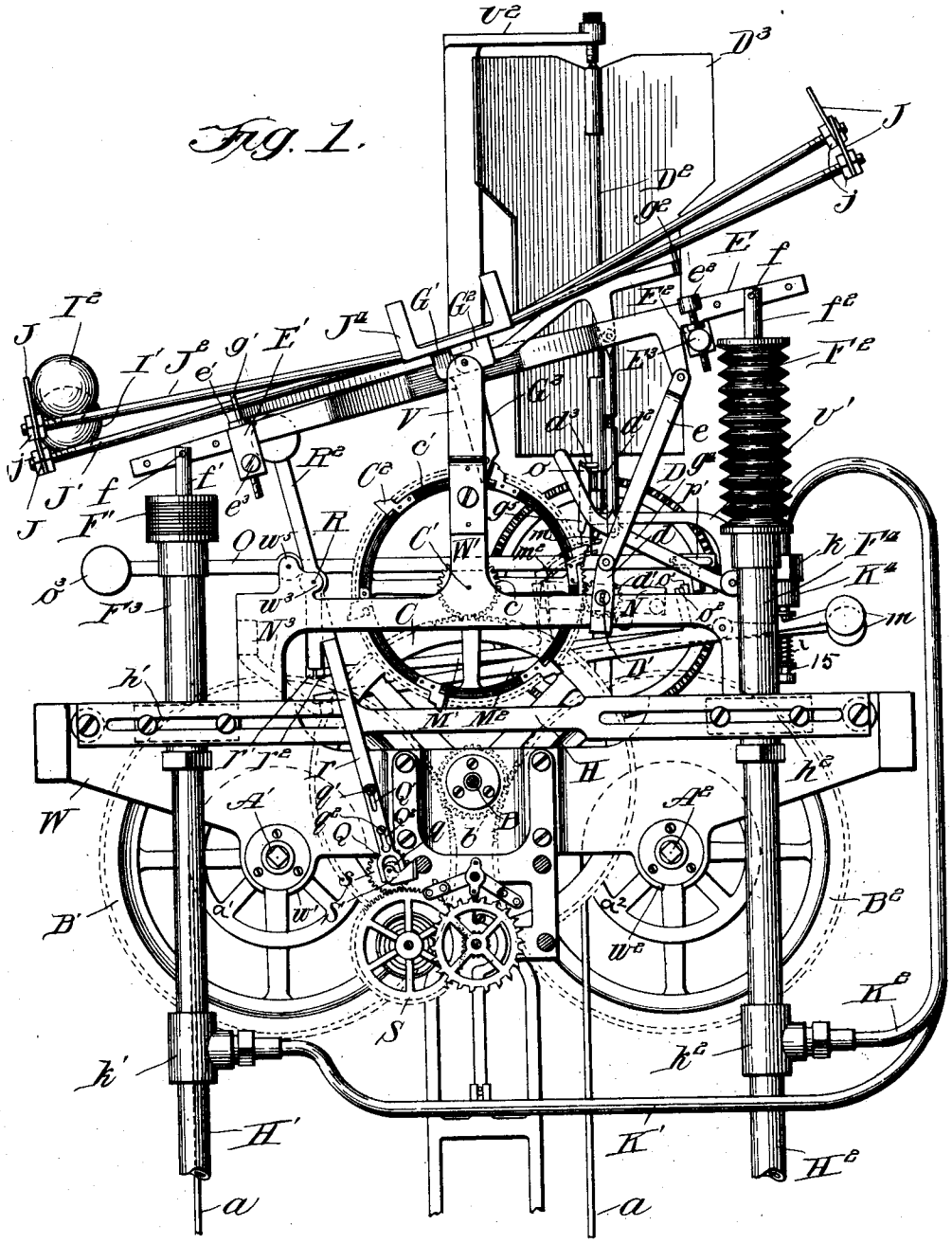
PNEUMATIC CLOCK.

APPLICATION FILED MAY 11, 1908. RENEWED JAN. 3, 1911.

999,779. Patented Aug. 8, 1911.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 2.

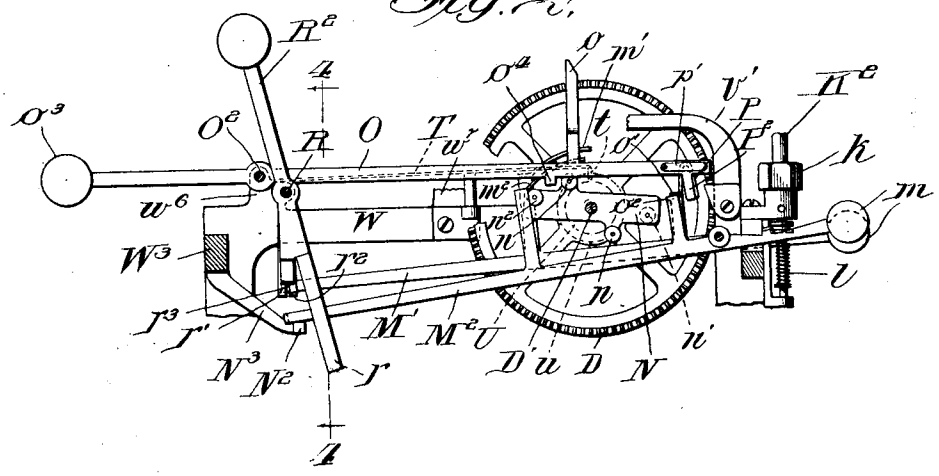

Fig. 3.

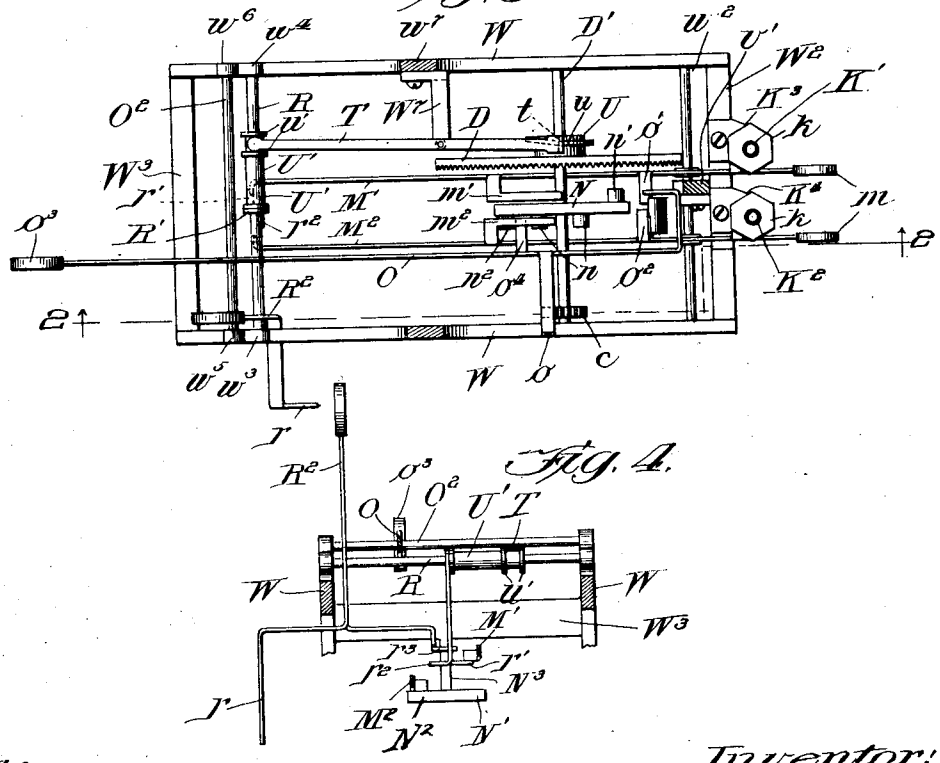

Fig. 4.

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4 SHEETS—SHEET 3.

Fig. 5.

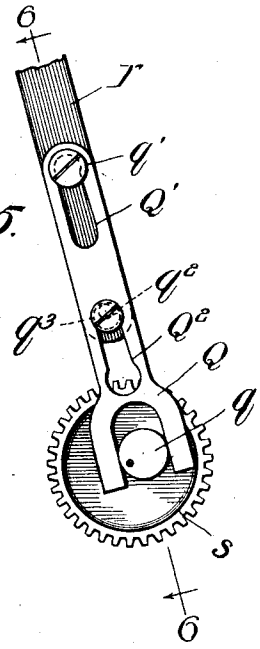


Fig. 6.

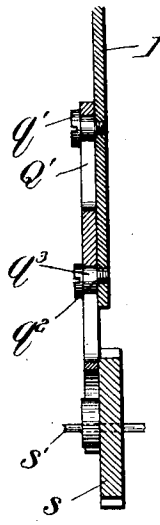


Fig. 7.

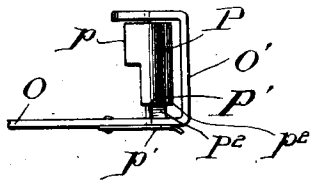


Fig. 8.

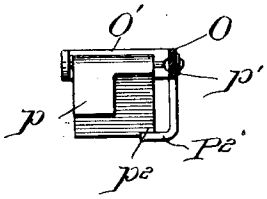


Fig. 9.

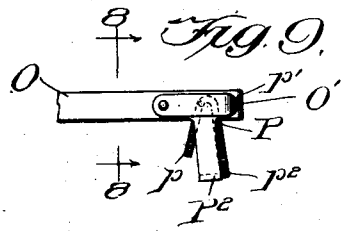
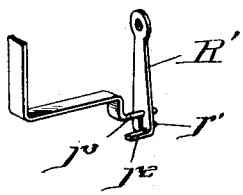


Fig. 10.



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4 SHEETS—SHEET 4.

Fig. 11.

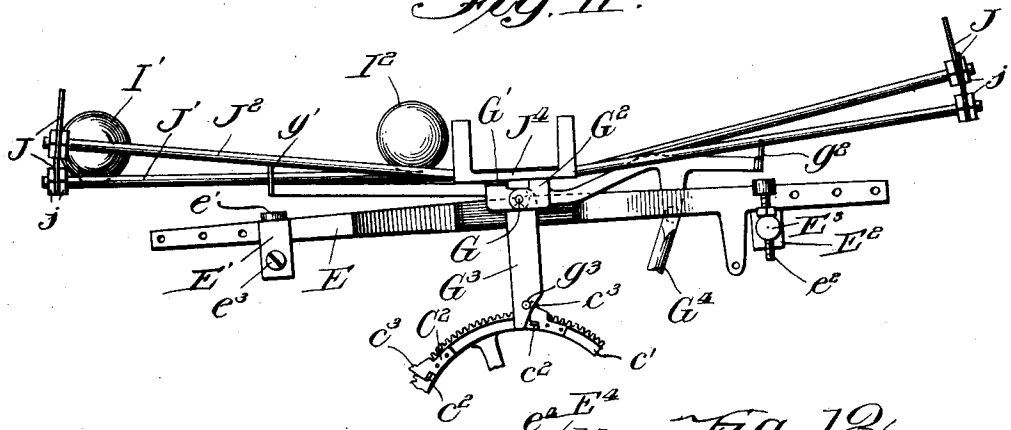


Fig. 12.

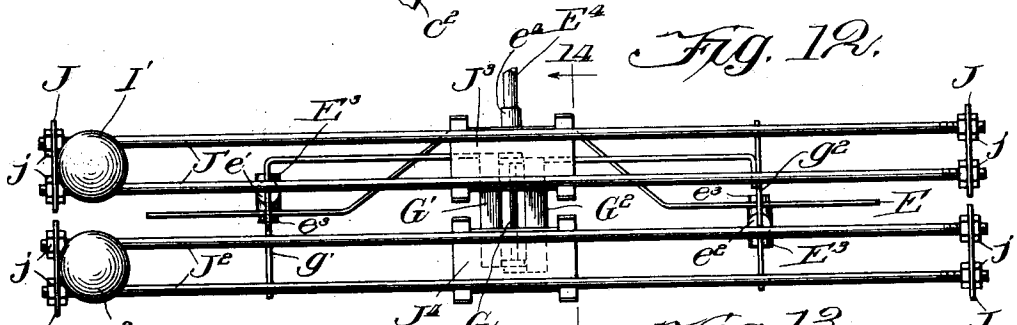


Fig. 13.

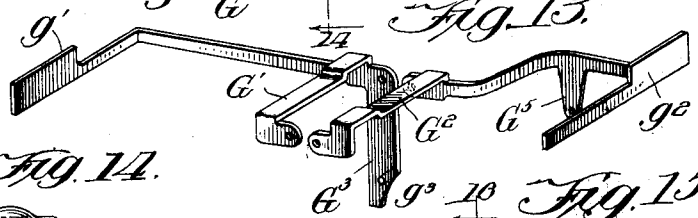


Fig. 14.

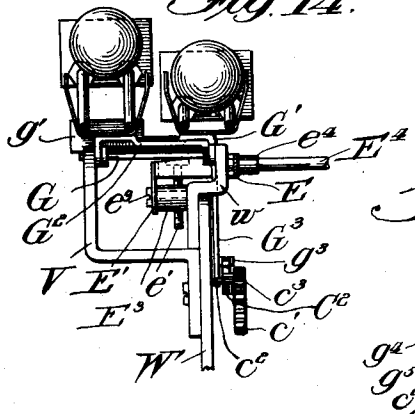


Fig. 15.

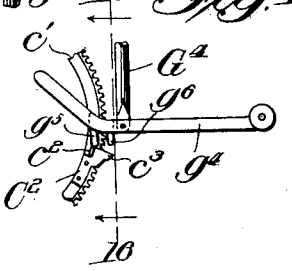
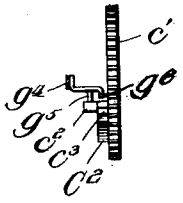


Fig. 16.



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UNITED STATES PATENT OFFICE.

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PNEUMATIC CLOCK.

999,779. Specification of Letters Patent. Patented Aug. 8, 1911.

Application filed May 11, 1908, Serial No. 432,035. Renewed January 3, 1911. Serial No. 600,524.

To all whom it may concern:

Be it known that I, AUGUSTUS L. HAHL, a citizen of the United States, residing at Chicago, county of Cook, State of Illinois, have invented a certain new and useful Improvement in Pneumatic Clocks, and declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification.

My invention relates in general to clocks, and more particularly to pneumatic clock systems.

In my pending application Serial No. 277,810 filed September 11, 1905, I have described and claimed an improved pneumatic clock system of the type covered by U. S. Letters Patent No. 598,066 granted to me January 25, 1898.

My present invention relates to improvements in the clock system covered by my copending application.

The primary object of my invention is to provide in a pneumatic clock system a direct non-interfering balanced detent lever actuated at predetermined intervals by the time train of a master clock for releasing the motor to actuate the impulse mechanism, and also for opening the valve from the service pipe containing pressure, which will impose a minimum load upon the time train and will relieve the same from all pressure from the motor train.

A further object of my invention is to provide in a pneumatic clock system of the type covered by my prior patent and copending application above referred to, an improved auxiliary mechanism for utilizing the excess power of the motor during the initial part of its work when the air imposes only a nominal resistance upon the motor to assist the motor during the latter part of its work, when the air imposes a maximum resistance upon the motor thereby rendering it possible to reduce the size of a motor for a given number of clocks with a corresponding reduction in the cost of installing and operating the system, and thereby also making the operation of the motor more uniform.

A further object of my invention is to provide an improved pneumatic clock system by means of which a maximum number of clocks may be efficiently operated at a minimum cost.

In my copending application above referred to the detent lever for releasing the motor and for controlling the opening of the valves is successively engaged by pins carried by the time train, and is mounted upon an oscillating frame, the oscillations of which by the motor locate the detent lever in position to be engaged by the successive pins and also locate supports in position to sustain the valve levers as they are alternately lifted by the motor in positions to close the valves.

In my present invention I dispense with the oscillating frame and provide the detent lever with a yoke engaged by an eccentric rotated by the time train so that at predetermined intervals the detent lever will be oscillated to release the motor and to alternately open the valves, the hangers for supporting the valve levers which are oscillated by the detent, being laterally movable into position to alternately receive the valve levers when they have been lifted by the motor.

My present invention further consists in providing a plurality of shifting weights which are lifted by the motor during its initial operation to successively shift to positions to assist the motor in its work, the load imposed upon the motor being thereby rendered more uniform by gradually transferring the weights from a load upon the motor to an aid to it in its operation.

My invention will be more fully described hereinafter with reference to the accompanying drawings in which the same is illustrated as embodied in a convenient and practical form, and in which—

Figure 1 is a front elevational view; Fig. 2 a sectional view on line 2—2 Fig. 3; Fig. 3 a detail plan view; Fig. 4 a sectional view on line 4—4 Fig. 2; Fig. 5 an enlarged detail view of the connection between the detent lever and time train; Fig. 6 a sectional view on line 6—6 Fig. 5; Figs. 7, 8, and 9 detail views of the pawl for supporting the stop lever upon the valve lever; Fig. 10 a detail view of the connection between the detent lever and the hangers for supporting the valve levers; Fig. 11 a side elevational view of the shifting weights and mechanism for shifting the same by the motor, one of the weights being shown as being trans-

ferred from a load on the motor to an aid to the motor; Fig. 12 a plan view of the mechanism shown in Fig. 11; Fig. 13 a perspective view of the oscillating frames upon which race-ways for the weights are supported; Fig. 14 a sectional view on line 14—14 Fig. 12; Fig. 15 a detail view of the means for oscillating in one direction the supporting frames of the race-ways; and Fig. 16 a sectional view in line 16—16 Fig. 15.

The same reference characters are used to designate the same parts in the several figures of the drawings.

Reference characters A′ and A² indicate power shafts suitably journaled in brackets w' and w^2 depending from a supporting frame W. Mounted upon the power shafts A′ and A² are drums a' and a^2 around each of which is secured a weight cord a. It will of course, be understood that other motive power than weights may be employed if desired. Fixed to the power shafts are gear wheels B′ and B² which mesh with an intermediate pinion b, fixed to a shaft B. A gear wheel C is also fixed to the shaft B and meshes with a pinion c fixed to a shaft C′, the latter being suitably journaled in the supporting frame at W′. A gear wheel c' is fixed upon the shaft C′ and meshes with a pinion d' fixed upon a shaft D′. A crown gear wheel D is fixed upon the shaft D′ and meshes with a pinion d^2 fixed upon a vertical staff D², the latter being journaled at its lower end in a bracket v' and at its upper end in a bracket v^2. Fixed upon the staff D² is a fly governor D³. A radial arm d^3 projects from the staff D² preferably at a point immediately above the pinion d^2.

Projecting from the shaft D′ is a crank arm d to which is pivotally connected a link e, the upper end of the latter being pivotally connected to a bracket secured to a lever E. The lever E is fulcrumed intermediate of its ends by a collar e^4 thereon surrounding a rod E⁴ supported by a bracket w at the upper end of the frame W′. The opposite ends of the lever E are pivotally connected to rods f' and f^2 respectively, by means of pins f, f engaging holes in the lever. The lower ends of the rods are secured to bellows F′ and F², mounted upon the upper ends of pipes F³, and F⁴, with which they communicate. The pipes F³ and F⁴ are supported in vertical positions by blocks h' and h^2 which are adjustable laterally between the supporting frame W and a slotted guide plate H secured thereto. The lower ends of the pipes F³ and F⁴ communicate with service pipes H′ and H² leading to air chambers located at predetermined points for actuating subordinate clocks. Branch pipes K′ and K² extend from the main pipes H′ and H² and communicate therewith by means of T-couplings k' and k^2 respectively. The ends of the branch pipes lead to valve casings K³ and K⁴ supported upon the frame W². Each of the valve casings is provided with a cap k surrounding the upper end thereof and securing thereto a coupling at the end of the respective branch pipe. Located within the valve casings are valves which coöperate with valve seats to control the exhaust ports leading to the atmosphere. The valves are provided with depending valve stems which extend through the valve casings and are guided at their lower ends in brackets.

Surrounding each valve stem is a spring l bearing at its lower end upon a pin l^5 and at its upper end engaging a collar loosely surrounding the valve stem and limited in its upward movement by a pin. Fulcrumed upon a rod w^2 extending adjacent the supporting frame W² are valve actuating levers M′ and M² the former of which is provided with a yoke engaging the collar on one valve stem, while the latter of said levers is provided with a similar yoke (not shown) for engaging the collar on the other valve stem. The ends of the levers M′ and M² are provided with counter-balancing weights m. The valve actuating levers extend inwardly from their fulcrums and terminate above the supporting arms N′ and N² projecting laterally from the opposite sides of a bracket N³ which extends from the supporting frame W³. The levers M′ and M² are provided with upwardly projecting cams m' and m^2 which are adapted to be engaged by rollers n' and n^2, respectively secured to the opposite ends of a lever N fixed to the shaft D′.

The construction above described is the same as that disclosed in my pending application above referred to and is merely illustrated and described in this case in order that the construction and operation of my present improvements may be fully understood.

A lever O is fulcrumed upon a shaft O², the ends of which are supported in bearings w^5 and w^6 projecting upwardly from the supporting frame. Extending outwardly from the shaft O² is a counterbalance weight o^3 secured to the end of the lever O. The opposite end of the lever O from the weight o^3 is provided with a pawl P which is adapted to alternately rest upon lugs o' and o^2 projecting from the levers M′ and M², thereby supporting the lever O in position to retain the upwardly projecting finger o thereon in the path of the stop arm d^3 which projects from the shaft D². The lever O is provided with a cam o^4 adapted to be alternately engaged by rollers n, n carried by the lever N at opposite sides of the shaft D′.

The pawl P is secured to a rod P′ the ends of which are journaled in openings in the parallel portions of the bent end O′ of the

lever O. A spring p' engages one end of the rod P′ to retain the ends of the same within the holes in the portions of the lever O. The pawl P is preferably of inverted U-shape and is provided with detent portion p^2 adapted to engage a post P^2 depending from the frame O. The portion p of the pawl is adapted to rest upon either of the lugs o' or o^2. The post P^2 prevents the pawl from swinging in one direction beyond a position which will insure its over-laying the lugs, but will permit its automatically swinging in an opposite direction owing to the weight of the part P^2 when it is elevated to a position above either of the lugs.

In order that the motor may be assisted during the latter part of its work when the greatest load is imposed upon it, the power of the motor during the first part of its work is stored up and applied by the following mechanism: A pair of oppositely extending oscillating frames G′ and G^2 are pivotally supported at their inner ends by means of a rod G passing through alined holes in over-lapping portions of the frames. One end of the rod G is supported in the upper end of the bracket V which is secured to the frame W′, as shown in Fig. 14. The opposite end of the rod G is supported in the bracket w secured to the upper end of the frame W′. The frames are preferably constructed as best shown in Fig. 13. The frame G′ is provided with a depending arm G^3 the lower end of which extends into the plane of lugs c^2 carried by brackets C^2 secured to the gear wheel c'. A laterally projecting pin g^3 is carried by the arm G^3 and extends into the path of movement of lugs c^3 carried by the brackets C^2.

The frame G^2 is provided with a bracket G^5 to which is pivotally connected the upper end of a connecting rod G^4, the lower end of the latter being pivotally connected to a lever g^4. The lever g^4 is pivoted at one end to the supporting frame and is provided with a bracket having lugs g^5 and g^6 thereon, the former of which projects into the path of movement of the lugs c^2 on the brackets C^2, while the latter extends into the plane of the lugs c^3 on the bracket C^2, as clearly shown in Figs. 15 and 16.

A bracket E′ is secured to the lever E at a point immediately below the portion g' of the oscillating frame G′. A stud E^3 is secured to the bracket E′ by a suitable fastening device such for instance as a screw e^3. A vertically adjustable screw e' extends through a screw-threaded hole in the stud E^3, the head of the screw underlying and adapted to support the portion g' of the frame G′. A similar bracket E^3 is carried by the lever E below the portion g^2 of the frame G^2, such bracket also having secured thereto a stud E^3.

e^2 designates a vertically adjustable screw extending through a screw-threaded hole in the stud E^3. The head of the screw e^2 underlies and is adapted to support the transverse portion g^2 of the oscillating frame G^2.

J′ and J^2 designate race-ways upon which are supported rolling weights I′ and I^2 respectively. Each race-way is preferably formed of a pair of rods united at their ends by plates J, such plates being secured to the ends of the rods by means of nuts j surrounding the screw-threaded ends of the rods on opposite sides of the plates. The race-way J′ is supported intermediate of its ends upon a saddle J^3 secured to the frame G′ adjacent to its fulcrum. The saddle is provided with upwardly projecting arms between which the weight I rolls when the raceway is oscillated. A similar saddle J^4 is secured to the frame G^2 and supports the race-way J^2, upwardly projecting arms being provided on the saddle to serve as guides between which the weight I^2 rolls. The saddles J^3 and J^4 are supported paralled to each other as shown in Figs. 12 and 14.

R^2 indicates the detent lever which is pivotally mounted upon a shaft R, the ends of the latter being supported in brackets w^3 and w^4 projecting upwardly from the side supporting frames. The detent lever is divided below the rod R one portion r extending downwardly to a point adjacent to the time train of the master clock as shown in Fig. 1. The portion r of the detent lever is provided at its lower end with a yoke Q adjustably connected thereto by means of clamp screws q', q^2 extending through slots in the yoke into engagement with screw-threaded holes in the part r. The screw q^2 is provided with an eccentric q^3 thereon so that by adjusting such screw the relation of the yoke to the detent may be adjusted.

Located within the yoke Q is an eccentric q fixed upon a shaft s' journaled in a bracket S′ secured to any convenient part of the frame of the time train. A pinion s is fixed to the shaft s' adjacent to the eccentric q and meshes with the gear wheel S of the time train. Any suitable time train may be employed such as illustrated in Fig. 1, and as the operation of such mechanism is well known, it need not be further described in detail.

Extending from the detent lever R^2 in an opposite direction from the portion r is a finger r^3 which engages a slot in an oscillating hanger R′, the upper end of the latter being loosely supported upon the shaft R. The hanger R′ is provided at its lower end with oppositely extending portions r', r^2 adapted to alternately support the ends of the valve levers M′, M^2 respectively.

The upper end of the hanger R′ is secured to a sleeve U′ surrounding the shaft R and adapted to move axially thereon. The sleeve U′ is provided with collars u' between which

extends the end of a lever T. The lever T is fulcrumed upon a bracket W^7 projecting from the portion w^7 of the supporting frame. The opposite end of the lever T is provided with a downwardly extending fork t which engages a cam flange u formed around the periphery of a hub U fixed upon the shaft D′ adjacent to the crown gear wheel D.

The operation of my invention is as follows: At predetermined intervals, such for instance, as each minute, the eccentric q moves the lower end r of the detent lever, and oscillates the same sufficiently to disengage the finger r' or r^2 of the hanger R′ from beneath the inner end of the valve lever M′ or M^2. When the parts of the mechanism are in the positions indicated in Figs. 1 to 4, the valve in the casing K^3 is closed by reason of its actuating lever M′ being supported by the hanger finger r'. The system of clocks in communication with the service pipe H′ have been actuated by an impulse of air produced by the compression of the bellows F′ while the system of clocks in communication with the service pipe H^2 have been actuated by the return of the air to the distended bellows F^2 under normal conditions and also by the escape of air through the valve casing K^4 in case of change of temperature. A slight oscillation of the detent lever R′ through the engagement of the eccentric with the yoke on the lower end of the finger r, removes the hanger r' from beneath the inner end of the lever M′ thereby permitting such lever to fall upon the stop N′ and opening the valve in the casing K^3 so that air under pressure is released from the service pipe H′. The release of pressure from the service pipe H′ together with the distention of the bellows F′ actuates the air chambers of the various subordinate clocks, so that the hands thereof are moved forward one minute, or any other predetermined distance corresponding to the master clock.

The movement of the lever M′ from its position upon the hanger r' to its place of rest upon the support N′ removes the supporting lug o' from beneath the pawl P on the end of the lever O thereby permitting the latter to fall from the position shown in Fig. 1. The fall of the lever O removes the finger o thereon from the path of movement of the pin d^3 on the shaft D^2 thereby permitting the rotation of such shaft and the consequent operation of the motor. The weights through the supporting cords a rotate the drums a' and a^2, which in turn rotate the power shafts A′ and A^2. The gear wheels B′ and B^2 fixed upon the power shafts rotate the shaft B through their engagement with the pinion b fixed thereon. The rotation of the shaft B rotates therewith the gear wheel C which in turn rotates the gear wheel c and the shaft C′ upon which it is fixed. The gear wheel c' rotates with the shaft C′ and through the pinion d' which it engages, rotates the shaft D′. The shaft D′ rotates the crown gear D thereon, which meshes with the pinion d^2 fixed upon the shaft D^2, thereby revolving the fly governor D^3.

The rotation of the shaft D′ carries the roller n^2 on the lever N into engagement with the cam m^2 on the lever M^2 thereby oscillating the latter so that its inner end will be elevated in position to fall upon the hanger r^2 when the roller n^2 passes from beneath the cam m^2. The rotation of the shaft D′ through the engagement of the cam groove u in the drum U with the pin t on the end of the lever T, swings such lever laterally so that the hanger r^2 is moved laterally to a position beneath the end of the valve lever M^2 so that the latter will fall upon the hanger when the roller n^2 passes from beneath the cam m^2. The elevation of the lever M^2 closes the valve in the casing K^4 thereby cutting off the communication between the service pipe H^2 so that the compression of the bellows F^2 will force an impulse of air through such service pipe and actuate the air chambers of the various subordinate clocks and move forward the hands the predetermined degree corresponding to the master clock.

The continued rotation of the shaft D moves one of the rollers n on the lever N into engagement with the cam o^3 on the lever O so that the latter is oscillated with the result that the pawl P is in position to fall upon the lug o^2 on the lever M^2 when the roller n passes from beneath the cam o^4. The stop finger o on the lever O is consequently elevated into such a position that the upper end thereof lies within the path of movement of the rod d^3 so that the motor will be again stopped upon the rod d^3 engaging the upper end of the finger o. The operation of the motor is thereby discontinued until the movement of the time train rotates the eccentric q 180 degrees when the detent lever R^2 will be oscillated sufficiently to swing the hanger finger r^2 from beneath the end of the lever M^2 through the engagement of the extension r^3 on the detent lever with the hanger R′. The lever M^2 is consequently permitted to fall upon the support N^2 thereby opening the valve in the valve casing K^4 and permitting the escape of compressed air to the atmosphere from the service pipe H^2 which in conjunction with the subsequent distention of the bellows F^2 actuates the air chambers in communication therewith and moves the subordinate clocks forward the predetermined degree. The falling of the lever M^2 also serves to remove the lug o^2 from beneath the pawl P so that the lever O drops thereby

removing the stop finger o from the path of the rod d^3 and permitting the motor to again run. The operation of the motor rotates the lever N, which carries the roller n' into contact with the cam m', thereby elevating the lever M', which closes the valve in the casing K^3 and places the service pipe H' in condition to receive an impulse of air produced by the compression of the bellows F'. The lever M' is retained in its elevated position by the hanger finger r', which has been moved laterally below the same through the engagement of the lever T with the cam groove u. The motor continues to run until one of the rollers n engages the cam o^3 on the lever O, thereby swinging the same upwardly and projecting the stop finger into the path of the arm d^3, the lever being retained in such position by the pawl P resting upon the lug o' on the lever M.

It will be observed that when either of the levers M' or M^2 is supported by the corresponding hanger finger r' or r^2, it forces downwardly the yoke on the corresponding valve stem, thereby seating the valve connected thereto and closing the corresponding branch pipe K' or K^2 from communicating with the atmosphere.

Operation of impulse mechanism.—When the mechanism is in the condition shown in Fig. 1 the release of the motor by the finger o dropping from the path of the rod d^3, oscillates the lever E through the link e connecting the same with the crank d on the shaft D'. The oscillation of the lever E compresses the bellows F^2 and distends the bellows F'. The compression of the bellows F^2 forces the air through the service pipe H^2, the exhaust valve leading therefrom having been previously closed as above described, and actuates the subordinate clocks through the medium of their air chambers. It is evident that the power required to compress the bellows gradually increases and were it not for the employment of auxiliary mechanism the motor would have to be of sufficient power to exert the requisite force to complete the compression of the bellows. In my copending application, heretofore referred to the motor during the first part of the compression of the bellows, when there is practically no resistance, lifts the rolling weight so that the work of the motor in completing the compression of the bellows is assisted by the weight. In my present invention two rolling weights are provided which are successively shifted thereby imposing a more uniform load upon the motor.

The movement of the gear wheel c' in Fig. 1 brings the lugs c^2 on the bracket C^2 adjacent the arm G^3, into contact with the lower end of said arm, thereby commencing the oscillation of the frame G' and with it the race-way J'. After the oscillation of the frame has commenced it is continued by the engagement of the lugs c^3 on the bracket C^2 with the pin g^3 on the arm G^3. By providing the two lugs on the bracket a greater leverage is attained to commence the oscillation of the frame and a less leverage to continue the oscillation of the frame, consequently when the greatest load is imposed upon the motor at the commencement of the oscillation of the frame a greater leverage exists than when the load is lightened at which time a less leverage exists.

It will be observed that the oscillation of the race-ways is accelerated so that the weights will be shifted before the lever E reaches a horizontal position, consequently the weights are utilized to assist the operation of the motor during more than the last half of its work. In this manner the oscillation of the race-ways into positions to shift the weights is performed by the motor during its initial operation when there is practically no resistance imposed upon it by the impulse mechanism.

The left half of the race-way J^2, is supported slightly above the left half of the race-way J' owing to the contour of the transverse support g' on the frame G' upon which the race-ways rest. The center of gravity of the rolling weight I^2 is consequently shifted by the oscillation of the supporting frame before the oscillation of the frame shifts the center of gravity of the weight I^2. The weight I^2 consequently first rolls down the inclined portion of its race-way and continues along the race-way to its opposite end thereby oscillating the frame G^2 downwardly upon the head of the screw e^2 whereby the weight I^2 assists the motor in oscillating the lever R to compress the bellows F^2. A further oscillation of the frame G' shifts the center of gravity of the weight I' which rolls down its race-way and further assists the operation of the motor owing to the race-way resting upon the frame G^2 and the latter resting upon the lever E through the medium of the stop-screw e^2.

When the bellows F^2 has been compressed and the parts are in the opposite positions from those shown in Fig. 1 the initial succeeding operation of the mechanism opens the air release valve in the service pipe H^2 while the valve leading from the service pipe H' is closed. When the motor is again released by the finger o falling out of contact with the rod d^3, the motor commences to oscillate the lever E in a direction to compress the bellows F'. After a slight compression of the bellows F' the movement of the gear wheel c' brings the lug c^2 on one of the brackets C^2 into contact with the lug g^5 on the lever g^4 thereby swinging said lever upwardly a slight distance until the lug c^3 on the bracket engages the lug g^6 on the le-

ver when the lever g^4 is further oscillated in an upward direction by the movement of the gear wheel. The upward movement of the lever oscillates the frame G^2 through the connecting rod G^4. The oscillation of the frame G^2 first shifts the center of gravity of the weight I′ and subsequently shifts the center of gravity of the weight I^2, owing to the different inclinations of the race-ways J′ and J^2. The rolling weights consequently are applied to the lever through the medium of the race-ways, the frame G′ and the stop screw e', thereby assisting the motor in its work of completing the compression of the bellows F′.

The inclinations of the race-ways may be varied by adjusting the stop screws e' and e^2 thereby determining the exact point in the operation of the motor when the centers of gravity of the weights will be shifted. The brackets C^2 are located at such intervals apart upon the gear wheel e' that they will alternately engage the stops on the arm G^3 and on the lever g^4, and at such periods with respect to the operation of the motor as to evenly distribute the work of the motor in compressing the bellows.

From the foregoing description it will be observed that my improved non-interfering direct balanced detent imposes a minimum load upon the time train as it is only necessary that the detent lever should be slightly oscillated by the eccentric in order to remove the hanger fingers r' or r^2 from beneath the ends of the lever M′ or M^2. The work of alternately lifting the lever M′ or M^2 as well as the lifting of the lever O is imposed upon the motor which also, through the interposed lever T moves the hanger laterally in the position for the fingers r', r^2 to alternately receive and support the ends of the valve levers M′ and M^2 after they have been elevated by the cams on the lever N.

It will be further observed that I have invented an improved auxiliary mechanism whereby the load imposed upon the motor is so equalized as to permit a motor of less power to be employed than would be necessary were it not for the storing of the power of the motor during its initial operation and applying such stored power to assist the final work of the motor.

Having now fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism for varying the air pressure in said pipe, a motor for actuating said mechanism, and a plurality of devices for successively and cumulatively assisting the motor during the latter part of its work.

2. In a pneumatic clock system, the combination with two service pipes, of impulse mechanism for alternately varying the air pressure in said pipes, a motor for actuating said mechanism a plurality of shifting weights lifted by said motor during the first part of its work, and means for successively applying said weights to assist the motor during the latter part of its work.

3. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism for varying the air pressure in said pipe, a motor for actuating said mechanism, a plurality of weights successively shifted by said motor during the first part of its work, and means for successively applying said weights to assist the motor during the latter part of its work.

4. In a pneumatic clock system, the combination with two service pipes, of a compressible chamber communicating with each service pipe, a motor for alternately compressing and expanding said chambers, a plurality of shifting weights lifted by said motor during the first part of its work, and means for successively applying said weights to assist said motor during the latter part of its work.

5. In a pneumatic clock system, the combination with two service pipes, of impulse mechanism for varying the air pressure therein, a lever fulcrumed intermediate of its ends and connected to each of said impulse mechanisms, a motor connected to said lever for oscillating the same and thereby actuating said mechanisms to alternately vary the pressure in the service pipes, and a plurality of devices successively actuated by said motor during the initial oscillation of said lever in one direction for assisting in the final oscillation of said lever.

6. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism for varying the air pressure in said pipe, a motor actuating said mechanism, an oscillating frame, a plurality of shifting weights supported upon said frame, means for oscillating said frame during the first part of the work of the motor, and means whereby the oscillation of said frame successively shifts said weight to assist the motor to complete the actuation of said mechanism.

7. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism for varying the air pressure in said pipe, a motor for actuating said mechanism, an oscillating frame, a plurality of race-ways supported upon said frame, a shifting weight supported upon each raceway, means for oscillating said frame by said motor, means for successively varying the inclinations of said race-ways to successively shift said weights, and means for applying said weights when shifted to assist the operation of the motor in completing the actuation of said mechanism.

8. In a pneumatic clock system, the com-

bination with a service pipe, of impulse mechanism for varying the air pressure in said pipe, a motor for actuating said mechanism, an oscillatory race-way fulcrumed intermediate of its ends and comprising upwardly inclined end portions, a shifting weight guided upon said race-way, means for oscillating said race-way to shift said weight by said motor during the first part of its work in actuating said mechanism, and means for applying said weight when shifted to assist the motor in completing the actuation of said mechanism.

9. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism for varying the air pressure in said pipe, a motor for actuating said mechanism, an oscillatory frame fulcrumed intermediate of its ends, a shifting weight guided upon said frame, connections interposed between said frame and said motor for oscillating said frame, said connections comprising means for providing greater leverage during the initial oscillation of said frame than during the completion of the oscillation thereof, and means for applying said weight when shifted by the oscillation of said frame to assist the motor in the completion of the actuation of said mechanism.

10. In a pneumatic clock system, the combination with two service pipes, of impulse mechanism communicating with each service pipe for varying the air pressure therein, a lever fulcrumed intermediate of its ends and connected to each of said mechanisms, a motor connected to said lever for oscillating the same, and thereby actuating said mechanism to alternately vary the pressure in the service pipes, an oscillating frame comprising two portions pivotally connected about a common fulcrum, a pair of race-ways pivotally supported above said frames upon an axis vertically alining with the axis of said frame, said race-ways comprising upwardly inclined end portions, shifting weights guided upon said race-ways, means for oscillating said frame by said motor, means whereby the oscillation of said frame successively varies the inclination of said race-ways, and means whereby said weights are successively applied to assist the motor in the oscillation of said lever.

11. In a pneumatic clock system, the combination with a service pipe, of a compressible chamber communicating with said pipe, a motor for compressing and expanding said chamber, a valve controlling a port leading from said pipe to the atmosphere, a lever operatively connected to said valve for seating and unseating the same, means actuated by said motor for oscillating said lever to close the valve, an oscillatory hanger for supporting said lever in position to close said valve, means actuated by said motor to locate said hanger in position to support said lever, and a time train independently of said latter means for oscillating said hanger to release said lever and thereby open the valve.

12. In a pneumatic clock system, the combination with a service pipe, of a compressible chamber communicating with said pipes, a motor for compressing and expanding said chamber, a stop for interrupting the operation of said motor, a time train, an oscillating detent for effecting the removal of said stop from engagement with the motor, an eccentric engaging the lower end of said detent for oscillating the same, means for rotating said eccentric by the time train, and means actuated by the motor for locating said stop in position to interrupt the operation of the motor without moving the detent.

13. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism communicating with said pipe, a motor for actuating said mechanism, a valve controlling a port leading from said pipe to the atmosphere, a lever operatively connected to said valve for seating and unseating the same, means actuated by said motor for oscillating said lever to close said valve, an oscillatory hanger for supporting said lever in position to close said valve, a detent engaging said hanger for oscillating the same to release said lever, an eccentric engaging the lower end of said detent for oscillating the same and thereby oscillating said hanger, and means for rotating said eccentric by said time train.

14. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism communicating with said pipe, a motor for actuating said mechanism, a valve controlling a port leading from said pipe to the atmosphere, a lever operatively connected to said valve for seating and unseating the same, means actuated by said motor for oscillating said lever to close said valve, an oscillatory hanger for supporting said lever in position to close said valve, a detent engaging said hanger for oscillating the same to release said lever, an eccentric engaging the lower end of said detent for oscillating the same and thereby oscillating said hanger, means for rotating said eccentric by said time train, and means actuated by said motor for axially moving said hanger into position to support said lever.

15. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism communicating with said pipe, a motor for actuating said mechanism to vary the pressure in said pipe, a valve controlling a port leading from said pipe to the atmosphere, a lever operatively connected to said valve for seating and unseating the same, means actuated by the motor for oscillating said lever into position to

close said valve, oscillatory hangers for supporting said lever in position to close the valve, a time train, means actuated by said motor for axially moving said hanger into position to support said lever, and means actuated by the time train for swinging said oscillatory hanger out of engagement with said lever to permit the latter to fall and open the valve.

16. In a pneumatic clock system, the combination with two service pipes, of impulse mechanism communicating with each of said pipes, a motor for actuating said impulse mechanism to alternately vary the pressure in said pipes, valves for controlling ports leading to the atmosphere from said pipes, levers operatively connected to said valves for seating and unseating the same, means actuated by the motor for alternately oscillating said levers into position to close said valves, oscillatory hangers for alternately supporting said levers in position to close the valves, a time train, means actuated by said motor for axially adjusting said hanger into positions to alternately support said levers, and means actuated by the time train for swinging said oscillatory means alternately from engagement with said levers to permit them to fall and open the valves.

17. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism communicating with said pipe, a motor for actuating said impulse mechanism, a valve for controlling a port leading from said pipe to the atmosphere, a lever operatively connected to said valve to open and close the same, means actuated by the motor for lifting said lever in position to close said valve, an oscillatory hanger for supporting said lever in position to close said valve, a detent connected to said oscillatory hanger, a time train, an eccentric engaging the lower end of said detent to oscillate the same, and thereby oscillate said hanger, and means for rotating said eccentric by the time train.

18. In a pneumatic clock system, the combination with two service pipes, of impulse mechanism communicating with each pipe, a motor for actuating said mechanism to alternately vary the pressure in said pipes, valves for controlling ports leading from said pipe to the atmosphere, levers operatively connected to said valves for opening and closing the same, means actuated by the motor for alternately lifting said levers into position to close said valves, an oscillatory hanger for alternately supporting said levers in position to close said valves, a detent connected to said hanger, a time train, means actuated by said motor for axially adjusting said hanger into positions to alternately support said levers, an eccentric engaging said detent to oscillate the same and thereby oscillate said hanger, and means for rotating said eccentric by the time train.

19. In a pneumatic clock system, the combination with a service pipe, of impulse mechanism communicating with said pipe, a motor for actuating said impulse mechanism, a valve for controlling the pressure in said service pipe, a detent controlling the operation of said valve, a yoke on said detent, a time train, an eccentric engaging said yoke to oscillate the detent, and means for rotating said eccentric by the time train.

20. In an automatic clock system, the combination with a service pipe, of impulse mechanism communicating with said pipe, a motor for actuating said impulse mechanism, a valve for controlling the pressure of said service pipe, a detent controlling the operation of said valve, a time train, an eccentric, means for rotating said eccentric by the time train, a yoke engaging and oscillated by said eccentric, and means for adjustably securing said yoke to said detent.

In testimony whereof, I sign this specification in the presence of two witnesses.

AUGUSTUS L. HAHL.

Witnesses:
WM. F. FREUDENREICH,
RUBY V. NASH.