

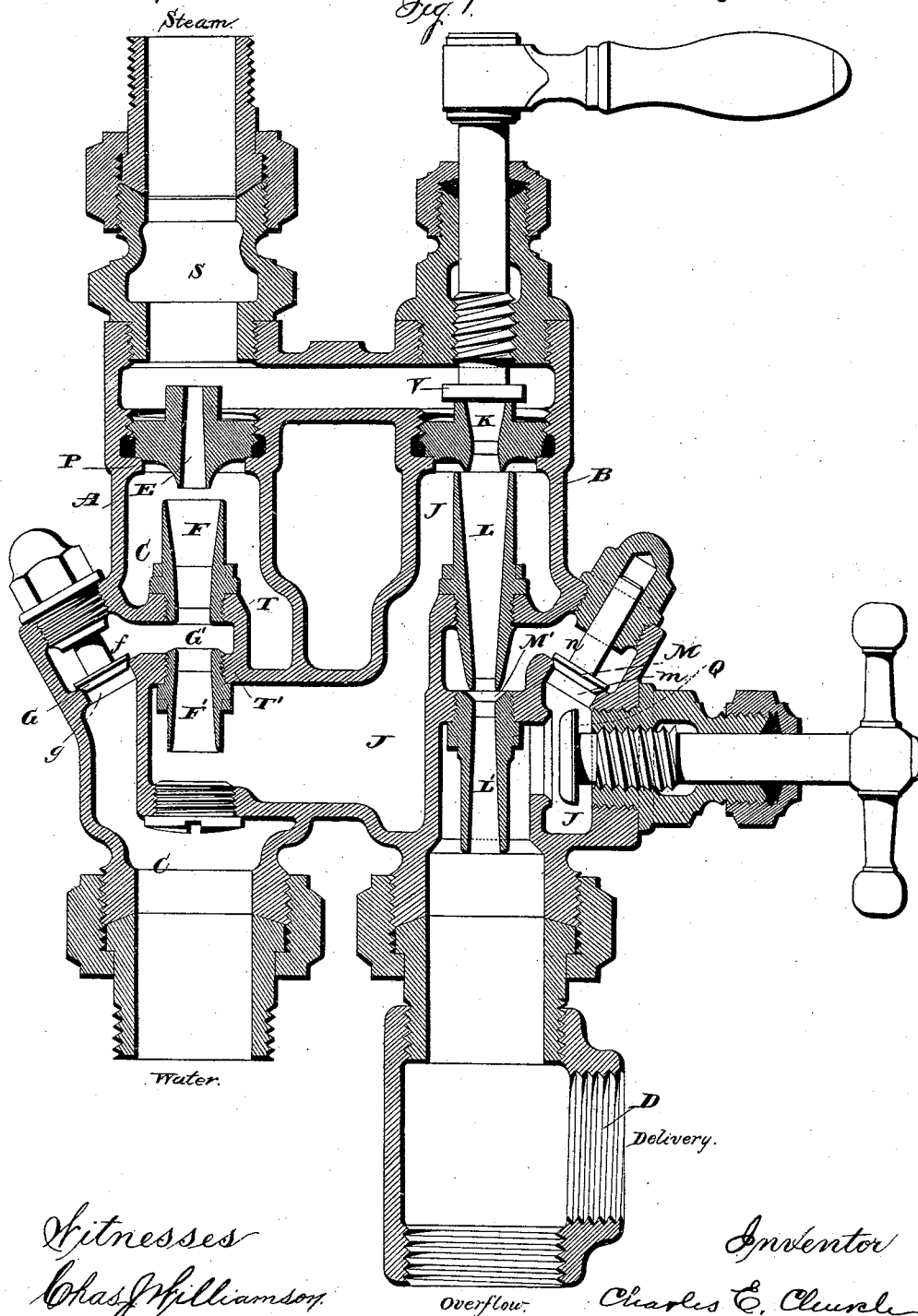
(Model.)

2 Sheets—Sheet 1.

C. E. CHURCH.
INJECTOR.

No. 475,201.

Patented May 17, 1892.



Witnesses
Chas. Williams
Jas. Hutchinson

Inventor
Charles E. Church
by Prindle & Russell
his Attorneys

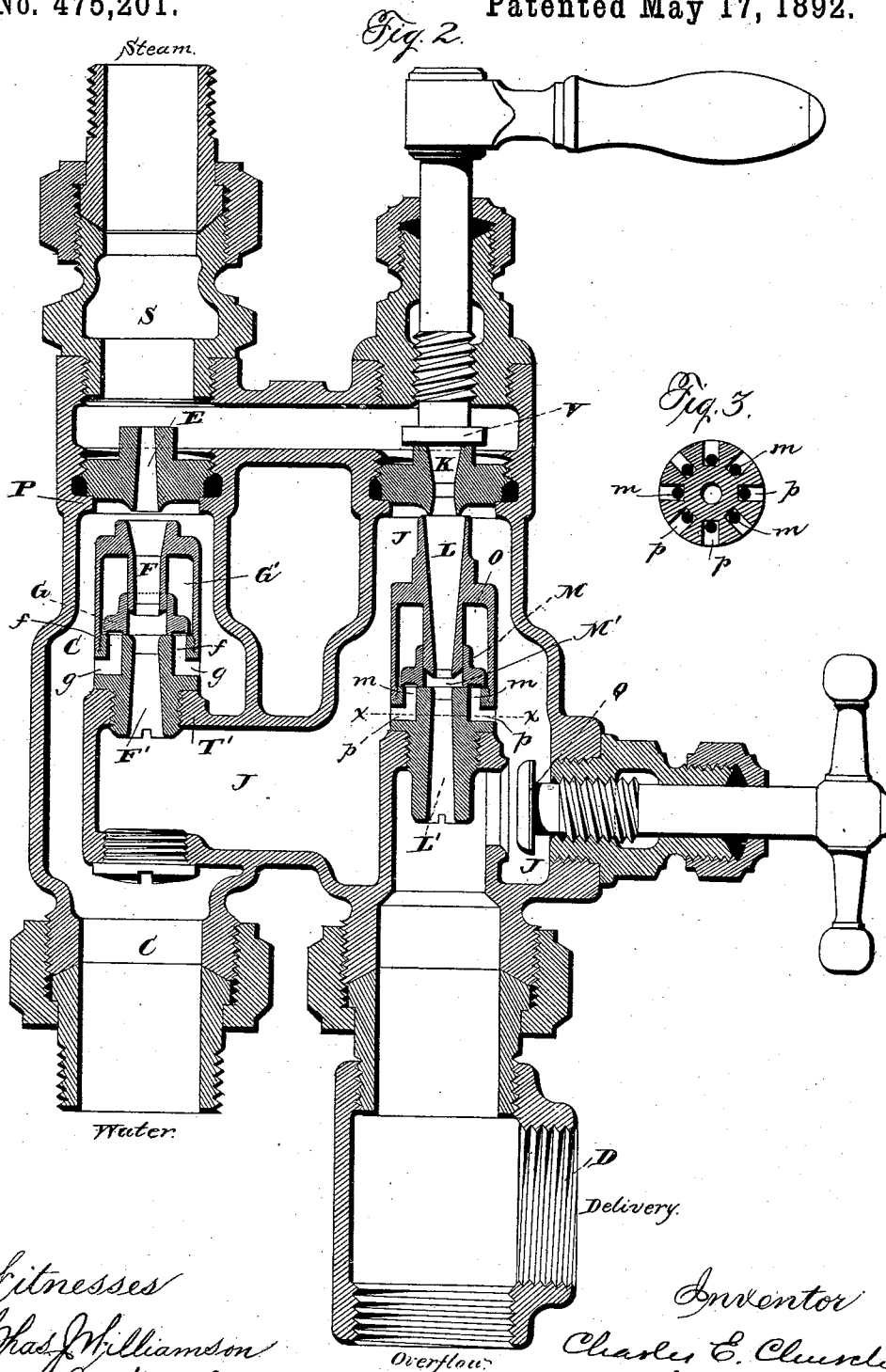
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2 Sheets—Sheet 2.

C. E. CHURCH.
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Inventor
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his Attorneys

UNITED STATES PATENT OFFICE.

CHARLES E. CHURCH, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE
HANCOCK INSPIRATOR COMPANY, OF SAME PLACE.

INJECTOR.

SPECIFICATION forming part of Letters Patent No. 475,201, dated May 17, 1892.

Application filed April 22, 1890. Serial No. 348,982. (Model.)

To all whom it may concern:

Be it known that I, CHARLES E. CHURCH, of Boston, in the county of Suffolk, and in the State of Massachusetts, have invented certain
5 new and useful Improvements in Injectors; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, in which—

10 Figure 1 represents a vertical longitudinal section through the center of my improved apparatus; Fig. 2, a similar section of a modified construction, and Fig. 3 a horizontal section through dotted lines *xx* of Fig. 2.

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

My invention relates, primarily, to the class of injectors known as "single-jet forcing-injectors," and also to those injectors in which
20 a lifting-jet apparatus and a forcing-jet apparatus are combined and known as "double-jet injectors;" but it relates more particularly to the well-known "Hancock inspirator"—an injector of the latter kind.

25 It has for its object to increase the amount of fluid delivered and to enable such injector to operate more efficiently over a wider range of steam-pressure, especially on long lifts, and also when the supply-water or other fluid
30 is of a higher temperature than has been heretofore practicable.

To this end my improvement consists, when applied to a single-jet forcing-injector, in the construction and arrangement of a supplemental inlet to the combining and delivery
35 tube of the apparatus formed by one or more ports communicating with the interior of said tube through one or more openings therein (preferably at or near its throat) and with the
40 water-supply chamber, with a valve adapted to permit a flow of fluid from the said chamber through the said inlet to the interior of the tube when the pressure within said tube at the point therein where the inlet commu-
45 nicates therewith is about equal to or is less than the pressure in the water-chamber, and which valve will close automatically when the pressure within the tube at the said point therein is about equal to or is greater than
50 the pressure in the water-supply chamber,

thereby preventing reflux of the fluid from the tube through the inlet into the said chamber.

When applied to a double-jet injector like the inspirator, it consists, first, in combining
55 with the above-described forcer apparatus an ordinary lifter apparatus, the latter being adapted and arranged to deliver water or other fluid continuously to the said forcer; second, in combining with the said forcer a
60 lifter, the combining and delivery tube of which lifter is provided at its mouth with the usual inlet from the suction-chamber and is provided, also, with a supplemental inlet formed by one or more ports communicat-
65 ing with the interior of the tube through one or more openings and with the suction-chamber, with a valve adapted to close the said supplemental inlet when the pressure
70 within this tube is about equal to or greater than the pressure in the suction-chamber, such lifter being suitably adapted and arranged to deliver water or other fluid continuously to the said forcer; third, in combin-
75 ing with an ordinary forcer the above-described lifter having a supplemental inlet and valve to control the same, said lifter being adapted and arranged to deliver water or other fluid continuously to the water-sup-
80 ply chamber of said forcer, and, fourth, in combining with the forcer, having a supplemental inlet, as described, and either with or without a valve to control the same a lifter
also having a supplemental inlet, as described, and either with or without a valve to control
85 this inlet, such lifter being adapted and arranged to deliver water or other fluid continuously to such forcer.

In the drawings, the casing of the apparatus is designated by A B. The pipe for the
90 admission of the actuating-steam is to be connected with the chamber S, the pipe communicating with the well or reservoir is to be connected to the suction-chamber C, and the pipe for delivery or discharge of water to the boiler
95 is to be connected at D.

In Fig. 1, E is the steam-jet tube of the lifting apparatus seated in the partition P. F F' is its combining and delivery tube made in
100 two portions, the upper portion F, inclosed in

the suction-chamber C, being seated in the partition T; and the lower portion, inclosed in the intermediate or forcer supply chamber J, being seated in the partition T'. Between these two partitions is formed a chamber G', connected with the water-chamber through the conduit *f* and aperture *g*, forming a supplementary inlet to the interior of this tube, which inlet is controlled by the valve G, seated in the aperture *g* and guided by means of its stem, which fits loosely in the bonnet *h*, screwed into the casing A. The water-chamber C extends around that portion of the interior casing which incloses the conduit *f* and chamber G', so that water from the well may rise around the upper portion of the tube F to enter the mouth thereof, and, as is clearly shown, may also enter the interior of the tube F F' through the conduit *f* and chamber G' when the valve G is open. This lifting apparatus, though slightly modified in its construction, is substantially the same in principle as that described (and shown by Fig. 3 of the drawings thereof) in Letters Patent of the United States No. 405,992, dated June 25, 1889, which were granted to me for improvements in ejectors, in which patent some of its advantages are more clearly set forth.

K is the steam-jet tube of the forcing apparatus, and LL' is its combining and delivery tube, made in two portions and seated in partitions which form a chamber M' and conduit *n*, which connect with the intermediate or forcer supply-chamber J through aperture *m*, forming a supplementary inlet to the interior of this combining and delivery tube, which inlet is controlled by the valve M, operating substantially as does the valve G of the lifting-apparatus. The intermediate or forcer supply-chamber J surrounds that portion of the interior casing which incloses the chamber M' and the tube L', and when the injector is in operation conducts the water delivered by the lifter up to the mouth of the combining-tube L of the forcer and also through aperture *m*, conduit *n*, and chamber M' to the interior of the tube L L' when the valve M is open. The chamber J communicates, also, with the delivery-pipe D through an aperture controlled by the valve Q, and an ordinary valve which is to be attached to the lower end of the delivery-pipe D when open will afford free access to the atmosphere. This opening will constitute the final overflow, and that controlled by the valve Q the first or intermediate overflow of the inspirator.

The operation of the apparatus shown in Fig. 1 is as follows: The forcer steam-valve V being closed and the intermediate overflow-valve Q and the final overflow-valve being open, steam is admitted through the pipe S and will flow through the lifter steam-jet tube E, the lifter combining and delivery tube F F', the intermediate chamber J, and thence through the forcer combining and delivery tube L L', and also through the outlet controlled by the valve Q into the delivery-pipe

D, and thence to the atmosphere through the final overflow. The air will thereby be exhausted from the water-supply pipe and suction-chamber C and will be expelled with the outflowing steam. Water will rise from the well or reservoir in the pipe and chamber C and will pass up around the exterior of the tube F F' and enter the latter at its mouth, where, being acted upon by the steam issuing from the jet-tube E, its velocity will be accelerated, and the water drawn from the well or reservoir will follow the course heretofore taken by the steam. The valve Q should then be closed. All the water delivered from the lifter will then pass through the forcer combining and delivery tube L L' to the final overflow. The valve V should then be open to admit steam to the forcer steam-jet tube K, which in issuing from that tube will impart such velocity to the stream of water in the tube L L' that after closing the final overflow-valve the water will enter the boiler from which the actuating-steam is taken.

Both in starting the instrument and after it is in full operation, whenever the pressure in the combining and delivery tube F F' at the supplementary inlet G' is a little less than the pressure in the water-chamber C, a portion of the water will pass from the chamber C through the aperture *g*, raising the valve G, and through the conduit *f*, and will enter the combining and delivery tube F F' at the supplementary inlet G', and whenever the pressure within the tube F F' at the point where the supplemental inlet G' communicates therewith is about equal to or is greater than the pressure in the water-chamber C the valve G will be automatically closed and will prevent a reflux of the water from the tube F F' into the water-chamber C.

Whenever the pressure in the forcer supply-chamber J is a little greater than the pressure in the combining and delivery tube L L' of the forcer at the point where the supplemental inlet M' communicates therewith, water from the chamber J will flow through the aperture *m* (raising the valve M) and through the supplemental inlet M' to the interior of the tube F F' and will be forced through it into the delivery-pipe, and whenever the pressure in the tube L L' at the supplemental inlet is about equal to or is in excess of that in the chamber J the valve M will be automatically closed and will prevent a reflux of the water from the tube L L' into the supply-chamber J. While this valve remains closed the supplemental inlet M' performs no function and the tube L L' operates substantially as if it were a continuous tube.

Fig. 2 of the drawings represents an alternate construction, showing how the supplemental inlet and a valve for controlling it automatically can be formed wholly in the combining and delivery tube and be arranged in the casing of an inspirator as now manufactured without making any material change

in said casing for their reception. In this figure E is the steam-jet tube or nozzle of the lifter, and F F' the lifter combining and delivery tube, which tube is made of two pieces F and F', joined by screw-threads, as shown, and screwed into and held in position in the partition T'. Within this combining and delivery tube an annular chamber G' is formed, which communicates with the water or suction chamber C through the ports or passages *f f g g* and with the interior of the tube through the opening between the adjacent ends of the two portions F and F'. An automatic annular valve G, seated on the inner upper end of the lower portion F' of the tube and encircling and loosely fitting the cylindrical lower end of the upper portion F within the casing G', controls the supplemental inlet formed by the ports *f f g g* in the lower portion F' of the tube. This construction of a lifter is substantially the same as is shown in said Patent No. 405,992, Figs. 1 and 2. The forcer of Fig. 2 is similarly constructed. K is the steam-jet tube or nozzle, and LL' the combining and delivery tube. Its supplemental inlet is formed by the ports *m m p p* and space M' between the two portions LL' of the tube. It communicates with the forcer supply-chamber J and is controlled by the valve M in the chamber O in the tube LL'. The arrangement of the passages or ports *m m* and *p p* are more clearly shown in Fig. 3, which is a horizontal section through the tube LL' on dotted line *xx*, and the arrangement of the similar ports in the lifter-tube F' is substantially identical therewith.

The operation of the apparatus shown in Fig. 2, being the same as that shown in Fig. 1, needs no further description.

An injector constructed as shown in said figures possesses all the advantages of the inspirator, and in addition it will operate with more efficiency over a greater range of steam-pressures, especially on long lifts and with hot supply-water, and over the range of steam-pressure at which an inspirator with ordinary continuous tubes of similar bore and proportions is usually operated my improvement will increase the quantity of water delivered, more especially on long lifts with comparatively high pressures of steam.

With an injector constructed as shown in Figs. 1 and 2, operating under certain favorable conditions of lift, steam-pressure, temperature of supply-water, and quantity delivered, no injurious excess of pressure will be created in the combining and delivery tube of the lifter or of the forcer at the inlet, even though one or both of the valves G and M be removed from the casing, and yet an advantage will be obtained by reason of the supplemental inlets G' and M'; but, as when the injector is operated under more unfavorable conditions, such excess of pressure will be created which will require one, and sometimes both, of the valves to close the respective inlet or inlets, I prefer to use the said valves,

as shown and described, in order to prevent a reflux of fluid from the respective combining and delivery tubes, that would otherwise prevent the starting of the injector or prevent its operation under said conditions. An ordinary lifter may be used, combined with a forcer provided with said supplemental inlet and valve to control the same. So, also, the lifter, as shown and described, with the valve to control its supplemental inlet, may be combined and used with an ordinary forcer. An advantage will be obtained by both combinations. I have shown and described the supplemental inlets in each combining and delivery tube as communicating with the interior of the tube at or near the throat, where the velocity of the fluid is at its maximum, and hence where the pressure in the tube is thought to be at its minimum; but I do not limit myself to this exact location, as they will evidently perform their function with some degree of efficiency if they communicate with the interior at some other point along the axis of these tubes between the mouth and delivery end. More than one supplemental inlet to each combining and delivery tube, communicating with its interior at different points along the axis of the tube and with the water-supply chamber, with a separate valve to control each inlet independently, may be used, and as the valves would not then necessarily open or close simultaneously doubtless better results would be obtained and a more uniform pressure be maintained within the tube than with the single inlet and valve I have shown and described; but the latter construction, being more simple and less expensive to manufacture, is therefore deemed preferable.

Although I have shown and described my improvement applied to a lifter and to a forcer having central steam-jet nozzles, yet it is alike applicable to those having annular ones, and therefore I do not propose to limit the scope of my invention by confining its use to injectors that have central steam-jets only. It is also applicable to those double injectors in which the lifter discharges directly into the mouth of the combining-tube of the forcer, instead of into an intermediate chamber, (as J in the drawings.) The supplemental inlet to the forcer combining and delivery tube in this injector could then communicate with the suction-chamber or with the delivery-tube of the lifter through a suitable conduit leading therefrom.

In the combined lifter and forcer arranged and constructed as hereinbefore described and shown in the drawings there is a co-operation and interdependence of action of the parts, the result of which is an improved and more certain operation of the apparatus to supply water to a boiler than can be obtained in the other forms of combined apparatus heretofore made and used.

As indicated hereinbefore, one part of my injector will adapt its action to that of the

other part, with the result of making the operation of the whole apparatus more certain and continuous. This is so even where no automatic valves are used to close the port or ports from the respective water-supply chambers of the lifter and forcer to the spaces between the respective combining and delivery tubes. In such case, as already set forth hereinbefore, injurious excess of pressure in the combining and delivery tube of the lifter or at the inlet of the forcer will be prevented when the injector is working under favorable conditions.

To further improve the operation of the apparatus and make it more certain, even under unfavorable conditions of steam-pressure, height of lift, and temperature of water, I make use of the automatic valves which have been shown and described. The use of one of these valves on either the lifter or forcer is advantageous, though I prefer to supply both of such parts of the apparatus with the valves. Where the lifter only is valved and the forcer has a port or opening from the chamber into which the lifter discharges to the space between its combining and delivery tube, the automatic valve in the lifter can act to regulate the water delivered according to the needs or capacity of the forcer. Should the lifter tend to deliver more water than the forcer could act upon, so that the pressure is raised in the water-chamber between the lifter and forcer, the valve would, because of back-pressure on the delivery-tube of the lifter, be closed, so as to diminish the delivery of water into said chamber. On the other hand, if the forcer should be delivering more water than the lifter with its valve closed could supply, said valve would, because of the lowering of the pressure in the communicating chamber or passage between the lifter and forcer, and consequently in the delivery-tube of the lifter and the space between the combining and delivery tubes of the latter, automatically open to admit more water to the delivery-tube.

If the forcer only be provided with the described supplemental automatic valve to close the opening into the space between its combining and delivery tubes which communicates with the space or chamber to which a lifter delivers water, it is possible to insure such action of the forcer as will keep down the pressure in the chamber or space to which the lifter delivers its water, so that such lifter will not have to act against too great pressure, which might interfere with its operation. If when the aperture is working the pressure in said space or chamber to which the lifter delivers water should tend to rise above that at the point between the combining and delivery tubes of the forcer, the valve M would be opened to allow water to pass from said chamber into the delivery-tube, and the pressure against which the lifter would have to act would be diminished, said valve will also, by automatically closing, when the press-

ure in the chamber or space to which the lifter delivers tends to get below that between the combining and delivery tubes of the forcer, act to prevent said pressure from getting too low.

The use of the specified valve on the forcer of a combined lifter and forcer, whatever the form of lifter, for supplying water to the water-chamber of the forcer, is then productive of a new and useful result in causing the action of the forcer to be automatically adjusted to that of the lifter and consequently preventing undue back-pressure on the latter.

While the use of one of my supplemental valves on either the lifter or the forcer is advantageous as improving and making more certain the action of the apparatus under varying circumstances, I prefer the construction in which both lifter and forcer are valved, as shown and described. In such an injector each of the two connected lifting and forcing devices, respectively discharging into and taking from the same chamber or passage, will automatically adapt its working to that of the other, so that they will both co-operate to make the starting of the injector easy and its operation continuous, even under varying conditions of steam-pressure, height of lift, and temperature of the water. By practical tests it has been demonstrated that under given conditions of such pressure, height, and temperature, the lifter and forcer constructed and combined in any of the ways set forth in my claims, will deliver a greater quantity of water than when the lifter and forcer are arranged and combined as heretofore in the inspirator upon which the apparatus shown and described herein is an improvement.

Having thus described my invention, what I claim is—

1. In an injector, a forcer the combining and delivery tube of which is provided at its mouth with the usual inlet from the water-supply chamber and is provided, also, with a supplemental inlet formed by one or more ports communicating with the interior of said tube through one or more openings therein and with said supply-chamber, with a valve adapted to close said supplemental inlet automatically when the pressure within said tube at said openings therein is about equal to or is greater than the pressure in said supply-chamber, substantially as and for the purpose described.

2. In an injector, a forcer the combining and delivery tube of which is provided at its mouth with the usual inlet from its water-supply chamber and is provided, also, with a supplemental inlet formed by one or more ports communicating with the interior of said tube through one or more openings therein and with said supply-chamber, with a valve adapted to close said supplemental inlet automatically when the pressure within said tube at said openings therein is about equal to or is greater than the pressure in said supply-chamber, and a lifter which is suit-

ably adapted and arranged to deliver water or other fluid continuously to the supply-chamber of said forcer, substantially as and for the purpose described.

5 3. In an injector, a forcer the combining and delivery tube of which is provided at its mouth with the usual inlet from its water-supply chamber and is provided, also, with a supplemental inlet formed by one or more
10 ports communicating with the interior of said tube through one or more openings therein and with said supply-chamber, and a lifter the combining and delivery tube of which is provided at its mouth with the usual inlet
15 from the suction-chamber and is provided, also, with a supplemental inlet formed by one or more ports communicating with the interior of the tube through one or more openings there-
20 in and with the suction-chamber, such lifter being suitably adapted and arranged to deliver water or other fluid continuously to the supply-chamber of the said forcer, substan-
tially as and for the purpose described.

4. In an injector, a forcer the combining
25 and delivery tube of which is provided at its mouth with the usual inlet from its water-supply chamber and is provided, also, with a supplemental inlet formed by one or more
30 ports communicating with the interior of said tube through one or more openings therein and with said supply-chamber, with a valve adapted to close the said supplemental inlet
automatically when the pressure within said tube at said openings therein is about equal
35 to or is greater than the pressure in said supply-chamber, and a lifter the combining and delivery tube of which is provided at its mouth with the usual inlet from the suction-
40 chamber and is provided, also, with a supplemental inlet formed by one or more ports communicating with the interior of the tube through one or more openings therein and
with the suction-chamber, such lifter being
45 suitably adapted and arranged to deliver water or other fluid continuously to the supply-chamber of the said forcer, substantially as and for the purpose described.

5. In an injector, a forcer the combining
50 and delivery tube of which is provided at its mouth with the usual inlet from its water-supply chamber and is provided, also, with a supplemental inlet formed by one or more
ports communicating with the interior of said tube through one or more openings therein
55 and with said supply-chamber, and a lifter the combining and delivery tube of which is provided at its mouth with the usual inlet from the suction-chamber and is provided,
also, with a supplemental inlet formed by one
60 or more ports communicating with the interior of the tube through one or more openings

therein and with the suction-chamber, with a valve adapted to close the said supplemental inlet automatically when the pressure within
65 this tube at the said openings therein is about equal to or greater than the pressure in the suction-chamber, such lifter being suitably adapted and arranged to deliver water or
other fluid continuously to the supply-chamber of the said forcer, substantially as and for
70 the purpose described.

6. In an injector, a forcer the combining
and delivery tube of which is provided at its mouth with the usual inlet from its water-
75 supply chamber and is provided, also, with a supplemental inlet formed by one or more ports communicating with the interior of said tube through one or more openings therein
and with said supply-chamber, with a valve
80 to close said supplemental inlet automatically when the pressure within said tube at said openings therein is about equal to or is greater than the pressure in said supply-chamber, and
a lifter the combining and delivery tube of
85 which is provided at its mouth with the usual inlet from the suction-chamber, and is provided, also, with a supplemental inlet formed by one or more ports communicating with the
interior of the tube through one or more
90 openings therein and with the suction-chamber, with a valve adapted to close the said supplemental inlet automatically when the pressure within this tube at said openings
therein is about equal to or greater than the
95 pressure in the suction-chamber, such lifter being suitably adapted and arranged to deliver water or other fluid continuously to the supply-chamber of the said forcer, substan-
tially as and for the purpose described.

7. In an injector, a forcer and a lifter, the
100 combining and delivery tube of the latter being provided at its mouth with the usual inlet from the suction-chamber and provided, also, with a supplemental inlet formed by one
or more ports communicating with the inte-
105 rior of said tube through one or more openings therein and with the suction-chamber, with a valve adapted to close said supplemental inlet and prevent reflux of the fluid
from the interior of said tube through the
110 supplemental inlet into the suction-chamber, such lifter being adapted and arranged to deliver water or other fluid continuously to the supply-chamber of the said forcer, substan-
tially as and for the purpose described. 115

In testimony that I claim the foregoing I have hereunto set my hand this 20th day of March, 1890.

CHAS. E. CHURCH.

Witnesses:

WILLIAM A. SARGENT,
ALBERT J. HOSLER.