

Aug. 27, 1963

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3,101,906

SPRAY NOZZLE

Filed Jan. 11, 1962

2 Sheets-Sheet 1

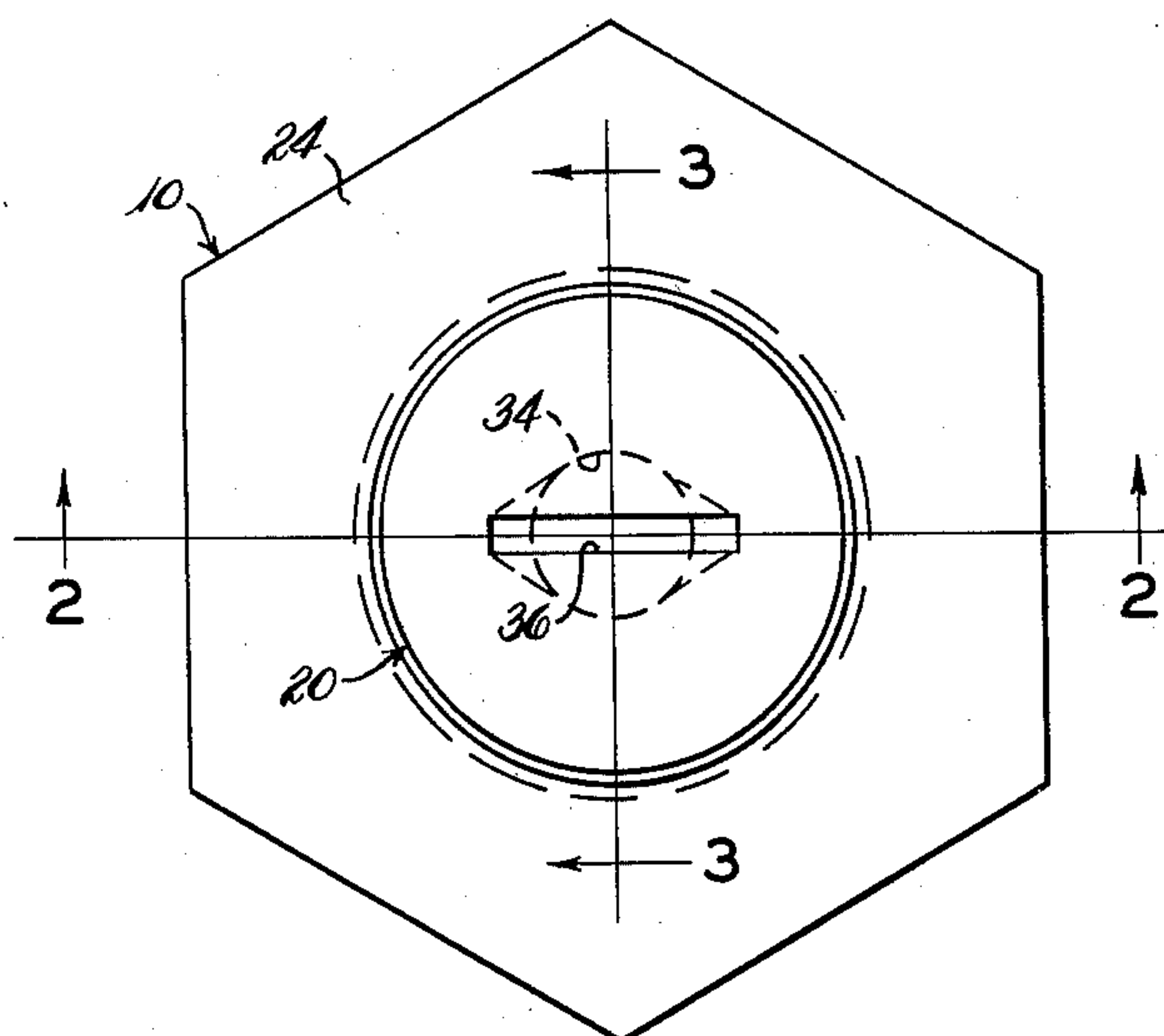


FIG. 1

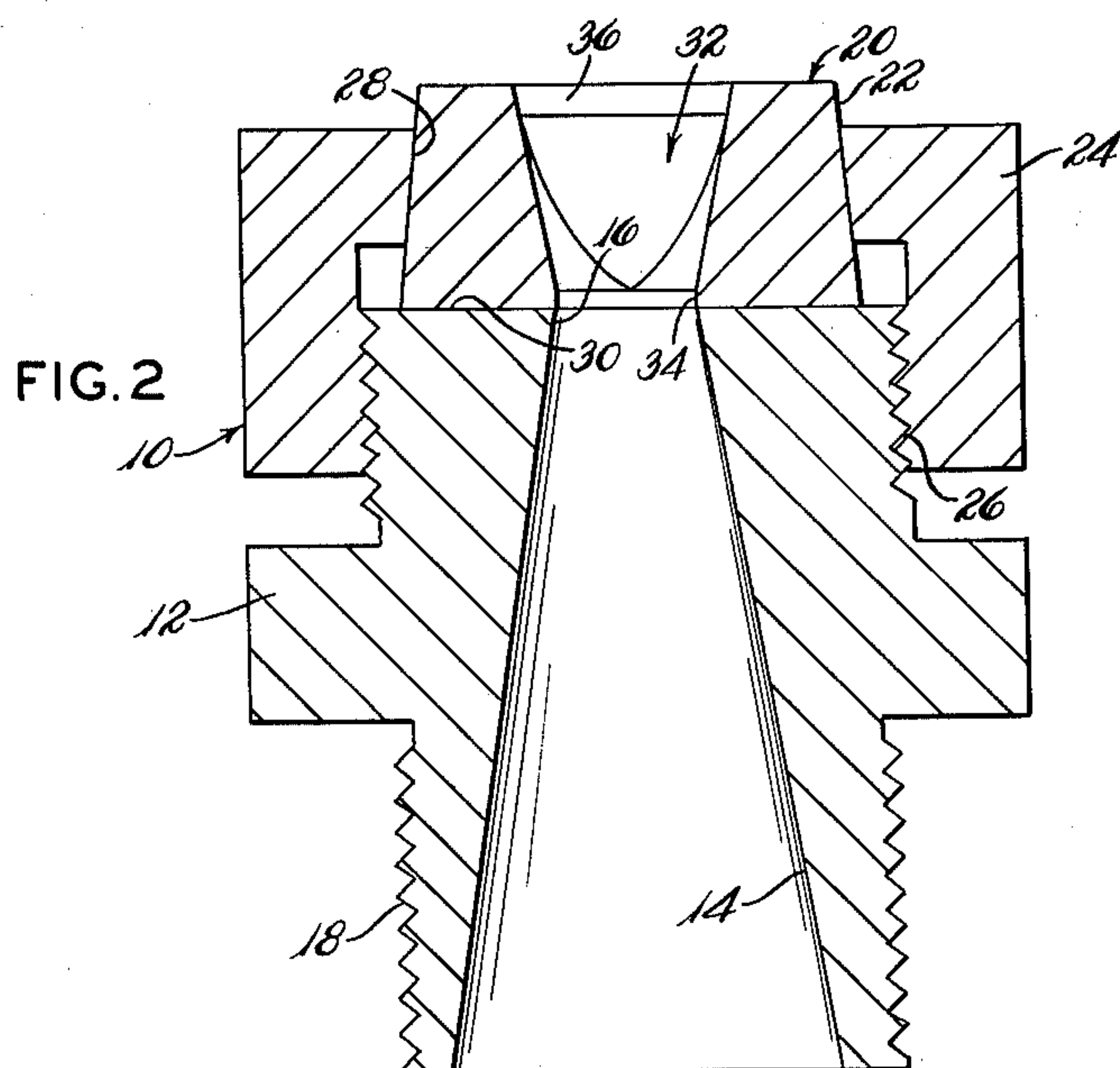


FIG. 2

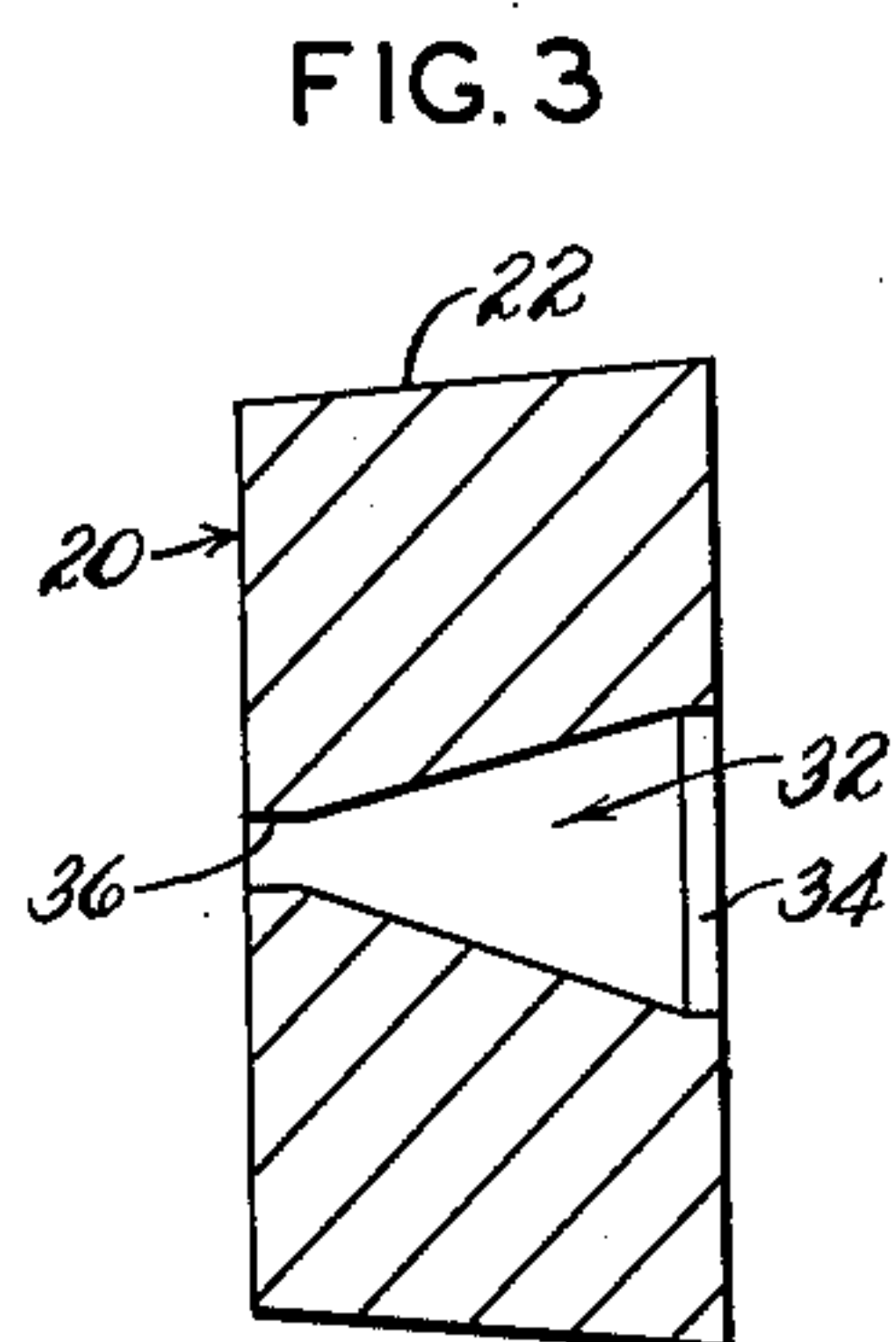


FIG. 3

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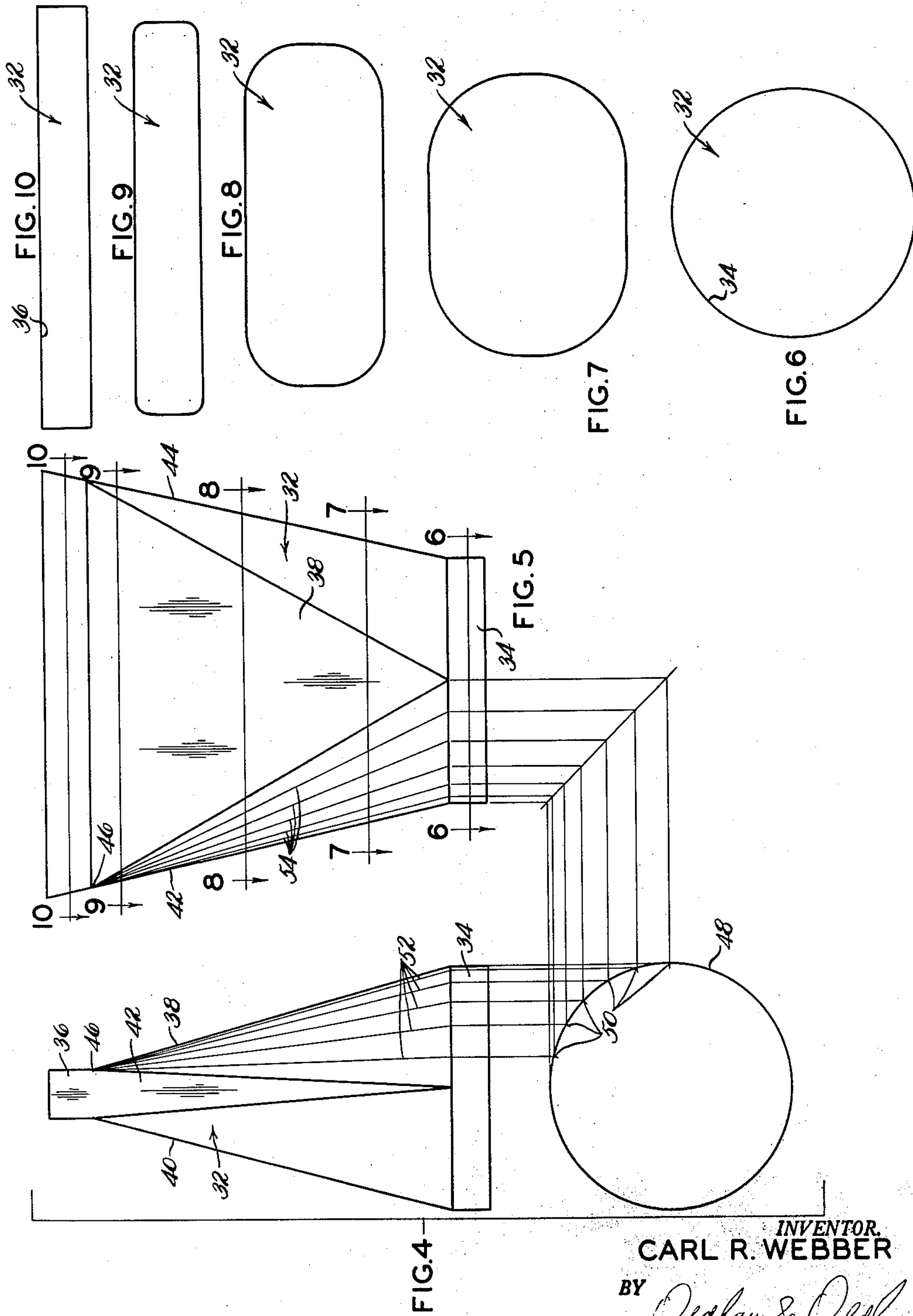
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Filed Jan. 11, 1962

2 Sheets-Sheet 2



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3,101,906

SPRAY NOZZLE

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Filed Jan. 11, 1962, Ser. No. 165,486

6 Claims. (Cl. 239-592)

This invention relates to spray nozzles, and, more particularly, to nozzles for spraying water against hot steel to remove scale therefrom prior to a rolling operation.

U.S. Patent No. 1,889,201 discloses a spray nozzle for the purpose described, but open to the objection that the disc forming a part of the nozzle is made in two halves each containing a complementary part of a slot through the disc so that when the two halves are put together and held in engagement with the body portion of the nozzle a slot is provided through which the water is discharged. Spray nozzles of this type are open to the objection that the two halves of the disc are difficult to machine, often requiring hand finishing operations which are not uniform, and with disc halves not being interchangeable with other disc halves, but being carefully marked as mating pairs. Moreover, it has been found that the necessary machining and finishing operations result in the disc halves getting out of round, and with no one nozzle spraying the same as another nozzle.

When a plurality of the nozzles of U.S. Patent No. 1,889,201 are placed together to form a wide bank of nozzles, as across the width of a hot steel strip, it is necessary to carefully examine the spray pattern or "foot-print" of the plurality of nozzles against the strip to see if the pattern is thin in one part, overly thick in another, is of proper width, and the like, followed by some effort to correct this pattern to provide a uniform spray action over the entire hot strip. If this is not done, the strip may not be properly de-scaled before passing to a rolling mill, and should this occur, portions of the strip may be ruined in the rolling operation and the rolls of the mill may likewise be damaged, and this is very costly and obnoxious.

It is the general object of the present invention to avoid and overcome the foregoing and other difficulties of and objections to spray nozzles of the prior art by the provision of a spray nozzle having replaceable single piece discs formed with fluid passing slots of high uniformity and characterized by a smooth non-turbulent transition of the water or other fluid from the round to a flat knife-like body.

Another object of the invention is the provision of a spray nozzle which discharges water under high pressure in the form of a relatively wide, flat, knife-like edge without burbling and flow disrupting turbulence, the knife-like edge of the discharged water being maintained even though the spray nozzle is placed at different distances from the surface of the metal to be de-scaled, thereby giving the spray nozzle greater versatility in applications for specific uses.

Another object of the invention is to provide a spray nozzle having a replaceable one-piece slotted disc which is precision cast from abrasion and corrosion resistant metal alloys, and with the slot through the disc being formed during the casting by a destructible and removable core of high precision, made from a master mold whereby a better but a less expensive product is produced.

For a better understanding of the invention reference should be had to the accompanying drawings wherein FIG. 1 is an end elevation, on an enlarged scale, of a nozzle constructed in accord with the invention;

FIG. 2 is a longitudinal sectional view taken substantially on line 2-2 of FIG. 1;

FIG. 3 is a cross-sectional view of the disc forming a

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part of the nozzle and taken substantially on line 3-3 of FIG. 1;

FIG. 4 is an enlarged diagrammatic view of a solid representing the shape of the opening through the disc of the nozzle, the figure including a circle used to help draw the solid of FIG. 4;

FIG. 5 is a view of the solid of FIG. 4, but taken at right angles to FIG. 4, and with the circle of FIG. 4 having points thereon projected into FIG. 5 to help construct the figure thereof; and

FIGS. 6 through 10 are taken respectively on lines 6 through 10 of FIG. 5 and illustrate diagrammatically the transposition from the circular opening of FIG. 6 to the narrow slot-like rectangular opening of FIG. 10.

The above stated objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by a spray nozzle having a body portion with a tapered bore, a one-piece disc, means for securing the disc to the body portion at the small end of the bore, the disc having an opening therethrough in alignment with the bore, the opening being circular adjacent the small end of the bore and of substantially the same diameter, the other end of the opening being in the form of a substantially rectangular slot, the circular and slot portions of the opening being connected by substantially flat portions extending from the sides of the slot to the edges of the circular portion, the substantially flat portions being joined by substantially quarter round fillets of gradually decreasing radius from the circular portion to the slot.

In the drawings, the numeral 10 indicates generally a spray nozzle having a body portion 12 formed with a tapered bore 14, of circular cross section, and which terminates at its small end in an axially short cylindrical portion 16. The body portion is appropriately formed at the large end of the bore 14 with suitable means, such as threads 18 whereby the body portion can be attached to a conduit or manifold (not shown) containing fluid, usually water, under relatively high pressure.

Adapted to be secured to the other end of the body portion 12 is a disc indicated as a whole by the numeral 20. One convenient manner of securing the disc 20 in position is to form the outer periphery of the disc 20 with a tapered surface 22 tapering in the same direction as the bore 14, and to provide a ring nut 24 threaded at 26 upon the body portion 12. The ring nut 24 is formed with an inwardly directed flange having a surface 28 which is complementary to the tapered outer surface 22 of the disc 20, so that tightening of the nut 24 onto the body portion 12 very firmly holds the disc 20 against the body portion 12 adjacent the small end of the bore 14 through the body portion. The engaging surfaces, indicated by the numeral 30, between the disc 20 and the end of the body portion may be flat ground to insure a completely fluid-tight engagement between these surfaces.

The disc 20 is formed with an opening therethrough which is indicated as a whole by the numeral 32, and the shape of this opening forms an important part of the present invention. Reference should be had to FIGS. 4 through 10 which illustrate the manner in which the opening 32 is shaped. More specifically, FIGS. 4 and 5 are elevational views, one from the end and one from the side of a solid illustrating, on enlarged scale, the shape of the opening 32. The opening 32 has an axially short cylindrical portion 34 of a diameter equal to the short cylindrical portion 16 of the bore 14 at the inner side of the disc 20 and an elongated relatively narrow rectangularly shaped slot 36 at the outer surface of the disc 20. The slot 36 can be described, as seen in FIG. 4, as being substantially rectangular, and in the specific form shown substantially square in cross section, and as seen in FIG.

5, being of equilateral trapezoidal shape in longitudinal section.

Four flat planes extend from the innermost edges of the four sides of the slot 36 to points tangent to the cylinder portion 34 of the opening 32, the two flat planes 38 and 40 extending from the longitudinal edges of the slot 36 to the cylindrical portion 34, and two flat planes 42 and 44 extending from the flat ends of the slot 36 to the cylindrical portion 34.

The flat planes 38, 40, 42, and 44 are connected together by quarter circle radiuses or fillets equal to or substantially equal to the radius of the cylindrical portion 34 adjacent the cylindrical portion, but gradually decreasing to zero at the point 46 at the corner between the longitudinal and the transverse sides of the slot 36. The shape of these radiuses, and the manner of constructing them, is illustrated in FIGS. 4 and 5 as including a circle 48 which has a quarter segment thereof marked off at 15 degree arcs, these marks being indicated by the numeral 50. Projection lines then drawn from these marks 50 up to the cylindrical portion 34 on each of FIGS. 4 and 5 provide points for the drawing of projection lines 52 and 54 up to the point 46 with these projection lines then defining the surface of the fillet.

FIGS. 6 to 10, taken respectively on lines 6 to 10 of FIG. 5, serve to illustrate diagrammatically the change in shape of the space 32 provided between the circular portion 34 and the slot 36. Thus, FIG. 6 shows the opening to be completely round. In FIG. 7 the opening is beginning to flatten and elongate. In FIGS. 8 and 9 the opening flattens and elongates still more, and in FIG. 10 at the slot 36 the opening is completely rectangular. FIGS. 6 to 10 illustrate the gradual reduction in the length of the radius joining the flat sides and ends formed by the flat planes 38, 40, 42, and 44.

The result is the provision of an opening 32 through the disc 20 which transposes the flow of fluid, and particularly of water, from a round cylindrical stream into a wide flat stream with a minimum of turbulence, and with the wide flat stream having a knife-like impingement of very uniform pattern and at high speed against the surface of hot steel to be de-scaled. The uniform pattern or "footprint" of the water discharged from the spray nozzle of the invention is maintained even though the spray nozzle is placed different distances from the surface of the steel, it being understood that when the nozzle is spaced a greater distance from the work, the footprint will be bigger but still uniform although the impingement force normally decreases as the square of the distance from the work. In certain operations where high impingement forces are advisable between the sprayed water and the work, the nozzles are placed closer to the work, and necessarily closer to each other to form a combined pattern covering the entire width of a strip, for example, whereas in other cases the nozzles may be moved farther from the work, and the nozzles separated a greater distance laterally from each other while still providing a combined spray pattern covering the full width of the work but with less impingement force.

The improved nozzle of the invention not only eliminates the laborious machining and hand working operations heretofore performed upon two-part discs but gives more sharply knife-like and uniform nozzle discharge patterns. Leaking between disc parts and between the disc parts and the body portion of the nozzle is materially reduced. Replacement of discs 20 in the improved nozzle is a relatively simple procedure in the event of disc wear after long service, or in order to provide the spray nozzle with a disc having a different size discharge slot 36.

It will be understood that the nozzles of the invention can be made in a variety of sizes to discharge greater or less quantities of water against a given work piece, and, in addition, that the discharge slot 36 on the same size

nozzle can be made of a slightly different ratio of length to width should this be desired.

The ratio of the cross-sectional area of the slot 36 to the cross-sectional area of the cylindrical portion 34 may be varied between about 1 to $1\frac{1}{2}$ and about 1 to 3, and usually is about 1 to 2 or about 1 to $2\frac{1}{2}$. In any event, as the fluid flows under heavy pressure through the nozzle the speed thereof is materially increased by the tapered bore 14 and then by the reduction in area of the opening 32 in the disc 20. Thus, it is discharged at high velocity against the hot work piece with a knife-like cutting action to act, together with the generation of steam, so as to blow the scale from the work piece.

The invention has been particularly described as applied to hot steel strip prior to a rolling operation. However, it will be evident that this is only one example of the many possible applications of the invention which include positioning between stands of a continuous rolling mill, prior to or between passes of a reversing or three high rolling mill, prior to or after the forming or welding of a tubular product, prior to the forging of a billet or section of a bar or rod, prior to or after pickling and/or tinning, and the like.

While a certain representative embodiment and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in this art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

What is claimed is:

1. The combination in a spray nozzle of a metal body portion having both ends externally threaded, a section of greater diameter than the remainder of the body portion and positioned between the threaded ends and having flats adapted to receive a wrench, said body portion having a flatly tapered conical bore therethrough terminating at its small end in an axially short cylindrical section, a one-piece disc positioned at the small end of the bore having a continuous circular flat face against the continuous circular end of the body portion, the outer periphery of the disc being tapered in the same direction as the bore, a metal ring nut screwing on the end of the body portion and having an inwardly directed peripheral flange having a surface complementary to the taper of the disc for holding the disc on the body portion, the disc being cast from a cobalt alloy having excellent corrosion and abrasion resistance and having an opening therethrough which is in the form of an axially short cylinder adjacent the small end of the bore, the cylinder being of the same diameter as the small end of the bore, the opening at the outer surface of the disc being in the form of a long narrow slot having substantially a square shape in transverse cross section and an equilateral trapezoid shape in longitudinal cross section and of greater length than the diameter of the cylinder, the remainder of the opening in the disc connecting the cylinder to the slot and being defined by four flat planes extending from the innermost sides of the slot to points tangent to the cylinder, and with the flat planes being connected at their edges by quarter circles having a radius substantially equal to the radius of the cylinder adjacent the cylinder and gradually decreasing to substantially zero at the innermost corners of the slot.

2. The combination in a spray nozzle of a metal body portion having a threaded end, said body portion having a flatly tapered conical bore therethrough terminating at its small end in an axially short cylindrical section, a one-piece disc positioned at the small end of the bore having a continuous circular flat face against the continuous circular end of the body portion, the outer periphery of the disc being tapered in the same direction as the bore, a metal ring nut screwing on the end of the body portion and having an inwardly directed peripheral flange having a surface complementary to the taper of the disc for holding the disc on the body portion, the disc being cast and

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having an opening therethrough which is in the form of an axially short cylinder adjacent the small end of the bore, the cylinder being of the same diameter as the small end of the bore, the opening at the outer surface of the disc being in the form of a long narrow slot of greater length than the diameter of the cylinder, the remainder of the opening in the disc connecting the cylinder to the slot and being defined by four flat planes extending from the sides of the slot to points tangent to the cylinder, and with the flat planes being connected at their edges by quarter circles having a radius substantially equal to the radius of the cylinder adjacent the cylinder and gradually decreasing to substantially zero at the corners of the slot.

3. The combination in a spray nozzle of a metal body portion having a flatly tapered conical bore therethrough terminating at its small end in an axially short cylindrical section, a one-piece disc positioned at the small end of the bore having a continuous circular flat face against the continuous circular end of the body portion, means for releasably holding the disc on the body portion, the disc having an opening therethrough which is in the form of an axially short cylinder adjacent the small end of the bore, the cylinder being of the same diameter as the small end of the bore, the opening at the outer surface of the disc being in the form of a long narrow slot of greater length than the diameter of the cylinder, the remainder of the opening in the disc connecting the cylinder to the slot and being defined by four substantially flat planes extending from the sides of the slot to points tangent to the cylinder, and with the flat planes being connected at their edges by quarter circles having a radius substantially equal to the radius of the cylinder adjacent the cylinder and gradually decreasing to substantially zero at the corners of the slot.

4. The combination in a spray nozzle of a metal body portion having both ends externally threaded, a section of greater diameter than the remainder of the body portion and positioned between the threaded ends and having flats adapted to receive a wrench, said body portion having a flatly tapered conical bore therethrough, a one-piece disc positioned at the small end of the bore having a continuous circular flat face against the continuous circular end of the body portion, the outer periphery of the disc being tapered in the same direction as the bore, a metal ring nut screwing on the end of the body portion and having an inwardly directed peripheral flange having a surface complementary to the taper of the disc for holding the disc on the body portion, the disc being cast from a cobalt alloy having excellent corrosion and abrasion resistance and having an opening therethrough which is in the form of a circle adjacent the small end of the bore, the circle being of the same diameter as the small end of the bore, the opening at the outer surface of the disc being in the form of a long narrow slot of greater length than the diameter of the cylinder, the remainder of the opening in the disc connecting the circle to the slot and being defined by four flat planes extending from

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the sides of the slot to points tangent to the circle, and with the flat planes being connected at their edges by quarter circles having a radius substantially equal to the radius of the circle adjacent the circle and gradually decreasing to substantially zero at the corners of the slot.

5. The combination in a spray nozzle of a metal body portion having both ends externally threaded, a section of greater diameter than the remainder of the body portion and positioned between the threaded ends and having flats adapted to receive a wrench, said body portion having a flatly tapered conical bore therethrough terminating at its small end in an axially short cylindrical section, a one-piece disc positioned at the small end of the bore having a continuous circular flat face against the continuous circular end of the body portion, the outer periphery of the disc being tapered in the same direction as the bore, a metal ring nut screwing on the end of the body portion and having an inwardly directed peripheral flange having a surface complementary to the taper of the disc for holding the disc on the body portion, the disc being cast from a metal alloy having excellent corrosion and abrasion resistance and having an opening therethrough which is in the form of an axially short cylinder adjacent the small end of the bore, the cylinder being of the same diameter as the small end of the bore, the opening at the outer surface of the disc being in the form of a long narrow slot having substantially a square shape in transverse cross section and an equilateral trapezoid shape in longitudinal cross section and of greater length than the diameter of the cylinder, the remainder of the opening in the disc connecting and smoothly verging from the cylinder to the slot.

6. A spray nozzle having a body portion with a tapered bore, a one-piece disc, means for securing the disc to the body portion at the small end of the bore, the disc having an opening therethrough in alignment with the bore, the opening being circular adjacent the small end of the bore and of substantially the same diameter, the other end of the opening being in the form of a substantially rectangular slot, the circular and slot portions of the opening being connected by substantially flat portions extending from the sides of the slot to the edges of the circular portion, the substantially flat portions being joined by substantially quarter round fillets of gradually decreasing radius from the circular portion to the slot.

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