

Feb. 28, 1956

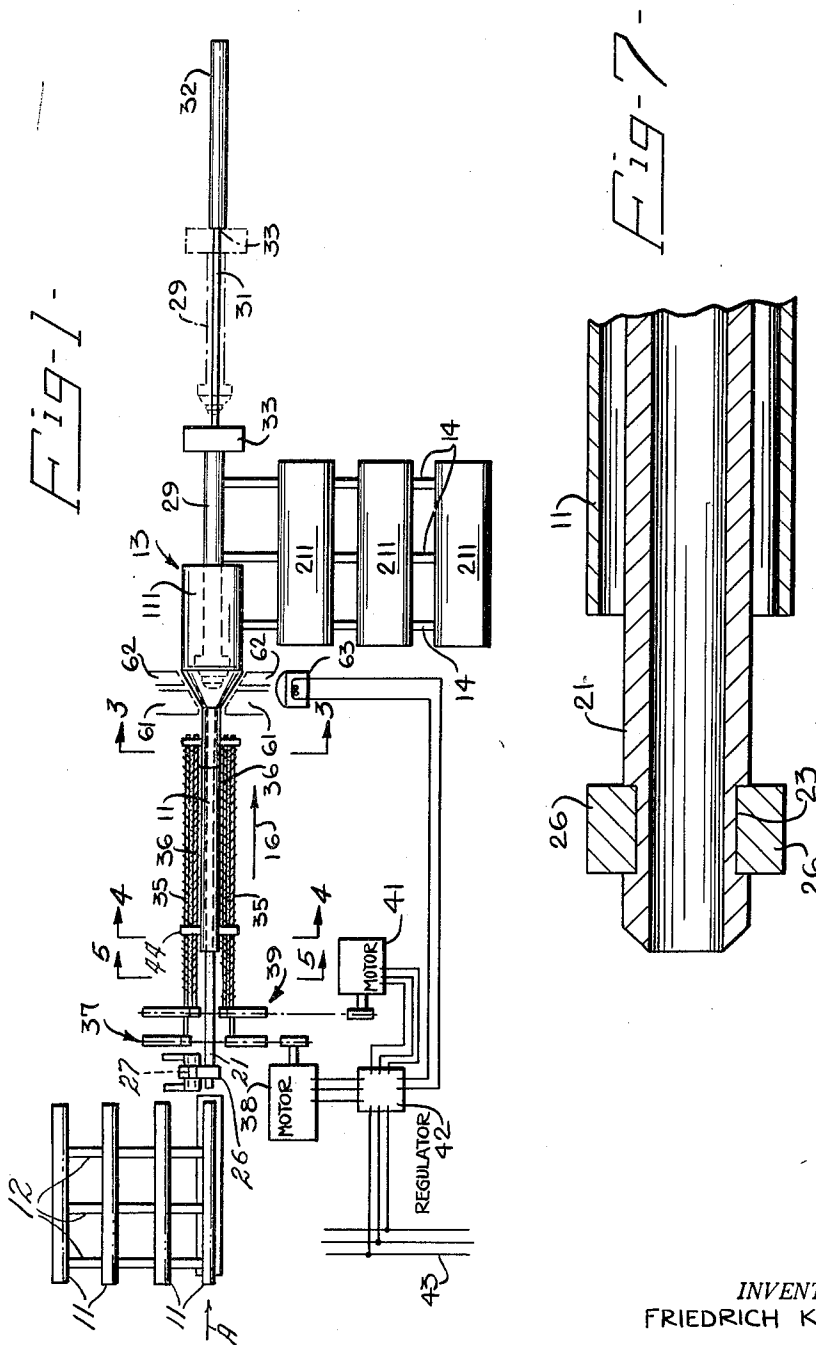
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2,736,361

MACHINE FOR EXPANDING TUBES

Filed May 19, 1950

3 Sheets-Sheet 1



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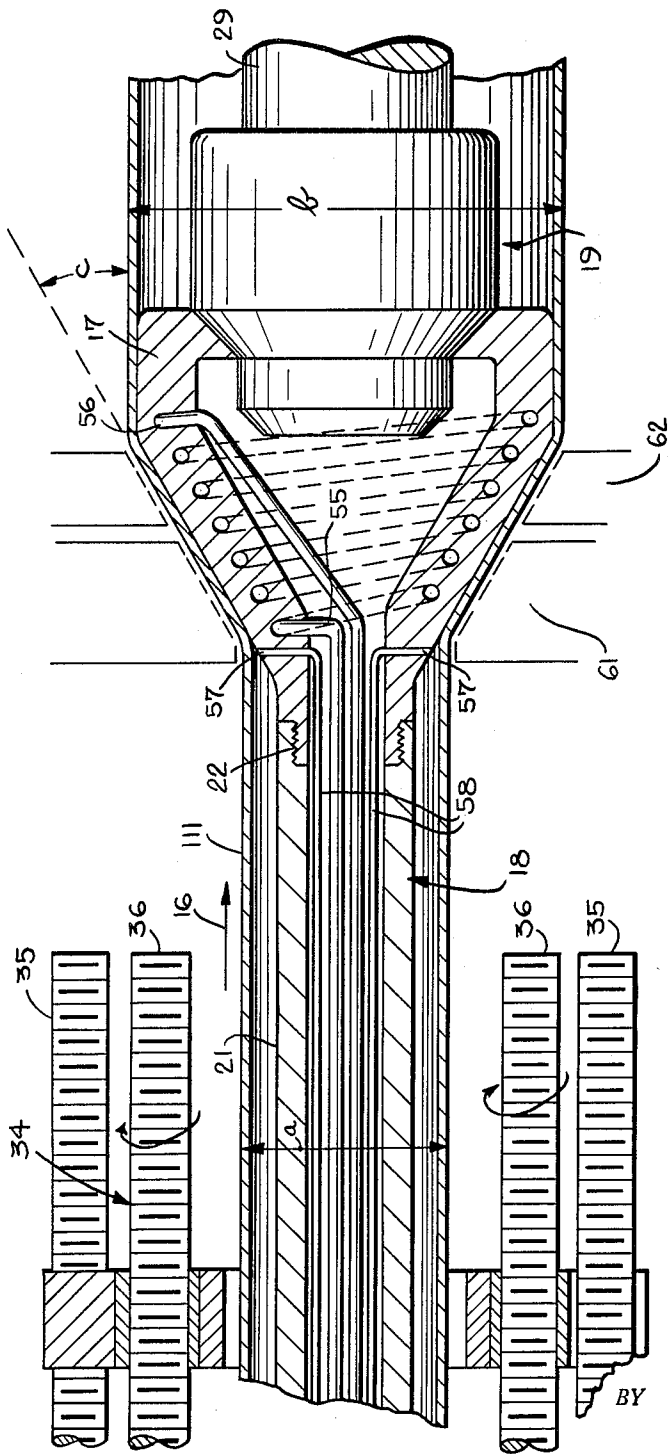


Fig-2-

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Fig-3-

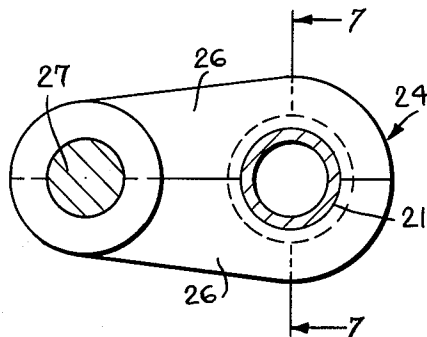
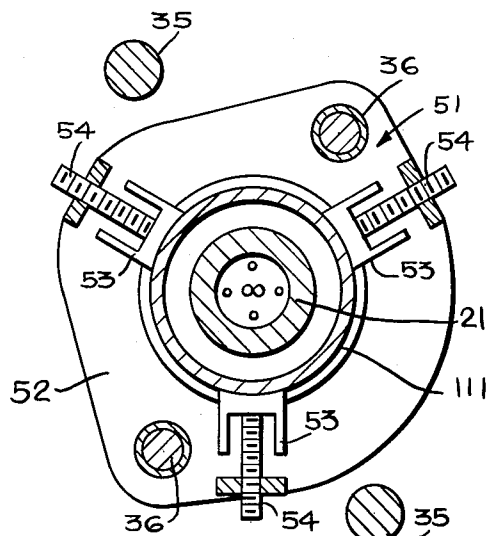


Fig-5-

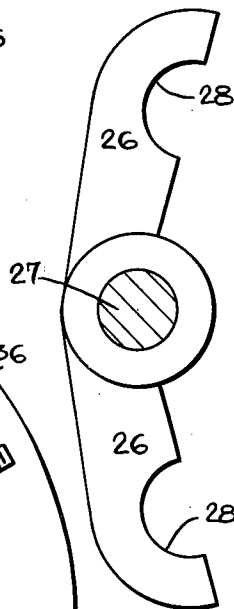
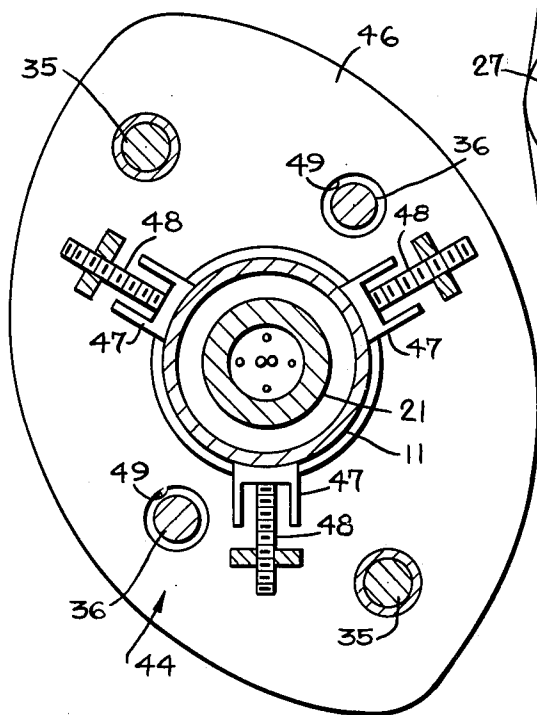


Fig-6-

Fig-4-

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2,736,361

MACHINE FOR EXPANDING TUBES

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Application May 19, 1950, Serial No. 162,975

2 Claims. (Cl. 153—80.5)

The invention relates to the expansion of tubes, and relates more specifically to methods of and machines for expanding tubes, particularly for seamless steel tubes.

In its broadest aspects expansion in accordance with the invention is carried-out by forcing a tube over a taper while heating the tube.

It is therefore one of the principal objects of the invention to provide methods of heating the tube while it expands over a taper.

It is another object of the invention to provide for regulation of the feeding speed of the tube in dependence of the heat imparted to the tube during expansion.

A further object of the invention is the provision of machinery suitable for carrying out the foregoing operations, particularly in a continuous process.

A still further object of the invention is the provision of moving successive tubes towards and over the taper while maintaining the latter in fixed position alternately from opposite sides to permit feeding and discharge of successive tubes.

Further objects and advantages of the invention will be set forth in part in the following specification and in part will be obvious therefrom without being specifically referred to, the same being realized and attained as pointed out in the claims hereof.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description, taken in connection with the accompanying drawings, in which:

Fig. 1 is a schematic plan view of a tube expansion machine in accordance with the invention;

Fig. 2 is a fragmentary sectional view showing certain details of the taper, heating mechanism and feed mechanism for the tubes;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 1;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 1;

Fig. 5 is a sectional view taken on line 5—5 of Fig. 1;

Fig. 6 is a sectional view similar to Fig. 5 but showing the open position; and

Fig. 7 is a fragmentary sectional view taken on line 7—7 of Fig. 5.

In carrying the invention into effect in one of the embodiments which has been selected for illustration in the accompanying drawings and for description in this specification, and referring now particularly to Figs. 1 and 2, a series of tubes 11 is shown disposed on racks 12 preparatory for entry into the expansion machine 13. One of the tubes 11 is shown disposed in the machine but in advance of the expansion mechanism thereof, and one tube designated 111 is shown in the process of expansion.

Following expansion, the tubes of wide diameter, designated 211, are disposed on racks 14 for delivery away from the machine.

Each of the tubes before expansion, designated 11 in that state, has a small diameter a , and after expansion when the tubes are designated 211 they have a diameter b . As best shown in Fig. 2, the tube 111 has the diameter

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a before expansion and the diameter b following expansion.

The expansion is carried out by forcing each of the tubes in direction of the arrow 16 over a taper 17. The taper 17 is hollow and is held in fixed location by alternately applying from opposite sides holding means designated 18 and 19, respectively. The holding means 18 is applied to the small side of the taper 17 after the tube has been fed into the machine and holds the taper 17 immovably axially against the tube feeding force. The holding means 19, on the other hand, is applied to the large side of the taper 17 and operates to maintain the taper immovably by a pushing force during the periods when the holding means 18 is disconnected to permit insertion of a new tube 11, and prior to the discharge of an expanded tube 211.

The holding means 18 comprises a hollow rod 21 that is with one end in permanent threaded connection 22 with the small side of the taper 17. The other end of the rod 21 is provided with a circular groove 23 that cooperates with a lock 24 for releasably latching the rod 21 and thereby the taper 17 axially immovably in predetermined position, as best shown in Figs. 5 and 7.

The rod 21 serves as a mandrel to guide each newly introduced tube 11 towards the taper 17 while the lock 24 is released. After the admission of the tube, the lock 24 is closed, thereby activating the holding means 18—while at the same time the holding means 19 is deactivated. Means may be provided, merely by way of schematic illustration shown in the drawing by an arrow A (Fig. 1), for pushing the last tube 11 of the racks 12 onto the rod 21.

The lock 24 includes two oppositely disposed latch members 26 that are pivoted on a shaft 27 that is mounted adjacent the end of the rod 21 but independent thereof. Each latch member 26 has a semi-circular depression 28 to engage therewith the circular groove 23 of the rod 21. The distance between the shaft 27 and the rod 21 is sufficient to permit the passage over the rod 21 of a tube 11 during admission thereof into the machine.

The holding means 19, on the other side of the taper 17 comprises a pushing member 29 that is reciprocally movable by a piston 31 of a power mechanism 32 operating either pneumatically or hydraulically or by other suitable means. In the active position in which the pushing member 29 abuts against the large side of the taper 17, the piston 31 is extended and a bearing surface 33 carried on the pushing member 29 provides an abutment for the pushing member 29 to hold it in place. This position is shown in Fig. 1 in solid lines; the retracted position is shown in Fig. 1 in broken lines indicating that the pushing member 29 is retracted, and completely clears the space necessary for discharging an expanded tube 211 onto the racks 14.

A feeding mechanism, generally indicated at 34, is provided to feed successive tubes towards and over the taper 17. It comprises two pairs of transportation spindles, the spindles 35 for the transportation of the tubes 11 and spindles 36 for the transportation of the tubes 111. The spindles 35 are driven from a power drive 37 that is interconnected by a transmission to the motor 38; the spindles 36, on the other hand, are driven by a power drive 39 that receives its energy from a motor 41. Both motors are interconnected in circuit with a regulator 42 that is interconnected to an electric network 43, as best shown in Fig. 1.

The spindles 35 and 36 are revoluble in opposite directions and are driven by the motors 38 and 41, respectively. Rotation of the spindles in one direction will propel the tubes, and in the other direction will prepare the mechanism for feeding the next tubes.

The pair of spindles 35 is in threaded engagement with bushings of a platen 46 of a chuck 44 and, depending on the direction of spindle rotation, transports the chuck either in the feeding direction 16 or in the opposite direction, respectively. The platen 46 carries a clamping mechanism having, for instance three clamps 47, that are movable radially and operated by clamp moving devices, such as three screws 48. The turning of the screws 48, which may be operated by a manually actuable wrench, will grip and release, respectively, the tube 11. It will be understood, that the clamping mechanism may also be operated in any other suitable manner.

The platen 46 furthermore is provided with two apertures 49 that are so positioned and sufficiently large to pass the spindles 36 which operate independently of the platen 46.

In a similar arrangement, the spindles 36 propel and retract a chuck 51 for releasably gripping the tube 111. The chuck 51 is provided with a platen 52 that engages the spindles 36 and carries movable clamps 53 that are operated by a clamp moving mechanism, such as, screws 54 that are similar to the previously mentioned screws 48.

The hollow taper 17 is provided on its interior with a labyrinthal bore 56, to circulate in the taper wall a cooling liquid, such as water or the like, and a pipe 55 connects the bore with the exterior through the inside of the hollow rod 21 for recovering and discharging the coolant.

Near the small side of the taper, there are furthermore provided outlets 57 that are interconnected to the exterior of the machine by means of pipes 58 which extend through the inside of the hollow rod 21. Lubricant, such as oil or graphite or a mixture thereof, is fed through the pipes 58 and discharged through the outlets 57 for facilitating the expansion of the tube 111 over the taper 17, by reducing friction between the inner surface of the tube 111 and the conical outer surface of the taper 17.

Means may be provided, not shown in the drawing, to connect, and to disconnect, the pipes 55 and 58 with outside sources of supply, for instance a flexible hose carrying such supplies and having a releasably quick acting connecting clamp, the connection and disconnection to take place at the time of closing and respectively of opening of the latch member 26.

Near the conical surface of the taper 17, but spaced therefrom sufficiently wide to permit the passage of the tube 111, there are provided two electric heating elements, designated 61 and 62 that are interconnected to an electric source (not shown). These elements serve the purpose to heat the tube during expansion thereof. In accordance with the invention, it is preferred to heat the tube during the start of its expansion to a lower temperature than at a further point along the conical surface of the taper, in order to prevent the occurrence of wrinkles in the tube 111 during expansion. Accordingly, the element 61 is arranged to deliver a lower temperature than that delivered by the element 62.

It is furthermore preferred, for reasons of economy, to keep the temperature imparted to the tube by the first element 61 below the magnetic conversion point of the steel of the tubes, since electric current of normal frequency, for instance 60 cycle frequency, can be used. For generating the higher temperature, such as that delivered by the element 62, it will be necessary to use high frequency currents, for instance A. C. currents of above 10 kilocycles frequency. Since heating by normal frequency currents, the over-all cost of heating is reduced by this stepped heating arrangement. In the exemplification only two such steps, represented by the elements 61 and 62 have been shown, but it will be understood that the number of steps may be increased, if desired, without departing from the scope of the invention save as limited in the claims hereof.

In accordance with the invention, the speed of feeding the tubes in direction 16 is regulated by the temperature

to which the expanding tube 111 is heated. In carrying out this phase of the invention, there is provided a measuring instrument, for instance a bi-metallic thermo element 63, that is interconnected in circuit with the drive mechanism for the spindles 35 and 36, such as by electric interconnection to the regulator 42 that controls the motors 38 and 41.

The operation of the invention is as follows.

During the continuous operation, a tube 11 is inserted through the open lock 24 while the taper 17 is supported immovably between the clamping chuck 51, gripping the tube 111 and the pusher member 29 of the holding means 19 the latch taking up the axial force of the taper, to surround the hollow rod 21. Then the lock 24 is closed to engage the groove 23 of the hollow rod 21 in order to actuate the holding means 18 for the taper 17. At the same time, the holding means 19 is de-activated by retraction of the pneumatic piston 31 and of the bearing 33. The taper 17 is then supported between the chuck 51 gripping the tube 111 and the holding means 18. The clamps 47 are operated by turning the screws 48, for instance manually by means of a wrench, to grip the exterior of the tube 11. The motor 38 energizes the power drive 37 to turn the spindles 35 for propelling the chuck 44, and therewith the tube 11 in the direction 16. After the tube 11 passes through the normal retracted position of the chuck 51, the clamps 53 of the latter are operated to grip the tube 11 and the clamps 47 of the first chuck 44 release that tube. Thereupon, the power drive 37 is reversed to retract the chuck 44, and the power drive 39 is energized by the motor 41 to propel the tube 11 towards and onto the taper 17 (tube 111).

Thereafter, in the meantime, the next tube 11 will be gripped by the first chuck 44, after the latter has returned to its vertical position. In this manner, one tube 11 after the other will be inserted, be gripped by the chuck 44, thence by the chuck 51, and thereafter be pushed over the taper, be widened and discharged, while during this continuous operation the holding means 18 and 29 are manipulated for alternate take-up of the sliding pressure exerted from the chucks 44 and 51 onto the tubes.

In this manner, in a continuous process, tubes 11 are fed from the racks 12 into the machines and expanded tubes 211 are discharged therefrom into the racks 14.

Shortly before the tube is expanded by the taper, it will be lubricated by lubricants emerging from the outlets 57 and will be heated at first by the element 61 and later on also by the element 62.

The feeding speed is regulated by means of the measuring device 63 that measures the heat absorbed by the expanding pipe and controls the speed of the power drives 37 and 39 automatically.

After the expansion is completed, the tube 211 is discharged onto the racks 14.

With the above-described process and machine, it is possible to expand tubes of identical initial dimensions to various final dimensions of outside diameter and/or wall thickness. For instance, if it is desired to expand a tube from an initial outside diameter a of sixteen inches to a final outside diameter b of thirty inches, the initial wall thickness of $\frac{3}{4}$ " may selectively be changed to a final wall thickness, for instance of either $\frac{3}{8}$ " or $\frac{5}{8}$ ". This is done by selecting tapers of different tapering angle c . For example, if the angle c equals 10° the expansion will be carried out over a long distance and the wall thickness will be reduced only for a small amount, while the tube length will be shortened to a marked extent.

On the other hand, if the angle c is large, for instance 30° – 40° , the taper 17 will be short in axial direction, and the wall thickness will be reduced to a great extent but the length of the tube will be reduced only for a small amount.

It will be understood that the tapers 17 can be selected to have, within a reasonable range, any desired end di-

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ameter. Thereby tubes 211 of desired end diameter and wall thickness can be produced by simply selecting the proper taper 17.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific exemplifications thereof will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claims they shall not be limited to the specific exemplifications of the invention described herein.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. In a machine for expansion of a series of tubes, in combination, a taper for expanding said tubes, a mandrel connected to the smaller side of said taper guiding the tubes to said taper for expansion and having a length greater than a tube before expansion, two alternately actuatable oppositely disposed devices operable to take up the axial force applied to said taper from said tube during tube expansion for immobilizing said taper during feeding and discharge of tubes in succession, comprising a first device including a clamp operable for releasably clamping said mandrel near the free end thereof to apply tension to said taper at the small side thereof against said axial force, and a second device including a ram reciprocable axially of said taper and operable for releasably applying pressure against the large side of said taper against said axial force, the length of said ram being greater than the length of an expanded tube, means connected to said ram and operable for projecting said ram and for holding it in the projected position and, respectively, for retracting said ram to clear a discharge path for the expanded tube, a reciprocably movable powered first feed mechanism operable to feed a tube in direction towards said taper, a powered second reciprocably

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movable feed mechanism, actuatable to take over the tube feeding prior to and during expansion thereof on said taper while said first mechanism is returned to its initial position for subsequent feeding of a succeeding tube, each feed mechanism including a clamping element for releasable tube gripping for feeding, said mechanisms being energizable and movable independently of each other, and power means for energizing said mechanisms.

2. In a machine, as claimed in claim 1, together with, heating means adjacent said taper and spaced therefrom throughout the circumference thereof for a distance sufficient for the passage therebetween of said tubes, and operable to heat each tube during expansion thereof, and a heat-sensitive device adjacent said heating means and extending to said power means and operable for regulating the feeding speed in response to the heating temperature of the tube during expansion.

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