

March 11, 1941.

H. HEETKAMP

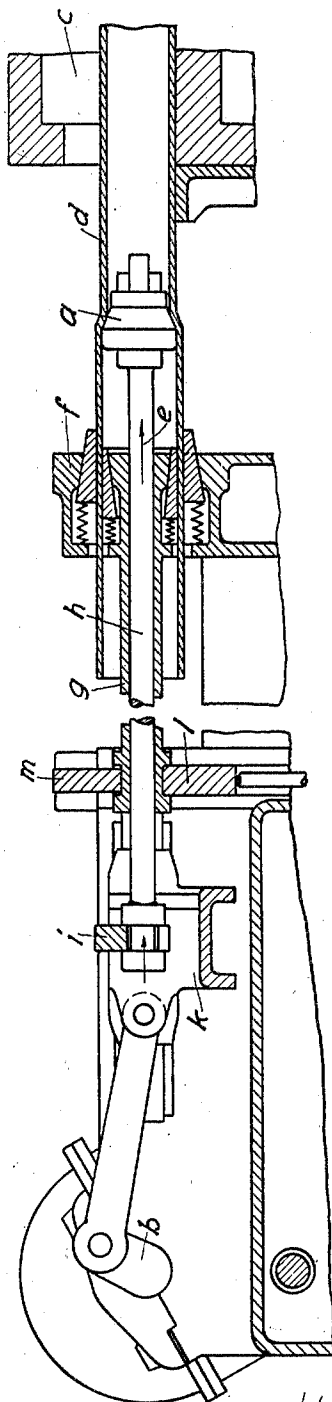
2,234,863

PROCESS AND APPARATUS FOR EXPANDING TUBES

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4 Sheets-Sheet 1

Fig. 1.



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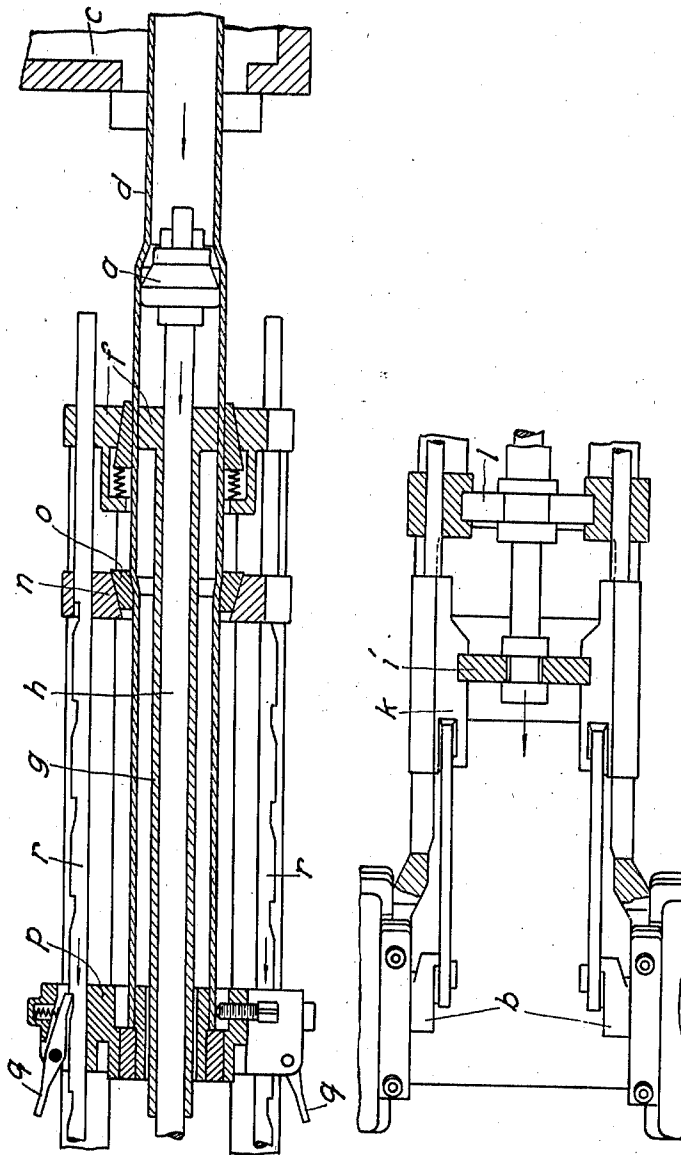


Fig. 2.

Fig. 2a.

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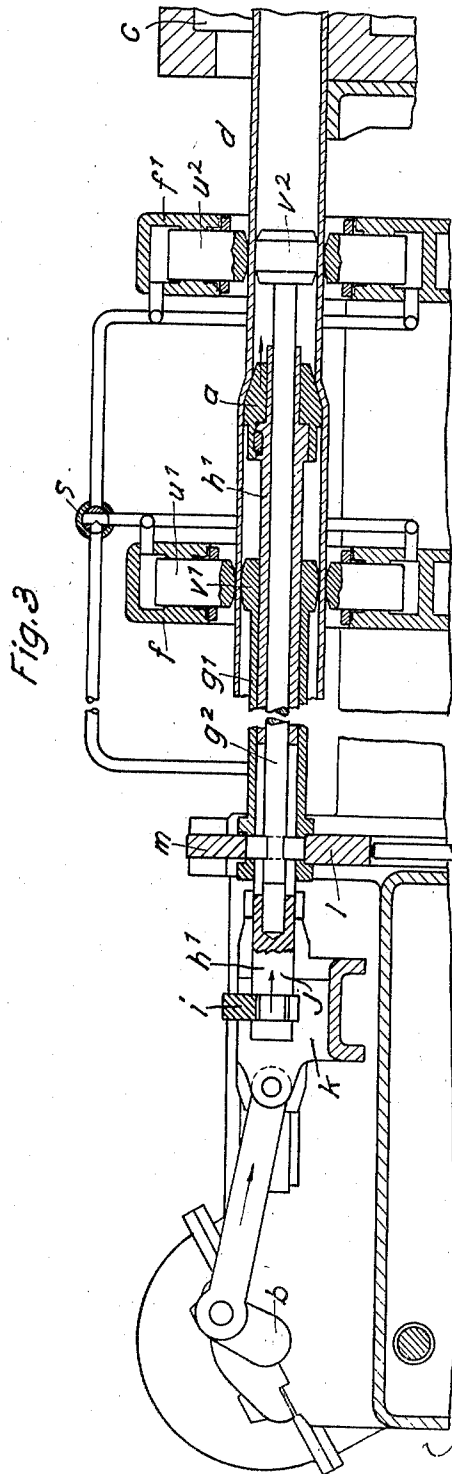
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PROCESS AND APPARATUS FOR EXPANDING TUBES

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PROCESS AND APPARATUS FOR EXPANDING TUBES

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4 Sheets-Sheet 4

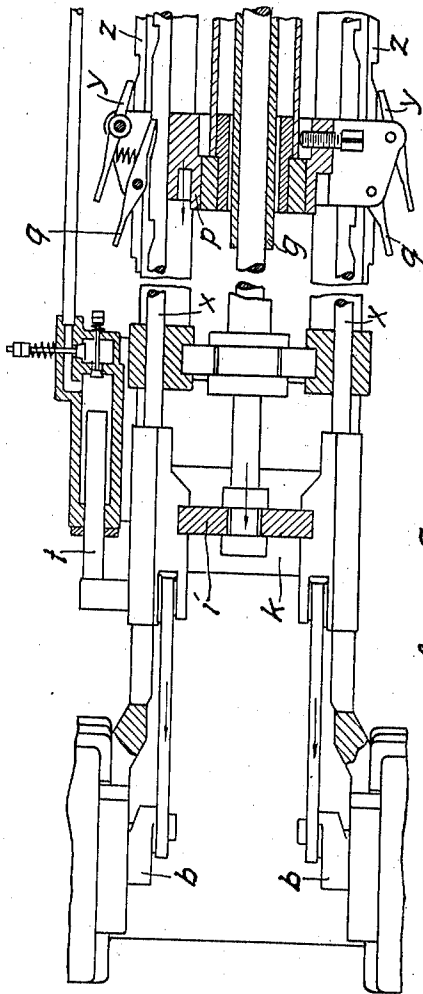


Fig. 4.

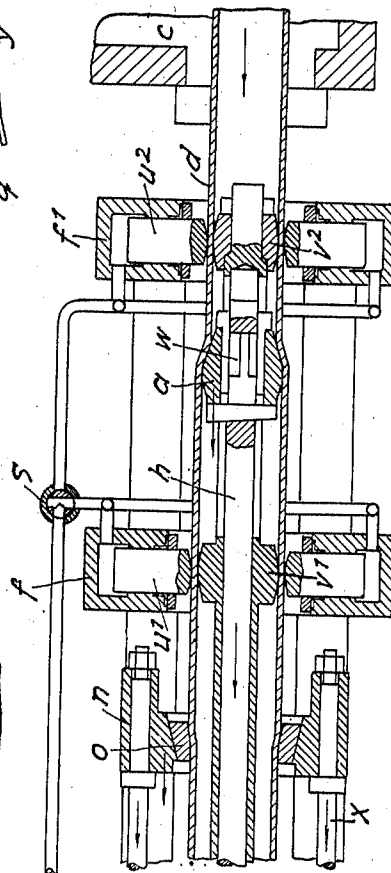


Fig. 4a

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UNITED STATES PATENT OFFICE

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PROCESS AND APPARATUS FOR EXPANDING TUBES

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13 Claims. (Cl. 205-4)

Many proposals have already been made for increasing the diameter of tubes by driving through them a mandrel head the diameter of which is greater than the internal diameter of the tube to which it is applied. Thus, for example, a process is known in which the tube is held at one end against an abutment and the expanding mandrel drawn through the tube from the opposite end. In this process the tube to be expanded is subjected to compressive stress along the progressively diminishing unexpanded portion of its length and if it be a thin-walled tube and very long it is liable to get up-set, corrugated or buckled in the process, especially if the expanding operation be carried out on a hot tube. In order to overcome this drawback a process has been evolved whereby a tube previously socketed out to the requisite extent, is clamped at the end at which the mandrel head enters. During the expanding operation the cross sections of the tube which have already been expanded are then subjected to tensile stress, so that the risk of buckling or corrugating is eliminated. In this process a tube, after having been heated in a furnace to a temperature suitable for drawing, is brought to the draw bench and the mandrel rod is threaded through it, the expanding operation being then carried out by drawing the mandrel through the tube. However, it is not possible in the course of this operation to avoid variation of the temperature at which the different parts of the tube change their shape because the rear portions of the tube will have lost part of their heat by the time the expander mandrel reaches and passes through them.

According to the present invention the expanding operation, which puts under tensile stress any previously expanded portion of the tube is carried out unlike the known process, in stages, using a short-stroke reciprocating expander mandrel. During the expanding stroke the tube is held by a clamping device applied to that part of it which has already been expanded. This clamping device, which is arranged on the expansion bed close to the rear dead point of the stroke of the mandrel head, releases the tube after the expansion thereof has been completed, so that the tube, binding on the mandrel, is carried bodily therewith at every return or idle stroke. When the mandrel head, carrying the tube, arrives at the rear dead point position, the clamping device grips the tube, so that, on the succeeding forward stroke the mandrel expands the said tube over a length equal to the length of stroke. This is followed again, as already ex-

plained, by a feed movement of the tube, brought about by return stroke of the expander mandrel. In the process proposed, only a short piece of the tube is subjected, on each occasion to the tensile stress set up by the expanding operation. Moreover, it is not necessary to thread a long mandrel rod into the tube. Another special advantage of the process resides in the fact that the expanding apparatus can be arranged in close proximity to a heating furnace, so that the tubes can be transferred gradually from the furnace, in stages alternating with the expanding strokes of the mandrel. Thus the leading end of a tube may be still in the furnace while the trailing end is already expanded. The entire expanding operation can therefore be carried out on a tube which is always uniformly and thoroughly heated.

Owing to the alternate gripping and releasing of the tube by the clamping device, it is not possible in all circumstances to avoid a certain amount of irregularity (albeit a very small amount) in the tube after expansion. To correct this the invention includes the provision (if required) of a die ring behind the clamping device, the internal diameter of this die ring being slightly less than the external diameter of the expanded tube. The tube is moved through this die ring either during the tube feeding stroke or during the expanding stroke and, in this way, any irregularities in its shape and dimensions are completely eliminated. The use of dies is not, however, an essential feature of the expanding process of this invention, for even when no such dies are employed, the quality of the expanded tube is perfectly satisfactory for most of the purposes to which such tubes would be applied.

In case the forces due to friction between the tube and the expander mandrel do not suffice to move the tube through the die ring during the return stroke, a further, but movable auxiliary clamping device for the already expanded leading end of the tube is provided. This auxiliary clamp participates in the return movement of the mandrel but during the expanding stroke it remains stationary or is fixed. Instead of an externally acting clamp, an auxiliary gripping device associated with the expander mandrel and acting on the inside of the tube may be provided. This device, like the external clamp is arranged to be operative only during the return stroke and under these conditions, to carry the tube with it.

In order to initiate the expanding process the

tubes must be previously socketed out to a diameter corresponding to the required expansion and the socket must extend over a length sufficient to enable the leading end of the tube to be passed over the mandrel head (then in its rearmost position) and into the clamping device. If, on the other hand, it be desired to avoid socketing, then there must be interposed between the heating furnace and the mandrel head an additional clamping device which holds the tube during the expanding stroke and releases it during the return stroke of the mandrel, such additional clamp remaining in operation until the expanded leading end of the tube can be gripped by the clamp which lies behind the mandrel.

In the accompanying drawings several constructional forms of apparatus for carrying out the new process are shown as examples.

Figure 1 is an elevational view of the tube expanding machine in longitudinal section.

Figures 2 and 2a together constitute a sectional plan of the apparatus shown in Figure 1.

Figures 3, and 4 and 4a together, are an elevation in longitudinal section and a sectional plan view, respectively.

Referring first to Figure 1, the expander mandrel *a* is reciprocated by a driving crank *b*. The tube *d* issuing from the furnace *c* is held by a clamping device *f* during the expanding stroke of the mandrel *a*, which stroke takes place in the direction indicated by the arrow *e* and on the return stroke of the mandrel the tube is carried with it. The clamping device *f* is located in proximity to the rear dead point position of the mandrel *a*, that is to say its final position at the end of its return stroke and its initial position at the beginning of its expansion stroke. The outer part of the clamping device *f* is connected to the frame of the machine while the part which lies inside the tube is attached to one end of a sleeve *g* the other end of which is connected, outside the range of travel of the tube, to the frame of the machine the manner of attachment being such as to permit of easy release. The sleeve *g* also functions as a guide for the mandrel rod *h*, the rear end of which is coupled by a bifurcated plate *i* to a cross head *k*. By lowering the plate *i*, turning back the yoke *m* and lifting out the plate *i* it is possible to take out the finished expanded tube *d*.

Figure 2 includes certain modifications of the apparatus shown in Figure 1, but is, in other respects, a sectional plan view of what is shown in that figure. Close behind the clamping device *f* and contained in a holder *n*, connected to the frame of the machine, a die ring *c* is provided. In Figure 2 an auxiliary clamping device *p* is also shown; this is carried by rods *r* which are parallel with the mandrel rod and are reciprocated therewith. The said clamp *p* is engaged with the rods *r* by means of spring actuated pawls *q* which are so arranged that the clamp moves with the rods during the return stroke of the mandrel but not during the expanding stroke. The presence of this auxiliary clamp *p* is necessary when using a die ring (as *o*) in order to draw the already expanded part of the tube through the die ring.

Whereas, in the construction shown in Figure 1, the clamping device *f* has clamping parts outside and inside the tube, in the other constructions (as shown in Figures 2 to 4) nothing but an annular bearing surface is provided inside the tube.

Figures 3 and 4, being an elevation in longitudinal section and a sectional plan view, respectively, show a further constructional form of an expanding machine, in which, in addition to the main clamping device *f*, a second clamping device *f*¹ disposed in front of the mandrel is provided. This second clamping device *f*¹ comes into operation only during the expansion of the front part of the tube, when it is desired to avoid preliminary socketing, which is disadvantageous per se.

The apparatus shown in Figure 3 is arranged and operated as follows: At the beginning of the expanding operation the three-way cock *s* is turned to shut off the pipe conveying fluid to the clamping device *f*. The tube *d* is pushed through the opened clamping device *f*¹ and up to the front of the expanding head *a* which is in its rearmost position. During the forward stroke of the mandrel, which begins when the crank drive is set in motion, the piston *t* (Figure 4) also moves forward and fluid is forced into the clamping device *f*¹ the plungers *u*² of which are thereby pressed against the tube. In this way the tube is held fast so that the mandrel can enter it in order to expand the said tube. When the expanding mandrel recedes, the plungers *u*² are again relieved of the load on them, by simultaneous recession of the piston *t*, and the tube is, therefore carried along with the mandrel. The expanded part of the tube now passes into the main clamping device *f*. By turning the cock *s* the other way, the clamping device *f* with the plungers *u*¹ is actuated in the same way as has already been described with reference to the clamping device *f*¹.

The clamping device works differently from the clamping devices shown in Figures 1 and 2. The apparatus of Figures 3 and 4 will now be described in greater detail.

To correspond with the two clamping devices *f*, *f*¹ two supports *v*¹, *v*² are provided in the interior of the tube. In the construction shown in Figure 3 the support *v*¹ is connected to a sleeve *g*¹ and the support *v*² to a rod *g*² concentric with the sleeve *g*¹, both being connected to the frame of the machine. The expander mandrel *a* is mounted on a sleeve *h*¹ interposed concentrically between sleeve *g*¹ and rod *g*², this sleeve *h*¹ being coupled to the cross head *k* by the plate *i*. Slots *j* in the sleeve *h*¹ make it possible for this sleeve to move relatively to the stationary parts *g*¹, *g*².

In the tube expanding machine shown in Figure 4 the supports *v*¹ *v*² are mounted on a single hollow rod or sleeve *g*. Inside this sleeve moves the mandrel rod *h*, having a slot in which are retained two longitudinal keys *w* and a transverse cotter between which the expanding mandrel head *a* is fixed. The die ring holder *n*, carrying the die ring *o* is driven by rods *x* so that it reciprocates with the expander mandrel. During the expanding stroke the tube, which is firmly held in the device *f* is rectified by the die ring *o*. The return stroke of the expander head and die ring advances the tube, the trailing end of which is gradually drawn up to and through the die by reason of the leading end being gripped in and advanced by the auxiliary clamping device *p*. This latter, when the expander mandrel *a* recedes, carries the tube with it, as in the construction shown in Figure 2, the die ring *o* also receding simultaneously, by reason of engagement of the pawls *q* with ratchet teeth formed in the rods *x*. When the expander mandrel and the die ring move forward on the ex-

panding stroke the auxiliary clamp *p* is kept stationary by the engagement of pawls *y* in racks *z* provided on the frame of the machine.

I claim:

5 1. Process for expanding tubes by passing an expander mandrel through the tube while holding the latter in a clamping device engaged with a part of the tube which has already been expanded, characterised by the fact that the mandrel executes a short-stroke reciprocating movement and that the tube is held fast during the expanding stroke by a clamping device which is operative only in one direction of mandrel movement but during the idle stroke of the mandrel is moved in the direction in which the mandrel moves.

2. Process for expanding tubes, as claimed in claim 1, characterised by the fact that the tube is subjected intermittently, in the course of its expansion, to a rectifying pass, during the idle stroke of the mandrel.

3. Process for expanding tubes, as claimed in claim 1, characterized by the fact that the tube is subjected intermittently, in the course of its expansion, to a rectifying pass, during the expanding stroke of the mandrel.

4. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander mandrel through the tube held by said clamping device, said mandrel passing means having a short stroke reciprocating movement, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling.

5. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander mandrel through the tube held by said clamping device, comprising a crank and a rod driven thereby and which is under compression during the expanding operation, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling, said clamping device being located in proximity to the rear dead point position of the mandrel.

6. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander mandrel through the tube held by said clamping device, comprising a crank and a rod driven thereby and which is under compression during the expanding operation, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling, said clamping device having a part located inside the tube and constructed as a simple support.

7. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander mandrel through the tube held by said clamping device, comprising a crank and a rod driven thereby and which is under compression during the expanding operation, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling, said clamping device having a part located inside the tube, a sleeve inside said tube having one end attached to said inside clamping device and the other end detachably attached to the machine frame outside the range of travel of the tube, said sleeve acting as a guide for said mandrel rod.

8. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander mandrel through the tube held by said clamping device, comprising a crank and a rod driven thereby and which is under compression during the expanding operation, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling, and at least one auxiliary clamping device which moves in the direction of the mandrel idling stroke but remains stationary during the expanding stroke, said auxiliary clamping device gripping the leading end of the tube and producing the feed movement thereof.

9. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander mandrel through the tube held by said clamping device, comprising a crank and a rod driven thereby and which is under compression during the expanding operation, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling, and at least one auxiliary clamping device, said auxiliary clamping device being connected to the mandrel and acting in the interior of the tube.

10. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander mandrel through the tube held by said clamping device, said mandrel passing means having a short stroke reciprocating movement, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of

mandrel idling, and a die ring arranged in proximity to the rear dead point position of the mandrel for subjecting the tube intermittently in the course of its expansion, to a rectifying pass.

5 11. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander 10 mandrel through the tube held by said clamping device, said mandrel passing means having a short stroke reciprocating movement, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, 15 said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling, and at least one auxiliary clamping device which 20 moves in the direction of the mandrel idling stroke but remain stationary during the expanding stroke, said auxiliary clamping device gripping the leading end of the tube and producing the feed movement thereof, and a die ring for 25 subjecting the tube intermittently in the course of its expansion, to a rectifying pass.

12. Apparatus for expanding tubes, comprising in combination, an expander mandrel, a clamping device constructed and arranged to engage with 30 a part of the tube which has already been expanded, and means for passing said expander mandrel through the tube held by said clamping device, said mandrel passing means having a short stroke reciprocating movement, and said 35 clamping device holding the tube fast during the

expanding stroke of the mandrel and being operative only in one direction of mandrel movement, said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling, and a starter clamping device located in front of the expander mandrel and serving to hold the tube fast at a part thereof which has not yet been expanded, said starter clamping device being operative during the expanding stroke of 10 the mandrel but releasing the tube for the idle stroke and continuing to operate until the expanded leading end of the tube can be gripped by the first mentioned clamping device located behind the mandrel.

13. Apparatus for expanding tubes, comprising 15 in combination, an expander mandrel, a clamping device constructed and arranged to engage with a part of the tube which has already been expanded, and means for passing said expander 20 mandrel through the tube held by said clamping device, said mandrel passing means having a short stroke reciprocating movement, and said clamping device holding the tube fast during the expanding stroke of the mandrel and being operative only in one direction of mandrel movement, 25 said clamping device releasing said tube during the idle stroke and said tube being moved by said passing means in the direction of mandrel idling, said apparatus being so arranged in the immediate vicinity of a heating furnace that heating of 30 the untreated part of the tube in the furnace can still continue while another part of the same tube is being treated in the expanding apparatus.

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