(Model.) 2 Sheets—Sheet 1.

# E. DAVIES & J. METCALFE.

## INJECTOR.

No. 535,360. Patented Mar. 12, 1895.

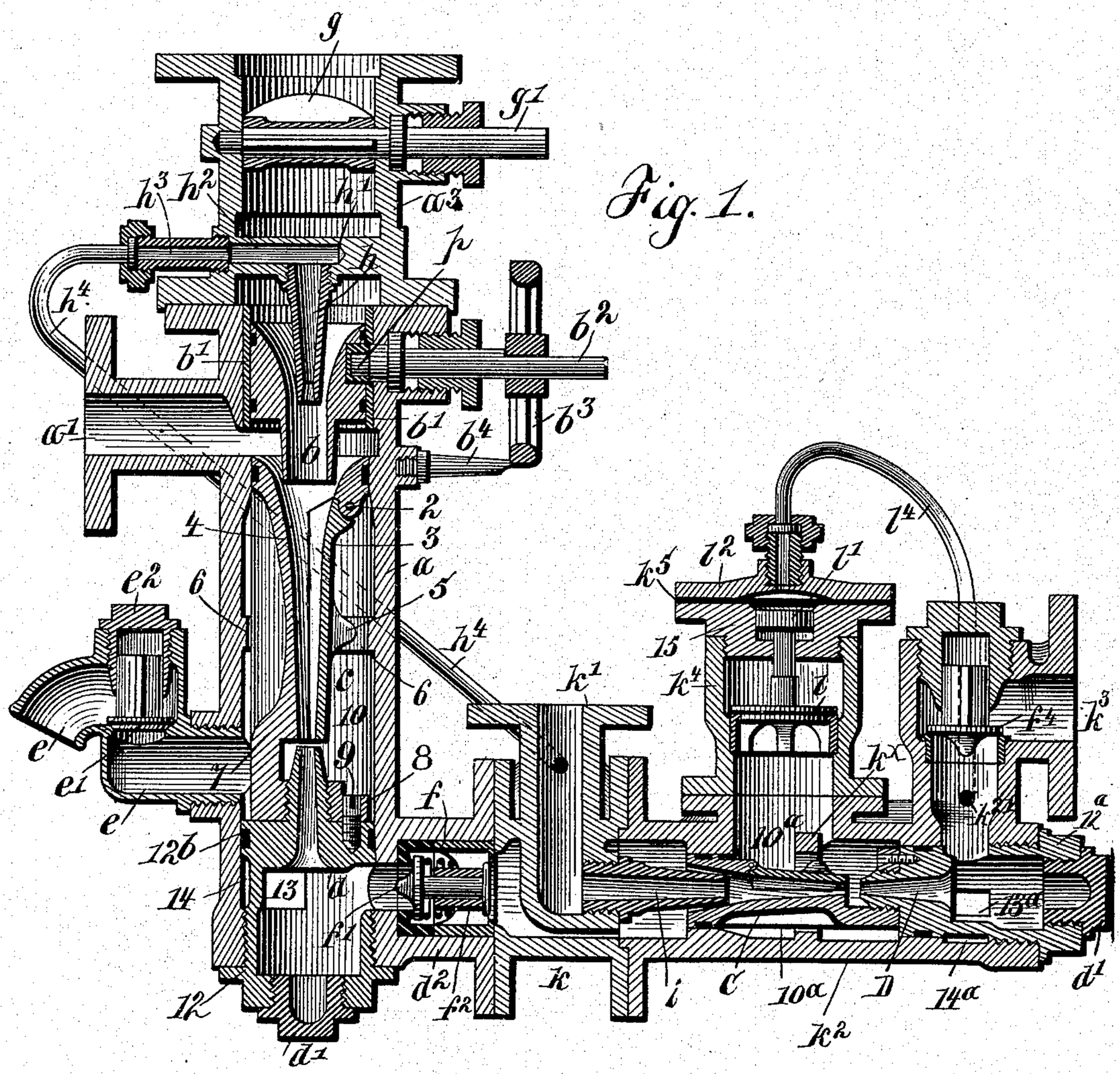

Fig. 1.

Witnesses:
H. G. Dieterich
Henry Orth

Inventors:
Edward Davies and
James Metcalfe
by Munn & Co
Attys.

(Model.) 2 Sheets—Sheet 2.

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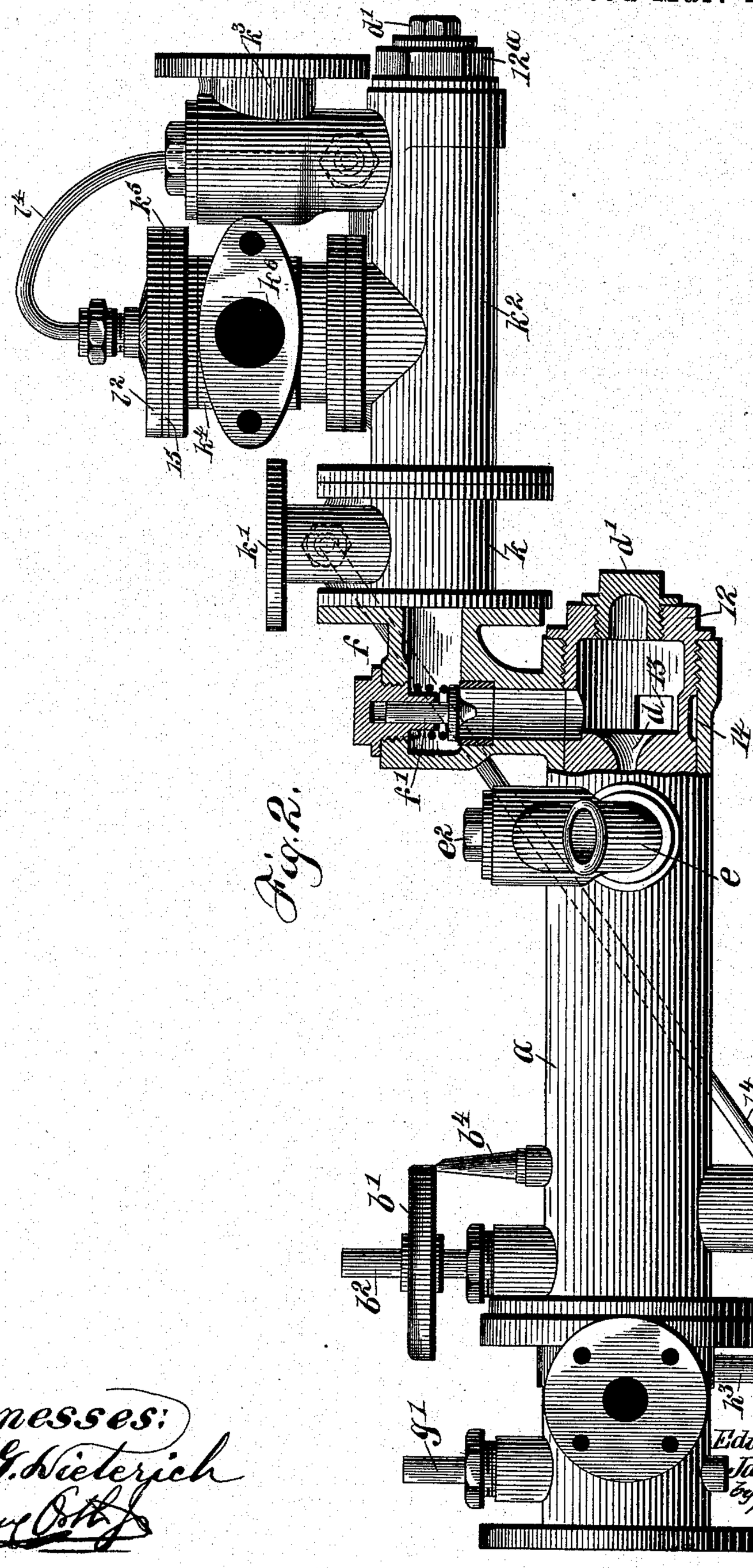


Fig. 2.

Witnesses:
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Edward Davies and
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# UNITED STATES PATENT OFFICE.

EDWARD DAVIES, OF LLANDINAM, AND JAMES METCALFE, OF ABERYSTWITH, ASSIGNORS TO THE PATENT EXHAUST STEAM INJECTOR COMPANY, LIMITED, OF MANCHESTER, ENGLAND.

## INJECTOR.

SPECIFICATION forming part of Letters Patent No. 535,360, dated March 12, 1895.

Application filed January 31, 1894. Serial No. 498,655. (Model.) Patented in France March 30, 1888, No. 189,692; in Belgium March 31, 1888, No. 81,249; in Italy April 2, 1888, XLVI, 99; in England November 7, 1888, No. 16,125, and in Austria-Hungary May 26, 1891, No. 1,488 and No. 1,355.

*To all whom it may concern:*

Be it known that we, EDWARD DAVIES, of Plas Dinam, Llandinam, in the county of Montgomery, and JAMES METCALFE, of 28 North Parade, Aberystwith, in the county of Cardigan, England, have invented certain new and useful Improvements in Injectors, (for which we have obtained Letters Patent in Great Britain, No. 16,125, dated November 7, 1888; in Italy, Vol. XLIX, No. 487, dated March 16, 1889, being an addition to Patent No. 99, Vol. XLVI, dated April 2, 1888; in Belgium, No. 85,406, dated March 30, 1889, being an addition to Patent No. 81,249, dated March 31, 1888; in France, dated May 9, 1889, being an addition to Patent No. 189,692, dated March 30, 1888, and in Austria-Hungary, dated May 26, 1891—Austria, No. 320, XLI/1,488, and Hungary, 20,291, XXV/1,355;) and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters and figures of reference marked thereon, which form a part of this specification.

Our invention has relation to injectors, and more particularly to compound injectors in which both low pressure or exhaust steam and high pressure or live steam are employed to impart greater velocity, hence penetrating power, to the jet of water produced by low pressure or exhaust steam or by both low pressure or exhaust steam and high pressure or live steam.

Our said invention has for its object the provision of means whereby the operation of the injector is made automatic after the injector has been started, that is to say, after the live and exhaust steam and water have been turned on, or to make such injector automatic both as to starting, stopping, and restarting, by perpetually connecting the same with the source of low pressure or exhaust steam and high pressure or live steam and water supply. Such an injector comprises a low pressure or exhaust steam injector and one or more supplementary or high pressure or live steam injectors.

By low pressure or exhaust steam injector, we mean one that imparts velocity to a jet of water for feeding a boiler or for other purposes by means of steam at, or approximately at atmospheric pressure, such as the exhaust steam from an engine or other source, or high pressure steam purposely wire drawn.

By high pressure injector, we mean one that receives water from an exhaust injector and which is so constructed as to cause the water received to combine with high pressure or live steam for the purpose of imparting to the water a greater velocity, and consequently a greater penetrating power than would be the case with low pressure or exhaust steam alone, or when the jet is started with combined low pressure or exhaust steam and high pressure or live steam. By these means we are enabled to feed boilers working at a greater pressure than about seventy-five pounds to the square inch, as it is well known that injectors working with low pressure or exhaust steam cannot be used for feeding boilers working at a pressure much higher than seventy-five pounds to the square inch. Hence, these injectors are not available for feeding high pressure boilers, as locomotive boilers, for instance.

Our invention has for its further object the provision of an automatically operating starting valve for the supplementary or high pressure steam injector, adapted to be closed by pressure arising from a jet of fluid produced by low pressure or exhaust and high pressure, or live steam; also the provision of means whereby the volume and initial pressure arising from a jet of fluid produced by low pressure or exhaust steam may be varied or adjusted to open said starting valve.

Our invention has for its further object the combination with a low pressure or exhaust steam injector of a plurality of supplementary or high pressure steam injectors; but that our invention may be fully understood we will describe the same in detail, reference being had to the accompanying drawings, in which—

Figure 1 is a longitudinal axial section of an injector embodying our improvements. Fig. 2 is a side elevation partly in section illustrating a modification in the relative arrangement of the low pressure or exhaust steam injector and the high pressure or live steam injector.

Similar symbols indicate like parts wherever such may occur in said figures of drawings.

Having given a clear definition of what we mean by exhaust and live steam injectors, we will hereinafter so denominate the said injectors.

Referring to Fig. 1, *a* indicates the exhaust injector casing, in the upper end of which is arranged a bushing or lining *b'* that serves as a bearing for the adjustable exhaust steam nozzle or cone *b*, said nozzle or cone having peripheral grooves for the reception of packing rings, so as to form a fluid-tight joint with its bearing *b'*. At its said upper portion the casing *a* has a stuffing box for a spindle $b^2$ that has at its inner end an eccentric pin *p* that works in a transverse recess formed in the side or periphery of the exhaust steam cone *b*, between its packing grooves. The spindle $b^2$ carries at its outer end an indexed hand wheel $b^3$, there being a pointer $b^4$ secured to casing *a* whereby the degree of rotary displacement of the wheel may be ascertained. By turning the wheel and spindle $b^2$ in one or the other direction, a rectilinear movement in a corresponding direction is imparted to the exhaust steam cone *b* for purposes presently to be explained. To the outer end of the casing *a* is secured a supplementary casing $a^3$ adapted to be connected with the source of exhaust steam supply and provided with a suitable cut-off valve as a swivel throttle valve *g* of well-known construction. Across the bore of the casing is a hollow bridge provided centrally with an interiorly threaded branch for a live steam nozzle or cone *h*, the interior of the bridge being connected by a suitable passage as a pipe $h^4$ and coupling $h^3$ with the live steam branch *k'* of the supplementary live steam injector, hereinafter to be described, so that live steam may be supplied to the exhaust injector through cone *h* which projects axially into the exhaust steam cone *b* of the exhaust injector.

The object of making the exhaust steam cone *b* adjustable relatively to the combining cone *c* is to regulate within certain limits the volume of water admitted to the injector.

In starting the injector, for the purpose of providing a greater area and freer outlet of the fluid, we provide means whereby the live and exhaust steam passage of the exhaust steam injector may be expanded. To this end, we preferably use a two-part combining cone of the construction shown in Letters Patent of the United States No. 240,101, dated April 12, 1881, (granted to Edward Davies, one of the parties hereto.) This combining cone *c* is composed of two parts 3 and 4, hinged together at or near the wider end or mouth of the cone, as shown at 2. The section 3 of the cone is free to move laterally, thereby expanding or enlarging the internal passage of the cone from the hinge connection to the delivery end, the hinged section being provided with a boss or projection 5, and the casing with an annular abutment 6, for the purpose of limiting the lateral motion, or degree of expansion of the movable cone section 3. The fixed section 4 of the combining cone *c* has at its outer end an arm 7 terminating in an interiorly screw-threaded ring bearing 8 into which is screwed the receiving and discharging cone *d*, said cone being locked to the ring against accidental unscrewing by means of a lock screw 9. The overflow chamber 10 formed between the upper end of the combining cone *c* and the receiving and discharging cone *d* has an overflow branch *e* in which is formed a valve port and seat for a gravity controlling valve *e'* that is guided in its movements to and from its seat in a tubular plug $e^2$ screwed into the overflow branch *e* whereby ready access may be had to said valve. The receiving and discharging cone *d* has one or more peripheral packing grooves for a suitable packing $12^b$ for the purpose of forming a fluid tight joint between it and the casing *a*, and said cone is formed integral with a casing 12 open at its outer end and peripherally threaded to screw into the lower end of casing *a*, the opening in the outer end of casing 12 being closed by a screw plug *d'*, by means of which construction both combining and receiving and discharging cones *c*, *d*, can be adjusted, if found desirable or necessary, relatively to the exhaust steam cone *b*, and whereby said cones *c*, *d*, can readily be removed from the casing, or access had to said cones by removal of screw plug *d'* for inspection, or removal of obstructions. The casing 12 has ports 13 that open into an annular chamber 14, formed in the lower part of casing *a*, which is of increased diameter at that point and provided with a lateral branch $d^2$ to which the supplementary injector casing is secured. In branch $d^2$ is preferably secured a bushing or casing *f* constructed to form a valve seat for a spring-actuated back pressure valve *f'* adapted to open outwardly, the stem of said valve being guided in a sleeve $f^2$ formed centrally of the casing *f*.

For the sake of greater convenience we preferably construct the supplementary live steam injector casing in two parts, *k* and $k^2$, connected together and to the branch $d^2$ of the exhaust injector casing *a*, the part *k* intermediate of the part $k^2$ and branch $d^2$ being provided with a live steam branch *k'* (hereinbefore referred to) extending axially into part *k* and being screw-threaded interiorly for the live steam nozzle or cone *i* of the second or supplementary live steam injector, co-operating with a two-part combining cone C, and a receiving and discharging cone D of the same construction and relative arrangement as the

corresponding cones above described in reference to the exhaust injector, the ports $13^a$ in casing $12^a$ of the receiving and discharging cone D leading to an annular chamber $14^a$ connected with a delivery branch $k^3$ in which is formed a valve seat for a check or back pressure valve $f^4$ adapted to open outwardly, the object of which is well understood.

The overflow chamber $10^a$ has an overflow branch $k^4$ in which is formed a valve seat for a piston gravity valve $l$ adapted to open outwardly, the piston $l'$ at the upper end of the stem of said valve working in a piston cylinder 15 screwed into the end of the overflow branch, and closed by a head $l^2$ between which and the said cylinder is secured a diaphragm $k^5$. The cylinder head $l^2$ is provided with a junction for a pipe $l^4$ that is connected at $k^{21}$, or thereabout, with the delivery branch $k^3$ below the seat for the back pressure valve $f^4$, so that the pressure arising from a jet of fluid produced by combined exhaust and live steam in said delivery branch in excess of the weight of the overflow valve $l$ will be exerted upon the back of the diaphragm $k^5$, and through the latter upon the piston head of the valve $l$ to close the same. When the valve $l$ is open the fluid escapes through a side branch $k^6$, Fig. 2.

In the injector above described the combined exhaust and live steam injector is arranged at right angles to the supplementary live steam injector, but we do not desire to confine ourselves to this arrangement, as said elements may be arranged parallel to each other, as shown in Fig. 2, the necessary changes to suit the altered position of the casing $a$ being made, the position of the overflow branch $e$ and its valve $e'$ and the back pressure valve $f'$ being changed to suit said altered arrangement.

The operation of the injector may be briefly described as follows: It being understood that the supply of exhaust and live steam and of water to the injector is either constant or turned on, the jet of fluid will be started by the combined exhaust and live steam, or said jet may first be started by exhaust steam alone. In either case the area of the steam passage, in the exhaust injector, about the overflow gap between the combining and the receiving and discharging cones will be expanded or enlarged, whereby the flow of fluid to the overflow chamber 10 and overflow branch $e$, is facilitated, the valve $e'$ being lifted off its seat by said fluid, which latter escapes freely until the combined jet of steam and water has acquired the necessary velocity, when the combining cone $c$ will again contract and the overflow valve $e'$ will close, the jet being now fully established. The pressure arising from the jet of fluid produced by exhaust steam, or by combined exhaust and live steam will cause the back pressure valve $f'$ to open, the jet passing into the live steam injector, its combining cone expanding or opening, producing pressure in the overflow chamber $10^a$ for purposes stated, then causing the overflow valve $l$ to open, and allowing fluid to escape until the jet is fully established, when, through said live steam injector the combining cone C will again contract and the overflow valve $l$ will close under the pressure in the delivery branch transmitted to said valve through pipe $l^4$ and diaphragm $k^5$, the delivery or back pressure valve $f^4$ being moved off its seat by the pressure of the established jet of fluid allowing the latter to pass on to its destination.

By the construction of injector described it will be seen that the velocity, and consequently the penetrating power of the jet during its passage through the exhaust steam injector is materially increased under the action of the live steam, said velocity being further increased during the passage of the jet through the supplementary live steam injector by the live steam admitted thereto through branch $k'$.

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

1. A compound injector, comprising a high pressure or live steam passage, and means whereby pressure arising from a jet of fluid produced by steam will cause the live steam passage to expand at a given point, for the purpose set forth.

2. A compound injector comprising a high pressure or live steam passage, a normally closed overflow passage in communication therewith and means whereby pressure arising from a jet of fluid produced by steam will cause the live steam passage to expand at the point where such passage communicates with the overflow passage, for the purpose set forth.

3. A compound injector comprising a high pressure or live steam passage, an overflow passage in communication therewith, a valve controlling the overflow passage, and means whereby pressure arising from a jet of fluid produced by steam will cause the live steam passage to expand at the point where such passage communicates with the overflow passage, produce pressure therein, and cause said overflow valve to open, for the purpose set forth.

4. A compound injector, comprising a high pressure or live steam passage, a normally closed overflow passage in communication therewith, a valve controlling the overflow passage, means whereby pressure arising from a jet of fluid produced by steam will cause the live steam passage to expand about the point where it communicates with the overflow passage, produce pressure therein and cause the valve to open, and means whereby pressure and increased velocity arising from a jet of fluid produced by exhaust and live steam will cause said live steam passage to contract and close the overflow valve.

5. An injector comprising a low pressure or exhaust steam passage, a high pressure or

live steam passage, overflow passages communicating with said exhaust and live steam passages, and means whereby pressure arising from a jet of fluid produced by steam will cause both exhaust and live steam passages to expand at their point of communication with their overflow passages, for the purpose set forth.

6. In a compound injector comprising a low pressure or exhaust steam injector and a plurality of high pressure or live steam injectors, the combination with said injectors of expansible combining cones, for the purpose set forth.

7. In a compound injector comprising a low pressure or exhaust steam injector and a high pressure or live steam injector, the combination with a combining cone, of a live steam nozzle or cone, an exhaust steam cone encompassing said live steam cone, said exhaust steam cone adjustable relatively to the combining and live steam cones, for the purpose set forth.

In witness whereof we have hereto signed our names in the presence of two witnesses.

EDWARD DAVIES.
JAMES METCALFE.

Witnesses:
PETER J. LIVSEY,
WILLIAM FAULKNER.