Dec. 13, 1955 H. C. FISCHER 2,726,704

APPARATUS FOR SIZING TUBING

Filed May 23, 1952 2 Sheets-Sheet 1

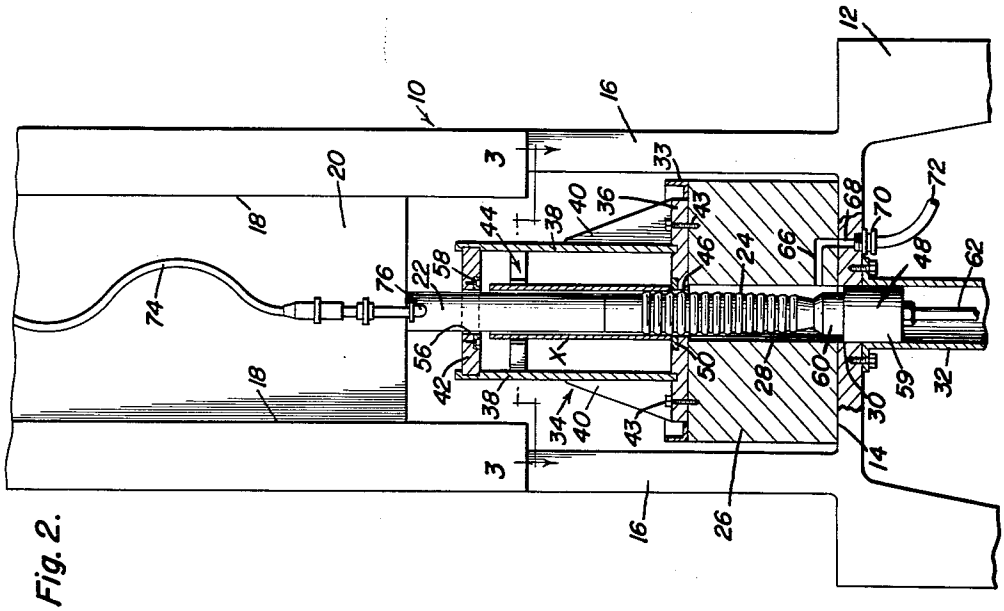

Fig. 2.

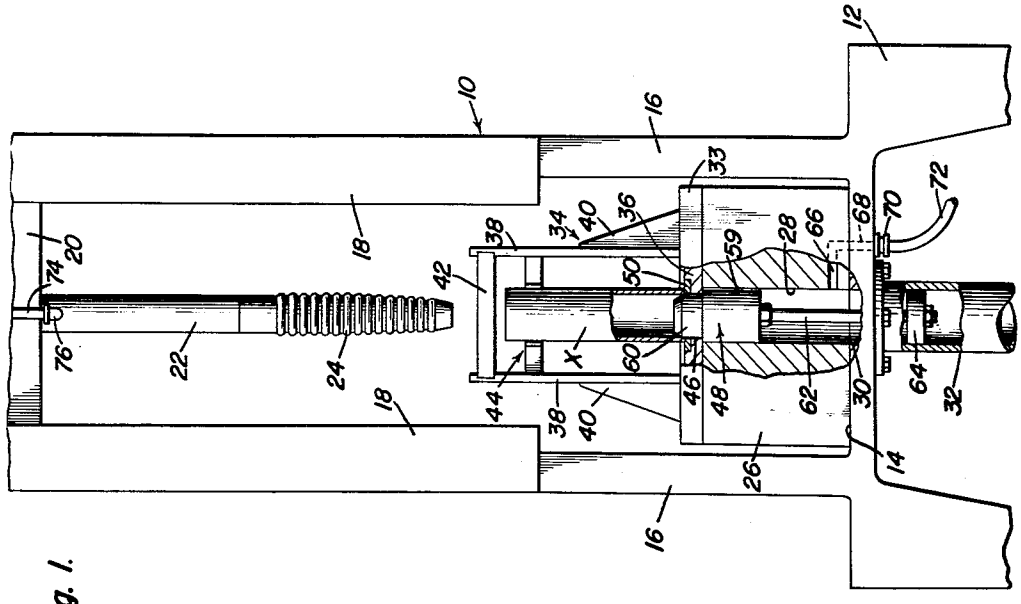

Fig. 1.

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Fig. 5.

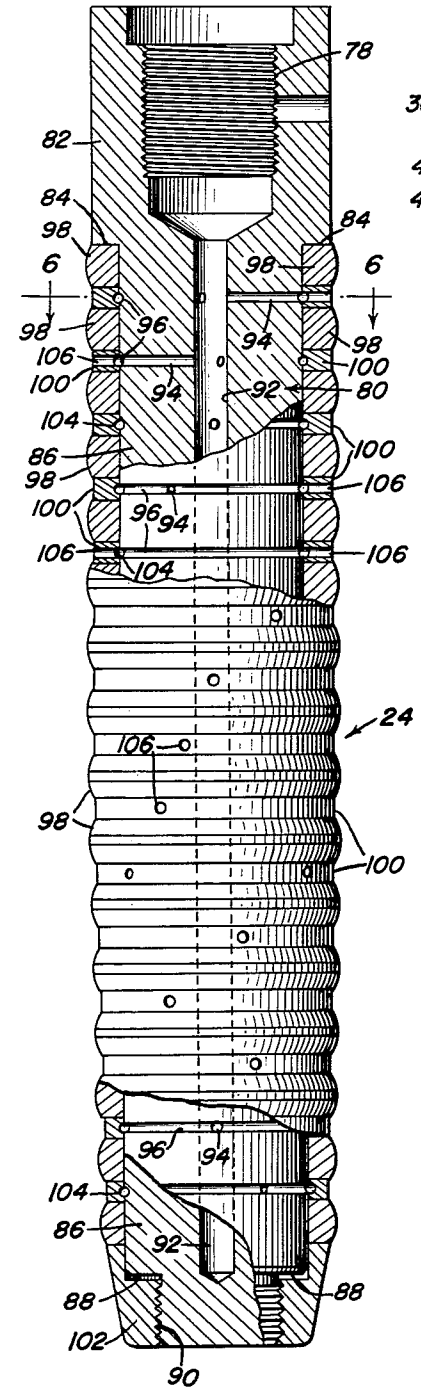
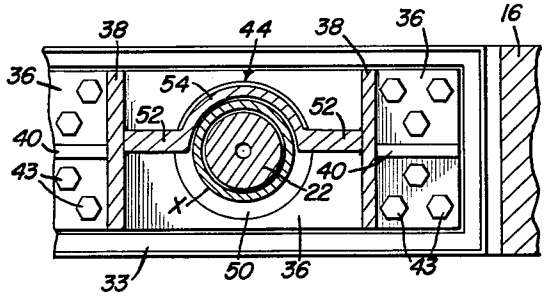


Fig. 3.



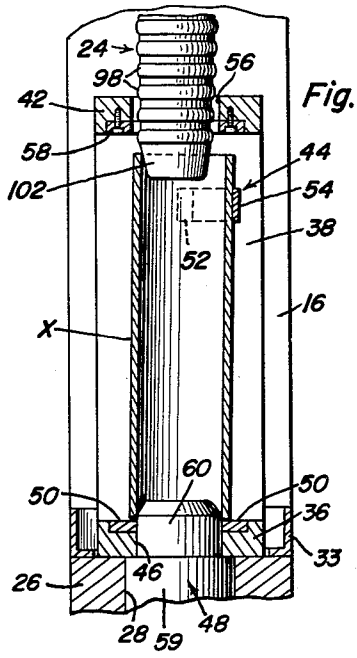


Fig. 4

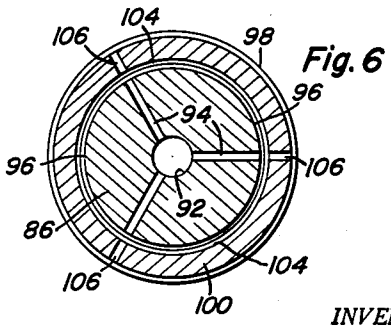


Fig. 6

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APPARATUS FOR SIZING TUBING

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Application May 23, 1952, Serial No. 289,705

9 Claims. (Cl. 153—80.5)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates generally to the production of precision tubing and particularly to apparatus for accurately finishing the inside and outside diameter of seamless tubing.

It is of utmost importance in producing precision tubing, such as casings for projectiles and shells, that it be as nearly cylindrical as possible and that it be susceptible to high speed mass production. In these fields, it is conventional to start with a forged or cold drawn, seamless tubing from a tube mill, and to turn the outside diameter and then to broach or bore the inside diameter. This has been necessary because tubing received from the mill is not perfectly cylindrical. It frequently has an ellipticity in its inside and outside diameter of plus or minus ten per cent of the wall thickness of the tubing. By the conventional methods, metal is removed from both the inside and outside of the tubing. It should be noted that removal of metal is both time consuming and wasteful from a cost standpoint because the removed metal has to be scraped.

It is an object of this invention to provide apparatus for taking seamless tubing and substantially eliminating the ellipticity in its inside diameter without removing any appreciable amount of metal from the tubing.

It is another object of my invention to provide apparatus for eliminating ellipticity in seamless tubing wherein the inside of the tubing is finished in approximately one-sixteenth the amount of time it takes to bore a tube.

It is a further object to provide a method and apparatus for finishing the inside of seamless tubing wherein the tubing is expanded and stretched to the desired shape.

It is a still further object to provide apparatus for finishing the inside of seamless tubing wherein the tubing is expanded and stretched to the desired shape by one stroke of a press which forces a ram through the tubing.

It is a specific object of this invention to provide apparatus for finishing the inside of seamless tubing wherein the tubing is expanded and stretched to the desired shape solely by a ram and without any external means holding the tubing stationary, and without a draw bench or tube feeding means.

It is another specific object of this invention to provide apparatus for finishing the inside of seamless tubing wherein the tubing is expanded and stretched to the desired shape, the interior of the tubing receiving a glossy finish without any minor imperfections, such as pits or indentations, and is work hardened, all of the preceding being accomplished by one stroke of a press which forces a ram through the tubing.

The above and other objects will become more apparent from the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a front elevation of the apparatus showing a tube in position to be finished, and the parts of the apparatus in position prior to operation of the press, a portion of the apparatus and tube being broken away and shown in section.

Fig. 2 is a view generally similar to Fig. 1, showing the position of the apparatus and tube after the press has been operated.

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2.

Fig. 4 is a fragmentary sectional view taken on a vertical line which passes through the center of the apparatus showing the parts in position just as the ram enters the tube.

Fig. 5 is a view of the ram in elevation showing portions broken away and shown in section.

Fig. 6 is a sectional view taken on line 6—6 of Fig. 5.

Referring to the drawings wherein like reference characters refer to like parts throughout, 10 generally indicates an hydraulic punch press having base portion 12, table portion 14, side portions 16, guides 18, and head 20, all of which is conventional press structure.

Head 20 is vertically reciprocable in guides 18 and supports depending adapter 22 which in turn removably supports ram 24, which will subsequently be described in detail. Base block 26 is secured to the table portion 14 in any conventional manner and has a vertical bore 28 formed therein which registers with bore 30 in table portion 14. Cylinder 32 is secured to the underside of table 14 in a conventional manner and extends vertically downwardly therefrom to a point of termination (not shown) where it is adapted to be connected with a conventional source of fluid under pressure (not shown). Block 26 supports a lubricant splash guard 33 and a work holder 34 which comprises base plate 36, vertical side plates 38, reinforcing webs 40, top plate 42, and work rest 44. Base plate 36 is secured to block 26 by bolts 43 and has an opening 46 formed therein which is in alignment with bore 28. Opening 46 is smaller in diameter than bore 28 and constitutes an upper stop for locator 48 which will subsequently be described. In its upper surface, base plate 36 supports a hardened, annular insert 50 which surrounds opening 46. Work rest 44 (see Fig. 3) comprises lateral supporting portions 52 with semi-circular, rest portions 54 positioned therebetween, the opposite ends of straight portions 52 being secured to side plates 38. Top plate 42 has an opening 56 formed therein and has a hardened, annular insert 58 secured in its underside which surrounds said opening.

Locator 48 comprises piston portion 59 and head portion 60, and is connected to piston rod 62 which has a piston 64 formed on its lower end (see Fig. 1). Head portion 60 is of smaller diameter than piston portion 59 and is adapted to project through opening 46 in plate 36, with its upper frusto-conical portion protruding above the surface of said plate. Both piston 64 and piston portion 59 are adapted to slide within the cylindrical guideway formed by cylinder 32 and bore 28. The normal position is for the locator to be in its uppermost position (shown in Fig. 1). In this position the frusto-conical portion of locator head portion 60 protrudes above plate 36 and constitutes a positioning means for the tubing which is to be sized. The locator is maintained in this position by fluid under pressure which acts on the under side of piston 64. This fluid is introduced into cylinder 32 by the aforementioned source of pressure fluid, and a constant pressure is maintained therein. The pressure of the fluid while normally being sufficient to urge the locator upwardly, is "soft" enough to permit retraction of the locator to its lowermost position (shown in Fig. 2) under certain circumstances. In a sense, the pressure fluid in pressing against the piston 64 acts in a manner similar to a spring.

Base block 26 is further provided with an L-shaped

passageway 66 which extends from the side of bore 28 to a point where it connects with port 68 in table portion 14, which in turn communicates with fitting 70, to which hose 72 is coupled. Hose 72 exends to a filter and pump (both not shown) which in turn communicate with hose 74 which constitutes a lubricant intake, which is coupled to fitting 76 of adapter 22. Adapter 22 is hollow and at its lower end has an externally threaded portion which is received in internally threaded box 78 formed in the top of core 80 of ram 24 (see Fig. 5). Core 80 is made of heat treated steel and comprises an enlarged cylindrical portion 82 formed at its upper end, a shoulder 84, elongated, reduced, cylindrical portion 86, shoulder 88, and further reduced, cylindrical portion 90, which is externally threaded. Core 80 has a central elongated bore 92 formed therein which extends from the upper end of core 80 axially through said core to a point short of the lower extremity of the core. Bore 92 communicates with spaced, transversely disposed passages 94 which extend radially from bore 92, through core 80 to annular grooves 96 which are axially spaced in the outer surface of core 80.

Mounted on elongated, cylindrical portion 86 of core 80 are a series of sizing rings 98 and oil rings 100. There are sixteen tungsten carbide sizing rings 98, the uppermost one of which abuts shoulder 84. The upper eight sizing rings have the same outside diameter. The lower eight sizing rings progressively increase in their outside diameter from the lowermost sizing ring, which has the smallest outside diameter, to the eighth sizing ring from the bottom, which is just slightly smaller in outside diameter than the upper eight sizing rings. There are fifteen hardened and ground oil rings 100 dispersed among the sixteen sizing rings so that each oil ring is positioned between two sizing rings. Each oil ring 100 has an annular groove 104 formed in its inner surface and radially extending ports 106 formed therein which communicate with said groove. Draw nut 102 is threaded onto reduced cylindrical portion 90 of core 80, abutting the lowest sizing ring and maintaining all the rings securely in position.

Having described my apparatus for sizing tubing, there follows a detailed description of its mode of operation. It should be noted at this point that tubing of different dimensions may be sized by selecting a ram of appropriate dimensions. Test sizings have been successfully made on tubing from one and one-eighth inches to six inches in inside diameter, and with wall thicknesses up to one-half inch. The greatest length tried successfully on a production basis was a sixteen inch-long tubing. The above noted sizes of tubing are indicative of the range of dimensions that have been successfully employed with a one hundred and fifty ton press. These figures are intended to be exemplary and not limitations, for they are not critical. The capacity of the apparatus to handle a particular size tubing is dependent upon the size of the apparatus which can be varied within the limits of practical and physical considerations.

Specifically, the apparatus operates as follows: referring to Fig. 1, a piece of tubing to be expanded, indicated by reference character X, is placed end up on hardened insert 50 of base plate 36 while the ram 24 is in its upper position. By reference to Figs. 3 and 4, it will be seen that tubing X is positioned by locator head portion 60 of locator 48 and by work rest 44. The lower open end of tubing X surrounds locator head portion 60, seating thereof being facilitated by the frusto-conical portion of said locator head portion, thereby determining a point around which the tubing X can pivot. The tubing X is placed against semi-circular rest portion 54 of work rest 44 and is maintained in a stationary, tilted position thereby. Fig. 4 clearly shows the position of tubing X to be tilted out of alignment with vertically disposed ram 24 prior to said ram entering said tubing on its downward stroke. Ram 24 is adapted to reciprocate in a vertical plane by the conventional hydraulic punch press 10. It will be observed that the lower tip of the ram is of smaller outside diameter than the minimum inside diameter of tubing X, and that the draw nut 102 is adapted to enter the tubing X without jamming against the upper, leading edge of said tubing. By reference to the detailed description of ram 24, it will be recalled that the lower eight sizing rings 98 of said ram progressively increase in outside diameter and culminate in the constant, final diameter of the upper eight sizing rings. Therefore, as the lower tip of the ram penetrates into tubing X, either the first or second sizing ring 98 will contact the side of tubing X which is opposite to the side thereof which contacts work rest 44, and will urge it toward a vertical position, thereby lifting said tubing away from said work rest. As the ram penetrates further, the larger sizing rings enter said tubing and begin to stretch and expand said tubing so that its inside diameter conforms to the substantially round outside diameter of the ram, thereby eliminating any ellipticity in the inside diameter of the tubing.

During movement of the ram, lubricant is force fed through the intake hose 74, adapter 22, and through the following parts of the ram: bore 92 of core 80, passages 94, annular grooves 96 of core 80, annular grooves 104 of oil rings 100, and out ports 106. This lubricant supply system lubricates the contacting surfaces of the ram and tubing during the expanding operation. Lubricant splash guard 33 limits the movement of any lubricant that might escape out of tubing X onto block 26. When the ram has penetrated into and partially through tubing X, to the position shown in Fig. 2, the entire tubing will have been subjected to the expanding effect of one or more of the largest diameter sizing rings. Since the outside diameter of the sizing ring constitutes the desired size, the tubing X will have been expanded to the desired inside diameter, and substantially all ellipticity will have been eliminated therefrom. In the process of expanding the tubing, minor imperfections in the inside surface of the tubing are eliminated, and a glossy, work-hardened interior surface is produced.

Still referring to Fig. 2, it will be seen that the tip of ram 24 has contacted locator 48 and forced it downwardly against the pressure supplied beneath piston 64. In its lower, retracted position, locator 48 is below passageway 66, thus permitting said passageway to communicate with bore 28, and the inside of tubing X. While the parts are in this position, lubricant flows out from between the ram 24 and tubing X, through bore 28, passageway 66, bore 68 and out hose 72 to the filter and pump (both not shown), where the lubricant is filtered and pumped to and through intake hose 74 for supply to the ram and recirculation through the lubricating system.

When the ram is retracted upwardly, the tubing X might be carried along with it until the upper, leading edge of the tubing contacts hardened insert 58 of top plate 42, which prevents further movement of the tubing, thereby removing it from the ram. When the ram is in its uppermost position, the finished, sized tubing X is removed and the next piece of tubing to be sized is placed in position for the next downward stroke of the ram.

With the inside diameter sized, the outside diameter of the tubing may then be turned to roundness by locating the sized piece of tubing in the turning apparatus from its finished inside diameter.

The above-described apparatus and method of sizing tubing achieves each and every object of this invention and possesses the following outstanding advantages: (1) production of finished tubing is tremendously increased over old methods which included boring or broaching, (2) waste is eliminated because no appreciable amount of metal is removed and scraped as in old methods which included boring or broaching steps, (3) minor imperfections in the interior surface of tubing are eliminated by the action of the ram, (4) a glossy finish is imparted to the interior surface of the tubing, which facilitates loading

of the tubing when it is used as a shell casing, (5) the interior surface of the tubing is work-hardened by the ram, which results in finer, deadlier fragmentation of the tubing when it is used as a shell casing and exploded, and (6) the need for testing the finished tubing bores is eliminated because the method produces standardized bores when identical tubing is used.

While I have fully described my apparatus and method in detail with respect to the illustrated, preferred embodiment, I do not intend thereby to limit myself thereto, but intend to embrace all modifications which fall within the spirit and scope of the appended claims.

I claim:

1. Apparatus for sizing tubing comprising a base, a support mounted on said base and adapted to support one end of a piece of tubing in a substantially fixed position, a circular opening in said support, a reciprocable locator mounted on one side of and in alignment with said opening, means normally holding said locator in a position in which it projects through said opening to thereby position the end of the tubing contacting the support, a rest positioned on the other side of said support for supporting the side of said tubing, a ram having a cylindrical trailing portion and a tapered leading portion mounted for reciprocation in alignment with said opening, reciprocating means constructed and arranged to thrust said ram through said opening and then withdraw said ram back through said opening and the tubing, means for causing said locator to move away from said support after said ram has entered the tubing, and a stop so positioned as to engage the tubing and strip it from the punch as the punch is withdrawn.

2. Apparatus as defined in claim 1 wherein said reciprocating means comprises a punch press.

3. Apparatus as defined in claim 1 wherein said locator has a frusto-conical portion which facilitates seating said tubing.

4. Apparatus as defined in claim 3 wherein said locator is mounted in the base of said apparatus and said frusto-conical portion projects upwardly above said base.

5. Apparatus as defined in claim 4 wherein said locator is movably mounted in a bore in said base, and which includes means for urging said locator upwardly.

6. Apparatus as defined in claim 1 wherein said rest includes a transversely disposed, semi-circular portion which is adapted to support a side of said tubing, said semi-circular portion being positioned relative to said locator so as to cause said tubing to be maintained in a plane which is inclined slightly relative to a vertical line.

7. Apparatus as defined in claim 6 wherein said ram is disposed and reciprocable in a vertical plane and is positioned relative to said locator and said rest so that the tip of the tapered portion of said ram will penetrate into said tubing when said ram is moved toward said tubing, but wherein said ram will not be in alignment therewith.

8. Apparatus for sizing tubing comprising a locator for positioning an end of a piece of tubing, a rest for supporting a side of said tubing, a tapered, cylindrical ram reciprocably mounted, the smaller diameter portion of said ram being adapted to penetrate into said tubing and the larger diameter portion being adapted to penetrate and expand said tubing, and means for reciprocating said ram, said locator being mounted in a bore in the base of said apparatus, said ram having a plurality of openings and means for supplying lubricant to said openings, said base being provided with a passageway which communicates with said bore at a point which is normally below said locator but which is above said locator when said locator is moved into the bore to its retracted position, and lubricant disposition means communicating with said passageway.

9. Apparatus as defined in claim 8 wherein said ram is in alignment with said locator and adapted to move it below the level of said passageway when said ram is moved downwardly.

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