Aug. 25, 1953 F. E. DUDLEY 2,649,889

TUBE EXPANDING

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Fig. 1.

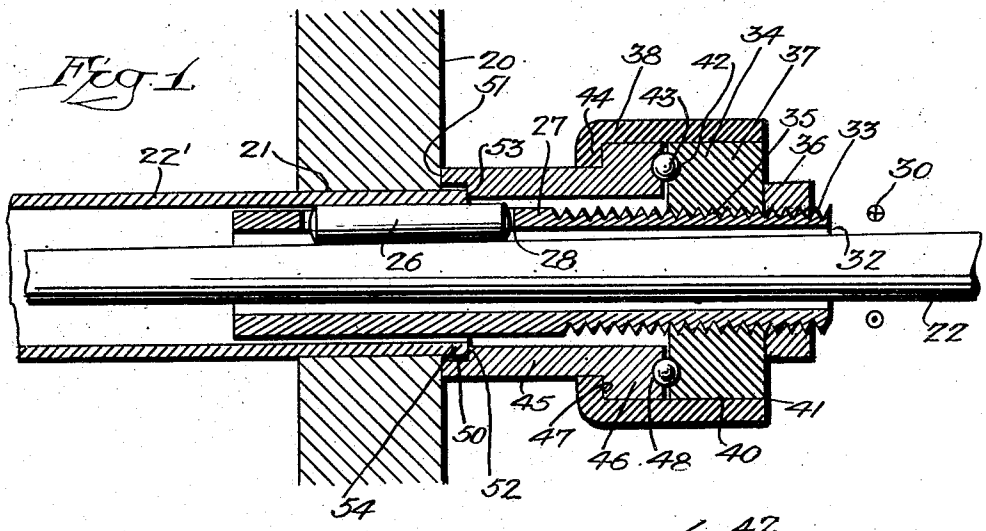


Fig. 2.

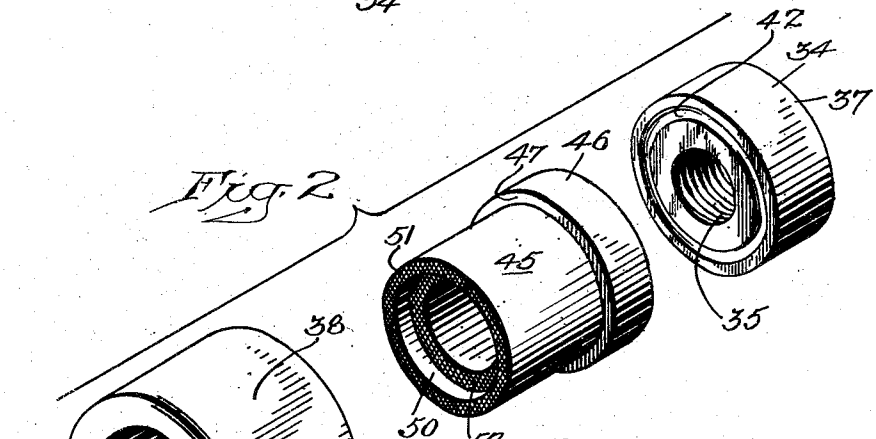
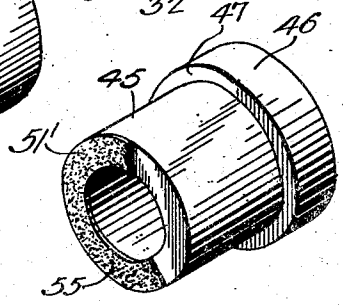


Fig. 3.



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Fig. 4.

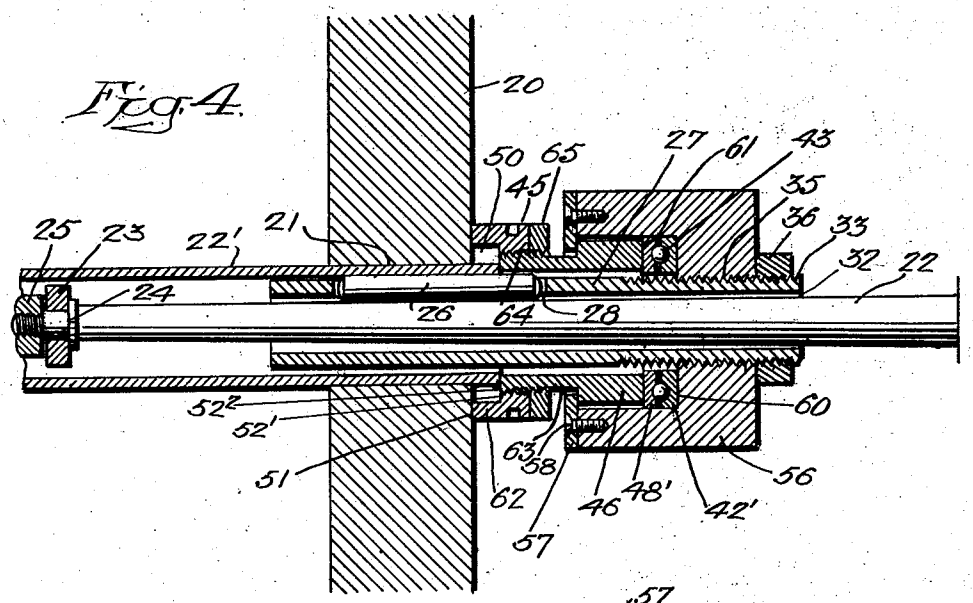


Fig. 5.

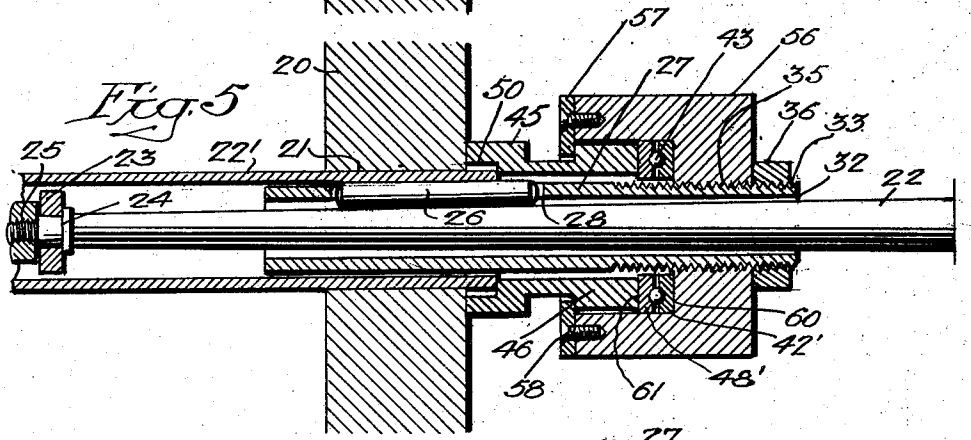
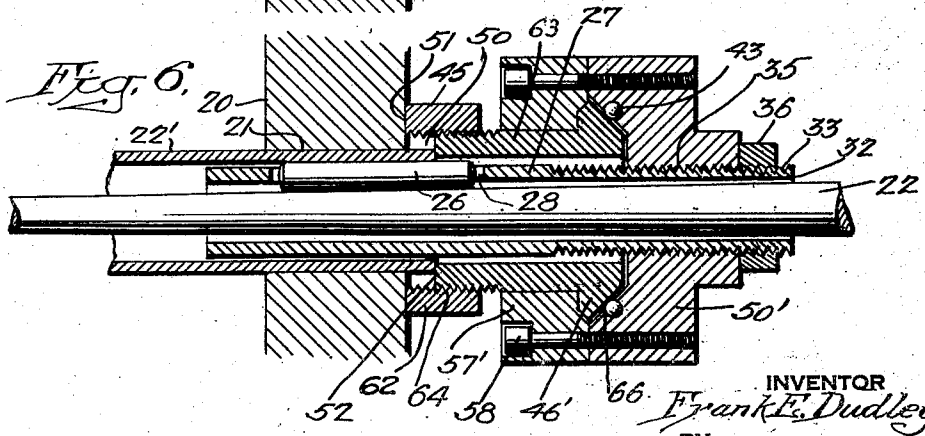


Fig. 6.



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Fig. 7

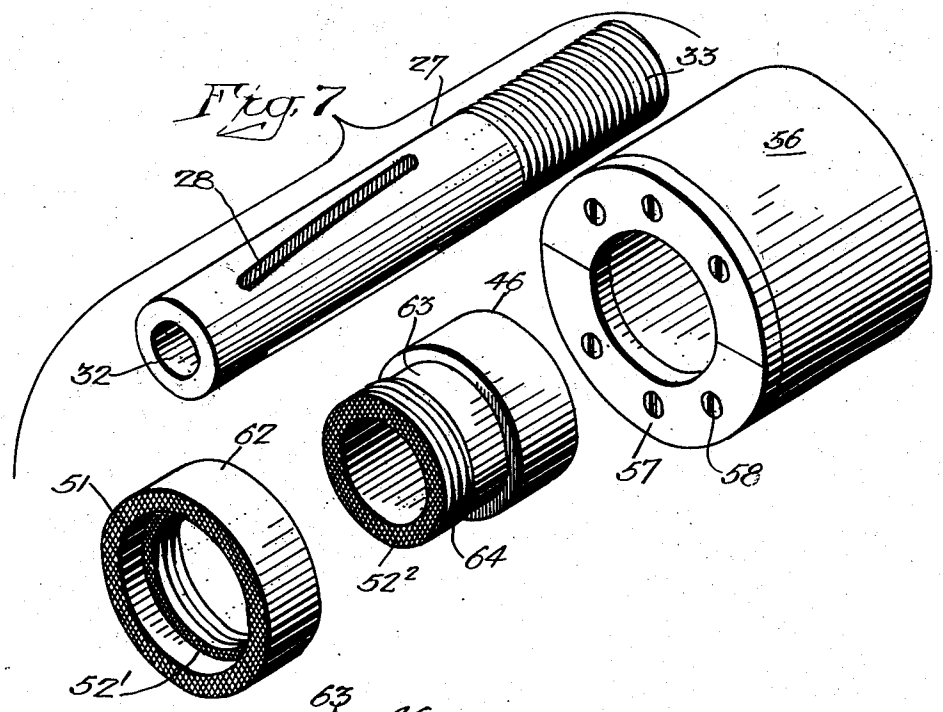
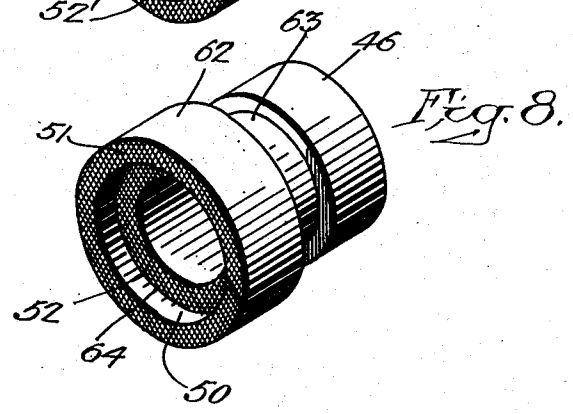


Fig. 8.



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UNITED STATES PATENT OFFICE

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TUBE EXPANDING

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Application March 30, 1948, Serial No. 18,006

4 Claims. (Cl. 153—82)

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The present invention relates to processes of expanding tubes of heat exchangers and the like and to tube expanding tools.

A purpose of the invention is to simplify the problem of holding heat exchanger tubes against rotation during rolling, and to avoid the cold working of such tubes of the cooperating faces of the tube sheets and also to avoid enlargement of the tube sheets incident to rotation of the tubes during rolling.

A further purpose is to permit automatic positioning of the tube with respect to overhang beyond the tube sheet without requiring separate gaging of the overhang, by self feeding the tube outwardly to a distance determined by a recess in the stop collar.

A further purpose is to make the stop collar recess adjustable to vary the extent of overhang produced by self feeding.

A further purpose is to employ a recess stop collar and to knurl the end of the recess and preferably also the end of the stop collar radially outside of the recess, so that the recess and the knurling will position the tube as to overhang and will grip the tube against rotation.

A further purpose is to simplify and cheapen the construction of tube rolling tools by providing a flange on the forward edge of the housing and a shoulder on the stop collar to engage the flange.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate a few only of the various embodiments in which my invention may appear, choosing the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a diagrammatic fragmentary longitudinal section of a tube rolling tool in position against the work.

Figure 2 is a detached perspective of components of the tube expander as shown in Figure 1.

Figure 3 is a fragmentary perspective of a variant in the stop collar.

Figures 4, 5 and 6 are diagrammatic fragmentary longitudinal sections of variant forms of expander in accordance with the invention.

Figure 7 is an exploded perspective of components making up the expander of Figure 4.

Figure 8 is a detailed perspective of the stop collar employed in the form of Figure 4.

Describing in illustration but not in limitation and referring to the drawings:

In Figures 1 and 2 I illustrate a portion of a

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heat exchanger having a tube sheet 20, a tube opening 21 and a tube 22' about to be expanded. The tool or expander comprises a suitable tapered mandrel 22 mounted in an electric tap gun or the like (not shown) and carrying at its forward end (shown only in Figures 4 and 5) a guide roller 23 rotatable between a shoulder 24 and a nut 25 threaded to the mandrel.

As well known in the art, the actual expanding is accomplished by expanding elements, suitably tapered rollers 26 (Figure 1, only one of which is shown), larger at the forward end, which are rotated oppositely to the rotation of the mandrel and pressed out against the interior of the tube. The rollers are conveniently circumferentially and longitudinally positioned by a tubular cage 27 having slots 28 (only one of which is shown). As well known in the art, the slots radially converge to prevent the rollers from dropping out of the cage.

The expander as shown is intended for clockwise rotation of the mandrel as suggested by the arrow 30, and the rollers are supported in the cage in a position inclined or canted with respect to the axis as shown in Figure 7, in a direction to make them tend to feed endwise rearwardly or toward the adjoining open end of the tube. This will be evident when it is appreciated that the expander rollers are rotating oppositely from the mandrel (that is, counterclockwise) and the longitudinal component of the force exerted by the expander rollers will tend to pull the tube out of the tube sheet and conversely will tend to pull the expander into the tube (the former tendency being opposed by the pressure applied forwardly by the operator). This self feeding feature is used in the present invention to provide positioning and gripping of the tube.

The cage is suitably longitudinally interiorly bored at 32 to pass the mandrel and the rearward end is conveniently exteriorly threaded at 33 to engage a housing 34. The housing is interiorly threaded at 35 and a lock nut 36 secures the cage.

The housing is suitably made of separate components, the rear in Figure 1 being formed of a metallic flange or disc 37 and the exterior and forward portion comprising a sleeve 38. The sleeve is suitably permanently joined to the flange, as by providing a press fit at 40 and rolling the edge at 41.

Within the housing, the forward end of the flange 37 has an annular bearing race 42 which receives ball bearings 43.

The forward end of the sleeve 38 is conven-

iently inwardly flanged at 44. The sleeve 38 is a forward housing element, secured to the rearward element 37 and the forward housing element 38 extends forwardly of the rearward element and extends radially inward near the front of the housing. Within the flange and sleeve is held in rotatable position a stop collar 45 having near its rearward end an outer annular flange 46 and a shoulder 47 engaging the flange 44 on the sleeve of the housing. The rearward end of the stop collar has a bearing race 48 which cooperates with the race 42 in engaging the roller bearings 43.

The forward end of the stop collar is recessed at 50, providing a forward engaging surface 51 which is of larger diameter than the tube and contacts the tube sheet and an end 52 of the recess which is partly of the same diameter as the tube and contacts the end 53 of the tube 22'. The end 52 of the recess is rough, preferably due to knurling as shown, so that it will tend to prevent relative rotation between the tube and the stop collar. The forward end 51 of the stop collar is of larger diameter and therefore acts on a larger lever arm to prevent rotation, so that knurling is less necessary, but in the preferred embodiment the forward end 51 of the stop collar is also rough, for example due to knurling.

It will be seen that the tube can be set in the tube sheet without any special care to determine the exact overhang and the expander inserted in the tube and set to work. If the tube is too far out as initially set, it will be pushed in until it overhangs at 54 by an amount equal to the depth of the recess 50. If the overhang as originally set is too small, the self feeding of the expanding elements or rollers will immediately pull the tube out endwise until, through determination of the correct depth of the recess 50, the correct overhang will be immediately assured. The desired overhang will be maintained throughout the rolling operation, and, after the rolling operation is complete, the overhanging end, if on the inflow side, can be flared or belled in accordance with standard practice. It is merely necessary to have the correct depth of recess on the stop collar. For example, if the overhang is to be $\frac{1}{16}$ inch the stop collar depth should be $\frac{1}{16}$ inch, and if the overhang is to be $\frac{1}{8}$ inch the recess in the stop collar should be $\frac{1}{8}$ inch deep. In accordance with this procedure either the inlet or outlet end can be rolled first and still the correct overhang will be assured.

Errors in overhang are not likely to occur, because the self feeding action exerts a strong longitudinal pressure by the tube against the bottom of a stop collar recess and any slight burr or irregularity is not likely to interfere with firm seating of the tube in the recess under the self feeding action of the expander.

The roughness on the end of the recess and also on the forward end of the stop collar assures gripping of the stop collar by the tube sheet under the pressure applied by the operator, and gripping of the end of the tube by the end of the stop collar recess under the self feeding pressure due to the inclination of the rolls with respect to the mandrel axis. The tube is in this way secured against rotation.

The roughness on the end of the stop collar may be employed to prevent rotation even though it is not desired to have overhang and even though no recess is used in the end of the stop collar. This is illustrated in Figure 3 where the end 51' of the stop collar extends straight across without a recess and engages the tube sheet and also the end of the tube. The desired roughness in this case is obtained by affixing an abrasive layer 55 on the end of the stop collar, for example by cementing on sand or Carborundum paper as shown.

A somewhat variant form of housing may be employed as shown in Figures 4 and 5, where the housing is made up of a cup member 56, which is threaded on the cage and a forward split flange or ring 57 secured thereto by screws 58. The bearing in this case is provided with separate races 42' and 48' which are positioned between an end seat 60 in the cup and an end wall 61 on the stop collar. The stop collar is in this form outwardly flanged at 46 as elsewhere described.

As shown in Figure 4 the depth of the stop collar recess is made adjustable as best seen in Figure 7, by separating the forward end ring 62 of the stop collar from the body 63, threadedly interconnecting the two at 64 and providing the roughness due to knurling at the forward end 51, at the surface 52' in the end of the recess radially outward of the body and at the surface 52^2 in the effective end of the recess at the end of the body. As seen in Figure 4, the end of the tube is gripped by the end of the recess 52^2. Provision is made for locking the two parts of the stop collar in adjusted position by a lock nut 65.

As shown in Figure 5, the housing construction of Figures 4 and 7 can be applied without an adjustable stop collar recess, in this case employing a stop collar recess of a different but invariable length.

A variant housing construction is shown in Figure 6, in which the cup portion 50' is shortened, the forward ring portion 57' is thicker and the bearing surfaces are set diagonally as shown at 66. The radial outer flange 46' of the stop collar is accordingly varied. This form is equipped with a variant adjustable stop collar, which is shown in Figure 8 as applied to the form of Figure 4. In this case the forward ring 62 carries the forward roughened end 51 and the line of threading 64 is exactly at the outer diameter of the recess so that the knurling on the end of the recess at 52 is entirely on the end of the body 63.

It will be evident that some of the various forms of stop collars are interchangeable.

It has been found in practice that the invention greatly reduces the labor and increases the uniformity of rolling heat exchanger tubes and the like.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the process or structure shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a tube expander for expanding a tube in a tube sheet, a mandrel tapering from a larger rear end to a smaller forward end, expanding elements surrounding and engaging the mandrel, a cage around the mandrel, recessed to retain the expanding elements, and having a rearward portion toward the larger end of the mandrel with respect to the expanding elements, a housing around the rearward portion of the cage comprising a rearward housing element which engages the rearward portion of the cage

and is fixed in a particular position with respect thereto, and a forward housing element secured to the rearward element which forward housing element extends forwardly of the rearward element and extends radially inwardly near the front of the housing, a bearing engaging the forward face of the rearward element, a stop collar around the cage in front of the housing, extending rearwardly into the housing and engaging the bearing on the opposite side of the bearing from the engagement by the rearward element, having a forward shoulder inside the housing which forwardly engages the radially inwardly extending portion of the forward element of the housing, and extending forwardly beyond the housing to engage the tube sheet.

2. In a tube expander for expanding a tube in a tube sheet, a mandrel tapering from a larger rear end to a smaller forward end, expanding elements surrounding and engaging the mandrel, a cage around the mandrel, recessed to retain the expanding elements, and having a rearward portion toward the larger end of the mandrel with respect to the expanding elements, a housing around the rearward portion of the cage comprising a rearward housing element which engages the rearward portion of the cage and is fixed in a particular position with respect thereto and a forward housing element secured to the rearward element which forward housing element extends forwardly of the rearward element and extends radially inwardly near the front of the housing, a bearing engaging the forward face of the rearward element, a stop collar around the cage in front of the housing, extending rearwardly into the housing and engaging the bearing on the opposite side of the bearing from the engagement by the rearward element, having a forward shoulder inside the housing which forwardly engages the radially inwardly extending portion of the forward element of the housing, extending forwardly beyond the housing, having an annularly recessed end and having positive roughening at the extreme forward surface of the end outside of the recess and also at the bottom of the recess.

3. In a tube expander for expanding a tube in a tube sheet, a mandrel tapering from a larger rearward end to a smaller forward end, expanding elements surrounding and engaging the mandrel, a cage around the mandrel recessed to retain the expanding elements and extending rearwardly of the expanding elements around the mandrel, a housing collar around and secured to the rear of the cage, a housing sleeve which surrounds and is secured to the housing collar, extends forwardly of the housing collar and at the forward end extends radially inwardly forming a flange, a bearing engaging the forward face of the housing collar, a stop collar around the cage in front of the housing sleeve extending rearwardly inside the sleeve engaging the opposite side of the bearing from that engaged by the housing collar, the stop collar having a shoulder inside the sleeve which forwardly engages the flange of the sleeve, extending forwardly beyond the housing and being positively roughened on the forward end at the diameter of the tube and also at the diameter of the tube sheet.

4. In a tube expander for expanding a tube in a tube sheet, a mandrel tapered from a larger rearward end to a smaller forward end, expanding elements surrounding and engaging the mandrel, a cage around the mandrel recessed to retain the expanding elements and extending rearwardly of the expanding elements around the mandrel, a housing collar around and secured to the rear of the cage, a housing sleeve which surrounds and is secured to the housing collar, extends forwardly of the housing collar and at the forward end extends radially inwardly forming a flange, a bearing engaging the forward face of the housing collar, a stop collar around the cage in front of the housing sleeve extending rearwardly inside the sleeve engaging the opposite side of the bearing from that engaged by the housing collar, the stop collar having a shoulder inside the sleeve which forwardly engages the flange of the sleeve, extending forwardly beyond the housing, having an annular recess at the inside of the forward end and being positively roughened at the extreme end of the stop collar beyond the recess and also at the bottom of the recess.

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