B. HOLLY.

APPARATUS FOR UTILIZING STEAM IN HEATING, &c.

No. 193,086. Patented July 17, 1877.

Fig. 1

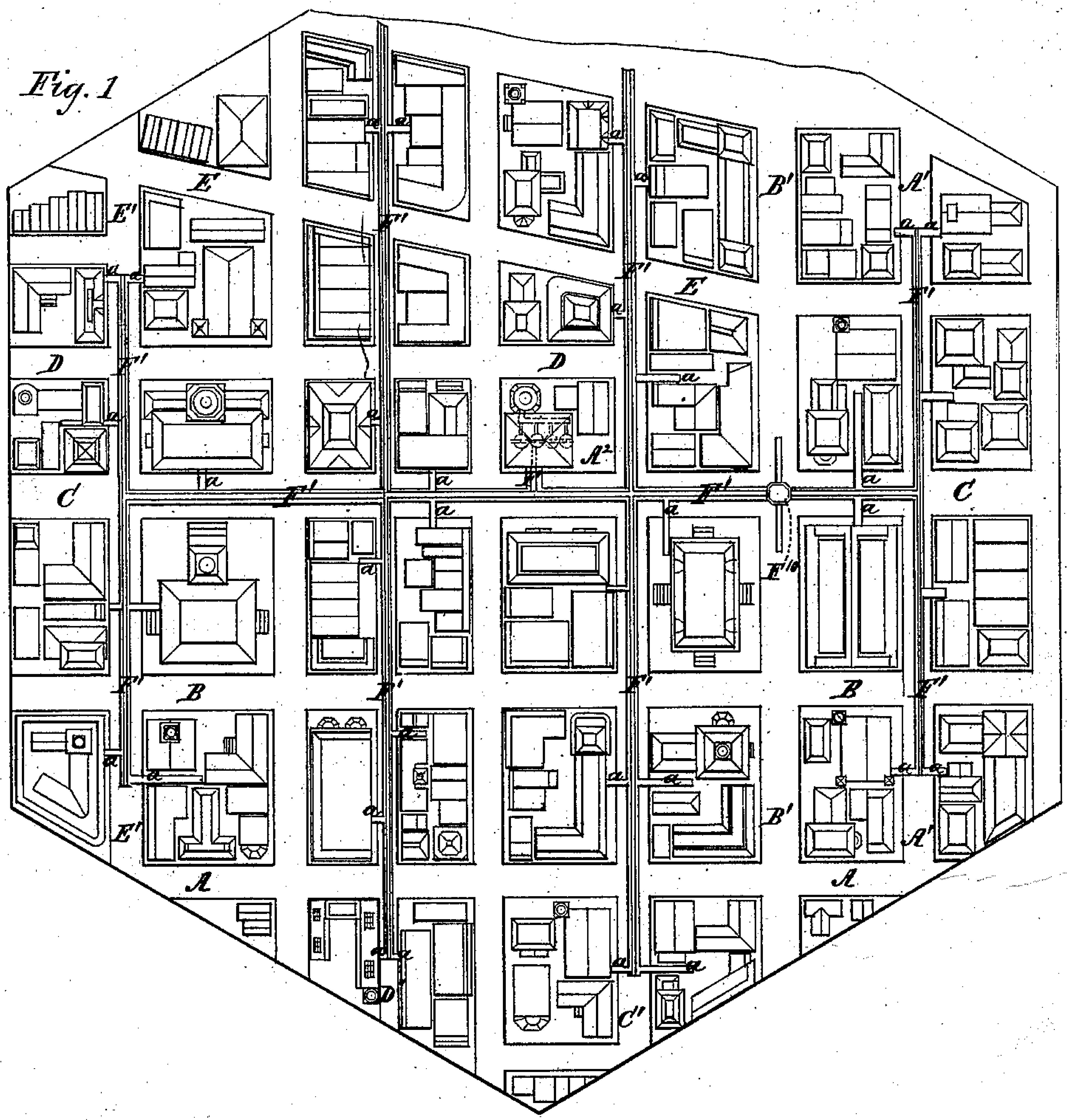
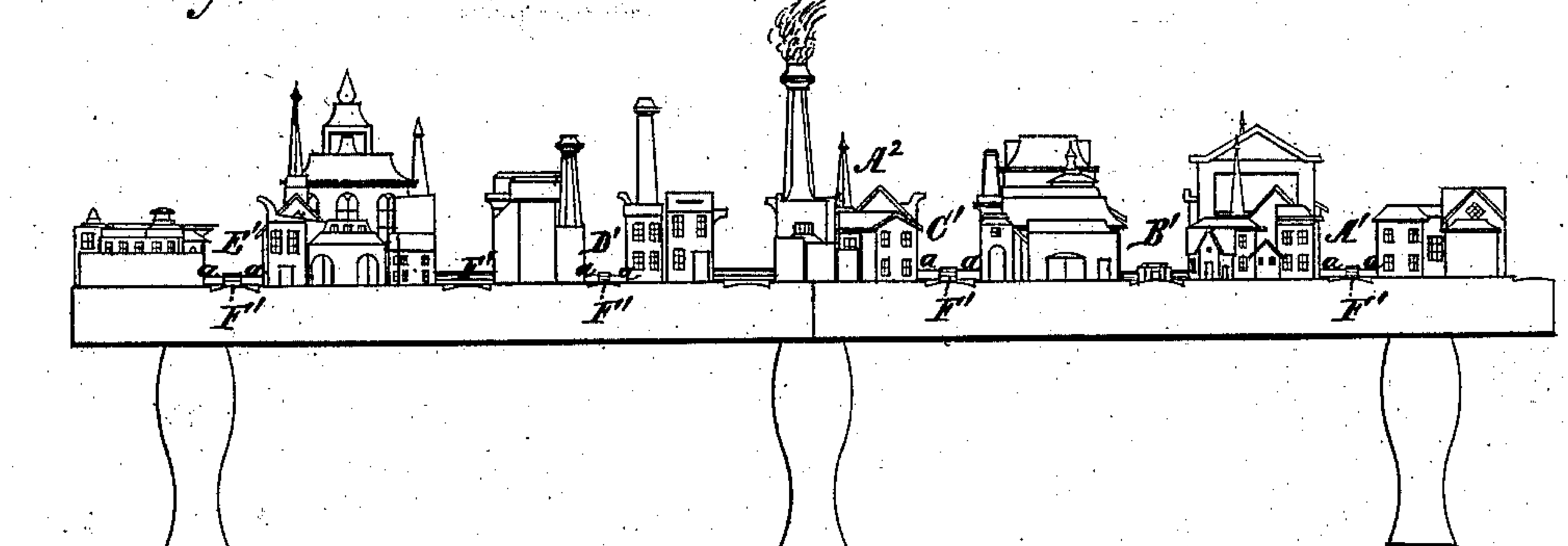


Fig. 2



Witnesses.
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Fig. 3

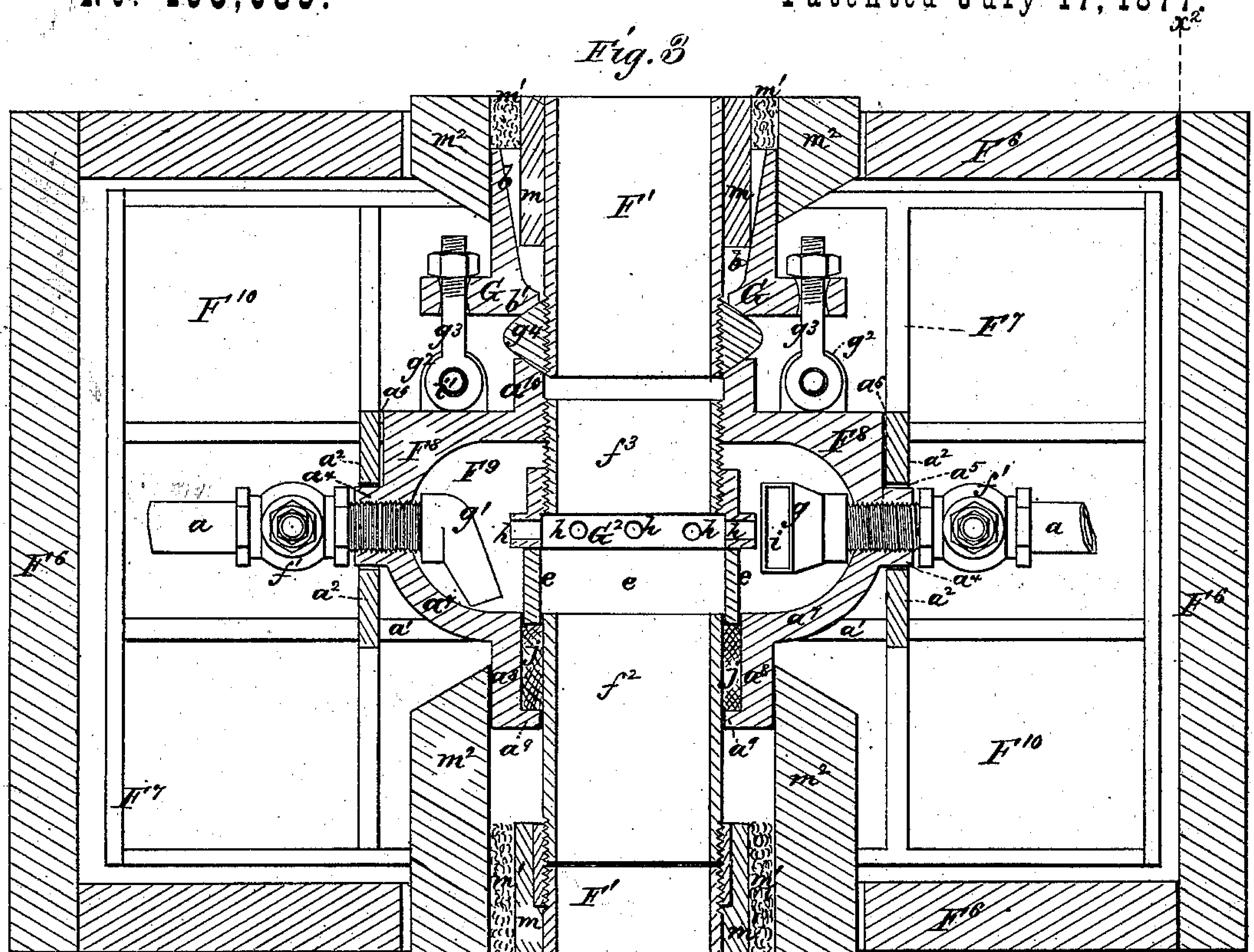
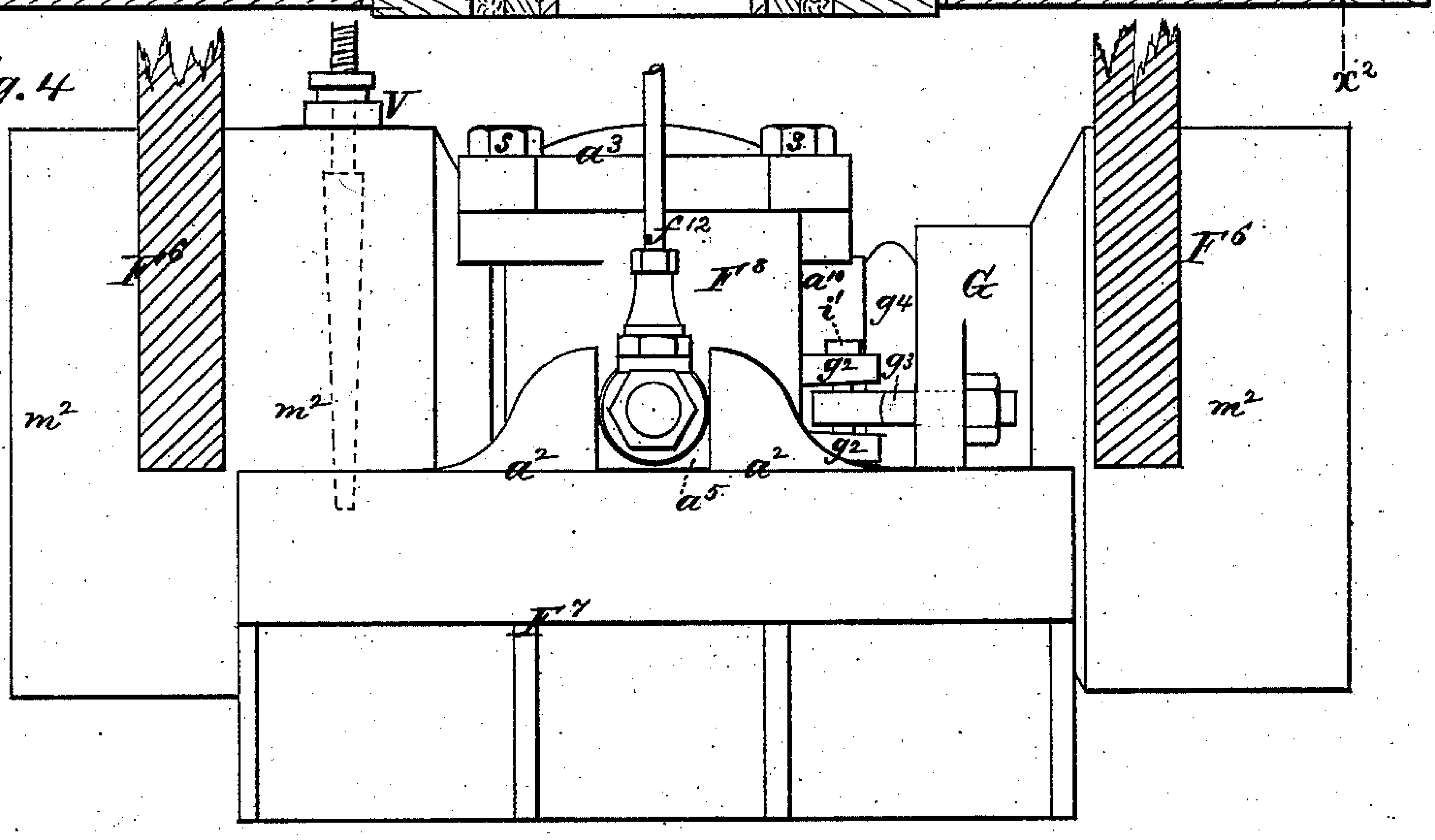


Fig. 4



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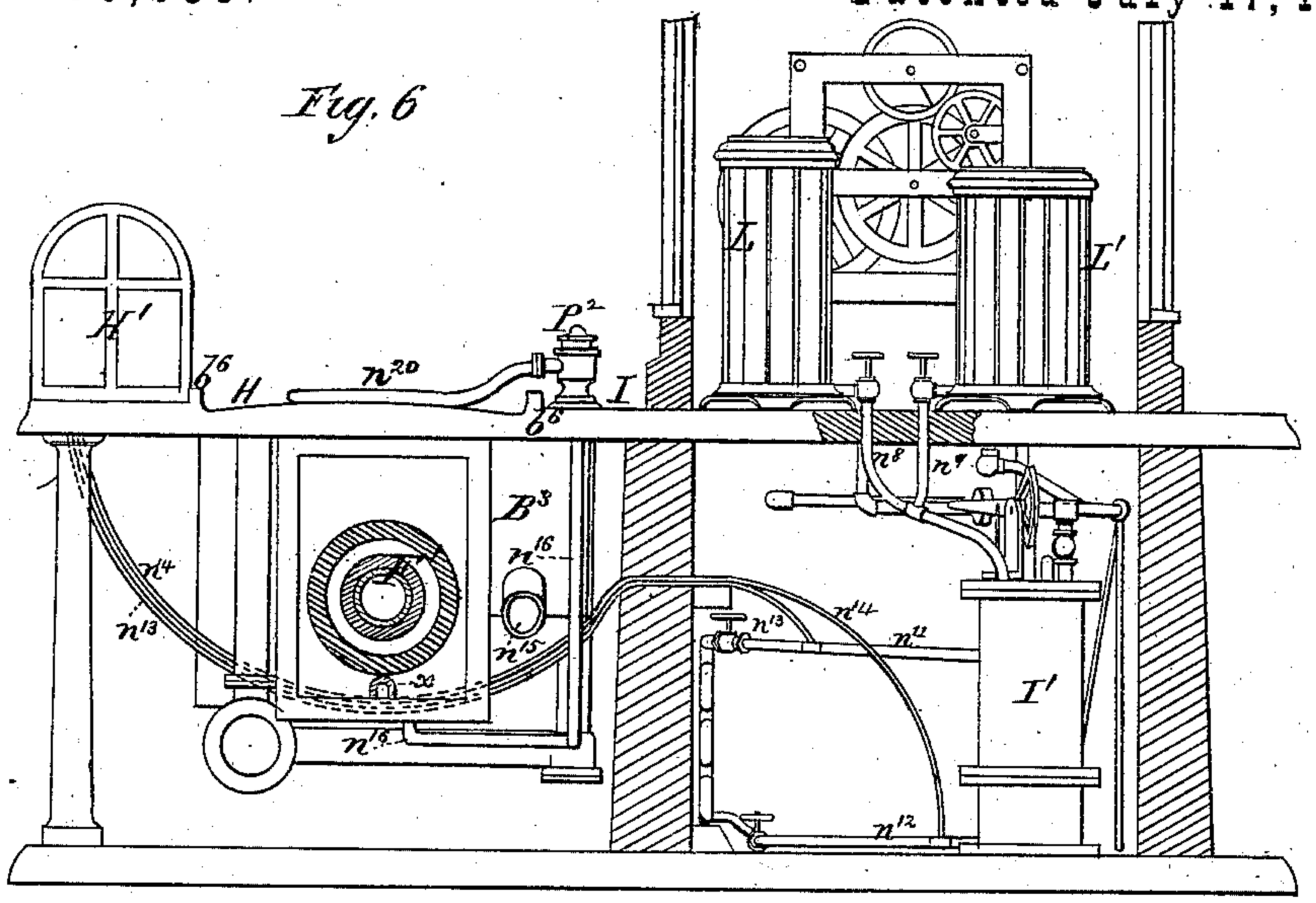

Fig. 6

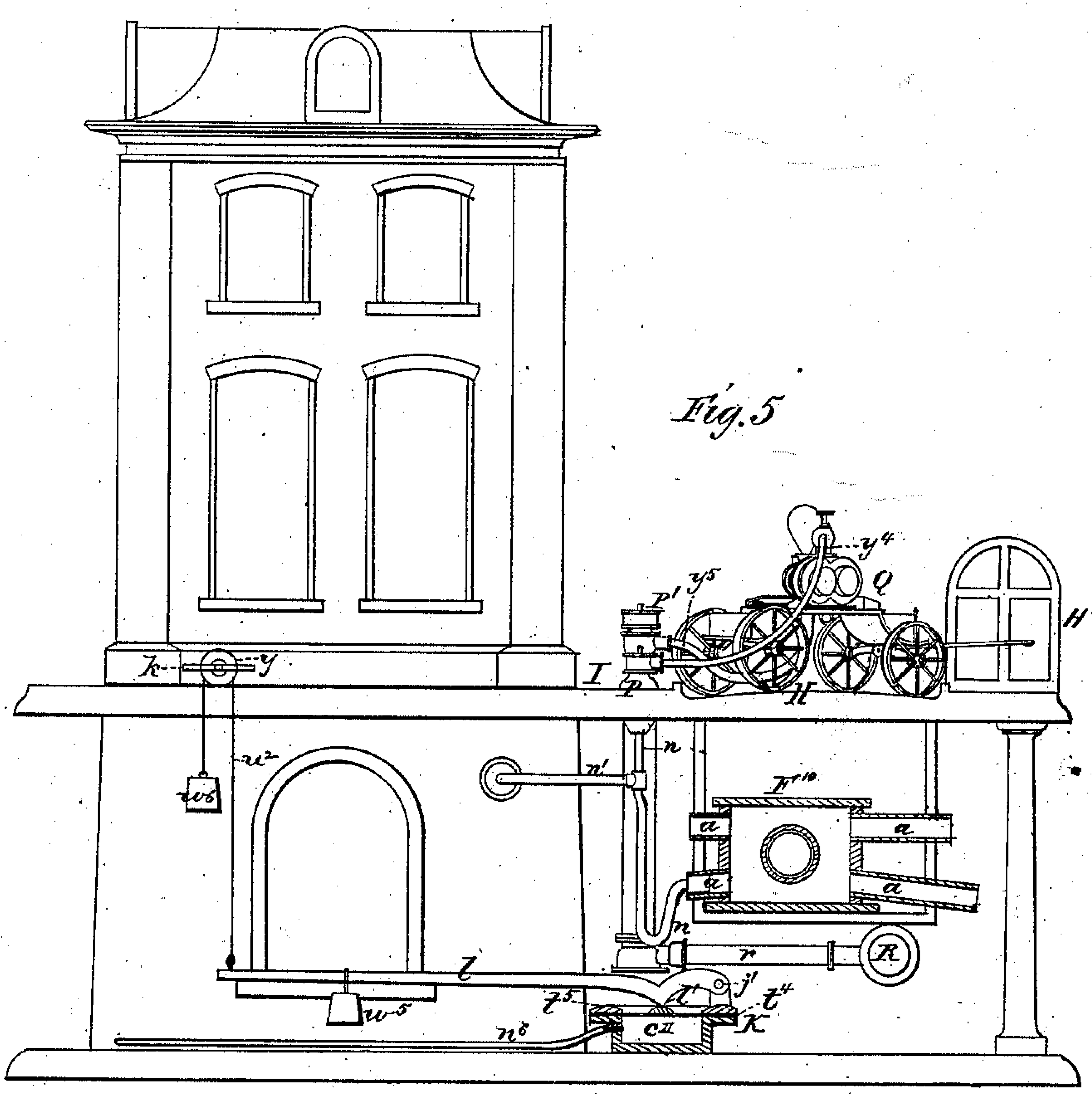

Fig. 5

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Fig. 8

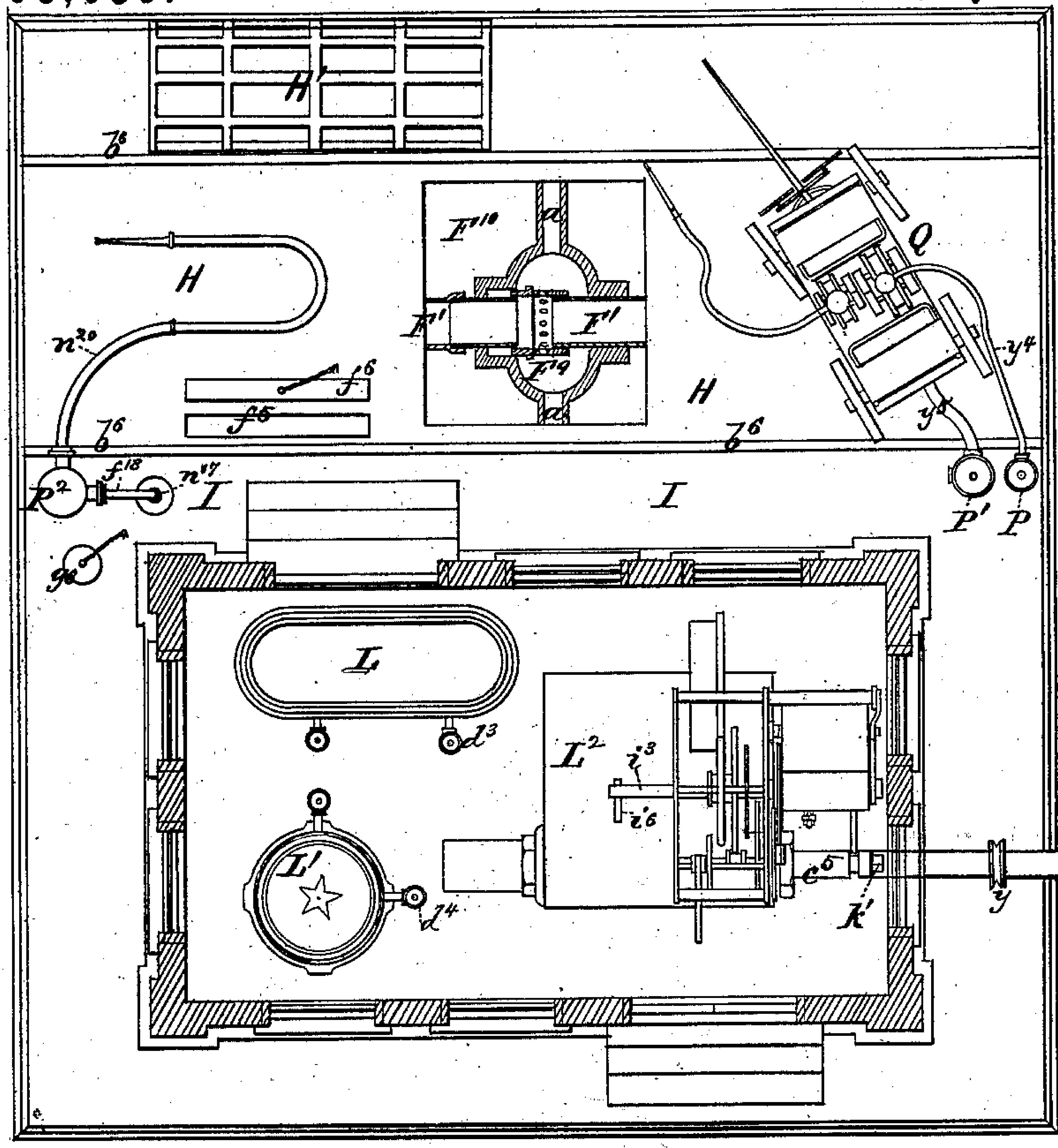

Fig. 7

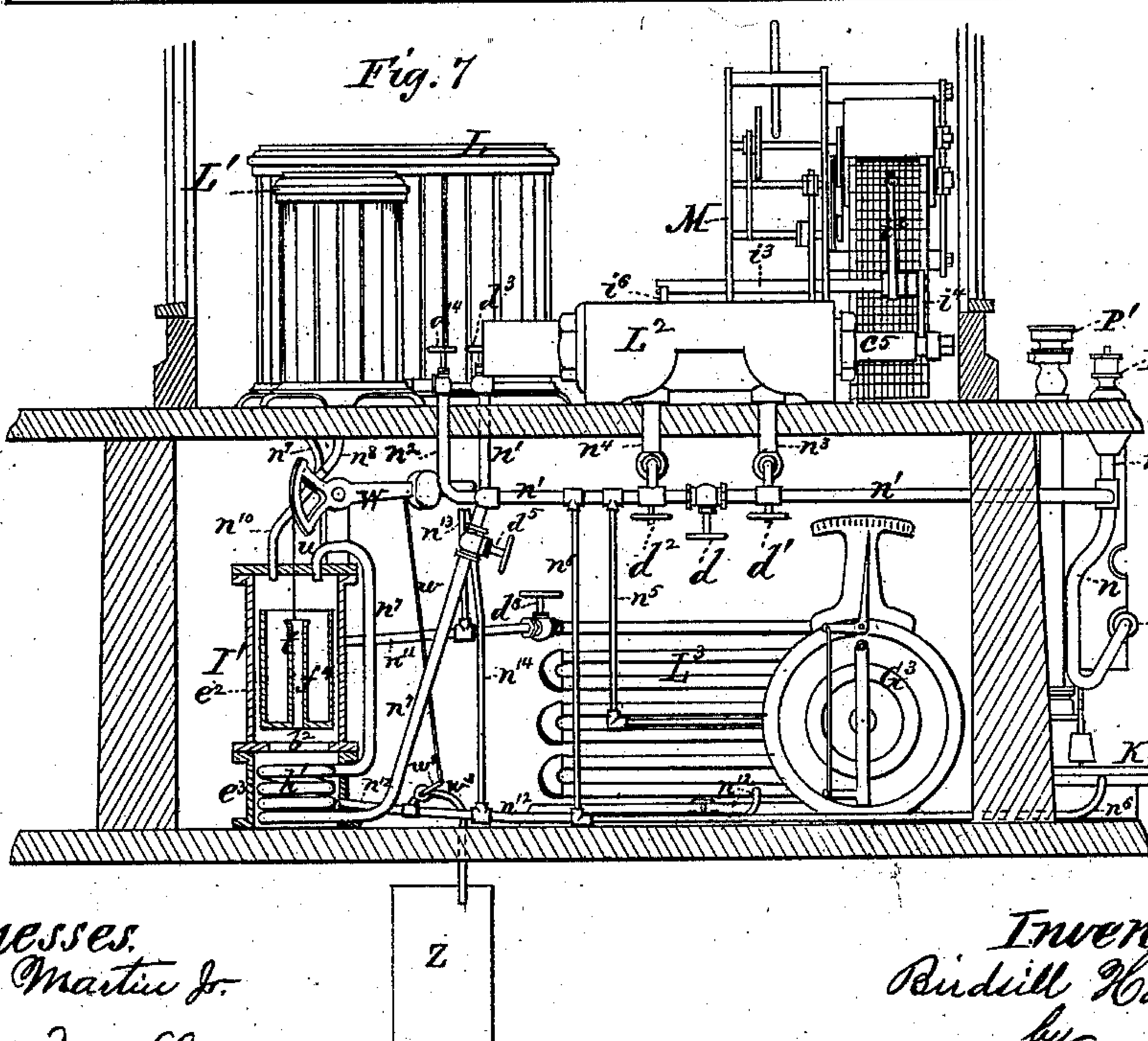

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Fig. 11

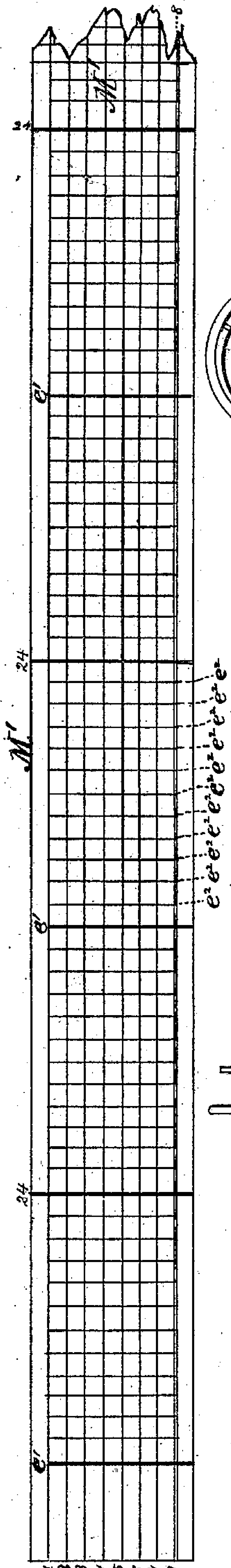

Fig. 10

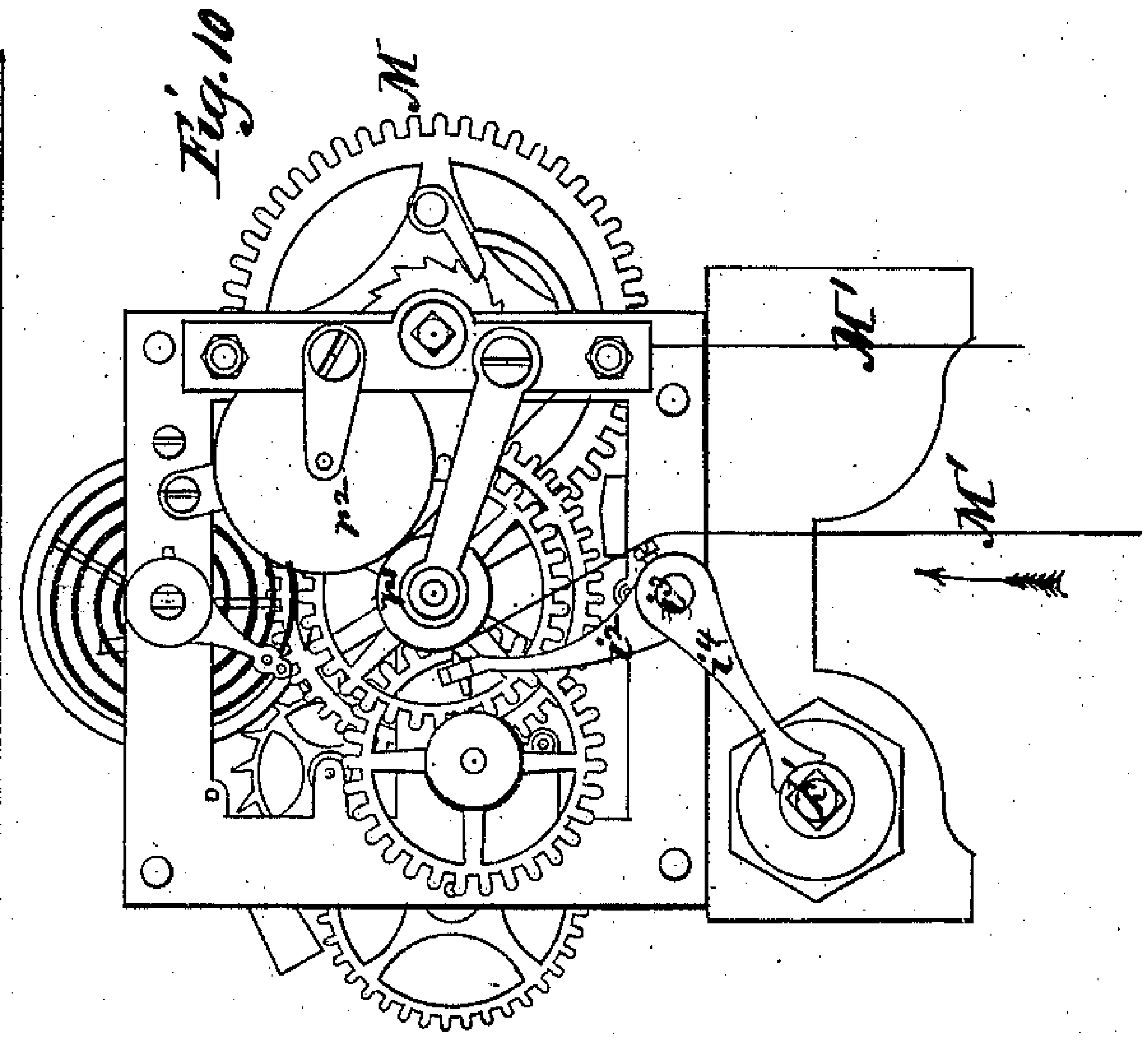

Fig. 9

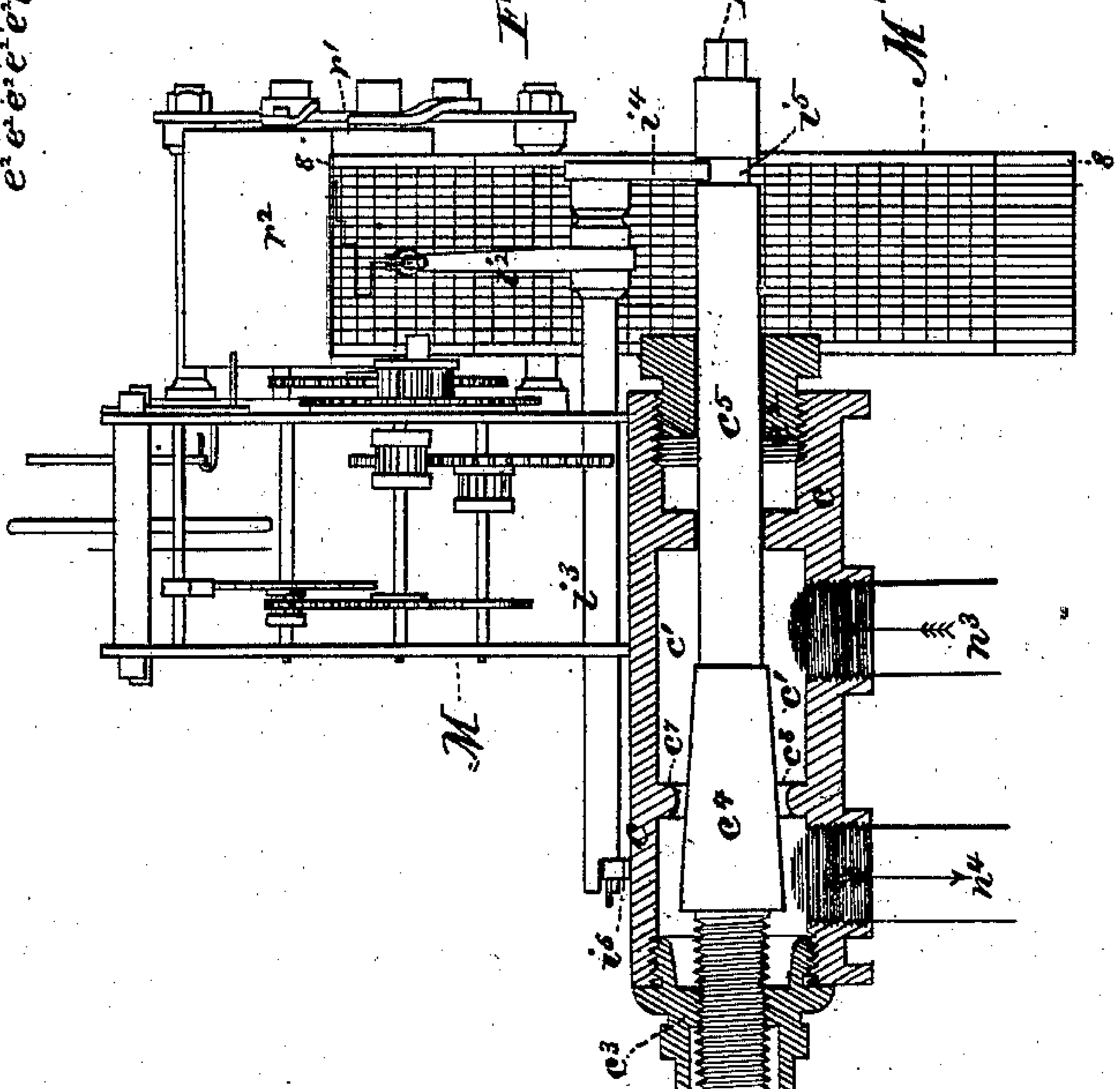

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Fig. 14

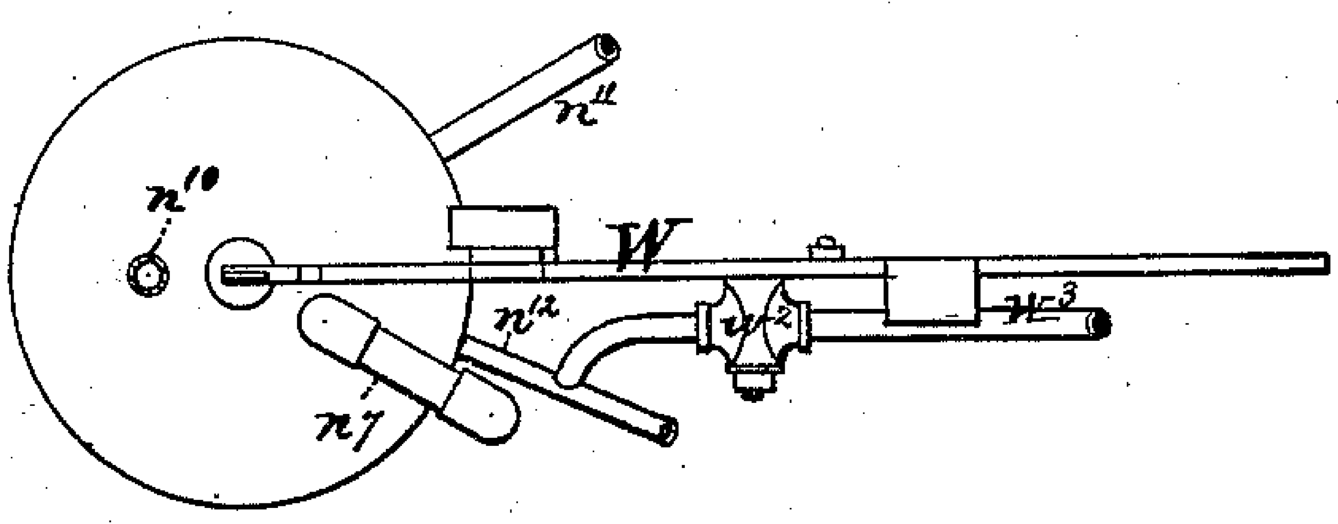

Fig. 12

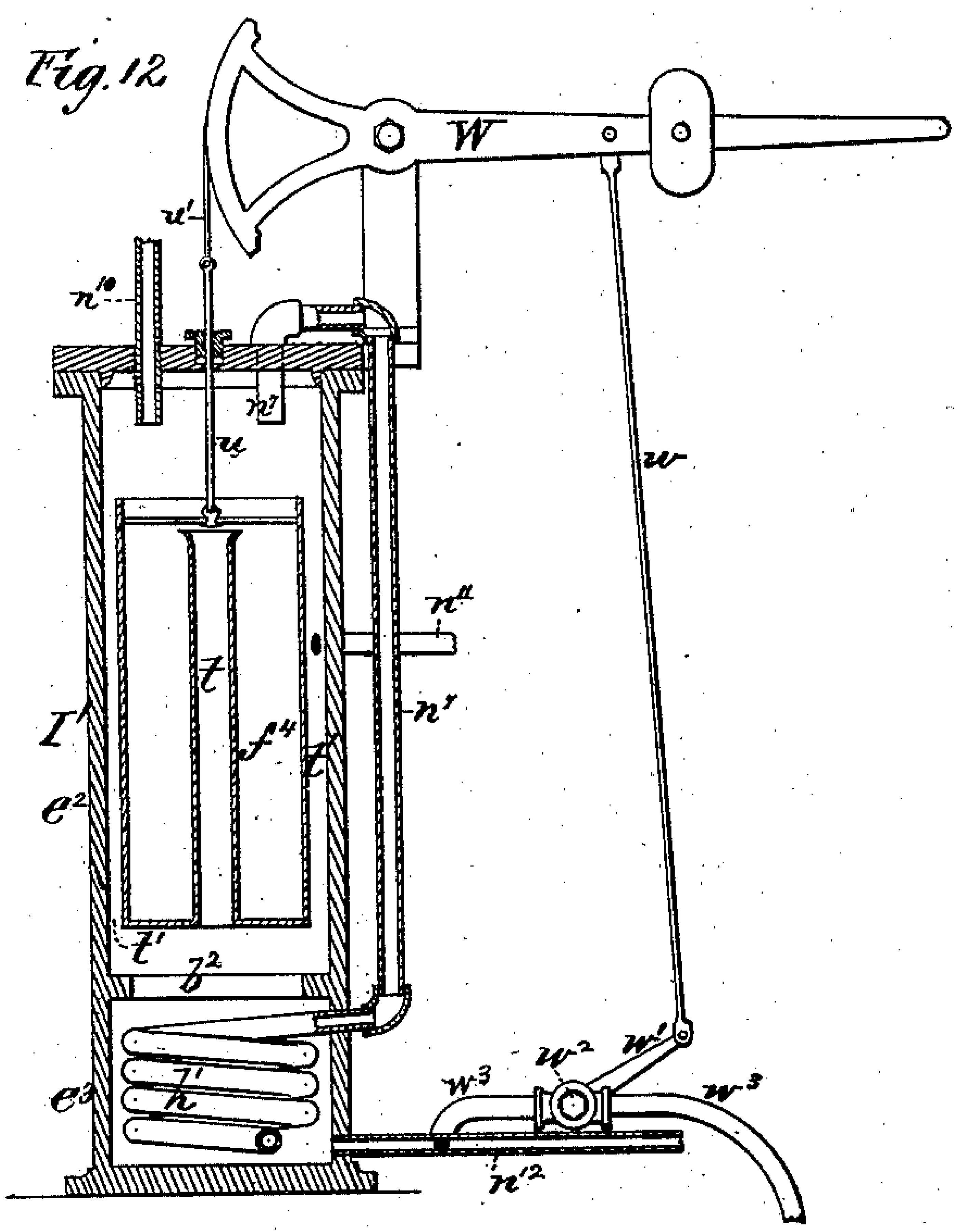

Fig. 13

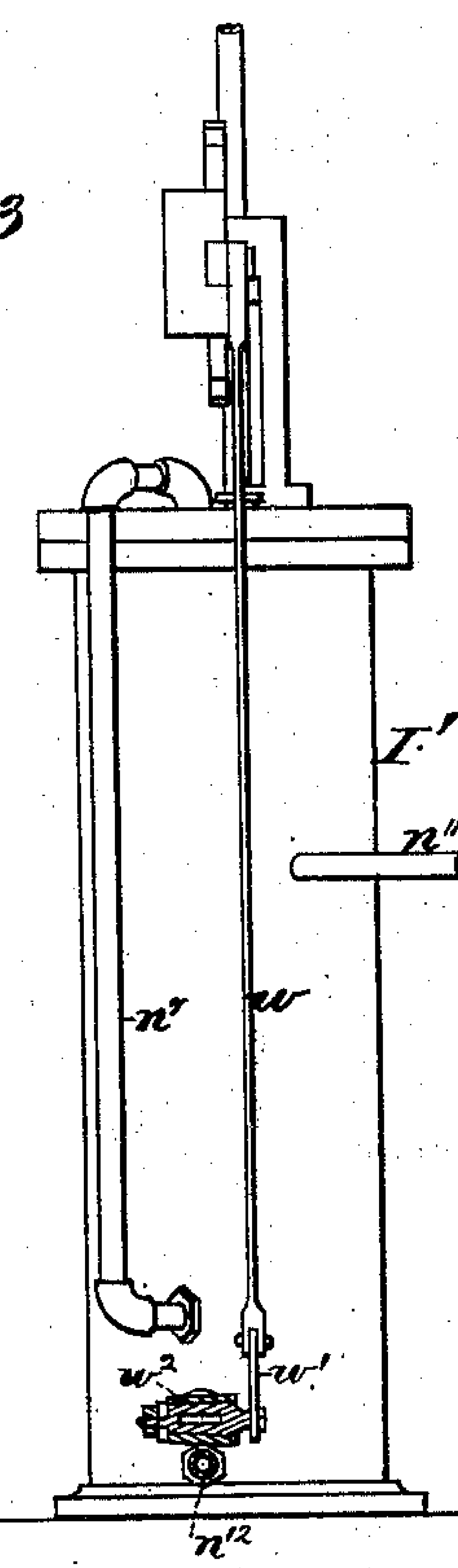

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Fig. 15

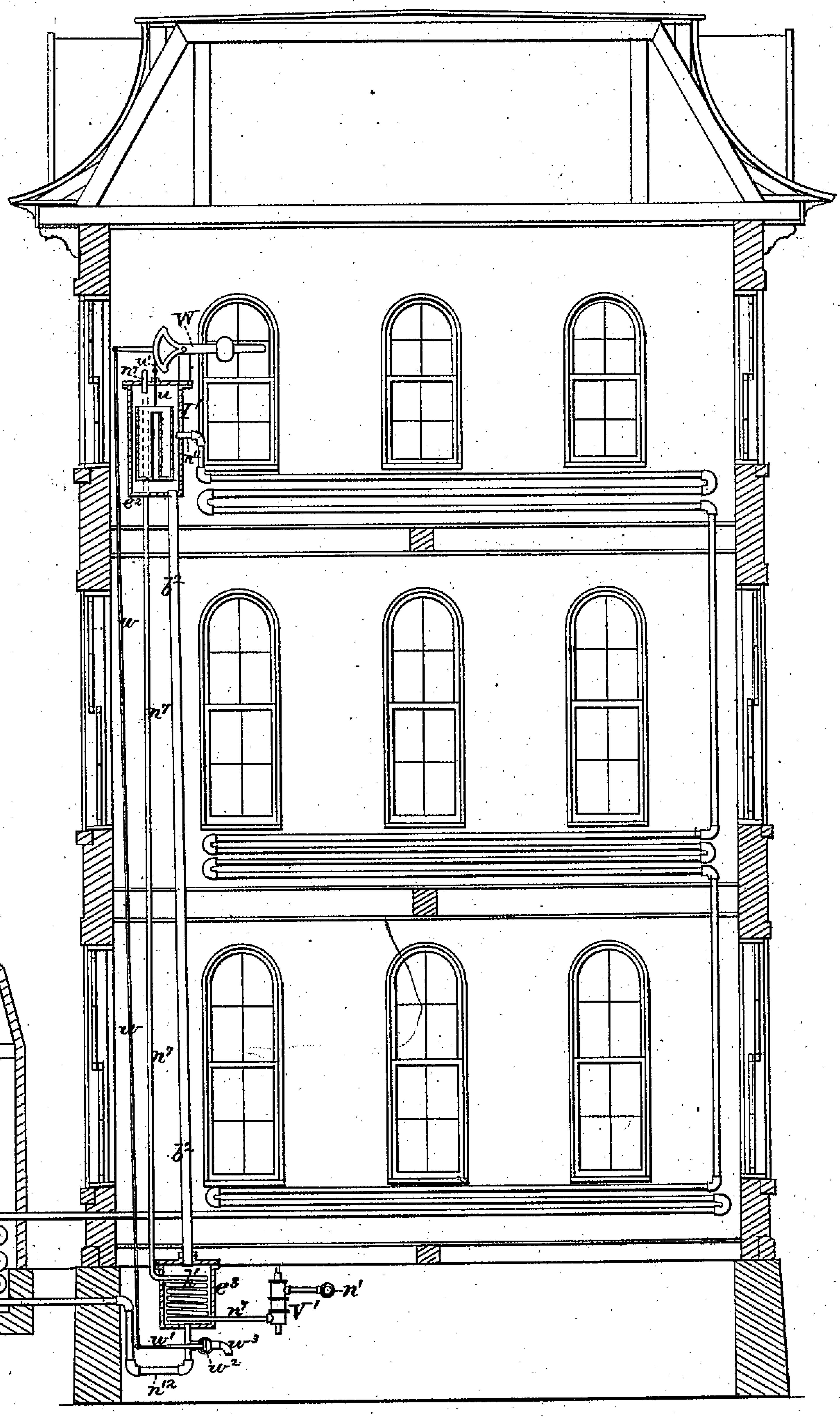

Fig. 16

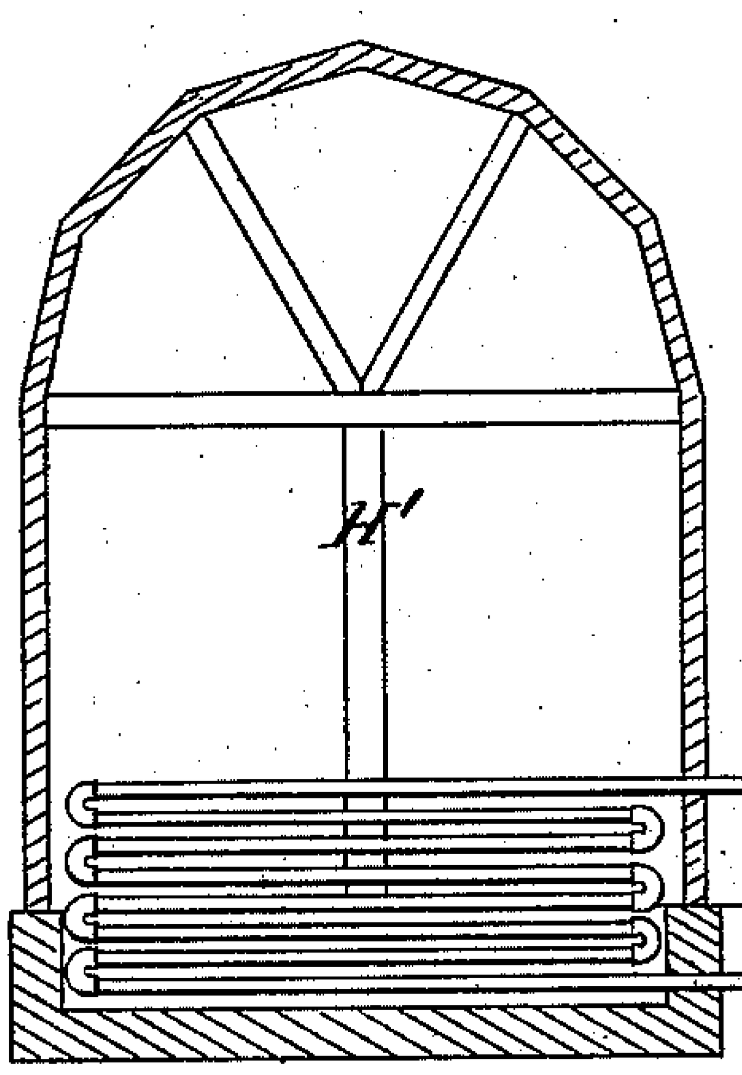

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Fig. 18

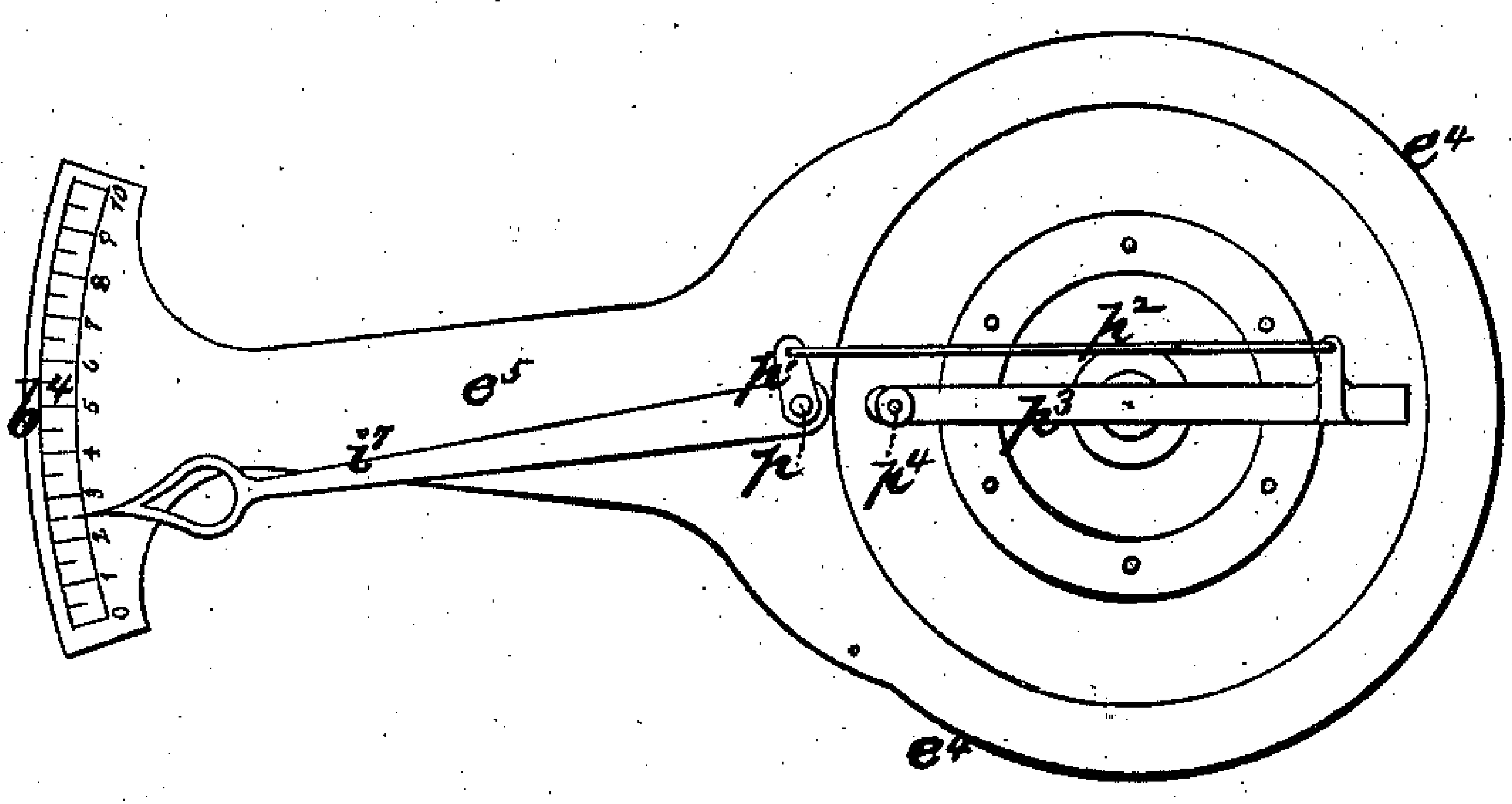

Fig 17

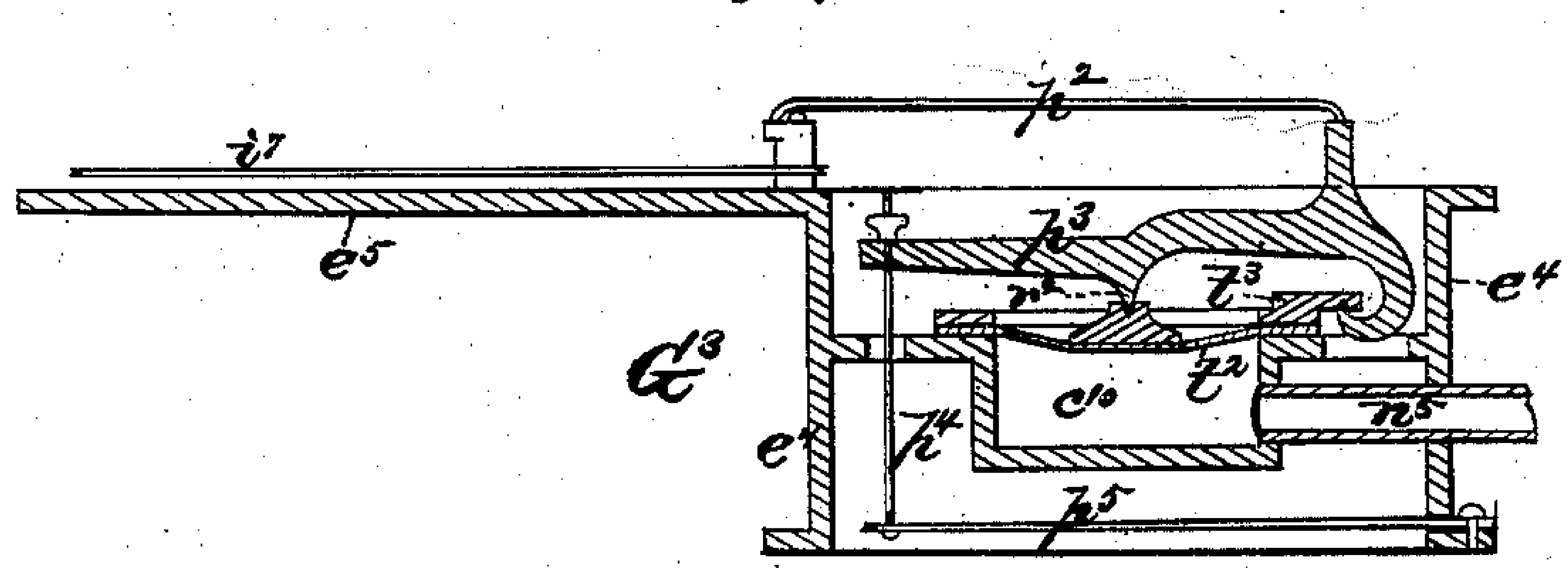

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Fig. 19

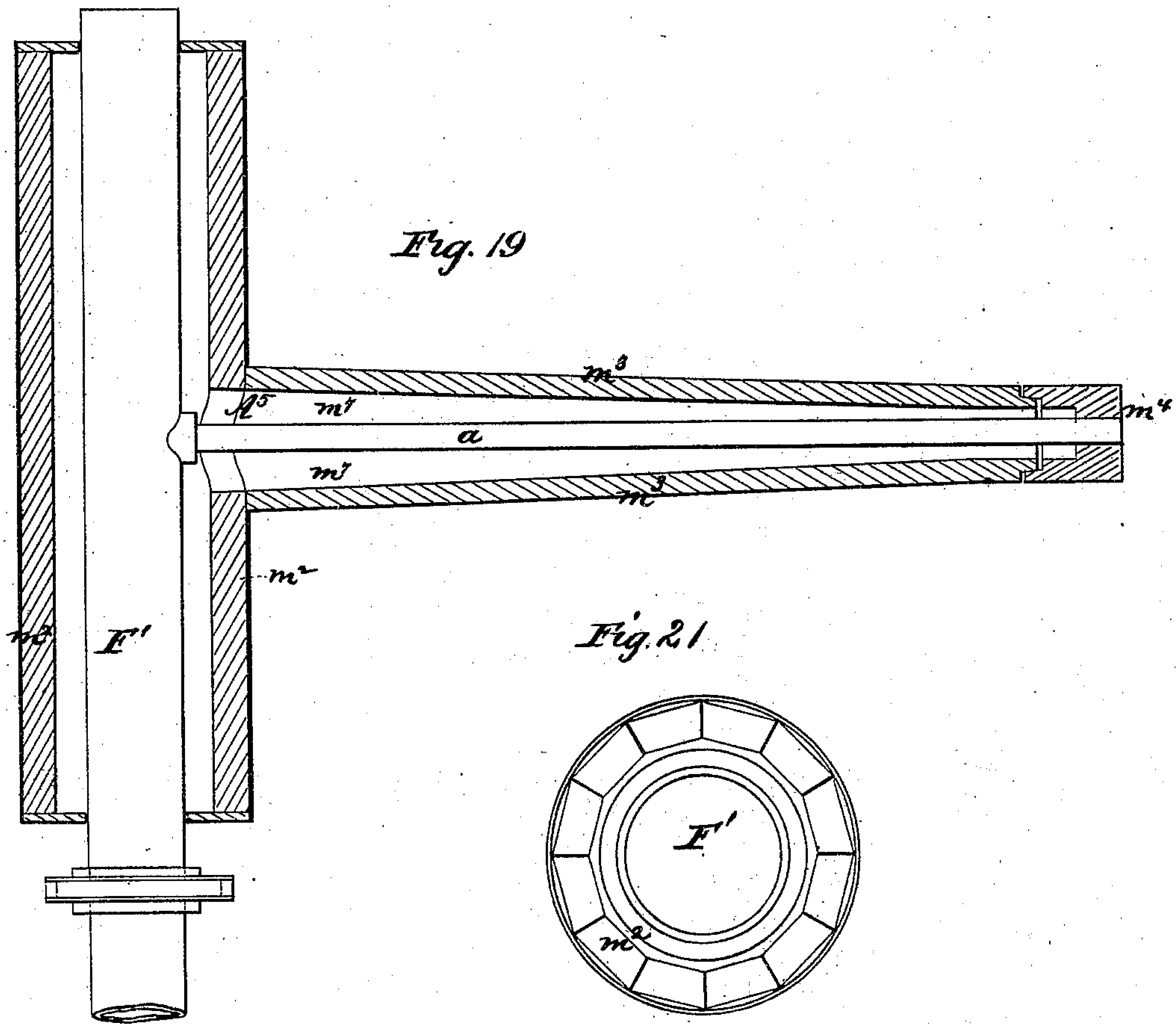

Fig. 21

Fig. 20

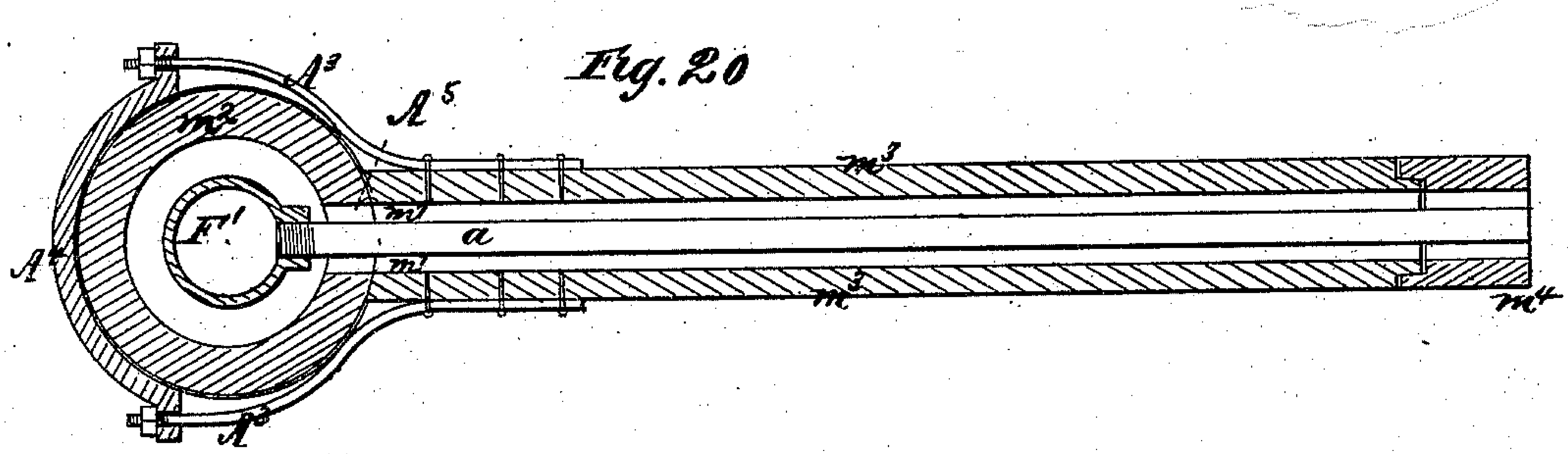

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Fig. 23

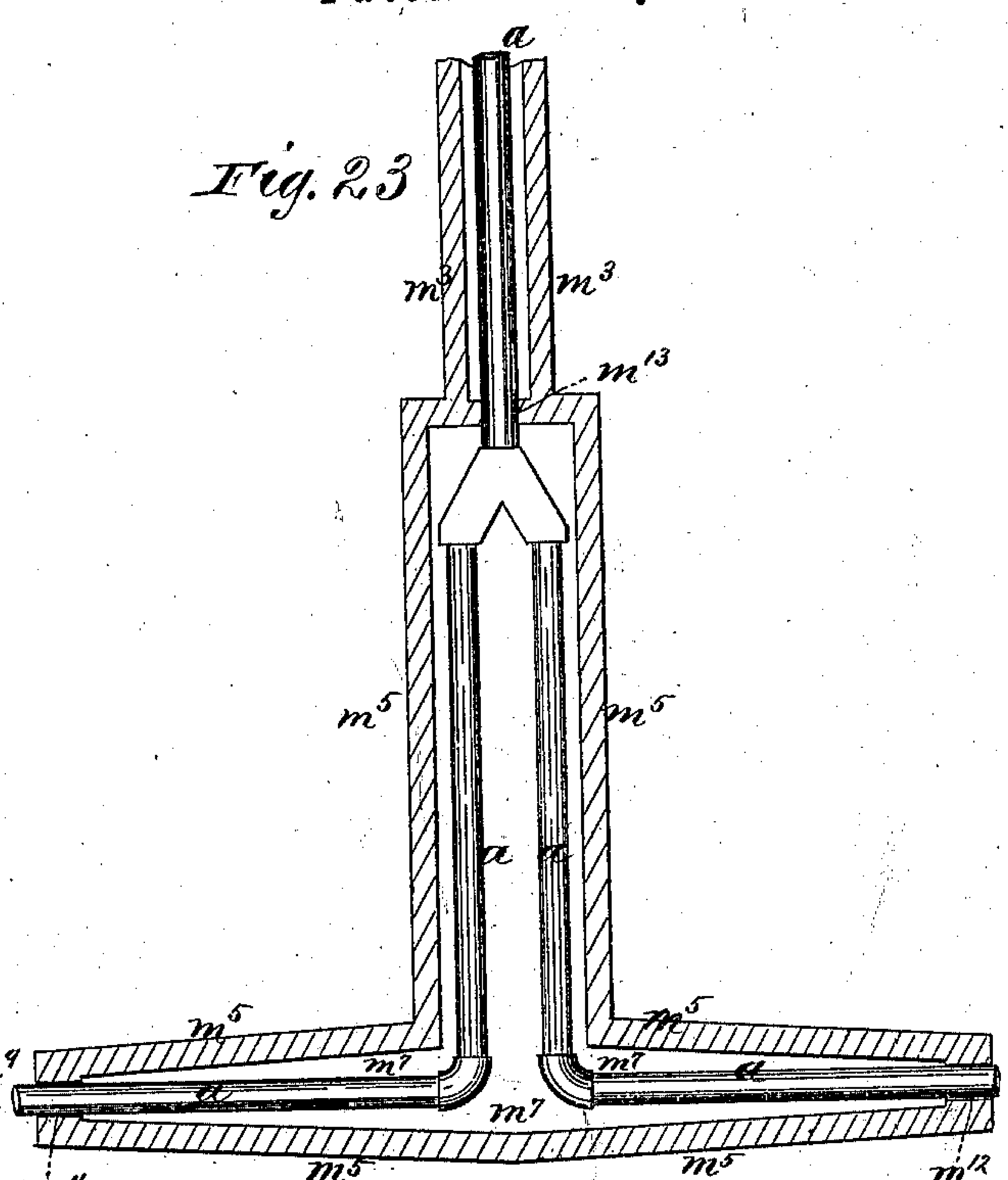


Fig. 22

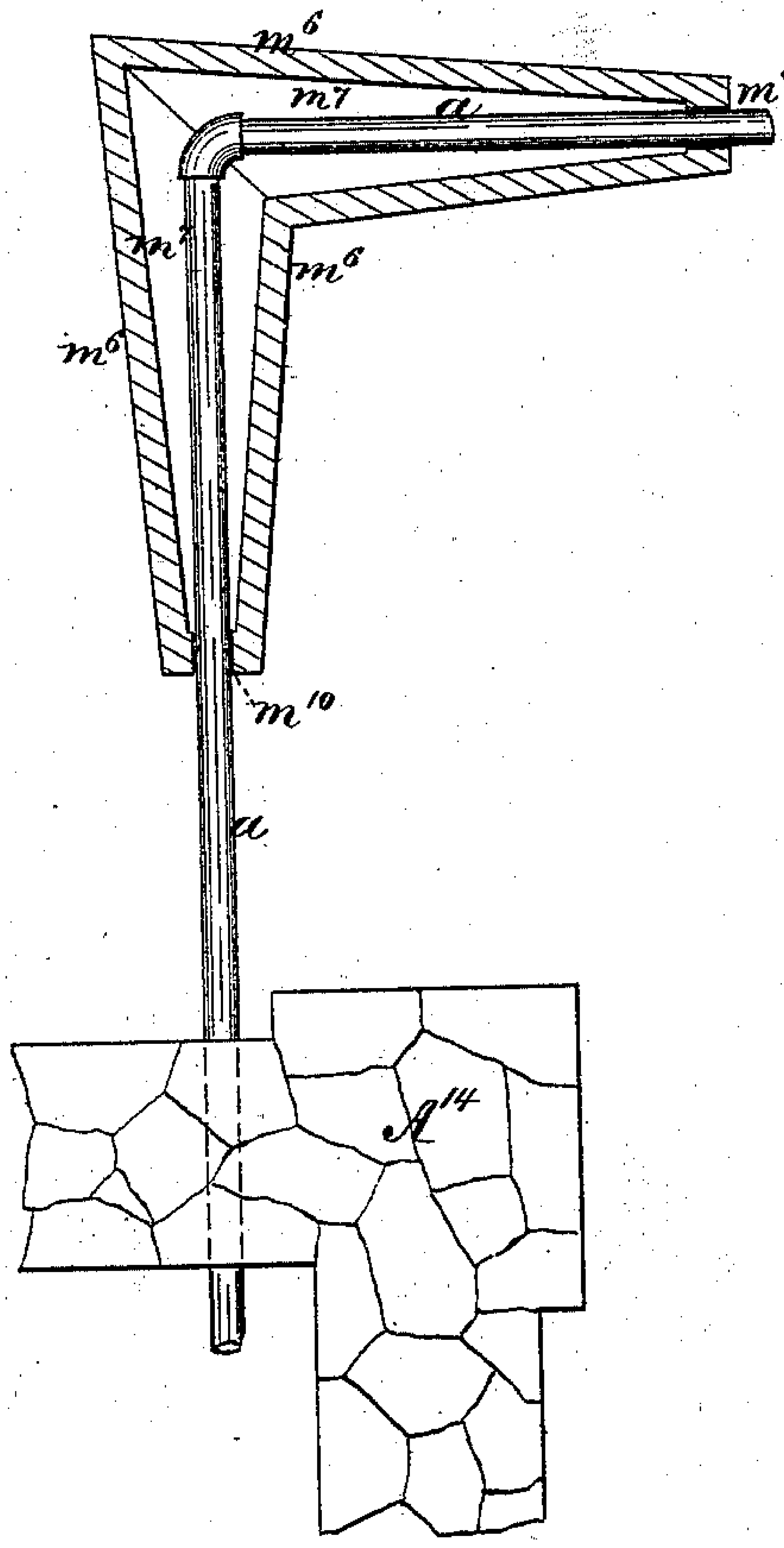
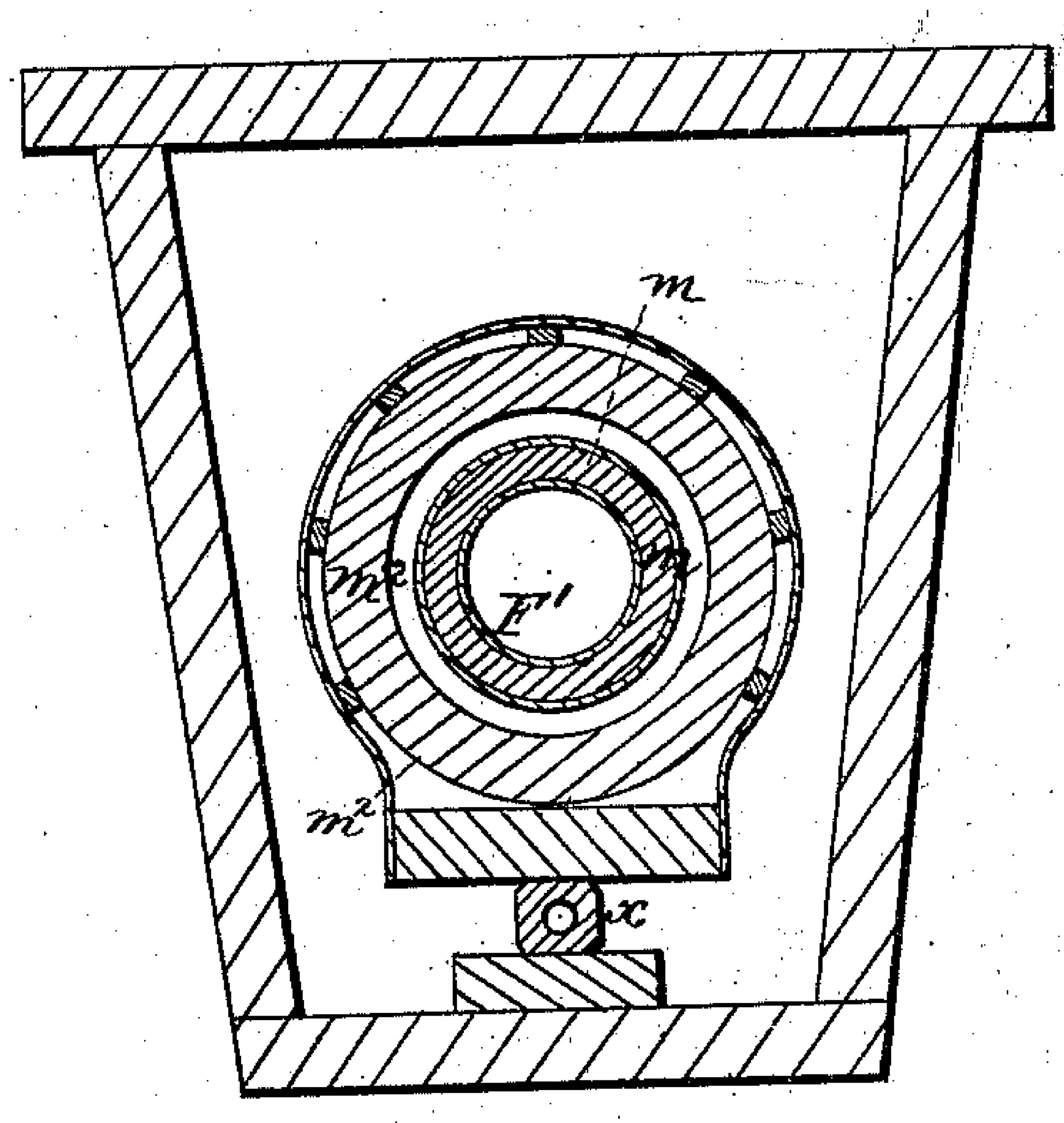


Fig. 24



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UNITED STATES PATENT OFFICE.

BIRDSILL HOLLY, OF LOCKPORT, NEW YORK.

IMPROVEMENT IN APPARATUS FOR UTILIZING STEAM IN HEATING, &c.

Specification forming part of Letters Patent No. **193,086**, dated July 17, 1877; application filed May 14, 1877.

CASE A.

To all whom it may concern:

Be it known that I, BIRDSILL HOLLY, of Lockport, in the county of Niagara and State of New York, have invented a new and Improved Apparatus for Utilizing Steam for Heating Buildings and Driving Machinery, and other purposes, in cities and towns; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 illustrates a plan view of my invention applied for heating a district of buildings in a city or town, and for transmitting steam for use for power in such districts. Fig. 2 is an elevation of the same. Fig. 3 represents a horizontal section of one of the junction service-boxes of the street-mains, and the connections thereof; and Fig. 4 is a vertical longitudinal section of the same in line x^2 of Fig. 3. Fig. 5 is a vertical transverse section through a junction service-box of the mains, and through a steam-regulator, and also an elevation of parts connected therewith, and of a building to be warmed, and a fire-engine to be supplied with steam from the mains. Fig. 6 is a transverse section and partial elevation through the building, shown in Figs. 5 and 8. Fig. 7 is a vertical longitudinal section through the same building, near the front wall thereof. Fig. 8 is a horizontal section of a junction service-box of the mains, and of the building shown in Fig. 5, and a plan view of the parts which are above the basement-story, as well as those which are on a level with the street. Fig. 9 is a longitudinal section and elevation of a steam-meter, with its metal frame L^2 (shown in Figs. 7 and 8) removed. Fig. 10 is an end elevation of the same. Fig. 11 is a plan view of the record-ribbon of the meter. Fig. 12 is a vertical section of the steam-trap shown at Fig. 7, in connection with the radiators of the building. Fig. 13 shows an elevation of the trap, and a section through its waste-cock. Fig. 14 is a top view of the trap, with a section through the pipe which leads water of condensation into the trap. Figs. 15 and 16 show a modification of the trap and its manner of application to the building and a greenhouse. Figs. 17 and 18 are a section and front elevation of a steam-gage, used for indicating the pressure of steam in the radiators. Figs. 19, 20, 21, 22, and 23 are views in which a connection of the service-pipes with the mains is shown, as well as the casing of the service-pipes. Fig. 24 is a vertical transverse section of one of the steam-mains, and shows protecting and heat-insulating covering with tile beneath.

My invention relates to a new and useful mode of supplying large districts of dwellings, and other buildings in cities and villages, with steam, not only for the purpose of warming, but also to supply power for driving machinery within buildings in such districts; also, the means whereby the fire-engines of a city or town may at all times be utilized for the extinguishment of conflagrations, although such engines be constructed so as to dispense with steam-boilers and attendant mechanism for "getting up steam;" also, the means whereby ordinary hydrants of a city or town may at all times be economically and securely protected against freezing; also, a cheap and ready means for freeing the streets of cities of accumulations of snow and ice; also, the means whereby greenhouses, conservatories, and other outhouses may be heated; and, finally, the means whereby steam and hot water may be supplied for culinary and other domestic purposes.

In Letters Patent for steam-boilers for generating steam, of even date herewith, I have shown a series of boilers, and described their uses, which are particularly designed to carry into effect the invention embraced in this patent; but I do not in this patent confine myself thereto, as steam-boilers of ordinary arrangement and construction would answer a good purpose to carry out the invention embraced by this patent.

In Fig. 1 of the drawings I have illustrated, in plan view, a section or district of a city or town having streets, as at A, B, C, D, E, and A^1, B^1, C^1, D^1, and E^1, intersecting each other as shown. From a central, or nearly a central, point of such a section or district of a city or town to any given point of its boundary I intend shall be a distance of about one-half of a mile in extent. At this central point, and within a building designated as at A^2, I erect the necessary boiler-works for the generating of steam to be distributed throughout said district for the purposes contemplated in carrying out my invention. The steam in the building A^2 is conveyed by a proper pipe or pipes from the boilers therein to a short steam "street-main" pipe, F, which connects with, and through which steam is supplied to, all the other steam-main pipes, as shown at F^1, within the district. All these steam-mains are laid underground on the line of the several streets of the city or town included in such district, and about four feet below the surface of the street; and service-pipes, as at *a*, also in like manner laid underground, convey steam from the said mains into the dwellings and buildings situate on said streets, as indicated in the drawings.

The capacity of the steam-boilers in the boiler-house A^2 should be sufficient to afford a steady supply of steam to the main pipes F F^1, or such other number of steam-mains as might be laid down, at a pressure within said pipes of about from forty to sixty pounds to the square inch of interior surface, which pressure it has been determined by experiment will be sufficient for the various uses desired within a district of the dimensions heretofore stated.

In rigorous climates—in fact, in all climates—these mains, although embedded beneath the streets at considerable depth, are more or less subject to longitudinal expansion and contraction, due to changes of temperature. Hence it is necessary to provide against such expansion and contraction, in order to avoid either breakage of the mains, leakage of steam, or other damage, which would make the use of lengthy underground steam-mains impracticable. To this end I provide said mains, at convenient points about one or two hundred feet apart, with junction service-boxes F^{10}, in which provision is made for the longitudinal movement of the end of a section of a large main which enters the expansion-chamber of such box, while the chamber itself is not moved by such movement of the mains. In Fig. 1 I have indicated at F^{10} one of these junction service-boxes on the underground main F^1 on the line of the street C, and in Fig. 2 have shown an end elevation of Fig. 1, and in Fig. 3 a plan and partly sectional view of such a junction service-box placed in the ground along the line of the main pipe at intervals of about one hundred or two hundred feet apart.

Each junction service-box is made of sufficient size and with a trap-door, so as to be accessible for repacking the expansion joints and valves and repairing the works within the box. The interior of this box is, at its bottom, provided with metal frame-work F^7, for the proper support of, and to hold in a fixed position, an expansion-chamber, F^8. This chamber is made of metal and firmly seated upon the cross-plates a^1, and between the cross-plates a^2 of the frame F^7, and is provided with a metal cover, a^3, which latter, when in place upon the expansion-chamber F^8, is held in position by screws *s*. Annular bearings, as at a^4, which project from two sides of the expansion-chamber, seat themselves in "gains" a^5 formed in the cross-plate a^2; and as a portion of this chamber, on two sides thereof, as at a^6, have a flush bearing against the inside surface of the cross-plates a^2 a^2, said chamber is thus firmly seated in a fixed position in the metal frame F^7. The inner surface of the bearings a^4 a^4 are screw-threaded, and receive, as indicated in the figure, the ends of service-pipes *a a*, which thus communicate with the expansion-chamber F^8, into the interior of which chamber, indicated at F^9, steam is admitted from the steam-main F^1, and thence is passed into a building on either side of a street through said service-pipes *a a*.

The expansion-chamber F^8 serves a double purpose, to wit: it receives the thrust of the end of a section of the large main, and permits such end to alternately move forward and backward, in accord with the longitudinal expansion and contraction of the large main F^1; and it also serves as a chamber from which the steam from the mains may be distributed, through small service-pipes, to buildings along a street.

Cut-off valves, as at f^1 f^1, are provided for the service-pipes, in order to cut off, by a key-rod, f^{12}, the flow of steam from the main to the buildings when desired. To the inner threaded end of these service-pipes hoods *g* and g^1 are screwed, which hoods may be turned up or down more or less, in order to admit into their open end *i* either dry or wet steam from the interior of the expansion-chamber F^8. In the figure the hood *g* is turned with its opening *i* toward the zenith, and hence dry steam only will pass into its service-pipe, and thence into a building which the service-pipe enters, while the hood g^1 is shown turned down in a horizontal position, thus admitting the wet steam, which will occupy a lower portion of said chamber; and, if desired, the hood may be turned down with its opening *i* toward the nadir, in which case the commingled wet steam and water of condensation which may have accumulated in the bottom of the chamber will be forced through the service-pipe into the building connected therewith. One wall of the expansion-chamber F^8, forward of its curved portion a^7, terminates in a tubular portion, a^8, with inwardly-projecting shoulders a^9, which closely fit and receive one end, f^2, of a section of the steam-main F^1. An annular space is thus formed between the portion f^2 of a section of the main and the parts a^8 and a^9 of the expansion-chamber, for the reception of suitable steam-packing *j*, so as to form a steam-tight joint around the end f^2 of a section of the main pipe F^1. A removable metal ring, as at e, is made to seat itself upon this packing, and thus prevents the escape of steam, as will be hereinafter described.

Projecting from the opposite wall of the expansion-chamber F^8 are two sets of lugs, g^2, which receive eyebolts g^3, the bolts being retained in position within the lugs by a pin, as at i^1. The forward ends of these bolts pass through doubly-beveled bolt-holes made in the rim of a sectional tube, G, the interior of which is flaring, as shown at b; and at the point b^1, where the inner end of the tube G adjoins a convex ring, g^4, said tube is beveled so as to form a perfect fit to the convexity of the ring g^4. A like fit is made between the opposite convex face of the ring g^4 and an annular projection, a^{10}, of the expansion-chamber F^8.

The convex ring g^4, it will be seen, is screwed upon the steam-main F^1, and may be removed at pleasure by disconnecting the eyebolts g^3 from the sectional tube G, and thus allow the substitution of a new section of main pipe when necessary.

It will also be seen that a section of the main F^1, which I have just referred to as having the metal ring g^4 screwed thereon, passes through the sectional tube G, and that when the screw-nuts shown upon the bolts g^3 are tightened up the convex ring g^4 will be firmly seated against the annular projection a^{10} of the expansion-chamber F^8, thus forming a steam-tight joint between g^4 and a^{10}, so that in the passage of the main supply of steam through the steam-mains F^1 no steam will waste through such joint. And, further, it will be seen that, owing to the construction of this steam-joint between g^4 and a^{10}, and the like joint between g^4 and sectional tube G, and the beveled portions b in said tube, and the beveled bolt-holes in the rim of the tube G through which the bolts g^3 pass, the main pipe F^1 on this side of the expansion-chamber F^8 is capable of deflection from a right line to accommodate it to the grade or meet any other contingency of position. I thus provide against a strain falling upon the main pipes at or near their connection with the junction service-boxes, which would ensue from a deflection of said mains for any cause from their proper condition as laid down, and at the same time provide against leakage of steam by reason of such deflection.

A short section of a main pipe, F^1, is shown at f^3, having a screw-thread cut into its outer surface, so that one end of said section may be screwed into a corresponding opening in the wall of the expansion-chamber, as shown. The opposite end of this section f^3 engages with a metallic steam-discharge ring, G^2, which has apertures h through it to admit of the free passage of steam from the main F^1 into the interior F^9 of the expansion-chamber. By turning this discharge-ring in one direction it will be screwed along upon the section f^3 a sufficient distance to allow of the removal of the metal ring or stuffing-box follower e, and thus give access to the packing j should such packing need replacing; and after the ring e is thus removed the steam-discharge ring G^2 can itself be removed either for repair or the substitution of a new one, its removal also giving access to the main F^1. By turning said ring G^2 in an opposite direction to that just named it will force the metal ring e down upon the steam-packing j, as shown in Fig. 3, thereby packing the joint and preventing the escape of steam from the main as well as from the interior of the expansion-chamber at the end f^2 of a section of the main F^1, which enters said chamber.

The outer surface of the end f^2 of last-named section is intended to slide forward and backward in contact with the packing j, and the forward end of such section will be projected into the expansion-chamber F^8 more or less, according to the longitudinal expansion or contraction of the main pipe F^1, which is between the source of the supply of steam to such pipe and the junction service-box F^{10}. This iron section of the main F^1 has its end f^2 nickel-plated on that portion of its exterior surface which comes in contact with the steam-packing j. This is done in order to avoid rust and the great expansion of brass, in case this section were to be made of brass, to avoid rust; and besides this a smooth anti-frictional surface is thus secured, which is not subject to great expansion.

In this manner expansion-joints may be applied at intervals where required throughout the whole system of the steam street-mains, thus rendering the use of such mains practicable, notwithstanding the very considerable longitudinal expansion and contraction to which long lines of such pipe are subjected, by reason of varying temperature.

The steam-mains F^1 throughout their entire extent, up to and slightly within the junction service-boxes, are surrounded by a wrapping of asbestus, hair-cloth, or any other non-conducting substance, or with both asbestus and hair-cloth, as shown, thus confining, and, as it were, insulating, the steam within the mains, and so preventing its condensation. The mains, with their wrapping, are then inclosed in a water-tight outside pipe, either of wood or iron lined with wood, and this pipe is then embedded in and covered, as in Fig. 24, first with sheet-zinc or tile, and thereafter with some porous substance like tan-bark or sawdust, to retain confined air, while underneath such outside pipe tiles x, Figs. 6 and 24, are properly laid to carry off water, which would otherwise settle around it in the trenches in which the mains are laid. In Fig. 3 of the drawings the asbestus wrapping is designated at m, the hair-cloth at m^1, and the water-tight pipe at m^2, which pipe is carried into and connected with the parts of the junction service-box F^6, as shown, the fitting of this pipe with the junction-box being a loose one.

At some convenient point within each junction service-box, and between its steam and expansion chamber and the source of supply of steam to the mains F^1, a main stop-valve, indicated at V in Fig. 4, will be applied to the mains, in order that steam may be cut off from the expansion-chamber F^8 during the act of repairs or an adjustment of the mechanism therein. From these mains the service-pipes *a* conduct the steam to the buildings on either side of the street along which said mains may be laid, in which buildings the steam may be used for either or all of the purposes heretofore named to which my invention relates.

I have described the mains F^1 as having a longitudinal movement, by reason of their contraction and expansion; and now, in order to show that provision is made against undue straining of the service-pipes *a*, whether they pass at right angles from the mains to a building indicated at A^{14}, or around corners before reaching a building, making themselves a right angle either to the right or left, or both to the right and left, I will proceed to describe the plan shown by Figs. 19, 20, and 21, and the plans shown by Figs. 22 and 23. F^1 in Figs. 19, 20, and 21 shows the main, which, in all respects, is constructed, laid down, and protected as before described; and *a* is a service-pipe leading out at right angles from said main to the curb-line, or to the back yard of a building. In plan 19 the connection of the service-pipe *a* with the main F^1 is made by cutting an oblong hole, A^5, of about two inches length through the wooden pipe or covering m^2 of the main. To close this hole, which is made in order to allow the service-pipe, when expansion and contraction takes place, to vibrate between its inner end m^4 and its connection with the main F^1, a wooden tube, m^3, having an internal flaring expansion-chamber, m^7, is placed around the service-pipe from its inner end m^4 to its connection with the main F^1, and firmly strapped in place, as illustrated at A^3 and A^4, Fig. 20. The joint around oblong hole A^5 and between the wood pipe m^2 and the wood pipe m^3 is made water-tight in any proper manner. It is evident that the service-pipe *a*, if made fast or impacted by earth at its end m^4, will still have freedom, by means of the flaring chamber of the wooden tube m^3 and the oblong hole A^5, to vibrate when the steam street-main F^1 contracts and expands; and this, without much strain upon it, as the great length of pipe between the fixed point m^4 and the point of connection with the main will cause the movement of the service-pipe at its fixed point m^4 to be exceedingly slight. Now, if the service-pipe *a* is to be bent so as to form an elbow, as shown in Fig. 22, or is to be united to two elbows, as in Fig. 23, for the purpose of leading the steam into buildings not situated for a service-pipe, such as is shown in Fig. 19, I inclose it in a water-tight wooden casing, such as is shown at m^5 in Fig. 23, or as shown at m^6 in Fig. 22, accordingly as the case may require. The interior of these casings forms a flaring chamber, m^7, and the service-pipe *a* is only impinged upon, and that loosely, at the points m^9 m^{10} in the plan shown in Fig. 22, and at the points m^{11} m^{12} m^{13} in the plan shown in Fig. 23. With either of the constructions shown by Figs. 22 and 23 the elbowed portion of the pipe *a* and all other portions thereof, between the points which are impinged upon loosely and the elbows, will have freedom to vibrate in the flaring chamber of the casings m^5 and m^6 to any extent that the expansion and contraction of the service-pipe *a* may render necessary.

I will now describe one practical plan for utilizing the steam from said mains in a dwelling within the district of buildings shown in Fig. 1, such description having reference to Figs. 5, 6, 7, and 8 of the drawings. In Figs. 5, 6, and 8 the roadway of the street is indicated at H and the sidewalk at I. In Fig. 5 a junction service-box F^{10} is shown beneath the street-roadway H, from which box, through one of its service-pipes, *a*, steam is conveyed into a conducting-pipe, *n*, which leads into a steam-hydrant, P, situated upon the sidewalk. In this said figure an ordinary water-main is indicated at R, from which, through pipe *r*, water is supplied to a street-hydrant, P^1, from which water can be furnished to a city fire-engine; and in order to prevent the water in the hydrant P^1 from freezing during the winter season the conducting-pipe *n* is made to impinge against such hydrant, as signified in Figs. 5 and 7.

At Q, in Figs. 5 and 8, a fire-engine is represented which has no boiler or fire, and which takes its steam from the steam-hydrant P, through a steam-pipe or hose, y^4, simultaneously with its supply of water from the hydrant P^1 through a water-hose, y^5.

The advantages are apparent in that the water in hydrant P^1 is never frozen, and the steam in the hydrant P is always "up" and ready for the engine. Besides this, the cost and weight of a fire-engine may be reduced about one-half that of any other; at the same time the alarming appearance caused by the fire, smoke, and noise, while running to and working at a fire, as well as attendant casualties, are avoided.

I will here state that the steam admitted to the steam-hydrant P will be at high pressure, and that proper cocks for letting on and cutting off steam to and from the same, are to be provided. In case there should be no city hydrant adjacent to a building to which steam is to be supplied, the conducting-pipe leading steam into such building will connect directly with the service-pipe *a*. In this instance a conducting-pipe, n^1, receives its steam from the conducting-pipe *n*, and thence passing into the building, as indicated in Figs. 5 and 7, may supply steam directly to a heater or radiator, L, and so warm an upper room, as shown in the latter figure, while a branch conducting-pipe, n^2, connecting with the pipe n^1, may lead into another heater, as at L^1, in the same or another apartment.

It is desirable, however, not only to regulate the supply of heat to a given building, but also to ascertain the amount of steam supplied under a given pressure, as well as record such supply, in order that a uniform proper price may be charged to the occupant of the building for the steam used to heat the same, and for other purposes. To this end, a cut-off cock, d, is applied to the conducting-pipe n^1 to compel the steam to pass into and through a steam-meter, by means of which the pressure and supply of the steam is primarily regulated within the building and the consumption recorded. The steam-pipes n^3 and n^4 (shown in Figs. 7 and 9) connect such meter with the pipe n^1, and cocks, as at d^1 and d^2, are applied to the pipes n^3 and n^4, so that when the cock d is closed and the cocks d^1 and d^2 are open, the steam will pass into the meter through pipe n^3, and out of the meter through the pipe n^4, back to and within the pipe n^1, and so on to the radiators L and L^1, as well as to other parts hereinafter described. This meter is more clearly shown by Fig. 9 than in the other figures, and is, preferably, constructed mainly as shown, though other constructions might be used to effect the same results for which it is intended. In this figure, c is a metal cylinder, having a steam-chamber, c^1, to receive steam through the pipe n^3, which connects with the pipe n^1, (shown in Fig. 7,) heretofore described. The ends of this cylinder are closed steam-tight with a properly-fitting stuffing-box, c^2, at one end, and with a steam-tight tubular valve-stem bearing, c^3, at its other end, as shown. Within this cylinder is a cone-valve, c^4, connected at one of its ends with a valve-stem, c^5, and at the other end with a screw-threaded stem, c^6, which takes into a nut of the valve-stem bearing c^3, as shown. The cone-valve c^4, which admits the steam from the chamber c^1 into the pipes leading to the different rooms and radiators, passes through an annular diaphragm, c^7. The area of the opening c^8 in the diaphragm, when it surrounds the small end of the cone-valve, must be of a sufficient size to supply all the radiators required in a given dwelling, or have about an area of three-fourths of a square inch for every hundred thousand cubic feet of space to be warmed. The large end of this cone-valve c^4 should fill the diaphram-opening c^8 so as to form a close joint. The amount of steam passing through the diaphram c^7 will depend on the position of the cone-valve as it moves forward and back through said opening c^8. M in said Fig. 9 indicates clock-work regulated to keep good time, which gives movement to a ribbon of paper, M′. This ribbin passes over and is moved forward by a roller, r^1, fastened upon an extension of a shaft which in ordinary clock-work gives movement to the hour-hand of a clock. The ribbon in its forward movement is held down upon the roller r^1 by a loosely-revolving roller, r^2, the ribbon passing between them, as shown, as the roller r^1 is slowly rotated by the clock-work. The ribbon M′, as in Fig. 11, is ruled lengthwise with eight or ten black parallel lines and with a red line on one edge, indicated at 8 8, which is termed the "zero"-line of the ribbon, and on which zero-line the pointer i^2 will rest when the valve c^4 is closed. It is also ruled with black cross-lines, as at 24 24, to represent days, and with lines as at e^1 to represent half-days, and with lines e^2 to represent hours. Any number of these ribbons may be provided in advance of their use, as the same ribbon will answer for all the different sizes of meters within the district of buildings to which the steam is supplied, as well as for all pressures of the steam. As before stated, the amount of steam passing through the diaphragm c^7 depends on the position of the cone-valve c^4; and its position is accurately recorded upon the ribbon M′ by a pencil-finger, i^2, secured to a sliding bar, i^3, which latter is supported in a horizontal position by the frame of the clock-work, and in such manner as to allow of a sidewise movement either to the right or left. This bar i^3 has a clutch, i^4, attached to one of its ends, which clutch travels in a circular groove, i^5, cut around the valve-stem c^5, as shown, and at the opposite end of said bar a flat spring, as indicated at i^6, is secured to the bar. The spring moves with the bar to right and left, according as the bar is moved, and upon the plane surface of a metal frame, L^2, (shown in Figs. 7 and 8,) which incloses the cylinder c of the meter and also supports its clock-work M. The pointer i^2 is so adjusted in position upon the bar i^3 that its pencil will always press upon the ribbon M′ at a point where the ribbon is in firm contact with the periphery of the roller r^1, while at the same time the clutch i^4 is so adjusted on said bar as to travel in the groove i^5 of the valve-stem c^5, and in these positions said bar and clutch are always held by the tension of the spring i^6 upon the cover L^2 during the forward and backward movements of the valve-stem c^5 and cone-valve c^4. In other words, the pencil-finger i^2 is automatically held to its work by the spring i^6, and as the pencil is moved crosswise of the ribbon through the connection of the bar i^3 with the valve-stem c^5 the slightest movement of the cone-valve c^4 will be felt by the pencil, and such movement recorded upon the ribbon M′, as indicated by the zigzag line on said ribbon in Fig. 9. The cone-valve c^4, it will be seen in the figures, is moved backward or forward through the diaphragm c^7 by means of a screw-movement, as indicated at c^3 and c^6, but it is practicable to effect the opening and closing of the cone-valve by a lever without revolving the valve.

I will here state that while the steam in the mains, as well as the valve-chamber c^1, is always at high pressure, yet, by being "wire-drawn" around the cone-valve through the diaphragm, the steam is reduced to low pressure, and in this condition can be safely used for warming the building. My object in using high pressure in the mains F^1 and a low pressure in the dwellings is to keep the said mains as small as possible, on account of expense and loss by condensation, while low pressure in the buildings is not as liable to cause leakage in the joints, valves, and packing, besides being considered safer.

Each different size meter should have its number, and each ribbon of paper placed on a meter should be numbered to correspond with the number of the meter on which it is to be used. This being done the value of the steam between the longitudinal lines will be known by its number. This value may be computed with considerable accuracy by the area of the diaphragm-aperture c^8 and the velocity of steam at given pressures. But when greater accuracy is required, a company or producer supplying a city or town with these works should be provided with an apparatus for that purpose consisting simply of a surface-condenser, or coil of pipe submerged in cold water, of sufficient size and length to condense all the steam that will pass through the largest meters within a given time. Then the value is obtained as follows: Supposing the meter is to be used with a pressure of forty pounds above the cone-valve c^4, and at or near the pressure of the atmosphere below the cone-valve, as at n^4, Fig. 9 first, close the cone-valve c^4 and thus station the pencil i^2 on the zero or red lines 8 8 of the ribbon; then open the cone-valve until the pencil reaches the first black line, 7, which runs lengthwise of the ribbon, and there stop. This will allow a small quantity of steam to pass into the condenser, (the condenser being attached to n^4 or other convenient pipe communicating with n^4,) where it will be condensed and come out pure distilled water. Let the valve remain open one hour, then close it and weigh the water. Multiply the weight in pounds by 27.7 which will give the number of cubic inches of water. Each cubic inch of water was a cubic foot of steam at the pressure of the atmosphere, before entering the condenser. Then multiply the cubic feet of steam by 24 (the hours in a day) and the result by 30, (the days in the month,) and this will give the number of cubic feet of steam for one month. Then, again, open the valve c^4 till the pencil i^2 reaches the second black line, 6, running lengthwise of the ribbon, and repeat the process at each of such lines until the cone-valve c^4 is wide open—the movement of the valve during this process being effected by a hand-key, K, Fig. 8, applied to k' of the valve-stem, c^5.

If the result of the above test should show an increase of one hundred cubic feet of steam for every successive longitudinal line reached by the pencil, over the number of cubic feet shown for the immediately-preceding longitudinal line, then the meter would be of proper size for a dwelling or other building containing fifteen thousand cubic feet of space to be warmed. I will suppose this meter to be in operation in a dwelling, and at the end of a month the amount recorded averaged five full spaces, and each of such spaces between e^2 e^2, and between 8 to 7 and so on, of the ribbon M′, represents the consumption of one hundred cubic feet of steam for one hour. To obtain the cost for one month or one year is as follows: Example: One hundred cubic feet per hour multiplied by the number of hours in a day shows the consumption of twenty-four hundred cubic feet each day, which, multiplied by the number of days in a month, shows the consumption of seventy-two thousand cubic feet for one month, which, multiplied by two, the number of cents charged for a thousand cubic feet, will amount to one dollar and forty-four cents per month for each full space, and such sum being multiplied by five, the number of spaces, will make a total sum of seven dollars and twenty cents per month; or, a grand total of fifty-seven dollars and sixty cents per year, if the said value per month be multiplied by eight, which is the estimated year's use of steam for warming the building. These ribbons M′ may be collected once a month, and any broken spaces, indicated by the pencil, arranged before they go to a book-keeper, who, having a table with the price per month of each of said full spaces of the ribbons for the different size meters, will know at once how to make out his bills. This meter will work practically correct, even if the mean pressure of steam should vary five pounds either way from forty pounds pressure, in which case the loss or gain to the consumer would not exceed two per cent.

I have described the meter shown by Figs. 9, 10, and 11 only as a meter for steam; but it is equally as good for measuring many other fluids, either hot or cold, where the pressure below the cone-valve is less than above it. It may be opened or closed by hand, and after having been opened it may be more or less opened and closed automatically by the pressure of the steam below the cone-valve, and thus the steam in the house kept at a uniform pressure, as will be hereinafter shown. I have also spoken of transmitting steam through long lines of pipe. The same apparatus is equally good for hot fluids, either water, air, or oil.

As the steam passes out of the meter, Fig. 9, through the pipe n^4 back into the pipe n^1, it will be under low pressure, and then passes directly into the radiator L through pipe n^1, and into radiator L^1 through pipe n^2, the cocks d^3 and d^4 of the radiators being open; also through pipe n^5 into a pressure-gage, G^3, to indicate the pressure in the building; also through pipe n^6 into a diaphragm-regulator, K, attached to the key of the meter to regulate the pressure in the building.

In Figs. 7, 12, 13, and 14 I show a steam-trap, which I have constructed expressly for use in connection with my improved apparatus for warming, which I am now describing. This trap answers a double purpose, that of a reheater and a steam-trap. In many places it can be used as follows: For instance, in order to warm a large dwelling or store, as indicated in Fig. 7, where there are a number of radiators in the rooms above ground, the steam will come into the basement through the meter, then up through all the radiators, as just described. The condensed steam being returned to the basement through pipes n^8 n^9 and junction-pipe n^{10} into the trap I′, the balanced float f^4, being open at the upper end, as shown, receives the water from the return-pipe n^{10} and will remain full, or up to the top of its center tube *t*. The top of the tube *t* and the water in the float f^4 being about eight inches higher than the water surrounding the float, gives the water in the center tube *t* that much "head," and forms a current of hot water down through the bottom of the float. The temperature of the descending water being hotter than that in the trap below will increase its temperature and cause it to ascend in the space t^1 beween the float and the interior of the trap I′, a little above the pipe n^{11}, through which pipe it will leave the trap and circulate through a radiator, L^3 in the basement, then back through pipe n^{12} into the bottom of the trap I′, when it ascends and is reheated by the hot water descending through tube *t*. If the temperature of the circulating water is too low to warm the basement-radiator L^3, live steam, by opening the valve d^5, can be admitted to the trap through the pipe n^7, coiled as h^1, in the bottom of the trap, and so reheat the water and raise its temperature as high as required. The steam condensed in this coil h^1 will be forced up through the pipe n^7 into the top of the trap I′, and increase the temperature of the water descending through the center tube *t*. When the water rises too high in the trap, the float f^4 (which is connected by a rod, *u*, and a cord, u^1, to a lever, *w*, as shown) will ascend and lower the weighted end of the lever W, which, by means of the rod *w* and lever w^1, will open the cock w^2 in a waste-pipe, w^3, which communicates with the trap I′ through the pipe n^{12}, and thus allows the surplus water to pass off into a hot-well, Z; and if at the same time it should be desirable to heat a greenhouse with the water of condensation returned to the trap, a hot-water pipe, as in Figs. 6 and 7 at n^{13}, may be used to lead such water from pipe n^{11}, which connects with the trap I′ to the greenhouse H′, and through heating-pipes therein, and thence be returned through pipe n^{14} to pipe n^{12}, and thence to the trap I′, in which it is reheated for repeated circulation, while all surplus water will be discharged into the reservoir Z, as before described. A way-cock, as at d^6 is provided for the pipe n^{11}, and pipes n^{13} will be provided with a similar cock.

It is manifest that the hot water from the trap may be carried through pipe n^{11} to a tank in the kitchen of the building, there to be used for culinary and other domestic purposes, a return-pipe being provided to return the water from such tank to the trap I′ in a like manner as provided by pipe n^{12}, for returning the hot water from the heater L^3 to said trap, and in like manner hot water can be supplied for use throughout the building wherever needed.

In this manner I am enabled to utilize, either in the condition of steam or in the condition of hot water, nearly all the heat let into the building.

I will here state that while I prefer to use the trap above described, still a trap of ordinary construction might, with good results, be substituted therefor, for the purpose of heating by steam only.

In the aforegoing description, I have spoken of the trap I′ as a reheater for warming either the basements of buildings, or greenhouses, by circulating hot water. But this combined trap and reheater, need not be used simply to heat such localities. If desired, the trap proper may, for instance, be located in the upper story of a building and warm all parts of the building, as well as a greenhouse, by circulating hot water from such upper story, as signified by Figs. 15 and 16; and, there being no danger of fire from its use, the trap proper (section e^2) may be located in any back hall or closet. In Fig. 7 I have shown the outer shell or cylinder of the trap made with two sections or main parts, an upper one, e^2, in which the float operates, and a lower one, e^3, in which the coil *h′* is located, the two sections freely communicating through an annular opening, b^2. There is thus practically a float-chamber for the upper section, and a coil-chamber for the lower section, the two communicating through b^2.

We will now suppose that it is desirable to locate the trap proper in the third story of a dwelling, as in Fig. 15. In this case the coil-chamber or lower section e^3 will be located in the basement and thus act partially as a heater for such room, while the upper section e^2 will be located in the third story of the house, and thus act partially as a heater for such story; and from this latter section e^2 the hot water will circulate through all the radiators on that floor, then descend to the next, and so on until it reaches the basement, from whence it may circulate through a greenhouse, H′, and, finally, be returned to the bottom e^3 of the trap, and so be reheated for repeated circulation, while all surplus water will be discharged into a hot-water reservoir, as signified in Fig. 7. In this supposed case the live steam, after having passed through the meter, is taken from the pipe n^1, (shown in Fig. 7,) into an "upright" as at V′, Fig. 15, from which the steam passes through the pipe n^7 and its coil *h′* in the section e^3, along up said pipe n^7, and discharges into the upper section e^2, in the third story. The corresponding parts of the trap shown in Figs. 7 and 15 perform the same function and are designated the same letter. It will thus be seen that any one or more of the buildings situate within the district of buildings signified in Fig. 1, can, at option, be heated either by steam, or by circulating hot water, as may be desired; or parts of the same building may be heated by steam, while other parts may be heated by circulating hot water, the agent for doing all this being the steam generated in the building A^2 located at or near the center of said district, and passed through mains F^1 under high pressure.

In Figs. 17 and 18 I have shown a pressure-gage, to indicate the pressure of the steam let into the radiators and other steam-fixtures of a dwelling. This gage may be situated in the basement of a building, as indicated in Fig. 7, and receives steam through pipe n^5, when the steam leaves the meter, as shown in said figure. It consists of a cylindric frame, e^4, its upper extended portion, e^5, being provided with a scale indicating pounds and half-pounds, as at b^4. It is provided with an index-pointer, i^7, pivoted at p, and with a short lever-arm, p^1, which receives a rod, p^2, that is attached to a rear portion of a vertical lever, p^3. The extremity of the curved rear portion of this lever p^3 seats itself loosely beneath a projecting part of an annular rim, t^3, while a projecting portion, r^2, rests upon a boss which is secured centrally upon a flexible diaphragm, t^2, which covers and is secured over the steam-chamber c^{10} of the gage, as shown. A rod, as at p^4, connects the lever p^3 with a flat spring, p^5, secured at its rear end to the frame e^4. This spring, when not under tension by the action of the steam in the chamber c^{10}, will cause the pointer i^7 to rest at the zero-point of the scale b^4, and to this normal position the pointer will always return after the pressure of the steam has ceased to act within the chamber c^{10}. As seen in Fig. 17, the pointer is supposed to be at zero, and the diaphragm t^2 at rest. If steam is now let into the chamber c^{10} through pipe n^5, the flexible diaphragm t^2 will be forced outwardly from the steam-chamber, thus forcing outwardly the forward part of the lever p^3, and at the same time drawing down the rod p^2, which, in turn, draws down the short arm p^1, thus causing the pointer to move forward upon the scale b^4. This act puts the spring p^5 under tension, and it will remain under any given tension corresponding to a given pressure of the steam so long as such pressure is maintained, and as the pressure varies the pointer will indicate the varying pressures upon the scale, and when all pressure ceases the pointer i^7 will return to its normal position at the zero-point.

The steam, after passing through the meter, also passes from pipe n^1 into a pipe, n^6, which conducts it into a diaphragm-regulator, K. (Shown in Figs. 5 and 7.) This regulator is connected with a key, k, upon an arbor, k^1, on the end of the valve-stem c^5 of the cone-valve c^4, and regulates the pressure of the steam within the building. The regulator is of simple construction, having a steam-chamber, c^{11}, to receive steam from pipe n^6, and a flexible diaphragm, t^4, held in place by an annular ring, t^5, similar to that shown in Fig. 17. A lever, l, is pivoted at j', at its rear end, to an upright projection of the ring t^5, and a downward projection, l', of the lever rests upon a boss secured to the flexible diaphragm t^4, corresponding to the boss shown in Fig. 17. The lever is provided with a movable weight, w^5, which may be slid along the bar, as desired. A cord, as at u^2, has one end secured to the forward end of the bar, while the other end of the cord is secured to a weight, w^6. This cord, when the regulator is to come into action, is passed over a sheave, y, of the key k. (Shown in Figs. 5 and 8.) I will now suppose the cone-valve c^4 to be closed, and that the operator desires to let a quantity of steam into the radiator L sufficient to heat it, and that such quantity will be furnished at a pressure of two pounds. To do this the key k is turned forward by the hand of the operator, thereby opening the valve. The forward movement of the key is continued until the pressure-gage G^3 indicates the two pounds pressure. This done, the operator raises the cord u^2 over the sheave y, and adjusts the weight w^5 along the lever l of the regulator K, until the lever l assumes a horizontal position, as indicated in Fig. 5, care being taken, during such act, not to further open the cone-valve c^4. This being done, a steady heat at two pounds pressure of steam will be furnished said heater. After a while it becomes desirable to set the heater L^1 in operation, and accordingly the inlet-valve d^4 is properly turned and steam admitted. This act at once reduces the two-pound pressure in the chamber c^{11} of the regulator K, whereupon the weighted lever l will commence to fall below a horizontal position, and so draw upon the cord u^2, at the same time elevating weight w^6, and thereby opening the cone-valve until the given pressure is re-established for both heaters, the same as it previously had been for only one. After another interval of time it may be found desirable to only use one of the heaters L and L^1. Accordingly the steam is cut off from radiator L^1, and this act increases the steam-pressure in the regulator. This extra pressure in the chamber under the diaphragm of the regulator will accordingly raise the weighted lever l, and close the cone-valve just enough to keep the right supply of heat to the radiator L, and practically under the original two-pounds pressure. In large cities, many narrow streets, during the winter season, become at times so much obstructed by snow and ice as to impede travel, as well as entail a heavy expense for the removal of the same.

In carrying out my improved mode of heating buildings in cities and other large towns, I provide for a ready and inexpensive removal of such snow and ice, as indicated in Figs. 6 and 8 of the drawings. In the latter figure, at one side of the street H, an opening, f^5, is made along the sidewalk-curb b^6, a cover, f^6, being provided for such opening when not in use. This opening f^5 leads into a large underground tank or box, B^3, provided with an exit-pipe, n^{15}, which is made to communicate with an underground sewer of the city or town. This box may be located near one of the steam-hydrants P, above described; or, if deemed best, a special steam-hydrant, as at P^2, in Figs. 6 and 8, may be provided at convenient points on the sidewalk I. Such hydrant P^2 is made to take steam from one of the street-mains F^1 through a pipe, n^{16}, and it is also provided with proper valves to let on and cut off the steam when desired. A pipe, as indicated at n^{17}, Fig. 8, situated near the steam-hydrant P^2, passes from near the surface of the sidewalk down into the box B^3, and is coiled upon the bottom of said box. This coil may be perforated, or it may be imperforated, but open at its termination, so that a heavy flow of high-pressure steam may be let into the box. The opening f^5 is of such width and length as to admit of one, two, or more cart-loads of ice and snow, gathered from the street, to be dumped through it at one time, and with steam let on during such dumping the snow and ice will melt and run off into the sewer of the city with very great rapidity. At f^{18} I have shown a short connection-pipe between the hydrant P^2 and the pipe n^{17}, leading into the box B^3. This connecting-pipe need only be used when steam is let into the box B^3, and, when not wanted for such purpose, it can be removed, and its cover g^6 adjusted over the pipe n^{17}.

I thus have provided a ready and inexpensive means for freeing streets from accumulations of snow and ice, and, if needed, an auxiliary steam-pipe, as at n^{20}, connecting with the hydrant P^2, can also be brought into action, either to melt the snow in the box or for clearing the sidewalk and street of snow by throwing hot steam thereon.

In my aforegoing description I have illustrated and described a practical way of distributing steam, and the condensation of steam throughout buildings within a district of buildings signified in Figs. 1 and 2; but I do not confine myself to the relative location of the several devices employed for such purpose, as the same may be varied according to locality and surrounding circumstances, without departing from my invention.

It is manifest that in some cases where the steam is to be used as a motor for propelling machinery, and under a higher pressure than necessary for simply warming a building, as indicated in the drawings, the steam may be conducted directly to an engine in a building in the said district of buildings, by a steam-pipe connecting with an outlet-pipe, as signified at n^4 of a meter shown in Figs. 7 and 9. In such case, a meter might be used of a size large enough to pass such a volume of steam, and under such pressure, as would suffice to furnish the power required, and thus preserve a record of the amount of steam used. Or a rubber hose might have one of its ends connected with high-pressure steam in pipe n^1 or pipe n^3, Fig. 7, before the steam enters the meter, and its other end movable, so that it could be taken to any part of the house to extinguish small fires, or for the purpose of boiling clothes, running washing-machines, sewing-machines, or other machines requiring power to work them.

Finally, I would state that in case any hissing noise should be communicated through the steam-pipes leading from the meter to radiators in rooms above, the same may be remedied by having such pipes made with a short section of rubber tube at some convenient point of their length in the basement.

It may be desirable under some circumstances to take steam from the mains at other points than the junction service-boxes—as, for instance, at a four-way branch, where one street connects with another, but does not cross, a service-pipe could be taken out from the fourth or unoccupied side of the four-way branch. And I do not limit myself to an expansion-chamber to receive the longitudinally-expansive thrust of the main pipe F^1, which shall also serve as a chamber from which to distribute steam to the service-pipe *a*, as it may, in some instances, be desirable to use an expansion-chamber to receive the longitudinally-expansive thrust of the main pipe, without having a service-pipe connected therewith.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An underground steam street-main in combination with steam-supplying apparatus, and with a meter constructed to control the pressure of steam in a building, and also record the consumption of steam from such main, substantially as described.

2. Underground street-mains, connected with steam-supplying apparatus, and with junction-boxes which permit expansion and contraction of the mains longitudinally, and with heat-radiators in buildings contiguous to streets where the mains are laid, substantially as and for the purposes described.

3. In combination with steam-conveying pipes of a building, for conveying steam to heat the building, and for other purposes, a steam-meter constructed to control the pressure of steam in such pipes, and also record the consumption of steam in the building, substantially as described.

4. An underground steam street-main, in combination with steam-supplying apparatus, and with a heat-radiator of a building, and with a meter, substantially as described.

5. Underground street-mains connected with steam-supplying apparatus, and with a heat-radiator, and with a steam-trap, substantially as described.

6. Underground street-mains connected with steam-supplying apparatus, and with a heat-

radiator, and with a steam-trap, which answers the double purpose of a reheater and a steam-trap, substantially as described.

7. An underground steam street-main in connection with steam-supplying apparatus, and with a heater of a building, and with a water-hydrant, substantially as and for the purpose described.

8. An underground steam street-main connected with steam-supplying apparatus, and with a heater of a building, and with a street steam-hydrant, substantially as and for the purpose described.

9. Underground street-mains connected with steam-supplying apparatus, and with a heat-radiator, and with an automatic steam-regulator or governor, substantially as and for the purpose described.

10. Underground steam street-mains connected with steam-supplying apparatus, and with a heat-radiator of a building, and with underground snow and ice reservoirs having open-ended or perforated steam-pipes in said reservoirs for the escape of steam therein, substantially as and for the purposes described.

11. A steam street-main expansion-chamber, F^8, substantially as described.

12. An adjustable hood, g, in combination with street-main F^1, service-pipe a, and an expansion-chamber, which serves as a steam-chamber, substantially as described.

13. The combination of the expansion-chamber F^8, the street-main F^1 screw-threaded as at f^3, the adjustable ring G^2, and the follower e, substantially as and for the purpose described.

14. The wall of the expansion-chamber F^8 of the junction-box F^{10}, made to support the inner end of a section of the steam-main, and the outer covering m^2 of the steam-main, substantially as described.

15. The section f^2 of the steam-main, made of nickel-plated metal, substantially as and for the purpose described.

16. The combination of the convex ring g^4 of the steam-main F^1, the wall of the expansion-chamber, tube G, and eyebolts g^3, substantially as and for the purpose described.

17. Steam street-mains, insulated as described, drained by tiles, as at x, substantially as and for the purpose described.

18. The meter-cylinder c, having inlet n^3, an outlet, n^4, and an annular diaphragm, c^7, in combination with a longitudinally-adjustable cone-valve, c^4, a laterally-traveling pencil-finger, i^2, clock movement M, and ribbon M′, substantially as and for the purpose described.

19. One or more than one radiator heated heated by steam supplied through the passage of the cone-valve c^4, in combination with the regulator K, whereby the same determined pressure of the steam is practically maintained either in one radiator, or in more than one radiator, whether only one radiator or more than one radiator is in use at the same time, substantially as described.

20. The spring i^6 in combination with the bar i^3, the pencil-finger i^2, clutch i^4, and valve-stem c^5, substantially as and for the purpose described.

21. The combination of the conducting-pipe n^1 and steam-pipe n^7, having a coil, h', and the trap I′, having connected chambers e^2 and e^3 and pipe n^{11}, substantially as and for the purpose described.

22. The suspended trap-float f^4, provided with a tube, t, of less height than the depth of the chamber of the float, in combination with the pipe n^{11}, pipe n^{12}, cock w^2, and pipe w^3, substantially as and for the purpose described.

23. A reheater interposed between radiators, which are heated by steam from the source of supply, and radiators which are heated by water of condensation from the same steam, substantially as and for the purpose described.

24. The reheater-pipe n^7 in combination with the trap I′, substantially as and for the purpose described.

25. A street steam-hydrant connected with the street-main F^1, and located in close contiguity to a water-hydrant, which is warmed by a pipe, n, connected to said main F^1, whereby steam and water may at all times be simultaneously supplied from the same locality to an engine for extinguishing fires, substantially as described.

26. The casings m^5 and m^6 for the service-pipes, said casings serving for preventing the major portion of the service-pipes from becoming impacted by earth, and for permitting them to expand and contract freely, substantially as described.

27. A contrivance or contrivances for supplying steam for warming districts of dwellings in cities and towns, and for driving machinery, and for other purposes in said districts, consisting of steam-supplying apparatus, street-mains having expansion junction service-boxes, service-pipes having connecting-pipes, and meters, substantially as described.

Witness my hand in the matter of my application for a patent for new and improved apparatus for utilizing steam for heating and other purposes in cities and towns, this 21st day of April, A. D. 1877.

BIRDSILL HOLLY.

Witnesses:

SAML. ROGERS,

I. H. BABCOCK.