This invention relates to pull-type tube expanders of the sort chiefly used to expand boiler and heat exchanger tubing 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 the ability to perform different jobs. A particular object of my invention is to provide a complete apparatus having the characteristics listed above, which embodiments of my present invention are 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 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 inlet 7 and 34 of the cylinder 3 by means of the pipes 8 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 8 and pipe 2 to pipe 6.

The hydraulic mechanism of the device comprises a cylinder 3 having an outer head 8 through which the fluid port 1 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 18 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 3. By means of this passage hydraulic pressure in the cylinder 3 is communicated to the channel of the U-ring 36, thus providing a pressure-seal around the piston rod 18. 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 39 remov-
ably affixed to it by the set screw 33. This horn 35 surrounds the piston rod 18 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 22 and the steel balls 28 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 18, as shown at 16, connects the taper pin 10 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 28. 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 28 from passing through them but is kept large enough to permit a substantial part of the balls 28 to protrude past the inside surface of the horn 35. The balls 28 are resiliently held in the bottoms of the holes 41 by the fingers 30 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 43 threaded around it. This guide collar 43 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 the 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 28.

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 10 carrying on the threaded portion 22 at its inner end the adjustable collar 17. I have within 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 25 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 discharge pipe 2 to pipe 6. 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 bears on the cylinder 9 and the tapered portion 10 of the expander head 25 forces the expander 24 past the balls 28 which drop into the recess 40 at the outer 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 22 of cylinder 9, substitute a different expander proper, taper pin 10 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 present, adjustment is made by removing horn cup 30 by means of set screw 34 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 38 in the inner head 32 of the cylinder 5 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, as variations and modifications 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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