No. 671,775. Patented Apr. 9, 1901.

F. H. RICHARDS & H. F. DUNHAM.

FIRE EXTINGUISHING APPARATUS.

(Application filed Sept. 6, 1899.)

(No Model.) 3 Sheets—Sheet 1.

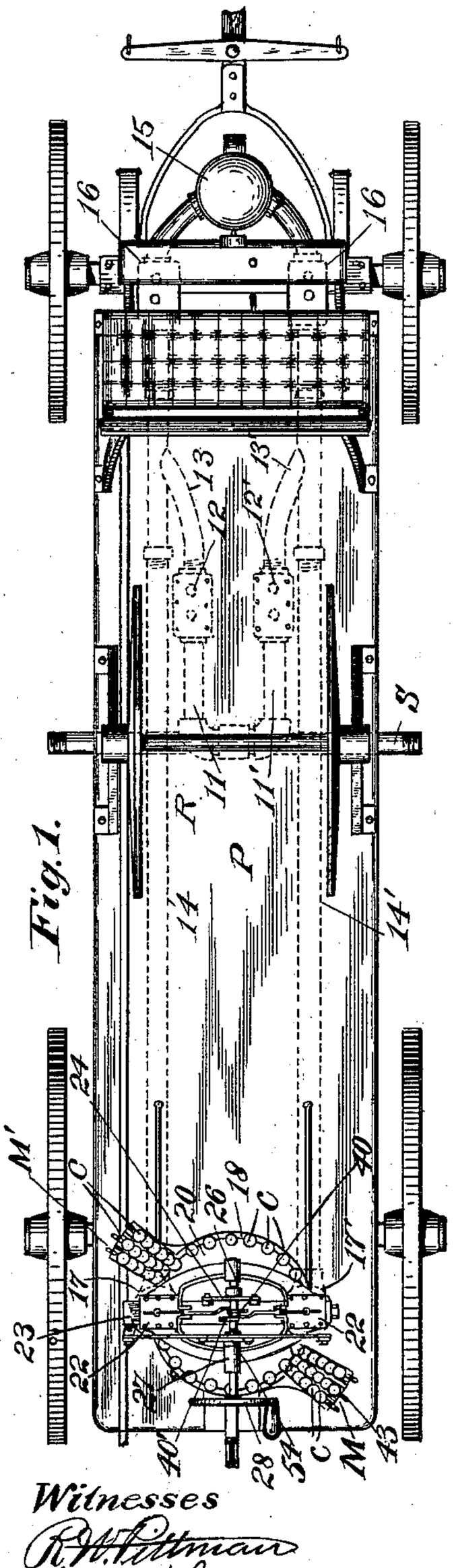

Fig. 1.

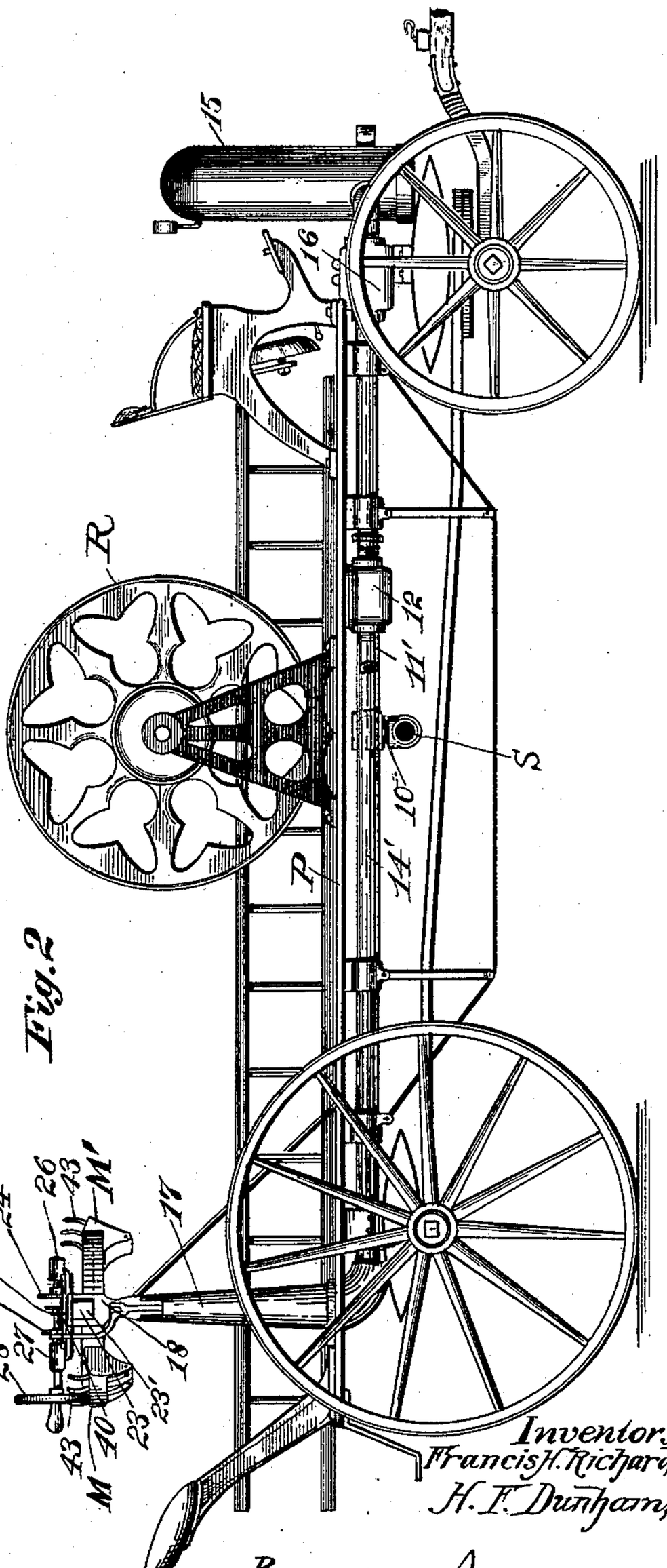

Fig. 2.

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(No Model.) 3 Sheets—Sheet 2.

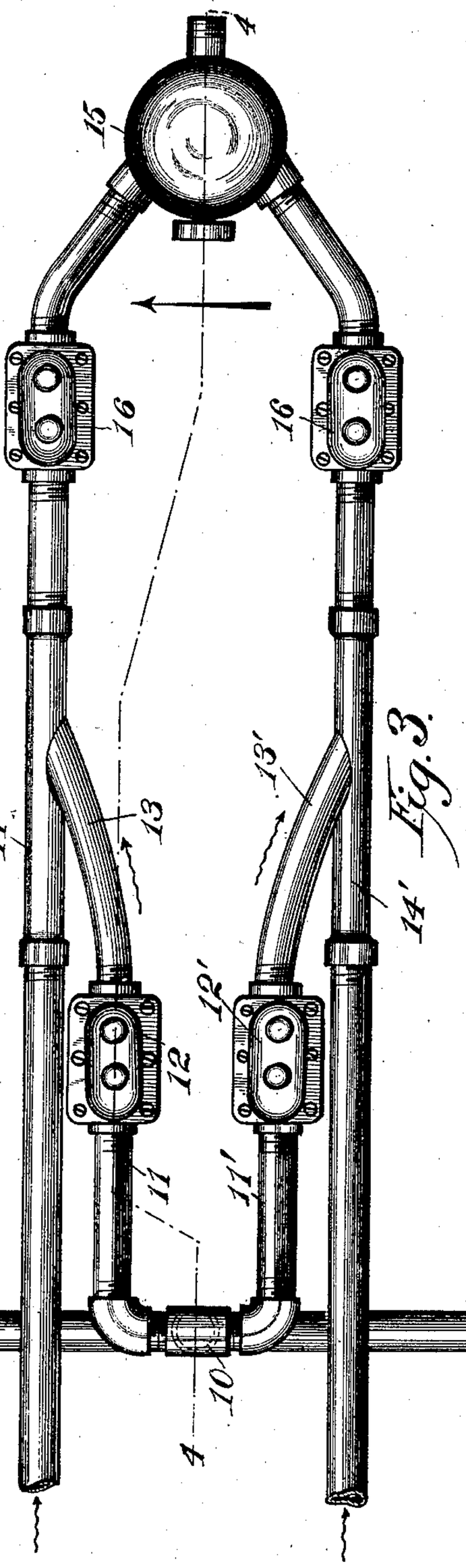

Fig. 3.

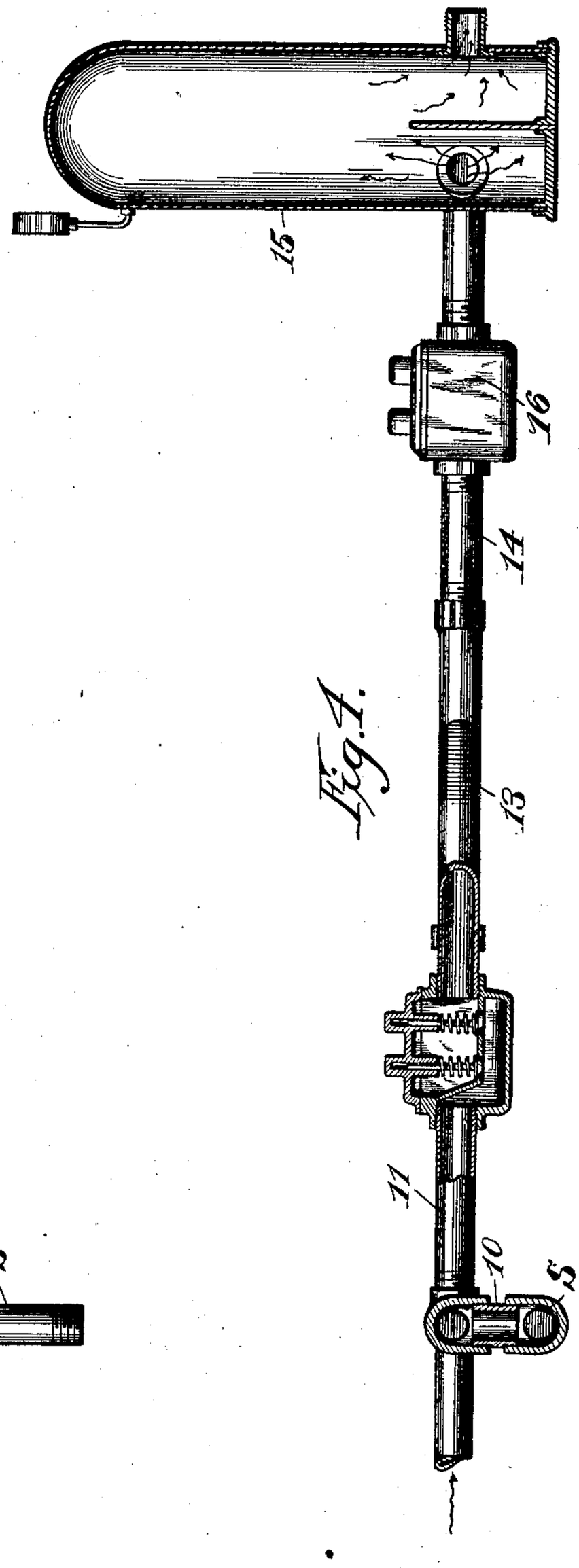

Fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 5.

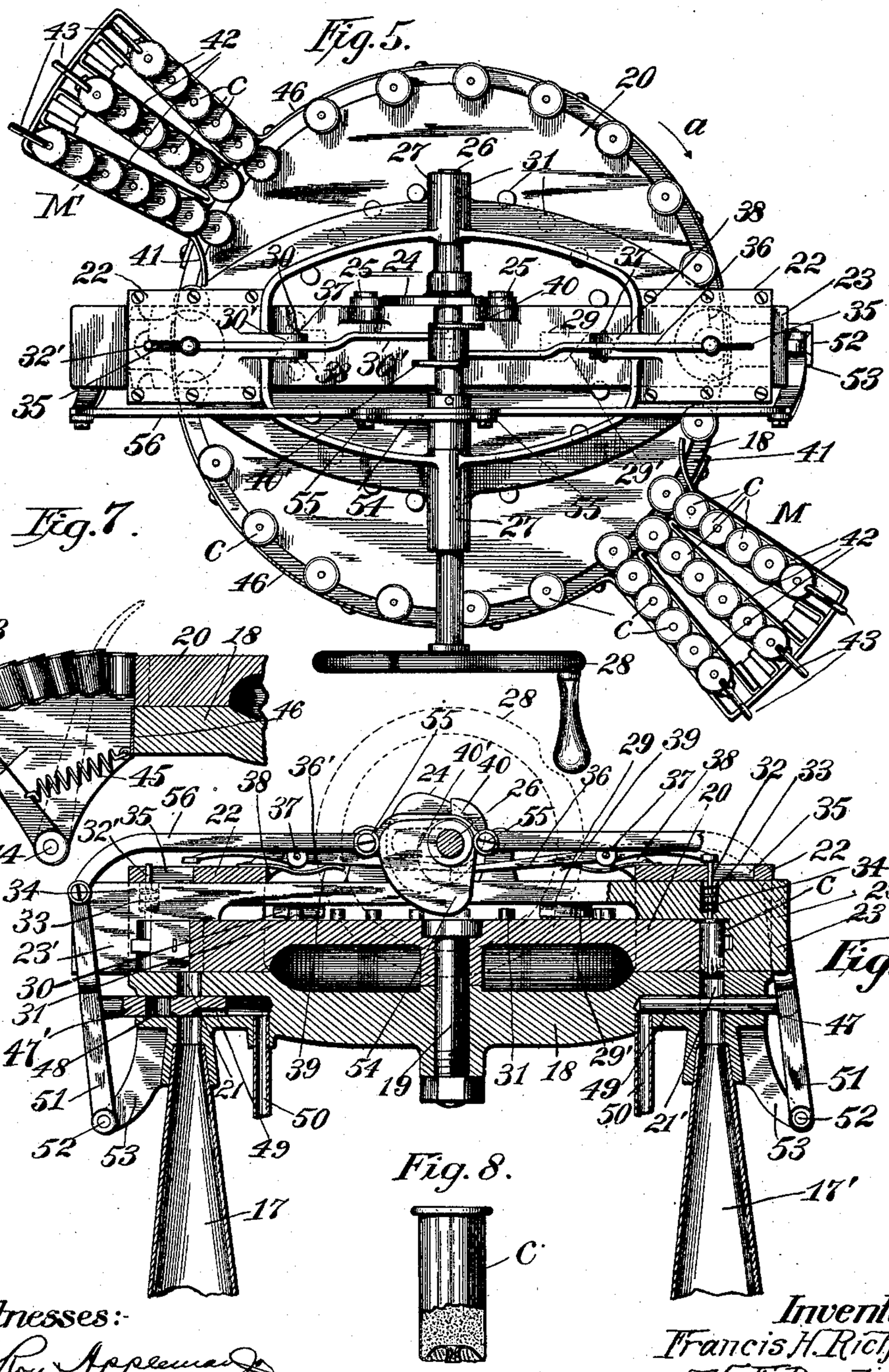

Fig. 7.

Fig. 8.

Fig. 6.

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UNITED STATES PATENT OFFICE.

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FIRE-EXTINGUISHING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 671,775, dated April 9, 1901.

Application filed September 6, 1899. Serial No. 729,609. (No model.)

To all whom it may concern:

Be it known that we, FRANCIS H. RICHARDS, residing at Hartford, in the county of Hartford and State of Connecticut, and HERBERT F. DUNHAM, residing at New York, in the county of New York and State of New York, citizens of the United States, have invented certain new and useful Improvements in Fire-Extinguishing Apparatus, of which the following is a specification.

This invention relates to fire-extinguishing apparatus which may be used in connection with a water-supply having a comparatively low pressure, and has for its object the provision of a device of the class mentioned in which a column of water will be discharged under a high pressure imparted to it by a series of rapidly-succeeding explosions, the present invention being an improvement on that shown and described in Patent No. 632,702, dated September 12, 1899.

Our invention embodies an apparatus which preferably comprises a plurality of what may be termed "working chambers," to which a supply of water will usually be constantly furnished and which may be in communication with a plurality of explosion-producing devices for imparting successively and preferably alternate impulses to the water columns to be discharged from said working chambers.

One important feature of this apparatus is that organization of the working parts of the mechanism whereby the explosion device may cause the delivery of more water than is directly displaced in the working chambers by the gases produced by an explosion and whereby the water in immediate contact with the gases is disposed of in such a manner as not to carry such gases to any considerable extent into the delivery pipes or conduits. For this reason the main conduit leading from the working chamber may be made of relatively considerable length and may form substantially a barrel, which is supplied with water for recharging the working chambers at a point relatively remote therefrom. By means of this organization a large body of water is set in motion in the main conduit or barrel by the force of an explosion in the working chambers and will have a considerable momentum imparted thereto, thus obtaining an impulse directly from the explosion, which will tend to keep such column of water in motion even after the force of the explosion may have been dissipated. In the drawings are represented two separately-operable working chambers discharging streams into an air-chamber common to both and wherefrom the water may be ejected in a single stream through a line of hose attached thereto. Valves may be employed to prevent the water from reentering the supply-conduit after an explosion has taken place in the working chamber, and other valves may be employed to prevent a return of the water from the air-chambers to the working chambers after the explosions therein have spent their forces. On the completion of the discharge from one of the working chambers the latter will be supplied by the backward flow of water in the main conduit or barrel, this in turn being supplied by a continuance of the movement already taking place in the supply-pipes, so that this movement of the supply-water will instantly operate to resupply the working chambers through said main conduit. By means of this organization that body of water which during one explosion was nearest to the gases and therefore liable to be fully impregnated therewith will be uppermost in the working chambers during the refilling thereof, and it is evident that when a vent-passage at that point of the working chambers is opened the gas-charged water will be permitted to escape through the vent and in this manner free the working chambers after each operation from such gases and gas-charged water, and therefore a comparatively gas-free body of water will again be presented to be acted upon by the next explosion in the working chambers. The main conduit for supplying water to the chambers and which also serves as a discharge-conduit forms substantially a barrel in which a column of water is contained and in which the water will be carried forward by means of its acquired momentum, even after the gases, by reason of their expansion, have ceased to be effective. The working chambers are preferably made of tapering form

and connected at their smaller ends to the explosion-chambers, so that the gases produced by an explosion will act first upon a small body of the fluid, which for that reason will normally receive at once a high velocity and which in imparting its forces to the fluid farther along in the working chambers operates to set in motion a larger body of fluid, but at a lower velocity, thereby in effect converting the large body of water into a projectile moving at a relatively low velocity. At first the gases expand to a maximum volume and then immediately contract to a much smaller volume, thus tending to create a partial vacuum, which will assist in the prompt refilling of the chambers with water.

A further object of our invention is the improved organization and construction of the explosion device, as will be hereinafter set forth and as is illustrated in the accompanying drawings, in which—

Figure 1 is a top view of a fire-extinguisher embodying our invention. Fig. 2 is a side view of the same. Fig. 3 is a plan view of the forward part of the main supply and discharge conduits. Fig. 4 is a section on line 4 4, Fig. 3. Fig. 5 is a top view of the device for producing explosions. Fig. 6 is a vertical central section of the same. Fig. 7 is a detail view of a magazine employed in connection with said explosion device, and Fig. 8 represents in detail a cartridge of preferred form to be used in connection with the explosion device.

Similar characters of reference designate like parts in all the figures of the drawings.

In the drawings a fire-extinguishing apparatus constructed in accordance with our invention is mounted upon a truck such as is usually employed in fire departments, and which is provided with means for carrying a supply of hose, shown in the nature of a reel R, which is mounted upon a platform P, upon which ladders or other fire-department paraphernalia may be carried. Arranged between the front and rear wheels is a supply-pipe S, extending transversely across the truck and having its ends adapted for a coupling for securing a hose to be connected with a hydrant, which may furnish water to the supply-pipe S under a comparatively low pressure. A short vertical pipe 10 is connected with the supply-pipe S and furnishes water or other fire-extinguishing liquid to horizontal pipes, such as 11 and 11′, provided with check-valves, preferably constructed as shown at 12 and 12′ in Figs. 3 and 4, and which are in communication by means of pipes 13 and 13′ with the main conduits 14 and 14′, respectively, extending forwardly to the air-chamber 15 and each provided with a check-valve 16. At their rear ends the main conduits 14 and 14′ are connected with the lower ends of preferably vertical working chambers 17 and 17′, which may be filled with water from the supply-pipe S in the manner hereinbefore described. This air-chamber 15 is provided with means, such as a division-wall 15′, effective to turn the column of fluid upwardly away from the discharge pipe or outlet, and thereby tending to preserve a more even pressure at the discharge, and also affords an opportunity for delivering into the upper part of such chamber any gases which may be in the water-supply, and thus keep the air-chamber properly supplied with air or gas and at the same time provide for the delivery of the water with a minimum of gas therein. The upper ends of the working chambers may be tightly secured to a bed-plate 18, (see Fig. 6,) carrying a stud 19, upon which is journaled a carrier, which may be made in the form of a disk, such as 20, and provided in its periphery with a series of recesses or notches, which are adapted to receive cartridges to be supplied to chambers 21 and 21′, formed in the bed-plate 18.

The chambers 21 and 21′ constitute explosion-chambers into which the cartridges *c* as they are consecutively carried into position by the carrier 20 may be discharged, such discharge being effective to impart an impulse to the column of water contained within the working chamber in communication therewith, and thus force the same under a very high but rapidly-diminishing velocity into the air-chamber 15, the return of such water being prevented by the check-valves 16 above mentioned.

Suitable means are provided for properly placing a cartridge in alinement with the explosion-chamber, the preferred device for this purpose being a slide 23, mounted in bearings 22, which are secured to the bed-plate 18, and to which slide 23 reciprocatory motion may be imparted by a cam 24, disposed between rollers 25, journaled upon such slide. The cam 24 is secured to a shaft 26, journaled in bearings 27, which are supported by the bearing-blocks 22, said shaft carrying at one end a hand-wheel 28, whereby rotary motion may be imparted to it by the operator. Near its outer extremities the slide 23 is provided with downwardly-projecting heads 23′, the inner faces of which are concaved to conform to the shape of the shell of the cartridge *c*, and which in conjunction with the disk 20 serves to locate the cartridge properly and to retain the same in position until fired.

As above stated, the bed-plate 18 is supported by the chambers 17 and 17′, while the carrier 20 is pivotally secured on said plate, and in order to close the joint between the carrier 20 and the plate 18 and also the joint between the under side of the head 23′ and said plate sufficiently to form a "gas-check" we preferably employ a cartridge, such as is illustrated in Fig. 8 of the drawings and which embodies a shell having its end portion formed of yielding material, so as to be adapted to be crimped and twisted and reentered into the shell for the purpose of packing the charge. Upon the cartridge being freed the yielding end will be projected into

the explosion-chamber 21 and will readily open and expand to hug the wall of the explosion-chamber tightly.

An intermittent motion may be imparted to the carrier to remove an empty cartridge-shell and carry a new cartridge into alinement with the explosion-chamber, such movement being preferably effected by cam-blocks 29 and 30, which are secured to the under side of the slide 23 and which are provided with inclined faces 29′ and 30′, adapted to engage a series of pins, such as 31, held in the carrier. Said cams 29 and 30 are of a width equal to the spaces between each adjacent pair of pins 31, so that when said carrier has been shifted by an advancing movement of either cam 29′ or 30′ and the movement of the slide 23 is continued in the same direction said cams will serve as a means for locking the carrier against further rotary movement.

The cams 29 and 30, in conjunction with the pins 31, constitute an escapement for advancing the carrier to bring a new cartridge into alinement with the explosion-chamber 21 during the travel of the slide in one direction, while another cartridge is supplied to the other explosion-chamber 21′ upon the movement of the slide in the reverse direction.

In order to guard against premature explosion, we preferably organize the firing mechanism so as to be carried by the slide 23 and in this manner bring the same into effective working position when a space for a cartridge in the carrier is in alinement with the explosion-chamber.

The firing mechanism consists substantially of firing-pins 32 and 32′, carried by the slide 23 and acted upon by springs 33, disposed within the recesses 34, provided therefor in such slide and normally tending to project said firing-pins above the bearing-blocks 22, which are provided with slots 35 to permit such movement of the slide and firing-pins.

Means are provided for acting upon the firing-pins, such means consisting, in the preferred form thereof shown, of levers 36 and 36′, which are pivoted at 37 to ears 38, carried by the above-mentioned blocks 22. The outer ends of said levers 36 and 36′ are so positioned that when the firing-pin coöperating therewith is in alinement with the explosion-chamber said pin may be forced downward to explode a cartridge and against the action of the spring 33 by springs 39 in engagement with said levers 36 and 36′, the inner ends of which are engaged to depress and quickly release the same at predetermined periods by cams, such as 40 and 40′, secured to the shaft 26, said cams being substantially alike, but so set that they will act to depress the levers 36 and 36′ to discharge the cartridges alternately.

When the carrier 20 is rotated in the direction of the arrow *a* in Fig. 5, the empty shells are shifted away from the explosion-chambers 21 and 21′, the inner ends thereof being forcibly withdrawn by the movement of the carrier from such explosion-chambers and carried around with said carrier into a position where such shells may drop out of the recesses in said carrier or be positively extracted therefrom, as by means of inclined blades 41, arranged in horizontal alinement with the cartridge-heads and secured in position on the sides of the magazines M and M′, each of said magazines preferably embodying a series of chambers 42, shown herein as three in number, for receiving a number of cartridges which may be fed automatically to the empty spaces or notches in the rotating carrier by levers, such as 43, pivoted at 44 to the magazine-casing and actuated by suitable springs, such as 45. The cartridges after having been placed in this manner in the carrier may be held in position therein by stationary guard rails or bands 46, extending concentrically around said carrier, each from one magazine to a point where the cartridge is extracted by the extractor, each slide being recessed to provide for its band, whereby that part of the slide above and below the band will engage the cartridge.

It is evident that when a cartridge is exploded in the explosion-chamber the water which is contained within the working chamber, and more especially that body of water adjacent thereto, will be more or less impregnated with the gases generated by such explosion, and inasmuch as it is essential that the products of such explosion, which has performed its function in partially forcing the water out of said working chamber, shall be permitted to escape, means are provided whereby the explosion-chamber is closed or shut off automatically from the working chamber, and simultaneously therewith a passage or vent is opened for relieving the pressure in the upper part of said working chamber and for permitting the same to be filled from the main supply-pipe S.

The means illustrated in Fig. 6 of the drawings comprise shiftable valves 47 and 47′, having apertures 48, adapted to establish communication between the explosion and working chambers, and are provided at their inner ends with passages 49, through which the gases and the gas-impregnated water may pass and be discharged through vent-pipes 50. The ends of the reciprocatory valves 47 are attached to levers 51, pivoted at 52 to projections 53 on the bed-plate 18, and movement is imparted to said levers to shift said valves 47 either to shut off the vent-ports and open communication between the explosion and working chambers, or vice versa, by a cam 54, coacting with rolls 55, which are journaled on a pitman-rod 56, having its outer ends pivotally secured to the above-mentioned levers 51.

The operation of a machine constructed in accordance with our invention as shown herein is as follows: The supply-pipe S is connected by means of a hose with a water-

supplying means, which may be an ordinary street-hydrant, for filling the main conduits and working chambers with water, while at the same time the air-chamber is supplied according to the pressure of such water. The explosion device may now be started, when cartridges will be supplied alternately to the explosion-chambers and discharged by the firing mechanism, thus producing explosions in the explosion-chambers, which will tend to force that body of water between the explosion device and the air-chambers into the line of hose attached thereto. As the hand-wheel 28 of the explosion device is rotated the firing-levers 36 and 36′ are depressed alternately by their respective cams, and upon their release the firing-pins will be struck alternately. The further rotation of the shaft 26 will operate the valves 47 to open the vent-passage 50 and permit the gases and gas-impregnated water still contained within the working chamber 17′ to escape. Slide 23 is then operated by its cam 24 to move toward the right, whereby the locking-cam 30 will be withdrawn from between a pair of pins 31, and the cam 29 is rendered effective to rotate the carrier 20 in the direction of the arrow *a* in Fig. 5, by which movement the now empty shell will be displaced and extracted from said carrier by one of the extractor-blades 41 coming in contact therewith. As the slide 23 is moved from the left to the right by its cam the firing-pin at the right-hand end thereof will be carried out of alinement with the working chamber and the firing-pin 32′ on the left will be brought into alinement with a cartridge which has been carried into proper position by the rotation of the carrier and which may upon further rotation of the shaft be fired by the lever 36′, the valve 47′ being then in position to have its aperture 48 establish communication between the explosion-chamber 21 and the working chamber 27. On the further rotation of the shaft 26 the same sequence of movements will take place, the slide 23 being moved toward the left instead of to the right, and as the empty shells are withdrawn from the carrier blank spaces are presented to the magazines, such spaces being refilled from either of the chambers of said magazines with fresh cartridges in an automatic manner by any one of the spring-actuated levers 43. It will be understood that according to the speed with which the shaft 26 is rotated new cartridges may be fed to the explosion-chambers and fired and the rapidity of firing governed, and that therefore the forces generated in the explosion-chambers may result in imparting rapidly-successive impulses to the water-columns contained within the working chambers and main conduits.

Particular attention is invited to the organization of the working chambers, upon the construction of which the efficiency of the apparatus depends to a great extent. To secure a large total efficiency from an explosive, it is necessary that the said explosive should be so confined at the moment of ignition that it will exert a pressure such as would result if the explosive had been confined in a space equal to that of its own volume. To secure the largest total efficiency, it will be necessary to make such provision for the expansion of the gases as to permit them to do work while expanding and at the same time prevent them from escaping while under working pressure. A working chamber of tapering formation in connection with its barrel accomplishes this result. The high initial pressure in the small end of such chamber can be resisted by comparatively thin walls, and as the gases are expanding and force the water in the working chamber downward the pressure will diminish; but while this reduction in pressure is taking place the available energy of the gases will be imparted as velocity to the water, which will be put in motion of increased velocity both in the working chamber and in the barrel, and the expanding gases will continue to exert their force until it is entirely spent. In the present instance the high initial energy of the gases will first give high velocity to a small volume of water, which will impart its energy to a larger volume, and the gases in expanding will thus act directly upon a larger volume, so that in effect the small body of water moving at a high velocity becomes gradually a much larger and heavier column moving at a low velocity, and thereby makes available under such low pressure as a fire department requires the energy derived from the high initial pressure for producing desirable and economical results.

In the foregoing specification the fire-extinguishing medium has been referred to as being water; but it is evident that any other suitable liquid or fluid may be used in lieu thereof, the invention not being limited to that particular medium.

Having described our invention, we claim—

1. The combination, with a fluid-receiving working chamber having different diameters and having in connection therewith a fluid-inlet and a fluid-outlet, of means for producing an explosion, the gases resulting therefrom having contact with such fluid, thereby to utilize the same as a medium for forcing fluid through such outlet.

2. The combination of a tapered working chamber having a liquid-inlet and a liquid-outlet in communication therewith, and means for producing an explosion, the gases resulting therefrom having contact with such fluid in said chamber, thereby to utilize the same as a medium for forcing liquid through said outlet.

3. The combination of a tapered working chamber having in communication therewith a fluid-inlet and a fluid-outlet, and means in connection with the smaller end of said chamber for producing an explosion, thereby to force liquid through said outlet.

4. The combination, with a working chamber having different diameters and having in communication therewith a liquid-inlet and a liquid-outlet, of means, in connection with that part of said chamber having the smallest diameter, for producing explosions, thereby to force liquid through said outlet.

5. The combination of a pair of working chambers each of tapered formation and having in communication therewith a liquid-inlet and a liquid-outlet, and means in connection with each of said chambers adjacent to the apex thereof for producing explosions alternately, thereby to force liquid through said outlet.

6. In a fire-extinguishing apparatus, the combination, with liquid-supply means and liquid-discharge means, of means for producing explosions to discharge liquid under pressure, and a pressure-reducing working chamber of different diameters for transmitting the impulses of the explosions to the liquid to be discharged.

7. The combination, with a working chamber of tapered formation having a liquid-inlet and a liquid-outlet, of means for controlling the passage of liquid relatively to said inlet; means for controlling the passage of material relatively to said outlet; and means in connection with the apex of said working chamber and effective to produce an explosion, thereby to force liquid through said outlet.

8. In a fire-extinguishing apparatus, the combination, with a working chamber having a liquid-inlet and a liquid-outlet, of means for effecting an explosion thereby to apply pressure to the liquid in the working chamber, and means operative at one period to permit the escape of gaseous products from the working chamber and in another direction to open communication between said working chamber and said explosion-producing means, and means embodying cam mechanism for controlling the operation of said means.

9. In a fire-extinguishing apparatus, the combination, with a working chamber having a liquid-inlet and a liquid-outlet, of means for producing an explosion to apply pressure to the liquid in said working chamber, and means effective on one operation thereof to permit the escape of gas from the working chamber and on another operation thereof to permit communication between the explosion-producing means and said working chamber.

10. In a fire-extinguishing apparatus, the combination, with liquid supplying and discharging means embodying a working chamber in connection with the supplying means, of a device embodying an explosion-chamber for applying pressure to the liquid in the working chamber, and a valve operable in one direction to permit the escape of gas from the working chamber and operable in another direction to open communication between said explosion and working chambers.

11. In a fire-extinguishing apparatus, the combination, with liquid-supplying means embodying a check-valve to prevent back pressure, of an explosion device embodying an explosion-chamber, and a working chamber in communication therewith and adapted to be filled by said liquid-supplying means, said chamber being smaller adjacent to the explosion-chamber than at the discharge end thereof.

12. In a fire-extinguishing apparatus, the combination, with an explosion device embodying an explosion-chamber, of a working chamber having different diameters and connected near the point of the smallest diameter with the explosion-chamber; a conduit connected with the working chamber to supply liquid thereto; a check-valve for preventing the return of such liquid; a discharge-conduit; and an air-chamber connected therewith.

13. In an apparatus of the class specified, the combination, with a working chamber of tapered formation and having a liquid-inlet and a liquid-outlet, of means for controlling the passage of liquid relatively to said inlet; means for controlling the passage of liquid relatively to said outlet; means in connection with the apex of said working chamber and effective to produce explosions thereby to force liquid through said outlet; and an air-chamber in communication with said working chamber and outlet.

14. In a fire-extinguishing apparatus, the combination, with a working chamber having a vent, and means for supplying liquid to said chamber, of an explosion-chamber adapted to communicate with said working chamber and to contain a cartridge; firing mechanism; and means for opening said vent and closing the explosion-chamber after the discharge of a cartridge.

15. In a fire-extinguishing apparatus, the combination, with a working chamber having a vent and means for supplying liquid to said chamber, of an explosion-chamber adapted to communicate therewith; a carrier for supplying cartridges to said explosion-chamber; firing mechanism; and means for opening said vent and closing the explosion-chamber after the discharge of a cartridge.

16. In a fire-extinguishing apparatus, the combination, with a working chamber having a vent, and means for supplying liquid to the chamber, of an explosion-chamber adapted to communicate therewith; a carrier for supplying a cartridge to said explosion-chamber; firing mechanism; means for opening said vent and closing the explosion-chamber after the discharge of a cartridge; and means for extracting the cartridge-shell.

17. In a fire-extinguishing apparatus, the combination of a tapered working chamber having a liquid-inlet and a liquid-outlet; an explosion-chamber in communication with said working chamber; a carrier for supplying a cartridge to such explosion-chamber; and means for imparting movement to said carrier.

18. In a fire-extinguishing apparatus, the combination, with working chambers and means for supplying liquid thereto, of explosion-chambers adapted to communicate therewith; a shiftable duplex carrier having cartridge-carrying recesses and operative to supply a cartridge to each explosion-chamber alternately and a device for setting a cartridge in alinement with the explosion-chamber.

19. In a fire-extinguishing apparatus, the combination of a tapered working chamber having a liquid-inlet and a liquid-outlet; an explosion-chamber in communication with said working chamber; a shiftable cartridge-carrier carrying cartridges; and a reciprocatory device for locating a cartridge in position relatively to the explosion-chamber.

20. In a fire-extinguishing apparatus, the combination, with a working chamber and means for supplying liquid thereto, of an explosion-chamber adapted to communicate therewith; a shiftable carrier having cartridge-holding means to receive cartridges; a device for setting a cartridge in alinement with the explosion-chamber; and means operable by such setting device for shifting the carrier.

21. In a fire-extinguishing apparatus, the combination, with a working chamber and means for supplying liquid thereto, of an explosion-chamber adapted to communicate therewith; a shiftable carrier having recesses to receive cartridges; a device for setting a cartridge in alinement with the explosion-chamber; and an escapement carried by the setting device for shifting the carrier.

22. In a fire-extinguishing apparatus, the combination, with a working chamber and means for supplying liquid thereto, of an explosion-chamber adapted to communicate therewith; a carrier having projections; a slide for setting a cartridge in alinement with the explosion-chamber; and a cam carried on said slide and engaging said projections for shifting the carrier.

23. In a fire-extinguishing apparatus, the combination, with a working chamber and means for supplying liquid thereto, of an explosion-chamber adapted to communicate therewith; a carrier having pins; a slide for setting a cartridge in alinement with the explosion-chamber; and an escapement for shifting the carrier.

24. In a fire-extinguishing apparatus, the combination, with a working chamber and means for supplying liquid thereto, of an explosion-chamber adapted to communicate therewith; a carrier having pins; a slide for setting a cartridge in alinement with the explosion-chamber; and a cam carried on said slide and engaging said pins for shifting the carrier and locking the same in position.

25. In a fire-extinguishing apparatus, the combination, with a working chamber and means for supplying liquid thereto, of an explosion-chamber adapted to communicate therewith; a shiftable carrier for supplying cartridges to said explosion-chamber; a device for setting a cartridge in alinement with the explosion-chamber; a firing-pin carried by such device; and means for operating said setting device and for shifting the carrier.

26. In a fire-extinguishing apparatus, the combination, with a pair of working chambers and means for supplying liquid thereto, of a pair of explosion-chambers adapted to communicate with said working chambers; a carrier for supplying cartridges to said explosion-chambers; and means for alternately firing the cartridges.

27. In a fire-extinguishing apparatus, the combination, with a pair of working chambers, means for supplying liquid thereto, discharging means embodying an air-chamber, and check-valves for preventing back pressure in the working chambers and in the liquid-supplying means, of an explosion device for alternately applying pressure to the liquid in the working chambers.

28. In a fire-extinguishing apparatus, the combination, with a plurality of working chambers and means for supplying liquid thereto and discharging liquid therefrom into a single stream, of means for applying a series of rapidly successive explosive impulses first to one and then to another of the discharge-streams before they unite, whereby a continuous force is applied to the united single stream.

29. In a fire-extinguishing apparatus, the combination, with a pair of working chambers, a pair of barrels communicating therewith, means for supplying liquid to each of the barrels and embodying a check-valve, and discharging means embodying an air-chamber, of a pair of independent explosion devices for applying pressure to the liquid in the chambers alternately, and for setting in motion the liquid in each barrel with a sufficient momentum to continue the flow thereof into the air-chamber during the interval between the explosions.

30. In a fire-extinguishing apparatus having a pair of working chambers provided with means for firing cartridges therein in alternation, the combination, with a pair of working chambers, of an air-chamber; a pair of barrels extending from the working chambers, respectively, to the air-chamber, each of said barrels having a capacity in excess of the capacity of its working chamber; means for resupplying each working chamber through its barrel; and valves for controlling the influx and discharge from the barrels whereby, on firing a cartridge in one working chamber, the fluid column in the barrel may be set in motion with a sufficient momentum to continue the flow thereof into the air-chamber during the interim between the firing of the cartridge in the working chamber of said barrel and the firing of a cartridge in the working chamber of the other barrel, thereby to secure a continuous flow of liquid

into the air-chamber, substantially as described.

31. In a fire-extinguishing apparatus, the combination, with a pair of working chambers, of means for supplying liquid thereto, of an explosion-chamber in communication with each of said working chambers; a duplex carrier for receiving cartridges and for alternately supplying the same to the explosion-chamber; means for shifting the carrier to withdraw the shells from said explosion-chambers and to supply cartridges thereto; and means for extracting the shells from the carrier.

32. In a fire-extinguishing apparatus, the combination, with a pair of working chambers and means for supplying liquid thereto, of explosion-chambers adapted to communicate therewith; a duplex carrier for receiving cartridges and for supplying the same to the explosion-chambers alternately; means for shifting the carrier to withdraw the shells from the explosion-chambers and to supply cartridges thereto; means for extracting the shells from the carrier; and a spring-actuated lever for placing the cartridges in the carrier.

33. In a fire-extinguishing apparatus, the combination, with a pair of working chambers and means for supplying liquid thereto, of explosion-chambers adapted to communicate therewith; a duplex carrier for receiving cartridges and for supplying the same to the explosion-chambers alternately; means for shifting the carrier to withdraw a shell from one explosion-chamber and to supply a cartridge to the other; means for extracting the shells from the carrier; and a magazine for charging said carrier with cartridges.

34. In a fire-extinguishing apparatus, the combination of a tapered working chamber having a liquid-inlet and a liquid-outlet; an explosion-chamber adapted to communicate therewith; a carrier for receiving cartridges and for supplying the same to the explosion-chamber; means for shifting the carrier to withdraw a shell from the explosion-chamber and to supply a cartridge thereto; means for extracting shells from the carrier; and a magazine for supplying cartridges to said carrier.

35. In a fire-extinguishing apparatus, the combination of a tapered working chamber having a liquid-inlet and a liquid-outlet; an explosion-chamber adapted to communicate therewith; a recessed carrier for receiving cartridges and for supplying the same to the explosion-chamber; means for shifting the carrier to withdraw a shell from the explosion-chamber and to supply a new cartridge thereto; means for extracting a shell from the carrier; a magazine for supplying loose cartridges to the recesses in said carrier; and means for retaining the cartridges in said recesses.

36. In a fire-extinguishing apparatus, the combination of a tapered working chamber having a liquid-inlet and a liquid-outlet; an explosion-chamber in communication with the smaller end of said working chamber; a shiftable cartridge-carrier carrying cartridges; a reciprocatory device for locating a cartridge in position relatively to said explosion-chamber; and means including cam mechanism for shifting said reciprocatory device.

37. In a fire-extinguishing apparatus, the combination of a tapered working chamber having a liquid-inlet and a liquid-outlet; an explosion-chamber in communication with the smaller end of said working chamber; a shiftable cartridge-carrier carrying cartridges; a reciprocatory device for locating a cartridge in position relatively to said explosion-chamber; means for shifting said reciprocatory device; and means for firing said cartridge.

38. In a fire-extinguishing apparatus, the combination, with liquid-supplying means and liquid-discharge means, of a duplex device effective to produce alternate explosions thereby to discharge liquid under pressure, and a pair of pressure-reducing working chambers for transmitting the pressure of such explosions to the liquid in the discharge means.

39. In an apparatus of the class specified, the combination, with a pair of working chambers each one having different diameters, of a liquid-inlet and a liquid-outlet in communication with said chambers, and means in connection with each of said chambers adjacent to that part having the smallest diameter and effective to produce explosions thereby to force liquid through said outlet.

40. In an apparatus of the class specified, the combination, with a pair of working chambers each of tapered formation, of an air-chamber in communication with the larger end of each working chamber and having an outlet and provided with means for effecting an even pressure of the discharge; means connected with the smaller end of each air-chamber and effective to produce an explosion thereby to force liquid through the air-chamber and its outlet.

41. In an apparatus of the class specified, the combination, with a pair of working chambers each of tapered formation, of an air-chamber in communication with the larger end of each working chamber and having an outlet and provided with means for effecting an even pressure of the discharge; means connected with the smaller end of each air-chamber and effective to produce an explosion thereby to force liquid through the air-chamber and its outlet; and means located intermediate said working chambers and air-chamber to prevent back pressure.

42. In an apparatus of the class specified, the combination, with a working chamber having a liquid-inlet, of means for controlling the passage of liquid relatively to said inlet thereby to prevent back pressure; an air-chamber in communication with said work-

ing chamber and having an outlet, said air-chamber having means for preserving an even pressure of the discharge through said outlet; means located intermediate said working and air chambers to prevent back pressure; and means in connection with said working chamber and effective to produce an explosion thereby to force liquid through the air-chamber and its outlet.

43. In a portable fire-extinguishing apparatus, the combination, with a vertically-located tapered working chamber having a liquid-inlet; a discharge-conduit in communication with said chamber; and means in connection with the smaller end of said working chamber for producing an explosion, the gases resulting therefrom having contact with the liquid in said working chamber to force such liquid therefrom and into and out of said discharge-conduit.

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