(Model.)

3 Sheets—Sheet 1.

# R. G. BROOKE.

## INJECTOR.

No. 474,361. Patented May 10, 1892.

Fig. 2.

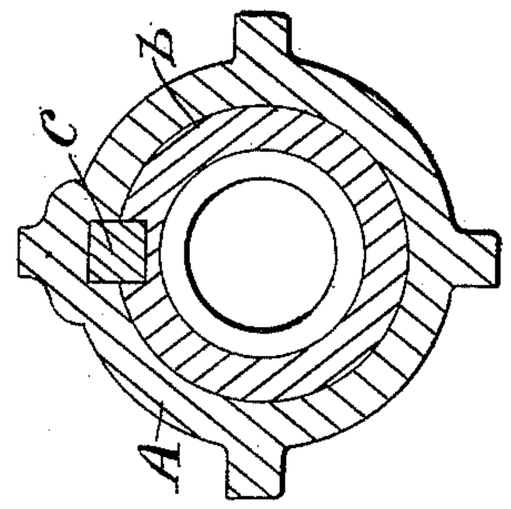
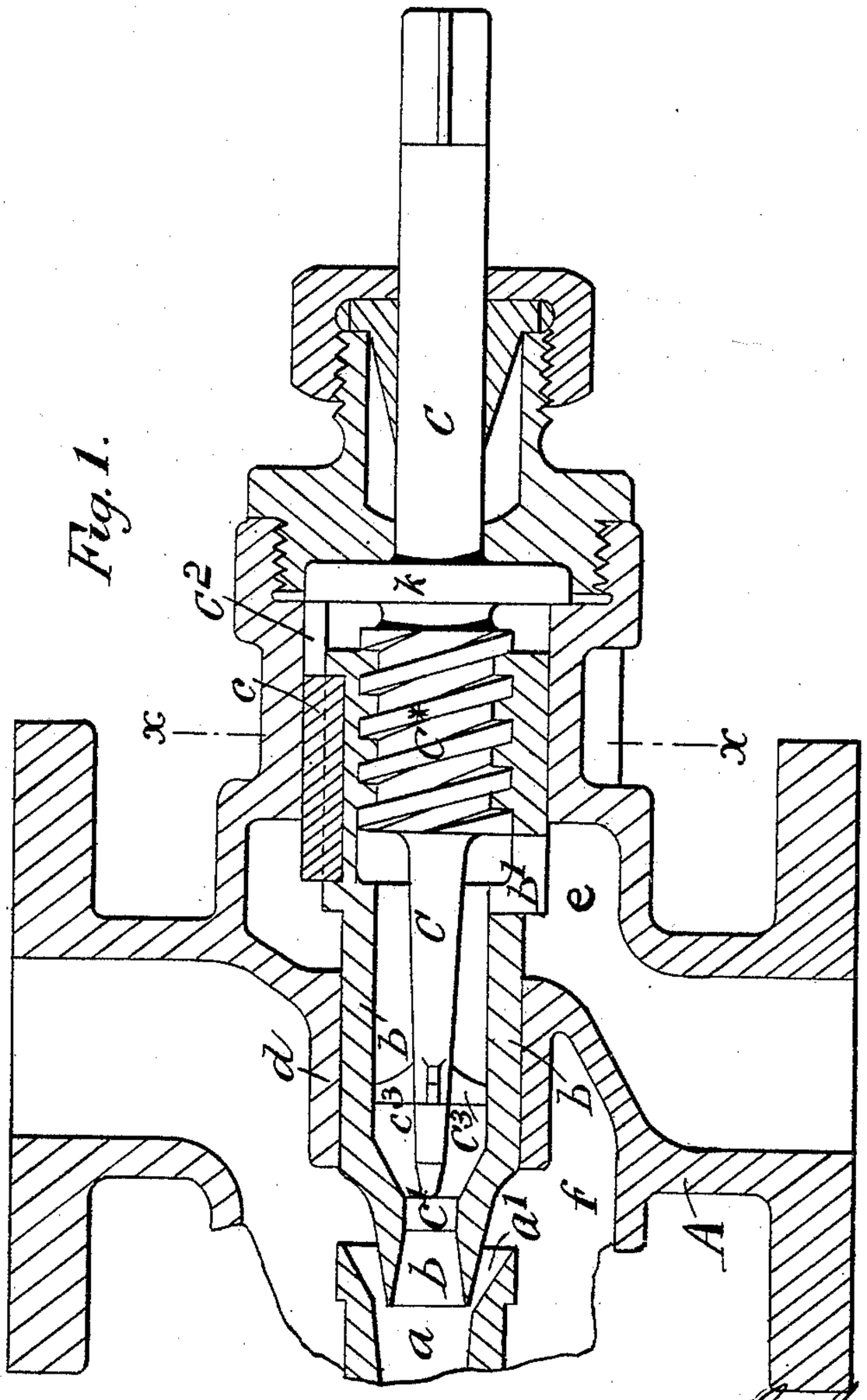



Fig. 1.




Witnesses
E. Duffy
H. C. Peak

R. G. Brooke
Inventor.
per
O. E. Duffy Atty.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(Model.)

3 Sheets—Sheet 2.

# R. G. BROOKE.

## INJECTOR.

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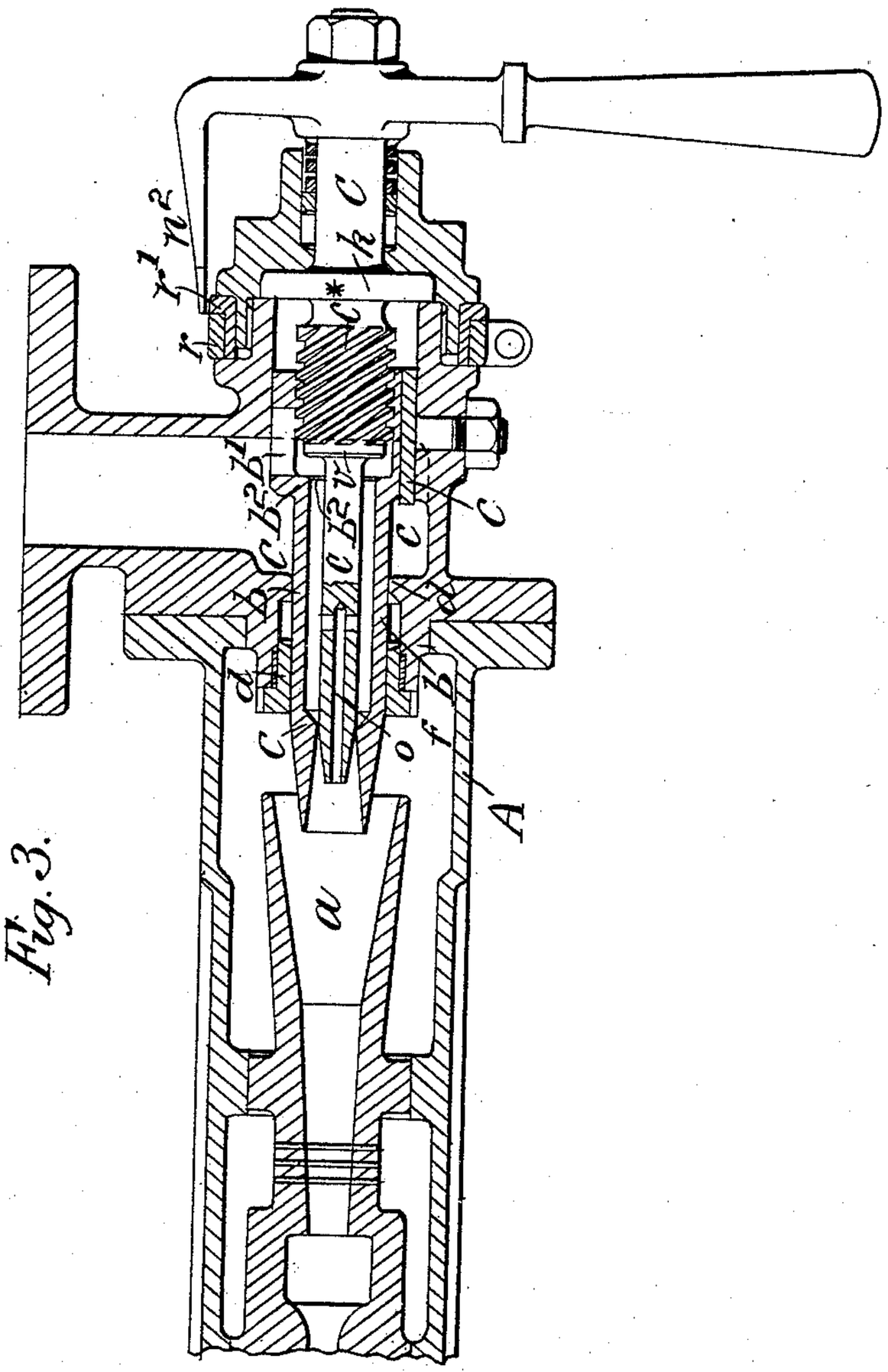


Fig. 3.

Witnesses
E. E. Duffy
E. E. Peck

R. G. Brooke
Inventor.
per E. E. Duffy
Atty.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(Model.) 3 Sheets—Sheet 3.

# R. G. BROOKE.

## INJECTOR.

No. 474,361. Patented May 10, 1892.

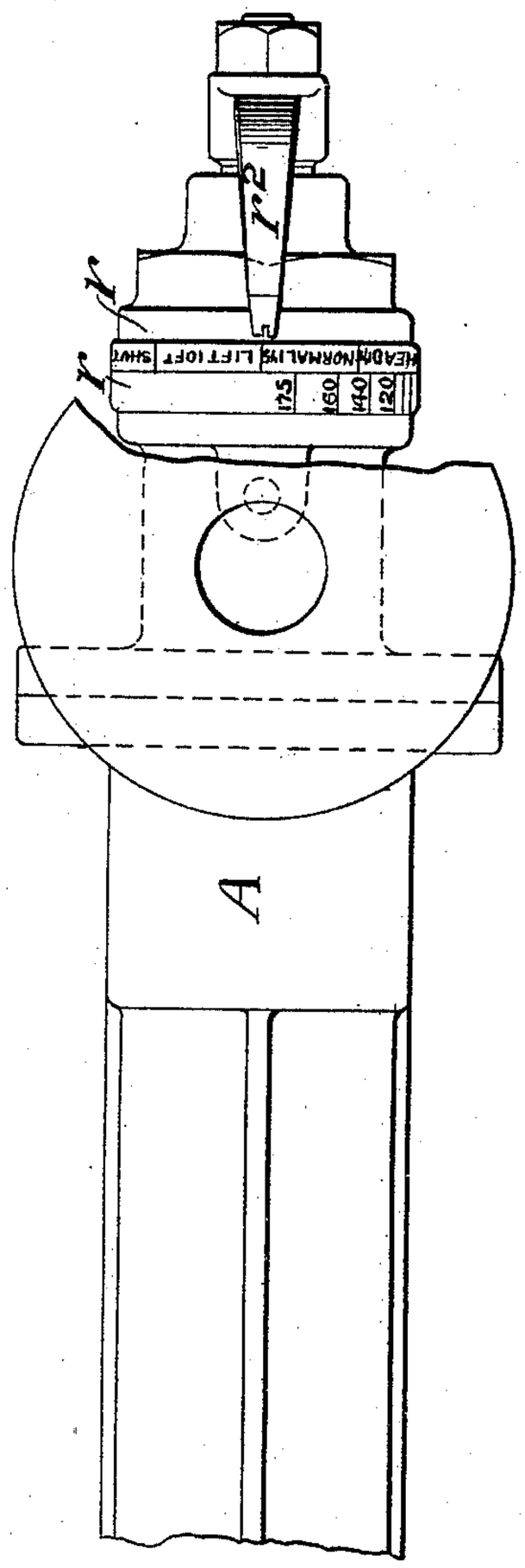


Fig. 4.

Witnesses
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

ROBERT GRUNDY BROOKE, OF BLACKPOOL, ENGLAND.

## INJECTOR.

SPECIFICATION forming part of Letters Patent No. 474,361, dated May 10, 1892.

Application filed November 16, 1889. Serial No. 330,582. (Model.) Patented in England May 26, 1888, No. 7,742; in France May 3, 1889, No. 197,959, and in Italy June 30, 1889, No. 457.

*To all whom it may concern:*

Be it known that I, ROBERT GRUNDY BROOKE, a subject of the Queen of Great Britain and Ireland, residing at Blackpool, in the county of Lancaster, Kingdom of Great Britain and Ireland, have invented Improvements in Injectors, (patented in England May 26, 1888, No. 7,742; in France May 3, 1889, No. 197,959, and in Italy June 30, 1889, No. 457,) of which the following is a specification.

My invention relates to injectors in which it is necessary or desirable to effect regulation of both steam and water.

To enable an injector to be adjusted from time to time to work at different steam-pressures and different positions relative to the feed-water supply, I construct it so that by one movement the necessary regulation can be effected of both steam and water passages in the nozzles. For this purpose I employ a spindle fixed in relation to the combining-nozzle and placed in the interior of a movable steam-nozzle, so as to serve for altering the area of its outlet. The steam-nozzle is movable longitudinally. The inner or forward end of the spindle is so fashioned and the spindle is fixed in such a way that as the steam-nozzle is withdrawn from the combining-cone in order to increase the water-space its narrowest internal diameter approaches the conical or tapered end of the spindle, and so the steam-exit is lessened. Moving the steam-nozzle in the contrary direction has the effect of enlarging the steam admission and closing the water-space. By suitably proportioning the alteration of area of the water and steam spaces due to a given traverse of the steam-nozzle the desired regulation is effected. The nozzles may be those of an ordinary injector or of an automatic restarting injector. In all cases the end of the spindle may be of any suitable shape, as circumstances may require. It may be explained that generally a low steam-pressure requires less water and more steam, while more water and less steam are required as the pressure rises. In what is known as a "single adjusting-injector," in which the adjustment is also accomplished by one movement, the steam area remains the same throughout if it is the water that is regulated, or if it is the steam only that is regulated, then the water area remains the same throughout; but in no way is such single adjustment as efficient as the adjustment of both steam and water.

Referring to the accompanying drawings, Figure 1 shows in section part of an injector, illustrating the application of my invention thereto. Fig. 2 is a cross-section on the line $x\,x$, but with the spindle C removed. Fig. 3 is a longitudinal section of a modified construction of injector, and Fig. 4 is an outside view illustrating a modified construction.

Referring to Figs. 1 and 2, A is a part of the body and casing of an injector, of which $a$ is part of the upper end of the combining-nozzle, and $b$ is the steam-nozzle arranged so as to slide tightly in a bearing $d$ between the steam-chamber $e$ and water-chamber $f$ and formed with a lateral inlet or inlets $b'$ for steam. The combining-nozzle may be divided or be provided with outlets at some point in its length for the purpose of rendering the injector an automatic self-starting injector, as well understood.

C is a spindle projecting down into that part of the steam-nozzle the diameter of which finally determines the admission of steam (or other fluid) through it into the injector. This portion of the nozzle I will call $c'$; but its exact position in the nozzle depends upon the construction and shape of the nozzle. The spindle C has a conical end, which sometimes projects into the nozzle at $c'$ and sometimes does not, according to the position of the nozzle from time to time. In the drawings the nozzle is shown at a low point. The annular water area $a'$ is small and the steam area $c'$ fully open. This would be the requisite position of the parts under the circumstances, where the steam-pressure was at a comparatively low point, at which it was intended the injector should work. The area of the steam-space $c'$ when the spindle is entirely withdrawn therefrom is made sufficiently large for the lowest pressure at which the injector is intended to work. If a greater steam-pressure than that just referred to should be employed, then more water and less steam would be required. This condition is attained by screwing back the nozzle $b$ sufficiently to give the increased water-space

required. As the nozzle *b*, and consequently its contracted part *c'*, will then have been moved toward the point of the spindle, which does not move endwise, the conical end of C becomes farther inserted into *c'* and so lessens the steam area. In this way the requisite regulation may be effected from time to time, as required. By the terms "steam" and "water" space I mean the area in a nozzle or between two nozzles by which the quantity of steam, water, or other fluid entering through or between such nozzles for combination is finally determined.

In Fig. 1 the spindle *c* is prolonged and taken through a stuffing-box to the outside of the injector, where by means of a handle or key it may be rotated. The spindle is formed with a screw-thread $c^{\times}$, that works in a correspondingly-formed screw-thread in the nozzle *b*, which is prevented from turning by a key C, carried by the nozzle and arranged to slide in a slot $C^2$ in the casing when the nozzle moves longitudinally. By this construction when the spindle is rotated the nozzle is forced by means of the screw-thread $C^{\times}$ to move endwise, so as to produce the differential regulations previously described. The spindle itself does not move longitudinally, and is provided with a collar *k* or any other efficient equivalent to prevent any such motion. In the interior of the steam-nozzle the spindle has webs $c^3$ near its conical end, in order to insure its being central. By making the spindle C of such a length that its inner or forward end terminates when the injector is at work at a point within the steam-nozzle, as shown, the steam after passing this end can expand and issue as a solid jet as compared with a hollow or annular one before coming in contact with the water to be raised and forced, so that the injector will work much more reliably as a self-starting and automatic restarting injector having double adjustments—viz., for water and for steam.

To utilize the action of the steam as far as possible for the purpose of starting and automatic restarting, the outlet-passage of the steam-nozzle can advantageously be made in my improved injector of gradually increasing cross-sectional area from the contracted part *c'* outward, as shown, that the jet of steam, although of annular form, as it passes the spindle can gradually expand as it issues and fill the outlet-passage before coming in contact with the water.

Figs. 3 and 4 show an arrangement similar to Figs. 1 and 2. These figures also show an application of my invention in combination with one of the well-known arrangements for making an ordinary injector lift its feed-water. The spindle, which in its most forward position is constructed to fit closely into the throat *c'* of the steam-nozzle, is provided with a central hole *o*, through which a jet of steam is admitted as soon as the seat at $b^2$ on the steam-nozzle *b* leaves the valve *v*. By means of this small jet a vacuum is created and the injector caused to lift its water, as is well known.

In combination with the arrangement for moving the steam-nozzle (illustrated in Figs. 3 and 4) there is shown a method of indicating the working position of the spindle for different pressures in injectors made according to my invention. By making the steam-nozzle with a quick-pitched screw it can be arranged to move the requisite distance for complete regulation by one turn of the spindle, and the various steam-pressures suitable for the various positions of the spindle during this one turn are marked on the ring *r*, which may either be separate or a part of the injector. On the drawings it is shown separate. This ring *r* is divided to form a "pressure-index," showing the position of the spindle for different pressures. Should the injector have to lift its feed-water a considerable height it would at any given steam-pressure require a greater water-space than if the water-supply ran to it. The point of regulation as given on the pressure-index would not therefore be correct under all circumstances. I therefore provide in some cases a second or "position" index *r'*, stating different "lifts" and "heads" of feed-water, and I set the point marked "zero" on the pressure-index to the point or figure on the position-index corresponding to the lift or head of water the injector has when fixed to work with. Suppose the injector had to lift its water ten feet and the steam-pressure was one hundred pounds, the ring *r* would be set considerably to the left in order to bring its position in line with the mark on the position-index corresponding to ten-feet lift, and the spindle-pointer would accordingly have to be carried so much farther to the left to bring it up to the "one-hundred-pounds" mark on the ring *r*. Consequently there would be greater water-space than would have been the case had there been no lift. The position of the spindle is determined by the pointer $r^3$ being brought opposite to the figure on the pressure-index representing the boiler-pressure, or as near that point as may at the moment be desirable.

My above-described improvements can be equally well applied to water lifters, elevators, &c., worked by steam or other condensing fluid, and also to air ejectors and injectors, liquid-fuel sprayers and injectors, or any jet apparatus where double adjustment is desirable.

What I claim is—

1. In an injector, the combination of a fixed combining-nozzle, a longitudinally-movable steam-nozzle, and a spindle the inner end of which terminates at a point within said movable nozzle, which is so proportioned and arranged in relation to said fixed nozzle and spindle that an internal area in said movable nozzle and also the area between the exterior of that nozzle and the interior or the end of the second nozzle will be simultaneously al-

tered by longitudinal movement of said movable nozzle alone, substantially as herein described.

2. In an injector, the combination of a combining-nozzle, a longitudinally-movable steam-nozzle formed with a valve-seat, and a spindle able to rotate but fixed in a longitudinal sense and formed with a valve, said parts being so proportioned and arranged that rotation of said spindle will cause said steam-nozzle to move longitudinally and open or close a passage for steam between said valve and valve-seat, substantially as described.

3. In an injector, the combination of a combining-nozzle divided or provided with outlets at some parts of its length in such a manner as to render the injector self-starting with steam fully on, a longitudinally-movable steam-nozzle, and a spindle able to rotate but fixed in a longitudinal sense, as herein described, for the purpose specified.

4. In an injector, the combination of a fixed combining-nozzle, a longitudinally-movable steam-nozzle closed at its outer end and formed with a lateral inlet for steam, and a central spindle able to rotate but fixed in a longitudinal direction and capable of causing longitudinal movement of said steam-nozzle, substantially as herein described, for the purpose specified.

5. In an injector, the combination of a fixed combining-nozzle, a longitudinally-movable steam-nozzle, and a spindle able to rotate but fixed in a longitudinal direction and capable of moving said steam-nozzle endwise, said spindle being made hollow from its free or forward end outward for part of its length and formed with an inlet for passage of steam to its hollow portion, substantially as herein described, for the purpose set forth.

6. In an injector, the combination of a fixed combining-nozzle, a longitudinally-movable steam-nozzle, and a spindle able to rotate but not to move longitudinally with said steam-nozzle, said spindle having its inner or forward end terminating at a point within said steam-nozzle and provided with an externally-screw-threaded enlarged part adapted to engage with a correspondingly screw-threaded portion of said steam-nozzle and said steam-nozzle having lateral inlets for steam located at the forward end of the screw-threaded part of said spindle, and a seat that bears against the enlarged part of said spindle when the nozzle is at its outermost position, substantially as herein described for the purpose specified.

7. In an injector, the combination of a fixed combining-nozzle, a steam-nozzle capable of sliding longitudinally and having an outlet of gradually-increasing size, and a spindle made hollow for part of its length and formed with a steam-inlet, said spindle being fixed in a longitudinal sense independently of said steam-nozzle but capable of rotating and of effecting endwise movement of said steam-nozzle, said spindle and sliding nozzle being so relatively constructed and arranged that said sliding nozzle by its sliding movement will cause the opening or closing, as required, of a passage through said spindle and at the same time will open, close, or alter the area of a passage between itself and the spindle, substantially as described, for the purpose specified.

8. In an injector, the combination of a fixed combining-nozzle *a*, a movable steam-nozzle *b*, contracted at *c'* and arranged to slide longitudinally in the injector-casing but not to rotate, and a spindle C, able to be rotated from the exterior of said injector but not to move longitudinally with said steam-nozzle and having its inner or forward end terminating at a point within said steam-nozzle, said spindle being formed with a screw-threaded part adapted to engage said movable nozzle and move the same endwise when rotated, and said steam-nozzle having lateral steam-inlet holes located at the forward end of its screw-threaded part, substantially as herein described, for the purpose specified.

9. In an injector, the combination of a fixed combining-nozzle *a*, a movable steam-nozzle *d*, arranged to slide longitudinally in the injector-casing but not to rotate, having an outlet of gradually-increasing cross-sectional area and provided with an internal screw-thread, and a spindle C, capable of being rotated from the exterior of the said injector but fixed in a longitudinal direction independently of said steam-nozzle, having its inner or forward end terminating at a point within said steam-nozzle and provided with an external screw-thread that engages the screw-thread in said nozzle, substantially as herein described, for the purposes specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ROBERT GRUNDY BROOKE.

Witnesses:
EDWIN JONES,
W. WARDLE.