United States Patent [19]

Kožušník

[11] **3,740,811**

[45] **June 26, 1973**

[54] **METHOD FOR MANUFACTURING PUMP SPINDLE**

[75] Inventor: **Karel Kožušník**, Olomouc, Czechoslovakia

[73] Assignee: **Sigma Lutin Narodni podnik**, Olomouc, Czechoslovakia

[22] Filed: **Sept. 4, 1970**

[21] Appl. No.: **69,963**

Related U.S. Application Data

[62] Division of Ser. No. 818,715, April 9, 1969, Pat. No. 3,606,789.

[52] **U.S. Cl.** **29/156.4**, 29/417, 29/517, 72/402

[51] **Int. Cl.** **B23p 15/00**

[58] **Field of Search** 29/156.4, 517, 417, 29/412; 72/402, 145, 367, 371

[56] **References Cited**

UNITED STATES PATENTS

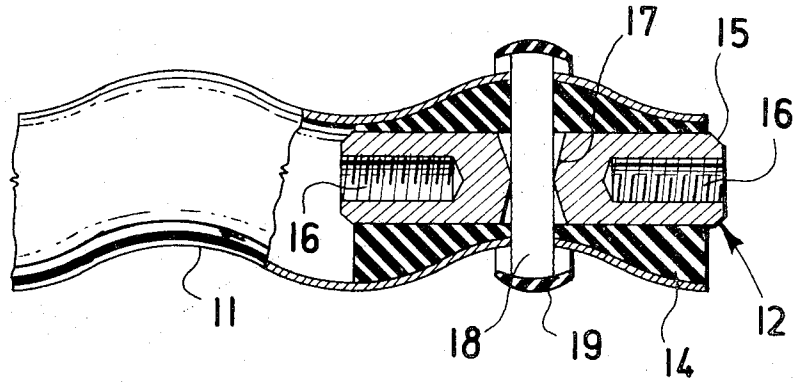
1,483,038	2/1924	Zederbaum et al.	72/402
2,225,345	12/1940	Lamoreaux	72/402
2,311,662	2/1943	Hunziker	29/508
2,978,263	4/1961	Walsh et al.	29/517
3,335,594	8/1967	Peterman et al.	29/508
3,372,460	3/1968	Burns et al.	29/417
3,503,246	3/1970	Shiokawa	72/370

Primary Examiner—Charles W. Lanham
Assistant Examiner—V. A. Dipalma

[57] **ABSTRACT**

A pump spindle has a screw-shaped configuration and is in the form of an elongated hollow tube of small wall thickness, carrying at one end a means through which a drive is transmitted to the pump spindle. The tube is given its required configuration by means of pressing jaws which press inwardly against the tube and which are suitably shaped so as to achieve the desired helical configuration for the hollow pump spindle. These jaws are supported not only for axial movement but also for radial movement toward and away from a given axis along which the tube is advanced and around which the tube is rotated, so that by advancing the tube in steps synchronized with the movement of the shaping jaws there will issue from an apparatus for manufacturing the pump spindle a tube of required configuration from which a section of predetermined length can be cut. Thereafter, a connecting means is fastened to one end of the thus cut tube to be able to transmit a drive to the tube through the connecting means.

1 Claim, 6 Drawing Figures



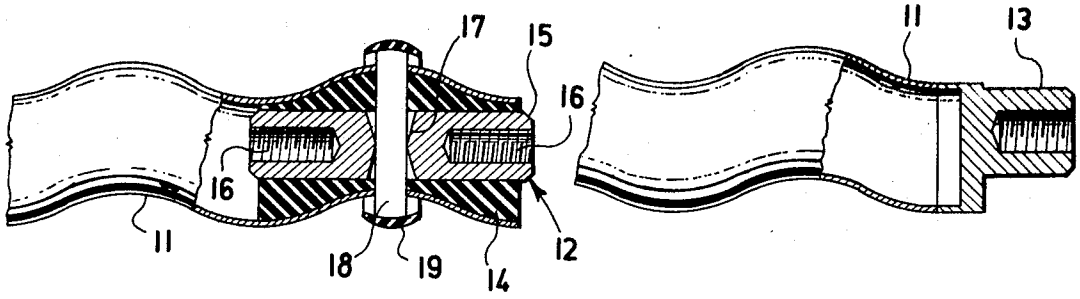


Fig. 1.

Fig. 2.

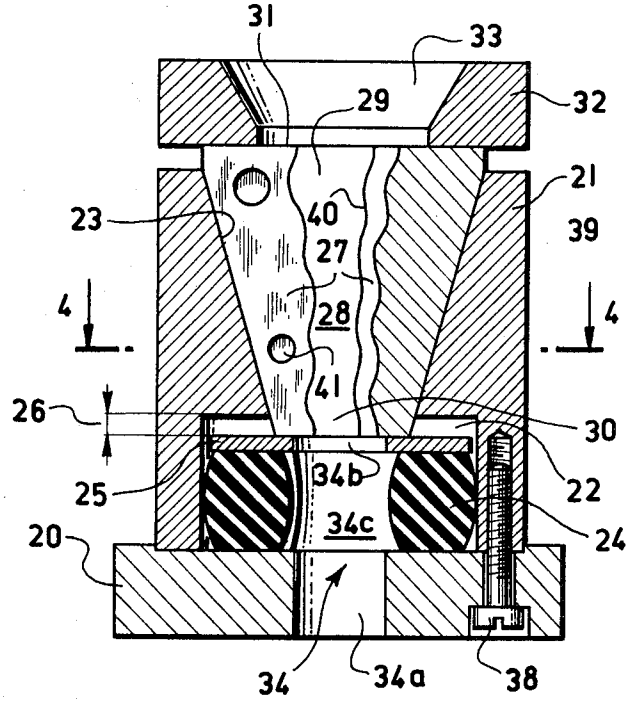


Fig. 3.

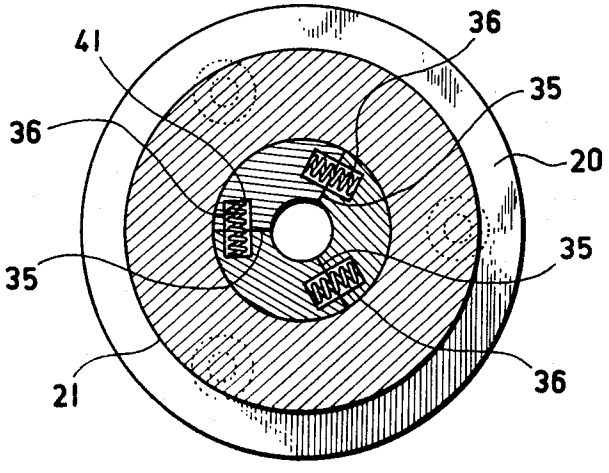


Fig. 4.

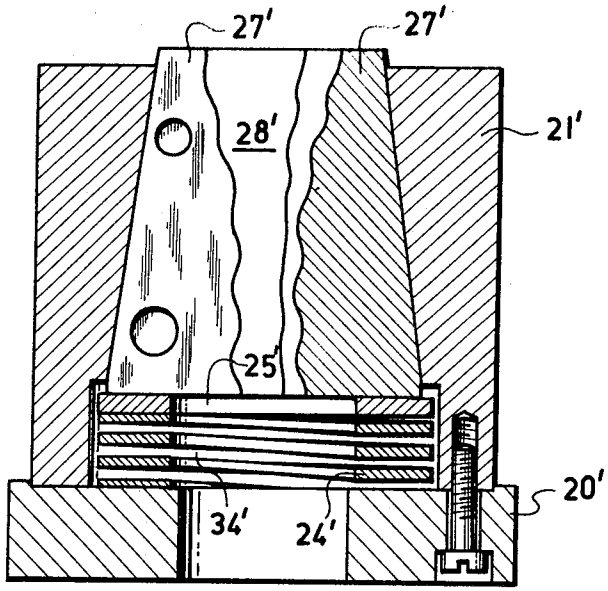


Fig. 5.

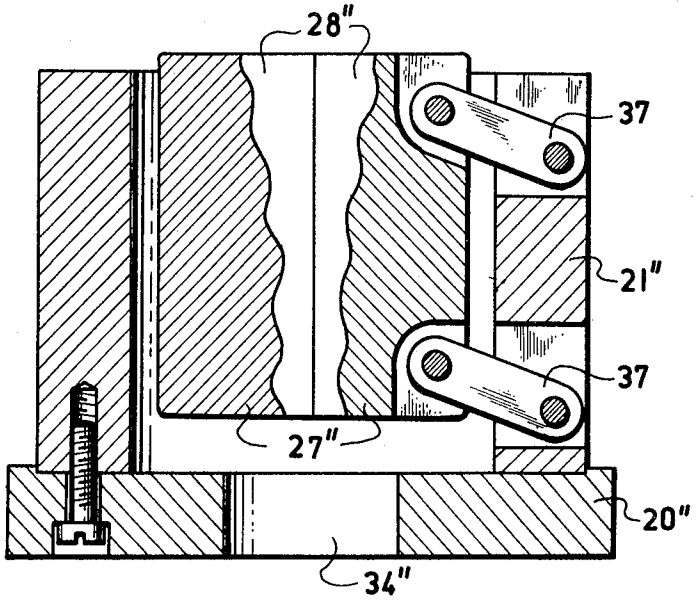


Fig. 6.

METHOD FOR MANUFACTURING PUMP SPINDLE

This application is a division of application Ser. No. 814,715, filed Apr. 9, 1969, now U.S. Pat. No. 3,606,789, Sept. 21, 1971, and claim is hereby made to all of the equitable and legal benefits derivable from each.

BACKGROUND OF THE INVENTION

The present invention relates to spindles.

More particularly it relates to pump spindles, especially for single-spindle pumps, as well as to a method and apparatus used for manufacturing such pump spindles.

It is known to provide for single-spindle pumps spindles which generally take the form of helical screws provided with a rounded cross sectional configuration. Such screws are rotated about a predetermined axis so as to slide against the inner surface of what corresponds to a pump cylinder, although this inner surface may be resilient, to yieldably press against the rotary spindle. Thus, as the spindle rotates it forms a pump chamber which will suck the fluid in through one end of the pump and advance it to the other end where it is discharged under pressure, as is well known with this type of pumps.

In order to enable such spindles to operate satisfactorily it is essential to provide a flywheel mass fixed to the spindle to provide for a continuous uniform rotary movement thereof. However,the mass of such a flywheel must be kept down to an absolute minimum inasmuch as a large flywheel mass will cause a comparatively large amount of noise and is also a decisive factor in determining the life of the pump and the performance which it will provide.

It has therefore become known in the art to relieve the spindles of some part of the load normally carried thereby by boring away part of the material from the interior of the spindle. However, where spindles of large cross section are required the removal of material from the interior of the spindle is insufficient since a great part of the material remains with the screw-thread configuration of the spindle. As a result it becomes impossible to provide large spindle pumps because the peripheral or centrifugal forces or inertia of the spindle during oscillatory rotary movements become highly unfavorable.

Spindles of relatively small pumps can be produced from solid bars by suitably turning them on special machines or by giving them the required configuration through a round turning process. However, methods of this latter type are extremely tedious and exacting and are, in addition, difficult to carry out inasmuch as the quality which is essential in the surface that is worked necessitates an edge or point type of impact between the manufacturing tool and the work. The result is that the tool itself will not have as long a life as is desired and the blade thereof rapidly wears out with its edge becoming uneven in a relatively short time, so that the final configuration of the worked article cannot be efficiently achieved.

SUMMARY OF THE INVENTION

A primary object of the present invention is to solve the problem of providing a spindle which will enable the mass of the flywheel to be greatly reduced.

Another object of the invention is to provide a method and apparatus for manufacturing such a spindle in such a way that the time required for the manufacture of a spindle is greatly reduced as compared with times which are required for this purpose now. Also, the actions required to carry out the manufacture of the spindle are greatly simplified so that the manufacture of such spindles is considerably facilitated.

A further object of the invention is to provide a spindle which will enable considerable savings in material, particularly when alloyed materials are used.

In accordance with my invention, the spindle is made from an elongated seamless tube which preferably has a maximum wall thickness on the order of 11 mm. The finished spindle is provided at one end with a connecting means to enable a drive to be transmitted through this connecting means, according to one of the important features of the invention, this connecting means may have an elastic yieldable property.

According to the method of the invention, the tube is axially fed while continuously rotated about its axis. Shaping jaws are radially pressed first inwardly against the tube and then retracted away from the tube while the latter is advanced through a given increment, whereupon these operations are repeated so that in this way there is achieved a tube of a predetermined desired configuration from which a section of a given length can be cut so as to then be able to have the connecting means joined to one end thereof.

The shaping jaws surround the axis along which the tube advances and have inner shaping faces directed toward this axis while being acted upon through a suitable means to be pressed inwardly toward the axis and retracted away from the latter. A spring means coacts with the jaws for urging them in one direction while a press can coact with the jaws to urge them in an opposed direction. The inner surfaces of the jaws define an elongated passage which is wider at its inlet end than at its outlet end in order to receive the tube while gradually providing the latter with the screw-shaped configuration which is required.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a fragmentary longitudinal sectional elevation of a pump spindle of the present invention;

FIG. 2 shows a pump spindle of the invention provided with a different connecting means for connecting a drive thereto, also in a longitudinal sectional elevation;

FIG. 3 is a schematic sectional elevation of an apparatus according to the invention, which may be used in the manufacture of the spindle of the invention;

FIG. 4 is a transverse sectional plan view of the structure of FIG. 3, taken along line 4—4 of FIG. 3;

FIG. 5 is a sectional elevation of another embodiment of an apparatus according to the invention; and

FIG. 6 is a schematic sectional elevation of yet a further embodiment of an apparatus according to the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

The spindle, particularly for spindle pumps designed to pump liquids, consists, in accordance with the invention, of an elongated hollow tubular spindle shaft 11

manufactured from a seamless tube made in most cases of metal.

The tube is made of steel, non-ferrous metals, stainless materials, and the like, although it is also possible to use plastics in some cases. Of course, the external diameter of the tube will vary in accordance with the size of the pump. Also, the wall thickness of the tube varies. However, in order to meet the requirement of relieving the load on the spindle as much as possible it has been found, in accordance with the invention, that with most of the usual types of tube the maximum thickness of the wall of the tube need not be greater than 11 mm.

A means is provided for transmitting a drive to one end of the spindle shaft **11**, and such means may have elastic properties as shown for the connecting means **12** in FIG. **1** or may be substantially rigid, as shown for the connecting means **13** of FIG. **2**.

In the case of FIG. **2**, the connecting means **13** is in the form of a rigid element which is welded directly onto one end of the spindle shaft **11** and which is provided with a threaded bore to receive a rotary motion-transmitting element of a drive well known in the art. However, it is also possible to provide, if desired, a threaded connection between a rigid connecting means similar to the connection means **13** and the tube **11**, or a rigid connecting means may have a press fit within the spindle **11**.

The elastic connecting means **12** of FIG. **1** includes an elastic insert **14**, made, for example, of a suitable resilient elastomeric material, such as a suitable rubber. The insert is axially bored and can, when inserted into the end of the tube **11**, be vulcanized directly thereto. An elongated spindle-driver **15** which may be made of a rigid metal or the like extends through the axial bore of the insert **14**. One or both of the ends of the driver **15** are provided with threaded bores **16**, so that irrespective of the orientation of the driver **15** there will be available, at the exterior, a threaded bore to which a motion-transmitting element of a drive can be connected. These connections of the driving devices are not illustrated inasmuch as they are conventional and form no part of the invention.

The spindle driver **15** is formed with a transverse radial aperture **17** which flares outwardly at its opposed ends, in the manner shown in FIG. **1**, so that a tapered aperture **17** of hourglass configuration is provided extending transversely through the driver **15**. An elongated motion-transmitting pin **18** extends through the aperture **17**, radially through aligned transverse openings formed in the elastic insert **14**, and through aligned openings formed in diametrically opposed parts of the wall of the tube **11**. End portions of the pin **18** are exposed at the exterior of the spindle. The configuration of the aperture **17** enables the pin **18** and the driver **15** to have a certain amount of freedom to move with respect to each other so that the driver **15** need not at all times extend perpendicularly to the pin **18**.

A means is also provided for securing the pin **18** in such a way that it will have no tendency to slip out. In the embodiment selected for illustration, this securement of the pin **18** is brought about by an annular elastic ring **19** which is drawn over the respective end portion of the spindle **11** and over the projecting end portions of the pin **18**, the ring **19** not only pressing against the ends of the pin **18** so as to remain securely connected thereto but being also capable of providing a fluid-tight covering and closure of the openings through which the pin **18** extends. Thus, the openings in the wall of the spindle **11** through which the pin **18** extends are fluid-tightly closed by the ring **19**. Impurities are prevented from penetrating into the insert **14**. Of course, it is also possible to situate the connecting means **12** at some other point of the spindle shaft **11** instead of at the end portion thereof.

The production of spindles according to the invention is brought about in such a way that the tubular product from which the screw spindle is manufactured is given the screw-shaped configuration in the shaping apparatus of the invention and according to the method of the invention. With the method and apparatus of the invention, the tube is rotated about its longitudinal axis as it is fed axially in steps so that between the feeding steps the tube is gripped by shaping jaws which press against the tube to give it the desired configuration.

The length of each feeding step is determined by the particular screw-threading achieved by the press in which the apparatus is mounted. The shaping operations take place along lines similar to those performed in radial presses which are centrally tapered to provide a gradual shaping. In accordance with the prevailing particular technical conditions encountered, either a cold-shaping or a hot-shaping method can be used. The shaping is carried out in at least one operation in accordance with the requirements of dimensional tolerance of the spindle. By way of the continuous shaping method of the invention it is possible to achieve tubes of unlimited length, at least in theory. The actual shaping method can be followed by smoothing and polishing of the article which is to be formed into the final spindle. Thus,during continuous shaping, after a given length of properly shaped tubing issues from the apparatus, a section of predetermined length is cut therefrom to provide a spindle of the predetermined length, and then after smoothing and polishing, if desired, the connecting means is attached in the manner described above.

The shaping which is carried out in accordance with the invention is equivalent to a metallurgical treatment of the material to increase its strength and resistance to wear. As was pointed out above the connecting means **12** and **13** are connected either elastically, as in the case of connecting means **12**, or rigidly as by welding, as in the case of the relatively rigid connecting means **13**. Of course, in the case of connecting means **12**, the rubber insert **14** is first introduced and vulcanized onto the tube in the interior thereof.

In order to provide the tubular pump spindle of the invention with the desired configuration it is shaped in a suitable apparatus,different embodiments of which are illustrated in FIGS. **3** to **6**. Referring to FIGS. **3** and **4** which show one possible embodiment, it will be seen that the illustrated structure includes a base plate **20** on which an exterior rigid body **21** is fixedly mounted as by suitable screws **38**. The body **21** has an exterior cylindrical surface **39** and an interior tapered surface **23** of a frustoconical configuration. The smaller end of the tapered surface **23** is situated at the side of the base plate **20** and joins an enlarged cylindrical recess **22** formed between the tapered bore **23** and the base plate **20**. The tapered bore **23** is centrally situated with respect to the cylindrical recess **22** so that the openings **22** and **23** have a common central axis.

A spring means of the apparatus is situated within the recess **22**. In the embodiment of FIGS. **3** and **4**, this

spring means takes the form of an annular spring means **24** made in the form of an elastomeric body such as a circular rubber body which has a lower face resting directly on the base **20** and an upper face which carries a pressure-transmitting plate **25** that is of circular configuration and engages the lower ends of shaping jaws **27** which extend axially along the interior of the bore **23.** It will be noted that in the lower portion of the jaws **27,** shown in FIG. **3,** a predetermined clearance **26** is provided between the plate **25** and the upper surface of recess **22** which extends radially from the lower end of the tapered bore **23.**

There are three elongated shaping jaws **27** uniformly distributed about the common axis of components **20** and **21.** At their inner surfaces **40** these shaping jaws **27** define an elongated helical cavity **28** of such configuration as will give the tubing which is worked on the desired shape. It will be noted that at its upper inlet end the passage **28** defined by the jaws **27** has an enlarged portion **29** which tapers inwardly and gradually becomes of a smaller diameter while at the lower discharge end **30** of the passage **28** defined by the jaws **27** the size of the passage correponds to the required size of the shaped tubing which forms the spindle **11.** Thus, the tube which is worked on to form the spindle **11** is fed by suitable increments downwardly through the passage **28** to issue through the bottom of the apparatus through a central aperture formed in the base plate **20.**

The top end **31** of the shaping jaws defines the inlet end thereof and engages a ring **32** which transmits the pressure of the press to the jaws **27,** the ring **32** being formed with a tapered inlet **33** through which the tube advances axially into the inlet **29** of the shaping passage **28** defined by the jaws **27.** The pressure-transmitting ring **32** will absorb the force of the press and engage the upper inlet end surfaces **31** of the jaws.

Downwardly beyond the discharge end **30** of the shaping passage **28** a continuous outlet passage **34** is provided for the work, the passage **34** being defined by coaxial openings **34***a* and **34***b* of the plate **20** and **25,** respectively, as well as by the central opening **34***c* of the spring ring **24.** Thus, the spindle shaft **11** with its final configuration will pass through the aligned openings **34***b*, **34***c* and **34***a* to discharge from the apparatus.

The shaping jaws **27** are provided at their exterior surfaces with a tapered configuration matching the slope of the tapered surface **23.** In addition, the shaping jaws have radial side surfaces which engage each other when the jaws are at their lower end positions illustrated in FIG. **3.** When the press is retracted so as to move upwardly and release the pressure from the pressure-transmitting plate **32,** the spring means **24** is free to expand so as to urge the plate **25** upwardly and thus advance the jaws **27** upwardly with respect to the work. At this time, the tubular work will be advanced through a given increment because the jaws **27** are retracted radially away from the tube.

It will be seen that the jaws are provided at their flat side surfaces **35** (see FIG. **4**) with aligned bores **41** which receive spreading springs **36** which spread the jaws apart from each other as they are advanced upwardly by the plate **25,** thus enabling the inner working surfaces of the jaws to be retracted away from the work which can then be advanced through the required increment before the next downward movement of the plate **32** caused by the press. This downward movement again results in inward radial movement of the jaws to further shape the tubular workpiece due to the inward camming of the jaws provided by the coaction of the tapered surface **23** with the exterior inclined surfaces of the jaws **27.**

According to the apparatus and method of the invention, the shaping of the tube is carried out in such a way that the tube is axially fed by steps while being continuously rotated, and the configuration of the shaping jaws **27** is such that upon raising of the jaws to release the work the latter will be rotated and axially advanced by a given increment. Then the jaws are again pressed inwardly against the work to continue the shaping thereof so that through these cycles there will issue from below the baseplate **20** a tubular spindle of the required configuration.

It is, of course, possible to provide different constructions of the apparatus of the invention. Thus, what amounts to a reversal of the arrangement of FIGS. **3** and **4** can be provided, as shown in FIG. **5.** Referring to FIG. **5,** it will be seen that the slope of the frustoconical cavity of the body **21'** is opposite to the slope of the surface **23.** The slope of the exterior surfaces of the jaws **27'** is also opposite to those of FIG. **3.** It is to be noted from FIGS. **3** and **5** that the left jaw **27** and **27'** is shown at its surface **35** with spring-receiving bores **41.** With the arrangement of FIG. **5,** similar aligned openings forming a passage **34'** are provided through which the finished tube will discharge, and the passages **28** and **28'** defined by the jaws **27** and **27'**, respectively, are similar.

However, in the case of FIG. **5** the radial inward pressing of the jaws is brought about during the upward stroke thereof as a result of the action of the spring **24'** which is in the form of a heavy coil spring surrounding the central opening of the passage **34'** through which the shaped tube will progress. This strong coil spring of FIG. **5** presses upwardly against the pressure-transmitting ring **25** which urges the jaws **27'** upwardly so that in the case of FIG. **5** during this upward movement the jaws **27'** will be pressed radially inwardly against the tube to work on the latter. In this case the press will also engage a pressure-transmitting plate similar to or identical with plate **32,** which during the downward movement brings about the release of the jaws **27'** from the work since the jaws **27'** will now retract automatically away from the axis of the work due to the action of the springs **36** and the inclination of the tapered surfaces of the body **21** and the jaws **27.** In this way it is possible with the construction shown in FIG. **5** to bring about a reverse of the operations and apparatus of FIGS. **3** and **4.**

It is also possible to provide a construction according to which the shaping forces act directly against jaws in a radial direction, instead of providing a radial component of pressure resulting from the action of inclined surfaces. With such an arrangement the stepwise axial feeding of the tube is carried out differently.

According to the embodiment shown in FIG. **6,** the outer body **21''** is of a cylindrical configuration at its inner surface as well as at its exterior surface. With this embodiment, the several jaws **27''** are carried by levers **37.** A pair of levers **37** are pivotally connected to each of the jaws **27''** as well as to the body **21''** in the manner shown for the right jaw **27''** of FIG. **6,** so that in this way a parallelogram linkage is provided, maintaining the jaws **27''** parallel to the vertical axis while being capable of advancing the jaws **27''** toward and away from

this vertical axis during turning of the levers **37.** In this case it is also possible to provide at either end of the jaws **27''** an advancing means for axially advancing the jaws and opposed means for retracting the jaws so that either the spring arrangement of FIG. **5** or that of FIG. **3** may be located at the bottom end of the jaws of FIG. **6,** with the press acting on the top end thereof. Due to the levers **37,** the radial movement of the jaws in both directions is precisely controlled and automatic movement can be derived directly from the press. The simple cylindrical interior of the body **21** will provide sufficient clearance for the movement of the jaws **27''** so that they can advance axially while moving toward each other to press against the work and can then be retracted away from each other while axially advancing in an opposed direction.

Of course, instead of the elastic means **24** shown in FIG. **3** of the drawing it is possible to use metal spring components rather than rubber plates. Further, instead of tapered openings to coact with the jaws **27** or **27'** it is possible to use wedge-shaped surfaces, cams eccentrics, or the like. Also the apparatus is provided with a suitable device which feeds the tube axially by given increments while rotating the tube, and if desired suitable polishing devices may be provided for polishing the exterior surface of the tube after the working thereof so as to improve the quality of the work.

While the invention has been described above in connection with hollow tubes, when making spindles for relatively small pumps, it is also possible to work solid bars according to the process and with the apparatus of the invention. Such bars can be cold-worked or hot-worked. All that is required is to select appropriate dimensions for the operating parts of the tool, taking into consideration the quality of the material. The tubes or bars can be of any required length, and any deformable materials may be used such as steel, stainless materials, non-ferrous metals, plastics, or the like.

The method of the invention is particularly suitable for the production of pump spindles. It has the great advantage of reducing very substantially the cost of manufacture while accelerating the rate of production and achieving spindles of reduced weight.

In addition, the exterior surface of the tube manufactured in accordance with the invention has been metallurgically worked so as to be of a high quality. The tubular spindles of the invention are relieved of their internal load because of the relatively small wall thickness and thus a relatively large interior space. As a result the tubular spindles of the invention are made of the minimum possible weight, which makes it possible to avoid undesirably large flywheel masses. Inasmuch as the mass of the flywheel used with the spindle of the invention can be very greatly reduced, as compared with conventional structures of comparable size, the life of the pumps of the invention are greatly increased, the noise produced by their operation is substantially eliminated, and the production of relatively large spindle pumps is considerably simplified.

I claim:

1. A method for manufacturing a tubular screw spindle of a pump from a seamless tube of small wall thickness, comprising the steps of feeding the tube axially while continuously rotating the tube about its axis, radially pressing shaping jaws against the exterior of the tube and then retracting the jaws, advancing the tube, and again pressing the tube with the jaws to provide the tube with a predetermined configuration, cutting from the thus-worked tube a selected length thereof, and then fastening to one end of the selected length of tube a means for transmitting a drive thereto.

* * * * *