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TUBE EXPANDER

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This invention relates to pull-type tube expanders of the sort chiefly used to expand boiler and heat exchanger tubes into drums and tube sheets, and, in particular, to improved actuating means for such expanders.

The object of this invention generally is to provide a tube expanding tool in which simplicity of structure and operation is combined with easy adaptability to different jobs. A particular object of my invention is to provide a complete apparatus having these qualities suited to carry out the method of tube expanding described and claimed in the co-pending application of Maxwell, Serial No. 274,749, filed May 20, 1939, now Patent No. 2,275,451, in which the expander head is positioned at the inner limit of the portion of tube to be expanded before the expanding operation is begun and the actual expanding is accomplished by forcibly enlarging the head thus positioned and drawing it outward by a straight pull while enlarged.

This type of expander is of particular importance to the industry because of the recent trend to higher temperatures and pressures. The resulting demand for heavier walls and smaller diameters in the tubes and greater thickness in the tube sheets presented a tube expanding problem which the conventional tools and methods of the prior art were unable to solve.

I am aware that a number of different actuating mechanisms for such expanders have been recently disclosed, particularly in my co-pending applications Serial Nos. 298,345 and 301,092, filed Oct. 25, 1939, now Patent No. 2,275,614, and the above mentioned application of Maxwell. The subject matter of the present invention is an improvement over these previously known actuating devices for pull-type expanders particularly in providing a simpler and more fool-proof device of outstanding flexibility of application both in the factory and in the field.

In general, I provide a hydraulically operated expander in which the expanding operation and the resetting of the expander is controlled by a simple two-position valve, the necessary differential movement between the taper pin and the expander head being automatically obtained. The means for accomplishing this automatic positioning of the parts of the expander proper are wholly outside of the hydraulic portion of the device, making for simplicity. The means provided for adjusting the device for different jobs are likewise wholly outside of its hydraulic portions, making for freedom from leaks.

The invention will be described in connection

with a preferred embodiment thereof, illustrated in the accompanying drawing in which:

Fig. 1 is a longitudinal section through a device embodying my invention showing it in position in a heat exchanger tube just prior to the commencement of the expanding operation;

Fig. 2 is an enlarged view of a portion of Fig. 1 showing the mechanism of my invention which prevents the rearward movement of the expander head before it has been fully expanded in its original position; and

Fig. 3 is a transverse section taken on the line 3—3 of Fig. 2.

In the following detailed descriptions of the structure and operation of my invention the terms "inner" and "outer" shall be taken to mean in a direction into and out of, respectively, the tube to be expanded into the tube sheet when the expander is in working position.

Taking up structure first and referring to the drawing, my complete device includes a supply pipe 1 and return pipe 2 by which fluid under pressure to operate the expander is brought to and from the hydraulic portions thereof. Pipes 1 and 2 are connected to the inlets 7 and 34 of the cylinder 9 by means of the pipes 5 and 6 through the valve 3. This valve is actuated by the handle 4 which has only two working positions and is the only control used in the operation of my invention. In one position valve 3 connects pipe 1 to pipe 5 and pipe 2 to pipe 6; in the other, pipe 1 to pipe 6 and pipe 2 to pipe 5.

The hydraulic mechanism of the device comprises a cylinder 9 having an outer head 8 through which the fluid port 7 communicates with the outer face 11 of the piston 10 and an inner head 32 through which the fluid port 34 communicates with the inner face 13 of the piston 10. The piston rod 15 passes through the inner cylinder head 32, leakage around it being prevented by a pressure seal comprising the U-shaped leather ring 36 held in place by the T-shaped metal ring 38 which is secured in a suitable annular recess in the head 32 by the screws 37. A number of holes 39 through the metal ring 38 provide a passage from the channelled face of the U-ring 36 to the inside of the cylinder 9. By means of this passage hydraulic pressure in the cylinder 9 is communicated to the channel of the U-ring 36, thus providing a pressure-seal around the piston rod 15. This piston rod is threaded at its outer end into the double acting piston 10, the inner and outer faces 11 and 13 of which are sealed by the cup leathers 12 and 14. The inner head 32 carries the horn 35 remov-

ably affixed to it by the set screw 33. This horn 35 surrounds the piston rod 15 which carries the connector sleeve 17 on its outer end. The horn 35 serves as a bearing for the sleeve 17 and is of sufficient length to permit that sleeve to have a free travel equal to the stroke of the piston 10 between the inner cylinder head 32 and the steel balls 29 set in the inner end portion of the horn itself.

The structure at the inner end of the horn 35 is of great importance in my invention and is shown enlarged in Figs. 2 and 3. The sleeve 17, threaded onto the piston rod 15, as shown at 16, connects the taper pin 19 of the expander proper to the piston 10. The inner end of the sleeve 17 is recessed as shown at 40 to permit it to clear the steel balls 29. These balls are inserted in the holes 41, here shown four in number, which are drilled radially in the walls of the horn 35 equidistant from its inner end. The diameter of the holes 41 is reduced at the bottoms thereof so as to prevent the balls 29 from passing through them but is kept sufficiently great to permit a substantial part of the balls 29 to protrude past the inside surface of the horn 35. The balls 29 are resiliently held in the bottoms of the holes 41 by the fingers 28 of the slit cylinder spring 27 fixed around the outside of the horn 35.

The outer end of the expander tube 24 carries the guide collar 23 threaded around it. This guide collar 23 is of slightly less outside diameter than the inside diameter of the horn 35, which serves as a bearing for it. At the extreme inner end of the horn 35 the horn cup 30 is removably affixed by the set screw 31. The set screw 31 bears against the collar 42 on the outer end of horn cup 30, this collar having an outside diameter proper to secure a snug fit inside the horn 35 and an inside diameter sufficient amply to clear the expander tube 24. The outer end of the collar 42 serves as a stop limiting the inward travel of the expander tube 24 by abutment against the piston guide 23.

The expander proper in the embodiment illustrated, consists of the expander tube 24 carrying at its inner end the longitudinally split expander head 25 and the taper pin 19 carrying on the threaded portion 22 at its inner end the adjustable stop 21. While I have illustrated my invention by a device employing this specific expander, it is to be understood that other pull-type expanders may be used, for example, with a diagonally slit expander head or with a single or double split-ring expander head.

Taking up the operation of my invention, when the device has been placed in the position shown in Fig. 1, with the expander head inside the heat exchanger tube 26 which is to be expanded into the tube sheet, the handle 4 of the valve 3 is turned to connect pipe 1 to pipe 5 and pipe 6 to pipe 2, admitting fluid under pressure to the inner face 13 of the piston 10 and permitting fluid in cylinder 9 outside the outer face 11 of the piston 10 to be discharged.

The pressure of this fluid on the forward face 13 of the piston 10 forces this piston rearward in the cylinder 9. The piston 10 draws with it, by means of the piston rod 15 threaded into it, the taper pin 19. The rearward motion of the pin 19, by wedge action of its tapered portion 20, operates to expand the slotted head 25 of the expander tube 24. This expansion continues until the adjustable stop 21 on the end of the taper pin 19 comes into contact with the forward

face of the head 25. The expander tube 24 is prevented from moving rearward during the expanding of its split head 25 by the resistance of the four steel balls 29 to the rearward motion of the piston guide 23 into which the expander tube 24 is threaded. These balls thus act upon the expander tube as stops or retarders. The pressure of the fingers 28 of the slit cylinder spring 27 is such that the resistance which the balls 29 offer to the rearward motion of the piston guide 23 is greater than the rearward force exerted on the expander tube 24 by the wedging action of the tapered portion 20 of the withdrawing pin 19, but by no means as great as the force exerted by the piston 10.

Thus, the tube 26 is expanded into the tube sheet at the point to which the expander head 25 reaches when the horn cup 30 is in position against the outer end of the tube 26. After the expander head 25 of the expander tube 24 has been fully expanded as described, the withdrawing of the taper pin 19 continues by reason of continued rearward motion of the piston 10 and the guide piston 23 forces open the steel balls 29. The now fully expanded head 25 passes rearward through the boiler tube 26 seating it securely the entire depth of the tube sheet. The whole tool is then withdrawn from the tube 26.

To reset the tool for expanding another tube of the same diameter into a tube sheet of the same thickness it is merely necessary to turn the handle 4 of the valve 3 to the position connecting supply pipe 1 to pipe 6 and discharge pipe 2 to pipe 5. Fluid pressure then forces piston 10 forward and discharges the fluid in cylinder 9 the inner face 13 of the piston. The motion of piston 10 carries piston rod 15 and taper pin 19 forward moving the expander tube 24 by contact between the inner face of the connector sleeve 17 and the outer face of the guide collar 23 until the moving parts of the tool are again in the position shown in Fig. 1. The forward motion of the piston 10 pushes the piston guide 23 past the balls 29 which drop into the recess 40 at the inner end of the connector 17 without any attention from the operator. Thus the entire cycle of operation is completed and the proper differential motion of the parts of the expander proper automatically secured by a simple two-position control.

When it is desired to adapt the tool for use with boiler tube of different diameter, it is only necessary to remove horn 35 by means of set screw 33 which holds it to the inner head 32 of cylinder 9, substitute a different expander proper, taper pin 19 and expander tube 24, and a different horn cup 30, all adapted to the new diameter, and reassemble the device.

The substitution of one expander mechanism for another is readily made by changing the connector 17 for one adapted at its inner end to receive the outer threaded portion 18 of the new taper pin and by changing the piston guide 23 for one adapted to receive the threads of the new expander tube. The outside diameter of the piston guide 23 and connector 17 remain the same and the operation of the device unaffected except for the diameter of the tube to be expanded.

If a different depth of tube sheet is presented, adjustment is made by removing horn cup 30 by means of set screw 31 and substituting a different horn cup of such a length that, when the moving parts of the device are positioned as shown in Fig. 1, the distance from expander head 25 to horn cup 30 is suited to the new tube sheet.

A particular advantage of my invention is that it provides a complete flexibility of range for the device without requiring any adjustment of, or interference with, the hydraulic portions of the actuating mechanism. Thus, when the cup leathers 12 and 14 of the piston 10 and the piston rod sealing leather 36 in the inner head 32 of the cylinder 9 are properly and satisfactorily fitted to give fluid tight joints, they are never disturbed by adjustments made to adapt the device from job to job.

Moreover, the structure of the hydraulic portion of the device is extremely simple. The complexity which might be introduced by the necessity of delaying the withdrawal of the expander tube 24 until the wedge 20 has fully expanded its head is entirely obviated by the employment of the steel balls 29 and spring 27. This feature of my invention provides a fully automatic means of securing the required relative position of expander tube 24 and taper pin 19 at all steps of the operation of the tool, both in expanding and in resetting.

It is to be understood that my invention is not limited to the details of construction illustrated and described, but includes all embodiments falling within the scope of the appended claims. In these claims, the meaning to be given to "inner" and "outer" and related terms is the same as that already defined and used in the foregoing specification.

I claim:

1. In apparatus for expanding and drawing a portion of a tube disposed in a tube seat formed in a wall of a pressure device, a mandrel having a tapered portion, an expansible tube drawing head mounted for relative longitudinal movement on the mandrel, a stop on the mandrel adjacent the larger end of said tapered portion, means for pulling the mandrel out of the tube after it has been so moved as to position the retracted head within the tube and at a position well beyond the outer end of the tube seat, and an automatically releasable retarder including spring pressed elements normally positioned in the path of movement of a retarder engaging element moving with the head and preventing said head from moving with the mandrel while said stop is approaching the head, the release of said retarder being produced when the longitudinal force of

the moving mandrel against the expander head overcomes the head retarding forces of the spring pressed elements of the retarder.

2. In apparatus for expanding and drawing a portion of a tube disposed in a tube seat formed in a wall of a pressure device, a mandrel having a tapered portion, an expansible tube drawing head mounted for relative longitudinal movement on the mandrel, a stop on the mandrel adjacent the larger end of said tapered portion, means for pulling the mandrel out of the tube after it has been so moved as to position the retracted head within the tube and at a position well beyond the outer end of the tube seat, and an automatically releasable retarder including spring pressed elements normally positioned in the path of movement of the head or a retarder engaging element moving therewith and preventing said head from moving with the mandrel while said stop is approaching the head, said spring pressed elements being structurally and functionally separate from said pulling means, the release of said retarder being produced when the longitudinal force of the moving mandrel against the expander head overcomes the head retarding forces of the spring pressed elements of the retarder.

3. In apparatus for expanding and drawing a part of a tube disposed in a tube seat formed in a wall of a pressure device, a mandrel having a portion tapered downwardly toward the adjacent end of the tube, an expansible tube drawing head mounted for relative longitudinal movement on the mandrel, a stop on the mandrel adjacent the larger end of said tapered portion, an operator pulling the mandrel out of the tube after the mandrel has been moved so as to position the retracted head within the tube and at a position well beyond the outer end of the tube seat, a retarder separate from the operator and including an element normally positioned in the path of movement of the head or a retarder engaging element moving therewith to prevent the head from moving with the mandrel until the head is effectively expanded, and means releasably mounting the retarder so that its release is effected when the longitudinal force of the mandrel against the expander head reaches a predetermined value.

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