J. I. THORNYCROFT.

SPRAYING APPARATUS.

APPLICATION FILED JAN. 4, 1907

957,014.

Patented May 3, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

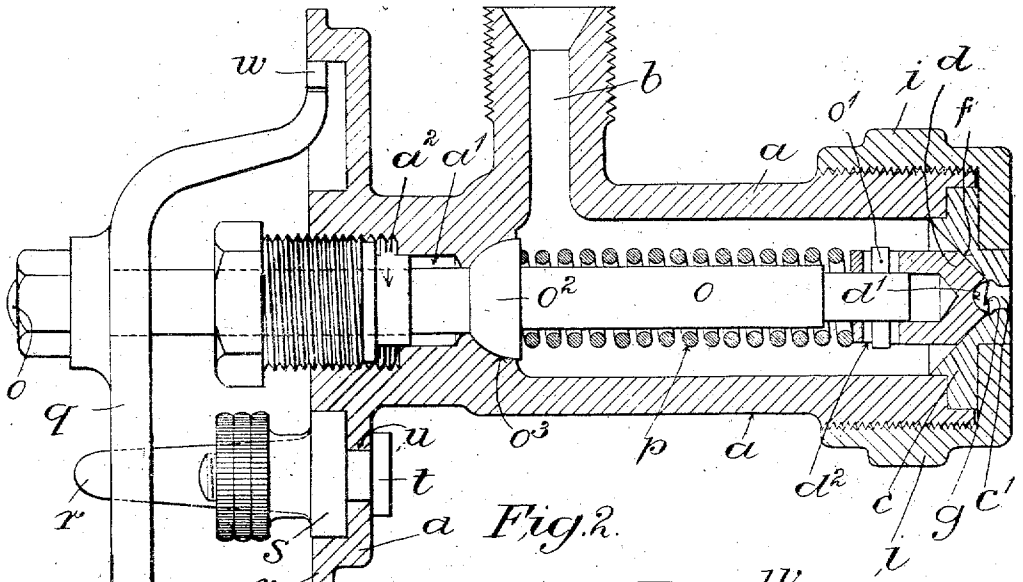
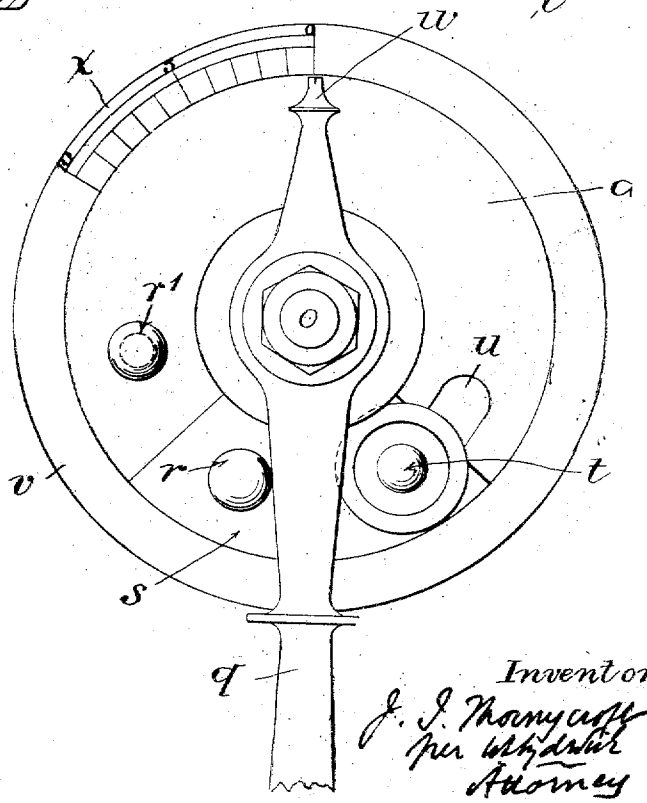


Fig. 2.



Witnesses.

W. Henry Simms

Geo. Babington Rice

Inventor.

J. I. Thornycroft

per Wheeler

Attorney

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2 SHEETS—SHEET 2.

Fig. 3.

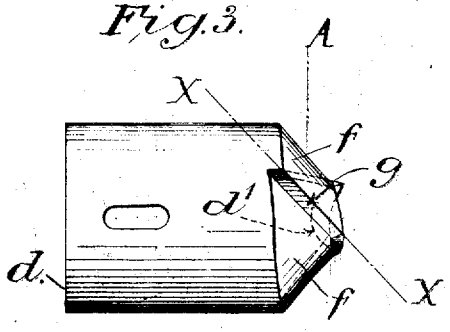


Fig. 4.

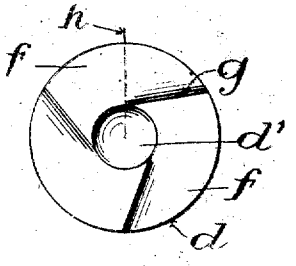


Fig. 5.

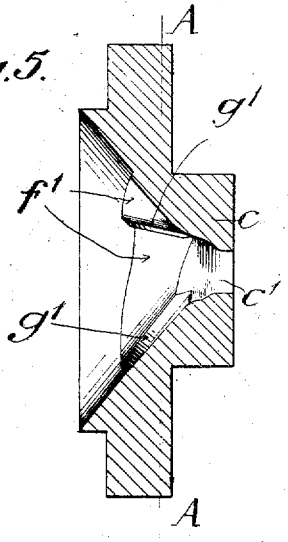


Fig. 6.

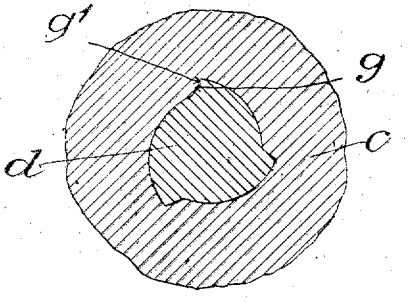
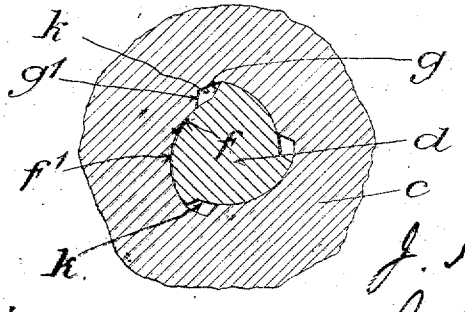


Fig. 7.



Witnesses

W. Hervey Simms

Geo. Babington Rice.

Inventor

J. I. Thornycroft

per Wilkinson & Wilkinson

Attorney

UNITED STATES PATENT OFFICE.

JOHN ISAAC THORNYCROFT, OF CHISWICK, ENGLAND.

SPRAYING APPARATUS.

957,014. Specification of Letters Patent. Patented May 3, 1910.

Application filed January 4, 1907. Serial No. 350,825.

To all whom it may concern:

Be it known that I, JOHN ISAAC THORNYCROFT, a subject of the King of Great Britain and Ireland, residing at Chiswick, in the county of Middlesex, England, have invented Improvements in or Relating to Spraying Apparatus, of which the following is a specification.

This invention has reference to apparatus for spraying liquid, more particularly for spraying liquid fuel into furnaces such as those of steam boilers and the like, in which the liquid is caused to flow under pressure through one or more holes or passages of comparatively small section and non-annular shape, as distinguished from an annular passage formed between stationary and movable conical members that are relatively movable in an axial direction.

In spraying apparatus of the kind referred to as heretofore constructed, the holes or passages have usually been formed through a solid head or plate and arranged in an annular series around the axis of the apparatus and inclined thereto so that the issuing streams will impinge upon one another.

In spraying apparatus of the type referred to constructed according to the present invention, the liquid discharge hole or passage, or each hole or passage, is formed between two relatively movable members having adjacent parts thereof shaped to interlock or engage with each other in such a manner that upon moving such members relatively to each other, there will be formed at the parts where the members interlock or engage, one or more liquid discharge passages the cross sectional area of which, or of each of which, can be varied throughout its length within wide limits and can be entirely closed, and which or each of which can be inclined to the axis of the discharge nozzle of the apparatus, and arranged to discharge the liquid more or less tangentially of the discharge orifice, so that the rate of supply of liquid can be varied without throttling or wire-drawing and in the event of the hole or passage, or any of them, being obstructed by solid matter, the hole or passage, or holes or passages, can be suddenly opened to a greater extent to enable the obstructing matter to be readily removed by the sudden rush of a greater quantity of liquid. Spraying apparatus of this kind can be constructed in various forms.

The invention also comprises various novel features of construction and combinations and arrangements of parts all as hereinafter more particularly described and pointed out in the claims.

In the accompanying drawings, Figure 1 shows partly in central section and partly in side elevation, and Fig. 2 in rear end view, one construction of spraying apparatus embody the present invention and suitable for supplying oil to the furnace of a steam generator. Fig. 3 is a side elevation and Fig. 4 an end view, both to an enlarged scale, of the movable member or plug of the nozzle shown in Figs. 1 and 3. Fig. 5 shows the nozzle in longitudinal section, Figs. 6 and 7 are cross sections of the plug and nozzle corresponding to the line A A of Figs. 3 and 5, the two parts being shown in different relative positions in the two figures.

a is the casing or body from which the oil fuel, introduced through an inlet pipe *b*, is to be discharged through the nozzle *c*.

d is the adjustable plug of the nozzle having its front end portion of truncated conical shape and its rear or base end portion of cylindrical shape, as shown. The conical end of the plug is, in the example, formed with three helical surfaces *f* each terminating in a step *g*, that is inclined to a line *h* connecting corresponding diameters at the base and apex end of the truncated cone and lying in an imaginary plane containing the axis of the plug. Each helical surface *f* and step *g* can conveniently be formed by mounting the plug in a holder by which it can be rotated in a step by step manner and simultaneously advanced to a small extent and causing a slotting tool to pass endwise over and take a cut from the conical end of the plug in the required angular direction of the step after each rotary and forward movement, so that the successive strokes of the tool, the first of which commences at the line *x x*, cut deeper and deeper into the surface of the conical extremity of the plug thereby forming the helical surface *f* and finally finishing when a step *g* of the required width of face is formed. In this way a portion of metal of gradually increasing thickness from the line *x x* to the step *g* in advance is removed from the conical end of the plug. The plug is then moved backward in an axial direction and the operation repeated for forming the next helical surface *f* and step *g*, and so on for each helical surface and step.

As the cutting is effected in a direction inclined to the said line h, each helical surface f will of course, be slightly concave as seen in a longitudinal section of the cone containing the axis of the plug. The inner surface of the nozzle c is similarly formed with corresponding helical surfaces f^1 and steps g^1 so that the surfaces and steps on the one part closely fit those on the other. The forward end of the plug d is preferably formed with a central cavity d^1, and the nozzle c is formed with a centrally arranged exit aperture c^1 of circular section. i is a cap or ring screwed onto the casing a so as to hold the nozzle c in place therein. The arrangement is such that as the plug d is partially rotated in the nozzle c, the stepped portions g of the plug and g^1 of the nozzle, which are normally in contact, as shown in Fig. 6, when the oil supply is arrested, will recede one from the other and form longitudinally extending exit passages k, as shown in Fig. 7, through which the oil will flow in an inclined or tangential direction from the casing a of the apparatus to the exit aperture c^1 where it will impinge at an angle against the wall of such aperture so that a rotary motion will be imparted to it and will thence escape over the outer edge of the aperture in the form of a thin hollow body and finally break up into a finely divided state or spray.

It will be understood that by reason of the helical formation of the surfaces f, f^1, the plug d while being partly rotated, is simultaneously retracted and that the size of the exit passages k will vary with the extent of such rotation. In the example illustrated the maximum effective rotation is confined to an angle of 120°.

The number of steps g, g^1 and corresponding helical surfaces f, f^1 on the plug d and nozzle c respectively, and consequently the number of oil passages k, can be varied to suit requirement. There may be only one or two of each, or more than three.

Rotary movement of the plug d can be effected by securing the same to a rotary spindle o, conveniently by a pin o^1 fixed to the spindle and extending through a slot d^2 in the plug so that the plug can move in an endwise direction while the spindle is prevented from moving endwise. In the example, the plug d is carried by the forward end of the spindle upon which it can slide to a small extent. The spindle o extends through a stuffing box a^1 and gland a^2 to the exterior of the casing a and may be formed with a collar o^2 having a part spherical surface at o^3 arranged to bear against a similar surface in the casing a. p is a coiled spring arranged between the plug d and the collar o^2 on the spindle so that it tends to force the plug d forward into the nozzle c. The outer end of the spindle o is provided with a hand lever q adapted to bear against an adjustable stop r. This stop is shown as a pin carried by a plate s that is capable of being adjusted on the casing a and of being fixed thereto by a bolt t extending through a segmental slot u in a flange v on the casing. The hand lever q is formed with a finger or indicator w arranged to work in proximity to a scale x on the flange v, so that the condition of oil supply prevailing at any time can be again restored after having been once disturbed.

The spindle o and plug d can, when required, be rotated by the hand lever q and caused to move backward against the action of the spring p to open the exit passages k to the required amount, the lever spindle and plug being held in place by the stop r which is adjusted to bear against the lever and prevent its return. The lever is however free to be turned to a further extent, limited by a stop r' in order to temporarily increase the size of the discharge passages k and so assist in removing any matter which may have become lodged therein or impede the flow of the oil therethrough, in which case as soon as the hand lever is released, the spring p will cause the plug d to automatically return to the proper operative position.

By the construction described it will be seen that upon removal of the screw cap or ring i, the spindle o, plug d, and nozzle c can be easily put in place or removed.

The details of construction can be variously modified.

What I claim is:—

1. Liquid spraying apparatus comprising coacting main nozzle elements the outer of which is provided with a tubular discharge orifice extending forwardly beyond the inner element, said nozzle elements having inter-engaging parts arranged to form by and between them the walls of a narrow liquid discharge passage that is arranged to discharge liquid obliquely against the inner surface of the wall of said discharge orifice, is completely bounded all around its contour by the said interengaging parts, which can be opened to varying extents by axial movement of one of said nozzle elements relatively to the other nozzle element, and which can be closed by relative axial movement of said nozzle elements in the opposite direction.

2. Liquid spraying apparatus comprising coacting main nozzle elements that are constantly in contact with each other and the outer of which is provided with a forwardly extending discharge orifice, said nozzle elements having inter-engaging parts arranged to form by and between them the walls of a plurality of separate liquid discharge passages each of which is arranged to discharge liquid in an inclined direction against the inner surface of the wall of said discharge orifice and is completely bounded all around

its contour by the said inter-engaging parts and all of which can be opened simultaneously to varying extents by axial movement of one of said nozzle elements relatively to but while still maintained in contact with the other nozzle element and which can be closed by relative axial movement of said nozzle elements in the opposite direction.

3. Liquid spraying apparatus comprising co-acting main nozzle elements that are constantly in contact with each other and the outer of which is provided with a forwardly extending tubular discharge orifice, said nozzle elements having inter-engaging parts arranged to form by and between them the walls of a narrow liquid discharge passage that is inclined inwardly toward said discharge orifice but obliquely to the axis thereof and is completely bounded all around its contour by the said inter-engaging parts, the cross sectional area of said discharge passage being varied by axial movement of one of said nozzle elements relatively to but while still maintained in contact with the other nozzle element and which can be closed by relative axial movement of said elements in the opposite direction.

4. Liquid spraying apparatus comprising co-acting main nozzle elements that are constantly in contact with each other and the outer of which is provided with a contracted forwardly extending tubular discharge orifice the inner surface of whose wall is of curved shape in longitudinal section at its inner end, said nozzle elements having inter-engaging parts arranged to form by and between them the walls of a plurality of separate liquid discharge passages each of which is inclined obliquely across the axis of the orifice so as to discharge liquid in an inclined direction against the inner surface of the wall of said discharge orifice, and each of which passages is completely bounded all around its contour by the said inter-engaging parts and can be opened and closed to varying extents by axial movement of one of said nozzle elements relatively to but while still maintained in contact with the other nozzle element.

5. In liquid spraying apparatus, a liquid discharge nozzle comprising a fixed element having a forwardly extending discharge orifice and a movable element, said elements having parts arranged to at all times fit one into the other and form between them a liquid discharge passage inclined obliquely across the axis of the discharge nozzle so as to discharge liquid in an inclined direction against the inner surface of the wall of said discharge orifice and closed in all around by the inter-engaging parts, said inter-engaging parts being arranged to move toward each other and close said discharge passage by combined rotary and axial movement of the movable element of the nozzle in one direction and to move apart to open the said passage to varying extents by combined rotary and axial movement of the said movable element in the opposite direction.

6. In liquid spraying apparatus, a liquid discharge nozzle comprising a fixed element having a contracted forwardly extending discharge orifice, and a movable element, said elements having parts arranged to at all times fit one into the other and form between them a plurality of liquid discharge passages each inclined forwardly, inwardly and across the axis of the discharge nozzle so as to discharge liquid in an inclined direction against the inner surface of the wall of said discharge orifice and closed in all around by the inter-engaging segmental parts and capable of being collectively closed by combined rotary and axial movement of the movable element of the nozzle in one direction and of being opened to various extents by combined rotary and axial movement of the said movable element in the opposite direction.

7. Liquid spraying apparatus comprising a stationary nozzle having interior passage-way components and a tubular discharge portion that extends beyond said passage-way components and the cross sectional area of which gradually decreases in a forward direction for part of its length and then continues of substantially constant cross section, an interior plug in constant engagement with said nozzle and having thereon exterior passage-way components, and means for retracting and advancing the plug within the nozzle to alter the relative position of the respective passage-way components and thereby vary the cross sectional area of the passage-ways formed by and between said components.

8. Liquid spraying apparatus comprising a nozzle having a contracted forwardly extending discharge orifice and a plurality of segmental passage-way components arranged obliquely to the axis of said orifice, a nozzle plug arranged within and in constant engagement with the nozzle and provided with segmental exterior passage-way components, and means for retracting the plug to alter the position of the plug passage-way components with respect to the nozzle passage-way components in accordance with the said retractive movement and thereby vary the cross sectional area of the passage-ways formed by and between said components.

9. Liquid spraying apparatus comprising an inclosing member having a contracted forwardly extending tubular discharge orifice and a recessed portion constituting one wall of a liquid discharge passage that extends forwardly and inwardly and obliquely toward the inner surface of the wall of said discharge orifice, an inner member having

a projecting portion constituting the remainder of the liquid passage wall and arranged to extend into and engage the said recessed portion, and means for axially moving the inner member within the inclosing member to vary the distance between the passage walls.

10. Liquid spraying apparatus comprising an inclosing member having recessed portions therein and a contracted discharge orifice common to and extending beyond said recessed portions, an inner member having projecting portions thereon arranged to enter and engage the recessed portions of said inclosing member, and means for axially moving the inner member within the inclosing member so that opposite parts of the recessed and projecting portions are in continuous contact in one position and are separated from each other by retraction of the inner member to produce independent discharge passages that extend forwardly and inwardly and obliquely across the axis of the apparatus.

11. Liquid spraying apparatus comprising two relatively rotatable members one within the other, stepped portions on the inner surface of the outer member, corresponding stepped portions on the outer surface of the inner member, and means for rotating one member with respect to the other so that the stepped portions of the inner member recede from the stepped portions of the outer member with one direction of rotation and produce passages which collectively are variable in cross sectional area throughout their length in accordance with the extent of rotation while rotation of the inner member in the opposite direction closes said passages.

12. In liquid spraying apparatus, the combination with a fixed nozzle part having a discharge orifice of circular section, of an interior plug capable of a combined axial and rotary movement with respect to the fixed part, the co-acting surfaces of the said plug and fixed part being stepped to permit of there being formed between them while in contact, a passage the cross sectional area of which is dependent upon the extent of said combined movement.

13. In liquid spraying apparatus, the combination with a fixed nozzle part having a discharge orifice of circular section, of an interior plug capable of a combined axial and rotary movement with respect to the fixed part, the co-acting surfaces of the said plug and fixed part being stepped to admit of there being formed between them while in contact a plurality of separate passages that can be opened and closed in accordance with the said movement.

14. In liquid spraying apparatus, the combination with a fixed nozzle having a discharge orifice, of a plug having a truncated conical extremity from the surface of which a part has been removed to constitute a helical surface and step, the fixed nozzle part being shaped to correspond so that relative rotary motion between the two parts will cause a passage of varying size to be produced between the steps on the said parts.

15. In liquid spraying apparatus, the combination with a fixed nozzle part having a discharge orifice, of a plug having a truncated conical extremity from the surface of which a part has been removed to constitute a helical surface and a step that is inclined in direction to a line joining corresponding diameters at the base and apex end of the truncated conical extremity, the fixed nozzle part being shaped to correspond so that relative rotary movement between the two parts will cause a passage of varying size to be produced between said parts.

16. In liquid spraying apparatus, the combination with a fixed nozzle having a discharge orifice formed as an extension of a surface which in general is that of a hollow truncated cone provided with helical surfaces and steps extending from the apex to the base, of a plug having a truncated conical extremity prolonged at the base and in cylindrical form and from which conical part, portions have been removed to form helical surfaces and steps corresponding to the helical surfaces and steps in the fixed nozzle part so that rotary motion of the said plug with respect to the nozzle will form passages the inlet ends of which are partly located in the cylindrical surface aforesaid.

17. In liquid spraying apparatus, a nozzle and co-acting plug each formed with a helical surface and a step inclined to the length of the plug, said nozzle and plug being capable of relative rotation to form a discharge passage of varying cross section between the steps thereon, and means adapted to automatically cause relative movement of the plug and nozzle in a direction to close said passage.

18. In liquid spraying apparatus a nozzle having a discharge orifice of circular section, a plug mounted to rotate relatively to said nozzle, and means acting to force said plug into said nozzle, said nozzle and plug each having a plurality of similar helical surfaces and a plurality of steps located between said surfaces and inclined to the common axis of the nozzle and plug.

19. In liquid spraying apparatus, the combination with a fixed nozzle part having a discharge orifice, of a plug capable of a combined axial and rotary movement in said nozzle and stepped to form therewith a liquid exit passage the cross sectional area of which can be varied at will, a spring adapted to oppose the opening movement of said plug, and a spindle capable of rotation but not of endwise movement and to which said

plug is connected so as to turn therewith but to move endwise independently thereof.

20. In liquid spraying apparatus, the combination with a fixed nozzle having a discharge orifice of circular section, of a plug capable of a combined axial and rotary movement in said nozzle and stepped to form therewith an exit passage the cross sectional area of which can be varied at will, a spindle capable of rotation but not of endwise motion and engaged with said plug, a spring arranged to oppose the axial opening movement of said plug, and an adjustable stop for limiting the extent of rotary movement of said plug and spindle in one direction.

21. In liquid spraying apparatus, the combination with a fixed nozzle having a cylindrical discharge orifice, of a plug capable of a combined axial and rotary movement with respect to said nozzle, the co-acting surfaces of said plug and nozzle being stepped to enable a plurality of independent forwardly extending liquid exit passages to be formed between them which can be opened and closed in accordance with the movement aforesaid, a spring acting to oppose movement of the plug in one direction, means whereby said plug can be manually moved to enable the liquid exit passages to be temporarily varied in size, and an adjustable stop for limiting the extent of movement in one direction of said manually operated means and plug.

22. Liquid fuel spraying apparatus comprising in combination, a body or casing, an inlet for liquid under pressure, a fixed nozzle having a truncated conical orifice terminating at the apex end in a central discharge orifice, a plug having a truncated helical extremity prolonged at the base end in cylindrical form, forwardly extending steps on the helical surfaces, inclined to a line joining corresponding diameters at the base and apex end and formed by removal of parts of the conical surface of the plug, correspondingly shaped steps and helical surfaces in the interior of the fixed nozzle, a spindle connected to the plug, a spring encircling said spindle and acting against said plug, a handle by which the spindle and plug can be moved to temporarily vary the size of the passages formed by and between the stepped portions of said nozzle and plug, an adjustable stop for limiting the angular movement of said spindle and plug in one direction, and an indicator and scale for setting the parts in any predetermined position.

Signed at London England this 15th day of December 1906.

JOHN ISAAC THORNYCROFT.

Witnesses:

H. D. JAMESON,

R. WESTACOTT.