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TUBE WORKING APPARATUS

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This invention relates to apparatus for performing shaping or reducing operations on tubular work, particularly to apparatus for swaging tube ends and simultaneously withdrawing free lubricant from the working zone, and it has especial reference to the pointing of draw stock preliminary to cold drawing.

The well known tube drawing process employing cooperative die and bulb elements is extensively practiced in the production of tubing of various diameters and wall thicknesses. Preliminary to drawing, the tube stock is required to be pointed at one and a half so that it may be projected through the draw die for gripping by gripping jaws of the drawbench carriage. Currently, much of the pointing is done in rotary swaging machines, but there is a serious drawback attendant thereto in that the liquid medium used in the swager as a lubricant or a coolant for the die mechanism undesirably enters the open end of the tube stock. Completion of the pointing operation finds this die lubricant, frequently commingled with particles of metal, trapped in the tube. In the subsequent drawing operation, it has been discovered, this die lubricant prevents the applied drawing lubricant from properly lubricating the inner wall of the tube, at the start of the draw, apparently because the film or coating of die lubricant appreciably contaminates the film of draw lubricant between the bulb over which the tube is drawn and the inner wall of the tube and materially reduces the ability of the draw lubricant to withstand the high bearing pressure as it is intended to do. The bulb cooperates with the die to control the wall thickness of the drawn tube and also its inside diameter. Actual drawing begins when the bulb moves up into drawing position in cooperative relation to the die in a well known manner. As a result of contamination, the film of draw lubricant apparently breaks down and allows metal-to-metal contact between the bulb and tube wall, which causes excessive wear on the bulb and scoring or tearing of the inner surface of the tube, and even tube rupture directly attributable to this cause frequently occurs. Ordinarily, the exterior of the tube may be wiped after pointing, but this expedient is obviously impractical for the interior of the tube. Sometimes the pointed tubes are disposed open end down to let the die lubricant drain away from the point, but it is ineffective and interposes delay; and to resort to methods such as heating or cleansing with a solvent is undesirable because of the imposition of an extraneous operation in the tube production program together with the time, labor and equipment needed to carry it out.

An object of the present invention is to overcome the foregoing difficulties by providing means for preventing entry of free lubricant into the interior of tubular work during the operation of pointing or otherwise shaping the same in lubricated die mechanism. Another object of the invention is to provide in a swaging machine or the like a simple and effective mechanism for inducing flow of air inwardly past the dies and through the hollow spindle of the machine. A further object of the invention is to provide improved swaging apparatus characterized by the provision of die lubricant removal means, means to recover the removed lubricant for re-use, and means automatically actuated upon presentation of the work to the dies for rendering the said removal means operative. A further specific object is to provide swaging apparatus adapted for pointing tube draw stock with points of given length and with the interior of the pointed stock in a clean condition ready for drawing.

The preferred embodiment of the invention is illustrated in the accompanying drawings in which Fig. 1 is a longitudinal sectional view of a swaging machine taken on the line I—I of Fig. 2; Fig. 2 is a front elevational view of the machine with the die mechanism thereof exposed; Fig. 3 is a sectional view on an enlarged scale of a portion of the apparatus of Fig. 1; Fig. 4 is an end view of the structure of Fig. 3; Fig. 5 is a sectional detail view taken on the line V—V of Fig. 3; and Fig. 6 shows a portion of a tube after pointing.

Referring to Figs. 1 and 2 of the drawings, the swager illustrated comprises a suitable base 10, constructed to serve as a sump or reservoir for liquid lubricant, and carrying on its upper side a suitable front housing or drum 11 for the die mechanism, and a pair of spaced bearing pedestals 12 and 13. A hollow shaft or spindle 14 is rotatably supported by suitable roller thrust bearings 15 in the pedestal 12 and anti-friction bearing 16 in the pedestal 13. A flywheel 17 is keyed or otherwise rigidly fixed to the shaft 14 and it is arranged to be driven by any suitable means, so that the shaft may be driven at the desired rate of rotation thereby. As here shown, the driving means comprises motor 18 mounted on a bracket 19, a pulley 20 secured to the motor shaft, and a plurality of V-belts 21, the peripheries of the flywheel and the pulley being grooved to receive the V-belts.

At its forward end, the shaft 14 is formed with a cylindrical die holder or head 22 which is cen-
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3 trally located in a bore in the drum 11. An annular series of hammer rollers 23 is confined between the outer periphery of the head 22 and the inner periphery of a liner ring 24 fixed in the bore of the stationary housing 11. The die holder 22 is provided with a diametrical slot 25 (Fig. 2) in which opposed swaging dies 26 and a hammer member or block 27 for each die are reciprocated. The blocks 27 preferably being provided with rollers 28 for contacting the rollers 23 successively as the die head 22 is rotated. Thereby, the swaging dies 26 and the blocks 27 are moved inwardly periodically to subject the work to be worked between the dies to swaging impacts, in a well known manner. Removable retainer and cover plates 30 for the dies 26 and the hammer rollers 23 are suitably secured to the front face of the drum 11, an opening coaxial with shaft 14 being provided therethrough for presentation of the work to the dies.

As here shown, the swaging dies 26 are adapted to work the end portion of tube draw stock 31 into a point of a desired shape which in the present instance embodies a substantially cylindrical tip portion 32 and a conical or tapered portion 33 between the tip portion 32 and the body of the tube 31 of the face of the dies 26 is provided with this configuration in the diametral plane therethrough paralleling the plane of die reciprocation. It is to be appreciated that the length of the point will depend upon how far the tube 31 is advanced endwise through the dies.

It is a feature of the invention that points of the same length will be produced on the various pieces of draw stock presented to the dies, and to this end a stop or gauge member 34 is provided in the bevel of the hollow shaft 14, the bore being identified by the numeral 35. This stop 34 is supported at the inner end of a tubular member or pipe 36 that extends coaxially through the shaft 14 and outwardly past the dies therefrom. At this outer end of the pipe, it is advantageously supported for endwise adjustment in upstanding spaced bosses 37 and 38 on bracket member 39 that is suitably secured to bearing pedestal 13. Suitable adjusting means may take the form here shown including a nut or sleeve member 40 rotatably mounted in the boss 38 and confined in axial shifting by a shoulder on one side of the boss and a collar on the other side of the boss, or in any other suitable fashion. Screw threaded engagement is provided between the pipe 36 and the adjusting nut 40 so that upon rotation of the latter the pipe 36 and the stop 34 will be advanced or retracted relative to the dies 26. The nut 40 may be provided with radiating handles, as shown, for convenience in rotating it, but any suitable tool may be used instead. Jam nut 41 is provided to lock the parts in adjusted position. Obviously, with the parts in adjusted position for a given length of tube point, each piece can only be advanced through the dies until its end engages the stop 34 and all points consequently will be of the same length.

The die mechanism described constitutes a rotative die device by means of which the end portion of a tube work piece is fashioned progressively to the contour of the die as the work is moved or advanced endwise into the die. Feeding of the work may be effected manually or by suitable feed devices. Lubrication of the die mechanism and the surface of the work in contact with the sleeve is essential and a light lubricating fluid such as oil of low viscosity index, or other suitable liquid medium of desired lubricant and coolant properties is preferably employed. The fluid lubricant is delivered to the die mechanism under pressure and in considerable volume so that all surfaces will be adequately covered. Indicative of a suitable manner of supplying lubricant to the rotary die device illustrated is a conventional macerator pump 42 having an inlet connected to withdraw a fluid lubricant from the sump in base 10 and an outlet connected to deliver the fluid to vertical duct 43 in the upper part of drum 11 through which the fluid flows to the moving parts of the die mechanism. Vertical drum 14 in the drum 11 permit flow or drainage of the fluid from the die mechanism to the sump in base 10.

During the working operation, it is apparent that fluid lubricant given off from the dies 26 will enter the open end of the tube 31 and, as heretofore pointed out, create a problem in connection with its removal, particularly in the case of tube stock pointed for drawing. However, in pursuance of the primary object of the invention, provision is made to prevent entry of the fluid lubricant into the tube 31 so as to eliminate the need for subsequently effecting the cleaning of the lubricant from the interior surface of the work. As a preferred form of means for this purpose, the drawings illustrate a vacuum inspirator for creating a zone of reduced atmospheric pressure or partial vacuum in the bore 35 adjacent the dies. The inspirator includes the aforementioned pipe 36 carrying a nozzle 45 at its inner end and having connection at its rear or outer end with a pressure fluid conduit or pipe 46, preferably a length of flexible tubing or hose 47 being included in the connection to accommodate axial shifting of the pipe 46, as above described. The pipe 46 is connected to any suitable source (not shown) of fluid under pressure, preferably compressed air, and flow of the compressed air is controlled by means of a suitable valve 48. It is contemplated that the air flow shall be automatic upon presentation of the work to the die device and continue until the work is withdrawn therefrom. To do this, various forms of control means responsive to movement of the work toward and away from the die device for effecting on and off actuation of the valve 48 may be utilized, but for simplicity it is desired to provide a common variety of spring-biased, two-way air valve and locate it in front of the die in such a position that a tube presented to the die will operate the valve. As shown, the valve 45 is located below the pass line and is provided with a trigger or lever 49, pivoted at 50 to the valve body and adapted to be depressed by the weight of the tube 31 rested thereon to actuate the valve and permit flow of air therethrough, the valve spring (not shown) shifting the flow and moving the trigger upwardly when the tube is removed.

The nozzle 45 is provided with a rearwardly facing, substantially continuous, annular orifice 51 through which the compressed air escapes at high velocity and flows through the bore 35 to the end of the spindle remote from the die mechanism. A simple, inexpensive, easily made construction here disclosed comprises a tube or sleeve 52 circling exteriorly tapered end portion 53 of the pipe 36 and a plurality of narrow spacer bars 54 (three being here shown) interposed between pipe 36 and sleeve 52 in circumferentially spaced relation, the bars and the sleeve being secured together and both being secured to pipe 36 suitably as by welding, thereby forming longitudinal flow.
passages terminating at orifice 51. The sleeve 52 is extended beyond the end of pipe 36 so that the air may flow readily into the flow passages, and the aforementioned stop member 34, in the form of a cap, closes the open end of sleeve 52 against air leakage and is suitably secured thereto as by welding. The diameter of stop 34 is less than that of the bore 35 for flow of fluid through the space therebetween. The desired orifice area is obtained by securing the sleeve 52 to the pipe 36 in a given position axially with respect to the tapered wall 53 thereof. For regulating the compressed air velocity, a choke or flow orifice 66 is installed in the air line ahead of the nozzle 45, and this choke may be adjustable or changeable as desired.

From the foregoing description, it will be apparent that when a tube 31 is moved endwise toward the dies, valve 48 is opened and compressed air flows continuously through the air line to nozzle 45 from which it discharges through the rearwardly facing orifice 51 and blows through the bore 35 to escape at the rear end thereof. Thereby, a partial vacuum is created in the bore 35 adjacent the dies 26 which causes air to flow in a stream from the exterior of the machine into the bore, thereby affording continuous protection against entry of the lubricant into the tube during the working operation. The efficacy of this method of continuously withdrawing free lubricant from the die working zone is greatly enhanced in connection with the working of tube stock open at both ends by reason of the fact that much of the inflowing air is drawn through the tube and has a blowing action that effectively opposes entry of lubricant into the tube.

In the swaging of metal that is subject to flaking, such as aluminum, it has been found from experience that a continuous flow of air through the vacuum inspirator causes the dies to dry and become coated with finely divided particles or flakes of aluminum which causes feeding of the tube to be very tedious. Therefore valve 48 has been provided to shut off the air and break the vacuum for the interval occurring between withdrawing one tube and starting the next. This break in vacuum discontinues flow of air past the die and allows the coolant or lubricant to flow freely, splash over the die surfaces from the hammer action of the dies and to wash the die surfaces and remove this objectionable film or coating.

In order not to waste the withdrawn lubricating fluid, means are provided to separate the same from the air stream and to return it to the supply for re-use. A preferred form of separating means, here illustrated, comprises a suitable casing or collector box 57 at the rear end of shaft 14 into which the admitted air and lubricant discharge. The box 57 is secured to the boss 37 in any suitable fashion and preferably a sealing gasket or packing gland 58 is provided for the pipe 38 to prevent leakage out along the pipe, since the wall of the casing through which the pipe extends is directly impinged by the fluid issuing from the bore 35. A flinger plate or disc 69 is secured to the end of shaft 14 for rotation therewith from the periphery of which particles of lubricant collecting thereon are discharged. It carries a cylinder member 60 that extends back along the shaft 14 through an opening 61 in the front wall of the casing 57, and an upstanding flange 62 is provided on the outer end of the cylinder 60. This construction provides an annular baffle structure forming a tortuous path outlet for the escape of air from the collector box.

As the air enters the collector box, its velocity materially decreases due to the expansion area provided therein and it is forced to reverse its direction of flow in order to escape through the baffle outlet. Hence particles of lubricant borne by the air separate out and collect on the flinger plate and on the walls of the box and gravitate to the bottom of the box so that a substantial part of the liquid lubricant becomes separated from the air as it flows sluggishly through the expansion chamber and escapes through the baffle outlet. A screen 63 is provided in the lower portion of the collector box 57 to screen out flakes of metal and other foreign matter, and the screened lubricant flows through drain pipe 64 to the pump in base 16.

The mechanism which I have described as representative of a specific embodiment of the various features characterizing my invention is susceptible of numerous variations, as will readily be understood by those skilled in the applicable art, without departing from the spirit of the invention as particularized in the appended claims. Also, the invention as a whole as well as certain features thereof, is suitable for use in various other relations than the one herein specifically pointed out.

What is claimed is:

1. In combination, rotary die mechanism for operating on tubular work, a hollow shaft coaxial with said die mechanism for rotating the same, means for driving said shaft, means operatively associated with said shaft for inducing flow of air therethrough inwardly past said die mechanism, and control means for rendering said last-named means operable, said control means being located in position to be actuated automatically in response to presentation of said work to said die mechanism.

2. In combination, rotary die mechanism for operating on tubular work, a hollow shaft coaxial with said die mechanism for rotating the same, means for driving said shaft, a nozzle disposed within said shaft adjacent to said die mechanism and arranged to discharge fluid under pressure therefrom in a direction extending rearwardly of said die mechanism, whereby a stream of air is drawn inwardly past said die mechanism, and means for supplying fluid under pressure to said nozzle.

3. The combination with a rotary swaging machine having opposed swaging dies and a die driving spindle provided with a bore therethrough, of a nozzle in said bore adjacent to said dies, said nozzle provided with a rearwardly facing, substantially continuous, annular orifice, a pipe extending axially through said bore to support said nozzle and to supply fluid under pressure thereto for discharge from said orifice to induce inflow of air past said dies, means for supporting said pipe at the rear end of said spindle, a conduit connected with said pipe for flow of pressure fluid therethrough, and a valve for controlling flow in said conduit.

4. In rotary swaging apparatus, in combination, a plurality of radially reciprocable dies adapted to swage tubular work, a rotary die head
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5. In rotary swaging apparatus, in combination, a plurality of radially reciprocable dies adapted to swage tubular work, a rotary die head carrying said die, a hollow drive shaft for said die head, means for driving said shaft, means for impacting said dies against said work upon rotation of said die head, means for supplying fluid to said die to lubricate the same, means for flowing air in a stream inwardly past said dies for discharge from the end of said shaft remote from said dies, whereby lubricant given off from said dies is carried away therefrom in said air stream, and means at the discharge end of said shaft for separating a substantial portion of the lubricant from the air stream discharged from said shaft.

6. In rotary swaging apparatus, in combination, a plurality of radially reciprocable dies adapted to swage tubular work, a rotary die head carrying said dies, a hollow drive shaft for said die head, means for driving said shaft, means for impacting said dies against said work upon rotation of said die head, means for supplying fluid lubricant to said dies, a casing at the end of said shaft remote from said dies, means for flowing air in a stream inwardly past said dies and through said hollow shaft to withdraw lubricant given off from said dies, said air and withdrawn lubricant discharging from said shaft into said casing, for expansion of the air therein and separation of lubricant from the air, a plurality of annular baffle members rotatable with said shaft and arranged coaxially thereof at either side of the front wall of said casing in spaced relation thereto, to form a tortuous path outlet for escape of the said air from said casing, and an outlet for draining lubricant from the lower part of said casing.

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