

April 1, 1930.

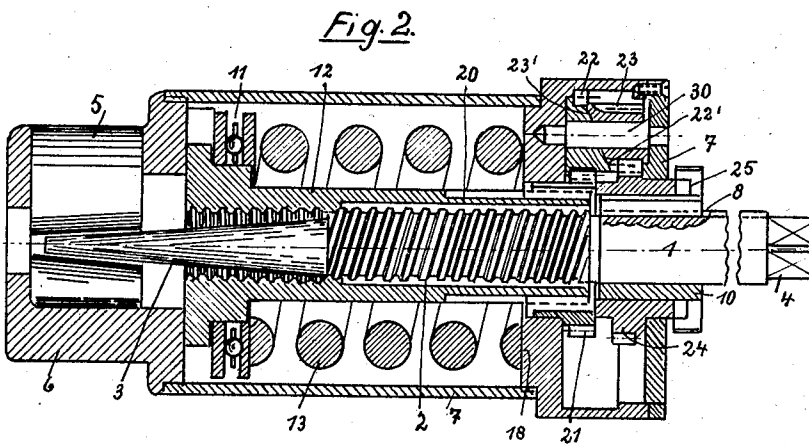
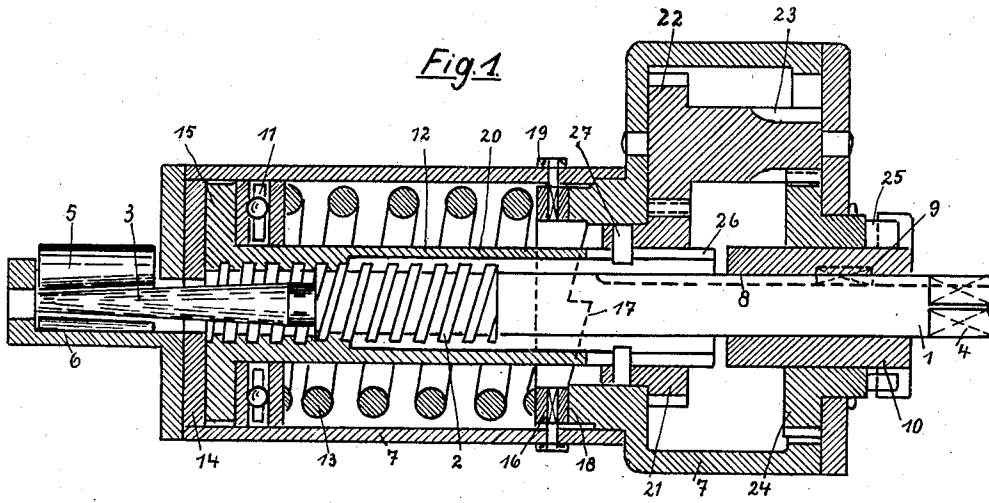
O. ZEIN

1,752,408

TUBE EXPANDER

Filed Feb. 10, 1928

2 Sheets-Sheet 1



Inventor:
Otto Zein
by *Stuckmann*
att.

April 1, 1930.

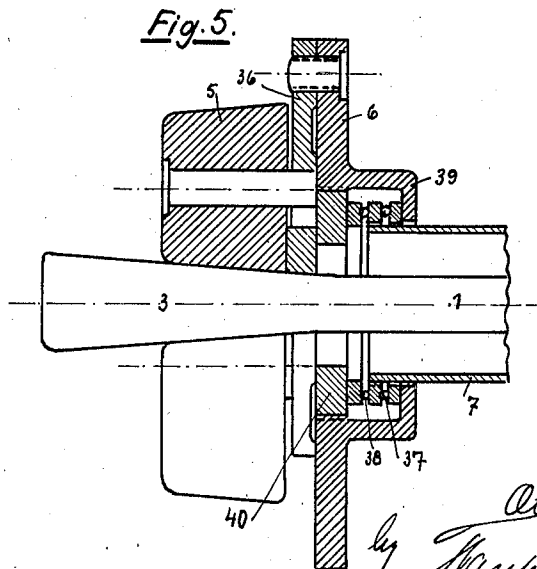
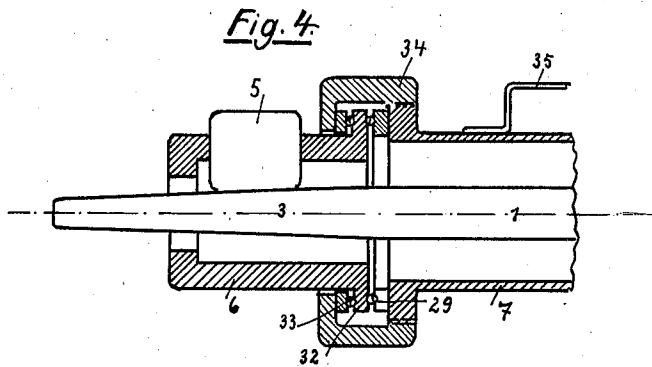
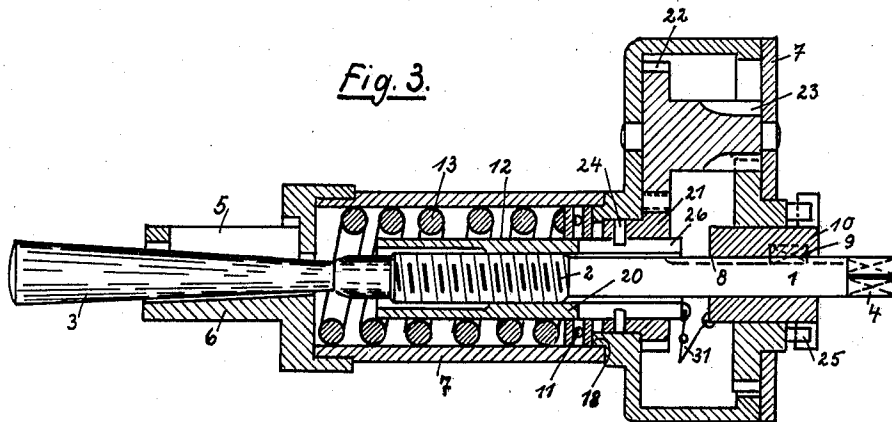
O. ZEIN

1,752,408

TUBE EXPANDER

Filed Feb. 10, 1928

2 Sheets-Sheet 2



Inventor:
Otto Zein
by *M. H. Schaeffer*
att'y

UNITED STATES PATENT OFFICE

OTTO ZEIN, OF BERLIN, GERMANY

TUBE EXPANDER

Application filed February 10, 1928, Serial No. 253,512, and in Germany June 1, 1927.

There are devices already well known for tightening tubes in walls, for example, boiler tubes in boiler walls, in the case of which several, usually three, rollers mounted radially displaceably in a housing are pressed against the wall of the tube by means of a conical expanding mandrel thrust between them, the cylindrical spindle of which mandrel is guided with a screw-thread in a nut subjected to the action of a counter-pressure spring and is driven by motor or by hand.

utilized to control the axial motion of the spindle there being imparted to the nut a motion relative to the spindle which is always rotating in the same direction, whereby the velocity of the feed of the spindle is influenced. If, for example, the spindle possesses such a direction of rotation and a thread of such a pitch that said spindle tends when the nut is stationary to screw itself into the position of rest, the nut must if rotating in the same direction be set rotating more quickly than the spindle.

The drive of the nut can be derived from the spindle through toothed wheel gear or frictional wheel gear, which is arranged in the housing of the tube expander. The spindle can in the case of a tube expander constructed according to the invention be driven at a fairly high speed without fear of the expanding mandrel being fed forward too quickly. By regulating the relative motion of the nut with regard to the spindle, that is by choosing the speeds and directions of rotation as well as the pitches of the screw-threads of the nut and spindle the velocity of the feed of the expanding mandrel can be set to any desired suitable degree. Moreover, the return of the spindle into the position of rest after the rolling-in operation takes place perfectly automatically and without altering the direction of rotation, an axial displacement of the nut and consequently the disengagement of the drive of the nut being brought about. A further improvement of the tube expander according to the invention is moreover rendered possible by the cage containing the rollers being so constructed that it is revoluble by itself alone independently of the rest of the housing, a feature which is advantageous for the work and for the working of the tube expander.

The drawing shows the tube expander according to the invention in Figs. 1 to 5 in several constructional examples in longitudinal section and enables the essence and the action of the new device to be seen in detail.

Fig. 1 represents a first embodiment of the invention in which the conical expanding mandrel passes out of the housing of the

5
10
15
20
25
30
35
40
45
50

There are devices already well known for tightening tubes in walls, for example, boiler tubes in boiler walls, in the case of which several, usually three, rollers mounted radially displaceably in a housing are pressed against the wall of the tube by means of a conical expanding mandrel thrust between them, the cylindrical spindle of which mandrel is guided with a screw-thread in a nut subjected to the action of a counter-pressure spring and is driven by motor or by hand.

In the case of the well-known constructions of such tube expanders the rollers are pressed against the as yet unstressed tube wall by means of the conical mandrel at the commencement of the tightening operation under a pressure which is very powerful in proportion to their speed of rotation. Consequently there is a danger that the wall of the tube will experience a deformation which will assume a triangular cross-section instead of a round one. Such a deformation will usually not be rectified again until the end of the rolling operation so that the material of the tube is undesirably strained during the whole rolling operation. Moreover, in the case of the ordinary tube expanders it is necessary to reverse the direction of rotation of the driving motor, if after the tightening operation the rollers are again to be removed from the tube wall and the conical expanding mandrel to be withdrawn. This makes the use of the tube expander and of the driving motor comparatively troublesome, in addition to which there is the point that the release and return of the rollers and of the mandrel out of the position occupied at the end of the rolling operation requires a fairly large power output.

Now the object of the invention is so to construct such tube expanders that a too powerful unfavorable initial pressure of the rollers is avoided and also that it is guaranteed that the direction of rotation of the spindle for the rolling operation and for the return into the starting position shall be permanently in the same direction of rotation. The simultaneous fulfilment of these two requirements is according to the invention attained by the nut surrounding the spindle being

device during the rolling operation. Fig. 2 shows a modification of the construction according to Fig. 1. Fig. 3 illustrates an embodiment of the invention in which the conical expanding mandrel is drawn into the housing of the tube expander during the working stroke. Figs. 4 and 5 show two modified constructions of the roller-cage which is revoluble independently of the housing of the device according to these figures.

In the case of the constructional form of the invention which is represented in Fig. 1, the cylindrical spindle 1 which is provided with a helical thread 2 terminates at its front end in the conical expansion mandrel 3 and at its hind end in the square 4. The expansion mandrel 3 projects in between the three rollers 5 which are so guided in a cage 6 that they can be forced radially outwards by means of the expansion mandrel 3. The cage 6 is removably secured on the housing 7 of the device by means of screws, for example, but not shown and can be exchanged for the purpose of employing other rollers. The motor for driving the tube expander is coupled with the end of the spindle provided with the square 4 which end projects out of the housing 7. The cylindrical portion of the spindle 1 is provided with a longitudinal groove 8 in which lies a wedge 9 which on the other hand also engages in the groove of a sleeve 10 which is movable along the spindle 1.

The spindle 1 is surrounded by a nut 12 which like the spindle possesses a trapezoid or flat thread and which with the aid of a ball-bearing 11 is revoluble in the housing 7 about the spindle. The powerful trapezoid or flat thread prevents with certainty the eating of the spindle into the nut. A helical spring 13 which surrounds the nut 12 and abuts against an inner projecting portion 18 of the housing 7 presses on the cage of the ball bearing 11 and consequently on the flange 15 of the nut 12 so that the latter is pressed against the wall 14 of the housing 7. The pressure of the spring 13 can be varied with the aid of a ring 16 which is adjustable in the housing 7 and which rests by means of saw-toothed-shaped oblique surfaces 17 against a surface, which is correspondingly toothed, of the inner projecting portion 18 of the housing. The ring 16 by being turned can be so shifted along the saw-tooth-shaped surface of the projecting portion 18 that it compresses the spring 13 more or less powerfully. The position in which the pressure ring 16 is set at the time can be securely maintained by means of screwbolts 19.

The nut 12 terminates in a sleeve-shaped extension 20 which carries at its free end a toothed wheel 21 which with the aid of the pins or wedges 27 engages in the longitudinal slot 26 in the sleeve 20 and engages with the

toothed wheel 22 mounted in the housing 7. On the same shaft as the toothed wheel 22 is mounted a pinion 23 which engages with a toothed wheel 24 which is mounted loosely on the sleeve 10 displaceable along the spindle 1 and which is releasably coupled with said sleeve by means of several claws 25 which engage in recesses in the flange of the sleeve 10. The transmission-ratio of the toothed wheels is such that the nut 12 is driven at a greater speed than the spindle 1. If the spindle 1 is rotated by the driving motor as usual in the clockwise direction, said spindle and the nut 12 have left-handed screw-threads; and if driven by the motor in the opposite direction, right-handed screw-threads.

The tube expander according to Fig. 1 works as follows:

The spindle 1 revolving in the clockwise direction transmits its motion through the gear 24, 23, 22, 21 to the nut 12, which rotates with a velocity greater relatively to the speed of revolution of the spindle, for example, with twice the speed of revolution of the spindle and in the same direction as the latter. Thereby the axial feed forward of the spindle 1 experiences a delay so that the driving motor can develop a fairly high speed without the spindle 1 being fed forward too quickly injuriously. The expanding mandrel 3 passes slowly between the rollers 5 and drives them gradually outwards against the wall of the tube to be expanded by roller, so that a sudden powerful pressure of the rollers at the commencement of the working operation and consequently the danger of an initial objectionable deformation of the tube which has to be rectified later is avoided.

As soon as in consequence of the forward movement of the expanding mandrel 3 the pressure of the rollers 5 against the wall of the tube has increased to such an extent that the spindle 1 is no longer fed forwards, there is brought about, since the rotation of the spindle 1 continues, an axial displacement of the nut 12 towards the coupling sleeve 10, the spring 13 being simultaneously compressed. The extension 20 of the nut 12 which by means of its longitudinal slit 26 can be displaced relatively to the wheel 21 thus meets the coupling sleeve 10 and pushes the latter outwards on the spindle. Thereby the claw-coupling 25 is released and the gear 24, 23, 22, 21 disengaged so that the nut 12 comes to a standstill. Consequently the spindle 1 which is continued to be driven in the clockwise direction is screwed quickly outwards back into its initial position and the nut 12 is transferred by the spring 13 into its starting position. After the sleeve 10 has been again coupled with the wheel 24 the whole tube expander is then ready again for a new working operation without the direction of the drive of the motor and spindle having to be altered.

The constructional form of the invention according to Fig. 2 is distinguished from the arrangement according to Fig. 1 in the manner in which the nut 12 is driven and as regards the mode in which the pressure of the spring 13 is regulated. According to Fig. 2 the toothed wheels 22, 23, which are situated with their outer side faces resting against the wall of the housing 7, are mounted as separate members loosely revolvably on a pin 30 mounted in the housing 7 and abut against each other with oblique contact surfaces 22', 23' which are so shaped that the wheel 23 when acting as a driver drives the wheel 22 with it, whereas the wheel 22, when acting as a driver is unable to drive the wheel 23, on the other hand the suiting of the pressure of the spring 13 to the thickness of the wall of the tube to be rolled in is attained in the case of the arrangement according to Fig. 2 by the distance between the coupling sleeve 10 and the extension 20 of the nut 12 being varied, coupling sleeves for example, of different lengths, which are added to the tube expander being placed on to the spindle 1. Furthermore Fig. 2 is distinguished from Fig. 1 by the gear being arranged in a cylindrical box concentric with regard to the other part of the housing 7, so that the part projecting at one side of the housing in Fig. 1 is avoided.

The tube expander according to Fig. 2 works as follows:

During the rolling operation the nut 12 is driven similarly as in Fig. 1 through the gear 24, 23, 22, 21 in the same direction but quicker than the spindle 1. The wheel 23 is driving during said time and consequently drives the wheel 22 by means of the oblique surface 22', 23'. If after the expanding of the tube the nut 12 is displaced backwards in the axial direction, since the spindle 1 does not move forward axially any longer but continues to rotate it strikes against the coupling sleeve 10 after a movement backward through a certain distance and uncouples the latter from the toothed wheel 24 in the same manner as in the case of Fig. 1. During this backward movement of the nut 12 the spring 13 is compressed and the spring pressure so attained may by the employment of a shorter or of a longer coupling sleeve 10 be increased or decreased.

Under the increased spring pressure an after-expansion of the tube takes place until the maximum pressure between the tube and the rollers counterbalances this spring-pressure. Further the surface-pressure between the screw-threads of the spindle and the nut is so increased by the counter pressure of the spring 13 that the spindle 1 which revolves permanently in the clockwise direction now tends to drive the nut 12. Thereby the toothed wheel 22, which engages into the toothed wheel 21 mounted on the nut 12, now

becomes a driving wheel. Consequently the wheel 23 is not driven, but the oblique surfaces 22', 23' become so displaced relatively to one another that the wheels 22 and 23 are pressed with their outer end surfaces against the walls of the housing 7 and are thereby braked. The nut 12 and the gear now come to a standstill and the spindle 1 rotates in correspondence with its pitch quickly back into the starting position. Otherwise the mode of action of the tube-expander shown in Fig. 2 is the same as in the case of Fig. 1.

As Fig. 3 shows, the tube expander according to the invention can also be constructed in such a manner that the conical expanding mandrel does not during the rolling operation as in Figs. 1 and 2 pass out of the housing of the device but is drawn into said housing. This direction of the movement is necessary when the expanding mandrel 3 is conically reduced not outwardly but inwardly in accordance with Fig. 3, which is advantageous for many rolling-in operations. In order, in the case to delay the axial thrust of the spindle 1 during the rolling operation by means of the more quickly rotating nut 12 for the purpose of preventing the rollers 5 from exerting an initial pressure which is too powerful and moreover in order to guarantee the same direction of rotation of the spindle for the working and for the return stroke, the spindle 1 and the nut 2 must be provided, when the motor drive is in the right-hand direction, with a screw-thread of the same direction, that is with a right-handed screw-thread. Moreover the ball-bearing 11 is not to be arranged in the neighborhood of the rollers 5, as in the case of Figs. 1 and 2, but in the neighborhood of the gear 24, 23, 22, 21 and the action of the nut 12 on the coupling sleeve 10 takes place through a lever system 31 which is indicated diagrammatically.

The expanding roller according to Fig. 3, which otherwise is constructed similarly to that in the case of Fig. 2, acts as follows: The nut 12, which for example is rotating in the clockwise direction twice as quickly as the spindle 1, causes the expanding mandrel 3 rotating in the same direction to be drawn into the roller-cage 6 only gradually. When at the end of the rolling operation the spindle 1 continues only to rotate but does not continue to shift axially the nut 12 is moved towards the cage 6 and after a certain length of stroke releases by means of the lever-system 31 the coupling-sleeve 10 from engagement with the toothed wheel 24. The gear and the nut come to a standstill and the spindle 1 screws itself quickly back into the starting position and carries the expanding mandrel 3 out of the cage 6. After rotating the nut 12 backwards into the initial position and putting into engagement the coupling-sleeve 10 the tube-expander of Fig. 3 is again ready for work. The gear 24, 23, 22, 21 may of

course be constructed also in the manner shown in Fig. 2.

If in the case of the arrangement according to Fig. 3 a spindle and a nut with a left-handed thread are employed, the spindle must be driven in the left-hand direction in order that the nut which is running more quickly may effect the desired delayed displacement of the spindle towards the gear. For the selection of the direction of rotation of the hand drive or motor drive and of the nut thread or spindle thread it is essential both in the case of Figs. 1 and 2 as also in the case of Fig. 3 that the spindle be brought back automatically into the starting position after the rolling operation without the direction of rotation being altered. If the nut is driven in the same direction as the spindle it must rotate more quickly than the latter, but in some circumstances the proportions may be such that the nut must rotate more slowly than the spindle in order to exercise the intended regulating effect on the spindle feed and to prevent the pressure of the rollers from increasing too quickly. The gear, which effects the transmission of motion from the spindle to the nut, must be designed and determined as regards its transmission-ratio in correspondence with the direction of rotation and the speed of rotation of the nut.

Figs. 4 and 5 show a further development of the new tube expander which consists in the roller-cage 6 being formed as a part which is revoluble independently of the housing 7 of the device. This arrangement offers the advantage that the whole tube expander does not, as in the case of Figs. 1 to 3, during the working stroke and during the releasing stroke of the spindle, rotate with a different velocity from time to time, but that only the cage 6 rotates with the rollers 5, whereas the housing 7 remains stationary. By these means a greater uniformity of the forward feed of the spindle is attained and the manipulation of the tube expander particularly when of comparatively large dimensions is materially facilitated. This revoluble arrangement of the roller-cage 6 may be employed both in the case, as shown in Fig. 4, of an expanding mandrel tapering off towards the front and in the case according to Fig. 5, of an expanding mandrel becoming broader towards the front.

According to Fig. 4 a ball-bearing 29 is inserted between the roller-cage 6 and the housing 7, on which bearing the one side of the end flange 32 of the cage 6 runs, while the other side of the flange rolls on a second ball-bearing 33. The ball-bearings 29, 33 and the cage flange 32 are pressed against the housing 7 by means of a box-nut 34 screwed on the end of the housing, so that the cage is able to rotate concentrically with regard to the expanding mandrel 3 opposite the stationary housing 7. The housing is provided with one or more

handles 35 for convenience of being held firmly. According to Fig. 5 the roller-cage 6 has the shape of a disk on which the rollers 5 are arranged with the aid of special levers 36 and which is supported revolvably on the end flange of the housing 7 with the aid of two ball-bearings 37, 38 of a nave-like extension 39 and of a pressure-ring 40 which is screwed-in.

The invention may, of course, be constructed as regards its details in a form departing from the examples in the drawings. In particular the size of the rollers, the pitch of the threads of the nut and the spindle, the conical form of the expanding mandrel, the strength of the counter-pressure spring, and the transmission-ratio of the gear are to be suited to the requirements of the individual case considered at the time, in addition to which the individual parts of the tube expander may be exchangeable.

What I claim is:

1. A tube expander comprising in combination a housing, several rollers mounted radially displaceably, a cage containing said rollers, a conical mandrel being enabled to be drawn between said rollers so as to spread them apart, a spindle bearing at its one end said mandrel and being provided with a thread, a nut guiding said mandrel spindle and mounted rotatably in said housing, a spring producing a counter-pressure on said nut, means for driving said mandrel spindle during the rolling-in feed-motion and during the return motion permanently in the same direction of rotation, and means for imparting to said nut during the rolling-in operation a relative movement with regard to said spindle so as to control the axial displacement of said mandrel during the working stroke.

2. A tube expander comprising in combination a cylindrical housing, a cage connected to said housing, several rollers mounted radially displaceably in said cage, a conical mandrel being enabled to be thrust between said rollers so as to spread them apart, a spindle bearing at its one end said mandrel and being provided with a thread, a nut guiding said mandrel spindle and mounted rotatably in said housing, a counter-pressure spring acting upon said nut, means for driving said mandrel spindle during the rolling-in operation and the return-motion permanently in the same direction of rotation, and means for driving said nut during the rolling-in operation more quickly than said spindle and in the same direction of rotation as the latter so as to effect the axial displacement of said spindle and said mandrel into the working position.

3. A tube expander comprising in combination a cylindrical housing, a cage connected to said housing, several rollers mounted radially displaceably in said cage, a conical man-

drel being enabled to be thrust between said rollers so as to spread them apart, a spindle bearing at its one end said mandrel and being provided with a thread, a nut guiding said mandrel spindle and mounted rotatably in said housing, a counter-pressure spring acting upon said nut, means for driving said mandrel spindle during the rolling-in operation and the return-motion permanently in the same direction of rotation, a transmission-gear arranged in said housing and serving for obtaining a rotary motion of said nut from said spindle, the transmission ratio being chosen so that during the rolling-in operation the nut runs more quickly than said spindle and in the same direction of rotation as the latter so as to effect the axial displacement of said mandrel into the working position.

4. A tube expander comprising in combination a cylindrical housing, a cage connected to said housing, several rollers mounted radially displaceably in said cage, a conical mandrel being enabled to be thrust between said rollers so as to spread them apart, a spindle bearing at its one end said mandrel and being provided with a thread, a nut guiding said mandrel spindle and mounted rotatably in said housing, a counter-pressure spring acting upon said nut, means for driving said mandrel spindle during the rolling-in operation and the return-motion permanently in the same direction of rotation, a transmission gear arranged in said housing and enabling said spindle to drive said nut during the rolling-in operation in the same direction at a revolution number higher than its own speed so as to effect the axial displacement of said mandrel into the working position, and means for automatically disengaging said transmission gear from the spindle after the rolling-in operation, said disengaging means being operated by the axial displacement of said nut.

5. A tube expander comprising in combination a cylindrical housing, a cage connected to said housing, several rollers mounted radially displaceably in said cage, a conical mandrel being enabled to be thrust between said rollers so as to spread them apart, a spindle bearing at its one end said mandrel and being provided with a thread, a nut guiding said mandrel spindle and mounted rotatably in said housing, a counter-pressure spring acting upon said nut, means for driving said mandrel spindle during the rolling-in operation and the return-motion permanently in the same direction of rotation, a transmission gear arranged in said housing and enabling said spindle to rotate said nut during the rolling-in operation in the same direction at a revolution number higher than its own speed so as to effect the axial displacement of said mandrel into the working position, adjustable means for automatically

disengaging said transmission gear from the spindle after the rolling-in operation with the aid of the axial displacement of the nut, and means for revolvably mounting the cage as a separate part on the housing.

6. A tube expander comprising in combination a cylindrical housing, a cage connected to said housing, several rollers mounted radially displaceably in said cage, a conical mandrel being enabled to be thrust between said rollers so as to spread them apart, a spindle bearing at its one end said mandrel and being provided with a thread, a nut guiding said mandrel spindle and mounted rotatably in said housing, a counter-pressure spring acting upon said nut, means for driving said mandrel during the rolling-in operation and the return-motion permanently in the same direction of rotation, a transmission gear arranged in said housing and enabling said spindle to drive said nut during the rolling-in operation in the same direction at higher speed, means for automatically disengaging the transmission gear after the rolling-in operation by the aid of the nut, the direction of the threads of the nut and the spindle being determined so that the spindle is brought back automatically into the starting position after the rolling operation without changing its direction of rotation.

7. A tube expander comprising in combination a cylindrical housing, a cage connected to said housing, several rollers mounted radially displaceably in said cage, a conical mandrel being enabled to be thrust between said rollers so as to spread them apart, a spindle bearing at its one end said mandrel and being provided with a thread, a nut guiding said mandrel spindle and mounted rotatably in said housing, a counter-pressure spring acting upon said nut, means for driving said mandrel spindle during the rolling-in operation and the return-motion permanently in the same direction of rotation, a transmission gear arranged in said housing and enabling the spindle to drive the nut during the rolling-in operation in the same direction at higher speed, two toothed wheels contained in said transmission gear on the same shaft and abutting against one another with oblique surfaces, and means for automatically disengaging the transmission gear after the rolling-in operation by the aid of the nut.

In testimony whereof I affix my signature.
OTTO ZEIN.