(No Model.) 4 Sheets—Sheet 1.

W. DANDISON.

INJECTOR FOR LIQUID FUEL, &c.

No. 541,074. Patented June 18, 1895.

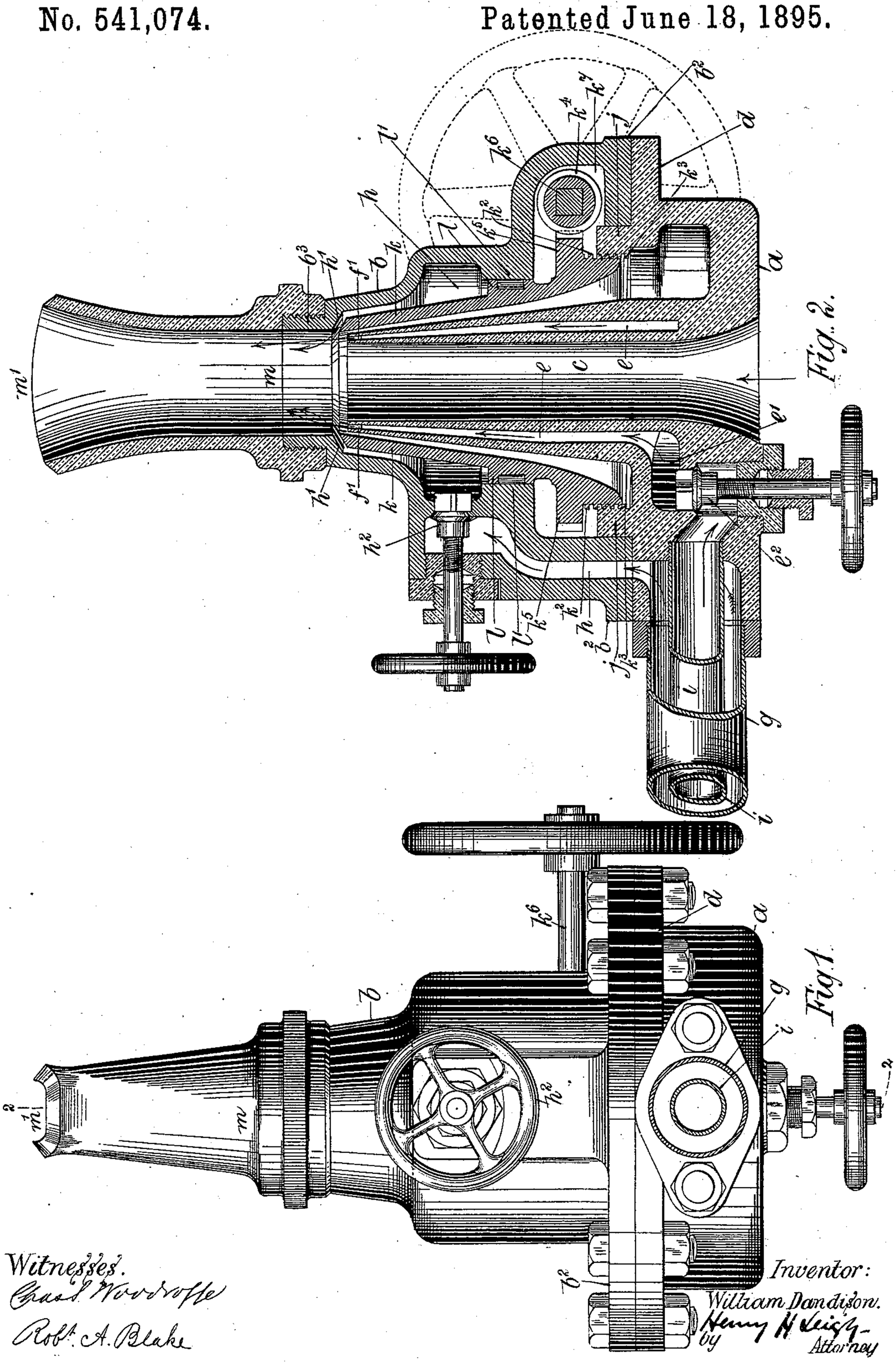

Fig. 2.

Fig. 1.

Witnesses.
Chas. L. Woodroffe
Robt. A. Blake

Inventor:
William Dandison.
by Henry H. Leigh
Attorney

(No Model.) 4 Sheets—Sheet 2.

W. DANDISON.

INJECTOR FOR LIQUID FUEL, &c.

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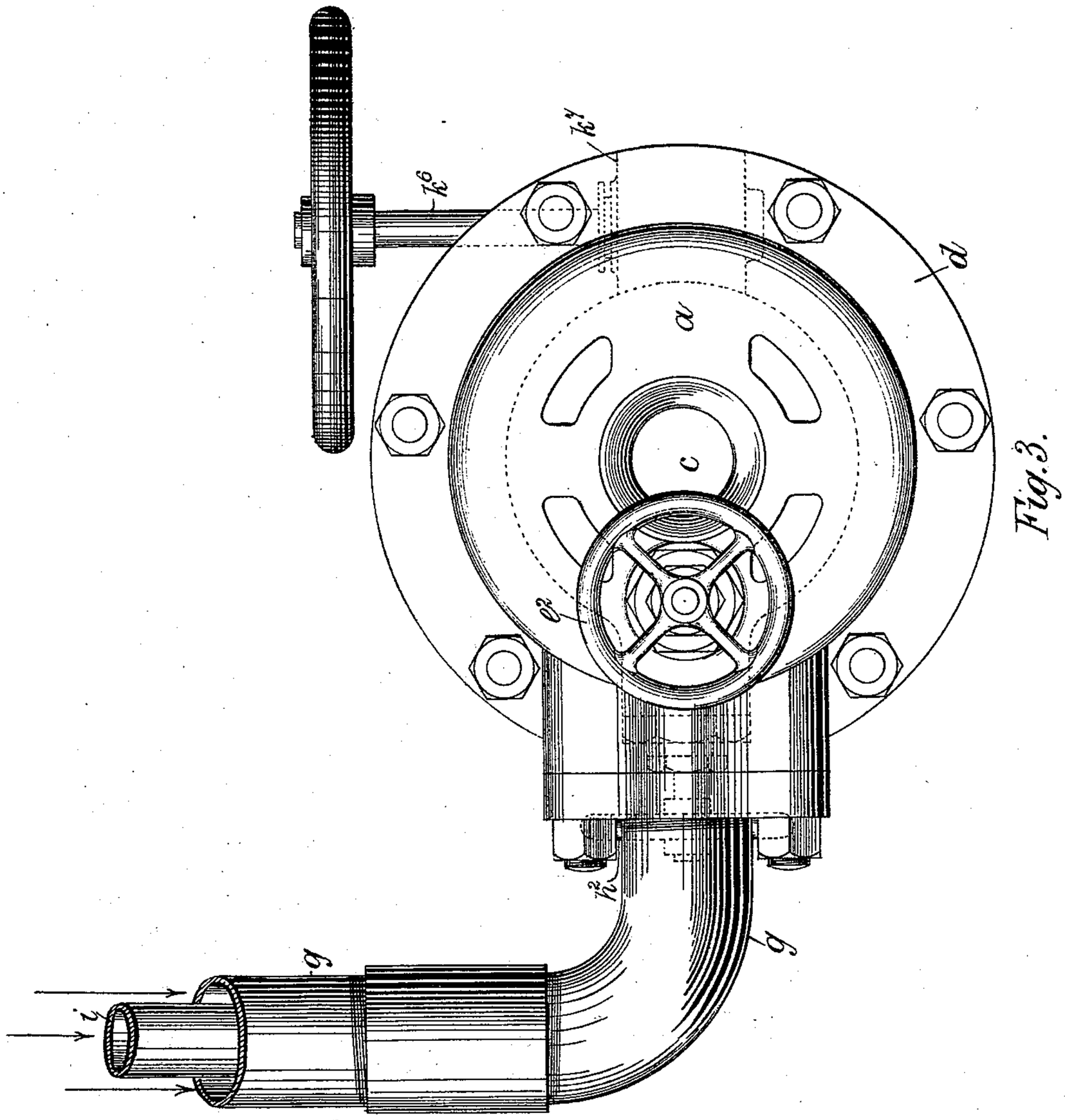

Fig. 3.

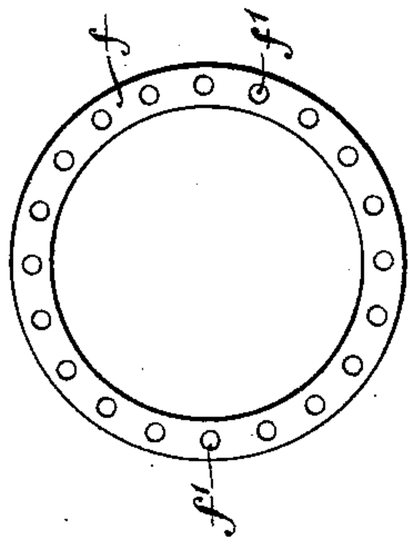

Fig. 4.

Witnesses.
Chas. L. Woodroffe
Robt. A. Blake

Inventor:
William Dandison.
by Henry H. Leigh
Attorney.

(No Model.) 4 Sheets—Sheet 3.

W. DANDISON.

INJECTOR FOR LIQUID FUEL, &c.

No. 541,074 Patented June 18, 1895.

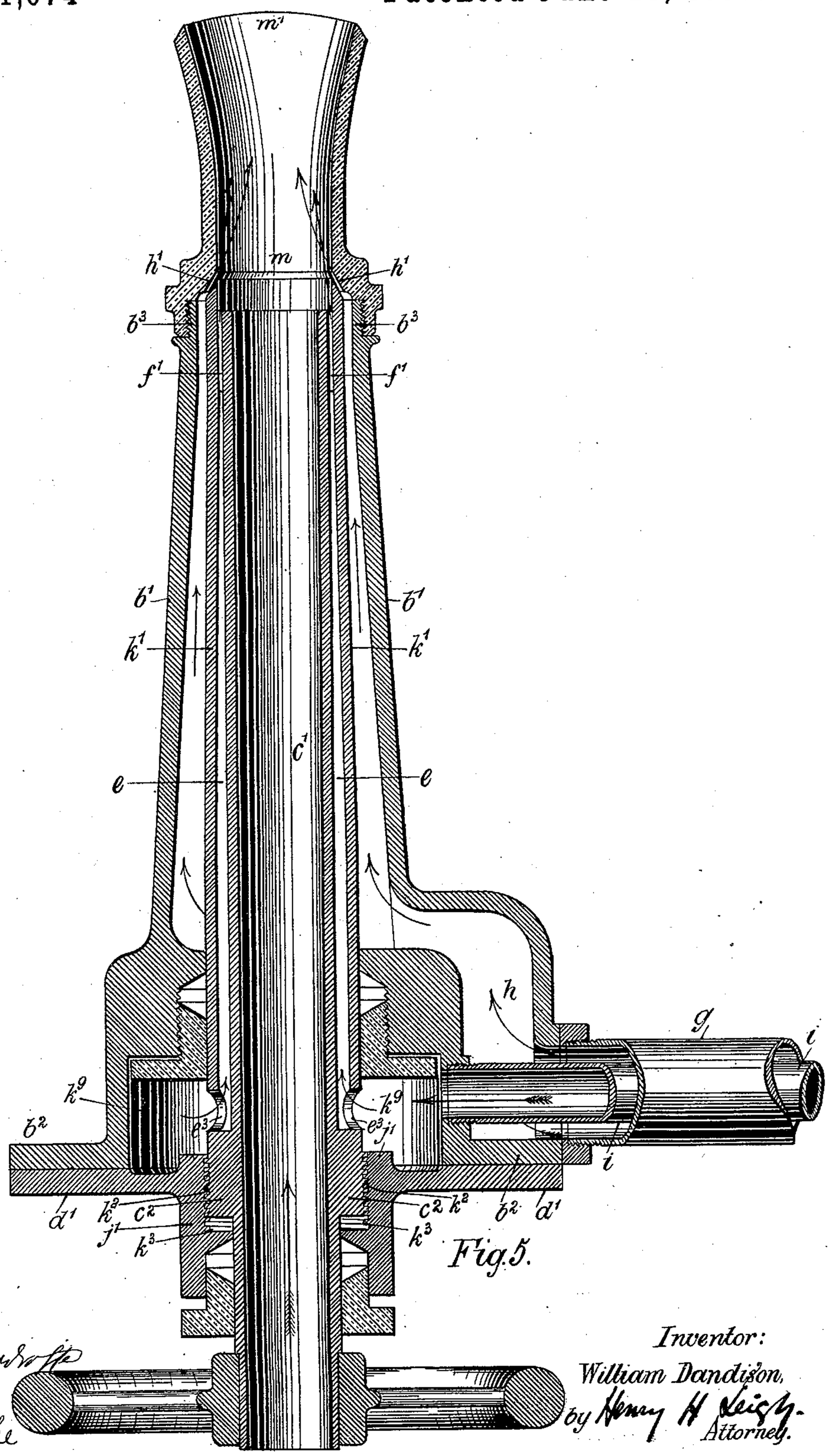

Fig. 5.

Witnesses.
Chas. L. Woodworth
Robt. A. Blake

Inventor:
William Dandison,
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(No Model.) 4 Sheets—Sheet 4.

W. DANDISON.

INJECTOR FOR LIQUID FUEL, &c.

No. 541,074. Patented June 18, 1895.

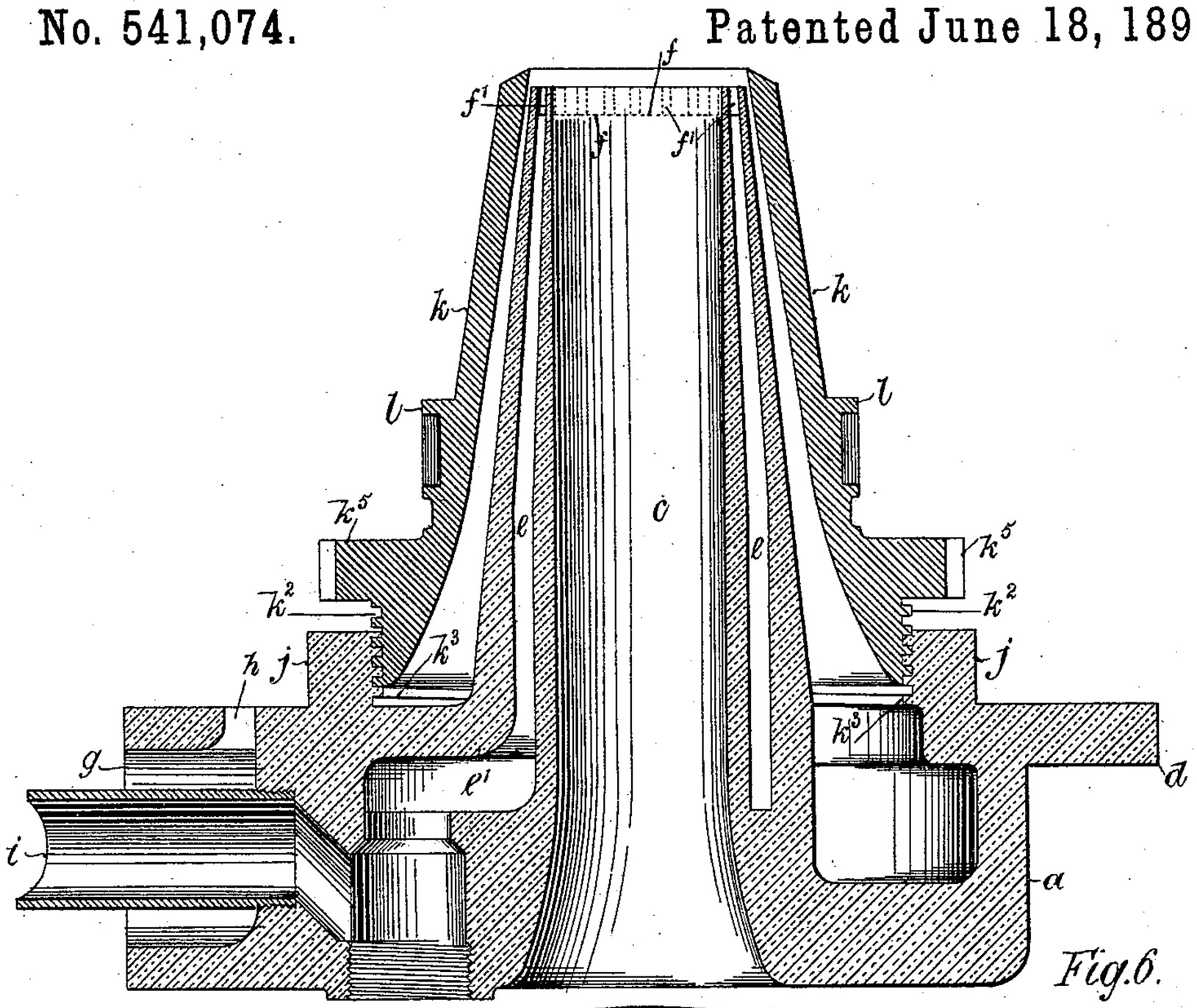

Fig. 6.

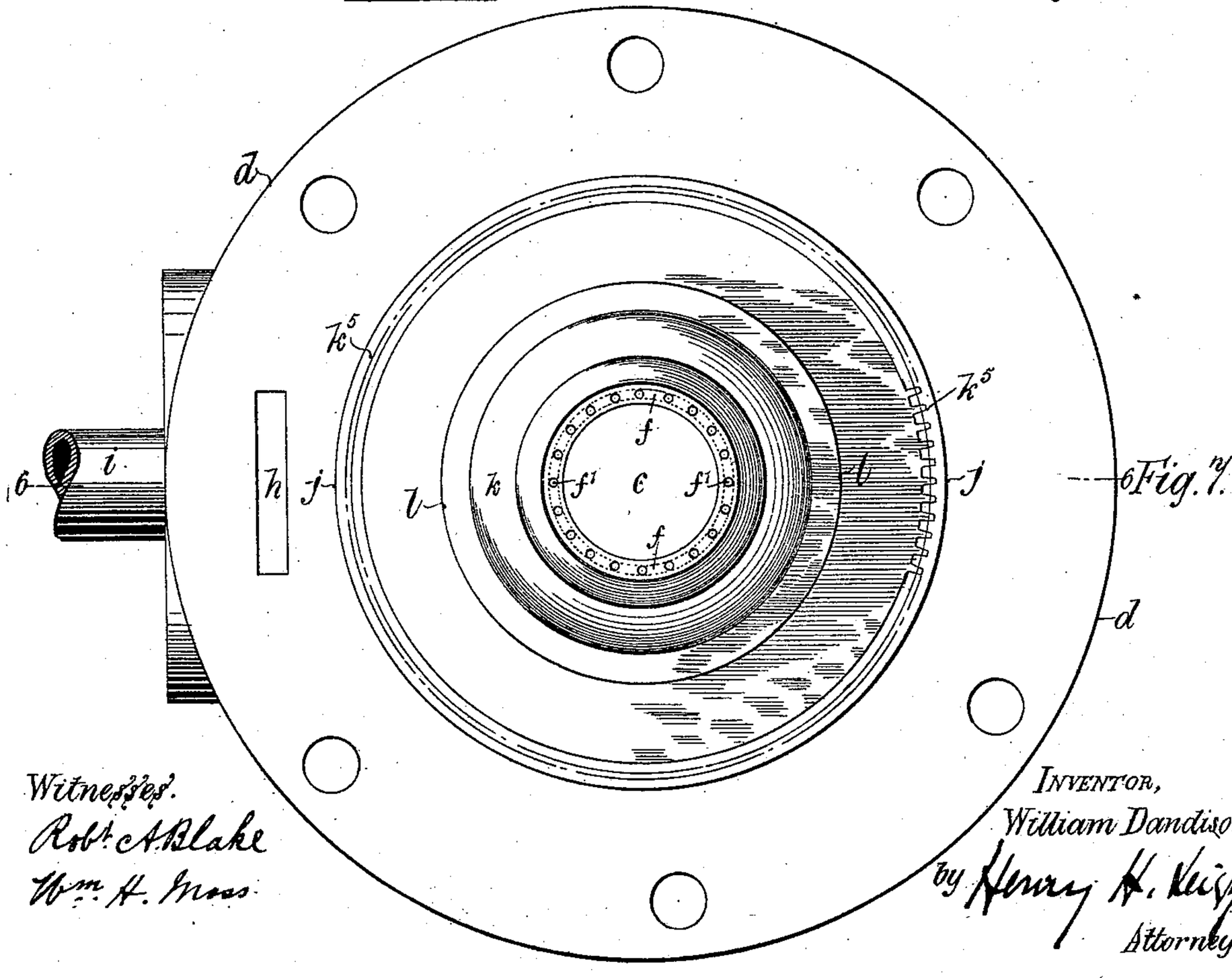

Fig. 7.

Witnesses.
Robt. A. Blake
Wm. H. Gross.

INVENTOR,
William Dandison
by Henry H. Keith
Attorney.

UNITED STATES PATENT OFFICE.

WILLIAM DANDISON, OF LONDON, ENGLAND, ASSIGNOR TO AMY STEERS, OF SAME PLACE.

INJECTOR FOR LIQUID FUEL, &c.

SPECIFICATION forming part of Letters Patent No. 541,074, dated June 18, 1895.

Application filed November 16, 1893. Serial No. 491,104. (No model.) Patented in England August 29, 1893, No. 16,278.

To all whom it may concern:

Be it known that I, WILLIAM DANDISON, consulting engineer, a subject of the Queen of the United Kingdom of Great Britain and Ireland, residing at No. 5 West Street, Finsbury Circus, in the city of London, England, have invented certain new and useful Improvements in Injectors for Liquid Fuel, &c., (for which I have obtained a patent in Great Britain, No. 16,278, dated August 29, 1893;) and I do hereby declare that the following is a full, clear, and exact description of the invention, reference being made to the accompanying drawings, which are to be taken as a part of this specification and read therewith, and one which will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in liquid fuel injectors or burners of that class in which the liquid fuel as well as the steam and air, are forced or injected through the injector or burner nozzle, into the combustion chamber.

The majority, if not all, of the liquid fuel injectors or burners of the class above mentioned, have one characteristic which seriously interferes with their economy in use, and that is this—they drip, *i. e.*, they let liquid fuel drip unconsumed from their respective nozzles. This dripping is the result of imperfect combustion and such imperfect combustion is the result of imperfect commingling within the body of the injector, of the liquid fuel and the air for its combustion.

The object of the present invention is to prevent the drip above mentioned and such prevention is accomplished by providing for perfect combustion of the liquid fuel and air.

The invention consists more particularly of a novel combination of the ports through which the steam, the liquid fuel, and the air for the combustion of the latter are, respectively, forced or injected.

Referring to the accompanying drawings, Figure 1 is a side elevation. Fig. 2 is a transverse sectional elevation on the line 2 2 of Fig. 1. Fig. 3 is an inverted plan of Fig. 2. Fig. 4 is a plan of the injecting-jet. Fig. 5 is a sectional elevation of a modification. Fig. 6 is a detail sectional elevation, on an enlarged scale, of the central portion of the construction illustrated in Figs. 1 to 3. It is taken on the line 6 6 of Fig. 7. Fig. 7 is a plan of Fig. 6.

Referring to Figs. 1 to 4, the hollow casing or injector-body consists of two portions *a* and *b* which have formed in them all the ports which are necessary to the present invention.

The portion *a* is a flanged tube, *c* being the tube and *d* its flange. The tube projects centrally from one side of the flange at right angles with it, the bore of the tube being continued through the flange to the opposite side of it where it is provided with a trumpet shaped mouth. The bore of the tube, excepting the mouth, is parallel and provides the axial port of the injector. The outer face of the tube is tapered for a reason which will appear in its place.

e is an annular port formed in the substance of the tube *c* parallel with its axis and extended in the same direction into the flange *d* for about half the distance through the latter. The mouth of the annular port *e* is closed by a ring *f* which is perforated with a series of equidistant holes *f'* the bores of which are aligned with the port *e*. The latter tapers outward from its mouth for more than half its length, thereby increasing in sectional area as it approaches its supply port and also rendering desirable a corresponding degree of taper in the concentric surrounding organs of the injector. The holes *f'* deliver in the same plane as the tube *c*. In other words they are flush with each other. The position of this perforated filling ring *f* in the mouth of the annular port *e* is clearly illustrated in Figs. 6 and 7.

g is a pipe making tight connection with the flange *d*. This connection is shown as at the edge of the flange and in a direction parallel with the faces of the latter, but it may be varied as may be required. The bore of the pipe *g* is considerable compared with the volume of fluid which it is intended to convey, but its diameter is rendered necessary by the presence of an internal pipe described farther on, which it surrounds for the whole of its length. The bore of the pipe *g* is, because of the position of the latter, prolonged into the flange *d* for a short distance. *h* is a

port from such prolongation running in a direction approximately parallel with the axis of the tube *c*. The internal pipe above referred to, *i*, is continued concentrically through the prolongation of the bore of the pipe *g*, its bore being, in its turn, led on through the flange in the direction of the concentric port *e* and made to communicate with it by a port *e'*. This port is provided with a controlling valve e^2 which can be adjusted from the outside without interfering with any other adjustable organ of the invention. The one illustrated is a wheel valve but the invention does not limit me in respect of the type of valve, but only in respect of its adjustability from the outside independently of any other adjustment required by the invention.

It is to be noted that the flange *d* is enlarged where necessary to make room for the ports and valve specified.

j is a ring on the inner face of the flange *d*. The function of it is described farther on.

The portion *b* is tubular in plan, but, unlike the tube *c* already described, it is of varying diameter internally. One end of it is provided with a flange b^2 of the same diameter as the flange *d*, while the other is contracted to fit, and to correspond with in respect of diameter, the inner end of the nozzle, as explained at length farther on. The object of the flange is to provide for the two portions *a* and *b* being held together by nuts and bolts in the manner illustrated. The flanged end of the portion *b* fits snugly over the ring *j*.

For the purpose of providing room within the portion *b* for all the internal organs of the injector, two extensions are formed upon it. Through one of these, the port *h*, already described as starting in the flange *d* from the prolongation therein of the bore of the pipe *g*, is continued in a direction more or less parallel with the axis of the tube *c*. Near the top of the said extension it is turned abruptly toward the said tube around which it becomes annular, and is then led forward toward the nozzle b^3 of the portion *b*. The terminal portion or front end of the annular portion of the port *h* converges toward the axis of the injector and stands in front of the series of holes *f'* for the double purpose of directing the fluid which flows along it into the injector nozzle, toward the said axis and in front of the jets of fluid issuing from the said holes. The oblique side *h'* of this terminal portion of the port *h* also serves as a seating for a regulating tube described farther on. Further, the said port is provided at the junction of the straight and annular portions of it with a controlling valve h^2 which can be adjusted from the outside of the injector independently of any other adjustable organ of it. Subject to this, the type of valve as well as its position, may be varied.

k is the regulating tube already referred to. It is circular in cross section and tapers in elevation from a diameter at its rear equal to that of the internal diameter of the ring *j* to one at its front end corresponding with the seating *h'* above described. Further, it is concentric with the axis of the injector. Its function is to regulate the sectional area of the annular portion of the port *h* at any point between closure and full open inclusive. The necessary to and fro motion of the tube *k* is derived from the engagement of a male screw thread k^2 fast upon it with a female one k^3 on the inner face of the ring *j*. I do not confine myself to the relative positions of these two threads for it is evident that as far as their functions are concerned, their respective positions might be reversed, the female thread being on the inside of the duly enlarged end of the tube *c*, and the male thread on the duly reduced outside of the ring *j*.

The circular motion of the tube in either direction necessary to impart the desired to and fro motion above mentioned is imparted to it by means of a worm k^4 engaging in a worm wheel k^5 which is fast upon the outside of the ring. Both screw threads k^2, k^3 and worm wheel k^5 are in planes at right angles with the axis of the tube *k*. The worm k^4 works within the second of the above mentioned extensions of the portion *b* where it is held fast to the end of an axis k^6 which passing out through a stuffing box is provided with an external hand wheel, or its equivalent, by means of which the position of the regulating tube can be adjusted from the outside of the injector independently of any other adjustable organ thereof. A suitable internal cavity k^7 is provided for the worm wheel k^5. The cavity k^7 is shut off from the annular port *h* and a suitable guide for the to and fro motion of the tube *k* provided by means of a ring *l* fast upon the outside of the tube and a second, *l'*, opposite to it fast upon the inside of the portion *b* of the injector-body. The latter ring is drawn deeper than its fellow because the ring *l* must pass over the ring *l'* without opening communication between the said port *h* and cavity k^7. For this purpose, the respective external surface carried by the tube *k* and the internal one provided by the injector-body are packed together after the manner of a piston to its cylinder.

The nozzle of the injector is of special contour. Its inner end *m* is circular in cross section and fits to the nozzle b^3 of the portion *b* making a continuous bore therewith. The bore of the nozzle is circular in cross section and of an unvarying diameter for nearly half its length when it begins to assume an oval contour until its mouth *m'* is, in plan, a flattened oval and, in elevation, an arc having its radius near the middle of the injector. The device by which the injector nozzle is connected to the portion *b* of the injector-body consists of a female thread in the rear end of the nozzle engaging with a male thread on the nozzle b^3 of the said portion, but this may be varied.

When the injector constructed as above described is to be used to inject liquid fuels it is connected and works as follows: Steam is supplied to the pipe *i* and the liquid fuel to the pipe *g*. The fuel therefore jackets the steam and is heated by it. As soon as the valves e^2 and h^2 are opened, the rush of the steam through the holes *f'* induces the fuel through the port *h* and the air through the port *c* into the circular portion of the injector nozzle, where both air and fuel are thoroughly comminuting and mixed up with each other ready for combustion, and from which they are injected into the furnace through the oval mouth *m'*. The quantity of fuel as well as the rate at which it is induced into the nozzle is regulated by adjusting the portion of the regulating tube *k* with reference to its seat *h'*.

Under certain circumstances it is inconvenient to have the mechanism for adjusting the position of the tube *k* worked from the side of the injector after the manner illustrated in Figs. 1, 2 and 3. To meet the requirements of such circumstances, I construct the injector as shown in Fig. 5. One practical advantage of the construction illustrated therein is that the hand wheel of the mechanism for adjusting the position of the regulating tube is at an increased distance from the fire, and will therefore keep cooler than when it stands in the position illustrated in Figs. 1, 2, and 3.

Referring to Fig. 5, *c'* is the central tube. It is parallel throughout. It may be parallel throughout as shown, or have a trumpet shaped mouth as illustrated in Figs. 1 and 2. It corresponds with the tube *c* of Figs. 1 to 3 as far as providing the axial port of the injector. The outer shell of the annular port *e* for the passage of the injecting fluid is provided by the regulating tube *k'*. This is made fast by its rear end to an annulus c^2 fast on the tube *c'*. The screw threads k^2, k^3 are cut, the former upon the periphery of the annulus c^2 and the latter in the socket *j'* of a flange *d'*. The socket *j'* and flange *d'* correspond so far to the ring *j* and flange *d* respectively of Figs. 1 to 3. The external hand wheel for adjusting the position of the regulating tube is fixed upon the outer end of the tube *c* which is prolonged outward through a stuffing box in the socket *j'* for that purpose.

The injector-body *b'*, the tube *c'* and the regulating tube *k'* are made longer than illustrated in the previous construction. The tube *c'* is prolonged through the flange *d'* to receive the handwheel of the regulating tube. The pipes *g* and *i* are led into the injector-body through a suitable enlargement of the latter near its flange b^2 instead of through the flange *d'*. The pipe *i* is continued through the port *h* and an internal enlargement of the injector-body into a chamber k^9 with which the annular port *e* communicates by ports e^3 in the regulating tube *k'*. Both the regulating tube *k'* and the tube *c'* pass through the front of the enlargement above mentioned and as it is provided with a suitable stuffing box it discharges the functions of the two rings *l*, *l'* of the said previous construction.

I am well aware of the numerous inventions of liquid fuel injectors or burners which have been made public, all of them more or less similar to each other and some of them apparently similar to my present invention; but according to my invention, the oil port is external to both the steam and the air ports, and the delivery end of it bent or inclined toward the axis of the nozzle so that the liquid fuel is delivered into the latter in the shape of a cone. It is well known that when liquid fuel is delivered from an annular port, it breaks up into fine spray at once; that steam delivered from an annular port does not break up into spray at once but keeps together much longer than does oil and that air delivered from a circular port into a nozzle, expands equally in all directions from the axis of the nozzle. Now I do not want the steam to remain unbroken or unsprayed. If it did so under the circumstances of its intermediate position between an expanding jet of air and a cone of sprayed liquid fuel, it would be mischievous instead of useful, because it is not sprayed. For that reason, I stop the end of the steam port with a perforated ring, and the perforations of the ring cause the steam to be delivered in independent jets. These jets break up into spray as they issue from their respective holes, and the steam spray being injected directly into the sprayed and commingled air and liquid fuel mixes them together thoroughly so that all the fuel injected from the fuel port, leaves the nozzle sprayed and intimately associated with its complement of air.

I claim—

The combination of injector body; an internal regulating tube concentric therewith and of an external diameter sufficiently smaller than the internal diameter of the said body to form an annular port between them, the said port adapted to deliver the vaporized combustible in a hollow cone into the nozzle of the injector; an annular contraction on the inner surface of the said body opposite the end of the internal regulating tube above mentioned; mechanism for adjusting the distance between the end of the regulating tube and the internal contraction; a central tube adapted to deliver air, concentric with the body and regulating tube and of a sufficiently smaller diameter than the latter to form an annular port between them adapted to deliver steam into the hollow cone above mentioned, and a perforated ring filling the end of the steam port.

In witness whereof I have hereunto affixed my signature, in presence of two witnesses, this 19th day of October, 1893.

WILLIAM DANDISON.

Witnesses:

HENRY H. LEIGH,

THOMAS LAKE.