(Model.) 2 Sheets—Sheet 1.

S. L. KNEASS.

INJECTOR.

No. 376,315. Patented Jan. 10, 1888.

Fig. 1.

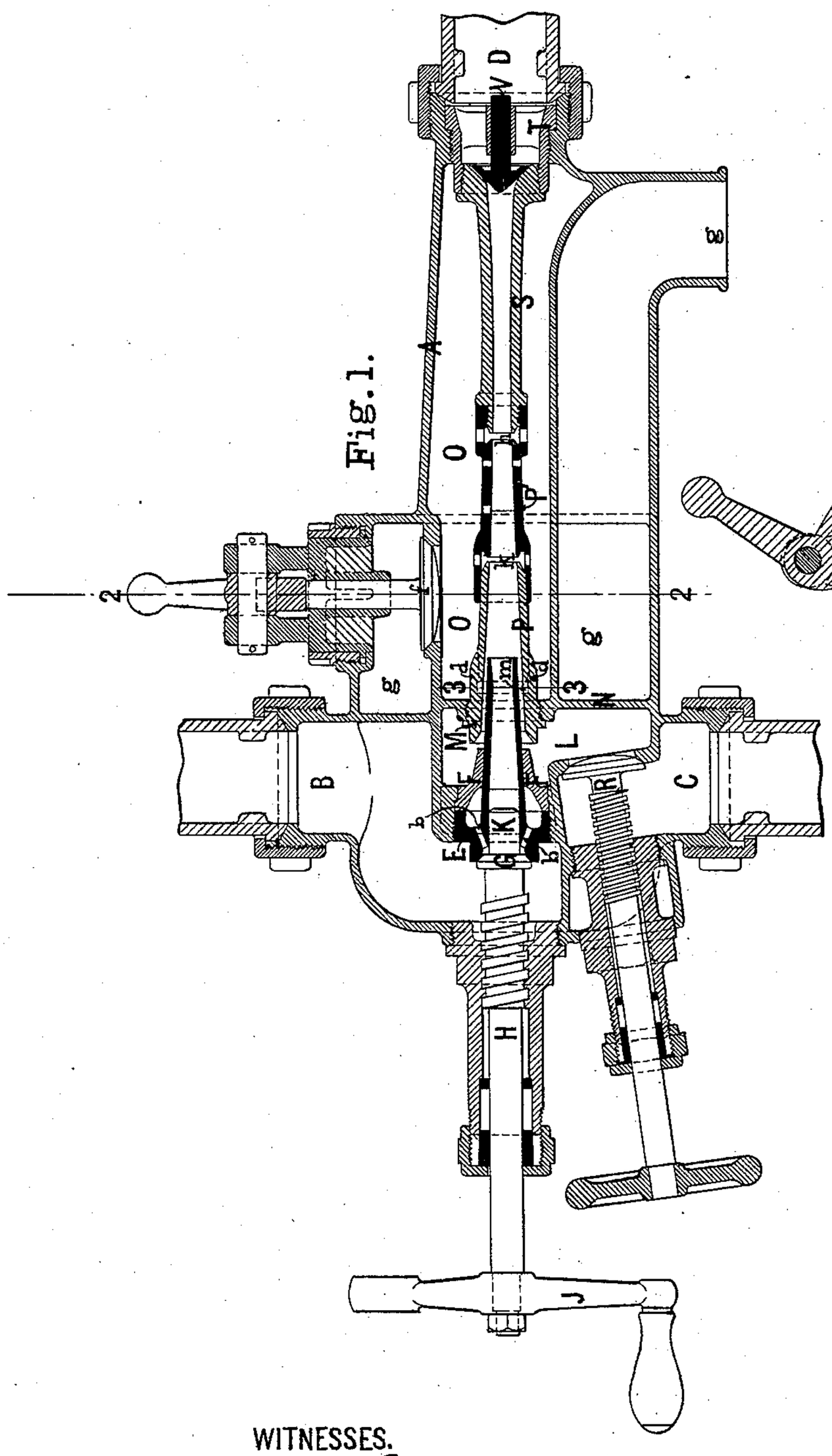

Fig. 2.

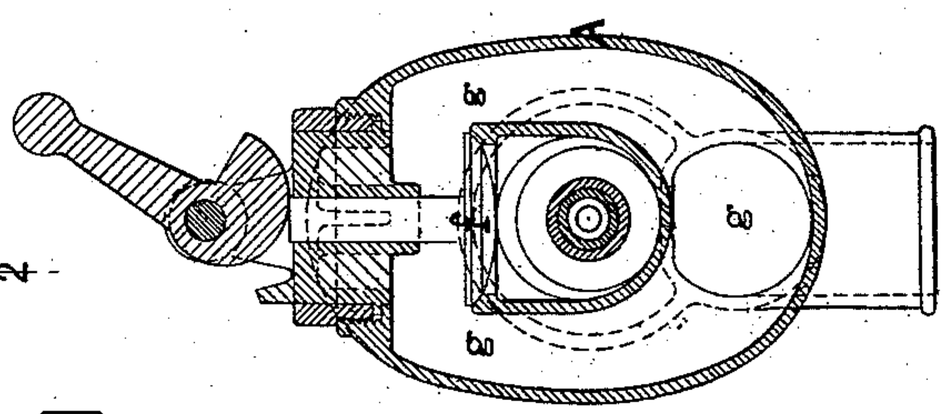

Fig. 3.

WITNESSES.

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Richard Kneass

(Model.)

2 Sheets—Sheet 2.

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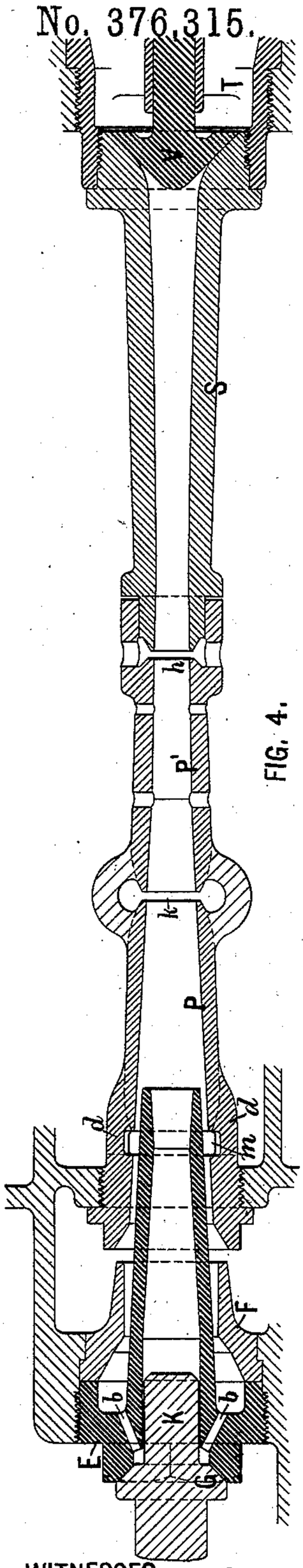

FIG. 4.

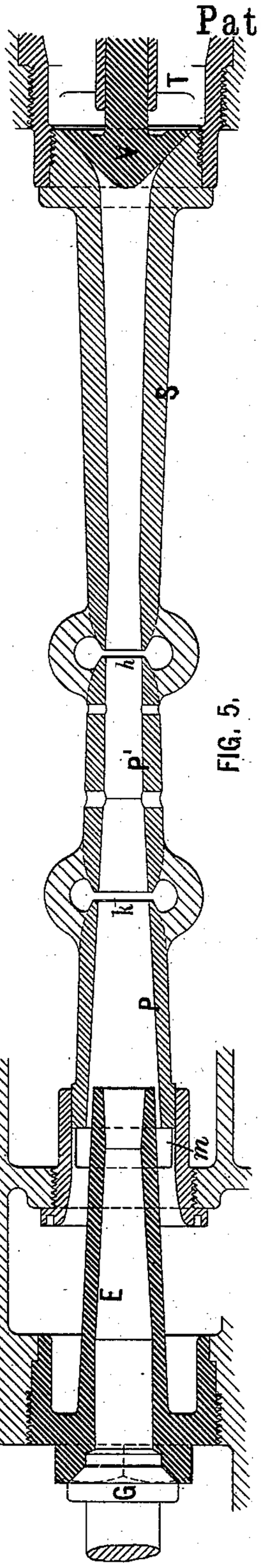

FIG. 5.

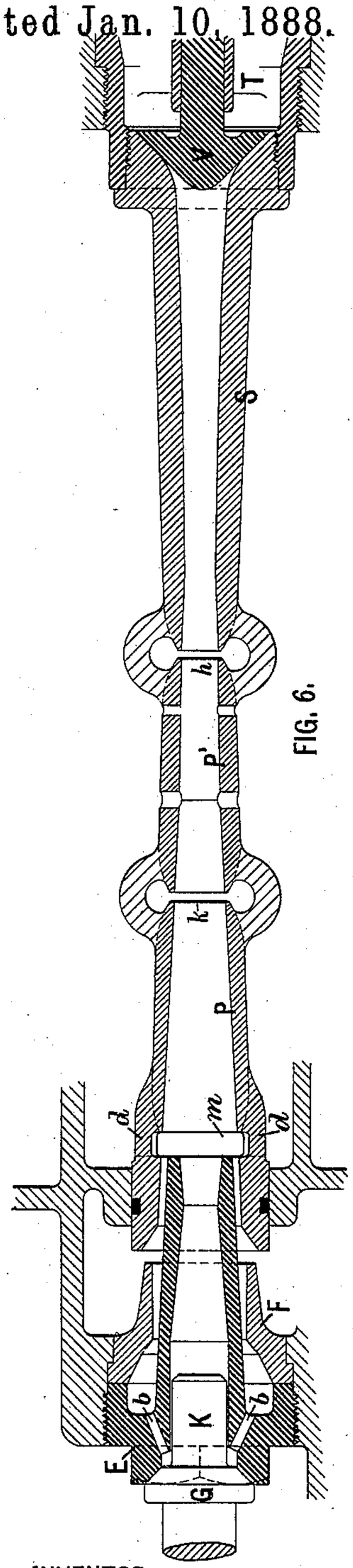

FIG. 6.

WITNESSES.

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UNITED STATES PATENT OFFICE.

STRICKLAND L. KNEASS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO WILLIAM SELLERS & COMPANY, INCORPORATED, OF SAME PLACE.

INJECTOR.

SPECIFICATION forming part of Letters Patent No. 376,315, dated January 10, 1888.

Application filed July 16, 1887. Serial No. 244,565. (Model.)

To all whom it may concern:

Be it known that I, STRICKLAND LANDIS KNEASS, of the city and county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Injectors, of which improvements the following is a specification.

My invention relates, principally, to that class of injectors in which the water receives successive impulses from two or more jets of steam arranged in the same axial line, the velocity of the water being continually accelerated without being diverted from its course until it has acquired the velocity requisite to enable it to enter the boiler, but is also applicable to injectors having but one steam jet under suitable conditions.

It is an object of my present invention to make an injector which shall be automatic in its action under variable conditions of water-supply and steam-pressure, and that shall be capable of restarting itself if from any cause the jet should be broken as soon as the disturbing cause is removed; and to this end my invention consists in providing an injector with a forcing combining-tube and a water-chamber provided with a water-inlet port and an overflow-port which communicates with the atmosphere, which chamber contains the receiving and overflow openings of this combining-tube, in combination with a forcing steam-nozzle which terminates forward of the receiving end of the combining-tube; and it further consists in an annular lifting steam-nozzle, an annular lifting combining-tube, a central forcing steam-nozzle, and a forcing combining-tube, the discharging end of the forcing steam-nozzle being forward of the lifting combining-tube; and it further consists in an annular lifting steam-nozzle, an annular lifting combining-tube, a central forcing steam-nozzle, and a forcing combining-tube, the discharging end of the forcing steam-nozzle being forward of the receiving end of the forcing combining-tube; and it further consists in an annular lifting steam-nozzle, an annular lifting combining-tube, a central forcing steam-nozzle, a forcing combining-tube provided with a forward overflow-opening, a rear overflow-opening located at a point in the rear of that where the diameter of the tube contracts to less than nine-tenths that of the discharging end of the steam-nozzle, with one or more intermediate overflow-openings, and an overflow-chamber in which all the overflow-openings are located.

In the accompanying drawings, which form part of this specification, Figure 1, Sheet 1, represents a longitudinal vertical section through an injector embodying my present improvements. Fig. 2 is a transverse section through the injector on the line 2 2 of Fig. 1. Fig. 3 is a transverse section through the ribs on the end of the forcing combining-tube on the line 3 3 of Fig. 1. Fig. 4, Sheet 2, is a longitudinal section through the steam-plug, steam-nozzles, and tubes, on an enlarged scale, and showing a different construction of the combining-tubes. Fig. 5 is a section of the same parts, showing another method of securing the tubes, and also shows the apparatus with one steam-nozzle only. Fig. 6 shows another method of securing the tubes and also a change in the position of the discharging end of the forcing steam-nozzle.

A is the body or case of the injector. B is the steam-inlet, C the water-inlet, and D the outlet through which the water is conveyed to the boiler; and for the purposes of this specification the end of the injector nearest the pipe that delivers the water to the boiler will be designated as the "forward end," and the end toward the crank-handle J will be designated as the "rear end," and the steam-nozzle through which the steam flows that imparts the sole or principal impulse to the water will be designated as the "forcing steam-nozzle," and where the injector is provided with two steam-jets the one that first acts upon the water will be designated as the "lifting steam-jet" and its nozzle as the "lifting steam-nozzle."

E is the forcing steam-nozzle, which is suitably secured in the case A of the injector, and is shown as securing in place the lifting steam-tube F, the space between this tube F and the nozzle E forming the annular lifting steam-nozzle. The nozzle E is provided at its rear end with a valve-seat adapted to receive the valve G, formed on the spindle H, which is provided with a screw-thread and nut and handle J, by which the valve G may be opened

to admit steam to the interior of the nozzle E. The forward end of the spindle H is cylindrical, and forms a steam-plug, K, which fits easily within the nozzle E, as shown on an exaggerated scale in Fig. 4, it not being necessary that the plug K should fit steam-tight in the nozzle E. When the valve G is first lifted from its seat to admit steam, the plug K prevents the steam from flowing freely through the forward end of the nozzle E, but allows it to escape freely through the openings *b b* into the annular space formed between the outside of the forcing-nozzle E and the inside of the annular jet-tube F, whence the steam discharges as an annular jet across the water-chamber L and into the lifting combining-tube M, which is secured in a partition, N, separating the water-chamber L from the overflow-chamber O, the space between the tube M and the forcing-nozzle E forming the annular lifting combining-tube. The exterior of the forcing steam-nozzle E thus forms the interior wall of both the annular lifting steam-jet and the annular lifting combining-tube throughout their entire length.

The forcing steam-nozzle E is described and shown as terminating within the receiving end of the forcing combining-tube P. It may, however, be made shorter, so as to terminate with the discharging end of the lifting combining-tube M, as shown in Fig. 6, in which case it would terminate at the overflow-opening *m*, or it may terminate at any desired point forward of the discharging end of the lifting combining-tube M; but the construction shown is preferred.

The tube M is shown as formed with and united to the forcing combining-tube P by means of the ribs *d d*. The space between the forward end of the tube M and the rear end of the combining-tube P forms a discharge or overflow opening, *m*, for the escape of the steam from the annular lifting-nozzle and the entrained air into the overflow-chamber O, whence they escape under the overflow check-valve *f* and through the overflow-passage *g g*. The forcing combining-tube P is shown as constructed in two parts, the forward part, P′, being secured at its forward end to the rear end of the delivery-tube S, which is shown as screwed to the piece T, which forms the guide for the boiler check-valve V, and is screwed into the forward or delivery end of the injector. By unscrewing the piece T the delivery-tube S and the forward part of the combining-tube P′ may be withdrawn from the body for the purpose of examination or repairs. The usual forward or starting overflow, *h*, is provided near and in the rear of the smallest diameter of the delivery-tube; but I also provide another or rear overflow, *k*, situated in the converging combining-tube in the rear of that point where the cross-sectional area of this tube contracts to less than the area of the smallest diameter of the forcing steam-nozzle. I also provide overflow-openings intermediate between the overflows *k* and *h*, for the purpose of facilitating the starting of the apparatus.

It is not essential that the tubes should be constructed as shown in Fig. 1, for the combining tubes P and P′ may be made in one piece, as indicated in Fig. 4, instead of separate, as shown in Fig. 1; or they may be made in one piece with the delivery-tube S, the rear end of the tube P being in this case supported by a ring carried by the ribs *d d* on the tube M, as indicated in Fig. 5; or, if desired, the tube M may also be joined to the others, in this case its bearing in the partition N being made without the screw-thread shown, but suitably packed to prevent leak, as in Fig. 6.

The operation of the injector is as follows: The water-inlet C being in communication with the water-supply, the valve R is opened to allow the water to enter the chamber L. Steam is admitted to the chamber B and the handle J is operated to lift the valve G from its seat and permit the steam to enter the annular lifting steam-nozzle F through the holes *b b*. The steam issuing from this nozzle passes through the annular combining-tube M and escapes from the instrument partly through the overflow-opening *m* and partly through the overflow-openings provided in the combining-tube P P′, through the overflow-chamber O and passage *g g*, and produces a strong vacuum in the water-chamber L, which lifts the water from the source of supply, and the united jet of steam and water is, by reason of its velocity, discharged into the rear or receiving end of the combining-tube P. The spindle H is now withdrawn until the steam-plug K is out of the forcing-nozzle E, allowing the steam to pass through the forcing-nozzle E and come in contact with the annular jet of water which is flowing into the combining-tube around the nozzle E. This jet of water has already considerable velocity, and the forcing steam-jet imparts to it the necessary increment of velocity to enable it to enter the boiler through the delivery-tube S and boiler-check V. If, now, from any cause the jet should be broken—say from a failure in the water-supply—the steam issuing from the forcing-nozzle E into the combining-tube P will escape through the overflows *k* and *h* and intermediate openings with such freedom that the steam which returns through the annular space formed between the nozzle E and combining-tube P and escapes into the overflow-chamber through the opening *m* will not have sufficient volume or force to interfere with the free discharge of the steam issuing from the annular lifting steam-nozzle and escaping through the same overflow, *m*, and hence the lifting steam-jet will always tend to produce a vacuum in the water-chamber L, which will again lift the water when the supply is renewed, and the combined annular jet of steam and water will be forced into the forcing combining-tube P against the feeble current of steam returning through this tube and into contact with the steam issuing from the nozzle E, when the jet

will again be formed and will enter the boiler as before.

When the injector can be placed so that the water flows to it under a head and is of comparatively low temperature, the annular lifting steam-jet and annular combining-tube may be omitted, and the water-supply chamber L and the overflow-chamber O will then be in free communication, and will form one water-chamber which will have a water-inlet port in free communication with the water-supply pipe and an overflow-port opening to the atmosphere, and which chamber will contain all of the openings of the forcing combining-tube. An arrangement for accomplishing this is indicated in Fig. 5, and the water flowing to the combining tube will surround the tube and submerge all of the receiving and overflow openings of this tube before overflowing into the passage *g g* under the check-valve, which is placed at the top of the water-chamber. These two chambers are apparently separated by a diaphragm, which, however, serves only to conveniently support and center the rear end of the combining tube, and when this combining-tube is supported in any other way this diaphragm would be omitted. Under these conditions the injector will be self-adjusting over a much greater range of steam-pressure than has hitherto been attainable with a fixed-nozzle single-jet injector. I have found that by prolonging the forcing steam-nozzle E until its discharging end is forward of the receiving end of the forcing combining-tube P, and by providing overflow-openings in this combining-tube, I am enabled to make a double-jet injector automatic at all steam-pressures capable of taking feed-water at higher temperature and of much greater range in quantity of water delivered than has hitherto been attained in this class of injectors.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is, in an injector—

1. A forcing combining-tube and a water-chamber provided with a water-inlet port opening into and an overflow-port opening out of said chamber, which chamber contains the receiving and overflow openings of this combining-tube, in combination with a forcing steam-nozzle which terminates forward of the receiving end of the combining-tube, substantially as described.

2. An annular lifting steam-nozzle, an annular combining-tube, and a central forcing steam-nozzle which terminates forward of the discharging end of the annular combining-tube, in combination with a combining-tube provided with an overflow-opening located at a point in the rear of that where the diameter of this tube contracts to less than nine-tenths that of the discharging end of the forcing steam-nozzle and forward of the receiving end of this combining-tube, substantially as described.

3. An annular lifting steam-nozzle, an annular lifting combining-tube, a central forcing steam-nozzle, and a forcing combining-tube provided with an overflow-opening located at a point in the rear of that where the diameter of the tube contracts to less than nine-tenths that of the discharging end of the forcing steam-nozzle and forward of the receiving end of this combining-tube, in combination with an overflow-chamber in which all of the overflow-openings are located, substantially as described.

STRICKLAND L. KNEASS.

Witnesses:
CHAS. E. PANCOAST,
JOHN L. PHILLIPS.