Oct. 23, 1956 H. C. MATHEWS 2,767,766

TUBE EXPANDER, INCLUDING A REVERSE ROLLING CHUCK

Filed July 2, 1953 3 Sheets-Sheet 1

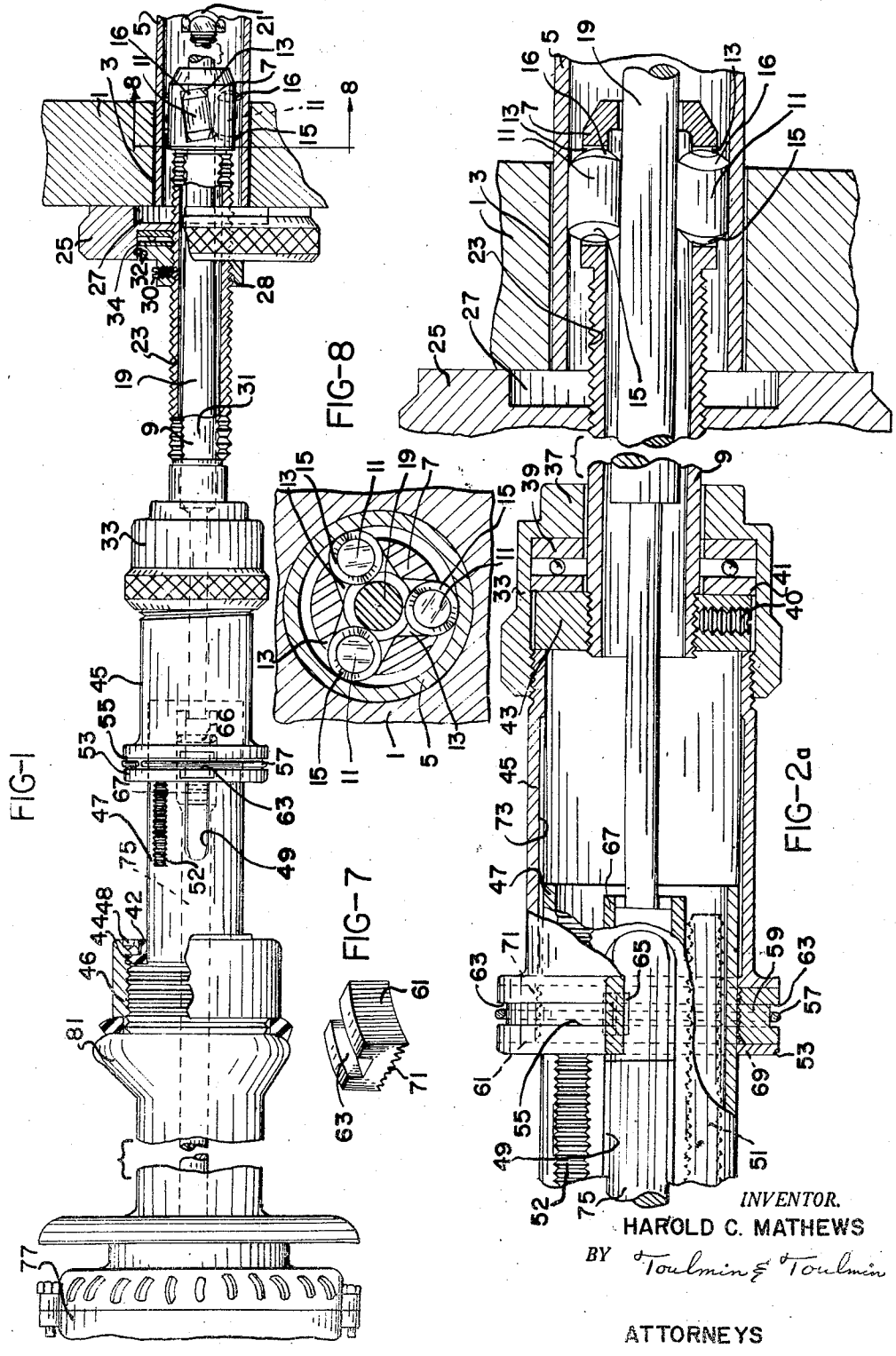


FIG-1

FIG-8

FIG-7

FIG-2a

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TUBE EXPANDER, INCLUDING A REVERSE ROLLING CHUCK

Filed July 2, 1953 3 Sheets-Sheet 2

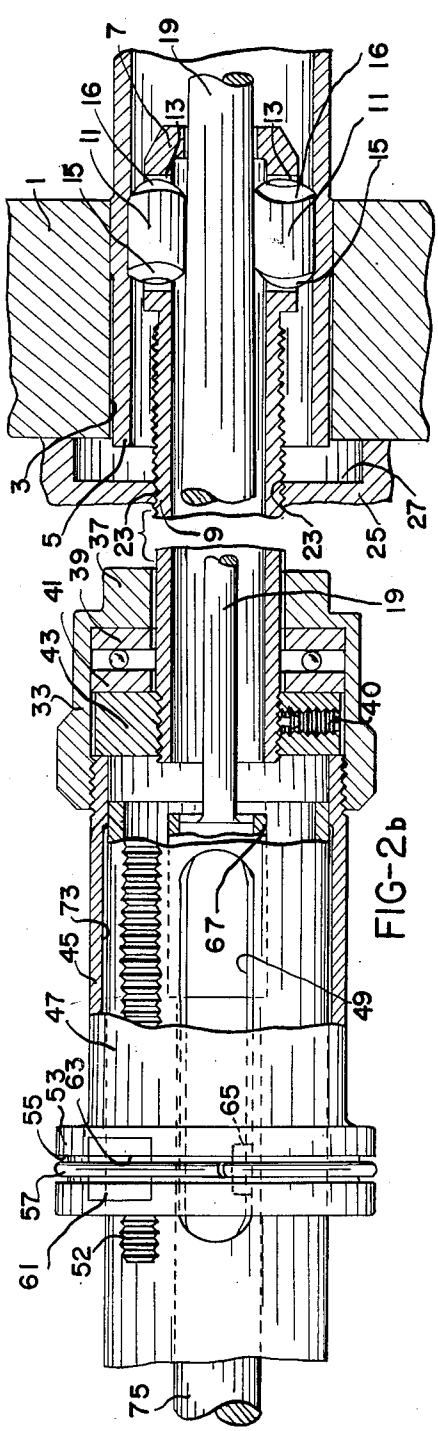


FIG-2b

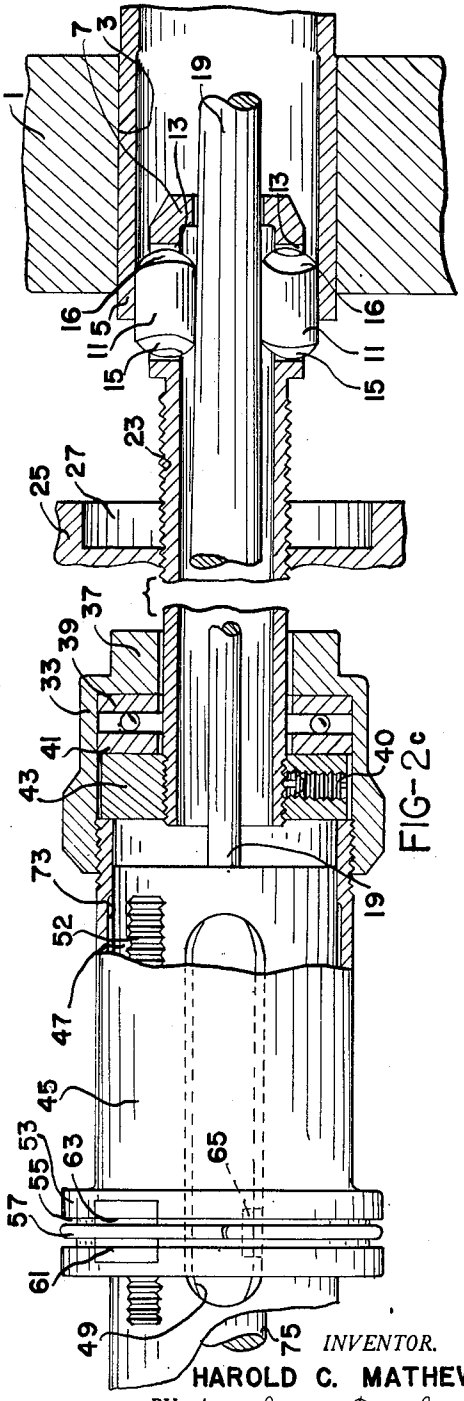


FIG-2c

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TUBE EXPANDER, INCLUDING A REVERSE ROLLING CHUCK

Filed July 2, 1953 3 Sheets-Sheet 3

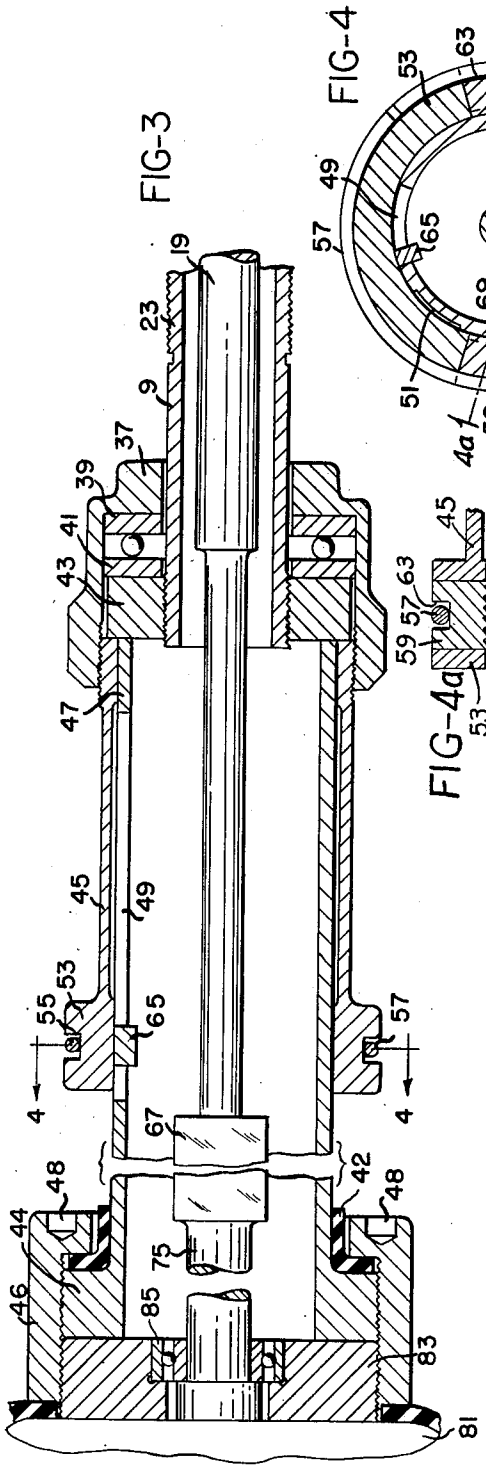


FIG-3

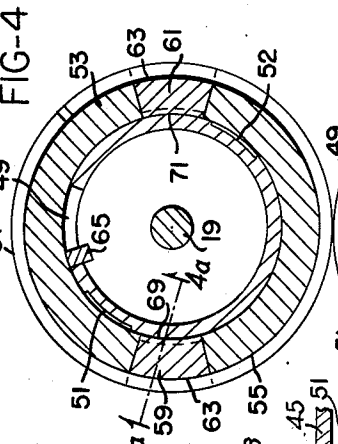


FIG-4

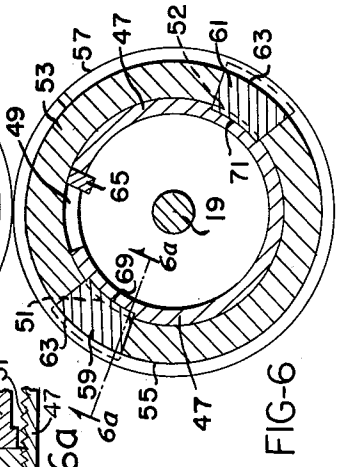


FIG-6

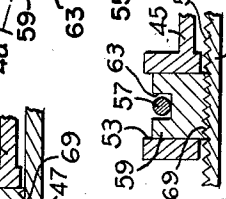


FIG-6a



FIG-4a

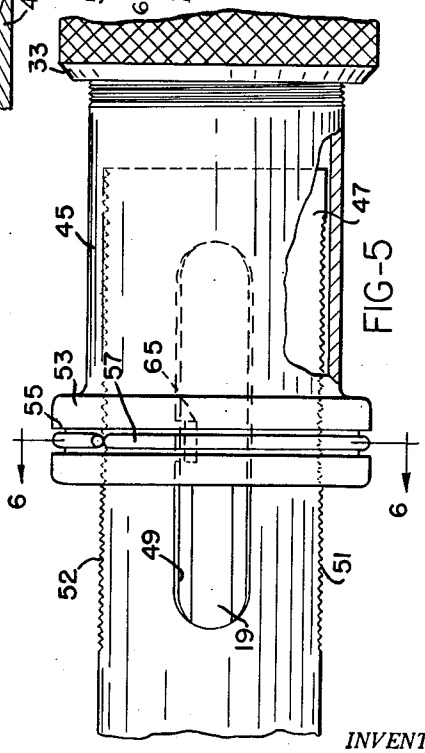


FIG-5

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2,767,766

# TUBE EXPANDER, INCLUDING A REVERSE ROLLING CHUCK

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Application July 2, 1953, Serial No. 365,629

3 Claims. (Cl. 153—82)

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. 2,736,950, 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 cooperable upon relative rotation of the sleeves to prevent relative longitudinal movement of the sleeves. Means are provided to limit the rotative movement of the sleeves and one of the sleeves is provided with cage-retaining means for a cage of a tube expander, the cage being rotatable with respect to the sleeve and longitudinally movable therewith.

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

Figure 2*b* is an enlarged fragmentary and exploded view similar to that of Figure 2*a* 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 2*c* is an enlarged fragmentary and exploded view similar to Figures 2*a* and 2*b* 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 4*a* is a sectional view taken on line 4*a*—4*a* 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 6*a* is a sectional view taken on line 6*a*—6*a* 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 sheet 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 **13** (Figure 2*a*) 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 radial movement of the rollers.

The rollers **11** are beveled on their inner ends **15**, **16** to avoid formation of spiral ridges on tube **5** when pressured thereagainst and are also slightly tapered between the beveled 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 stop member having a stationary potrion **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 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-retaining means **43** in which the cage **9** is secured (Figure 2*a*); a screw **40** passing through cage-retaining means **43** engages the cage **9** and the cage **9** is thus held that it may revolve freely while it it axially fixed with respect to the cage-retaining 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 frame 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 slidingly 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 2*a*, 2*b*, 2*c*, 5 and 6. The bosses may be disengaged by relative rotative movement (about ⅛ 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 (Figure 5) with 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, 2*a*, 2*b* and 2*c* 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 motor **77**, frame portion **81**, mandrel **19**, inner sleeve **47** and shaft **75** is limited by the collar or 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 2*a* with the expansible 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** relatively, 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 sleeves **45**, **47** are, in this position, relatively slidable. This is more clearly shown in Figure 4*a* wherein the plug **59** carrying the ratchet boss **69** is out of engagement with the ratchet boss **51**. Also as shown in Figure 6*a* 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 fed forwardly 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, but such action 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 occasions metal flow leftwardly and occurs just prior to the secure engagement of the tube **5** in the tube seat **3**, which secure engagement is illustrated in Figure 2*b*.

As rotation of the mandrel (to form the secure engagement) continues (in a clockwise direction) expansion of the rollers continues and the tube **5** is forced securely against the tube seat **3** thus causing metal flow both 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 5 becomes firmly engaged in the seat (Figure 2*b*).

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 9 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 ⅛ 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 limit 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 adopt 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 cooperable upon relative rotation of the sleeves to latch the same together against relative axial movement, a cage axially retained in a first 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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