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TUBE SPINNING TOOL HAVING ROLLERS EXPANDED RADIALLY BY A CONICAL SPRING PRESSED MANDREL AND A SPRING WHICH RELEASES THE MANDREL FROM THE ROLLERS

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Fig. 1.

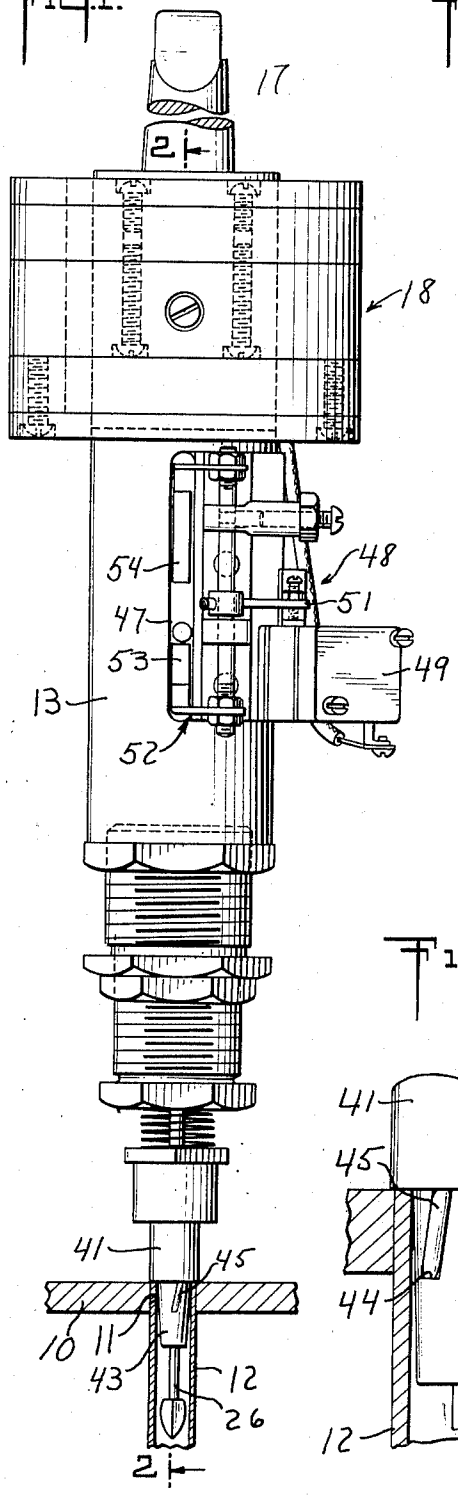


Fig. 2.

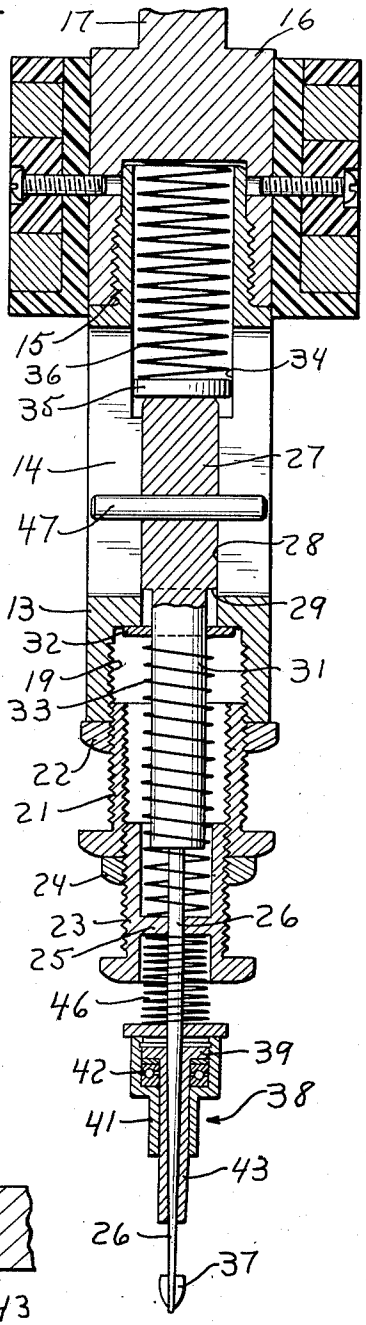
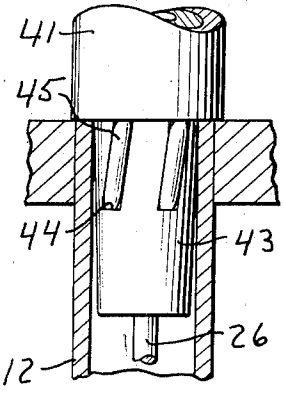


Fig. 3.



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TUBE SPINNING TOOL HAVING ROLLERS EXPANDED RADIALLY BY A CONICAL SPRING PRESSED MANDREL AND A SPRING WHICH RELEASES THE MANDREL FROM THE ROLLERS

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3 Claims. (Cl. 153—82)

This invention relates to tools for installing tubes in supporting plates, and has especial although not limited application to the art of securing thin walled heat exchange tubes in openings provided therefor in header plates. The invention is useful, for example, in the fabrication of oil cooling devices for aircraft wherein thin walled, hollow tubes are supported in adjacent parallel relation between supporting end plates for the flow of a first fluid through the tubes and flow of a second fluid around and between the tubes. It is required that the tube ends have a tight fitting mounting in the end plates, effective to prevent leakage and sufficiently strong to resist the stresses of fluid pressure and of vibration.

The invention is particularly concerned with that class of tool having a working end to enter the tube and to apply a radial, outwardly directed force which expands the tube end into intimate contact with the surrounding wall of the plate opening, according to a metal working concept sometimes called spinning.

An object of the invention is to enable the duration and extent of a tube securing operation to be predetermined in such manner as to avoid weakening of the joint produced.

Another object of the invention is substantially to eliminate the need for special operator skill in the securing of a tube end, it being proposed that the operator need merely bring the tool to a working position with the tool itself thereafter operating automatically to effect and to discontinue the spinning operation.

A further object of the invention is to obviate bowing of the tubes under developed pressures of the tube securing operation.

Still another object of the invention is to achieve a uniformity of results in the installation of multiple tubes.

A still furthr object of the invention is to present a tool which can be used in multiple form in a drill press or like machine for the simultaneous securing of a plurality of tube ends, it being a further object in this connection independently to control the several tools so that their operation may be separately and independently discontinued as required.

Other objects and structural details of the invention will appear from the following description when read in connection with the accompanying drawing, wherein:

Fig. 1 is a view in side elevation of a tool in accordance with the illustrated embodiment of the invention, shown inserted in a tube end preparatory to starting the spinning operation;

Fig. 2 is a view of the tool in longitudinal section, with the parts being shown in the same position as Fig. 1; and

Fig. 3 is a fragmentary enlarged view of the tip of the tool, shown inserted in a tube in the same position as Fig. 1.

Referring to the drawings, a fragment of a plate **10** is shown, having an opening **11** receiving the end of a tube **12**; the device of the instant invention operating from within the tube end to press the material of the tube outward into tight fitting contact with the wall of the opening. The device is disclosed as constructed and arranged for installing thin walled heat exchange tubes in header plates, the resulting structure having utility as the core of oil cooling and like devices.

The tool includes a cylindrical body **13** formed with a through slot **14** and having on its one end a projecting stem **15** in screw threaded engagement with a spindle extension **16**. The latter has a shank **17** adapted to be received in the head of a drill press or the like whereby the body **13** may be moved toward and from the plate **10** in an axial sense and also be rotated in forward and reverse directions. A commutator assembly **18** is mounted on the spindle extension **16** serving a purpose in controlling the bodily movements of the device which it is unnecessary here to understand.

The opposite end of the body **13** is formed with a counterbore **19** internally threaded to receive a bushing **21**, a lock nut **22** serving to hold the body **13** and bushing **21** in set positions of adjustment. The bushing **21** also is internally threaded and receives a second bushing **23**, held with respect to the first bushing by a lock nut **24**. The bushing **23** is formed with a transverse web **25** providing a bearing for a tapered mandrel **26**, the small end of which projects through and beyond the bushing **23**. The opposite end of the mandrel **26** is formed as a cylindrical portion **27** having a sliding fit in a bore **28** in the body **13**, such portion **27** being connected by a step down shoulder **29** to a somewhat smaller intermediate cylindrical portion **31**. A washer **32** surrounds the portion **31** and is urged by a compression spring **33** to a seat in the bottom of counterbore **19**, the spring **33** being based on the web **25**. The inner extremity of the cylindrical portion **27** projects into a counterbore **34** where it is acted on by a disc **35** and compression spring **36** in a manner tending to resist inward axial motion of the mandrel **26** relatively to the body **13**.

The outer extremity of the mandrel **26** is of a size for free entry into the end of the tube **12** and has a wing formation **37** serving to retain on the mandrel a sleeve assembly **38**. The latter includes an inner sleeve **39** and an outer sleeve **41** of a size to abut the end of the tube. The sleeves **39** and **41** are inter-connected through a bearing **42**. The sleeve **39** has a projecting portion **43** formed with a circumferential series of approximately radial inclined slots **44** in which are installed cylindrical rollers **45**. As may be seen, the construction and arrangement of parts is such that a relative axial motion of the mandrel and sleeve assembly will when accomplished in one sense press the rollers **45** outward into contact with the tube and when accomplished in an opposed sense relieve such pressure. Still further, on account of the angular disposition of the rollers **45**, relative rotation of the mandrel **26** in one direction will serve to draw the mandrel axially with respect to the sleeve assembly **38**, with the rollers **45** acting in effect as screw threads to induce such motion. It will be understood, in this connection, that the rollers **45** are mounted in the slots **44** with some freedom of lateral motion. Thus, upon a reversal of the direction of rotation of the mandrel, the rollers **45** may move to release the mandrel.

A compression spring **46** is interposed between the sleeve assembly **38** and the web **25** and tends to extend the sleeve assembly outwardly along the mandrel **26**. A transverse pin **47** is passed through the cylindrical portion **27** of the mandrel and its ends lie in the slot **14**. The mandrel **26** thus is connected to the body **13** for unison rotary movement but is permitted a relative longitudinal movement.

Normally, the mandrel **26** occupies a position relatively projected with respect to the position shown in Fig. 2. Thus the shoulder **29** on the mandrel normally rests on the washer **32** and the disc **35** is in the bottom of counter-

bore 34. The mandrel is in effect stabilized by or balanced between the springs 33 and 36. Further, under the influence of spring 46, the sleeve assembly 38 is normally relatively extended, with the sleeve portion 43 substantially engaging the winged formation 37.

In the securing of a tube end to the header plate 10, the tip 37 of the mandrel is inserted in the tube and is followed therein by the sleeve portion 43, it being understood that this is done by bodily advancing the device upon the work. The entering motion of the sleeve assembly is limited by engagement of the sleeve 41 with the end of the tube or with the plate and continued motion of the body 13 and mandrel 26 is effected relatively to the sleeve assembly 38. As a result, the rollers 45 move outward into contact with the wall of the tube and are in effect wedged there interrupting the relative axial motion of the mandrel. If now the body 13 is continued to be moved toward the work, it advances relatively to the mandrel 26 resulting in a compressing of the spring 36. There may be provided a fixed stop for the body 13, against which the operator may move the body.

It is not required, in this connection, that advance of the body perform any function in the actual securing of the tube, but merely that it properly locate the parts for such operation and place the spring 36 under compression or to tension it. Fig. 2 illustrates the device as it may appear when the operator has brought the body to such fixed stop. Rotation of the body 13 and, therefore, of the mandrel 26 may be continuous or may be initiated when the parts reach the Fig. 2 position. In such position, the spring 36 urges the mandrel outward wedging engagement with the rollers 45. Thus rotation of the mandrel induces a continued axially extending motion of the mandrel under the influence of the spring 36 and of the rollers 45 which exert a drawing effect on the mandrel, as before described. Accordingly, the mandrel 26 travels axially into the tube 12 and further expands the series of rollers 45 with a consequent deforming of the material of the tube into an intimate contacting relation with the wall of opening 11. As the mandrel 26 travels under the above described influences, the disc 35 returns to the bottom of the counterbore 34 and the shoulder 29 re-engages the washer 32, with continued travel of the mandrel displacing the washer 32 and placing the spring 33 under compression. Now when a sufficient deforming or spinning of the tube end has taken place, the direction of rotation of the mandrel is reversed. The effect, as previously noted, is to release the mandrel from the rollers 45 whereupon the spring 33 immediately returns the mandrel to a stabilized position between the springs 33 and 36. The body 13 then may be returned to its starting position, lifting the mandrel and sleeve assembly 38 out of the finished tube.

The duration of the spinning operation is in the illustrated instance dimensionally controlled. Thus a switch and switch operating assembly 48 is mounted on the body 13 and controlled by the pin 47. Such assembly includes a micro-switch 49 suitably connected in an electric circuit operable to stop the rotation of the body 13. The switch 49 is operated by an arm 51 connected to a carriage 52 which includes fixed abutment portions 53 and 54 engaged alternately by the pin 47. The device is individually controlled so that multiple spinning devices may be mounted for simultaneous operation in a single press. Thus the several devices may be lowered as a unit against a common stop and thereafter each device performs its spinning function independently of one another. As each completes its respective work it is stopped, and when all of the several devices have come to a stop, they may be reversed simultaneously. The mandrels thereby are retracted, whereupon the operator returns the several devices again to starting position.

What is claimed is:

1. A device for installing the ends of hollow tubes into tight fitting position in openings provided therefor in header plates, includng a body subject to longitudinal and rotary motions, a mandrel supported by said body in concentric relation thereto and for unison rotary and relative longitudinal motions, said mandrel having a projecting tapered end adapted freely to enter the end of a tube, a sleeve slidably mounted on the projecting end of said mandrel and having a first portion adapted to enter the tube and a second portion adapted to limit against the end of the tube, rollers carried by the said first portion of said sleeve and movable radially outward by said mandrel in response to an axially traveling motion of said mandrel into said tube relatively to said sleeve, said rollers being angularly disposed in such wise as to draw said mandrel into the tube in response to rotation thereof in one direction, a spring interposed between said body and said mandrel and tensioned by a continued longitudinal motion of said body in a direction entering said mandrel in the tube beyond that required to engage said rollers with the inner surface of the tube, and another spring tensioned by an axial motion of said mandrel relatively to said body under influence of said rollers and effective to move said mandrel in a withdrawing direction in response to rotation of said mandrel in the opposite direction.

2. A device for installing the ends of hollow tubes into tight fitting position in openings provided therefor in header plates including a body subject to rotary and longitudinal motions, a mandrel supported by said body for relative longitudinal unison rotary motions, said mandrel having a projecting tapered end adapted freely to enter the end of a tube, a sleeve slidably mounted on the projecting end of said mandrel and having a first portion adapted to enter the tube, and a second portion adapted to limit against the end of the tube, angularly disposed rollers carried by the said first portion of said sleeve, said rollers being displaced radially outward into contact with the inner tube surface by a relative longitudinal tube entering motion of said mandrel and said rollers further tending to draw said mandrel further into the tube in response to rotation of the mandrel in one direction following contact of the rollers with the tube surface, a spring tending to inhibit relative longitudinal motion of said body and mandrel, and tensioned by longitudinal motion of said body beyond that required to engage said rollers with the tube surface, and another spring tensioned by a longitudinal motion of said mandrel under influence of said rollers for releasing said mandrel from said rollers in response to rotation of said mandrel in the opposite direction.

3. A device for installing the ends of hollow tubes into tight fitting position in openings provided therefor in header plates, including a tapered mandrel, the small end thereof being adapted freely to enter the end of a tube, a sleeve slidably mounted on the mandrel and having a first portion adapted to enter the tube end and a second portion adapted to limit against the tube end, rollers carried by the said first portion and displaced radially outward into contact with the inner surface of the tube by an initial inward motion of the mandrel relatively to said sleeve, said rollers being angularly disposed to draw said mandrel further into the tube in response to rotation of said mandrel in one direction, a rotatable and longitudinally movable body carrying said mandrel, said mandrel being movable relatively to said body in a longitudinal sense, a spring inhibiting relative longitudinal motion of said mandrel and tensioned by an overtravel of said body beyond that required to effect the said initial inward motion of said mandrel, and a further spring tensioned by an inward motion of said mandrel under influence of said rollers for releasing said mandrel from said rollers in response to rotation of said mandrel in the opposite direction.

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