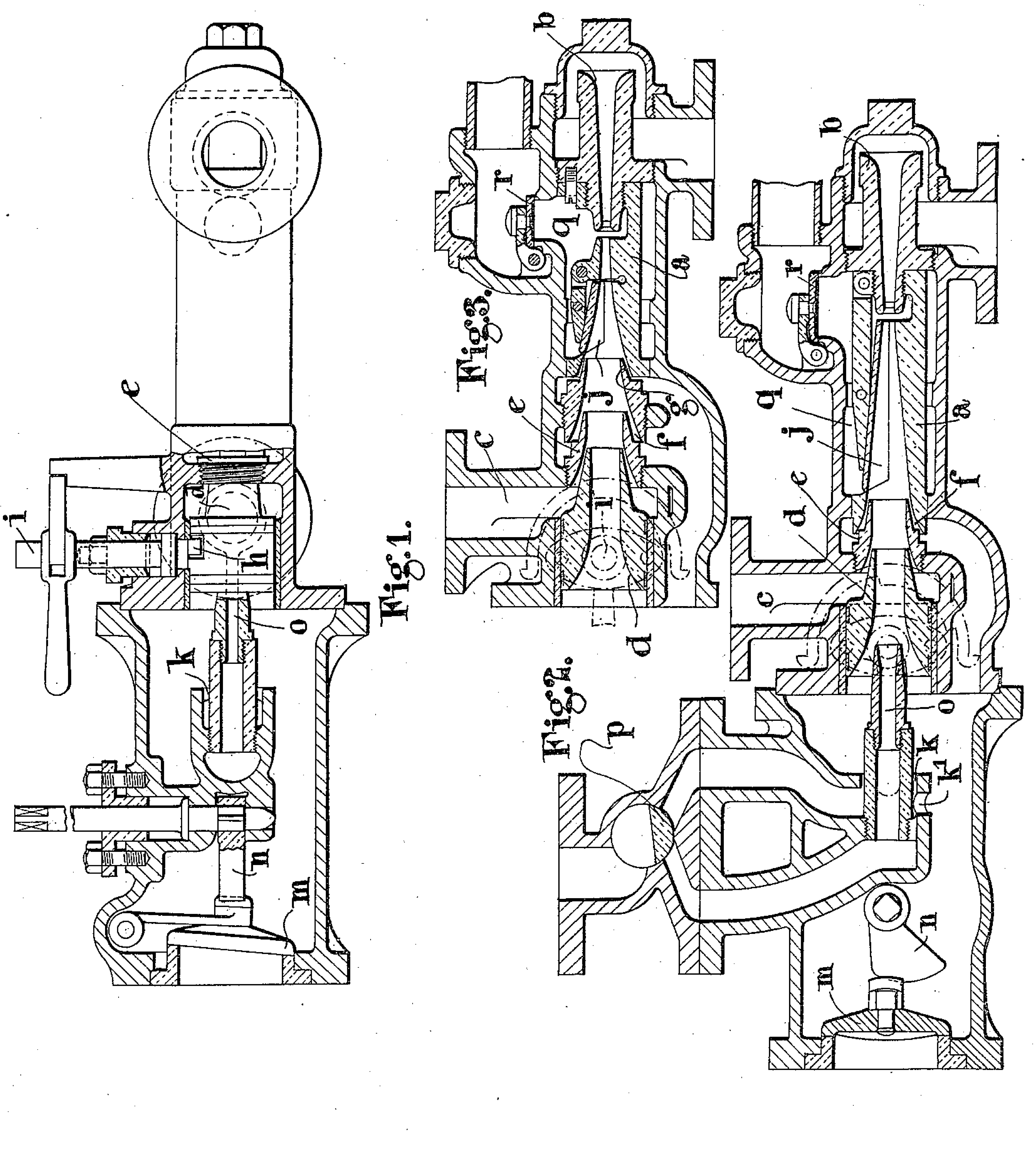
J., J. C. & R. D. METCALFE.

INJECTOR.

APPLICATION FILED DEC. 9, 1908.

944,455. Patented Dec. 28, 1909.



WITNESSES

W. P. Burke

A. F. Heuman

INVENTORS

James Metcalfe

James Croxon Metcalfe

Richard David Metcalfe

BY Wm. Wallace White

ATTY.

UNITED STATES PATENT OFFICE.

JAMES METCALFE, JAMES CROXON METCALFE, AND RICHARD DAVID METCALFE, OF FALLOWFIELD, ENGLAND.

INJECTOR.

944,455. Specification of Letters Patent. Patented Dec. 28, 1909.

Application filed December 9, 1908. Serial No. 466,672.

To all whom it may concern:

Be it known that we, JAMES METCALFE, JAMES CROXON METCALFE, and RICHARD DAVID METCALFE, subjects of the King of Great Britain and Ireland, residing at Sheen Bank, Lord street, Fallowfield, in the county of Lancaster, England, have invented new and useful Improvements in Injectors, of which the following is a specification.

This invention relates to injectors of the type which are worked by exhaust steam or steam at about atmospheric pressure.

With exhaust injectors, as at present constructed, working only with exhaust steam or steam at atmospheric pressure, it is impossible to deliver water therefrom against pressures exceeding 75 to 90 lbs. per square inch, dependent upon the temperature of the feed water being dealt with.

To enable exhaust injectors to deliver against higher pressures than aforesaid without the employment of supplementary live steam jets, it has heretofore been proposed to cause a jet of exhaust steam to act on the jet issuing from the end of the combining nozzle of the injector, but such proposals have been unsuccessful in accomplishing their object. It will be understood that the action of the exhaust steam issuing from the steam inlet nozzle upon the feed water is to raise the temperature of the latter as it passes through the combining or mixing nozzle, and though a vacuum or a partial vacuum may exist for the greater part or for the whole of the length of the combining nozzle, such vacuum decreasing in intensity toward the delivery end of the nozzle, little or no vacuum will exist at such end. Consequently any exhaust steam admitted to the delivery end of the combining nozzle, as has heretofore been proposed, will not meet the jet issuing from such nozzle with a sufficiently high velocity to be of service in driving forward the jet. Moreover, as the cross sectional area of the jet issuing from the combining nozzle is small, the amount of exhaust steam that could be drawn in thereat, even if a vacuum existed at that point, would be of little or no value.

As is well known it is the usual practice with all makers of injectors to employ a supplementary live steam jet on all injectors intended to deliver against pressures between 75 to 150 lbs. per square inch, dependent on the temperature of the feed water.

The object of our present invention is to enable an exhaust injector, using only exhaust steam, to deliver against greater pressures than is at present possible.

Our invention comprises an exhaust injector having the effective area of the exhaust steam inlet orifice lessened or restricted, and having one or more supplementary exhaust steam inlet apertures at points between said steam inlet orifice and the usual combining nozzle of the injector.

Referring to the accompanying sheet of explanatory drawings;—Figure 1 is a plan view, partly in section, and Fig. 2 is a sectional elevation of an exhaust injector constructed in one form according to our invention. Fig. 3 is a view corresponding to part of Fig. 2, but showing a modified form of our injector.

The same reference letters in the different views indicate the same or similar parts.

In carrying our invention into effect in the manner illustrated at Figs. 1 and 2, we provide our exhaust injector with combining and discharge or delivery nozzles *a* and *b* respectively of any usual and ordinary construction, and with a water inlet *c* and a main exhaust steam inlet nozzle *d* in the same axial line with the combining nozzle *a*.

It is usual with all makers of injectors worked by steam at atmospheric pressure to employ an exhaust steam inlet nozzle having a delivery orifice of about four or more times the diameter of the throat of the discharge nozzle, but according to our present invention we reduce or restrict the diameter of such steam inlet orifice, the most effective diameter being we find between 2.8 to 3.4 times the diameter of the throat of the discharge nozzle, but the ratios of such diameters may be slightly varied. By means of the aforesaid reduction in the diameter of the exhaust steam inlet orifice, the effective area thereof for the passage of exhaust steam is reduced by about one-half. (It will of course be understood that the exact ratios of the diameters of the steam inlet orifice and of the throat of the discharge nozzle depend on the pressure of the steam and temperature of the feed water dealt with by the injector, but in all cases we make this ratio less than that at present adopted under the same conditions.) We then pass the combined steam and water through a preliminary mixing nozzle or its equivalent *e* of such a length as will insure that a mixing of the steam and water passing therethrough shall take place for the purpose of condensing the steam and increasing the density of the jet sufficient to produce a very high degree of vacuum at the delivery end of the preliminary mixing nozzle *e*. The jet issuing from said preliminary mixing nozzle or its equivalent is, however, still of large cross sectional area and consequently a large volume of exhaust steam can be drawn into it. By the method and means aforesaid we are enabled to obtain a very high degree of vacuum at the delivery end of the preliminary mixing nozzle or its equivalent, said vacuum being about as great as that which is to be found at the place where the main steam jet and the water jet first unite. At this point of high vacuum, namely, at the delivery end of the preliminary mixing nozzle or its equivalent, we introduce a supplementary annular jet of exhaust steam at *f*, which therefore enters the injector with about the same velocity as does the main steam jet. The effect of such supplementary jet is to increase the rate of travel of the combined steam and water which it meets. If desired, we may introduce further supplementary jets of exhaust steam at different points, as at *g* Fig. 3, before the jet enters the usual or main combining nozzle or portion *a*, provided always that a sufficiently high degree of vacuum exists at such points. We may also if desired introduce cooling jets of water between each of the additional exhaust steam jets so as to reduce the temperature of the combined jets and thus increase the vacuum at the points where the additional steam jets enter.

For adjusting the area of the water inlet orifice or orifices as *c*, we may employ any usual and convenient device. We may for example move the main steam inlet nozzle relatively to the preliminary mixing nozzle or its equivalent before referred to, as by means of the eccentric pin *h* on the spindle *i*, and so adjust the area of the annular orifice between them, such orifice forming the water inlet.

We form the combining nozzle with ordinary gaps or slots, flaps or sliding nozzles in its length as usual. In Fig. 2 a long flap, and in Fig. 3 a short flap *j* is shown.

An exhaust injector constructed as before described is capable of delivering against pressures of about 120 to 130 lbs. per square inch dependent upon the temperature of the feed water, the pressure of the exhaust steam and other external conditions, thus giving an efficiency of about 50% upon exhaust injectors as at present constructed.

To render our injector capable of delivering feed water against higher pressures than those previously stated so as to adapt it for feeding boilers under the highest conditions of steam pressure, we employ a live steam inlet *o* which also serves as an inducer nozzle for causing the initial flow of exhaust steam to the injector. *k* is a live steam inlet branch for working the injector when exhaust steam is not available. The port or aperture *k′* in the nozzle *k* is for allowing steam to issue into the space around said nozzle and so prevent the formation of a vacuum behind the nozzle when the exhaust steam is cut off. *m* is an automatic back pressure valve which, when the injector is not being supplied with exhaust steam, closes and so prevents the possibility of any return flow from the injector. The valve *m* can be positively closed by the hand operated cam *n*. The steam supply to the inducer nozzle *o* and to the live steam nozzle *k* is controlled by the three way cock *p* capable of passing steam to the inducer nozzle *o* only, to both the inducer nozzle *o* and the live steam nozzle *k*, or of cutting off the live steam altogether.

By the position and arrangement of live steam connection *k* as before described, we obviate the loss in the velocity of the live steam at present experienced in exhaust injectors due to admitting said steam directly into the exhaust steam inlet pipe when its direction of motion has to be abruptly altered before it flows to the injector.

q is the overflow chamber of the injector and *r* a non-return valve thereon.

An injector of the type illustrated at Figs. 1 to 2 is capable of delivering into a boiler under the highest conditions of pressure for which with ordinarily constructed injectors a compound appliance is necessary, such appliance comprising an exhaust and a live steam jet co-axial with one another and a supplementary live steam injector which receives its water from the said exhaust injector and delivers it into the boiler or vessel being fed. We may however, if desired, employ a supplementary live steam injector in combination with our improved exhaust injector.

The characteristic feature of this invention is that the main exhaust steam jet is restricted and caused to issue into a preliminary mixing nozzle or its equivalent wherein the said main steam jet is condensed and a vacuum created which is maintained toward the outlet end, so providing at the said end, and at the mouth of the usual combining nozzle, a vacuous area such as will enable a supplementary jet to be introduced at high velocity.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:—

1. In injectors worked by exhaust steam or steam at about atmospheric pressure, an exhaust steam inlet conduit, an adjustable main exhaust steam inlet orifice leading

from said inlet conduit, a combining nozzle, a delivery nozzle, the effective diameter of said steam inlet orifice being 2.8 to 3.4 times the diameter of the throat of the delivery nozzle, a slot between said combining and delivery nozzles, a preliminary mixing nozzle between said main steam inlet nozzle and said combining nozzle, an adjustable water admission aperture surrounding the exit end of said main steam nozzle and at the inlet end of said preliminary mixing nozzle, an annular exhaust steam admission aperture (also leading from said exhaust steam inlet conduit) at the exit end of said preliminary mixing nozzle, an overflow chamber, a valve upon said chamber, and means adjacent the end of said preliminary mixing nozzle and between the latter and the aforesaid slot allowing a free escape of exhaust steam from the combining nozzle, substantially as herein set forth.

2. In injectors worked by exhaust steam or steam at about atmospheric pressure, a main exhaust steam inlet orifice, a combining nozzle, a delivery nozzle, the effective diameter of said steam inlet orifice being 2.8 to 3.4 times the diameter of the throat of the delivery nozzle, a preliminary mixing nozzle between said main steam inlet nozzle and said combining nozzle, an adjustable annular water admission aperture surrounding the exit end of said main steam nozzle and at the inlet end of said preliminary mixing nozzle, an annular steam admission aperture at the exit end of said preliminary mixing nozzle, a live steam nozzle co-axial with the combining nozzle, means allowing a free escape of steam from the combining nozzle, an overflow chamber, means preventing the pressure within said overflow chamber from obtaining access to the interior of said combining nozzle, a live steam inducer nozzle co-axial with the combining nozzle, a live steam inlet orifice co-axial with and adjacent said inducer nozzle, and means controlling the flow of steam to said inducer nozzle and live steam inlet, substantially as herein set forth.

3. In injectors worked by exhaust steam or steam at about atmospheric pressure, a main exhaust steam inlet orifice, a combining nozzle, a delivery nozzle, the effective diameter of said steam inlet orifice being 2.8 to 3.4 times the diameter of the throat of the delivery nozzle, a preliminary mixing nozzle, an adjustable annular water admission aperture surrounding the exit end of said main steam nozzle and at the inlet end of said preliminary mixing nozzle, an annular steam admission aperture at the exit end of said preliminary mixing nozzle, a live steam nozzle co-axial with the combining nozzle, means allowing a free escape of steam from the combining nozzle, an overflow chamber, means preventing the pressure within said overflow chamber from obtaining access to the interior of said combining nozzle, a live steam inlet orifice co-axial with and adjacent said inducer nozzle, means controlling the flow of steam to said inducer nozzle and live steam inlet, an exhaust steam inlet pipe, a back pressure valve on said pipe, and means closing said valve by hand, substantially as herein set forth.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

JAMES METCALFE.
JAMES CROXON METCALFE.
RICHARD DAVID METCALFE.

Witnesses:
ARTHUR HUGHES,
CHARLES CONRAD.