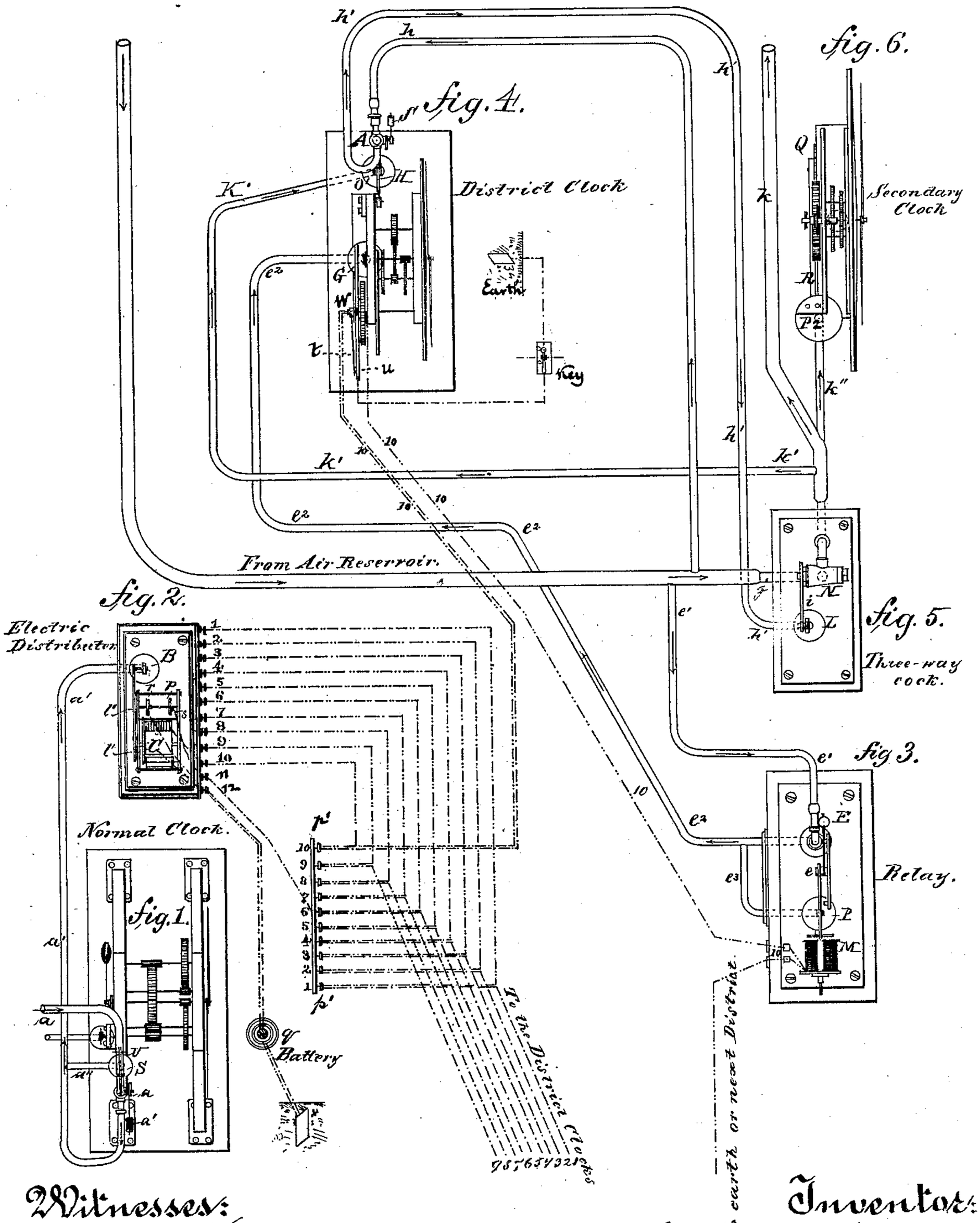
(No Model.) 5 Sheets—Sheet 1.

C. A. MAYRHOFER

ELECTRIC PNEUMATIC CLOCK SYSTEM.

No. 278,159. Patented May 22, 1883.



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(No Model.) 5 Sheets—Sheet 2.

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ELECTRIC PNEUMATIC CLOCK SYSTEM.

No. 278,159. Patented May 22, 1883.

Fig. 3a

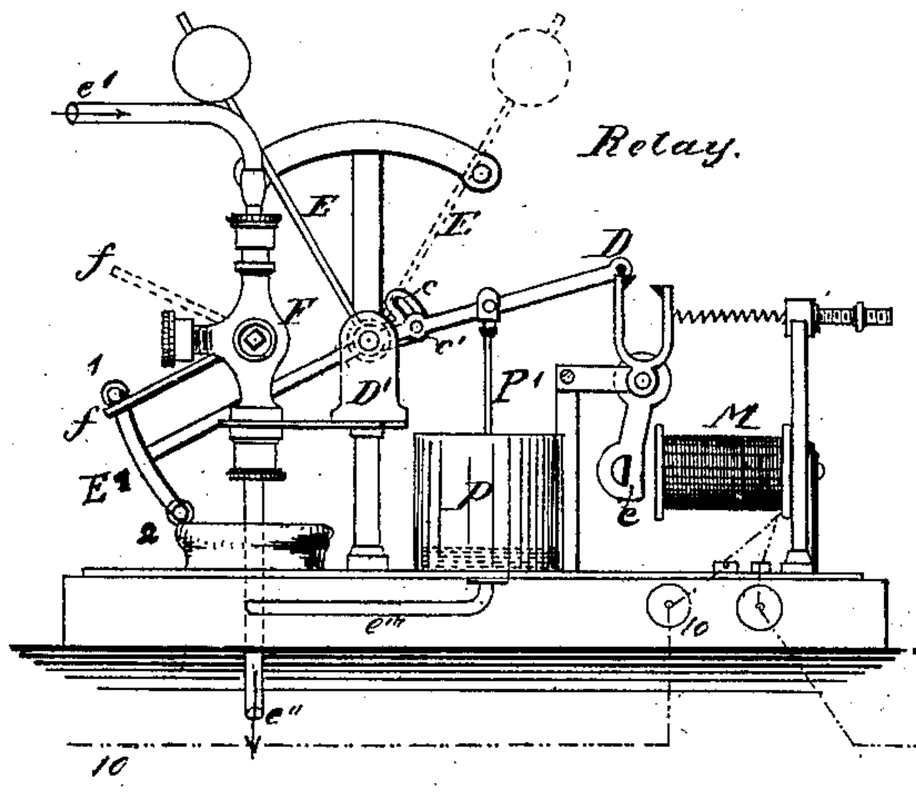


Fig. 2a

Electric Distributer.

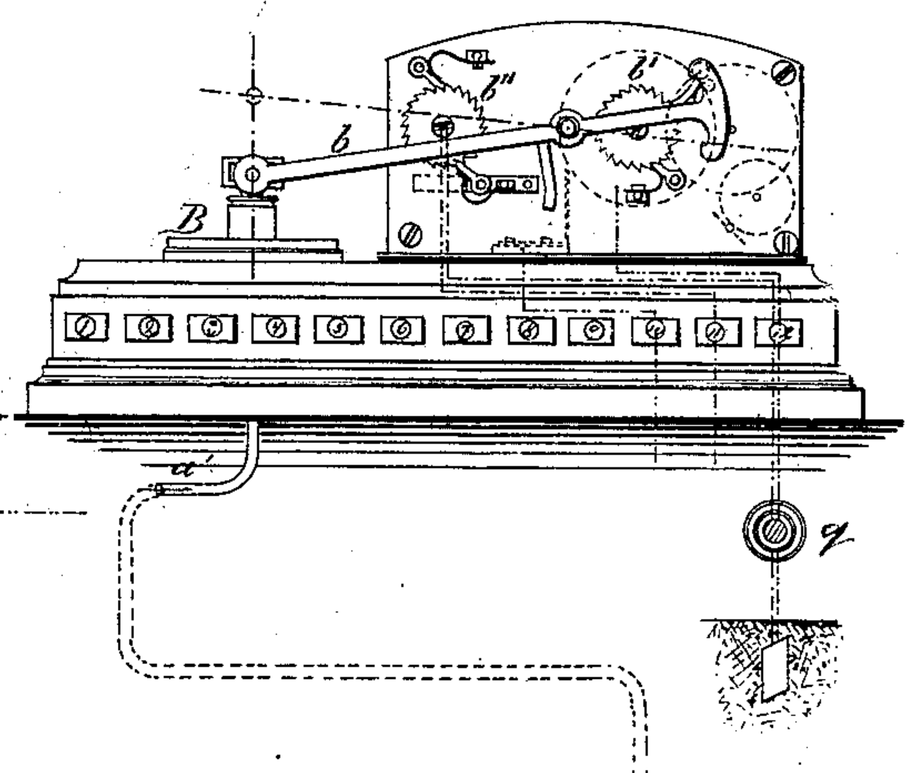
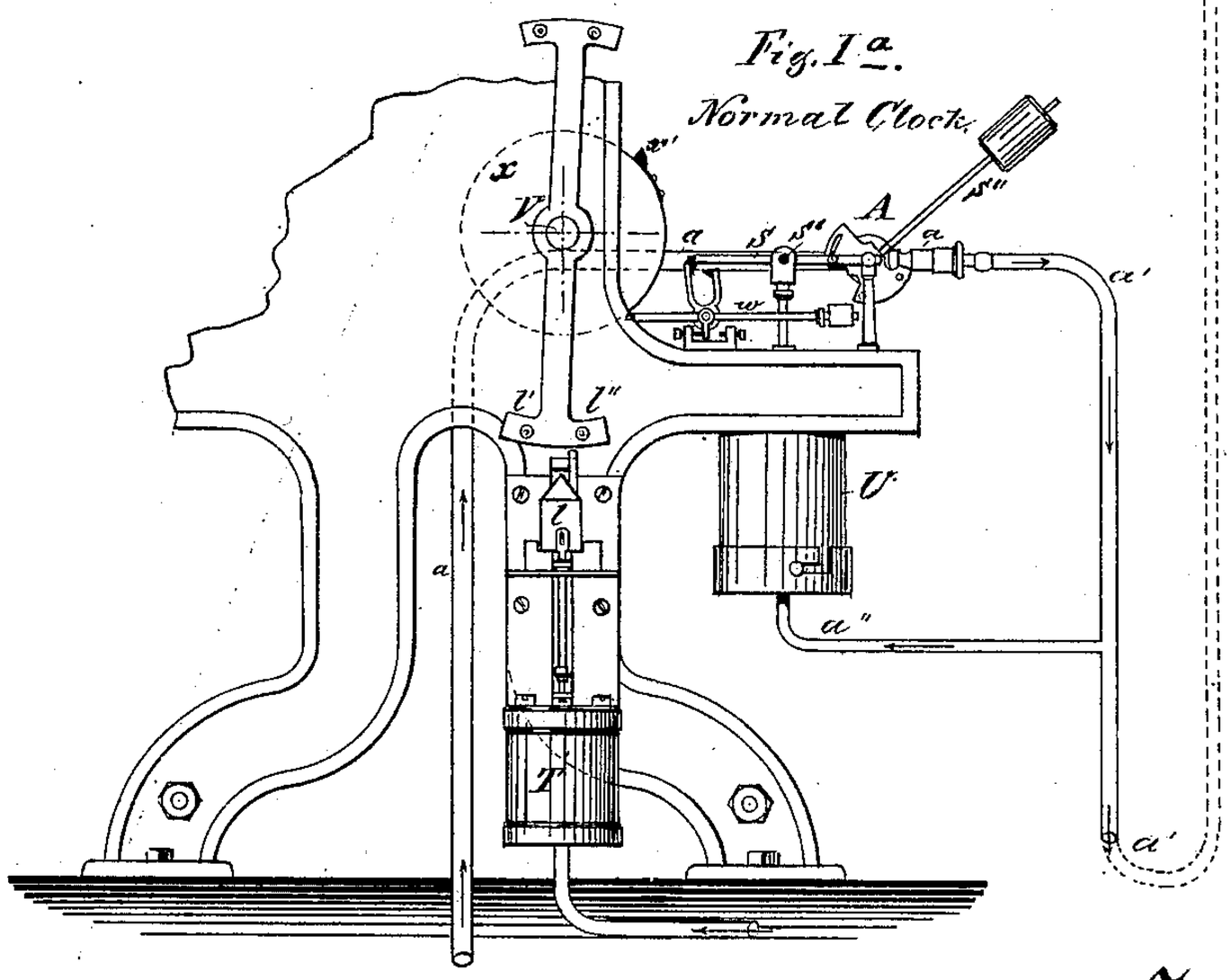


Fig. 1a.

Normal Clock.



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(No Model.) 5 Sheets—Sheet 3.

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ELECTRIC PNEUMATIC CLOCK SYSTEM.

No. 278,159. Patented May 22, 1883.

Fig. 6a

Secondary Clock.

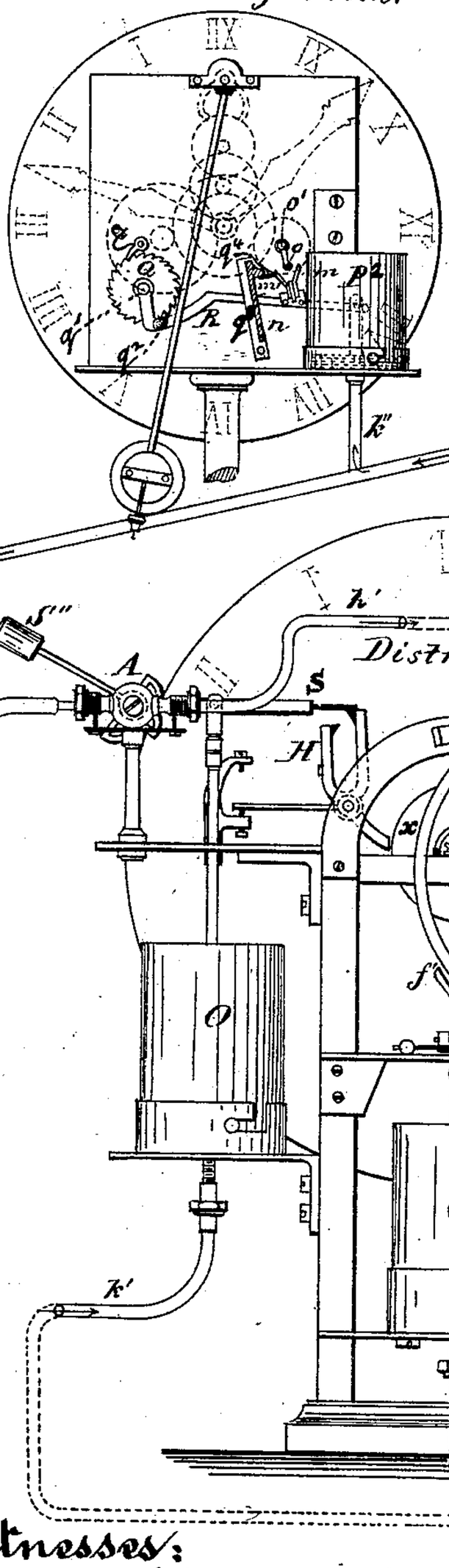

Fig. 5a

Three-way cock.

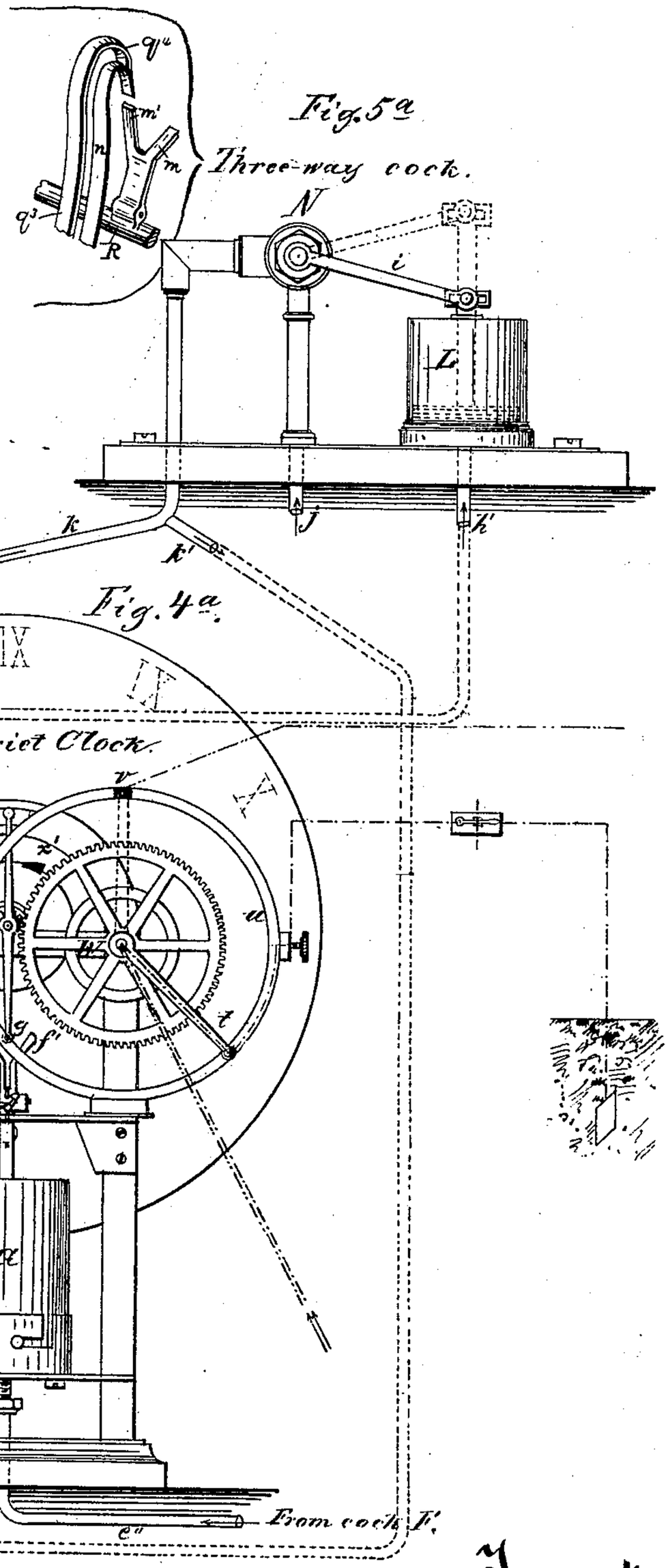

Fig. 4a.

District Clock.

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ELECTRIC PNEUMATIC CLOCK SYSTEM.

No. 278,159. Patented May 22, 1883.

Fig. 7.

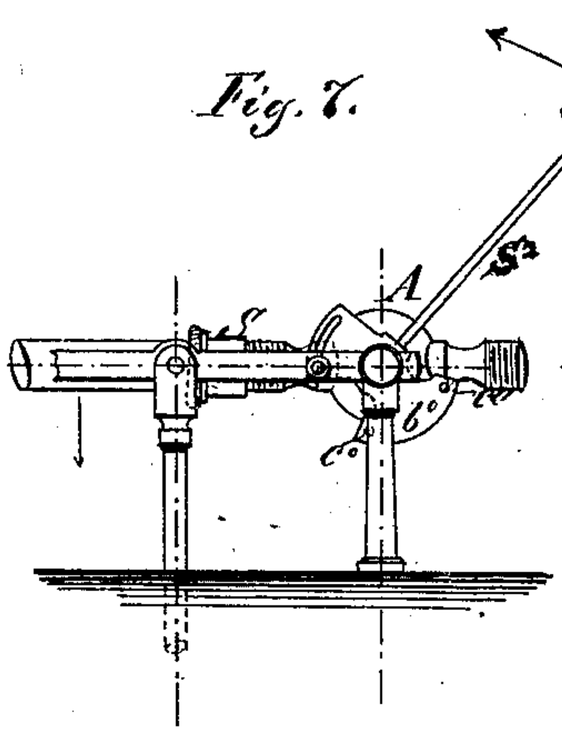


Fig. 8.

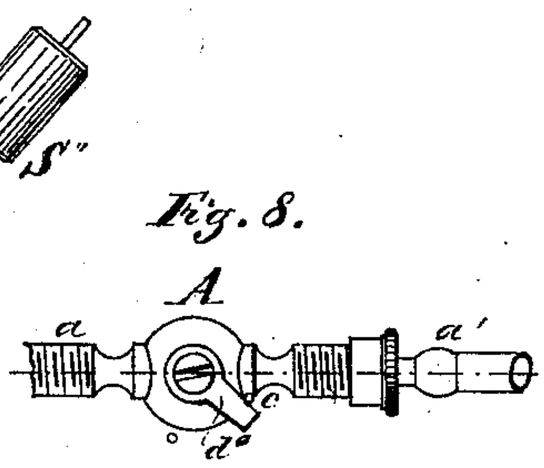


Fig. 9.

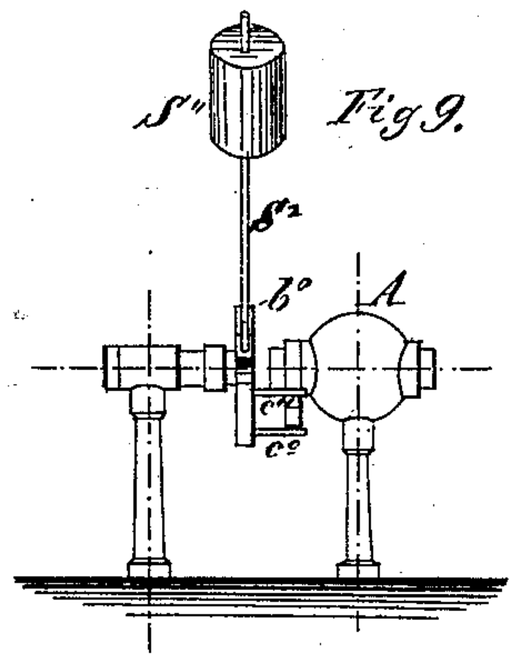


Fig. 10.

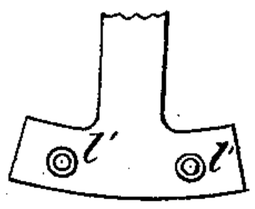


Fig. 11.

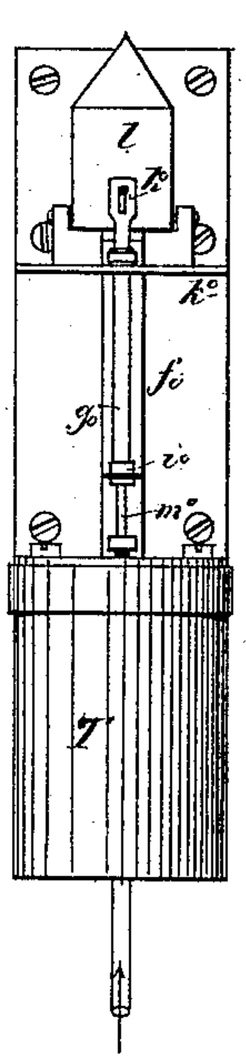


Fig. 12.

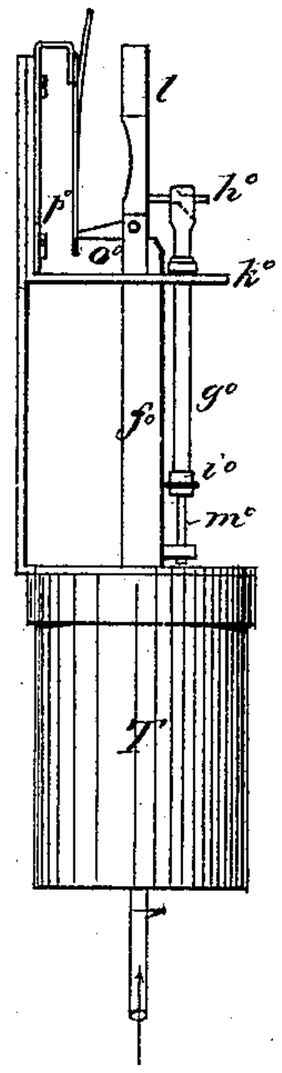
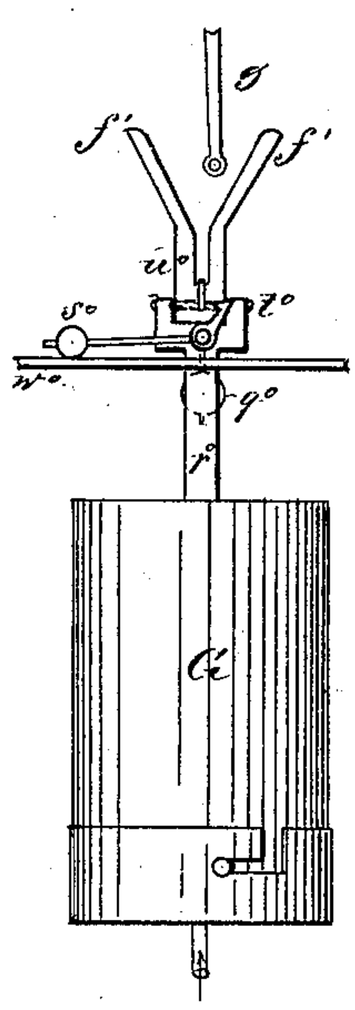
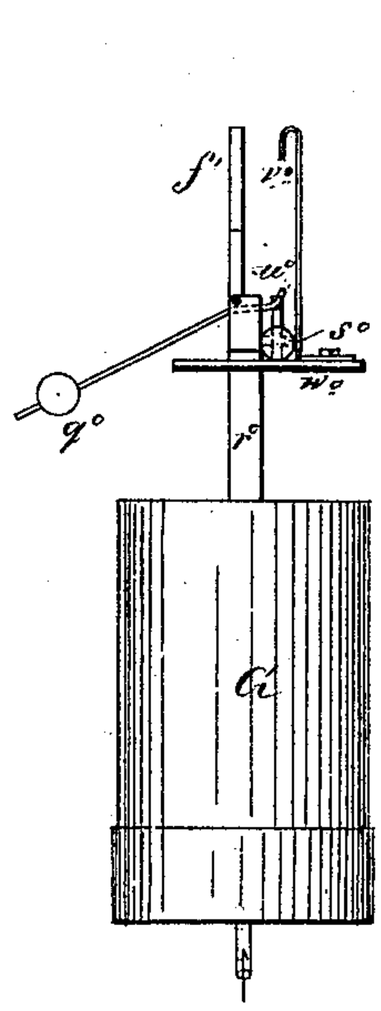


Fig. 13.





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ELECTRIC PNEUMATIC CLOCK SYSTEM

No. 278,159. Patented May 22, 1883.

Fig. 15.

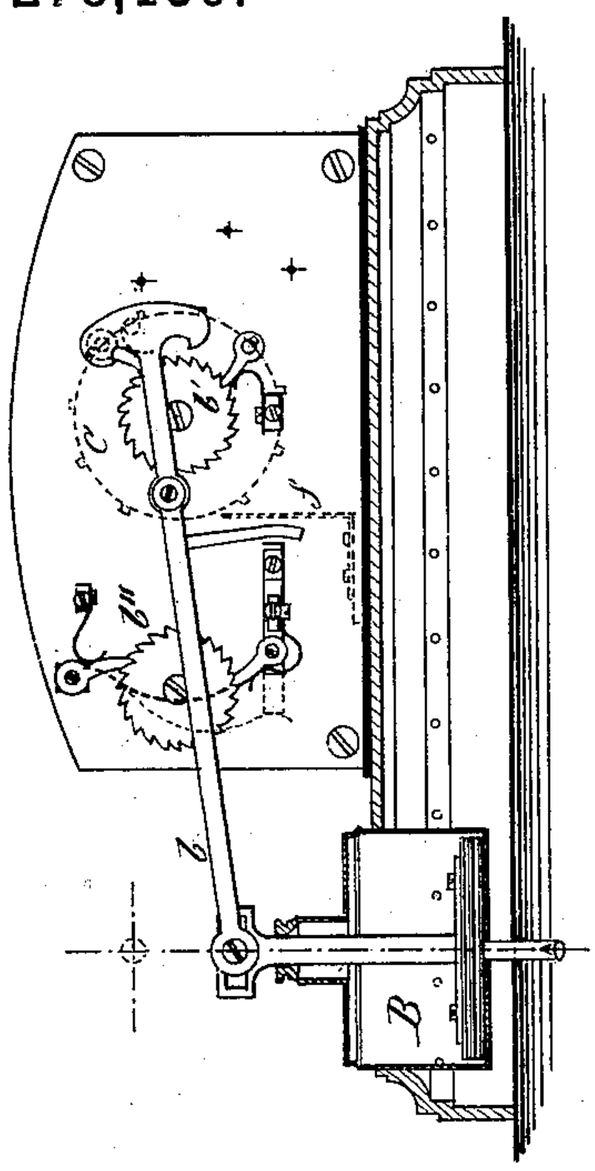


Fig. 16.

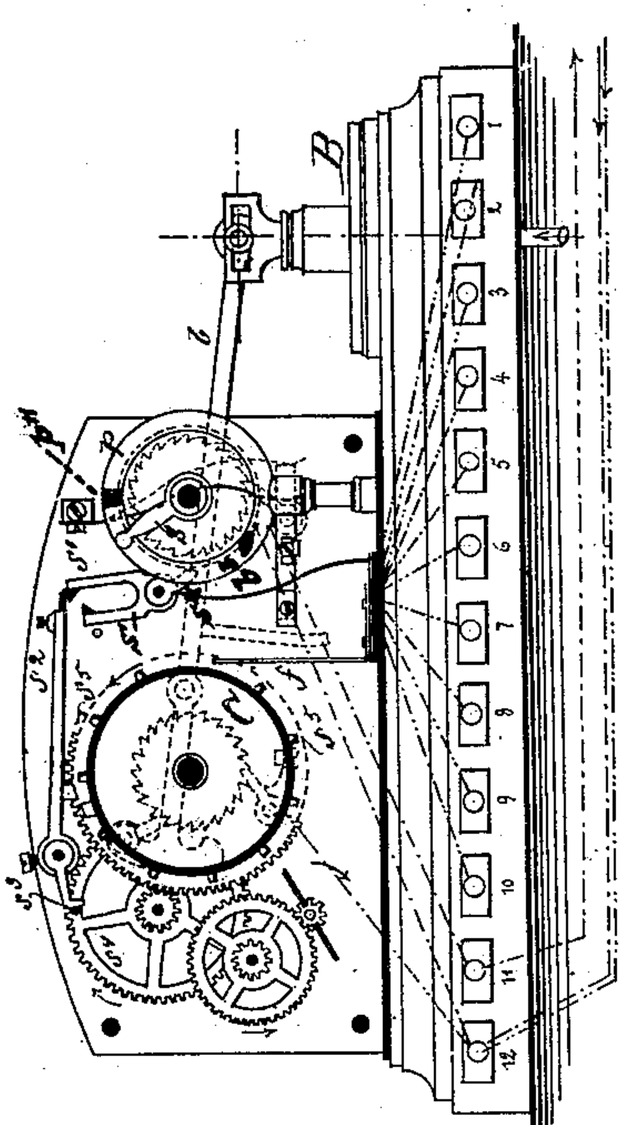
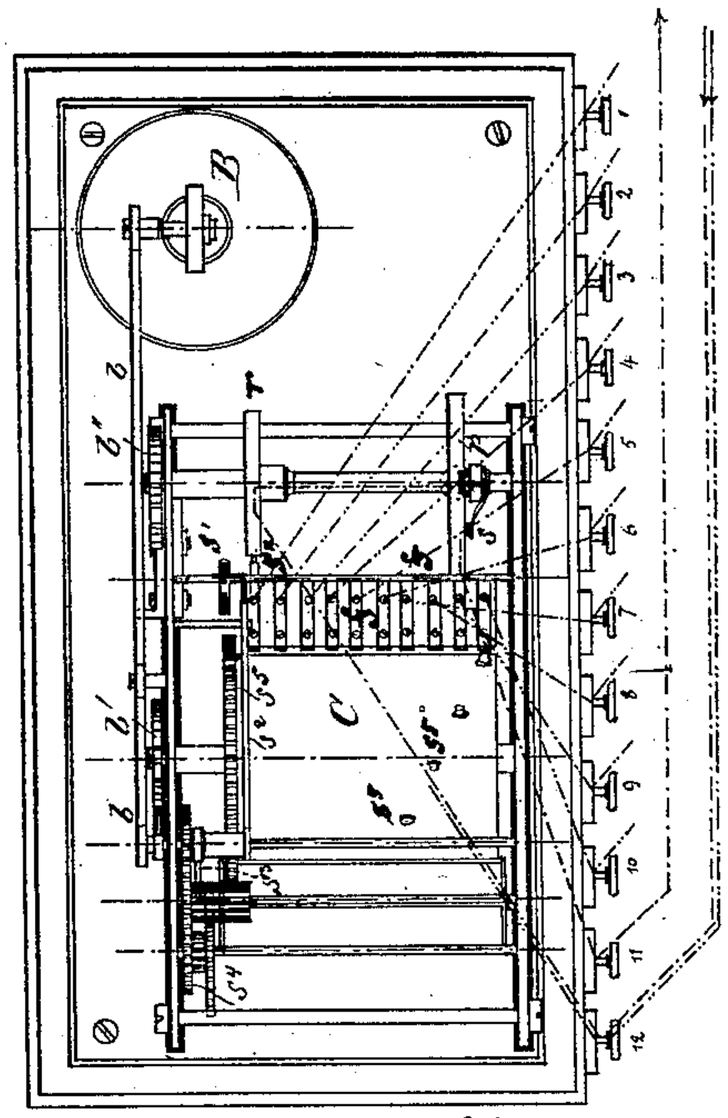


Fig. 17.



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UNITED STATES PATENT OFFICE.

CARL A. MAŸRHOFER, OF PARIS, FRANCE, ASSIGNOR TO HIMSELF AND WILLY OTTO, OF SAME PLACE.

ELECTRIC PNEUMATIC CLOCK SYSTEM.

SPECIFICATION forming part of Letters Patent No. 278,159, dated May 22, 1883.

Application filed September 1, 1882. (No model.) Patented in Belgium October 13, 1881, No. 55,958; in France October 14, 1881, No. 145,306; in Austria-Hungary October 15, 1881, and December 11, 1881; in Germany October 21, 1881, and in England October 31, 1881, No. 4,753.

To all whom it may concern:

Be it known that I, CARL ALBERT MAŸRHOFER, of Paris, in the Republic of France, have invented certain new and useful Improvements in Electro-Pneumatic Clock Systems, of which the following is a specification.

This invention has reference to an improved electro-pneumatic clock system for transmitting the correct time from a normal clock to a number of district-clocks, and thence to a number of secondary clocks in different parts of a city, the normal clock being regulated from an astronomical observatory, and the district-clocks electrically from the normal clock, while the secondary clocks are wound up and regulated by impulses of compressed air which are transmitted at certain intervals of time, by the action of the district-clocks, from a compressed-air reservoir to the secondary clocks.

The invention consists of a normal clock which is connected by an electric distributer with an electro-pneumatic relay and with any desired number of district-clocks. From the latter pneumatic impulses are transmitted at certain intervals of time to a three-way cock and to all the secondary clocks of a district, the compressed air being forced from a compressed-air reservoir through a system of distributing-pipes to any number of secondary clocks, where it actuates suitable winding-up and regulating appliances. The electro-pneumatic relay actuates at certain fixed intervals of time the regulating devices of the district-clocks, which are thereby kept uniform with the normal clock.

The different appliances for correcting the normal, district, and secondary clocks and for winding up the latter will be more fully described hereinafter, and finally be pointed out in the claims.

In the accompanying drawings, which fully illustrate my invention, Figures 1 to 6, Sheet 1, represent plan views of the different apparatus which compose my improved electro-pneumatic clock system, these parts being brought closely together to show their connection with each other, Fig. 1 representing a plan view of the normal clock; Fig. 2, of the electric distributer; Fig. 3, of the electro-pneumatic relay; Fig. 4, of a district-clock; Fig. 5, of the three-way cock for supplying the pneumatic impulses from the air-reservoir to the secondary clocks, and Fig. 6 of the secondary clock. Figs. 1ª to 6ª, Sheets 2 and 3, represent side elevations, respectively, of the same parts shown in Figs. 1 to 6. Figs. 7, 8, and 9 represent detail views of the three-way cock; and Figs. 10 and 11 detail views of the regulating appliances of the normal clock shown in Figs. 1 and 1ª. Figs. 12 and 13 are detail views of the regulating appliances of the district-clocks, said regulating appliances being all operated by compressed air; and Figs. 14, 15, 16, and 17 represent, respectively, a perspective view, a side elevation, partly in section through the air-cylinder, a vertical longitudinal section, and a plan view of the electric distributer on an enlarged scale, whereby at certain periods of time electric pulsations are transmitted from the normal clock to the different district-clocks and electro-pneumatic relays.

Similar letters of reference indicate corresponding parts.

The normal clock shown in Figs. 1 and 1ª is a strong and well-built clock, which is provided on the arbor of the quarter-minute wheel with a disk, *x*, having a projection, *x'*, that presses at each unlocking of the clock, which may take place hourly, upon a lever, S, pivoted to an upright standard at S', and having its other extremity in engagement with a weighted arm, S'', which it rocks and causes to open a three-way cock, A. By the opening of the three-way cock A compressed air is admitted by pipe *a* from a compressed-air reservoir to pipe *a'*, which conducts it to the air-cylinder or bellows B of the electrical distributer shown in Figs. 2, 2ª, 14, and 15, so that the lever *b* of the same is raised, and thereby the ratchet-wheels *b'* and *b''* turned for the distance of one or more teeth by means of the actuating-pawls of the lever *b*. A spring-contact drum, C, of the distributer is thereby wound up, and also intermittent rotary motion imparted to a shaft, carrying a contact-spring, *s*, Fig. 16. If this operation has taken place a certain number of times—for instance, twen-

ty-four times—the spring-actuated drum is released in the following manner: A tooth, b^3 (see Figs. 14 and 16,) of a disk, r, keyed to the shaft of the contact-spring s, presses upon the heel $s^\times$ of an oscillating fork, s', so that the long contact-arm of the same clears lever s^2, causing the same to drop and to withdraw a pin, s^3, at its opposite end from a gear-wheel, s^4, in mesh with the spring-drum C. The drum C is thereby set free to follow the motion of its spring, which imparts rotary motion to the same, so as to send by the successive contacts of projecting studs s^5, arranged spirally upon the surface of the drum, with a series of contact-springs, f, electric impulses over the binding-posts 1 to 10, and the line-wires to an electro-pneumatic relay of the different district-clocks, which relay then takes up the work and starts the pneumatic impulses required for working the secondary clocks of all the district systems.

As the electric impulses have to be sent only at infrequent intervals of time—say once in twenty-four hours—it is obvious that no special connecting-lines are necessary, and that already existing lines, whether they be used for telegraph, telephone, fire-alarm, or other purposes, can be employed without interfering with the regular functioning of the same. If, for instance, telegraph or other wires are used, a battery, q, is employed, of which one pole is connected to the earth, while the other is connected to the binding-post 12 of the electric distributer, Figs. 2 and 2^a, where it is electrically connected with the shaft of the disk r and contact-spring s. The contact-spring s is always in contact with a disk, p, placed on the same arbor, which is again connected with an intermediate contact-rod, p', Fig. 2, Sheet 1, which forms the joint connection with the battery. Now, if any one presses upon the push-button 10, which closes the circuit between the district-clock and the distributer by button 10 making contact with the intermediate contact-rod, p, the course of the current (indicated as follows on Sheet 1, —.—.—.—) is as follows: battery q of Fig. 2, binding-post 12, supporting-standard and contact-disk r, shaft and contact-spring s, to disk p, to binding-post 11, to contact-rod p', and from the same over line-wire 10 to the district-clock, (shown in Fig. 4,) where the current passes into the arbor W of the same, from arbor W through contact-spring t, which makes contact with rim u, through rim u, thence to the telegraph-office, and to the earth.

The metal disk p of the distributer, as well as the rim u of the district-clock, are provided at one point of their circumference with a recess, which is filled by a small insulated contact-piece, v, through which the circuit to relay, Fig. 3, is completed through line 10, when contact-spring t closes the circuit through it and cuts out the earth through rim u. This contact-spring t, carried round by the mechanism of the clock, constantly maintains its contact with the rim u, and thus completes the circuit to earth, except where rim u is interrupted by the insulated piles in which is the contact v. This contact v, insulated from the rim u, is also in the path of the revolving contact-spring t, and serves to establish a different circuit from the earth-circuit, which is broken by the passage of spring t over the insulated interruption in the ring. (See Figs. 4 and 4^a.) At certain fixed periods of time—for instance, every twenty-four hours—the contact-spring s of the distributer cuts out wire 11 and bar p' by passing over the insulated plate p'', Fig. 16, of disk p, and the contact-spring t of the district-clock breaks circuit through rim u and makes contact with insulated contact v. This is the time (about eight or nine seconds) for which the line is cut out from its usual work—that is, in which the spring-actuated contact-drum completes its revolution, so that the current takes the following course: battery q of Fig. 2, binding-post 12, standard and contact-disk r, and contact-drum C, successively over the springs $f\,f$, and thence over the binding-posts 1 to 10, and the different line views, as indicated by — - - — - -, until the current arrives at the arbor W, Fig. 4, of the first district-clock, which may be at any desired distance. There it passes over the contact-spring t, which is at this moment over insulated contact v, from which the current passes to the electro-pneumatic relay, (shown in Fig. 3,) where it excites the electro-magnets M M, passing through a binding-post either to the earth or through a second line-wire to one or more of the remaining district-clocks, where the same operation just described takes place nearly simultaneously. As soon as the contact-drum C of the distributer has completed its revolution its former position is restored and the contact-spring s passes from the small insulated plate p'' onto the metal ring. As this also takes place simultaneously in all the remaining district-clocks, the line is taken up but for a very short period. As the operation described is accomplished automatically, it may be arranged to take place in the midnight hours, so as not to interrupt the regular work of the telegraph or other lines, or interfere in any way with the lines made use of for the purposes of this time-keeping system. By the entrance of the current into the electro-pneumatic relay, Figs. 3 and 3^a, the electro-magnets M M attract the armature e, which is suspended from a standard in front of magnet M. The upper part of armature e branches into a fork. When the armature hangs in its natural position with no current passing through the magnet, the arm of the fork of lever e farthest from magnet M supports the arm of a lever, D, pivoted at its other end to an upright, D'. To the center of lever D is attached the rod P' of cylinder P. Pivoted to upright D' is a bell-crank, one arm of which consists of a weighted lever, E, the other arm of which, E', is T-shaped, having pins 1 and 2, between which lies lever f of the three-way cock F, their relation being such that when the weighted arm

E of the bell-crank is thrown into the position shown by dotted lines, Fig. 3ª, Sheet 2, arm E′ rises, pin 2 engages with arm *f*, lifts it and opens cock F. This is effected automatically by a pin, *c′*, on the end of lever D, which works in a slotted arm, *c*, forming part of and rigidly attached to the weighted lever E and T-shaped arm E′, freeing the bell-crank, so that when the armature *e* releases lever D by rocking its forked arm from under it, lever D, in its fall, carries with it arm *c*, throws lever E into the dotted position, and opens cock F, as shown in dotted lines in Fig. 3, and thereby the compressed air from the air-reservoir is admitted instantly through the pipe *e′* to the pipe e^2, and thence to the cylinder G of the district-clock, Fig. 4, where it lifts the regulating-fork *f″* and engages the regulating-pin *g*, so as to carry it exactly into vertical position. The cock is closed and the weighted arm E returned to its full-line position by the admission of air into piston P′. The other arm of the fork-armature limits the fall of the lever D. The district-clock is thus regulated electrically from the normal clock by the circuit passing through the distributer and pneumatically from the relay, which is in turn operated by the electric current sent from the district-clock to it. The district-clock, Fig. 4ª, continues to move independently, but drops at certain fixed intervals of time the lever S by the cam-wheel *x* and fork H, the dropping of the lever S reversing the cock A by means of the weighted lever S″, whose operation is in all ways similar to the similarly-lettered parts of the normal clock, lever S being dropped by cam and dropping-fork H, (see Fig. 4ª, Sheet 2,) so that the compressed air can pass from the air-reservoir and tube *h* to *h′*, and thence to the cylinder L of the three-way cock N, Figs. 5 and 5ª. The air-cylinder L raises the lever *i*, the compressed air passing then from the air-reservoir and tube *j* into the tube *k*, which connects with tube *k″* leading to the secondary clocks, the air accomplishing the work of winding up and regulating the same. From the tube *k* passes a branch tube, *k′*, to the air-cylinder O, Figs. 4 and 4ª, for the purpose of returning the lever S into its former position. In a similar manner the lever D in Figs. 3 and 3ª is returned into its former position by compressed air supplied to the cylinder P by tube e^3.

In the normal clock shown in Figs. 1 and 1ª, which also performs the function of a district-clock for its immediate neighborhood, the drop-lever S is returned into its former position by the air-cylinder U, which is supplied with compressed air by the tube a^2. The compressed air, which is conducted through the branch tube k^2 to the cylinder P^2 of the secondary clock, Figs. 6 and 6ª, raises the lever R, which is pivoted at *q′* to the same arbor as wheel Q, and carries a small spring-pawl, q^2, whereby the ratchet-wheel Q is turned round its axis and the clock wound up to such an extent that it is kept going until the next pneumatic impulse is imparted. Simultaneously the fork *m′* on the lever R is raised, whereby the pin *o*, which is applied to a small crank, *o′*, operating the gear-wheels of the hands, is carried into the proper position—that is to say, the clock is set—so that differences in the time indicated by the different clocks are rendered impossible. Thus both the winding up and set of the clock are accomplished at the same time. Pivoted to the lever R is a fork with two spreading-arms, *m* and *m′*. When the fork is lifted by lever R a pin, *o*, on a small crank, *o′*, which operates the hands of the clock by means of a ratchet, engages with one or the other of the two arms, and by the rising of the fork is pushed into a determinate position, which sets the hands of the clock at the right hour. That position is reached when the pin on crank *o′* is pushed into the crotch formed at the bottom of the fork by the two arms. Crank *o′* having reached this position, the fork *m m′* is caused to turn on its pivot and release pin *o*, so as not to interfere with the continuous running of the clock. It is done in this wise: An arm, q^3, is attached to and projects from the back of the clock, and is provided at its upper end with a hook, q^4, which extends inwardly, so as to engage with arm *m′* of the fork as lever R rises. A spring, *n*, is attached to the bottom of arm q^3, and extended up as far as the hook of arm q^3, where it also is bent inwardly, forming a catch, against which arm *m′* of the fork is thrown in the upward motion of lever R. As lever R continues to rise, arm *m′*, being held by spring *n*, pushes spring *n* away from the back of the clock. The fork being thus caused to turn on its pivot and fall away from crank *o′*, on the return of the lever R to its normal position the fork is again righted by the pressure of spring *n*, and is ready for the next setting of the clock. The dropping of the fork has the object to release the pin *o* immediately after the clock has been set, and without interfering in the least with the regular movement of the clock.

The correction of the normal clock is accomplished in the same manner as that of the district-clock by an electro-pneumatic relay, but with this difference, that the relay of the normal clock receives its electrical impulses from some astronomical observatory, while the relays of the district-clocks receive their impulses from the electrical distributer at the central station. In this case the wedge *l*, Figs. 10 and 1ª, is forced between the two anti-friction rollers *l′* and l^2, arranged on arms of the arbor V of the minute-hand.

Figs. 10 and 11 represent details of the mechanism for correcting the normal clock. When the rod f^o is raised by the pressure of the air in the cylinder T the rod g^o is carried along by means of the pin k^o, projecting from rod f^o, which engages its upper end. When the rod g^o has been lifted far enough so that a collar, i^o, strikes a bracket-arm, k^o, the rod g^o is retained, while the rod f^o continues to move, the then rod m^o telescoping into the lower part of the rod g^o. This continued motion of rod f^o,

while it is at the same time held back by the connection of pin h^o with rod g^o, causes the wedge-shaped end l to turn around its pivot-connection with the rod f^o—that is, to drop forward so as to clear the anti-friction rollers l' and l^2. To prevent the dropping of the wedge l during the upward motion of the rod f^o, a heel, o^o, of the same moves a friction-spring, p^o, as shown clearly in Fig. 11.

The detail figures, 7, 8, and 9, show the construction of the three-way cock A of the normal clock. The three-way cock A has the additional way in order to remove the pressure in the cylinders when the inflowing air from the reservoir is turned off. As soon as by the dropping of the lever S the weighted lever S^2 is carried toward the left the lever-segment b^o is moved through a certain angle without the pins c'' and c^o of the same acting upon the crank-arm d^o of the stop-cock, the pin c^o acting only upon the crank-arm d^o when the weighted lever S^2 has passed over the vertical position. By the return motion of the lever S^2 for the closing of the stop-cock A the reversed action takes place.

Figs. 12 and 13 show details of the mechanism for setting the district-clocks shown in Figs. 4 and 4^a. The fork f' f' is held by a balance-weight, q^o, in upright position. As soon as the rod r^o is raised by the pressure of the air in the cylinder G the lever of the small balance-weight s^o, which lever carries a latch, t^o, at its shorter arm, and is pivoted to r^o, by reason of its weighted arm s^o resting upon plate w^o, lifts its short arm t^o until stopped by the short arm u^o of lever q^o. When rod r^o has been carried up high enough short arm u^o of the counter-weight q^o engages with the fixed stop v^o. This raises its longer arm q^o, and consequently tilts forward the fork f', which is pivoted to r^o, and, as already said, was held upright by the counter-weight q^o. The fork f^o, being thus thrown forward, clears the pin at the lower end of the regulating-arm g of the district-clock. (See Figs. 4^a and 12.) Short arm u^o, being thus depressed by abutting against the fixed stop v^o, engages in the latch t^o of lever s^o, and fork f' is thus held out of engagement with regulating-arm g of the clock until the falling of the cylinder brings lever s^o again horizontal on plate w^o, and causes its short arm t^o to release lever q^o, which falls back, carrying with it fork f', which is restored to its normal position.

By the details just described the district-clocks are set and made to keep regular time with the normal clock at the central station. This is accomplished at certain fixed intervals by means of the electric distributer, which sends the electric impulses over the different lines to the electro-pneumatic relays of the district-clocks. These relays serve to regulate pneumatically the district-clocks. The district-clocks again set at certain fixed but shorter intervals of time a three-way cock in motion, which transmits pneumatic impulses to the different secondary clocks within each district, so as to wind up the movements of these clocks and regulate the hands of the same, so that they indicate uniform time with the district-clock.

I am aware that clocks have been worked heretofore by pneumatic impulses from a central station; but actual tests have shown that a purely pneumatic system is too expensive and not adapted to work clocks at great distances from each other. Consequently this system was only capable of doing work on a small limited scale. By the employment of electricity for regulating the normal and district clocks, and by using pneumatic impulses, not for running the secondary clocks, but simply for winding them up and setting the same, my improved electro-pneumatic system has been more fully adapted to the wants of larger cities, so as to be capable of general introduction, and, after the first cost of plant has been met, of running it with little expense, while it is possible to add continually to the number of public and private subscribers. The work is performed pneumatically with greater certainty and reliability than by purely electrical means, as it is not exposed to the annoying disturbances of the electric systems.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In an electro-pneumatic clock system, the combination of a normal clock, an electric distributer, set pneumatically thereby, an electro-pneumatic relay actuated by the distributer at certain intervals of time, one or more district-clocks, and means for regulating the latter so as to keep uniform time with the normal clock, substantially as set forth.

2. In an electro-pneumatic clock system, the combination of the normal clock of the electric system, an intermediate electric distributer, an electro-pneumatic relay, one or more district-clocks, their switching mechanism, one or more intermediate three-way cocks actuated electrically by the district clock or clocks, and a number of secondary clocks having winding-up and regulating appliances, the district-clocks being regulated electrically from the normal clock, while the secondary clocks are wound up and regulated automatically from the district-clocks, substantially as specified.

3. In an electro-pneumatic clock system, the combination of the normal clock, having pneumatic appliances actuated at fixed intervals of time, with an electric distributer provided with means for winding up the spring-drum of the same, and with means for automatically starting the spring-drum and sending electric impulses to the district-clocks, substantially as set forth.

4. In an electric pneumatic clock system, an electric distributer consisting of a drum, C, spring mechanism for rotating the drum, contact-springs f, and means whereby at certain intervals of time the rotating mechanism is released and the drum C allowed to rotate, so

as to send electrical impulses over the springs *f* and connecting-wires, substantially as set forth.

5. In an electro-pneumatic clock system, a district-clock having a rim, *u*, and insulated contact-plate *v*, in combination with the radial contact-spring *t*, as described.

6. In an electro-pneumatic clock system, the combination of the electro-magnets M, armature *e*, having a fork-shaped extension-lever, D, and an air-cock, F, whereby the lever E is dropped and the cock F opened as soon as the armature is attracted by the magnets, substantially as set forth.

7. In an electro-pneumatic clock system, the combination, with a clock-train of the secondary clock, of a winding-up lever, R, and a fork-shaped piece, *m m'*, for winding up and setting the clock, and the hook and spring, whereby, when the clock has been set, the fork is rocked out of engagement with the clock, as described.

8. In an electro-pneumatic clock system, the mechanism for regulating the normal clock, which consists of the vertically-movable wedge-piece *l*, pivoted to the vertically-moving shaft f^{o}, mechanism for moving the shaft f^{o}, the arm g^{o}, having the pin h^{o}, connecting it to the wedge-piece *l*, and the collar i^{o}, engaging with collar k^{o}, the shaft m^{o}, telescoping into arm g^{o}, and the friction rollers or arms of the arbor of the quarter-minute hand, whereby the wedge-piece *l* is lifted into engagement with the arms of the arbor to regulate the clock, and is subsequently rocked forward and out of the path of the arms, so as not to interfere with the running of the clock, substantially as described.

9. In an electro-pneumatic clock system, the mechanism for regulating the clock, which consists of the vertically-moving rod r^{o}, the fork pivoted thereto, the weighted arm q^{o} u^{o}, and weighted lever s^{o} t^{o}, pivoted as described, plate w'', spring v'', and the pin on the arbor of the clock, whereby the fork is rocked out of engagement with the clock after the latter is set, substantially as described.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

CARL ALBERT MAŸRHOFER.

Witnesses:
H. WINKLEY,
M. MAURY.