

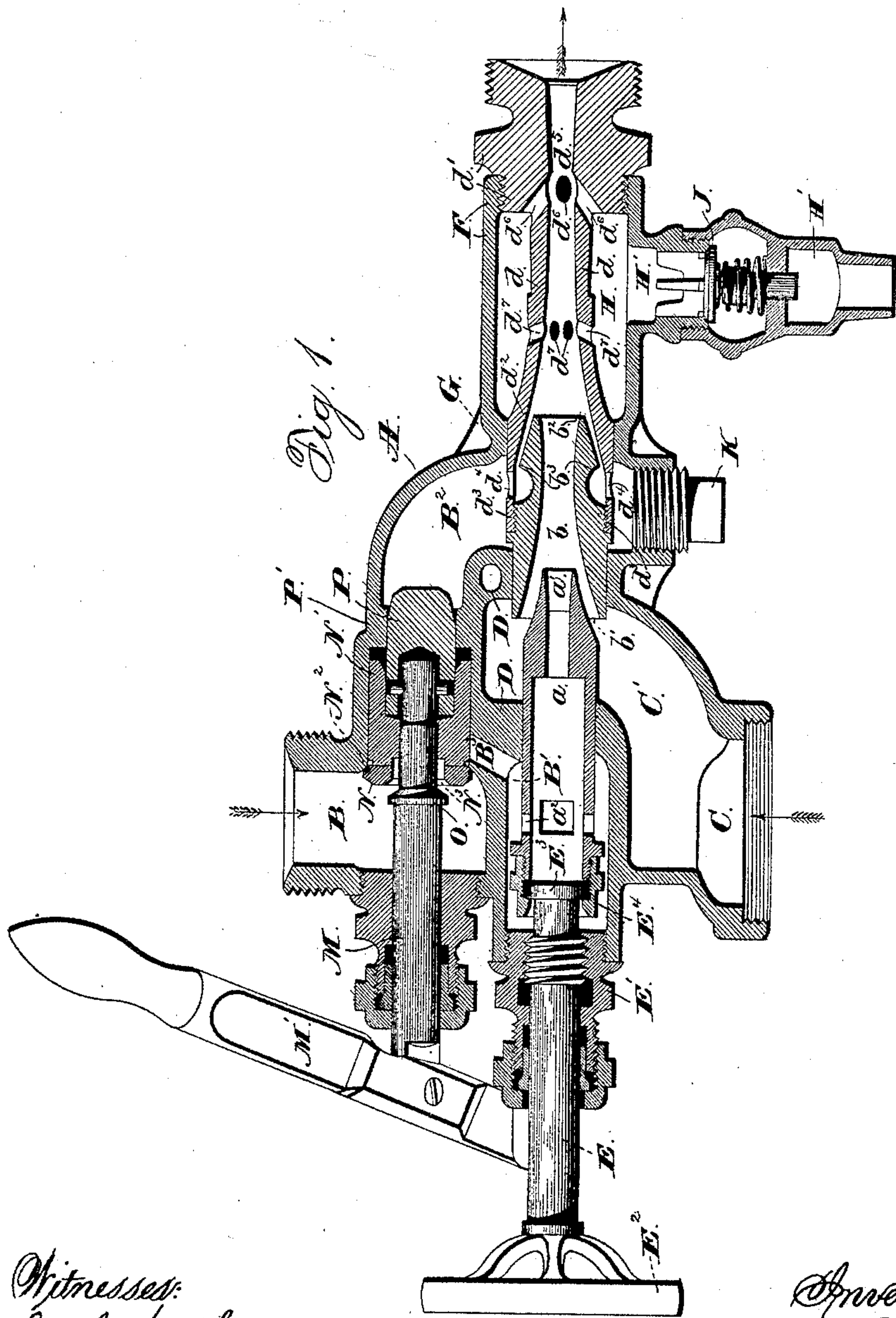
(Model.)

2 Sheets—Sheet 1.

J. D. LYNDE.
BOILER INJECTOR.

No. 440,488.

Patented Nov. 11, 1890.



Witnesses:
Jas. C. Hutchinson.
Henry C. Hazard.

Inventor.
John D. Lynde
by *Russell*
his Attorneys

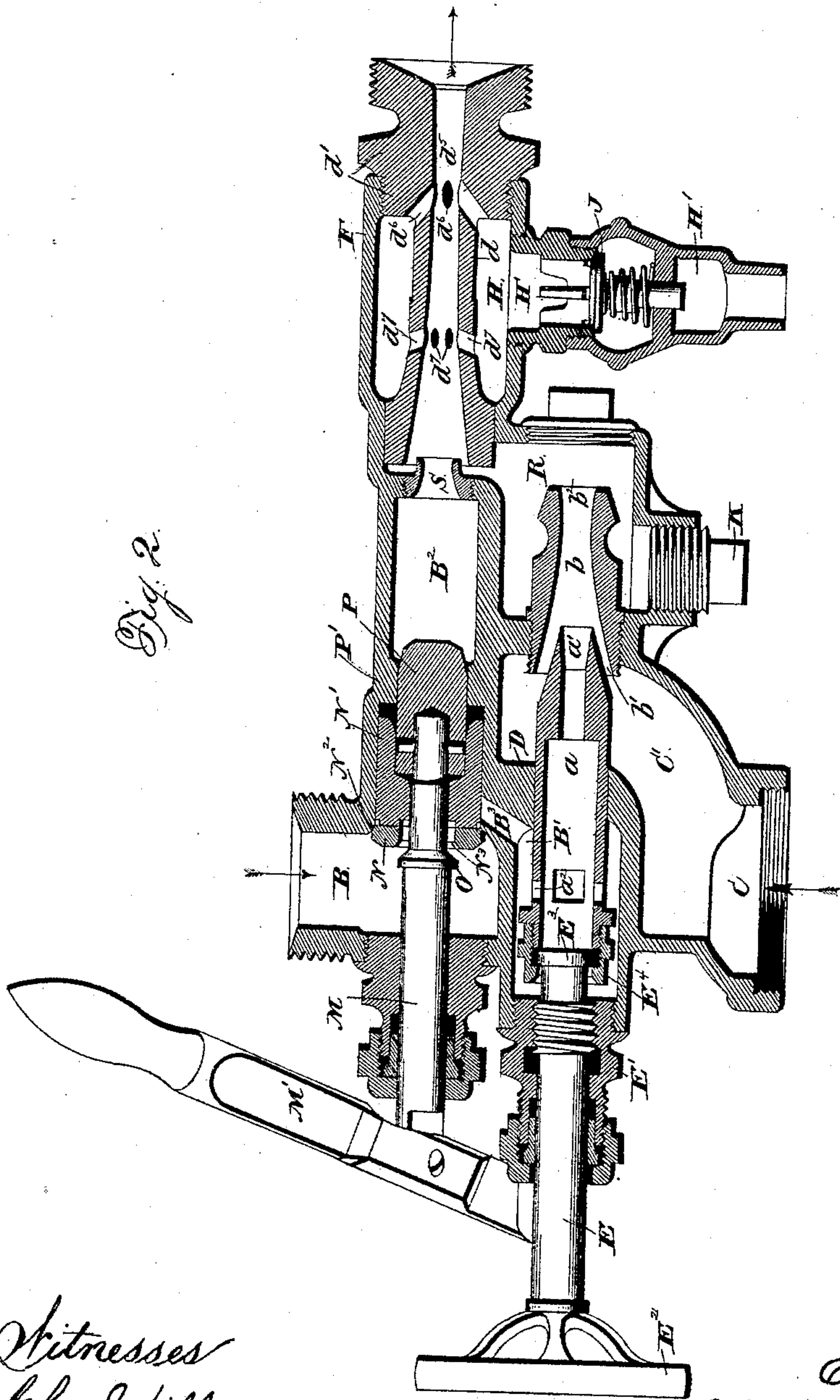
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J. D. LYNDE.
BOILER INJECTOR.

2 Sheets—Sheet 2.

No. 440,488.

Patented Nov. 11, 1890.



Witnesses
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by Prindle & Russell
his Attorneys

UNITED STATES PATENT OFFICE.

JOHN D. LYNDE, OF HADDONFIELD, NEW JERSEY, ASSIGNOR TO THE
HANCOCK INSPIRATOR COMPANY, OF BOSTON, MASSACHUSETTS.

BOILER-INJECTOR.

SPECIFICATION forming part of Letters Patent No. 440,488, dated November 11, 1890.

Application filed September 3, 1886. Renewed October 13, 1890. Serial No. 368,008. (Model.)

To all whom it may concern:

Be it known that I, JOHN D. LYNDE, of Haddonfield, in the county of Camden, and in the State of New Jersey, have invented certain new and useful Improvements in Boiler-Injectors; and I do hereby declare that the following is a full, clear, and exact description thereof.

My improvement relates to those injectors which contain a forcing apparatus and a lifting apparatus arranged relatively to each other, so that the lifting apparatus shall take water from a well or other supply and deliver it to the forcing apparatus, whence by the latter it is forced into the boiler or against a resistance even greater than the pressure of the actuating-steam. In such injectors prior to my invention the "lifter" (as I shall hereinafter call the first or lifting apparatus) has been provided with a waste-opening either in its combining-tube or between that combining-tube and the mouth or inlet end of the combining-tube of the "forcer" (as I shall hereinafter call the second apparatus) and communicating with the atmosphere, the object of this waste-opening being to facilitate the starting of the lifter. If this waste-opening is located between the discharge end of the combining-tube of the lifter and the mouth of the combining-tube of the forcer, as is usually the case, it must be closed after the lifter is well at work, in order that the lifter may thereafter deliver to the forcer all the water which issues from its combining-tube. The closing of this waste-opening has hitherto been effected usually by a valve manipulated by the engineer.

In this class of injectors the forcer is provided with a waste-opening, which may be located, as in the original Giffard injector, at or very near the throat of the forcer combining-tube, in which case a valve is usually provided to prevent the indraft of air at the opening after the injector is in operation, or the waste-opening may be located between the throat of the forcer combining-tube and the check-valve in the delivery-pipe, in which case a valve must be provided to close it after the stream through the forcer has attained the required velocity.

My improvement obviates the necessity for the waste-opening for the lifter located either

in its combining-tube or between that tube and the forcer combining-tube, except when water is to be lifted from a considerable depth below the injector, or when steam of high pressure is used to actuate the injector.

In getting injectors of this class into operation it sometimes occurs that steam is admitted to the forcer steam-jet tube before the current of water from the lifter is established through the forcer combining-tube, and in such case, as the steam which issues from the forcer steam-jet tube cannot escape, except through the throat of the forcer combining-tube (which is necessarily of small area relatively to the area of the smallest bore of the forcer steam-jet tube) or the usual waste-opening at or near that throat, it passes back into or toward the discharge end of the lifter and creates a back-pressure which hinders and often prevents the lifter from working.

My improvement, by affording an additional vent in the forcer combining-tube, enables the forcer to start more readily than heretofore, and consequently the forcer-steam interferes less with the working of the lifter.

My invention consists in providing an injector of the class described with an additional waste-opening located in the forcer combining-tube between its mouth and its throat—that is to say, between its throat and the discharge end of its forcer steam-jet passage—where the area in cross-section of the bore of that combining-tube is about equal to or greater than the area in cross-section of the smallest portion of the forcer steam-jet passage.

It also consists in providing an injector of the class described with an additional waste-opening located in the forcer combining-tube at or near or beyond its throat, as above described, and a valve whereby the efflux of fluid to the atmosphere from that opening is permitted and the influx of air prevented.

In the accompanying drawings, Figure 1 shows a vertical section of one injector embodying my improvements, and Fig. 2 a similar section of a modified form of injector also embodying my improvements.

Letters of like name and kind refer to like parts in each of the figures.

A is the casing, in which is an opening B

for the admission of steam and an opening C for the admission of water. A partition D separates the steam-chambers B' B² from the water-chamber C'.

5 *a a'* is the steam-jet tube of the lifter. This tube is fitted steam-tight in the partition D, but is made movable therein by means of a threaded stem E, working in the nut or bonnet E'. The stem E is enlarged at E³ on its
10 end at the right, as shown in the drawings. E⁴ is a nut encircling the enlarged portion E³ of the stem E, and is screwed onto the prolongation of the lifter steam-jet tube *a*, so that when the stem E is rotated the lifter steam-jet tube *a* is moved longitudinally, but is not
15 rotated. The bonnet E' is provided with a stuffing-box and the stem E with a hand-wheel E². Steam is admitted to the lifter steam-jet tube *a a'* through holes *a*², which
20 communicate with the steam-chamber B', which chamber is supplied with steam through the port B³.

b is the lifter combining-tube, enlarged at its mouth *b'*. Its discharge end is at *b*². The
25 bore of this tube is in axial line with that of the lifter steam-jet tube *a a'*. It passes through that portion of the partition D which separates the steam-chamber B² from the water-chamber C', and is fitted tightly enough there-
30 in, so that steam cannot pass around it into the water-chamber.

d is a tube, which is threaded at *d'* on its exterior and screws into the threaded end F of the casing A. This tube at *d*² passes
35 through and fits tightly in a partition G in the casing A, and thence into the steam-chamber B². It has an internal screw-thread *d*³ formed in the extreme end of that portion which extends into the steam-chamber B², and
40 into the nut thus formed the combining-tube *b* of the lifter is screwed.

That portion of the tube *d* which lies to the right of the discharge end *b*² of the lifter combining-tube constitutes the combining-
45 tube of the forcer. Its bore converges in the direction of the flow of the fluid until the throat *d*⁵ is reached, whence it expands and forms what is sometimes called the "delivery-tube." To the delivery end of the combin-
50 ing-tube the pipe for the delivery of the water to the boiler is to be connected, and in this pipe should be placed the usual check-valve to prevent the outflow of water from the boiler when the injector is not in opera-
55 tion.

That portion of the tube *d* which is in the steam-chamber B² is provided with holes *d*⁴, which afford communication between the steam-chamber B² and the bore of the tube *d*.
60 The exterior surface of the lifter combining-tube *b* from *b*³ to its end at *b*² is chamfered or made tapering, so that it is nearly concentric with the adjacent interior surface of the tube *d*, and thereby is formed the annular steam-jet tube or passage of the forcer.
65

*d*⁶ are holes made in tube *d*, which constitute the waste opening or overflow of the Gif-

fard injector shown in United States Patent No. 27,979, being located very near the throat of the forcer combining-tube.

*d*⁷ are holes which constitute the additional waste-opening to which I have referred. They are made in the forcer combining-tube between the plane where the water discharged from the lifter comes in contact with the
75 steam which issues from the forcer steam-jet tube or passage—that is to say, the mouth of the forcer combining-tube—and the throat of that tube. The area of the bore of the forcer combining-tube where the vent-opening
80 formed by the holes *d*⁷ is made should be about equal to or greater than the area of the smallest portion of the forcer steam-jet passage, for reasons which I shall hereinafter set forth.

Both the openings *d*⁶ and *d*⁷ communicate
85 with the overflow or waste chamber H, formed in the casing between the partitions F and G. In a branch in the casing is an opening H' from the chamber H to the atmosphere. A valve J, opening outwardly and supported
90 against gravity by a weak spring, permits the free outflow of any fluid from the waste-chamber H, but prevents the indraft of air.

The admission of steam first to the lifter and afterward to both the lifter and forcer is
95 controlled by valves operated by the stem M, to which is attached the hand-lever M', which has its fulcrum on the casing A.

N is a puppet-valve, which I will call the "main steam-valve." It is guided by wings
100 N' and is seated in the casing at N².

O is another puppet-valve, which I call the "lifter steam-valve," formed on the stem M. Its seat is formed in the valve N at N³. The stem M extends through a port in the valve N,
105 being made of smaller diameter than that port, and is attached to a piston-valve P, which has its seat in a cylinder P' in that part of the casing which separates the chamber B from the chamber B². The valve P is
110 guided between the wings N' in a recess formed therein. The valves O and P, being attached to the stem M will move when that is moved, and the recess in the wings N' is made deep enough, so that the valve O will
115 be opened fully before the rear end of the valve P will strike against and open the main valve N. The piston of the valve P is made of such length that it will not be withdrawn from its cylindrical seat, and thereby open a
120 free passage for the steam to the forcer until after the main valve N has been opened.

To operate the injector, assuming it to be properly connected with the boiler and the water-supply, and the steam-admission valves
125 to be closed, it is first necessary to move the lever M' enough to draw the lifter steam-valve O from its seat. Steam will then pass through the port in the main valve N and through the port B³ into the chamber B';
130 thence by the holes *a*² into the steam-jet tube *a a'* of the lifter. The piston-valve P at this time prevents steam from passing into the chamber B², except such as may leak around

the piston. The steam discharged from the lifter steam-jet tube and through the lifter combining-tube drives the air before it and exhausts it from the water-chamber C', and the steam and air and afterward the water which comes in from the supply are discharged into the waste-chamber H through the holes d^7 and d^6 , (the greater part through the former,) and thence through the passage H', opening the valve J, to the atmosphere. Such steam as leaks by the piston-valve P will also be discharged through the openings d^7 , together with the fluid discharged from the lifter. As soon as the stream of water is established through the lifter the valve M' should be further withdrawn. This will open fully the main steam-valve N and also withdraw the piston-valve P from the cylindrical passage P', and the steam entering at B will have free access to both the lifter steam-jet tube or passage and to the forcer steam-jet tube. The steam which issues from the latter coming in contact with the stream of water which is discharged from the lifter readily combines therewith and imparts velocity to it, owing to the vent afforded by the opening at the holes d^7 without creating any injurious back-pressure to resist the current from the lifter and discharges the water at first through the holes d^7 and then through those at d^6 until sufficient velocity has been imparted to the stream to enable it to overcome the resistance of the check-valve in the delivery-pipe, when the injector will be in operation. Water which is spilled from the forcer combining-tube in starting or after the injector is in operation will escape through the passage H', controlled by the valve J.

The quantity of water raised and delivered by the lifter can to some extent be regulated by the hand-wheel E². If in starting the injector the lever M is moved quickly, so as to open the valves N and P suddenly or before the current of water from the lifter is fully established, the opening afforded by the holes at d^7 will tend to vent the steam which issues from the forcer steam-jet tube or passage, so that it shall not make a back-pressure, and thereby hinder the action of the lifter. Under these circumstances the injector will start, when, in the absence of the additional vent afforded by the holes at d^7 , it might have been necessary to shut the valves N and P and begin over again.

The injector, which I have described and have shown in Fig. 1 of the drawings, is compact by reason of the arrangement of the lifter and forcer in axial line, the exterior of the discharge end of the lifter combining-tube penetrating into the prolongation of the mouth of the forcer combining-tube to form an annular forcer steam-jet passage, the waste-opening through the holes at d^7 being provided to vent the lifter and to assist in starting the forcer.

When the injector has been got into opera-

tion, its action thereafter is like all injectors of its class.

If at any time a freer vent for the lifter is required in starting than that afforded by the opening at the holes d^7 , the plug K may be removed and a pipe and stop-cock inserted in its place. The opening thus afforded will only be necessary when water is lifted from a considerable distance below the machine, or when high-pressure steam is used. It must be closed by the engineer after water has been lifted.

As the art of constructing both lifters and forcers and of proportioning them to act together when arranged as in this class of injectors is well known, I do not prescribe any details for making the bore of the interior contour of the several tubes of either the lifter or the forcer.

The holes d^7 , as I have before stated, should be located in the forcer combining-tube between the plane where the steam which issues from the forcer steam-jet tube or passage comes in contact with the water issuing from the lifter and the throat of the forcer combining-tube, and where the area in cross-section of its bore is about equal to or greater than that of the smallest bore of the forcer steam-jet tube or of the smallest portion of the forcer steam-jet passage. If placed nearer the throat, the waste-opening thereby afforded will be too small to be efficient. They may be placed as near to the mouth of the forcer combining-tube as will leave a sufficient length of combining-tube between the mouth and these holes to insure time for the proper condensation of the steam which issues from the forcer steam-jet tube or passage before the commingled water and steam reach these holes, so that after the injector is in operation the jet of water shall leap across the opening afforded by the holes and continue in the combining-tube and enter the boiler. It is obvious that the nearer these holes can be made to the mouth of the forcer combining-tube without preventing the steam from the forcer steam-jet tube or passage from acting with efficiency the greater will be the vent afforded for both the lifter and the steam-jet tube or passage of the forcer.

Instead of constructing the forcer as shown, with the ordinary waste-opening near the throat of its combining-tube, that opening may be located beyond the throat and between it and the check-valve in the delivery-pipe, as I have before stated. In such case the chamber H and valve J will serve merely to discharge the steam, air, and water which issue from the waste-opening at d^7 , and to prevent the indraft of outside air thereinto.

To attain the object of my invention, it is not necessary to arrange the lifter and forcer in an axial line with each other or to have the annular forcer steam-jet tube or passage, as shown in Fig. 1, and described hereinbefore. The lifter and forcer can be relatively

arranged as in the Hancock inspirator and as shown in Fig. 2, where the lifter discharges water into a chamber which communicates with the mouth of forcer combining-tube and
 5 supplies the water to the latter around a central forcer steam-jet tube. In this form of my apparatus I prefer to arrange the parts as illustrated in Fig. 2, referred to above. The lifter is precisely like that already described
 10 and shown; but its combining-tube b discharges into the chamber R , which communicates through a suitable passage with the mouth of the forcer combining-tube d , which tube is shown as above and out of line with
 15 the lifter combining-tube. The forcer steam-jet nozzle or tube S , which is of the ordinary and well-known construction, takes steam from the chamber B^2 and discharges it in the usual way in a solid jet into the forcer com-
 20 bining-tube d of the same form and construction as that shown in Fig. 1. The forcer steam-jet is then a solid instead of an annular one, and the water from chamber R is taken into the forcer combining-tube around and on
 25 all sides of the steam-jet. The entire lifter and the valves for admitting the steam first to the lifter and then to the forcer are the same in construction and operation as those shown in Fig. 1, and fully described herein-
 30 before. They need not then be again described in connection with the modified arrangement of the forcer. In the forcer combining-tube there are the same openings d^6 d^6 and d^7 d^7 as before communicating with the
 35 chamber H and valved outlet H' , the openings d^7 d^7 being located between the mouth and throat of the tube where the area of the bore of the tube in cross-section is equal to or greater than the area in cross-section of the
 40 smallest bore of the steam-jet tube.

The combined area of the holes d^7 should in all cases exceed the area in cross-section of the bore of the combining-tube at the place where they are located, so that the flow of the
 45 fluid from the combining-tube to the atmosphere shall not be retarded.

It is obvious that the lifter combining-tube can be held in place in the partition D independent of the tube d , and that the tube d
 50 may be made in several pieces--as, for instance, the part d^2 may be made in one piece and held in the partition G , forming with the end of the lifter combining-tube the forcer steam-jet tube or passage and a part of the
 55 combining-tube and the portion from the waste-opening at d^7 in one or more separate pieces. I prefer, however, the construction shown and described, as it permits of the ready removal of the tubes for examination.

60 I am aware that forcers have been made prior to this my invention with a waste-opening located as are the holes at d^7 ; but I am not aware that such an opening has been provided in an injector which contains a lifter
 65 and a forcer and in which the lifter delivers the water to the forcer, so that this additional

waste-opening shall serve, as I have described, both for a waste-opening for the lifter and to facilitate the starting of the forcer.

What I claim as my invention is—

1. An injector having a lifter and a forcer, the latter being provided with a waste-opening in its combining-tube, between the mouth thereof and its throat, where the area in cross-section of its bore is about equal to or greater
 75 than the area in cross-section of the smallest portion of the forcer steam-jet passage.

2. An injector having a lifter and a forcer, the latter being provided with a waste-opening in its combining-tube between the mouth
 80 thereof and its throat, where the area in cross-section of its bore is about equal to or greater than the area in cross-section of the smallest portion of the forcer steam-jet passage, and also provided with a valve whereby the ef-
 85 flux of fluid to the atmosphere from that waste-opening is permitted and the influx of air prevented, substantially as and for the purpose described.

3. In an injector having a lifter and a forcer, in which the lifter both in starting the apparatus and after it is in operation delivers all the fluid discharged through it to the forcer, a waste-chamber, with which the forcer combining-tube communicates through a waste-
 90 opening located between the throat of its combining-tube and the discharge end of its steam-jet passage, where the cross-sectional area of that tube is about equal to or greater
 95 than that of the smallest cross-sectional area of the forcer steam-jet passage, such waste-chamber being provided with a valve to permit the efflux of fluid to the atmosphere and to prevent the influx of air to the chamber, substantially as and for the purpose de-
 100 scribed.

4. In an injector having a lifter and a forcer, in which the lifter both in starting the apparatus and after it is in operation delivers all the fluid discharged through it to the forcer, a waste-chamber, with which the forcer combining-tube communicates through a waste-
 105 opening located between the throat of its combining-tube and the discharge end of its steam-jet passage, where the cross-sectional area of that tube is about equal to or greater
 110 than that of the smallest cross-sectional area of the forcer steam-jet passage, and also through a waste opening located at, near, or beyond the throat of its combining-tube, such
 115 waste-chamber being provided with a valve to permit the efflux of fluid to the atmosphere and to prevent the influx of air to the chamber, substantially as and for the purpose described.

5. An injector having a lifter and a forcer, in which the lifter delivers the water into a chamber or tube which has no outlet, except through the forcer, and in which the forcer is provided with a waste-opening between the
 120 throat of its combining-tube and the discharge end of its steam-jet passage, where

the cross-sectional area of the combining-tube is about equal to or greater than that of the smallest cross-sectional area of the forcer steam-jet passage, substantially as and for the purpose described.

6. An injector having a lifter and a forcer, in which the lifter delivers the water to the forcer, and in which the forcer is provided with a waste-opening between the throat of its combining-tube and the discharge end of its steam-jet passage at a point where the cross-sectional area of the combining-tube is about equal to or greater than that of the

smallest cross-sectional area of the forcer steam-jet passage, and in which the forcer is also provided with a waste-opening at, or near, or beyond the throat of its combining-tube, substantially as and for the purpose described.

In testimony that I claim the foregoing I have hereunto set my hand this 10th day of July, 1886.

JOHN D. LYNDE.

Witnesses.

JOS. T. SILL,

R. L. WRIGHT, Jr.