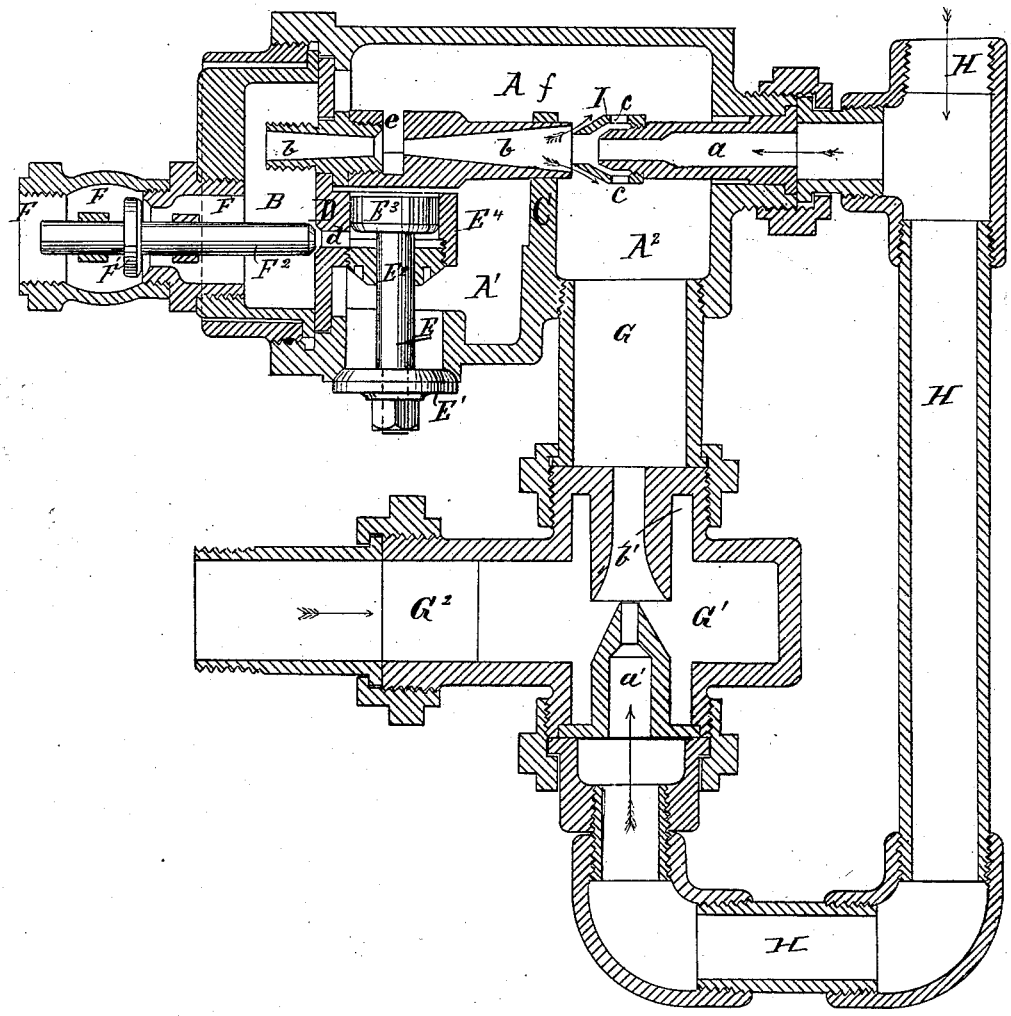
(Model.)

G. C. WILLIAMS.

STEAM INJECTOR.

No. 265,648. Patented Oct. 10, 1882.



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STEAM-INJECTOR.

SPECIFICATION forming part of Letters Patent No. 265,648, dated October 10, 1882.

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To all whom it may concern:

Be it known that I, GARNER C. WILLIAMS, of Ellenville, county of Ulster, and State of New York, have invented certain new and useful improvements of that apparatus commonly called an "injector," of which the following is a specification, reference being had to the accompanying drawing, forming part thereof, the same being a central longitudinal section of an injector embodying my invention.

The object of this invention is to produce an injector of plain construction, and capable of automatic action that will start in operation, lifting the water to itself, if necessary, simply upon the admission of steam, and without any further manipulation or adjustment of valves or cocks, which would require the attention of a skilled attendant, and also so arranged that if its action becomes interrupted it will readjust itself to its proper work again, and so continue as long as steam is supplied and there are no foreign substances to obstruct its operation. To accomplish this it is necessary to have one apparatus which will draw the water into the injector and deliver it with some force and great regularity to another apparatus that forces it to the place of final destination, and they must be so arranged and constructed that the second shall in no way at any time interfere with the first so as to prevent it from drawing the water into the injector, and also so that the second, when operating, shall receive the water delivered into the injector by the operation of the first apparatus; and it is also further necessary to provide a vent or outlet for the escape of the steam and water during the preliminary action of the injector without passing through the second apparatus, and to make the operation of the injector automatic this outlet must be fitted with a valve so arranged that it will close when the action of the injector is established and not before, and will remain closed so long as such action continues, but when such action is broken will open again to allow the injector to repeat the preliminary actions that go to produce its perfect working. Injectors have been made containing two sets of apparatus for the purpose indicated; but so far as I am aware their construction is such that when the injector has to lift its supply of water the second will not start in operation if steam is admitted to both at the same time, it being necessary for the apparatus that draws the water into the injector to be first put in operation and the water made to cover the second apparatus before the latter is started. This renders it necessary to have separate valves for letting on the steam to each, and complicates both the construction and operation of the injector, and requires skilled attention and manipulation, which I obviate. I am also aware that single-jet injectors have been made in which a valve fitted to the vent or outlet, commonly called the "overflow," has been closed automatically; but in such cases it has been done in either one of two ways—first, by the inward suction of the injector that may sometimes be established at the overflow, owing to an insufficient supply of water, or other imperfections in the working of the injector; but such closing is only to prevent air entering, and does not in any way prevent the escape of water when it is present at that point; second, by the pressure of the water in the injector upon the valve itself to close it when the stem thereof is released by the raising of the check-valve; but such valve must remain closed until the check-valve again presses it open, and as the pressure upon it must at all times, while steam is turned on the injector, be considerable, it will lose its automatic action unless the check-valve is carefully arranged to prevent any free escape of water around it, and it will then only regain it when the steam is turned off. In my invention the closing of the valve by the device herein shown prevents all ingress or egress of water or air at that point, and whenever the injector ceases to work there is nothing to prevent the check-valve returning to its seat, when all the pressure of the water or steam in the injector will press upon the valve and its attachments to open it.

In order that my said invention may be more fully understood, I will now more particularly describe it, referring to the drawing hereunto annexed, and to the letters of reference marked thereon.

The pipe G^2 communicates with the water-supply, and conducts the water to the steam-

nozzle a' and the water-inlet port b', which form the apparatus for drawing the water into the injector and for forcing it through the passage G to the second apparatus. The steam-nozzle a of the second apparatus opens into the chamber A and delivers its steam into the end of the combining-tube b. Both steam-nozzles a' and a receive their steam through the pipe H, which communicates with the boiler, and is provided with a suitable stop-valve for the purpose of admitting the steam as required to the two steam-nozzles.

A is a chamber in the body of the injector, and has a partition, C, which divides it into two compartments, A′ and A², communicating with each other by the open passage f at the top.

B is another chamber, separated from A by the diaphragm D.

a, b b, and I form the second apparatus, fitted to receive the water from the first apparatus and force it into B on its way to the point of delivery. The end of pipe b which is commonly called the "delivery-tube" passes through the diaphragm and terminates in chamber B. The other end, which is called the "combining-tube," passes through or over partition C and terminates in compartment A² of chamber A. e is an opening, called an "overflow," between the combining and the delivery tubes b b. Any one skilled in the art will know how to construct and proportion the pipes a a', b b, and b' to insure their operation upon the well-known principles of the steam-siphon and of the Giffard and other injectors.

Upon the inner end of the steam-nozzle a a shield, I, is interposed between it and the combining-tube b, as shown. At the base of this shield are openings c c to permit the water to flow in and meet the steam as it issues from a toward b.

The partition C rises from the bottom of chamber A and terminates at the level of or a little above pipe b, so that all the water delivered by the first apparatus shall be presented to the action of the second before it passes over said partition C and beyond the power of the steam issuing from a.

At the bottom of compartment A′, at E, is the vent or overflow port, provided with a valve, E′, which we will call an "overflow-valve," and which opens outward and is attached to a stem, E², having on its opposite end a piston, E³, fitted to work in the short cylinder E⁴.

d is a port permitting the entry of steam or water from the chamber B into the lower end of said cylinder and under piston-head E³.

F is the exit-passage leading out of chamber B to the pipes leading to the place of delivery, and is provided with a check-valve, F′, opening outward, attached to a stem, F², the opposite end of which is fitted to act as a valve to close port d when valve F′ is closed upon its seat.

I find it preferable to construct and arrange the chamber A as shown in the drawing—that is, with the partition C dividing the chamber into the water-receiving compartment A² (in which is the nozzle a and from which extends the combining-pipe b to the chamber B) and the overflow-compartment A′, to which the opening f in the partition C, above the level of the nozzle a, leads from the compartment A², this compartment A′ containing the overflow port and valve, and also the overflow e of the combining-pipe b; but I do not limit myself to this peculiar construction, for the partition C may be made a continuous wall and the compartment A′ dispensed with, and the valve E′ may be placed in an overflow-port opening from the chamber A² at any point above the level of the steam-nozzle, and the connection of said valve with the check-valve F′ by means of the described devices to secure the automatic action specified may then be established, communication between the water-chamber and the chamber B being secured by suitable means.

The operation of this apparatus is as follows: When the injector is not in operation the back or boiler pressure from the pipes leading out of F will keep valve F′ closed, and, port d being also closed, the valve E′ and its attachments will be free to act. Steam, being admitted into pipe H, passes through both jets a and a' at the same time into the body of the injector. That which passes out of a' will pass through b' into compartment A², and thence over partition C into compartment A′. The steam which passes out of a passes through I and enters the mouth of b. It is well known by those skilled in the making and use of injectors that in starting an injector, and until the steam as it flows through the injector's nozzle is sufficiently condensed, a part of the steam will pass through pipe b into chamber B and part will pass out of overflow e into compartment A′, and yet another considerable part will not pass through b, but will force itself back out of the entrance to b. This back-flowing steam will pass into compartment A², thence over partition C, with the steam from a', into compartment A′, thus uniting with the steam from e, and all will press upon the head of piston E³ and upon valve E′, and will open E′ and pass out of the injector through E. The passage in A, between compartments A′ and A² over partition C and the outlet-port E, being made of sufficient area to allow free outlet of the steam, so as not to press back upon the jet issuing from a' through b', an inward draft or suction will be established, expelling the air and drawing the water in through G², which will be ejected into A² and be taken up by the upper jet and driven through pipe b into chamber B until that chamber is filled. Then it will overflow through e into A′, and so out at E, and continue until the pressure or momentum or *vis viva* of the jet will overcome the resistance in F, when valve F′ will open and the water pass on to the point of final delivery. The opening of valve F′ will uncover port d and admit water out of chamber B into cylinder E⁴ under piston E³, which will close the

valve E′ and hold it closed so long as the pressure of the water in chamber B is sufficient to keep open the valve F′; but so soon as the pressure in B is lessened, so as to permit the closing of valve F′ by the back-pressure upon it, the port *d* will be covered and allow valve E′ to open. Then the several operations will be repeated with every repetition of the several above-described conditions, so that this apparatus must always be either in full working order or ready to start in full work. Should the full action of the apparatus be interrupted by any cause that does not actually disarrange its parts, it cannot get into a position or condition that will not admit of its automatically recommencing work, (differing in this from all other injectors, as far as I am aware,) but can only assume one of the positions or conditions that are necessary for the preliminary starting, and will continue in that position until the jet is re-established in full power.

It will be observed that I have made no specific provision for the escape of the water out of cylinder E^4 when the port *d* is closed, while it is necessary to get it out of said cylinder to allow the movement of the piston that will permit valve E′ to open. I assume that there will always be a waste around piston E^3 and the valve-stem E^2 sufficient for the filling of the cylinder; but if not, then provision can be made for sufficient vent either by a fine groove cut along piston E^3 or valve-stem E^2, though it must be very slight, as that waste will be continuous, and during the working of the injector all the water that thus escapes from E^4 will have to be taken up again, either at the mouth of *b* or re-entering at *e*.

In the varying conditions of the pressure of steam or supply of water or pressure against which an apparatus of this kind must work, or in the different ranges of duty it may be called upon to perform, it will often happen that more water may be taken into *b* than the jet from *a* will deliver with requisite force. At such times a portion will escape at *e*, and is usually lost at the overflow, though various devices have been made to prevent such loss. In this case it is evident it will be returned to *b* and again subjected to the action of the jet. This facility of return of overflow I deem an important feature in the arrangement of this apparatus. Again, at other times, it will occur that the jet *a* can deliver more than is taken in at the mouth of *b*. This causes an inward draft at *e*, and various plans have been used to supply water there, or to prevent air entering there, or to utilize the suction in one way or another; but in this apparatus the overflow *e* will always be surrounded by water when the injector is working, and if a suction occurs at *e* water will be taken in there till the full power of jet *a* is utilized. The amount of water supplied by the first apparatus will also depend upon the pressure in chamber A against which it must work. If the second apparatus be delivering water freely, there will not be much, if any, pressure in A. There may be at times a slight tendency to a vacuum in A. At such times the jet *a*′ will deliver water freely, and may at times be aided by the tendency to such vacuum.

If the second apparatus be delivering water slowly, and the water accumulates in A, it will retard the delivery of the first apparatus in proportion to the pressure in A. It is at such times as the putting of the second apparatus upon what is called "low duty"—that is, the delivery of small quantities—that the jet becomes liable to break and injectors stop working, owing to the want of proper condensation of the steam. In this apparatus at such times the increased pressure in A will facilitate the condensation and greatly reduce the liability to break.

I have now come to a point where I wish to show more fully the relation the shield I bears to the working of this injector and to its automatic action, as well as to describe more fully how it is to be constructed. If there be no water present in an injector, and the forcing-jet, which in this injector is the jet *a*, be supplied with steam, that portion of steam that will force itself back out of the combining-pipe, which in this injector is the pipe *b*, will flow with such force along the outer surface of the nozzle of the forcing-jet that water cannot reach the steam as it issues from the said nozzle. It is for this reason that it is first necessary to surround the forcing-jet with water before admitting steam to it. In this injector I have arranged the shield I so that all the steam issuing from the forcing-jet *a* will pass through I into *b*, and all the steam that reacts back out of *b* will strike the shield I, and so be prevented from reacting against the steam as it flows out of pipe *a*. There being an annular space between I and the end of *a*, the water can flow into the jet through the openings *c c*, and the relative areas of the nozzle *a* and shield I can be so proportioned as to cause a strong suction into the shield I through the openings *c c*. When water meets the jet issuing from *a* it will condense a portion of the jet, and, being thrown with great force through I, will prevent any further reaction of steam out of the inner end of *b*. Then the water will be free to enter *b*, between it and I, and a full supply can thus at all times be relied upon for the perfect working of the injector.

I do not limit myself to any particular form of the shield I. It may be made conical or cylindrical, or it may be a plain diaphragm. The end to attain is to prevent the reacting steam from interrupting the flow of the steam out of *a* and the inflow of the water to meet and condense said outflowing steam from *a*. To this end it is only necessary that when the water enters compartment A^2 it shall be free to enter or be drawn in between the pipe *a* and the shield I, and so come in contact with the jet as it issues from the pipe *a*, the function of this shield being to enable the water to come

in contact with the steam as it issues from the steam-nozzle of the forcing-jet, whether the water is admitted to or is drawn into the instrument before or after the steam has been turned on; but when the water-supply is above the instrument, and it is turned on before the steam is admitted, the water will flow through the instrument, and the injector will go to work with or without this shield.

I am aware that injectors have been made that have used a series of combining-pipes in sections that may have been so constructed that the reaction did not occur within the first section of the combining-pipe; but the steam that finally reacted out of the combining-pipe entered the water-inlet pipe with force enough to prevent water entering the injector. In my apparatus the steam from jet *a'* will force all the steam from the combining-pipe to pass out of overflow-valve E', so that reacting steam cannot impair the suction of the apparatus.

I have described this injector as a steam-injector; but it may be used for all purposes for which injectors may be used, the words "steam" and "water" used in this description being for the greater facility of description, as injectors are generally used for steam, and hence such description will be more readily understood.

In the apparatus as I have described it the steam-jets would be solid jets; but these jets may be made annular by the use of a plug or stem in the center of the jet, and the plug may terminate within the steam-pipes or beyond the end of the steam-pipes. It may be arranged so that the water shall enter either one or both sets of apparatus at those places where steam enters, and the steam may act upon the water in annular jets properly arranged and directed around the jets of water; so I do not confine myself to any particular forms of jets. Any known form may be employed.

While I regard the automatic features of the valve E' as desirable and as a novelty which I am entitled to claim, still the said valve may be made to operate by hand, if preferred, doing away with the piston-head E^3 and cylinder E^4, the port *d*, and its valve F^2, without materially affecting the operation of the other described parts of the injector.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a steam-injector, a water-inlet port opening into and an overflow-port opening out of one and the same chamber, constructed and combined to operate substantially as and for the purposes specified.

2. In a steam-injector, a steam-nozzle and a water-inlet port opening into one and the same chamber, and an overflow-port opening out of said chamber, constructed and combined to operate substantially as and for the purposes specified.

3. The combination, in a steam-injector, of the water-inlet port, the overflow-port, and the steam-nozzle, all in one and the same chamber, and arranged relatively to one another as described, whereby water entering the chamber will submerge the injector-nozzle before it can pass out through the overflow, substantially as set forth.

4. In a steam-injector, the combination of a steam-nozzle and a water-inlet port opening into one and the same chamber, an overflow-port opening out of said chamber, and a partition between said ports, so that water entering the chamber from the inlet-port must flow over the steam-nozzle and partition before it can pass out of the overflow-port, substantially as and for the purposes set forth.

5. In a steam-injector, the combination of a steam-nozzle and a water-inlet port opening into one and the same chamber, an overflow-port opening out of said chamber, a combining-tube, and a shield interposed between the steam-nozzle and the combining-tube, substantially as and for the purposes set forth.

6. In a steam-injector, the combination, with the overflow-port, of an overflow-valve opening outward under the pressure of the steam in the injector when the water is not flowing to the boiler and closed by the pressure of the water when it is flowing into the boiler, substantially as and for the purposes described.

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Witnesses:
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