METHOD OF EXPANDING TUBES

9 Claims, 13 Drawing Figs.

ABSTRACT: A tube expander apparatus and method for expanding heat-exchange tubing into pressure assembly with a header bore. Expanding power is supplied by hydraulically powered motive means supplied with pressurized fluid from electrically driven pump means. Torque-sensing means is employed to arm the automatic cycling of the expanding operation and to condition the apparatus for restoration to starting position at the end of the tube-expanding cycle. The expansion cycle can be held in dwell condition at any stage at the user's option for any purpose. Gripper means swivel mounted on the expander is effective to hold the tube against rotation during initial stages of the cycle should this be desirable.
METHOD OF EXPANDING TUBES

This invention relates to tube expanders and more particularly to an improved method and apparatus for expanding the end of heat-exchange tubing into assembled relation to a header in an automatic cycle and including provision for manually controlled interruption of the automatic cycle at any stage.

Various types of equipment and modes of operation have been proposed heretofore to expand exchanger tubes against seating bores therefore in header plates, but such equipment is subject to various shortcomings and disadvantages avoided by the present invention. Perhaps the most satisfactory prior construction is that disclosed in the Stary U.S. Pat. No. 2,690,205. The present apparatus and method have certain features in common with the apparatus there disclosed but include numerous new and improved features having decided advantages over the Stary expander. That apparatus is lacking in versatility and employs a complex control system subject to serious limitations. More specifically, the Stary concept revolves around means for timing and measuring quantities of work performed on metal undergoing work and intended to terminate the expansion cycle when such quantity of work has been performed. Typically, a portion of hydraulic fluid employed to work the metal is bled off at a predetermined rate and utilized to measure a time period. There is no way of interrupting either the operation of the timer or a tube-expanding cycle for any purpose as is highly essential under certain operating conditions commonly encountered in the use of that equipment.

Other disadvantages of prior expander equipment avoided by this invention include the lack of any provision for shifting a tube relative to the header and into proper expanding position during the expanding operation, nor does prior apparatus include means for holding the tube against rotation until such time as it has been expanded into a gripping relation with the header bore. Additionally, prior equipment lacks satisfactory means for suspending the expander tool selectively at a desired operating height and shifting it to a wide range of other operating heights while fully counterbalanced.

Still another unique feature of this invention is the provision of simple means for interrupting the advance or retraction of the expanding mandrel at any stage of the operating cycle and for locking it in this dwell position while the expander rollers continue in operation either to relieve stresses, to iron out high areas in the surface of the tubing, or to maintain a grip on the tubing while shifting it to a desired assembly position relative to the header. Means provided for these and the like purposes include valve means for controlling the mandrel reciprocating motor whereby this valve moves quickly and automatically to its neutral position when deenergized wherein it is effective to block all fluid flow to and from the mandrel reciprocating means. If the expander has reached its initial tube-gripping position, this grip can be positively maintained while the operator applies axial force to the tool to shift the tube into a proper assembly position and to hold it in this position as further advance of the mandrel is resumed. In this manner, a single operator in charge of the tool can utilize the expander tool to grip the tube and hold it in a proper position relative to the header as the tool resumes its normal expanding operation.

The present equipment also features a simple, unique and highly effective means for measuring mandrel torque as developed in expanding the tube. Thus, when the sensed torque, as determined by the electrical power requirements of the motor-pump unit supplying pressurized fluid to the mandrel drive motor reaches a predetermined value, load-sensing means operates automatically to arm the automatic control circuit for the expander. Pressure-responsive switch means in circuit with the arming switch responds to a preselected hydraulic fluid pressure, provided the circuit is armed, to initiate a sequence of operations including the automatic termination of the expansion cycle and the return of all components to their initial positions.

It is therefore a primary object of the present invention to provide a new and improved apparatus and method for expanding heat-exchange tubing into a header bore.

Another object of the invention is the provision of self-contained mobile automatic tube-expanding apparatus having load-sensing means responsive to the torque of the expander to arm an automatic cycle control circuit.

Another object of the invention is the provision of hydraulically powered tube expander apparatus having means carried on the expander tool for holding a tube against rotation until expanded into gripping relation with a header bore.

Another object of the invention is the provision of a tube-expanding apparatus and method featuring simple, easily controlled means for interrupting the reciprocation of the expander mandrel without interrupting the rotation of the tube-expanding rollers.

Another object of the invention is the provision of a self-contained mobile tube expander apparatus having improved means for supporting the expander tool selectively at various elevations and at different distances from the end of a tube undergoing expansion.

Another object of the invention is the provision of tube expander apparatus utilizing a single electrically driven motor to operate a plurality of hydraulic pumps each connected with a separate hydraulic motor and including load-sensing means in circuit with the driving electric motor and operative to arm an automatic cycle control circuit for said apparatus.

These and other more specific objects will appear upon reading the following specification and claims and upon considering in connection therewith the attached drawings to which they relate.

Referring now to the drawings in which a preferred embodiment of the invention is illustrated:

FIG. 1 is an elevational view partly in section showing a preferred embodiment of the invention in use to expand tubing;

FIG. 2 is a cross-sectional view on a slightly enlarged scale taken along line 2—2 on FIG. 1;

FIG. 3 is an enlarged view of the expander tool per se on an enlarged scale with portions broken away to show constructional details;

FIG. 4 is a cross-sectional view taken along broken line 4—4 on FIG. 3;

FIG. 5 is a cross-sectional view on an enlarged scale showing details of the tool suspension trolley mechanism;

FIG. 6 is a cross-sectional view on an enlarged scale taken along line 6—6 on FIG. 5;

FIG. 7 is a longitudinal sectional view on an enlarged scale taken through the tube expander components per se and showing the position of the components with the expander retracted and the tube gripper relaxed;

FIG. 8 is a view similar to FIG. 7 but showing the tube expander fully expanded and the tube gripper in gripping position;

FIG. 9 is a cross-sectional view taken along line 9—9 on FIG. 7 showing the expander contracted;

FIG. 10 is a cross-sectional view similar to FIG. 9 but showing the expander in an initial tube-gripping position;

FIG. 11 is a view similar to FIG. 10 but showing the tube more fully expanded;

FIG. 12 is a view taken along line 12—12 on FIG. 8; and

FIG. 13 is a schematic of the hydraulic and electrical controls.

APPARATUS IN GENERAL

Referring more particularly initially to FIG. 1, there is shown a preferred embodiment of the invention apparatus, designated generally 10, equipped with a chassis 11 provided with swiveling rollers 12. Rigidly supported on chassis 11 is an inverted L-shaped bracket comprising a tubular vertical leg 13 and an inverted channel-shaped horizontal leg 14. A trolley mechanism 15 concealed by leg 14 includes pairs of rollers 16.
(FIGS. 5 and 6) supported along the inturned lips of the channel member and having a downwardly projecting stem 18 supporting a pair of rollers 19 on a common pin. A suspension cable 20 for the expansion tool is trained over rollers 19. One end of this cable is secured to the bracket at the outer end of lip 14, while one other end of cable 20 is connected over one of pulley block 21 attached to the expander tool, then upwardly over the other one of pulleys 19, downwardly over pulley 22 at the upper end of bracket tube 13, through the counterweight pulley block 23, and thence upwardly to anchor strap 24. Attached to the underside of pulley block 23 is a rod 25 on which is supported an appropriate number of individual counterweights 26 which can be added and removed through access port 28 as necessary to balance the weight of the tool. It will therefore be evident from the foregoing that the expander tool can be raised and lowered to different levels, as well as moved to and fro horizontally lengthwise of bracket leg 14 with very little effort.

Mounted on chassis 11 is a hydraulic fluid reservoir, a single electric motor 31 coupled to drive each of the hydraulic pumps 32 and 33, a four-way valve 34 and various control components housed within cabinet 35.

The expander tool proper, designated generally 1, has a generally horizontally disposed main frame 38 along which the rotary hydraulic motor 39 is bodily reciprocated by the linear hydraulic motor 40. Motor 39 rotates mandrel drive shaft 41 as will be described presently and is effective components to expand the end of each of the tubes 42 into pressure contact with a bore through header 43. Expander tool 10 is provided with a manipulating handgrip 45 at the rear end thereof equipped with a push-push-type master control switch 46 and a normally closed holder switch 47. These switches are connected to control cabinet 35 by cabling 48, the reciprocating handgrip is so dimensioned to the hydraulic fluid circuit by fluid hoses 49, and rotary motor 39 is connected to these fluid circuits by high-pressure hoses 50.

THE EXPANDER TOOL

Referring to FIGS. 3 through 12 and initially more particularly to FIG. 3, it is pointed out that main frame 38 of tool 1 includes a forward plate 53 and a rear plate 54 rigidly interconnected by three parallel tie rods 55 forming a protective cage for motor 39. This motor is straddled by a U-shaped yoke 56 the legs of which extend horizontally along its opposite sides and having a crosspiece 56' bored to have sliding contact with one of tie rods 55 in the manner best shown in FIGS. 1 and 4. The forward ends of yoke legs 56 are anchored to flanges projecting from the body of motor 39 with the result that the yoke and its sliding connection with tie rod 55 is effective to anchor motor 39 against rotation while permitting it to slide to and fro lengthwise of the tie rods.

Linear motor 40 has a piston 58 connected by its piston rod 59 to motor 39. The opposite sides of the piston are supplied with pressurized fluid through hydraulic fluid hoses 49, 49. It will therefore be clear that movement of piston 58 operates to reciprocate motor 39 lengthwise of the main frame and in a direction depending upon the side of the piston to which pressurized fluid is supplied.

The right-hand end of motor 39 has a drive shaft 41 in axial alignment with piston rod 59 and connected to the motor through a combination rotary and thrust bearing assembly 60 of well-known construction.

Referring now more particularly to FIGS. 7 and 8, it will be noted that forward header plate 53 of the tool frame supports a tabular housing 62 enclosing a coupling 63 holding the inner end of tapered mandrel 64 coupled to motor shaft 41. Journelled in antifriction bearing assembly 66 at the forward end of tabular housing 62 is cage tube 67 surrounding the forward end of tapered mandrel 64. Cage tube 67 is provided with three elongated slots 68 having inwardly projecting lips 70 along their opposite lateral edges cooperating with mandrel 64 to hold rollers 69 captive within the slots. Further retaining assistance for the rollers is provided by a resilient sleeve 71 embracing the inner smaller ends of the rollers. It will be understood that the taper of rollers 69 is opposite and complementary to the taper of mandrel 64 with the result that the surface of the rollers adjacent surface of tube 42 is generally parallel thereto. If the true length of which the rollers are inclined slightly relative to the length of the mandrel for reasons well known to those skilled in this art.

A tube gripping or holding accessory, designated generally 75, is also desirablely present on the forward end of the tabular housing 62. This accessory serves an important function, particularly when expanding straight tubes to a header wherein the OD of the tube is less than the diameter of header bore 76. If the other end tube is not accessible or anchored to some other structure, it is likely to rotate within bore 76 making it impossible to start the expansion operation. In these circumstances, accessory 85 is operable to prevent tube rotation, a preferred embodiment being constructed and operating in the manner now to be described.

Accessory 75 includes a housing 78 seating loosely over a tabular boss 79 carried by the main frame and is held swivelly assembled thereto by means of the keeper screw 80 having its inner end seating loosely in an annular groove 81 formed in the exterior of boss 79. The forward end of housing 78 is formed with an angular recess 82 sized to telescope loosely over the foremost end of a tube 42 to be expanded, it being understood that with other tube 42 is customarily assembled to header bores 76 with their forward ends projecting slightly beyond the outer face of the header.

Accessory housing 78 includes a pair of parallel lugs 84 between which is pivoted an operating lever 85 on a pin 86 (FIGS. 7, 12). The forward end of housing 78 is notched at 88 to receive the inwardly projecting end 87 of lever 85 and this feature is so dimensioned to engage the end rim of tube 42, bite into and clamp the tube against the portion of bore wall 76 remote from the gripping lever. FIG. 7 shows the gripping end 87 of the lever out of engagement with tube 42, whereas FIGS. 10 and 12 show lever end 87 pivoted counterclockwise to clamp tube 42 against bore 76. A stop lug on the side of operating lever 89 (FIG. 7) engages housing 78 while the expanding tool is being inserted into its operating position thereby avoiding having the lever 85 pivot to a position interfering with insertion of the expander. Once the tool has been inserted, lever 85 may be employed to rotate accessory 75 to any convenient operating position about the axis of the expander.

THE AUTOMATIC CONTROL SYSTEM

Referring now to FIG. 13, there is shown a schematic of a preferred automatic control for the expander apparatus. The three-phase power supply 90 includes a suitable control box 91 for the starter equipment of a motor 31 driving the hydraulic pumps 32, 33. Pump 32 has its inlet connected to the hydraulic fluid reservoir 30 and supplies pressurized fluid to rotary motor 39 by way of the customary pressure-relief valve 92 and a manually adjustable flow regulator valve 93. The speed of motor 39 is regulatable by adjusting control 94 for valve 93. All spent pressurized fluid from valves 92, 93 and motor 39 returns to tank 10 in accordance with customary practice.

The pressurized fluid discharging from pump 33 passes to the linear motor cylinder 40 by way of pressure relief valve 96, four-way valve 34 and an adjustable pressure-compensating valve and temperature-compensating valve 97 having a manual regulating means 98 for varying the flow passing to the rear end of motor 40 to operate the expander in its advance direction. Also connected in the pressurized fluid line going to the advance end of motor 40 is a normally open pressure switch 100, a pressure gauge 101, and a recorder 102 to make a record of the operating cycle.

Four-way valve 34 is solenoid operated and is spring biased to return to its central neutral position if both solenoids are
deenergized. Under these conditions, all flow to and from motor 40 is blocked and the motor is locked rigidly against movement in either direction irrespective of the position it then occupies.

The normally open load-sensing switch 105 includes an operating coil 106 suitably coupled, as by a transformer not shown, to the power leads supplying electrical energy to motor 91 and functions to sense changes in the power supplied to this drive motor. The load-sensing control means includes conventional manually adjustable means, not shown, for changing the setting thereof to make switch 105 close when the power supply to motor 31 reaches a predetermined value bearing a known relationship to the torque force developed by motor 39 in driving mandrel 64 of the tube expander mechanism. In operation, for a variable period typically ranging between 0.0 and 1 second. During this time delay period the mandrel is automatically locked against axial movement but rotary motor 39 continues to rotate the expander rollers to smooth out any high areas in tube 42 which may be present at the end of the expanding operation and to relieve stresses in the tubing due to the substantial metalworking which has taken place. The several relays and other components of the circuit are connected between normally hot bus 110 and the common return bus 111, the various connections preferably being those shown in FIG. 13.

**OPERATION**

Let it be assumed that the operator has inserted the expander end of tool T into the free end of a U-shaped tube 42 having its other end previously expanded into a permanent fit with a header. Let it further be assumed that the free end of the tube into which the expander has been inserted does not terminate slightly forwardly of the front face of header 43 as it should before being expanded. Under these circumstances, the expander tool is rotated to obtain a grip on tube 42 and utilize this grip to pull the tube forwardly until its end projects beyond the forward face of header 43 by the desired distance and is held while being expanded into gripping relation with bore 76. The manner in which the tool is operated to accomplish this result is as follows: Starter control 91 for pump motor 30 is first operated to place this motor in operation and charging the hydraulic circuits with pressurized fluid. As this occurs, rotary motor 39 goes into operation to drive mandrel 64, then in its fully retracted position, the desired operating speed being achieved by adjusting the speed control 98 of valve 97. No pressurized fluid can reach linear motor 40 until the operator acts. The operator initiates the actual expansion operation by depressing push-pull switch 46 to close this switch thereby supplying power to relay R-1 causing this relay to shift to the left to supply power to the "advance" coil of the four-way valve 34 by way of the normally closed contacts of the deenergized R-2 relay and closed "hold" switch 47. The four-way valve then moves leftward to its advance position to supply pressurized fluid to the left-hand end of motor 40 causing its piston 58 to slowly advance the rotating motor 39 and mandrel 64 carried thereby to the right, as viewed in the drawings. As the smaller end of the mandrel advances, it forces rollers 69 outwardly into gripping relation with the interior of tubing 42. In the fully retracted and relaxed condition of the expander, the mandrel and rollers 69 are in the position shown in FIG. 9, but as the mandrel advances the rollers are forced outwardly until they engage the tube. When this occurs the rollers roll along the interior surface of the tube in the same direction as the mandrel. This operation is allowed to continue until the operator can sense that the rollers are firmly gripping tube 42. At this time the operator, without relaxing his grip on tool grip 45, depresses the button of normally closed switch 57 opening the latter and breaking the operating circuit of the "advance" control of four-way valve 34. Immediately the spring bias forming part of this valve shifts the valve to its neutral position blocking both the supply and exhaust flow passages of motor 40 and locking this motor against movement in either direction so long as switch 47 is held open.

However, the flow to rotary motor 39 continues to drive this motor and the firm grip of the rollers 69 on the tube 42. The operator then applies a pulling force to the outer end of tool T through handgrip 45 or, alternatively, allows the rotating expander 75 to drive the gripped tube outwardly by the screw action of the slightly canted rollers 69 until he observes that the outer end of tube 42 projects the desired distance beyond the front face of header 43. The opposite sides of the tube-holding accessory 75 are provided with viewing ports 113, and elsewhere if necessary, to provide the operator with a better and clearer view of the tube end. Once the tube has been pulled to a desired projecting position, the operator steadies the tool in this position and holds it firmly while relaxing his finger pressure on "hold" switch 47. As this switch closes, the four-way valve is reactivated to its "advance" position so that motor 40 resumes the advance of the mandrel lengthwise of rollers 69. The steady hold on the tube is required only for a short interval since the expander is substantially advanced to a position where tube 42 is in frictional contact with the bore wall.

Owing to the continuing rotation of the mandrel while being forcibly extended axially of the rollers, cold working of the tube is effective to expand it gradually into tighter and tighter pressure contact with bore 76. This working of the tube momentarily imposes an increasing torque load on mandrel 64 and on driving motor 39. This increasing torque load is accompanied by an increasing electrical power demand on motor 31 driving pump 32. Eventually this increasing power demand reaches a value effective to close load-sensing switch 105. This switch is preferably set to close just after the tube has been expanded against the bore wall sufficiently to prevent rotation or spinning of the tube.

The closing of load-sensing switch 105 arms or conditions the automatic control circuit, activation of the latter being consummated by the closing of pressure switch 100 to complete a power circuit through the coil of relay R-2. The operation of relay R-2 disrupts the power supply to the advance side of four-way valve 34 and simultaneously puts the "hold" side of the relay coil and its delay relay TD. However, this relay does not shift position until expiration of a predetermined time delay selected in advance by the setting of this relay. At the expiration of the time delay, the TD relay shifts position, closing a power circuit through the solenoid at the left-hand end of four-way valve 34, thereby reversing the flow of pressurized fluid through motor 40 and retracting the mandrel. During the time period axial movement of the mandrel is stopped in its advance position, motor 39 continues to rotate the mandrel and the rollers with the result that the tube metal is given a final working operation smoothing the interior of the tube and equalizing stresses in the freshly worked metal.
As soon as the time delay relay shifts to its alternate or left-hand position as viewed in FIG. 13, the mandrel begins to retract, allowing rollers 69 to relax, and all parts of the system to continue toward their initial starting positions. When fully retracted and restored to these initial positions, the system may continue to operate with pressurized fluid being supplied to the right-hand end of motor 40 without risk of injury to the equipment since the pressure relief valves in the hydraulic circuits open in response to any rise in pressure above a safe condition, thereby allowing excess fluid to return to reservoir 30. Deactivation of motor 40 occurs when the operator presses the push-pull switch 46 a second time thereby interrupting the power supply to the control circuit and deenergizing all three relay coils and allowing them to resume their normal positions illustrated in FIG. 13. As soon as the heavy torque load ceases on the mandrel, the load-responsive switch 105 opens and so does pressure switch 100. Accordingly, both of these switches resume their original normal positions well before the mandrel reaches its retracted position.

Now let it be assumed that the operator wishes to expand a tube 42 which has an initial loose fit in bore 46 and is not anchored at any point along its length. In these circumstances, the initial expansion of rollers 69 into contact with the tube is like to grip and rotate the tube about its own axis. If the mandrel fails to rotate, rollers 69 do not roll along the interior of the tube, and the tube is distorted into a triangular shape and it is impossible to expand it throughout its circumference into engagement with the bore wall. In these circumstances, no working of the tube metal occurs with the result that the torque forces do not build up in mandrel 64. Consequently, load-sensing device 105, 106 is not closed, the automatic control circuit is not armed and it is impossible to complete the expansion operation.

The foregoing undesirable results are safeguarded against in the present invention by employing the tube-gripping accessory 75 attached to the forward end of the main frame of the expander. The operator simply grasps the handgrip end of lever 85 and pivots it about pivot pin 86 forcing end 87 of the lever against the protecting end of tube 42 thereby clamping the tube firmly against the remote side of bore 76. This tool is highly effective in clamping the tube and holding it against rotation with the result that rollers 69 roll along the interior of the tube forcing the entire end of the tube to expand uniformly into firm contact with the bore wall. Once this occurs, the pressure on lever 85 may be relaxed and the expander operates automatically in the manner described above to complete expansion of the tube.

If at any time during the operation of the expander device it becomes desirable for any reason to interrupt either the advancement of the mandrel or its retraction, the operator need but press button 47 to interrupt the power supply to hydraulic valve 34 causing the latter to shift to its neutral position and lock motor 40 against movement in either direction so long as "hold" switch 47 is held open.

While the particular method and apparatus for expanding tubes herein shown and disclosed in detail are fully capable of attaining the objects and providing the advantages hereinafter stated, it is to be understood that they are merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the detail of construction or design herein shown other than as defined in the appended claims.

We claim:

1. That method of expanding tubing into high-pressure contact with the sidewall of a bore in a header which method comprises: gradually expanding a plurality of rollers against the interior surface of a tube end by gradually advancing a rotating tapered mandrel between and axially of said rollers thereby causing the rollers to roll about the interior of the tube in the same direction as said rotative mandrel, sensing the increasing torque load applied to the mandrel to rotate the same while expanding the tube against the sidewall of the header bore using pressurized fluid as the power source, sensing the pressure of the fluid pressure used to expand the tube, and terminating the tube expansion cycle when the sensed mandrel torque and the sensed fluid pressure have reached their respective predetermined values.

2. That method of expanding tubing as defined in claim 1 characterized in the steps of utilizing electrical energy to provide a source of motive power to rotate and advance said mandrel relative to said rollers, and wherein the sensing of the increasing torque load applied to said mandrel comprises sensing the increase in electrical energy required to power said mandrel as expansion of the tubing progresses.

3. That method of expanding tubing as defined in claim 1 characterized in the steps of utilizing electrical energy to pressurize hydraulic fluid, utilizing said pressurized fluid to rotate said mandrel and to advance the same axially of said tubing and said rollers, sensing the increasing torque applied to said mandrel by sensing the increased electrical energy employed to pressurize said hydraulic fluid, continuing the advance of said tapered mandrel until the sensed applied torque on said mandrel exceeds a selected value and until the pressure of the pressurized fluid reaches a selected value, and initiating the retraction of said mandrel relative to said rollers after a selected period of time following attainment of the selected pressure value of the hydraulic fluid.

4. That method as defined in claim 3 characterized in the steps of retaining the mandrel stationary against axial displacement relative to said tube while continuing to rotate the mandrel within the tube for said selected period of time, and thereafter withdrawing the mandrel axially of said rollers and allowing the latter to collapse away from the interior surface of the tube.

5. That method of expanding tubing as defined in claim 1 characterized in the steps of positioning the free end of the tube slightly forwardly of the bore in a header to which the tube is to be permanently secured, and gripping the projecting free end of the tube to hold the same from rotating about the tube axis as said expanding rollers initially contact the interior surface thereof, and maintaining said grip until the rollers have expanded the pipe into snug gripping contact with the surface of said header bore.

6. That method of expanding tubing into high-pressure contact with the sidewall of a bore in a header which comprises: expanding a plurality of rollers against the interior surface of a tube end by gradually advancing a rotating tapered mandrel between and axially of said rollers thereby causing the rollers to roll about the interior of the tube in the same direction as said rotating mandrel, and briefly locking the mandrel againstaxial movement relative to said rollers at any time while continuing to rotate said mandrel and said rollers relative to said tube.

7. That method defined in claim 6 characterized in the steps of continuing the advance of said mandrel relative to said rollers until the rollers are in firm gripping contact with the tube, briefly locking the mandrel against axial movement while bodily shifting the tube axially of the header bore, and holding the tube in a selected shifted position by force transmitted to the tube via said rollers while resuming the advance of the mandrel and the expansion of the tube into firm gripping relation with the bore sidewall.

8. That method of expanding tubing as defined in claim 1 characterized in the steps of utilizing the expansion of one of said torque load and said fluid pressure values to one of said predetermined values to arm the tube expansion cycle and the increase of the other thereof to its said predetermined value to terminate the tube expansion cycle.

9. That method of expanding tubing defined in claim 1 characterized in the steps of utilizing the increase of one of said torque load and said fluid pressure values to one of said predetermined values to arm the tube expansion cycle and the increase of the other thereof to its said predetermined value to terminate the tube expansion cycle.