TUBE EXPANDER, INCLUDING A REVERSE ROLLING CHUCK

Harold C. Mathews, Springfield, Ohio, assignor to The Airetool Manufacturing Co., Springfield, Ohio, a corporation of Ohio

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This invention relates to a reverse rolling chuck and more specifically to a reversible chuck and a tube expander in combination.

This application is related to my co-pending application, Serial No. 184,743, filed September 14, 1950, issued March 6, 1956, as Patent No. 2,736,050, and assigned to the same assignee as the present invention.

In my co-pending application there are described a method and apparatus for effecting the expansion of tubes into secure engagement with the tube sheets of condensers, heat exchangers and similar devices. In accordance with the method described therein the cage of the tube expander is inserted into the tube to be expanded and a mandrel is passed through the cage and rotated to cause radial movement of the expansion rollers which engage the tube and tension the same prior to the secure engagement of the tube with the seat of the tube sheet; the reaction of the rolls on the walls occasions this tensioning. When the mandrel is further rotated to cause the tube to expand the tube sheet metal flow occurs in both axial directions in the tube, and that metal flow which normally would place the tube under a compressive stress is offset by the initial tensioning referred to above. Thereafter the mandrel and cage are latched together against relative axial movement and the mandrel and cage together are rotated in a reverse direction out of the tube to complete the uniform tube expansion.

This invention contemplates an improved structure for effecting the above noted procedure and is directed to a particular structure in which the cage is readily latched against axial movement upon reversal of rotation of the mandrel.

It is also an object of this invention to provide a novel reverse rolling chuck which is particularly useful in conjunction with a tube expander.

It is an important object of this invention to provide a structure for tube expansion, which structure may be readily supported in the hands of an operator as substantially no rotation of heavy metal parts is involved in the operation.

These and other allied objectives of the invention are attained by providing a reverse rolling chuck having a pair of concentric sleeves which are relatively slidable and rotatable, one of the said sleeves having retaining means on a portion of the periphery thereof and the other said sleeve having latching means extending from a surface thereof, the said retaining means and latching means being cooperate upon relative rotation of the sleeves to permit rotative movement of the sleeves. Means are provided to limit the rotative movement of the sleeves and one of the sleeves is provided with cage-retenant means for a cage of a tube expander, the cage being rotatable with respect to the sleeve and longitudinally movable therewith.

To a power source is provided to which a tapered mandrel of the tube expander device may be suitably secured, the mandrel passing through the inner of the concentric sleeves and through the cage to engage radially movable rollers positioned at the outer extremity of the cage. This power source, one sleeve and the mandrel are latched together against relative axial movement; since the cage and the other sleeve are also latched against relative axial movement, the latching of the two sleeves together prevents relative axial movement of the cage and mandrel.

In the operation of this structure an operator grasps the outer sleeve with one hand and the power source with the other and moves one sleeve relatively to the other to position the rollers of the cage within a tube to be expanded; the operator then urges the mandrel forward to engage the rollers of the cage and in this operation the motor held in the hand of the operator is moved forward with the mandrel and is adapted to provide power thereto. The rolls themselves extend at an angle to the axis of the mandrel and are self-fed and as they grip the tube the same is tensioned; as further expansion takes place the tube contacts the tube seat of the wall into which the tube is being secured and the tube is thereby pressured against the seat. At this time the concentric sleeves are still in a relatively slidable position.

The operator then reverses the direction of rotation of the mandrel, or the same is reversed automatically at a predetermined pressure on the tube, and the sleeves are caused to rotate relatively one to the other (about ¾ turn) to the latching position and the cage which is secured to one of the sleeves is thereby restrained against axial movement. Thereafter, the operator with his hand upon the outer sleeve, which is stationary, continues to operate the motor to drive the mandrel in the said reverse direction and to rotate the expander as a whole out of the tube, uniformly expanding the same.

The invention will be more fully understood by reference to the following detailed description and accompanying drawings wherein:

Figure 1 is an elevational view partially in section illustrating a structure of the invention positioned in a tube to be expanded with the outer sleeve moved forwardly on the inner sleeve;

Figure 2a is an enlarged fragmentary and exploded view, partially in section, of the structure of Figure 1;

Figure 2b is an enlarged fragmentary and exploded view similar to that of Figure 2a but illustrating the apparatus with the inner sleeve and mandrel moved forwardly in the outer sleeve and with the apparatus expanded against an interior portion of the tube and the tube expanded against the tube seat at the interior portion, the sleeves being latched against relative longitudinal movement;

Figure 2c is an enlarged fragmentary and exploded view similar to Figures 2a and 2b but illustrating the expander in the expanded condition with the sleeves locked against relative longitudinal movement and with the tube almost completely expanded against the tube seat over its length as the apparatus is being withdrawn from the tube seat;

Figure 3 is a sectional view of a reverse rolling chuck in accordance with the invention, the chuck being in the unlatched position and with the outer sleeve fully retracted on the inner sleeve;

Figure 4 is a sectional view taken on line 4—4 of Figure 3;

Figure 4a is a sectional view taken on line 4a—4a of Figure 4;

Figure 5 is a view of a novel reverse rolling chuck in accordance with the invention the chuck being in a latched position and with the outer sleeve advanced forwardly on the inner sleeve with respect to the structure of Figure 3;

Figure 6 is a view taken on line 6—6 of Figure 5;
Figure 6a is a sectional view taken on line 6a—6a of Figure 6.

Figure 7 is a perspective view of the latch insert of the reverse rolling chuck of the structure of invention; and Figure 8 is a sectional view taken on line 8—8 of Figure 1.

Referring to the drawings and particularly Figure 1 there is indicated at 1 a wall of a tube sheet having a seat 3 in which a tube 5 is positioned, and for convenience it may be assumed that the remote end of the tube (not shown) has already been secured in an opposed shoulder and that the action of securing the end shown is about to be initiated.

Shown within the tube 5 adjacent the inner side of wall 1 is a head portion 7 of a cage 9 which head houses three radially movable rollers 11; the rollers extend at an angle with the axis of the cage 9 and seat within the slots (Figure 2a) which are somewhat narrower at their outer ends than the rollers (Figure 8) to prevent the rollers leaving the slots while yet providing for considerable axial movement of the rollers.

The rollers 11 are bevelled on their inner ends 15, 16 to avoid formation of spiral ridges on tube 5 when pressure is applied and are also slightly tapered between the bevelled ends to match the taper of a mandrel 19 which extends completely and axially through the cage 9 to cause the rollers to move radially when the structure is employed. The mandrel 19 is provided at the right hand end (Figure 1) with a nut 21 which prevents the mandrel from being completely drawn within cage 9.

The outer periphery of cage 9 is threaded as at 23 and receives thereon a conventional stopper having a stationary portion 25 and a portion 28 rotatable with respect to portion 25; portion 28 is secured by a set screw 30 in the longitudinal flat 31 of the cage 9 and accordingly rotates with the cage. Bearing 34 provides for relative rotation of the portion 28 with respect to the portion 25 and a C ring 32 retains the two portions together. Portion 25 has a cutout portion 27 adapted to receive an extruded metal from the tube 5 in the course of the expanding operation; other similar conventional arrangements for the same purpose may be employed as, for example, the bearing housing 33 itself now to be described.

The rear end of cage 9 extends into bearing housing 33 wherein ball bearing 39, retained in the housing by depending portion 37, provides for rotatable support of an internally threaded collar or cage-retainment means in which the cage 9 is secured (Figure 2a); a screw 40 passing through cage-retainment means 43 engages the cage 9 and the cage 9 is thus held that it may rotate freely while it axially fixed with respect to the cage-retainment means.

The bearing housing 33 is threaded onto an outer or latching sleeve 45 which is concentric with an inner rack or ratchet sleeve 47 and is slidable and rotatable relative thereto.

The inner sleeve 47 at the left hand end (Figure 3) is flanged at 44 and is threadedly secured in a nut 46; nut 46 also receives a threaded stationary nose 83 (Figure 3) of a motor 77 having a forward portion 81. The nose is drawn tightly against flange 44 and recesses are provided at 48 for receiving a Spanner wrench which is of assistance in securing the assembly together; gasket 42 is suitably provided between the flange 44 and nut 46. A motor bearing or suitable bearing 85 may be provided for rotation of motor shaft 75 with respect to nose 83.

The outer sleeve 45 at the left hand end (Figure 3) has integral therewith a peripherally slotted collar 53, the slot 55 of which receives a substantially circular retaining spring 57. The collar 53 has cutout portions on opposite diameters thereof to slide and receive identical plugs 59, 61 (Figure 4) which plugs are slotted as at 63 (Figure 7). The plugs 59, 61 so engage the collar that the slotted portions 63 thereof form with the slot 55 a continuous peripheral slot in which the said spring 57 is received.

The lower ends of the plugs 59, 61 are respectively provided with ratchet bosses 69, 71 which extend slightly below the inner surface 73 of the outer sleeve to engage the longitudinally extending ratchet bosses 51, 52 respectively, of the inner sleeve as shown in Figures 2a, 2b and 6 and 6. The bosses may be disengaged by relative rotative movement (about 1/4 turn) of the sleeves to the position shown in Figure 4.

A pin 65 extends from the lower surface of the sleeve 45 and is received in a longitudinal slot 49 of the inner sleeve, which slot is substantially co-extensive with the lower surface of the bosses 51, 52; the pin is of a lesser diameter than the width of the slot and traverses between the walls thereof when the sleeves are relatively rotated to provide a stop means against excessive rotation.

Referring again to Figs. 1, 2a, 2b and 2c the mandrel 19 is received freely within the cage 9, passes through the bearing housing 33, and is engaged by the pin 66 of chuck 67 on rotatable shaft 75 of motor 77; the motor 77 is preferably a conventional rotatable unit suitably constructed for holding in the hand. Rightward movement of the inner sleeve 45 and mandrel 19, therefore, from the position shown in Figure 4, the inner sleeve 47 and shaft 75 is limited by the collar 42 and cage locking ring 43 when the outer sleeve 45 is in its most leftward position as viewed in Figure 3.

In operation the assembly is initially positioned as shown in Figure 1 and Figure 2a with the expandable rollers in the tube 5 and adjacent the inner wall of the tube sheet 1. This positioning is effected by rotating the sleeves 45 and 47 respectively, to the position shown in Figure 4, and sliding the sleeve 45 and cage 9 forwardly on the inner sleeve 47. It is to be noted that in Figure 4 the plugs 59, 61 are shown out of engagement with their respective ratchet bosses 51, 52 and thus the sleeve 45, 47 are, in this position, relatively slidable. This is more clearly shown in Figure 4a wherein the plug 59 carrying the ratchet boss 69 is out of engagement with the ratchet boss 51. Also as shown in Figure 6e the ratchet boss 59, depressed by the action of the spring 57, has the ratchet boss 69 in engagement with the longitudinally extending ratchet boss 51 of the inner sleeve.

The stop member 25, having cut-out portion 27 is then moved into position against the outer walls of the tube sheet and serves to prevent the entry of the cage, to which it is secured, into the sheet during the operation. With the operator holding the outer sleeve 45 in one hand and the motor or power tool 77 in the other, the operator moves the motor, inner sleeve 47 and mandrel 19 forward as a unit to position the rollers 11 in contact with the mandrel within the tube 5. The operator then applies power to the shaft 75 and this causes tapered mandrel 19 to rotate in contact with the rollers and the tapered mandrel is forced forward due to the self-feeding angle at which the rollers engage the mandrel; the mandrel thus passes into the tube between the rollers causing the rollers to expand; the rollers themselves as they expand into secure contact with the tube wall tend to feed into the tube and to carry the cage along. The rotation is prevented by the engagement of stop 25 with the tube sheet. Accordingly as the rollers expand into the engagement with the unseated tube the reactions of the rollers on the tube cause the tube to be drawn leftwardly with the result that a tension is placed upon the tube itself as expansion continues. Such initial tensioning sometimes may cause leftwardly and occurs prior to the secure engagement of the tube 5 in the tube sheet 3, which secure engagement is illustrated in Figure 2b.

As rotation of the mandrel (to form the secure engagement) continues (in a clockwise direction) expansion of the rollers continues and the mandrel is forced securely against the tube sheet 3 thus causing metal flow leftwardly and rightwardly in the tube 5 (Figure 1). This flow occurs due to the pressure of the rollers on the tube
which latter is now supported by the wall of the tube sheet defining the tube seat. The compressive stress exerted by this rightward flow of metal, which would normally place the seated tube under compression, is offset by the initial tensioning referred to hereinbefore and the tube becomes firmly engaged in the seat (Figure 2b).

It is to be noted that when the mandrel is rotated in a clockwise direction the rollers tend to rotate in an anti-clockwise direction and the cage rotates in a clockwire direction also. The cage 19 however is restrained from movement through the tube by stop member 25, but is not restrained from rotation in this operation. When the tube has been expanded against the inner end of the seat of the tube sheet the motor is stopped, the outer sleeve is given a 1/4 turn to latch the sleeves together axially and the operator while still holding the outer sleeve 45 in his hand reverses the direction of rotation of the motor 77, thus reversing direction of rotation of the mandrel. This causes reversal of rotation of the rollers, and the cage now rotates in the same counterclockwise direction as the mandrel; since the whole assembly is latched together axially by the axially latched sleeves and since direction of rotation is such as to self-feed the mandrel and cage out of the tube the whole assembly will self-feed outwardly expanding the tube 5 as it does so.

It will be noted that when the sleeves were rotated to the latched position the pin 65 traversed rightwardly from the position shown in Figure 4 to the position of Figure 6 to allow the relative rotative movement of the sleeves.

It is to be noted that as the axial displacement of the metal of the tube 5 is carried toward the mouth of the tube by the retraction of the expanding unit, the elongation of the tube is in the same direction; the operation thus avoids axial compressive stresses.

There has thus been described a novel chuck and a novel arrangement of a chuck and tube expander which provides for uniform tube expansion with a minimum of effort on the part of an operator for he may readily support the whole unit in his hands during the complete operation.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. In a tube expander device a reverse rolling chuck comprising a pair of concentric relatively rotatable and axially slidable sleeves having means thereon operable upon rotation of the sleeves to latch the sleeves together against relative axial movement, a motor secured to one of the sleeves and having a shaft thereof extending internally of the sleeves, a cage-retaining means axially latched to the other of said sleeves and rotatable with respect thereto, a cage secured in the said cage-retaining means, and a mandrel passing through said cage into said sleeves and secured to the shaft of said motor.

2. In a tube expander device a reverse rolling chuck comprising a pair of concentric relatively rotatable and axially slidable sleeves having means thereon operable upon rotation of the sleeves to latch the sleeves together against relative axial movement, a motor secured to the inner of said sleeves and having a shaft thereof extending internally of the sleeves, cage-retaining means axially latched to the outer of said sleeves and rotatable with respect thereto, a cage secured in the said cage-retaining means, and a mandrel passing through said cage into said sleeves and secured to the shaft of said motor.

3. In a tube expander device, in combination a pair of concentric relatively rotatable, axially slidable sleeves having means thereon cooperation upon relative rotation of the sleeves to latch the same together against relative axial movement, a cage axially latched in a said one of said sleeves at an end thereof and rotatably mounted with respect to the sleeve, a mandrel extending through the cage into the sleeves, and a motor secured to the second one of the sleeves and axially movable therewith with respect to the first sleeve, a shaft of said motor extending internally of said sleeves and having the inner extremity of said mandrel secured thereto.

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