

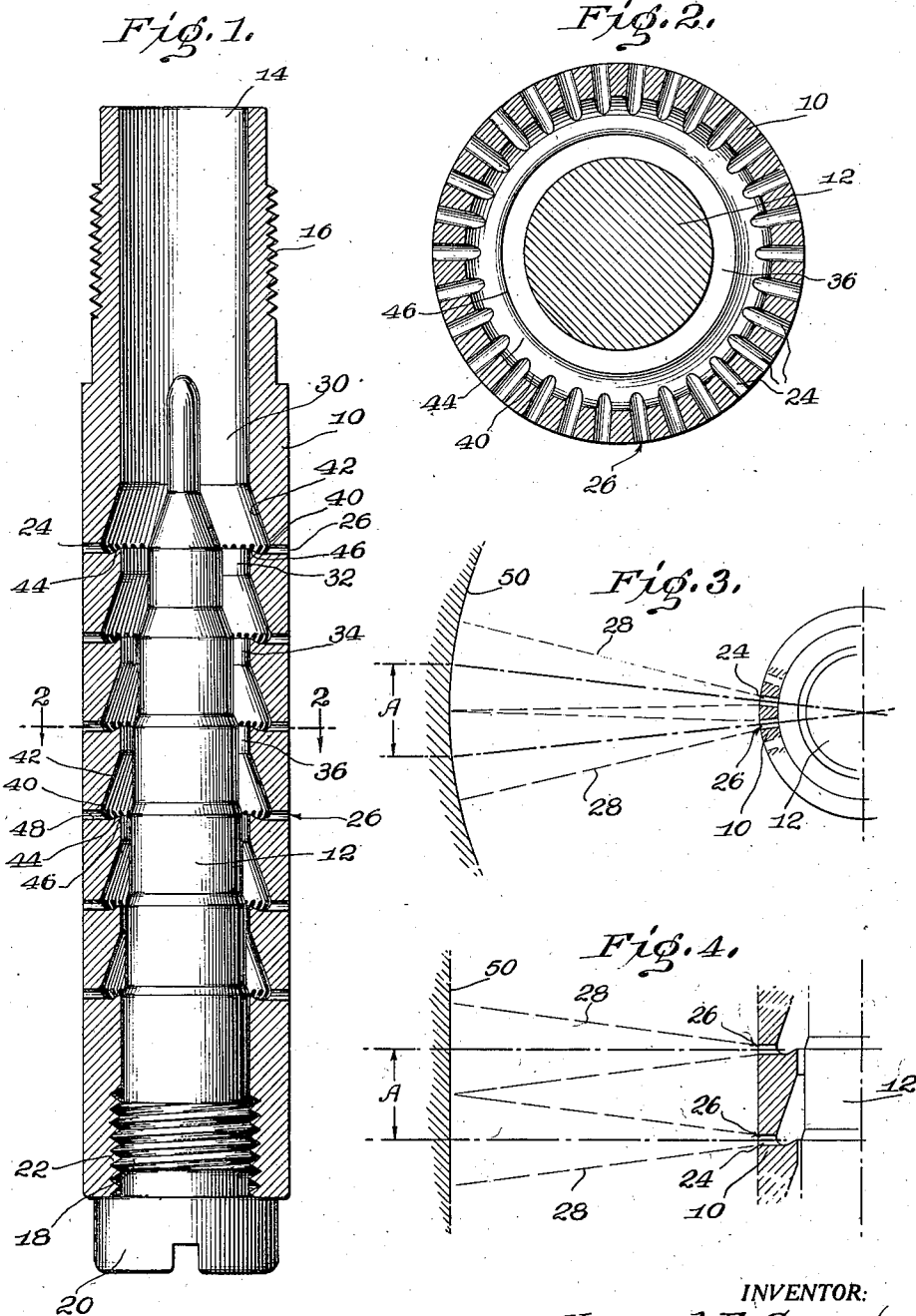
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QUENCHING NOZZLE

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QUENCHING NOZZLE

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This invention relates to an improved quenching nozzle and more particularly to a quenching nozzle adapted for use in conjunction with heat treatment apparatus.

In Patent No. 2,281,297, granted April 28, 1942, there is disclosed a heat treating machine of the electro-magnetic induction type particularly adapted to heat treat internal surfaces of sleeves, hub bores and similar objects. In the heat treatment of the internal surface of a wheel hub for example having an internal surface diameter of approximately three inches and axial length of approximately two inches, the internal layers up to approximately a tenth of an inch are brought to heat treating temperatures in a few seconds by an electro-magnetic inducing head inserted in the bore and thereafter the head is removed and the surface quenched.

This quenching is rendered difficult because the hub bore is open only at one end and although all portions of the bearing bore must be drastically quenched, the quenching coolant is forced to flow away from the closed end and through the adjacent portions being quenched. Various attempts have been made to produce a uniform quench throughout the entire surface of such an object and where the critical quenching speed is relatively low simplified quenching devices have been used more or less satisfactorily. However, where, due to low inherent hardenability of the metal being hardened, extreme drasticity of quench is required it is found that simple quenching mechanisms will not perform satisfactorily. The device constituting the present invention will obtain controllable distribution of coolant with the necessary controlled velocities and provide a uniform quenching effect, thereby developing the maximum hardness with the optimum depth of hardenability, dependant upon the depth to which the part being processed is heated and its inherent hardenability as determined by its metallurgy.

The present invention relates to a nozzle peculiarly constructed in order to fit the aforementioned desired conditions and has as an object to provide an improved quenching nozzle adapted to distribute quenching fluid to an internal bore in a uniform manner.

Another object of the invention is to provide a nozzle having its ports arranged so as to take into consideration the internal diameter of the bore surface which is to be quenched so that the uniform quantity of quenching fluid is applied uniformly throughout the surface. More specifically the surface to be treated may be considered

as broken up into a number of squares or areas and the nozzle ports are so arranged that one port is directed toward each square or area. Thus striations or non-uniform areas of hardening can be avoided when a predetermined pressure is used.

A further object of the invention is to provide a quenching nozzle having a metering pin therein associated with the various ports in a manner to assure uniform controllable fluid distribution through each port.

Yet another object of the invention is to provide a quenching nozzle having a metering pin therein, the nozzle having a bore and cooperating metering pin especially grooved and channeled and shaped so as to assure a smooth and rapid flow of large quantities of quenching fluid therethrough with a minimum of friction and turbulence and yet maintain uniform controllable discharge through all ports.

The above and other novel features of the invention will appear more fully hereinafter from the following detailed description when taken in conjunction with the accompanying drawing. It is expressly understood, however, that the drawing is employed for purposes of illustration only and is not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawing wherein similar reference characters refer to similar parts throughout the several views:

Fig. 1 is a longitudinal section through the quenching nozzle showing the detail thereof.

Fig. 2 is a transverse enlarged section through the nozzle taken on the line 2-2.

Figs. 3 and 4 are diagrammatic illustrations illustrating the manner of spacing the ports of the nozzle in order to produce uniform quenching of the quenching surface.

Referring to Fig. 1, there is shown a nozzle composed of a tubular member 10 having a metering pin 12 therein. The nozzle is open at one end as at 14 and provided with threads 16 for threaded engagement with a supply pipe not shown. The metering pin 12 is threaded at its lower end as at 18 and provided with a head 20 so that the same may readily be inserted into the lower threaded end 22 of the tubular member. The metering pin thus forms a plug for the lower end.

The tubular member is provided with a plurality of ports 24 preferably arranged in circular bands 26 uniformly spaced along the length of the nozzle. In order to provide a uniform

quenching pattern which will substantially avoid striations or non-uniform bands which would result from uneven distribution of quenching fluid upon a surface to be quenched, the ports are so spaced and shaped as to provide a single stream of fluid for each corresponding square or area of the surface to be quenched under a desired pressure. This is illustrated in Figs. 3 and 4 where it will be observed that the axial spacing A between the bands 26 of the ports 24 is so correlated with the circumferential spacing between the ports in each band so that the circumferential distance between the centers of impingement of adjacent quenching streams 28 is substantially the same as the axial distance between adjacent axial ports as indicated at A in Fig. 3. In order to attain such a result it is necessary that the circumferential spacing between ports upon the nozzle must be less than the axial spacing between ports by an amount substantially proportional to the ratio of the diameter of the quenching nozzle and the diameter of the surface to be quenched.

In addition to arranging the ports in the manner above-described it is essential that a controlled amount of coolant be discharged from each port or otherwise the full benefit of the port arrangement would not be obtained. In order to assure such controlled distribution of quenching fluid from each port, the metering pin 12 is so arranged as to constrict the bore of the tubular member of the nozzle in a stepped manner between the annular bands of ports. The steps are substantially uniform in so far as they reduce the annular area of cross section of the bore of the tubular member between successive bands of ports except for such variation as may be necessary to compensate for back pressure developed external to the quenching fixture and yet to deliver the required flow of coolant at the necessary velocity to the surface of the part being treated. For example, the cross sectional area of the annular passage at 30 is reduced by a certain amount at 32 and reduced by substantially a similar amount again at 34 and thereafter reduced by a substantially similar amount as at 36 and so on. Thus, the flow of quenching fluid through the various annular bands of ports can be closely regulated provided a proper pressure behind the quenching fluid is employed. In fact, in practice it has been ascertained that even considerable variations in the pressure of the fluid being discharged from the quenching nozzle does not seriously affect the uniform distribution from the various bands of ports. In order to reduce turbulence within the nozzle and thereby assist the same in handling large quantities of quenching fluid as is essential in heat treating, each band of ports originates in an annular groove 40 in the tubular member 10. The annular groove has a sloping entering contour 42 and a curved end contour 44 reentering into the stream and terminating in an acute angle ridge 46. The curved end contour is preferably tangent to the elements 48 of the radial ports. The annular grooves 40 are thus contoured so as to act in the manner of a scoop and redirect the axial flow so scooped into a radial flow so that upon emergence from the discharge ports 24 the stream will be more or less circular and substantially radially discharged from the nozzle proper. It will be observed that the point of restriction produced by the stepped metering pin occurs immediately in the plane of the acute angle ridge 46 and that the contour

of the pin tapers at each step to correspond to the internal shape of the tubular member at the port bands in order to reduce turbulence and friction to a minimum.

Quenching fluid entering the tubular member at 14 will thus obviously flow into the nozzle and predetermined portions thereof will be sheared from the stream at its passage past each band of ports and since the further constriction is uniform as each band of ports is passed, a substantially uniform quantity of water is removed from the stream and discharged through the ports. It will readily be understood that the nozzle may have greater relative diameter to the workpiece through a work surface 50 to be heat treated but that in the present instance, because the nozzle is adapted to cooperate with a heat treating machine such as that disclosed in the referred-to copending application, the nozzle's diameter has been maintained relatively small. Should the relative diameter be increased the circumferential spacing of the ports must be likewise increased. It will also appear that the ports may be cylindrical in their bore or they may be especially shaped in any desired manner either to produce a more or less diverging stream from each port or may be streamlined in order to reduce turbulences there-through. It will also appear that the ports may be arranged so as to provide a hexagonal pattern or some other pattern including geometrical figures such as equilateral triangles which will nest together and provide a uniform quench both circumferentially and axially of the workpiece. In practice a part may be variably hardened through variations in the metering pin and companion sleeve, thus varying the distribution and velocity of the coolant. Once a satisfactory nozzle and pin have been made the parts subsequently hardened thereby will conform with great regularity to the desired pattern.

Although a single embodiment of the invention has been illustrated and described, it is to be understood that the invention is not limited thereto but may be changed in various equivalent forms as suggested hereinabove. As many other changes in construction and arrangement may be made without departing from the spirit of the invention as will be apparent to those skilled in the art, reference will be had to the appended claims for a definition of the limits of the invention.

What I claim is:

1. A quenching nozzle for quenching an interior substantially cylindrical surface of a particular diameter, comprising a tubular member adapted to be concentrically inserted into the space surrounded by said surface, and having an axial length substantially corresponding to that of the surface provided with radial ports, said ports being uniformly axially spaced and uniformly circumferentially spaced, the axial spacing between adjacent ports being greater than the circumferential spacing between adjacent ports, the circumferential spacing being such that the radial discharge from any two circumferentially adjacent ports will strike an interior concentric surface of the said particular diameter with a spacing substantially equal to the axial spacing.

2. A quenching nozzle for quenching an interior substantially cylindrical surface of a particular diameter, comprising a tubular member adapted to be concentrically inserted into the space surrounded by said surface, and having an

axial length substantially corresponding to that of the surface provided with radial ports, said ports being uniformly axially spaced and uniformly circumferentially spaced, the axial spacing between adjacent ports being greater than the circumferential spacing between adjacent ports, the circumferential spacing being such that the radial discharge from any two circumferentially adjacent ports will strike an interior concentric surface of the said particular diameter with a spacing substantially equal to the axial spacing, and means within said tubular member for gradually restricting the flow area from one end to the other to assure uniform quenching from all ports.

3. A quenching nozzle for quenching an interior substantially cylindrical surface of a particular diameter, comprising a tubular member adapted to be concentrically inserted into the space surrounded by said surface, and having an axial length substantially corresponding to that of the surface provided with radial ports, said ports being uniformly axially spaced and uniformly circumferentially spaced, the axial spacing between adjacent ports being greater than the circumferential spacing between adjacent ports, the circumferential spacing being such that the radial discharge from any two circumferentially adjacent ports will strike an interior concentric surface of the said particular diameter with a spacing substantially equal to the axial spacing, and means within said tubular member for gradually restricting the flow area from one end to the other to assure uniform quenching from all ports, said means providing annular axially spaced constricted zones of gradually decreasing cross section immediately following each row of holes.

4. A quenching nozzle for quenching an interior substantially cylindrical surface of a particular diameter, comprising a tubular member adapted to be concentrically inserted into the space surrounded by said surface, and having an axial length substantially corresponding to that of the surface provided with radial ports, said ports being uniformly axially spaced and uniformly circumferentially spaced, the axial spacing between adjacent ports being greater than the circumferential spacing between adjacent ports, the circumferential spacing being such that the radial discharge from any two circumferentially adjacent ports will strike an interior concentric surface of the said particular diameter with a spacing substantially equal to the axial spacing, and means within said tubular member for gradually restricting the flow area from one end to the other to assure uniform discharge from all ports, said means providing annular axially spaced constricted zones of gradually decreasing cross section immediately following each row of holes, and an annular acute edge bounding the outer entering edge of the constricted zone to direct a portion of the fluid approaching said zone into the adjacent circumferential row of ports.

5. A quenching nozzle comprising a tubular member having a plurality of rows of circumferentially spaced ports arranged along lines extending around the member, internal annular grooves on the inside of said member substantially opposite each row of said ports and into which said ports lead, said grooves having an outwardly sloping entering face terminating substantially at the port line, said grooves having a curved end face and ending in a reen-

trant portion extending backwards and terminating with an acute angled ridge formed by the end face and the internal bore of said member, said grooves being thus adapted to pocket and direct a portion of a stream of fluid flowing through said member toward the end face and thence outward through the ports, a portion of the liquid passing through the ports being sheared from the stream by said acute ridges, and a complementary concentric metering member, said metering member having a stepped surface portion associated with said grooves and angled ridges to provide successively more restricted annular areas initiating substantially in the transverse plane passing through each ridge.

6. A quenching nozzle comprising a tubular member, having a stepped metering member therein graduating the internal annular cross section of said tubular member in a plurality of uniform constricting steps from one end to the other, and a plurality of discharge ports arranged in the tube in a plurality of annular bands, each of said bands being associated with one of said graduated steps in said metering member, whereby each constricting step causes a uniform discharge of fluid from each of said bands of ports.

7. A quenching nozzle for quenching an interior annular surface of determinate area when such surface is spaced from the nozzle by a distance substantially in excess of that needed for removal of quenching fluid after its impingement on said surface, comprising a tubular member adapted to be inserted into the space surrounded by said surface and provided with ports so spaced circumferentially and axially as to cause quenching fluid to impinge directly from said ports simultaneously on substantially all of said surface, and means effecting a progressive decrease in the cross-sectional flow area within said member in the direction of fluid flow, the relative cross-sections of the ports and the quenching fluid flow area within the tubular member in the vicinity of each port being such that there is discharged through each port that quantity of quenching fluid per unit of time which equates the extraction of heat per unit of area per unit of time from that area upon which the stream from the port impinges with the extraction of heat from each other unit of area upon which streams from the other ports impinge.

8. A quenching nozzle for quenching an interior annular surface of determinate area when such surface is spaced from the nozzle by a distance substantially in excess of that needed for removal of quenching fluid after its impingement on said surface, comprising a tubular member adapted to be inserted into the space surrounded by said surface and provided with ports so spaced circumferentially and axially as to cause quenching fluid to impinge directly from said ports simultaneously on substantially all of said surface, and means effecting a progressive decrease in the cross-sectional flow area within said member in the direction of fluid flow comprising a metering rod, the relative cross-sections of the ports, the quenching fluid flow area within the tubular member, and the metering rod in the vicinity of each port being such that there is discharged through each port that quantity of quenching fluid per unit of time which equates the extraction of heat per unit of area per unit of time from that area upon which the stream from the port impinges with the ex-

traction of heat from each other unit of area upon which streams from the other ports impinge.

9. A quenching nozzle for quenching an interior substantially cylindrical surface of a particular diameter comprising a tubular member adapted to be concentrically inserted into the space surrounded by said surface and having longitudinally and peripherally extending rows of liquid discharge ports of substantially the same size and shape, whereby a plurality of similar streams of quenching liquid may be directed radially outward onto the work surface being quenched, the center of impingement of the streams upon the work surface being substantially equally spaced from the center of impingement of each adjacent stream in peripherally extending alignment therewith, the center of impingement of a stream upon the work surface being substantially equally spaced from the center of impingement of each adjacent stream in longitudinally extending alignment therewith, in combination with means to effect a decrease of flow area longitudinally within said tubular member in the direction of liquid flow to distribute liquid substantially uniformly from each port.

10. A quenching nozzle for quenching an interior substantially cylindrical surface of a particular diameter comprising a tubular member adapted to be concentrically inserted into the space surrounded by said surface and having longitudinally and peripherally extending rows of liquid discharge ports of substantially the same size and shape, whereby a plurality of similar streams of quenching liquid may be directed radially outward onto the work surface being quenched, the center of impingement of the streams upon the work surface being substantially equally spaced from the center of impingement of each adjacent stream in peripherally extending alignment therewith, the center of impingement of a stream upon the work surface being substantially equally spaced from the center of impingement of each adjacent stream in longitudinally extending alignment therewith, in combination with means to effect a decrease of flow area longitudinally within said tubular

member in the direction of liquid flow to distribute liquid substantially uniformly from each port, the said means including a metering rod, the surface of which is of stepped form providing a progressively increasing rod diameter in the direction of liquid flow.

11. A quenching nozzle for quenching an interior annular surface when such surface is spaced from the nozzle by a distance substantially in excess of that needed for removal of quenching fluid after its impingement on said surface, comprising a tubular member adapted to be inserted into the space surrounded by said surface and having ports so spaced circumferentially and axially as to cause said quenching fluid to impinge simultaneously upon substantially all portions of the work surface, and means effecting a progressive decrease in the cross-sectional flow area within said member comprising a coaxial metering rod shaped to distribute a predetermined controlled quantity of fluid through each port, said rod having peripheral stepped portions adjacent each port proportioned to reduce the cross-sectional flow area within said member in the direction of fluid flow, and tapered surfaces connecting successive cylindrical portions.

12. A quenching nozzle for quenching an interior annular surface when said surface is spaced from the nozzle by a distance substantially in excess of that needed for removal of quenching fluid after its impingement on said surface, comprising a tubular member adapted to be inserted into the space surrounded by said surface and having ports so spaced circumferentially and axially as to cause quenching fluid to impinge directly from said ports simultaneously on substantially all portions of said surface, said conduit being of decreasing cross-sectional flow area in the direction of fluid flow to discharge predetermined controlled quantities of fluid through said ports, the wall of the conduit before each port being recessed to provide increased flow area to said port, and a ridge formed on the conduit wall adjacent each port shaped to intercept part of the fluid flowing through said conduit and direct it outwardly through the adjacent port.

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