Dec. 22, 1964 J. L. BIACH 3,162,071

TENSIONING APPARATUS

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FIG. 2

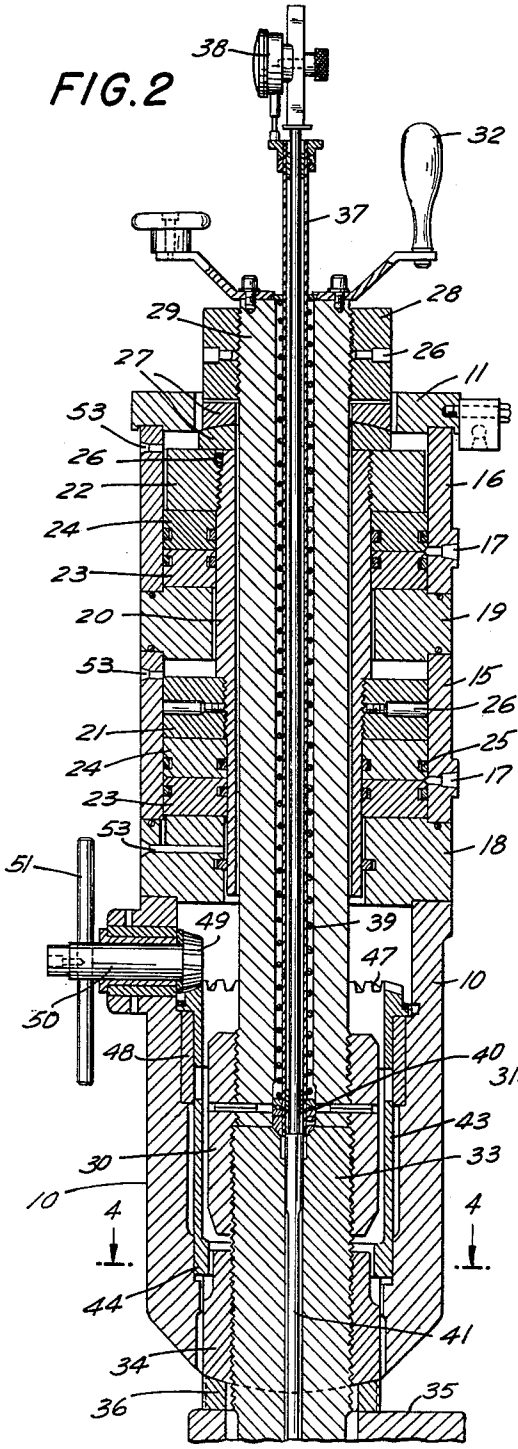


FIG. 1

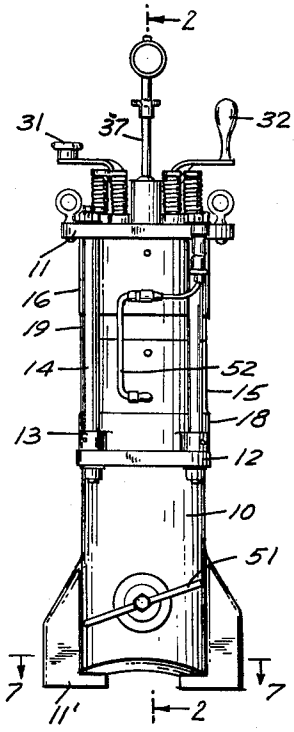
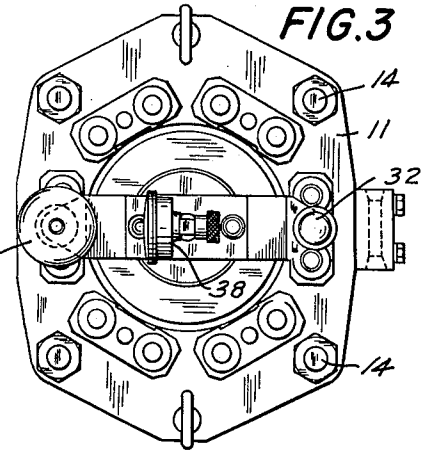


FIG. 3



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FIG.4

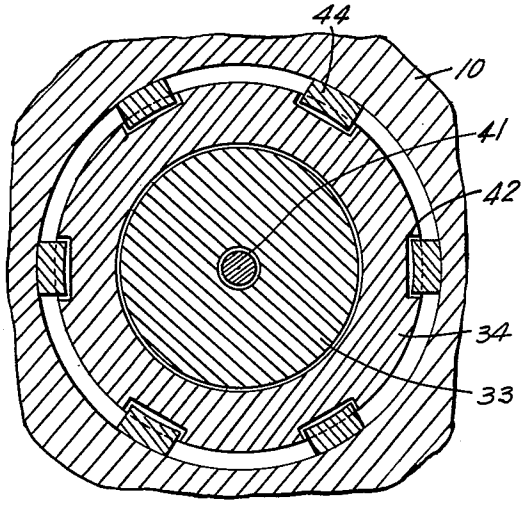
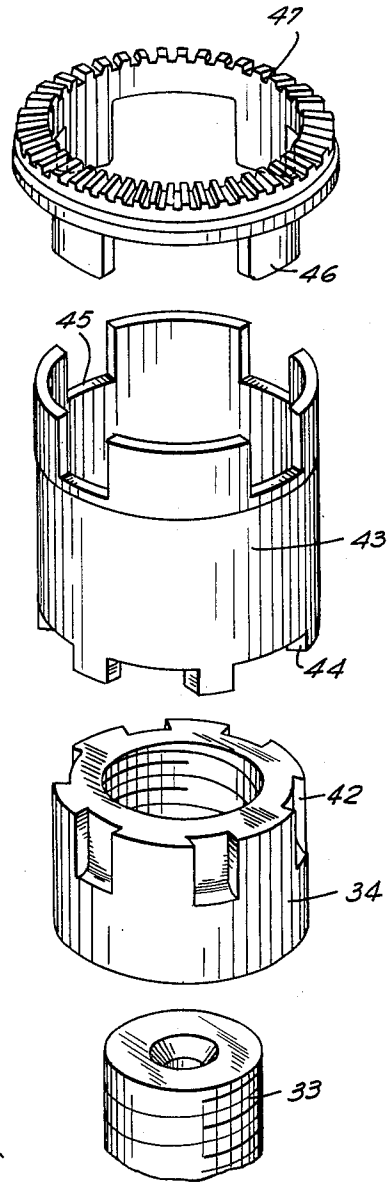


FIG.5



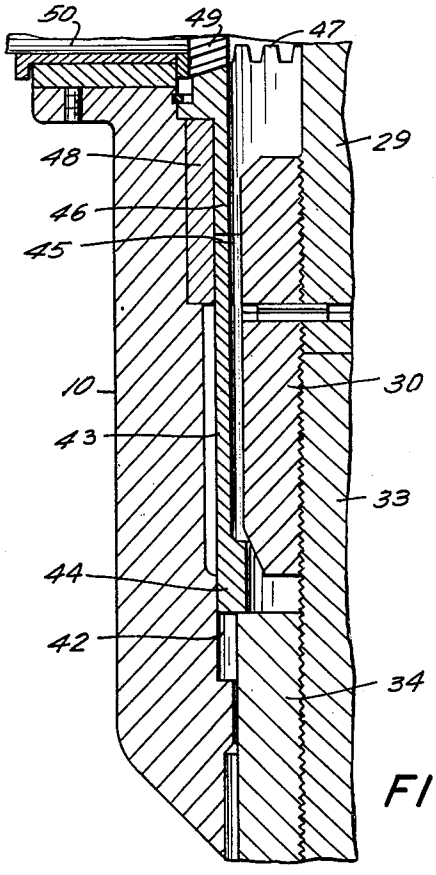


FIG.6

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FIG. 8

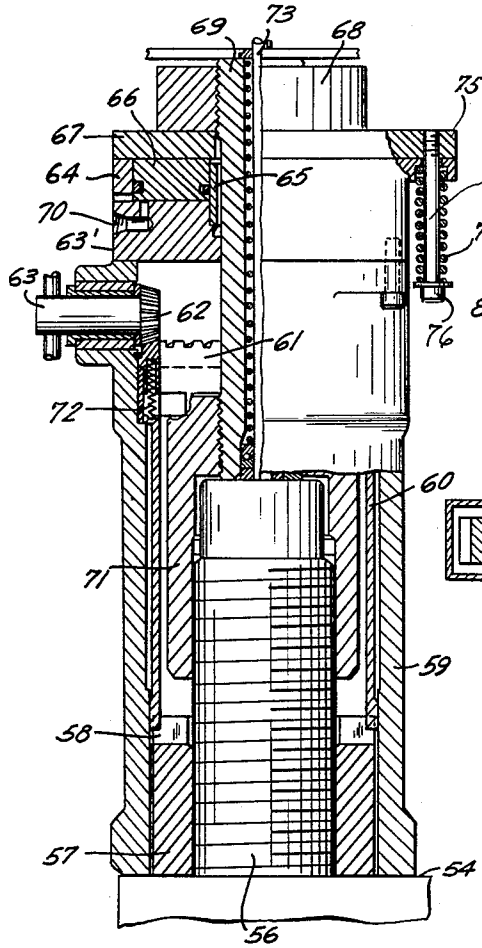


FIG. 9

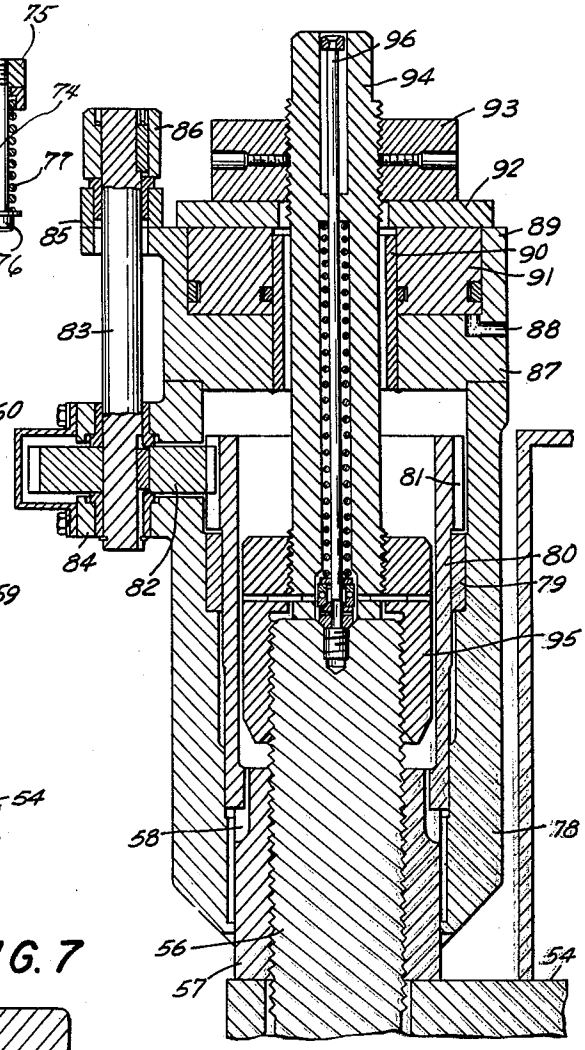
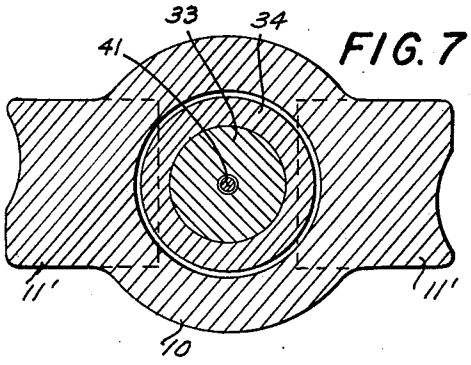


FIG. 7



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United States Patent Office 3,162,071 Patented Dec. 22, 1964

3,162,071

TENSIONING APPARATUS

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Filed May 8, 1961, Ser. No. 108,645
4 Claims. (Cl. 81—54)

This invention relates to a structurally and functionally improved bolt tensioning apparatus of the type shown in my prior United States Patent No. 2,866,370 of December 30, 1958.

It is a primary object of the invention to furnish a mechanism of this nature and in which there will be embodied structure such that difficulties heretofore experienced will be overcome. More particularly, it has frequently required several applications of a tensioning apparatus to the parts with which it is to cooperate in order to assure a proper disposition of the mechanism to the bolt which is to be tensioned and the nut mounted thereon.

This has arisen due to the fact that the wrench or equivalent unit forming a part of the apparatus is housed within the latter and the user cannot, therefore, observe the manner in which it is approaching the surfaces of the nut as the tensioning apparatus is lowered into position. Therefore, this wrench or equivalent part may be out of alignment with nut surfaces to be engaged thereby. Under these circumstances the wrench part will come to rest upon the upper faces of the nut rather than enclosing the surfaces of the latter. Thereupon the user will have to lift the entire apparatus and again lower it in an endeavor to secure proper engagement of the wrench and nut surfaces.

Especially where a relatively large tensioner is involved, such attempts to assure a proper seating or engagement of the wrench and nut surfaces is burdensome because of the weight of the parts. Under all conditions, a time consuming operation is involved. By means of the present teachings difficulties in this connection are overcome.

A further object is that of providing a structure in which proper cooperation of the wrench and nut surfaces is assured even if the bolt to be tensioned extends downwardly or horizontally.

Still another object is that of providing a design of apparatus in which no difficulties will be experienced in having the operating cylinder and piston assume proper relative positions upon the release of pressure.

Further objects are those of providing apparatus in which the parts involved to accomplish the foregoing will be relatively simple and rugged in design and will in no way interfere with the primary tensioning operations.

With these and other objects in mind, reference is had to the attached sheets of drawings illustrating practical embodiments of the invention, and in which:

FIG. 1 is a side elevation of one form of tensioning apparatus embodying the present teachings;

FIG. 2 is an enlarged sectional side view thereof taken along the lines 2—2 in the direction of the arrows as indicated in FIG. 1;

FIG. 3 is a plan view of the assembly;

FIG. 4 is a transverse sectional view taken along the lines 4—4 in the direction of the arrows as indicated in FIG. 2;

FIG. 5 is an exploded perspective view in enlarged scale showing one group of cooperating parts included in the apparatus;

FIG. 6 is a sectional side view of the assembly as illustrated in FIGS. 4 and 5;

FIG. 7 is a sectional plan view taken along the lines 7—7 in the direction of the arrows as indicated in FIG. 1;

FIG. 8 is a sectional side view of an alternative form of apparatus; and

FIG. 9 is a similar view of a still further form embodying the functions herein taught.

Referring primarily to FIGS. 1 and 3 it will be seen that the numeral 10 indicates the housing of the apparatus from which supporting legs or pedestals 11' extend through to a point below the lower edge of that housing. Supported above the housing is a cylinder and piston assembly which in the present exemplification embraces two units or stages. In turn above these a top plate 11 is disposed. The latter adjacent its outer edges is formed with openings. A flange 12 formed with aligned openings is conveniently provided as part of the housing adjacent its upper end. Also, apertured lugs 13 may extend from this housing. Through these apertures and openings tie rods 14 are passed and mount nuts which serve to retain all exterior parts of the assembly against movements with respect to each other.

Now considering the interior of the apparatus as especially shown in FIG. 2, it will be seen that the power mechanism is responsive to liquid pressure and that the two stages illustrated embrace cylinder portions 15 and 16 each provided with an inlet port 17. The first stage includes a base plate 18 interposed between the upper edge of housing 10 and the lower edge of cylinder 15. The second stage includes a base 19 interposed between the adjacent edges of cylinders 15 and 16. A sleeve 20 extends through the central openings of both the base 18 as well as 19 from a point adjacent the lower surface of the former through to a point adjacent the upper edge of cylinder housing 16. This sleeve has secured to it, preferably by means of threaded couplings, encircling pistons 21 and 22 at points spaced above base portions 18 and 19. Disposed in this space within each cylinder are pairs of ring shaped members 23 and 24. With the parts in a condition of rest, rings 23 lie in engagement with base portions 18 and 19 and in contact with rings 24. The latter bear against the underfaces of pistons 21 and 22.

It will also be observed in this view that the adjacent faces of rings 23 and 24 are preferably disposed in line with ports 17. Therefore, when fluid or liquid under pressure is introduced through these ports, rings 23 will simply bear against their adjacent base portions 18 and 19 while rings 24 will shift upwardly and thus serve as piston heads thrusting against pistons 21 and 22 to shift the latter. Those pistons being secured to sleeve 20, it follows that the latter will also be shifted. As shown, packing 25 may be used at all desirable points. For example, between the inner edge surface of base 18 and the adjacent face of sleeve 20 as well as between further faces of the latter and the ring members 23 and 24 in addition to between those members and the inner faces of cylinders 15 and 16. Additionally, as shown locking elements of any desirable and proper type as indicated at 26 may be used to assure against any accidental shifting of pistons 21 and 22 from the positions to which they have been adjusted along the sleeve 20.

A spherical set of washers 27 has their curved faces in engagement with each other other, with the lowermost washer supported upon the upper piston 22. These washers extend through the central aperture of top plate 11 and support above them a holding nut 28. The threads of this nut engage with the threads formed at the upper end of puller bar 29. The puller bar extends with adequate clearance through the bore of sleeve 20 into housing 10 and has its lower end threaded to mount a socket 30 which is preferably locked against all movements with respect to that bar and terminates in a lower threaded bore below the same. A knob 31 and handle 32 are conveniently attached to the puller bar to extend

above nut 28 so that it together with the bar may be rotated.

As will be understood the apparatus is employed to tension a bolt which mounts a nut to bear against a flange or equivalent surface. Such a bolt has been shown in FIG. 2 at 33 and is encircled by a nut 34 engaging its threads. A base or flange surface 35 presents an opening through which the bolt extends and a washer 36 may be interposed between this surface and nut 34. The lower edge surface of the nut and adjacent face of washer 36 may be curved to present a spherical set. This together with the set of washers 27 provides a self-compensating and aligning structure to relieve any undesired strains which may be set up as the parts are operated.

The threads in the lower portion of socket 30 correspond to the threads at the upper end of bolt 33. Therefore, they may be interengaged. The nut 34 will be rotated by a mechanism hereinafter described. Puller bar 29 is preferably formed with a bore through which a sleeve and rod 37 extend. The former mounts at its upper end above the holding nut 28 an adjustable gauge 38. It is encircled within the bore of the bar by a spring 39. A bearing 40 extends adjacent the lower ends of the sleeve and rod. The latter contacts a pin 41 disposed within the bore formed in bolt 33. The foregoing structure is in accordance with my prior application for United States Letters Patent on Bolt-Tensioning Apparatus filed November 17, 1959, under Serial No. 853,554, now Patent No. 3,015,975 of January 9, 1962.

As will be seen from FIG. 2 and FIG. 5, nut 34 is of the castellated type. In other words, it includes recesses 42 adjacent its upper edge for engagement with a suitable wrench structure. That structure as in these views and FIGS. 4 and 6 includes a driving sleeve 43 presenting downwardly projecting portions 44 at its lower edge. These projections have width and depth such that they may be accommodated within the recesses 42 of nut 34. Sleeve 43 at its upper edge presents slots 45 of a height greater than the height of projections 44. These slots or notches receive downwardly projecting portions 46 of a length equal to the depth of the notches and which projections form parts of a driven gear 47. This gear rests upon and has its projections 46 extending into a suitable bearing 48. Its teeth are engaged by a driving gear 49 secured to a shaft 50 extending beyond housing 10 and mounting a handle 51.

It, therefore, follows that with projections 44 of the drive sleeve 43 extending into the recesses 42 and handle 51 being rotated that gear 47 will be turned to similarly rotate the sleeve 43 and nut 34. In the event that the apparatus is lowered into position and projections 44 are not in registry with recesses 42 then it will be unnecessary to elevate and reposition the entire apparatus. Rather, under these circumstances, projections 44 will come to rest in contact with the upper edge of nut 34. The depending portions 46 of the driven gear 47 will extend into notches 45 of the sleeve under these circumstances. Therefore, by turning driving gear 49 the sleeve will be rotated to align recesses 42 with the projections. When this condition is established, then under the action of gravity, sleeve 43 will shift downwardly so that the projections 44 are received within recesses 42. Despite this shifting, however, the length of the vertical edges defining the notches 45 and the length of the adjacent side edges of projections 46 is such that these parts will remain in engagement. Therefore, a turning of the driving gear results in a rotation of the nut 34.

Thus, it is apparent that a bolt 33 may be caused to extend through the aperture in a flange or base member defining a surface 35 and may receive a washer such as 36 above which a nut 34 is disposed in engagement with the threads of the bolt and with the latter extending above the nut. Tensioning apparatus is now lowered into position until its pedestal or foot portions 11' bear against the surface 35. As afore brought out, in the event that the wrench does not have its projections 44 aligning with the recesses 42, then the sleeve 43 providing that wrench may be rotated until coupling engagement results. To establish connection between bolt 33 and socket member 30, puller bar 29 is rotated in one direction. Opposite rotation results in a disconnection. In the case of adjacent flanges requiring coupling, or a closure being applied to a surface under conditions of tension, then a number of the apparatus will be disposed at properly spaced points so that they may function simultaneously to draw the entire circumference of the flange or closure, under conditions of equal tension, into mating relationship.

To effect this result, each one of the tensioning apparatus is connected to a source of liquid under pressure by means of a pipe such as 52 (FIG. 1) which connects with ports 17. Puller bar 29 will be rotated to cause the lower end of socket member 30 to be engaged with the threads at the upper end of bolt 33. Thereupon, with liquid entering ports 17 it will move between the pairs of rings 23 and 24 and cause the latter to be elevated with corresponding movement on the part of pistons 21 and 22. This will result in a thrust being exerted against the holding nut 28 to elevate it with corresponding movement on the part of puller bar 29. The latter being coupled to bolt 33 it follows that this member will be tensioned. Obviously, with a number of these assemblies functioning and connected to the common source of liquid under pressure, tensioning will be equal throughout an entire series of bolts to which the mechanisms are connected. In any event after the tensioning has occurred to the extent desired, then with the maintenance of pressure, the wrench assembly in each apparatus will be turned by the handle 51 or its equivalent to cause each one of the nuts 34 to firmly bear against an adjacent washer 36 (if used) and thus against surface 35. With the nuts holding the bolts under tension the liquid pressure may be discontinued. Any venting which may be necessary will occur through suitably placed openings 53 during the foregoing operations.

The gauge 38 and structure associated therewith serves to register the elongation which the bolt or equivalent 33 embodies when subjected to tension. It may be used in assuring that a desired elongation of each bolt of a series occurs. Also, if desired this gauging mechanism may be dispensed with in any given assembly. In the presently illustrated embodiments, nuts of the castellated type have been shown. It is apparent that as in my prior patents, ordinary multi-sided nuts may be utilized, in which case the cooperating faces of the wrench will be suitably modified to cooperate with the side surfaces of those nuts. If other configurations and types are employed then again the wrench surfaces may be redesigned as necessary. The same results of assuring a proper cooperation of the wrench with the nut or its equivalent and despite improper alignment of the parts may also be achieved by diverse structures. Moreover, while in the case of the apparatus shown in FIGS. 1 to 7, inclusive, depends upon gravity to assure that the wrench assumes a proper position with respect to the nut, this dependence is not necessary. In fact, the principles of the present teachings may be incorporated in bolt tensioners which in use extend horizontally or even upwardly.

Thus, referring to FIG. 8, there is again shown at 54, an upper surface, defining, for example, a flange and beyond which a threaded bolt 56 extends. The threads of this bolt are engaged by an encircling nut 57. The latter presents recesses 58 in its upper face. The tensioning apparatus will include a housing 59 the lower edge of which bears against surface 54 and which encloses a wrench in the form of a drive sleeve 60 having downwardly projecting parts corresponding to projections 44 of FIG. 5. Above this sleeve a driven gear 61 is supported for rotation. Its teeth are engaged by the teeth of a driving gear 62 carried by a rotatable shaft 63, extending beyond housing 59. Connection between gear 61 and sleeve 60

is achieved by means of projections extending downwardly from the former into recesses in the upper edge of the latter as in FIG. 5. Also, in common with this figure the height of the projections defined in the lower edge of sleeve **60** will be less than the height of the cooperating recesses and projections in the driven gear and upper sleeve edge.

Housing **59** conveniently supports upon its upper edge a base **63'** provided with an upwardly extending flange **64** defining on its inner surface a cylinder. A collar **65** is supported by the base **63'** to define with flange **64** a well portion providing the cylinder. A piston **66** is disposed within this well and carries suitable packing or rings which bear against the inner face of the flange and the outer face of collar **65**, respectively. A top plate **67** rests upon the flange **64** and in turn supports a holding nut **68**. A puller bar **69** has its upper end secured against movement with respect to this nut and extends downwardly through the bore of the top plate, piston and base into housing **59**. A suitable inlet passage **70** is provided to communicate with the interior of the cylinder.

The lower end of puller rod **69** has secured to it by threads or otherwise a socket member **71** which extends below the bar and has a threaded bore to receive the upper end of bolt **56** and engage with the threads thereof. Finally, it will be noted with respect to this part of the structure that an annular series of suitably spaced springs **72** is interposed between driven gear **61** and driving sleeve **60**. These springs in aggregate develop a thrust in excess of the weight of the driving sleeve defining the wrench. Therefore, gravity does not have to be depended upon to assure an ensleevement of a nut or equivalent by the lower edge zone of the wrench with proper disposition of the mating surfaces. Rather, if the apparatus is maintained in a horizontal position, then with the parts not being in proper alignment, the edge of the sleeve will simply bear against the adjacent surface of the nut **57**. A repositioning of the entire apparatus will not be necessary. The procedure involved will obviously simply be that of turning gear **61** to a point where the adjacent surface parts of the sleeve and nut are properly aligned. Under those circumstances, the thrust exerted by springs **72** will be adequate to assure a "seating" of those surfaces with respect to each other by projecting the sleeve axially along the bolt **56**.

The tensioning operation will be as described in connection with the earlier figures. It will be noted, as in FIG. 8, that only a single stage tensioner has been shown. Obviously, a two-stage apparatus, as in FIGS. 1 and 2, might be employed, or even more stages could be present. Also, while the gauging apparatus, parts of which are indicated at **73**, could be included, this is not essential.

However, in the structure shown, FIG. 8, an arrangement of mechanism has been illustrated which assures that when the hydraulic pressure is relieved the piston together with its associated parts will return to a desired initial position. To this end, the top or spring plate **67** may be formed with a series of equally based openings around its periphery. These openings are threaded to receive the correspondingly threaded ends of bolts or pins **74**. The shanks of the bolts will also pass through apertured extensions **75** forming parts of the cylinder or housing defined by flange **64**. The heads **76** of bolts **74** extend downwardly and have thrusting against them the lower ends of springs **77**. The upper ends of these springs will thrust against the lower faces of the cylinder extensions **75** which may—as shown—be recessed to receive those spring ends. It is apparent that in this manner a return of the parts to initial positions is assured when the liquid pressures are relieved or vented.

In the form of apparatus illustrated in FIG. 9, the same reference numerals **56**, **57** and **58** have been employed to designate the bolt, nut and its recesses, as in the case of FIG. 8. In this view a housing **78** is provided which by means of a bearing **79** supports a wrench in the form of a sleeve **80**. The latter is provided adjacent its upper zone with an annular series of gear teeth **81**. These are engaged by the teeth of a gear **82**; the width of the latter being substantially less than the width of teeth **81**. Gear **82** is affixed to a shaft **83** mounted in suitable bearings forming parts of extended portions **84** and **85**. Above the latter a handle member indicated at **86** may be positioned for the purpose of turning the shaft and thus the sleeve.

Again, in this view, for the sake of simplicity, a single stage power apparatus has been illustrated. It includes a base **87** resting upon the upper edge of housing **78** and which base is formed with an intake port **88** for hydraulic liquid. In common with the structure shown in FIG. 8, a flange **89** may extend upwardly from the base at a point adjacent its outer edge while a sleeve **90** may be secured to the inner edge defining the bore extending through the base. Thus, a well portion is provided which forms a cylinder. Within the latter a ring-shaped member **91**, furnished with suitable packings is slidably disposed. It is apparent that as liquid under pressure enters port **88** this member will function as a piston to elevate within the cylinder. A return to its initial position may be assured either under the action of gravity, exterior pressures or springs as in FIG. 8.

A plate **92** rests upon the upper face of the piston and in turn supports a holding nut **93**. The threaded bore of the latter engages the correspondingly threaded upper zone of puller bar **94** and may be locked against accidental shifting with respect to the same. The puller bar extends downwardly through the openings in plate **92** and the bore defined by sleeve **90**. The lower end of the puller bar, in common with the previous forms, terminates within housing **78**. A socket member **95** is attached by screw threads or otherwise to extend inwardly of the lower end of bar **94** and is locked against movement with respect to the same. It is provided with threads suitable for cooperation with the threads of bolt **56**.

In this form of apparatus it is obvious that it may be disposed in proper relationship to bolt **56** and nut **57**. If the surfaces of the latter are not properly aligned with respect to the surfaces of the wrench provided by sleeve **80**, then the lower or inner edge of that sleeve will simply ride against the outer surface of the nut. Under these conditions the upper zone of the sleeve will shift to a position immediately adjacent the lower face of base **87**. However, due to the length of gear teeth **81**, the wrench will remain in driving engagement with gear **82**. Therefore, by rotating the latter gear, the sleeve may be turned to a point where its surfaces will align with the recesses or equivalent working surfaces **58** of the nut. With that relationship established, gravity will, of course, cause sleeve **80** to telescope over the nut surfaces. If springs such as **72** in FIG. 8, should be desired or necessary in connection with this apparatus, they may be employed. The same is true with the apparatus shown in FIG. 1 and succeeding figures of the first illustrated form.

Now, by introducing liquid under pressure through port **88**, piston **91** will rise and cause a corresponding movement on the part of nut **93**. This will be transmitted to puller bar **94** and therefore to bolt **56** which will be tensioned in the manner afore described. Gauging apparatus, the presence of which is suggested by rod **96**, may or may not be employed as desired.

In all of the illustrated embodiments a lost motion coupling is present. This coupling, as in FIGS. 1 to 7, inclusive, embraces the notches **45** in the sleeve **43** and the projections **44** at the lower edge of that sleeve. As will be seen, under all conditions, the sleeve will remain in driving relationship with gear **47**, whether that sleeve is in the position illustrated in FIG. 6 or whether the projections **44** are in overlapping relationship to the faces of the nut as defined by recesses **42**. The same will be true of the structure shown in FIG. 8, which additionally will lend itself to use in a horizontal plane, or even in

connection with a bolt which extends upwardly, towards a base surface. Of course, return springs which assure a descent or retraction of the piston when the pressure is relieved and as exemplified in FIG. 8, may be incorporated in the apparatus shown in the earlier figures, as well as in FIG. 9. It will be noted that again the length of teeth **81** in relation to the length or width of the teeth of gear **82** and the overlapping portions of the parts of sleeve **80** which engage with the faces of the nut is such that driving force will always be transmitted to the sleeve regardless of the position of the latter.

Gauging mechanism as traversed in Patent 3,015,975, afore identified, may or may not be used in association with the several forms.

Viewed in another light, the coupling embracing the lost motion may be said to involve a number of elements which are susceptible to lateral movements with respect to each other. These movements, however, do not disturb the driving relationship of the parts. In other words, as in FIGS. 4, 5 and 6, sleeve **43** may be shifted laterally with respect to projections **46** and the recesses or faces **42** while still being rotated incident to actuation of the driving gear; the same function being incorporated in the structure of FIG. 8. In FIG. 9 the upper end of sleeve **80** remains, at all times, within the zone of the annular series of teeth included in gear **82** but is susceptible to lateral shifting with respect to that gear. It is, of course, obvious that with only the weight of the sleeve and driven gear involved, no damage will occur to these parts even if the apparatus is not properly aligned with respect to a bolt to be tensioned. Rather, the mass of that apparatus will rest upon the pedestals or base portions **11'** upon a surface such as **54** with only the sleeve and its driven gear being supported by the nut. A simple turning of the sleeve will result in the desired overlapping relationship being established. Even under those conditions the mass of the apparatus remains supported as afore described. Accordingly, no damage need be feared and it will be completely unnecessary to lift and reposition the entire assembly each time the parts are not perfectly aligned.

Thus, among others, the several objects of the invention as specifically aforenoted are achieved. Obviously, numerous changes in construction and rearrangements of the parts may be resorted to without departing from the spirit of the invention as defined by the claims.

I claim:

1. Bolt tensioning apparatus including in combination a housing having one end adapted to thrust against a surface from which a threaded nut-supporting bolt extends, a puller bar having one end disposed within said housing and another end projecting beyond the other end of the housing, an internally threaded socket member fixed to the one end of said bar within said housing, bar rotating means mounted by the projecting end of said bar to rotate the latter to interengage the threads of the socket member with the threads of the nut-supporting bolt, power means within said housing and coupled with said bar to retract the latter and, consequently, said socket member to thereby tension said bolt when said socket member is engaged with the bolt, an axially shiftable and rotatable nut-engaging sleeve encircling said bar within said housing, sleeve supporting means on said housing adjacent its thrusting end for supporting the sleeve therein so that it is adapted to rotate and axially shift with respect to the housing and bar whereby it is adapted to axially shift into coupling engagement with the nut so that the nut may be rotated relative to the bolt, sleeve driving means for rotating said sleeve and, consequently, said nut, means for axially fixing the sleeve driving means relative to the housing, and interengaging means between said sleeve and said sleeve driving means for permitting the relative axially movement of the sleeve so that the sleeve is adapted to shift into engagement with the nut while maintaining its driving connection with the sleeve driving means, said interengaging means being substantially axially fixed with respect to the housing.

2. The invention in accordance with claim 1 wherein said power means includes a cylinder and piston with the piston being movable within said cylinder and encircling said bar, means for shifting said piston in said cylinder away from the thrusting end of the housing, and means connecting the piston to the bar whereby shifting of the piston away from the thrusting end of the housing causes retraction of the bar and consequent tensioning of the bolt.

3. The invention in accordance with claim 1 wherein the sleeve driving means comprises a drive gear movably supported by the housing and the interengaging means between the sleeve and the sleeve driving means comprises projections extending from the gear and notches formed in the sleeve for slidably receiving the projections.

4. The invention in accordance with claim 1 wherein yielding means are provided for biasing said sleeve towards the thrusting end of the housing.

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WILLIAM FELDMAN, *Primary Examiner.*