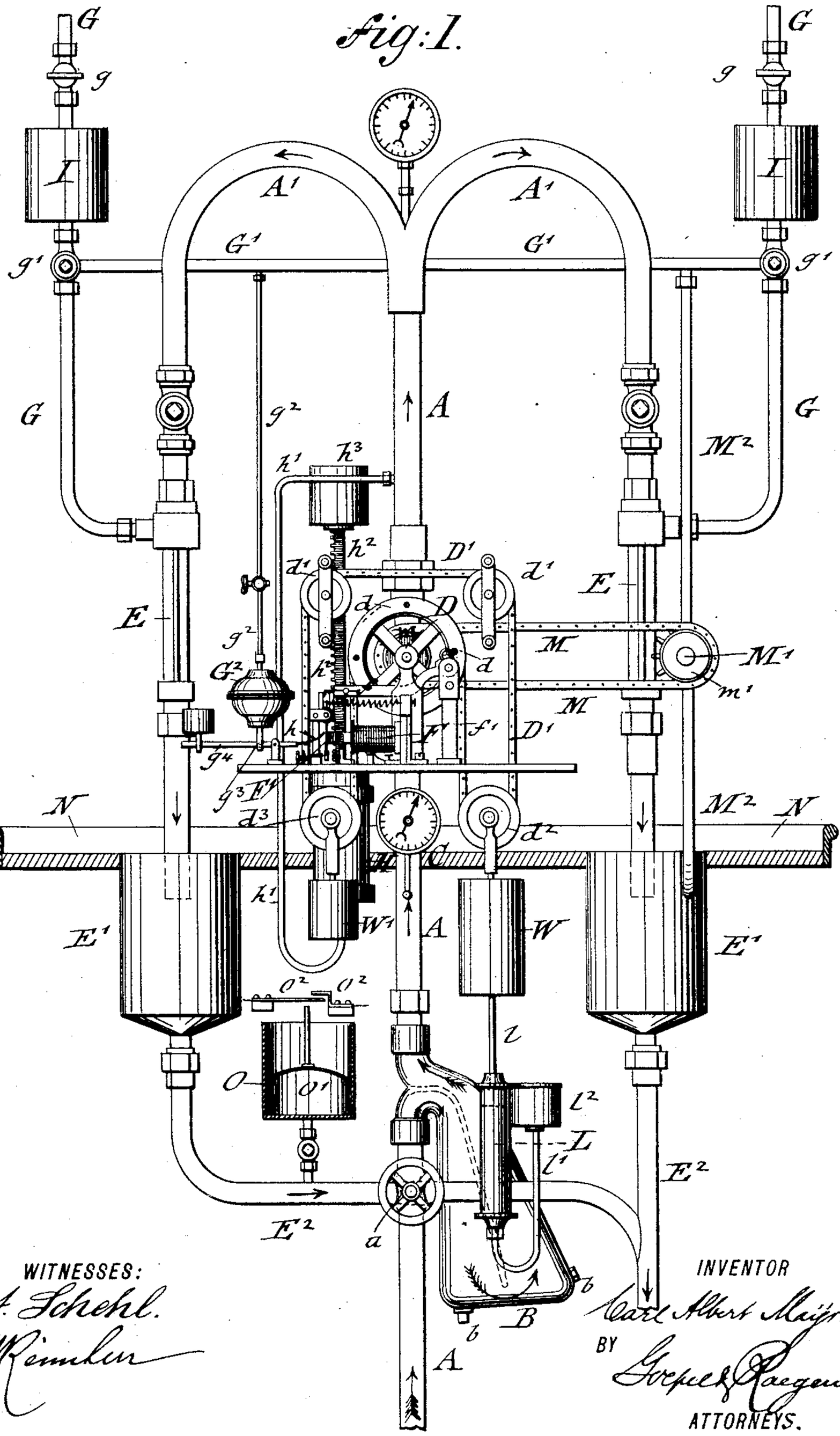
(No Model.) 2 Sheets—Sheet 1.

C. A. MAŸRHOFER.

ELECTRO PNEUMATIC CLOCK SYSTEM.

No. 427,781. Patented May 13, 1890.

Fig: 1.



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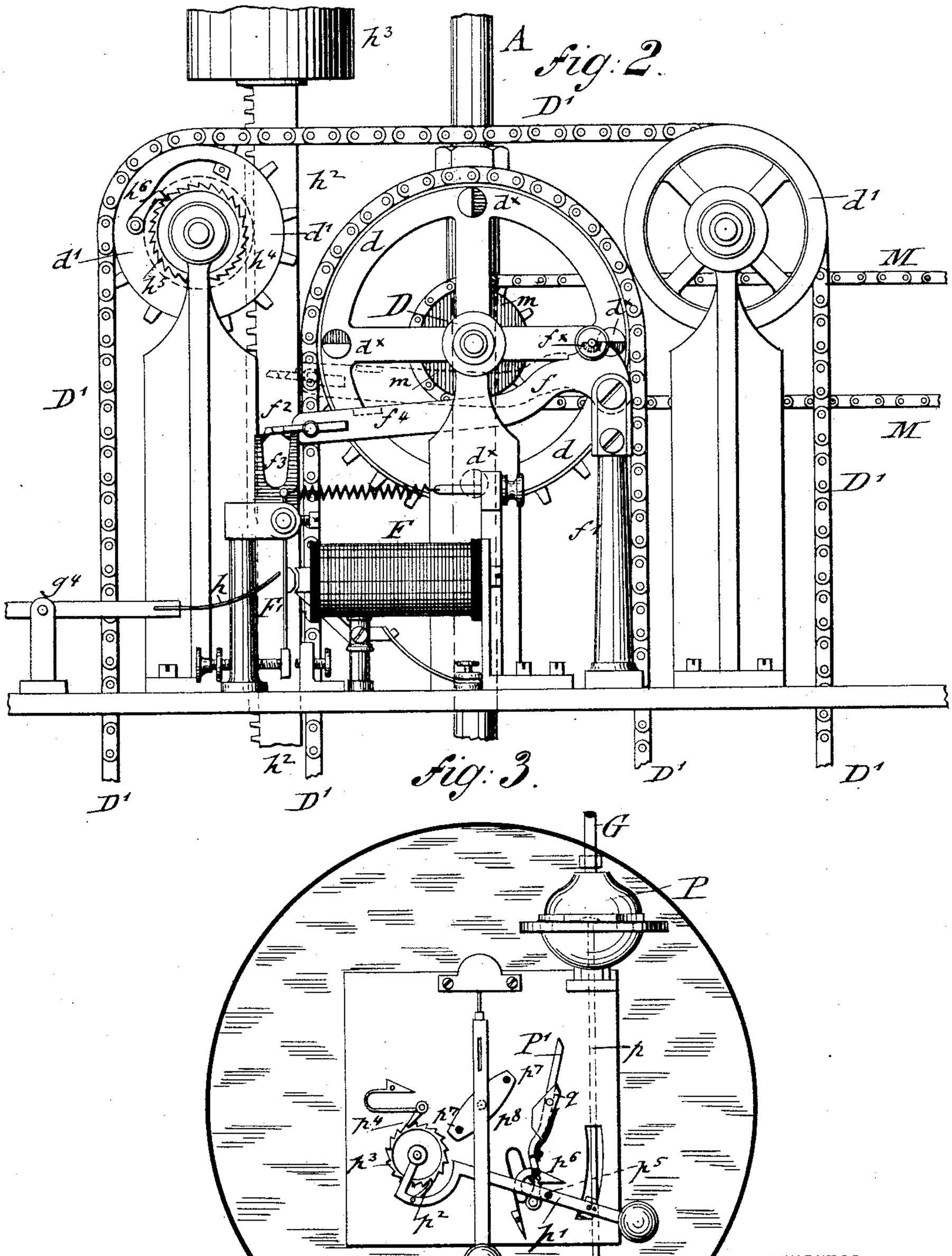

Fig. 2.

Fig. 3.

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UNITED STATES PATENT OFFICE.

CARL ALBERT MAŸRHOFER, OF BERLIN, GERMANY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE ELECTRO-PNEUMATIC TIME COMPANY, OF NEW YORK, N. Y.

ELECTRO-PNEUMATIC-CLOCK SYSTEM.

SPECIFICATION forming part of Letters Patent No. 427,781, dated May 13, 1890.

Application filed December 5, 1889. Serial No. 332,720. (No model.)

To all whom it may concern:

Be it known that I, CARL ALBERT MAŸRHOFER, of the city of Berlin, in the Kingdom of Prussia, Empire of Germany, a citizen of Austria-Hungary, have invented certain new and useful Improvements in Electro-Pneumatic-Clock Systems, of which the following is a specification.

In the Letters Patent No. 359,799, which were granted to me on March 22, 1887, for a hydro-pneumatic-clock system, I have described an apparatus by which a vacuum or partial vacuum is produced in a line-pipe or system of line-pipes through the medium of an ejector operated by water, steam, or other fluid, the vacuum being established at stated intervals of time for the purpose of acting on suitable mechanisms applied to a number of secondary clocks, which are thereby wound up and set.

The object of this invention is to simplify the apparatus described in said patent, so as to render the same less expensive, bring the parts thereof within a smaller compass, and render the operation of the same more reliable and effective; and the invention consists in the improved mechanism for producing the vacuum in a system of line-pipes by means of an injector, to which a suitable working-fluid is supplied by a main pipe, and a supply-cock that is opened and closed at regular intervals of time by means of a driving-gear and a suitable releasing mechanism for said driving-gear.

The invention consists, next, of the improved mechanism for producing and destroying the vacuum in a system of line-pipes by means of an ejector, to which the working-fluid is supplied by a main pipe, and a supply-cock operated by a driving-gear, released by suitable mechanism, said driving-gear also operating an air-valve connected with the vacuum line-pipe, so as to destroy the vacuum in the same when the evacuation is completed.

The invention consists, next, of certain additional details and combinations of parts, whereby the releasing mechanism is operated when the vacuum is established in the line-pipe and the driving mechanism rewound, as will be fully described hereinafter, and finally pointed out in the claims; and the invention consists, lastly, of certain improvements in the secondary clocks and the winding and hand-setting devices operated by my improved apparatus, so as to produce the reliable functioning of said secondary clocks.

In the accompanying drawings, Figure 1 represents a front elevation of the apparatus by which the vacuum is controlled in my improved electro-pneumatic-clock system. Fig. 2 is a front elevation of the main supply-cock and its operating mechanism, together with the releasing mechanism, drawn on a larger scale; and Fig. 3 is a rear elevation of one of the secondary clocks, showing the winding and hand-setting devices of the same.

Similar letters of reference indicate corresponding parts.

The vacuum-controlling apparatus receives its supply of water, steam, or other fluid through a main supply-pipe A, which is provided with a cock *a*, that is opened when the apparatus is to be set in operation. Above the cock *a* is arranged a sediment-trap B, which is provided with a central partition or diaphragm, around which the water passes for the purpose of depositing the sediments contained therein in the trap. The sediments are drawn off from time to time from the trap B by means of suitable openings closed by screw-plugs *b b*. Above the sediment-trap B is arranged in the main pipe a pressure-gage C, for indicating the pressure of the fluid in the main pipe A. The main pipe A is preferably connected by a branch pipe A′ with an ejector E, two branch pipes and ejectors being preferably arranged symmetrically one at each side of the main pipe A. Each ejector is connected with a line-pipe or system of line-pipes G, in which the vacuum is to be established, the lower ends of the ejectors terminating in receiving-vessels E′, which are connected to a waste-pipe E^2, through which the water or other liquid employed in establishing the vacuum in the line-pipes is conducted off. Any approved construction of ejector may be used.

In the main supply-pipe A is located, above the vacuum-gage C, a supply-cock D, to the spindle of which is keyed a sprocket-wheel d, over which is passed a drive-chain D′, that passes over fixed guide-pulleys d' and over pulleys d^2 d^3 of a drive-weight W and a balance-weight W′, by which latter the proper tension of the chain D′ is produced. The supply-cock D is prevented from being turned by the drive-weight W and chain D′ by means of four stop-pins $d^\times$ of the sprocket-wheel d, which abut against a stop $f^\times$ on a stop-lever f, that is pivoted to a fixed standard f'. The outer free end of the stop-lever f is provided with an adjustable tongue f^2, that rests on one of the pallets of the upwardly-extending fork of a fulcrumed armature-lever F′, which is operated by an electro-magnet F, that is supported below the stop-lever f. The electro-magnet F, the armature-lever F′, and its fork f^3, together with the stop-lever f and its stop-pin $f^\times$, constitute the releasing mechanism, by means of which the supply-cock D may be operated by the drive weight and chain at stated intervals of time—say once every hour—so as to open the supply-cock and cause the water to pass to the ejectors and produce a vacuum in the line-pipes or close the supply-cock and interrupt the working of the ejectors. To the armature-lever F′ is applied the usual tension-spring, while the motion of the armature-lever is confined by contact-stops, which engage the lower end of the same. The stop-pins $d^\times$ of the sprocket-wheel d are arrested by the stop $f^\times$ of the stop-lever f, so as to produce thereby the locking of the sprocket-wheel d and supply-cock D. This takes place when the armature-lever F′ is not attracted by the electro-magnet F, and the tongue f^2 of the stop-lever f is supported on the lower pallet of the fork f^3 of the armature-lever. The electro-magnet F is electrically connected with a standard clock provided with circuit-closing devices which are closed at stated intervals of time—say once every hour—and which then send a current over the line to the electro-magnet F, so as to attract the armature-lever F′ and produce the dropping of the stop-lever F. On the dropping of the stop-lever f the stop-pin $d^\times$, which abuts at the time against the stop $f^\times$, is released from the same, so that the sprocket-wheel d and the supply-cock D are free to be turned by the drive weight and chain for a quarter-rotation, so as to open the supply-cock D and permit the water to pass to the ejectors E. The stop-lever f is further provided at its inner side next adjoining the sprocket-wheel d with a shoulder f^4, which shoulder is engaged by one of the stop-pins $d^\times$ as the same passes upwardly by the rotating action of the sprocket-wheel d, so that the lever is lifted thereby high enough to permit the passage of the stop-pin $d^\times$ past the shoulder f^4, as shown in dotted lines in Fig. 2, whereby the stop-lever f is dropped and its tongue f^2 returned to its former position on the lower pallets of the armature-fork f^3. At the same time the stop $f^\times$ of the stop-lever f is returned into the path of the next stop-pin $d^\times$ on the sprocket-wheel d, so as to arrest the motion of the latter and hold the supply-cock D in open position. In case, for some reason or other, the armature-lever F should not be released from the electro-magnet the higher pallet of the fork f^3 serves for arresting the stop-lever f when its shoulder f^4 is released by the lifting stop-pin $d^\times$, said pallet supporting the stop-lever f until the armature-lever F′ is released and its fork f^3 moved back into its normal position, by which motion the lower pallet passes under the tongue of the stop-lever f and supports the latter thereby in its normal position of rest, as shown in Fig. 2.

In the vacuum line-pipes G, that extend from the ejectors E E, are interposed closed vessels I, from which the air is first exhausted by the action of the ejectors. These vessels serve for preventing the drawing up of the water into the line-pipes in case the air-valve by which the vacuum is destroyed should not be opened at the proper time. They prevent thereby the water from passing into the vacuum line-pipes so as to do damage. Above the vessels I I are arranged stop-cocks g, for shutting off one or both lines of vacuum-pipes, while below the same are arranged three-way cocks g', by which the connection between the vacuum line-pipes G and a transverse connecting-pipe G′ may be established or interrupted. From the transverse pipe G′ a pipe g^2 leads in downward direction to a casing G^2, in which a flexible diaphragm is arranged, the spindle g^3 of which is connected to a fulcrumed and weighted lever g^4, located near the armature-lever of the electro-magnet F. This fulcrumed lever is provided at the end next to the armature-lever F′ with a spring-tongue h, which extends toward said armature-lever. As soon as the required degree of vacuum is established in the vacuum line-pipes and in the diaphragm-casing G^2 the weighted lever g^4 is lifted by the diaphragm-spindle g^3 and the spring-tongue h pressed against the armature-lever F′, which is thereby oscillated, so that the pallet or its fork f^3 drops the stop-lever f, causing thereby the release of the sprocket-wheel d and, by the action of the drive chain and weight, the turning of the stop-cock D for another quarter-rotation, whereby the stop-cock D is closed and the supply of water shut off. By the turning of the sprocket-wheel d the stop-pin $d^\times$ of the same, which is at that time at the lower part of the sprocket-wheel, returns the stop-lever f into its normal position of rest on the fork f^3, so as to be ready to arrest the sprocket-wheel and lock the supply-cock in closed position when arriving at the end of its quarter-rotation.

From a point in the main pipe A above the supply-cock D extends a small pipe h' in downward direction and terminates in the

bottom of a cylinder H, in which a piston is arranged, to which a toothed piston-rod h^2 is applied, which latter carries a weight h^3 at its upper end. As soon as the supply-cock D is opened and water supplied to the ejector E the same enters also through the pipe h into the lower part of the cylinder H, and causes thereby the lifting of the weighted and toothed piston-rod h^2. The piston-rod h^2 meshes with a loose pinion h^4 on the shaft of one of the guide and sprocket wheels d' of the drive-chain, said pinion being connected by a ratchet-wheel h^5 and pawl h^6 with said guide and sprocket wheel d', so as to turn the latter and produce thereby the rewinding on the drive-weight. As soon as the supply of water is interrupted the weight of the piston-rod h^2 causes the piston to descend, so as to force the water from the cylinder H back into the main pipe A into the space above the stop-cock D. Below the drive-weight W is arranged a brake-cylinder L, which is filled with a suitable liquid and provided with a piston, the piston-rod l of which forms contact with the bottom of the drive-weight W. The lower end of the brake-cylinder L is connected by a curved pipe l' with an open cylindrical vessel l^2. The cylinder L, its piston, and the vessel l^2 serve as a hydraulic brake for the drive-weight W, so as to cause it to move slowly in downward direction and produce thereby the even motion of the drive-chain D' and the slow opening of the stop-cock D. The rewinding of the drive-weight W produces, by the pressure of the liquid in the vessel l^2 on the piston, the lifting of the latter, so that its piston-rod l follows the upward motion of the weight W, returning thereby the parts of the brake device into normal position, so as to be ready to act again as soon as the drive-weight is again called into action.

As soon as the vacuum has been established in the line-pipes G, connected with the secondary clocks, the supply-cock D is moved into closed position by the action of the pneumatically-operated lever g^4, spring-tongue h, armature-lever F', and the stop-lever, as before described. Simultaneously with shutting off the supply of water it is necessary to destroy the vacuum in the line-pipes G, which is accomplished by a second chain M, which passes over a second smaller sprocket-wheel m on the spindle of the supply-cock D and over a sprocket-wheel m' on the spindle of an air-valve M', located in an air-pipe M^2, which extends in downward direction from the transverse pipe G', as shown in Fig. 1. As soon as the supply-cock D is closed the sprocket-wheels m m' and chain M open the air-valve M', so as to destroy the vacuum in the line-pipes G, and vice versa. As soon as the supply-cock D is opened air-valve M' is closed, and thereby the entrance of air into the air-pipe M^2 prevented. The air-pipe M^2, which, with the air-valve M', serves for destroying the vacuum in the line-pipes, terminates in one of the receiving-vessels E', so as to conduct any water which perchance should pass into the transverse connecting-pipe G' to the vessel E' without causing it to do any damage or interrupt the working of the vacuum-controlling apparatus. A collecting-tray N, having openings for the receiving-vessels E', is preferably arranged above said vessels and extended across the whole width of the vacuum-controlling apparatus, so as to conduct any leakage from the supply-cock, ejectors, or other parts to the receiving-vessels and waste-pipe. A safety device, which is composed of a cylindrical vessel O, that is connected with one of the waste-pipes E^2 and a float O' in said vessel, serves to close by the upwardly-extending spindle of the float two contact-springs O^2 when the float is lifted. The contact-springs O^2 are located in a circuit with the electro-magnet F^2 and a suitable alarm device. In case of an overflow or irregular working of the apparatus the float is raised and the circuit closed by the contact-springs just described, whereby the armature of the electro-magnet F is attracted and the supply-cock D closed, so that the supply of water is shut off, while the alarm device calls attention to the fact that the apparatus is not in proper working order.

To the system of vacuum line-pipes are connected by branch pipes a number of secondary clocks, each clock being provided with a casing P, the diaphragm of which is connected to a spindle p, that is pivoted to a weighted lever p'. This lever is applied at its opposite end loosely to the arbor of the mainspring of the clock. The lever p' is provided with a pawl p^2, that engages a ratchet-wheel p^3, keyed to the arbor of the mainspring of the clock, while a check-pawl p^4 prevents the turning of the ratchet-wheel when the lever p' and the pawl p^2 are returned into their lower normal position. The lever p' is provided with a pin p^5, which lifts a weighted pawl p^6, that is pivoted to a pivoted and spring-actuated hand-setting lever P', so as to move thereby said lever toward the arbor of the hour-hand whenever the lever p' is lifted by the spindle p. The upper end of the hand-setting lever P' strikes against one of the pins p^7 on a double-crank arm p^8, which is keyed to the arbor of the hour-hand, and which by the action of the lever P' sets the hands to twelve. To the upper end of the hand-setting lever P' is pivoted a triangular spring-pressed cheek q, which secures the proper engagement of the crank-pins p^7, the obtuse-angled part of which projects beyond the lever P' and serves to engage one of the pins on the double crank p^8, whatever be the position of the crank-arm p^8, so as to prevent the locking of the crank-arm and hand-setting lever P' in case the crank-arm is at a nearly horizontal position. The cheek q acts, therefore, in the nature of a guard, so as to cause the proper action of the lever P', even if the double crank p^8 should be in a position at right angles thereto. Simultaneously with the hand-set-

ting action, caused by the lever P′, the main-spring of the clock is wound up by the action of the lever p' on the pawl p^2 and ratchet-wheel p^3. As soon as the vacuum is interrupted by the admission of air into the line-pipes the diaphragm in the casing P returns to its normal position, together with the operating-lever p', which return motion is assisted by the weight at the outer end of the lever p'.

The operation of my improved vacuum-controlling apparatus for electro-pneumatic-clock systems is as follows: Whenever the circuit-closing devices of the standard clock are closed, a current of electricity is sent to the electro-magnet F, by which the armature-lever F′ is attracted and the stop-lever f dropped, so as to move its stop $f^\times$ out of the path of the stop-pins $d^\times$ of the sprocket-wheel d, and produce thereby by the action of the drive-weight W the opening of the supply-cock D. The water or other liquid by which the vacuum is produced is then permitted to pass through the main pipe A to the ejectors E, which evacuate the air in the system of line-pipes and in the diaphragm-casings of the secondary clocks connected with the line-pipes. By the action of the vacuum all the clocks in the system are wound up and their hands set, which takes place once every hour. While the water is supplied to the ejectors E the drive-weight W is rewound again by the action of the water on the weighted piston-rod h^2, which engages the sprocket and guide wheel d' of the drive-chain D′. During the rewinding of the drive-weight the sprocket-wheels on the spindle of the supply-cock D turn loosely on the spindle in the same manner as the sprocket-wheel d on its spindle, so that no turning action is exerted on the supply-cock D′ or the air-valve M′ during the rewinding of the drive-weight. As soon as the hand setting and winding of the secondary clocks is accomplished by the evacuation of the line-pipes the releasing mechanism is again operated by the diaphragm located in the casing G^2, which operates the lever g^4, and thereby the armature-lever is oscillated by the spring-tongue of the latter, so that the lever f is dropped again and the supply-cock D closed by the action of the drive-weight. Simultaneously therewith the air-valve is opened and the vacuum in the system of line-pipes destroyed, which permits the actuating parts of the vacuum-controlling apparatus as well as of the secondary clocks to return to their normal positions ready for the next operation.

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 main pipe, a supply-cock interposed in said main pipe, an ejector connected with the main pipe, a vacuum line-pipe connected with the ejector, an air-valve connected with the vacuum line-pipe, driving mechanism applied to the spindle of the supply-cock and adapted to operate the supply-cock and air-valve, and a releasing mechanism connected with the supply-cock and operated at suitable intervals for opening and closing the supply-cock and air-valve, substantially as set forth.

2. In an electro-pneumatic-clock system, the combination of a main pipe, a supply-cock in said main pipe, an ejector connected with said main pipe, a vacuum line-pipe connected with said ejector, an air-valve connected with the vacuum line-pipe, and a closed vessel interposed in said line-pipe for preventing the drawing up of the working-fluid into the line-pipe in case the air-valve is not opened at the proper time, substantially as set forth.

3. In an electro-pneumatic-clock system, the combination of a main pipe, a supply-cock in said main pipe, an ejector connected with said main pipe, a vacuum line-pipe connected with the ejector, an air-valve connected with said line-pipe, driving mechanism for operating the supply-cock and air-valve, a releasing mechanism for said driving mechanism, and a pneumatically-actuated lever adapted to operate the releasing mechanism, so as to produce the closing of the supply-cock and the opening of the air-valve, substantially as set forth.

4. In an electro-pneumatic-clock system, the combination of a main pipe, a supply-cock interposed in the same, an ejector connected with said main pipe, a vacuum line-pipe, an air-valve connected with said vacuum-pipe, a driving mechanism for operating the supply-cock and air-valve, a releasing mechanism for controlling the operation of said driving mechanism, and a winding-up mechanism operated by the action of the operating-fluid, so as to rewind the driving mechanism after each opening of the supply-cock, substantially as set forth.

5. In an electro-pneumatic-clock system, the combination of a main pipe for supplying the working-fluid, a supply-cock in said main pipe, an ejector connected with said main pipe, a vacuum line-pipe connected with said ejector, an air-valve connected with said line-pipe, a driving mechanism for operating the supply-cock, a stop-lever for said driving mechanism, and an electro-magnet and its armature adapted to engage or release said stop-lever, so as to produce the opening or closing of the supply-cock and air-valve, substantially as set forth.

6. In an electro-pneumatic-clock system, the combination of a main pipe, a supply-cock interposed in the same, an ejector connected with said main pipe, a vacuum line-pipe connected with the ejector, an air-valve connected with the vacuum line-pipe, a driving mechanism for operating the supply-cock and air-valve, a stop-lever for said driving mechanism, an electro-magnet, an armature adapted for engaging or releasing said stop-lever, and a pneumatically operated and

weighted lever having a spring-tongue adapted to engage said armature, substantially as set forth.

7. In an electro-pneumatic-clock system, the combination of a vacuum line-pipe, a secondary clock, a pivoted and weighted lever connected to a diaphragm operated by the action of the vacuum in said line-pipe, a pawl on said lever, a ratchet-wheel on the arbor of the mainspring, a pivoted hand-setting lever engaged by a pin on the weighted lever, a triangular and spring-pressed cheek pivoted to the hand-setting lever, and a double crank on the arbor of the hour-hand, said crank having pins at its ends, substantially as set forth.

8. The combination of a secondary clock, a pivoted and weighted lever connected to a diaphragm operated by the action of a vacuum on the same, a hand-setting lever pivoted to the clock and engaged by a pin on the weighted lever, a triangular and spring-pressed guard-cheek pivoted to the hand-setting lever, and a double crank on the arbor of the hour-hand, said crank having a pin at each end, and being adapted to be set by said guard-cheek whatever be the position of the crank toward the hand-setting lever, substantially as set forth.

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

CARL ALBERT MAYRHOFER.

Witnesses:
MAX FRICK,
MONE KÖHLER.