Oct. 27, 1959 A. W. CALDER 2,910,049

HYDRAULIC CYLINDER ASSEMBLY

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FIG. 1.

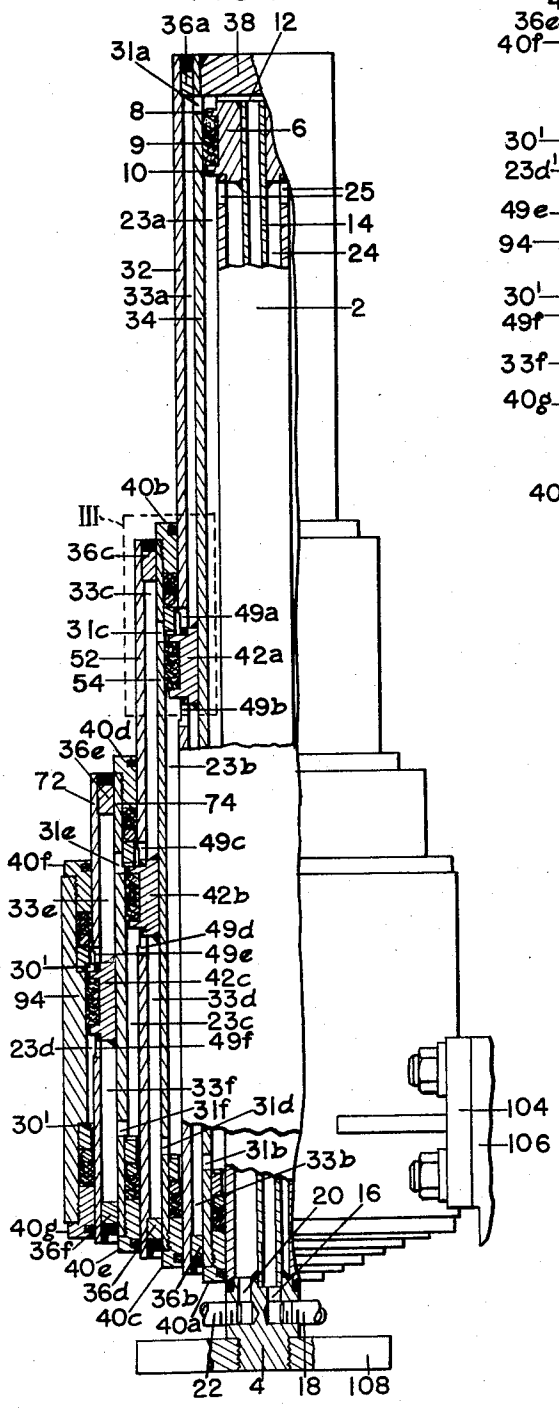

FIG. 2.

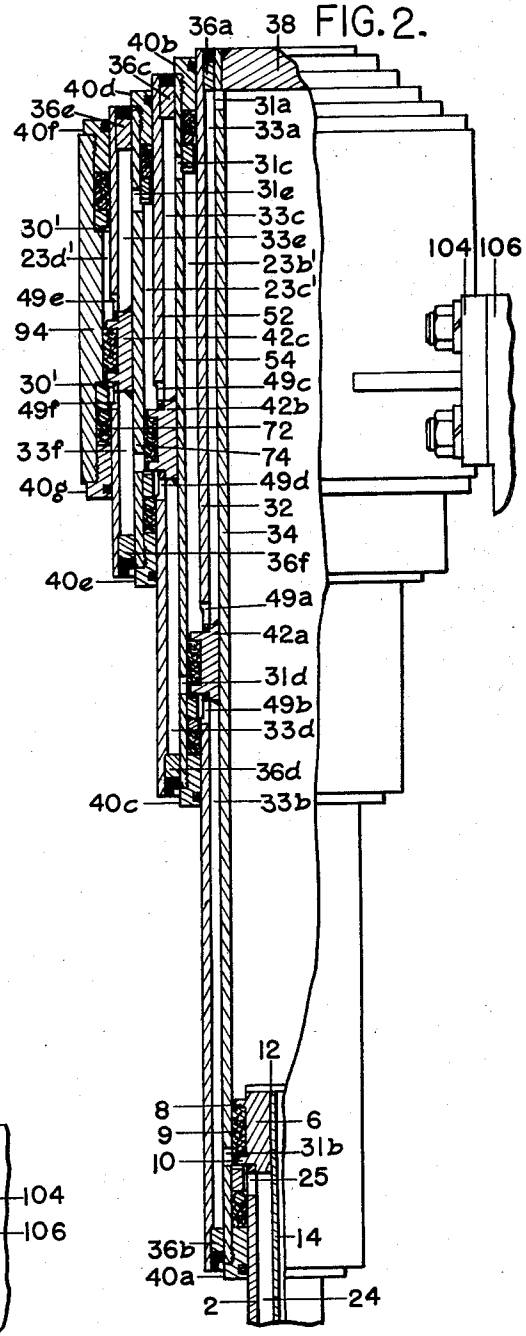

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FIG. 3.

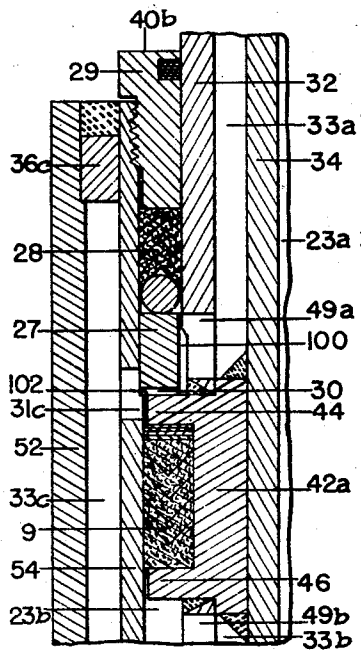


FIG. 4.

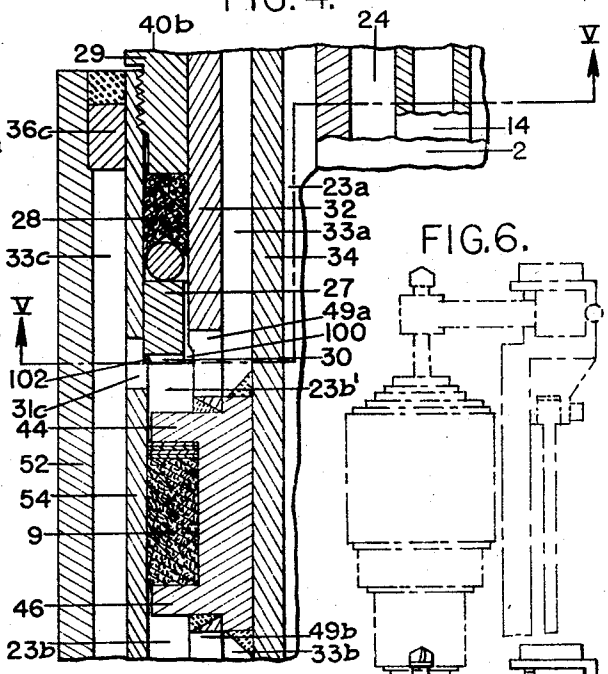


FIG. 6.

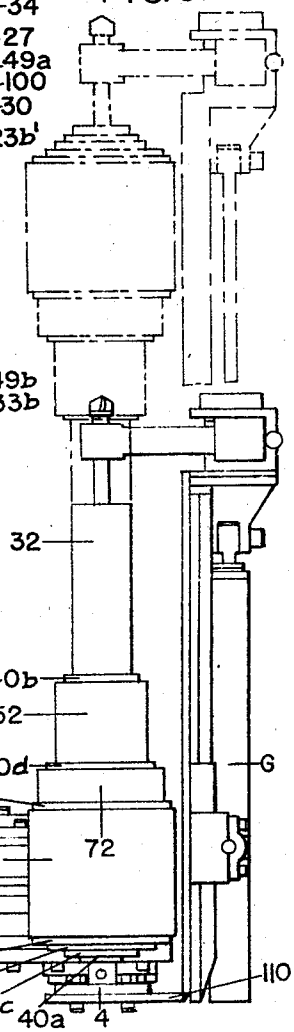
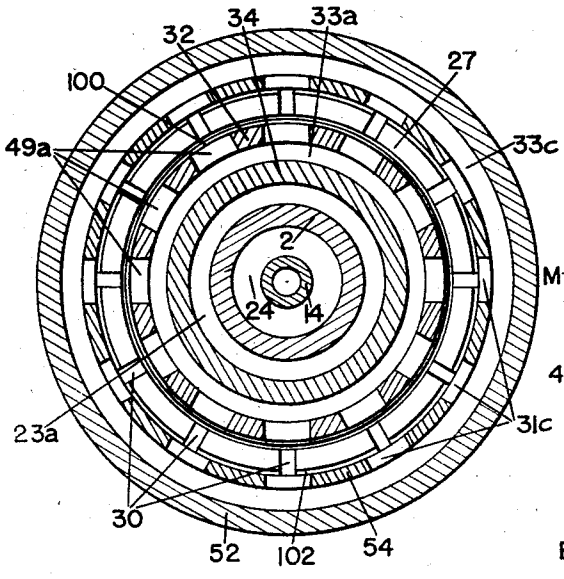


FIG. 5.



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HYDRAULIC CYLINDER ASSEMBLY

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Application September 20, 1957, Serial No. 685,138

19 Claims. (Cl. 121—46)

My invention relates to a hydraulic cylinder assembly and more particularly to a double-acting hydraulic cylinder assembly having a plurality of cylinders movable longitudinally about an elongated, centrally located, stationary cylinder which assembly can exert a constant pressure upon another body.

In modern underground mining, movable drilling devices are extensively employed to drill holes in the ceiling or roof of the mined area for receiving roof supporting bolts therein. Although various drilling devices for such purposes are commercially available, they have not been entirely satisfactory due to their inability to be automatically adapted to the varying roof heights as are commonly encountered in underground mining. Such devices are generally hydraulically operated, however, I am not aware of any such hydraulic devices whereby a constant force is automatically obtained on the drill which is desirable in order to obtain the shortest operating time. In addition it is desirable that such a device be operable to extend and retract at the same rate of travel.

Accordingly one object of my invention is to provide a new and improved hydraulic cylinder assembly comprising a plurality of concentric cylinders having hydraulic passageways formed therebetween whereby a hydraulic passageway is established therethrough to raise or lower the cylinder assembly.

Another object of my invention is to provide a new and improved hydraulic cylinder assembly comprising a plurality of concentric movable cylinders having connectible hydraulic passageways therein to permit hydraulic fluid to flow from one cylinder to another so that a constant pressure is exerted by the cylinder assembly throughout its travel.

Another object of my invention is to provide a new and improved hydraulic cylinder assembly comprising a plurality of concentric movable cylinders having connectible hydraulic passageways therein to permit hydraulic fluid to flow from one cylinder to another so that a constant pressure is exerted by the cylinder assembly throughout its travel and to obtain a constant rate of extension and collapse.

A more specific object of my invention is to provide a new and improved hydraulic assembly having a plurality of telescopic cylinders which are hydraulically connected by means of passageways in ring members which are secured to the cylinders to be moved, respectively.

Another more specific object of my invention is to provide a new and improved hydraulic assembly having a plurality of telescopic cylinders which are hydraulically connected by means of passageways in ring members which are secured to the cylinders to be moved, respectively, which ring members have the same area acted upon by a hydraulic fluid.

Still another specific object of my invention is to provide a new and improved multiple cylinder, hydraulic assembly which is provided with a hydraulic passageway system to cause movement of the assembly in one direction until a given point is achieved at which point an identical hydraulic passageway system is placed in operative relationship to obtain the reverse movement of the assembly.

These and other objects of my invention will become more apparent when taken in conjunction with the following description and drawings of a preferred embodiment of my invention in which:

Fig. 1 is a side elevational view of a hydraulic cylinder assembly constructed in accordance with the principles of my invention in a retracted position with portions thereof being shown in section to more fully illustrate the structure thereof,

Fig. 2 is a side elevational view of the hydraulic cylinder assembly as shown in Fig. 1 in a fully extended position,

Fig. 3 is an enlarged cross sectional view of the portion of the assembly shown in Fig. 1 enclosed by the dotted outline III showing the hydraulic passageways whereby one concentric cylinder is connected to another concentric cylinder prior to relative movement therebetween,

Fig. 4 is an enlarged cross sectional view of a portion of the assembly as shown in Fig. 1 similar to the portion shown in Fig. 3 after relative movement between the cylinders has occurred,

Fig. 5 is a cross sectional view of the hydraulic cylinder assembly taken substantially on line V—V of Fig. 4,

Fig. 6 is a reduced scale, side elevational view of the hydraulic cylinder assembly as shown in Fig. 1 and a support therefore with the extended position thereof being shown in dotted outline.

Referring to Figs. 1 and 5 of the drawings it will be noted that a hydraulic cylinder assembly constructed in accordance with the principles of my invention comprises a plurality of elongated tubular cylinders, hereinafter described, which are movable longitudinally along a centrally located, stationary, tubular cylinder **2**. The tubular cylinder **2** extends upwardly from a circular base **4** which is rigidly secured to the lower end. A circular head **6** is rigidly secured to the upper end of the cylinder **2** to extend longitudinally therefrom. Formed integral with and extending radially outwardly from the head **6** is a pair of longitudinally spaced upper and lower flanges **8** and **10**, respectively, between which a gland packing **9** of a well-known construction is located. Extending diametrically across the upper surface of head **6** is at least one open-ended groove **12** having sufficient depth and width to provide a suitable passageway for hydraulic fluid to flow therethrough as more particularly described hereinafter.

An elongated circular tube **14** is located within the cylinder **2** and extends angularly therein with the lower end thereof being rigidly secured to the base **4**. The upper end of tube **14** extends through a central bore in the head **6** with its upper end terminating at the bottom of the groove **12**. The lower end of tube **14** is hydraulically connected to a passageway **16** in base **4** which is provided with a suitable hydraulic fitting **18** whereby hydraulic fluid may flow from passageway **16** through tube **14** to groove **12** in the head **6**. The base **4** is also provided with a passageway **20** spaced from the passageway **16** and which passageway **20** is connected to a suitable hydraulic fitting **22** whereby hydraulic fluid can flow through the passageway **20** to a passageway **24** formed between the inner diameter of cylinder **2** and the outer diameter of tube **14** below the lower surface of the head **6**. A plurality of circular openings **25** are located adjacent the lower surface of head **6** and are circumferentially spaced in the wall of cylinder **2** and have sufficient combined cross section to permit the free flow of hydraulic fluid therethrough from passageway **24** to a passageway **23***a* which will be more fully described hereinafter.

Spaced radially outwardly of cylinder **2** are inner and

outer elongated tubular cylinders 34 and 32, respectively, which are telescopically received over the upper end of cylinder 2 and which are radially spaced from each other by a radial ring 36*a* secured to the upper ends thereof to form a leakproof seal therebetween. A circular head 38 is rigidly secured to the bore of the cylinder 34 at its upper end to form a leakproof head. The lower surface of head 38 rests upon the upper surface of head 6 when the cylinders 34 and 32 are in their retracted position. The ends of cylinders 32 and 34 and the upper surface of head 38 preferably terminate in the same flat plane above head 6. The lower ends of cylinders 32 and 34 are slidably supported outwardly of the outer surface of the cylinder 2 by a suitable gland packing unit 40*a* which is rigidly secured to the inner diameter of cylinder 34 at its lower end. As will become apparent herein, a number of gland packing units are employed in the structure of my invention the components of which are identical in arrangement and function to the components of the unit 40*a*. The various packing units are of different sizes so that they may be located in the hereinafter described locations. Accordingly, the various packing units have been identified by the same numeral followed by different letter designations. In Figs. 1 and 2, however, only the general designations have been employed for identifying purposes in order to simplify the understanding of my structure, however, it will be realized that each of the packing units has the same structural components and arrangement thereof. These remarks are equally applicable to other components hereinafter identified by the same reference numeral followed by a different letter designation.

Referring to Figs. 3 and 4, in which a packing unit 40*b* is shown, it will be noted that such a gland packing unit comprises an annular gland retaining ring 27 which is located inwardly between cylinders 32 and 54, hereinafter described, an annular packing gland 28 located directly above the gland retaining ring 27, and an annular adjustable flange member 29 which threadedly engages the inner diameter of the cylinder 54 to provide the necessary pressure and adjustment on the gland packing 28 to form a leakproof seal between cylinders 32 and 54 as is well known in the art. With such structure the packing unit 40*b* is movable with respect to the outer surface of the cylinder 32 while maintaining a hydraulic seal therebetween. Formed in the gland retaining ring 27 are a plurality of circumferentially spaced, radially extending, open-ended grooves 30 having sufficient cross section to permit the free flow of hydraulic fluid therethrough. In a similar manner the packing unit 40*a* provides a hydraulic seal engageable with the outer surface of the cylinder 2 which is movable longitudinally thereof. The packing 9 of head 6 engages the inner surface of the cylinder 34 to provide a hydraulic seal therebetween at all times as the cylinder 34 moves relative thereto as hereinafter described. As the inner diameter of cylinder 34 is spaced outwardly from the outer diameter of cylinder 2 a hydraulic passageway 23*a* is formed therebetween which extends downwardly from the lower surface of the lower flange 10 of head 6 to the upper surface of gland retaining ring 27 of gland packing unit 40*a*.

Spaced approximately midway between the ends of the cylinder 34 is an annular support 42*a* (Figs. 3 and 4) which extend radially outwardly from and is rigidly secured to the outer diameter of cylinder 34. Extending radially outwardly and being integral with support 42*a* are upper and lower flanges 44 and 46, respectively, which are spaced from each other to receive a packing gland 9 therebetween. The outer ends of the flanges 44 and 46 extend radially outwardly through an opening in the side of cylinder 32 beyond the outer surface thereof so as to be spaced radially inwardly of the inner diameter of the cylinder 54. Located in the wall at the upper and lower ends of cylinder 34 are a plurality of circumferentially spaced openings 31*a* and 31*b* respectively, which have sufficient cross section to permit the free flow of hydraulic fluid therethrough as is more fully described hereinafter. The openings 31*a* are spaced directly below the lower surface of head 38 and the openings 31*b* are spaced above gland retaining ring 27 of gland packing unit 40*a*.

The upper and lower sides of the central opening in the cylinder 32 are rigidly secured to an intermediate portion of the upper and lower surfaces of the flanges 44 and 46, respectively, of support 42*a*. With such a structure a passageway 33*a* is formed between the inner diameter of cylinder 32 and the outer diameter of cylinder 34 which extends downwardly from the lower surface of ring 36*a* to the upper surface of flange 44 of support 42*a*. A radial ring 36*b*, similar to ring 36*a* previously described, is rigidly secured between the lower ends of the cylinders 32 and 34 to provide a leakproof seal therebetween and form a passageway 33*b* between the inner diameter of cylinder 32 and the outer diameter of cylinder 34 which extends down from the lower surface of flange 46 of support 42*a* to the upper surface of ring 36*b*. Directly above and below the upper and lower flanges 44 and 46 of support 42*a* in the wall of cylinder 32 are a plurality of circumferentially spaced openings 49*a* and 49*b*, respectively, which are of sufficient cross section to permit the free flow of hydraulic fluid therethrough as will be more fully described hereinafter.

As shown, a pair of radially spaced tubular cylinders 52 and 54 are provided which are constructed similar to the cylinders 32 and 34 heretofore described with the head 38 thereof being eliminated. The cylinders 52 and 54 are of reduced length compared to cylinders 32 and 34 heretofore described in order to accomplish the principles of my invention. As shown, the cylinder 54 is concentrically located within the cylinder 52 and is provided with an inner diameter so as to be spaced outwardly from the outer surface of the cylinder 32. Packing gland units 40*b* and 40*c* are rigidly secured to the inner diameter of cylinder 54 at the upper and lower ends thereof to provide a hydraulic seal for opposite ends of a passageway 23*b* which is located between the inner diameter of cylinder 54 and the outer diameter of cylinder 32 and between the lower surface of lower flange 46 of support 42*a* to the upper surface of gland retaining ring of packing unit 40*c* when the cylinder 52 and 54 are in the retracted position, as shown. Cylinders 52 and 54 are spaced from each other by radial rings 36*c* and 36*d* rigidly secured at the upper and lower ends thereof, respectively, which are similar to the rings 36*a* and 36*b* previously described.

Spaced approximately midway between the ends of the cylinder 54 is an annular support 42*b* which radially surrounds and is rigidly secured to the outer diameter of cylinder 54. The support 42*b* is similar to the support 42*a* heretofore described, having upper and lower flanges 44 and 46 which are spaced from each other to receive a gland packing 9 therebetween. With such a structure a passageway 33*c* is formed between the inner diameter of cylinder 52 and the outer diameter of cylinder 54 which extends downwardly from the lower surface of ring 36*c* to the upper surface of flange 44 of support 42*b*. A passageway 33*d* is similarly formed therebetween which extends from the lower flange of the support 42*b* to the lower ring 36*d*. As clearly shown in Figs. 3 and 4 the cylinder 54 is provided with a plurality of circumferentially spaced openings 31*c* located approximately in lateral alignment with the portion of the cylinder 32 in which the openings 49*a* are provided so that the ring 27 of the packing unit 40*b* is located therebetween and whereby hydraulic fluid can flow from the passageway 33*a* to the passageway 33*c* through the grooves 30 of packing unit 40*b*. Referring to Fig. 1, the lower end of the cylinder 54 is also provided with circumferentially spaced openings 31*d* adjacent the ring 27 of the packing unit 40*c*.

In order to understand the principles of my invention the operation of the heretofore described structure will be

described although it is to be realized that the hereinafter described structure operates concurrently therewith. As is common with hydraulic devices of this type the various heretofore described passages are normally filled with a suitable hydraulic fluid prior to the operation of the device. Although not shown it is also to be realized that the fitting **18** is suitably connected to a suitable source of high pressure hydraulic fluid such as a hydraulic pump. Thus, when the assembly is in the retracted position of Fig. 1, as pressure is built up from the pump a corresponding high pressure will be transmitted through the passageway **16**, tube **14**, through groove **12**, across the upper flange **8** of the head **6**, through openings **31***a*, down passageway **33***a*, through openings **49***a*, through grooves **30** in the ring **27** of packing unit **40***b*, through openings **31***c* and into the passageway **33***c*. As is well known the pressure of the hydraulic fluid is uniform within an enclosed system so that the areas of my structure which result in movement thereof are subjected to the same actuating pressure.

It will be noted that as the cylinders **32** and **34** move together as a unit the fluid therebetween cannot exert any lifting force to cause movement of the head **38** upward. As the head **6** is stationary the high pressure fluid exerts an equal force against the upper area of the head **6** and the under surface of the head **38** to drive the cylinders **32** and **34** upward along the cylinder **2**. Thus, the effective area for causing movement of the cylinders **32** and **34** is determined by the area of the head **6** including the area therein occupied by the tube **14**. Similarly, as the cylinders **52** and **54** move together as a unit the fluid therebetween cannot exert any lifting force to cause their upward movement. It will be noted however (Fig. 3) that, disregarding the clearances involved, the support **42***a* can be considered as stationary with respect to the ring **27** of the packing unit **40***b* so that the area of the lower surface of the ring **27** of unit **40***b* is the effective area for causing lifting of the cylinders **52** and **54**. Since the force on the two effective areas is equal, the movement of the entire assembly upward will be uniform by providing equal effective areas.

In order to insure proper fluid flow is obtained from the passageway **33***a* to the underside of the ring **27** of unit **40***b*, the outer surface of the cylinder **32** (Fig. 3) adjacent the lower end of the ring **27** of unit **40***a* when the assembly is in the retracted position, is preferably undercut to provide an annular chamber **100** therebetween whereby a reservoir of hydraulic fluid always exists adjacent the grooves **30** which is directly connected to the passageway **33***a* through openings **49***a*. Once the ring **27** of unit **40***b* has been lifted off of the upper flange **44** of the support **42***a*, grooves **30** are no longer employed for any function as the entire effective area of the ring **27** of unit **40***b* is acted upon by the high pressure fluid. Thus, grooves **30** need only be of sufficient areas to cause the initial raising of the ring **27** of unit **40***b* from the flange **44** of support **42***a*.

As indicated fluid flow occurs through the openings **31***c* into the passageway **33***c*. Inasmuch as the ring **27** of unit **40***b* is not rigidly secured to cylinder **54**, it may tend to float around the outer surface of the cylinder **32** so that the grooves **30** therein may not necessarily be in radial alignment with the openings **31***c*. In such structure the outer lower edge of the ring **27** of unit **40***b* is preferably undercut to provide an annular chamber **102** therearound to form a reservoir of fluid which is directly connected to the opening **31***c* at all times. After the initial lifting of the ring **27** (Fig. 4) occurs the passageway **33***a* is connected to the passageway **33***c* by means of a connecting passageway **23***b'* as hereinafter described.

It will be obvious that as the cylinders **32** and **34** move along the cylinder **2** that the corresponding upward movement of the unit **40***a* will constantly decrease the length of the passageway **23***a* until the passageway is entirely eliminated by the engagement of the ring **27** of unit **40***a* with the lower flange **10** of the head **6**. Concurrently therewith as the cylinders **52** and **54** move upwardly the passageway **23***b* will be eliminated, however, a new passageway **23***b'* is formed (Fig. 2) between the inner diameter of the cylinder **54** and the outer diameter of the cylinder **32** and between the ring **27** of unit **40***b* and the flange **44** of the support **42***a* which achieves its maximum length when the ring **27** of unit **40***c* engages the lower flange **46** of support **42***a*. As the passageways **23***a* and **23***b* are eliminated the hydraulic fluid therein must be displaced. Thus, it will be noted that the hydraulic fluid in passageway **23***b* will flow through opening **49***b* through passageway **33***b*, through opening **31***b*, through as much of passageway **23***a* that may exist at a particular time, through openings **25**, through passageway **24**, through passageway **20** and out through fitting **22**. As is well known the fitting **22** may be hydraulically connected to a sump (not shown) from which the pump receives hydraulic fluid to pump into the passageway **23***b'* and the increased area above the head **6** as the cylinders **52**, **54** and **32**, **34**, respectively, move upwardly. When the cylinders have reached their uppermost position and passageway **23***a* is eliminated it will be obvious that fluid will flow directly from opening **31***b* through grooves **30** in ring **27** of unit **40***a* into openings **25**.

Once the assembly as heretofore described has reached the extended position of Fig. 2, it will be obvious that exactly the reverse effect, that is retraction, may be accomplished by reversing the pump so that a high pressure is transmitted through the fitting **22**, through passageways **20** and **24**, through openings **25**, through grooves **30** of ring **27** of unit **40***a*, and into passageway **33***b*. Accordingly, the same heretofore mentioned ring **27** construction and reservoirs similar to reservoirs **100** and **102** are employed. Similarly on retraction a fluid flow occurs which is the reverse of the first described fluid flow outwardly of the fitting **18**.

From the above description it will be apparent that additional cylinder pairs similar to the cylinders **52**—**54** may be provided which will function in the same manner as and in which are generally similar thereto. Thus, as shown, outer and inner elongated tubular cylinders **72** and **74**, respectively, are slidably received around the cylinders **52** and **54** which are of reduced length compared to cylinders **52** and **54**. Secured at the upper and lower ends of cylinder **74** are gland packing units **40***d* and **40***e*, respectively, which are similar to the unit **40***b* previously described. Packing gland units **40***d* and **40***e* slidably engage the outer diameter of cylinder **52** and prevent the leakage of hydraulic fluid therebetween. Spaced directly above and below the upper and lower flanges **44** and **46** of support **42***b* in the wall of cylinder **52** are a plurality of circumferentially spaced openings **49***c* and **49***d* respectively, which have sufficient cross section to permit hydraulic fluid to flow therethrough. Spaced adjacent to the grooves **30** formed in the retaining rings **27** of units **40***d* and **40***e*, in the wall of cylinder **74**, are a plurality of circumferentially spaced openings **31***e* and **31***f*, respectively, which are similar to the openings **31***c* and **31***d*, respectively, heretofore described. A support **42***c* is secured intermediate the ends of the cylinder **74** which is similar to the supports **42***a* and **42***b* previously described and which extend through the cylinder **72** with the outer end of the flanges **44** and **46** thereof being located closely adjacent the inner diameter of an outer cylinder **94**.

Spaced between the inner diameter of cylinder **74** and the outer diameter of cylinder **52** and extending downwardly from lower flange **46** of support **42***b* to the upper surface of retaining ring **27** of unit **40***e* is a passageway **23***c* which permits the flow of hydraulic fluid therethrough. Rings **36***e* and **36***f* are secured in sealed relationship between cylinders **72** and **74** at their upper and lower ends, respectively, which are similar to the rings **36***c* and **36***d* previously described. With such structure passageways **33***e* and **33***f* are formed between the cyl-

inders 72 and 74 above and below the flanges 44 and 46, respectively, of the support 42c. Circumferentially spaced openings 49e and 49f are provided in the cylinder 74 above and below the flanges 44 and 46, respectively, of support 42c similar to the openings 49a, 49b or openings 49c, 49d.

The operation of the device with the cylinders 72 and 74 is believed to be obvious in view of the above-described operation. Referring to the previously described operation it will be noted that a hydraulic fluid under pressure exists in the passageway 33c between the cylinders 52 and 54 which pressure is transmitted through the opening 49c, through grooves 30 in the ring 27 of the unit 40d, through opening 31e into the passageway 33e. As before, the support 42b may be considered as stationary with respect to the ring 27 of the unit 40d so that the area of the ring 27 of unit 40d is an effective area for causing upward movement of the cylinders 72 and 74 along the outer surface of the cylinder 52. As before, the operation of the ring 27 of unit 40d is similar to that of the ring 27 of unit 40b previously described and accordingly the lower surface is provided with the same effective areas as the rings 27 heretofore described. It will be noted that upon upward movement of the cylinders 72 and 74 the passageway 23c is gradually eliminated and (Fig. 2) a new passageway 23c' is formed between the outer surface of the cylinder 52 and the inner surface of the cylinder 74 above the flange 44 of the support 42b and the ring 27 of the unit 40d. In the same manner upward movement of the cylinders 72 and 74 will displace the fluid in the passageway 23c through the opening 49d into passageway 33d, through opening 31d into passageway 23b, and thereafter to the outlet fitting 22 as previously described. When the cylinders 72 and 74 have reached their outermost position the opening 31f will be approximately in lateral alignment with the opening 49d so that the cylinders 72 and 74 are retractable in the same manner as those heretofore described.

As shown a final concentric cylinder 94 is slidably received on the outer surface of the cylinder 72. Cylinder 94 is similar to the cylinders 74 and 54 previously described except that it is shorter than the cylinders 74 and 54. The opposite ends of the cylinder 94 are supported outwardly from the outer surface of the cylinder 72 by means of gland packing units 40f and 40g at its upper and lower ends thereof respectively, which are similar to the packing units, such as 40b previously described. In view of the fact that the cylinder 94 is the outermost cylinder, it is not provided with any openings similar to the openings 31a, 31b, 31c, 31d, 31e, 31f, previously described, inasmuch as no concentric cylinder is employed outwardly of the cylinder 94. In view of this fact it is not necessary that the radial grooves 30 previously described necessarily be provided in the ring 27 of the units 40f and 40g. Accordingly, as shown, an annular passageway 30' is provided in the rings 27 of the units 40f and 40g which passageways 30' are open towards the outer surface of the cylinder 72 and towards the adjacent surface of the flanges 44 and 46 of the support 42c. The function of the grooves 30', however, is identical to that of grooves 30 previously described. With such structures a passageway 23d is formed between the inner surface of the cylinder 94 and the outer surface of the cylinder 72 which extends between the lower surface of the flange 46 of the support 42c and the upper surface of the ring 27 of the unit 40g.

The operation of the outer cylinder 94 is again believed to be obvious in view of the above described operation. It will be noted that as previously described a hydraulic fluid under pressure in the passageway 31e causes a high pressure in the fluid in the grooves 30' to cause upward movement of the cylinders 94 in the manner as heretofore described. Such upward movement of the cylinder 94 causes the elimination of the passageway 23d and in turn creates a new passageway 23d' (Fig. 2) between the inner surface of the cylinder 94 and the outer surface of the cylinder 72 above the flange 44 of the support 42c, in the same manner as the passageways 23b' and 23c' are formed. As before, when the cylinder 94 reaches its uppermost position the ring 27 of unit 40g is located adjacent the opening 49f in the cylinder 72 so that the cylinder 94' is retractable in the same manner as heretofore described. Also as before, the area of the rings 27 of units 40f and 40g are made equal to the area of the other rings 27 heretofore described so that a uniform force is obtained to effect upward movement of the cylinder 94.

Figure 6 illustrates the utilization of a hydraulic cylinder assembly as previously described for the purpose of raising and lowering a drilling device. Thus, as shown, the cylinder assembly is provided with a flange 104 formed on the outer surface of the cylinder 94 to which a drill support 106 (only a portion of which is shown) is suitably secured in any suitable manner such as by being bolted thereto. The base 4 of the hydraulic assembly slidably engages a mounting flange 108 whereby the entire assembly may be rigidly secured to a support 110 of a structure as is well known in the art. The support 110 is normally stationary or supported so as to be portable but remains stationary with reference to the hydraulic cylinder assembly.

From the foregoing description of my invention it is apparent that when fluid is admitted under pressure through hydraulic fitting 18 in the base 4 from a conventional hydraulic supply source, that fluid will flow through passageway 16, up through tube 14, out through groove 12 in head 6, out through openings 31a in the wall of cylinder 34, down through passageway 33a, out through openings 49a in the wall of cylinder 32, out through grooves 30 formed in retaining ring 27, out through openings 31c in the wall of cylinder 54, down through passageway 33c, out through openings 49c in the wall of cylinder 52, through grooves 30, through openings 31e in the wall of cylinder 74, down through passageway 33e, out through openings 49e in the wall of cylinder 72 and finally into annular passageway 30'. When the hydraulic fluid has completely filled all of the above mentioned passageways, openings and grooves, it will exert a force on the lower surface of the head 38 and on the lower surface of the retaining rings 27 of the packing glands 40b and 40d which are secured to cylinders 52 and 54, 72 and 74, respectively. Fluid will also exert a force on the upper surface of the passageway 30' formed in retaining ring 27 of packing gland unit 40f which is secured to cylinder 94, therefore, simultaneously forcing the head 38 which is rigidly secured to cylinders 32 and 34, the retaining rings 27 which are secured in cylinders 52 and 54, 72 and 74, and 94 in an upward direction away from their respective supports. The effective area on the head 38 at its lower surface and the lower surface areas of the retaining rings 27 in their respective gland packing units are constructed to have the same area so as to impart a constant pressure on all the movable cylinders. It is to be noted that if a body such as a roof bolt drill is secured to the appropriate flange 104 which is rigidly secured to the outer diameter of cylinder 94 of my hydraulic cylinder assembly, the roof bolt drill will be forced upwardly until the roof bolt drilling member encounters resistance at varying roof heights. The upper surfaces of the retaining rings 27 located in the lower end of their respective cylinders will come in contact with the lower surfaces of flanges 10 of head 6 and the lower surfaces of flanges 44 of the supports 42, at which time the head 6 and supports 42 will act as stops for the maximum extension of the hydraulic cylinders. The maximum extension of my hydraulic cylinder can be readily seen in dotted outline in the upper part of Fig. 6 and also in detail in Fig. 2. It will also be noted because of the arrangement and construction of the packing gland units 40 in their respective units

they assume a staggered relationship with each other as clearly shown in the lower and upper parts of Figs. 1 and 2, respectively. With such a construction access to the threadedly adjustable flanges **29** is made relatively simple and the adjustment of the packing glands **40** in their respective cylinders is quickly accomplished.

Although in the preferred form of my invention I have described the retaining rings **27** of the packing gland units **40** of a floating type it is not necessary that such a construction be used to make my invention operative. Retaining rings **27** may be rigidly secured to the inner diameter of the respective cylinders without changing the operation of my invention. It is also to be noted although I have shown and described the openings **31***a*, **31***c* and **31***e*, and the grooves **30** and **30'** in relative positions these openings and grooves may be relocated and enlarged without changing the operation of my invention. My invention will be operative and can be constructed with the openings **31***c* and **31***e* raised in their respective cylinders so that the lower surface of the openings **31***c* and **31***e* fall in the same plane as the upper surfaces of the flanges **44** and at the same time increasing the height of the grooves **30** and **30'** so that their upper surfaces fall in the same plane as the upper surfaces of the openings **31***c* and **31***e*. With such a construction fluid under pressure will freely flow through the respective openings and grooves to effect the upward movement of my hydraulic cylinder assembly. As shown in Figure 6 a suitable motor M may be provided to obtain rotational movement of the drill and a suitable guide G may be provided for such movement as is well known in the art. Such upward movement of the drill will occur until the entire hydraulic assembly assumes a position as shown in dotted outline in Figure 6.

In the assembly as heretofore described various components have been rigidly secured to other components which may be accomplished in any suitable manner and as shown the majority of such components are suitably welded together. Accordingly, the various cylinders, supports and packing units heretofore described are formed from suitable material whereby such welding may readily be accomplished. It is to be realized that in view of the telescopical arrangement of the various components of my device that such assembly will necessarily be formed in progressive steps depending upon the manner in which it is desired to assemble the cylinder assembly.

It will also be noted that my hydraulic cylinder assembly described herein consists of a double acting, telescopic, constant area hydraulic cylinder and when used in conjunction with a fixed volume pump, such as a constant speed gear pump, the rate of extension or retraction will be constant and the available force will be constant also for a given hydraulic pressure.

Having described a preferred embodiment of my invention in accordance with the patent statutes, it is to be realized that modifications thereof may be made without departing from the broad spirit and scope of my invention. Accordingly, it is respectfully requested that my invention be interpreted as broadly as possible and limited only by the prior art.

What I claim is:

1. A hydraulic cylinder assembly comprising, a pair of spaced members portions of which are located adjacent each other and one of which has a hydraulic passageway therein, a first means rigidly secured to said adjacent portion of said one member to extend outwardly therefrom, and slidably engage the adjacent portion of the other of said members, a second means rigidly secured to said adjacent portion of said other member to extend inwardly therefrom and slidably engage the adjacent portion of said one member, said passageway being connected to an opening in said adjacent portion of said one member between said first and second means, a lifting member located between said members and adjacent said opening when said pair of members occupy particular relative positions, and said lifting member engaging said second means to move said members apart when a sufficient pressure exists in any portion of the hydraulic system.

2. A hydraulic cylinder assembly comprising, a pair of spaced members portions of which are located adjacent each other and one of which has a hydraulic passageway therein, a first means rigidly secured to said adjacent portion of said one member to extend outwardly therefrom and slidably engage the adjacent portion of the other of said members, a second means rigidly secured to said adjacent portion of said other member to extend inwardly therefrom and slidably engage the adjacent portion of said one member, said passageway being connected to an opening in said adjacent portion of said one member between said first and second means, a lifting member located between said members and adjacent said opening when said pair of members occupy particular relative positions, and said lifting member having a groove open towards said first means and extending towards said other member from said one member so that when said member so that when said members occupy said relative positions said lifting member engages said second means to move said members apart when a sufficient pressure exists in any portion of the hydraulic system.

3. A hydraulic cylinder assembly comprising, a pair of spaced members portions of which are located adjacent each other and one of which has a hydraulic passageway therein, a first means rigidly secured to said adjacent portion of said one member to extend outwardly therefrom and slidably engage the adjacent portion of the other of said members, a second means rigidly secured to said adjacent portion of said other member to extend inwardly therefrom and slidably engage the adjacent portion of said one member, said passageway being connected to an opening in said adjacent portion of said one member between said members and adjacent said opening when said pair of members occupy particular relative positions, a lifting member located between said members and adjacent said second means, said lifting member having a groove open towards said first means and extending towards said other member from said one member so that when said members occupy said relative positions said lifting member engages said second means to move said members apart when a sufficient pressure exists in any portion of the hydraulic system, and a reservoir formed between said one member and said lifting member to obtain a larger hydraulic connection between said groove and said passageway.

4. A hydraulic cylinder assembly comprising, a pair of spaced members having hydraulic passageways therein and portions of which are located adjacent each other, a first means rigidly secured to said adjacent portion of one of said members to extend outwardly therefrom and slidably engage the adjacent portion of the other of said members, a second means rigidly secured to said adjacent portion of said other member to extend inwardly therefrom and slidably engage the adjacent portion of said one member, each of said passageways being connected to openings in said adjacent portions of said members which are located between said first and second means, a lifting member located between said members and said openings when said pair of members occupy particular relative positions, and said lifting member engaging said second means to move said members apart when a sufficient pressure exists in any portion of the hydraulic system.

5. A hydraulic cylinder assembly comprising, a pair of spaced members having hydraulic passageways therein and portions of which are located adjacent each other, a first means rigidly secured to said adjacent portion of one of said members to extend outwardly therefrom and slidably engage the adjacent portion of the other of said members, a second means rigidly secured to said adjacent portion of said other member to extend inwardly therefrom and slidably engage the adjacent portion of said

one member, each of said passageways being connected to openings in said adjacent portions of said members which are located between said first and second means, a lifting member located between said members and said openings when said pair of members occupy particular relative positions, and said lifting member having a groove extending between said openings with one side thereof being open to at least a portion of said first means whereby said lifting member engages the said second means to move said members apart when a sufficient pressure exists in any portion of the hydraulic system.

6. A hydraulic cylinder assembly comprising, a pair of spaced members portions of which are located adjacent each other and one of which has a hydraulic passageway therein, a first means rigidly secured to said adjacent portion of said one member to extend outwardly therefrom and slidably engage the adjacent portion of the other of said member, a second means rigidly secured to said adjacent portion of said other member to extend inwardly therefrom and slidably engage the adjacent portion of said one member, said passageway being connected to an opening in said adjacent portion of said one member between said first and second means, a lifting member located between said members and adjacent said opening when said pair of members occupy particular relative positions, said lifting member having a groove open towards said first means and extending towards said other member from said one member whereby said lifting member engages said second means to move said members apart when a sufficient pressure exists in any portion of the hydraulic system, and a reservoir formed between said one member and said lifting member to obtain a larger hydraulic connection between said groove and said passageway in said last mentioned one of said members.

7. A hydraulic cylinder assembly comprising, a pair of elongated spaced members disposed in longitudinally overlapping relationship, one of said members being longer than the other of said members and having an elongated hydraulic passageway therein, a support means dividing said passageway into two portions and slidably engaging the adjacent surface of said other member intermediate its ends, sealing means secured to opposite ends of said other member, respectively, openings in said one member adjacent the sides of said support means, respectively, for connecting said portions of said passageway to the space between said members, lift members located within said space between said members inwardly adjacent said sealing means respectively, each of said lift members being locatable laterally adjacent one of said openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing movement of said other member over said one member when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway.

8. A hydraulic cylinder assembly comprising, a pair of elongated spaced members disposed in longitudinally overlapping relationship, one of said members being longer than the other of said members and having an elongated hydraulic passageway therein, a support means dividing said passageway into two portions and slidably engaging the adjacent surface of said other member intermediate its ends, sealing means secured to opposite ends of said other member, respectively, openings in said one member adjacent the sides of said support means, respectively, for connecting said portions of said passageway to the space between said members, lift members located within said space between said members inwardly adjacent said sealing means respectvely, each of said lift members being loctatable laterally adjacent one of said openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing movement of said other member over said one member when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway, another elongated member spaced from said one member on the side opposite from said other member, said last mentioned member being longer than said one member and having an elongated hydraulic passageway therein, and said last mentioned means and said one member having identical functioning components secured thereto to obtain movement of said one member over said last mentioned member as specified with relation to said one member and said other member.

9. A hydraulic cylinder assembly comprising, a pair of elongated spaced concentric hollow cylinders disposed in longitudinally overlapping relationship, one of said cylinders being longer than the other and having an annular longitudinally elongated hydraulic passageway therein, an annular support means dividing said passageway into two portions and slidably engaging the adjacent surface of said other cylinder intermediate its ends, sealing means secured to opposite ends of said other member, respectively, openings in said one member adjacent the sides of said support means, respectively, for connecting said portions of said passageway to the annular space between said cylinders, ring members located within said annular space between said cylinders inwardly adjacent said sealing means respectively, each of said ring members being loctatable laterally adjacent one of said openings when said cylinders occupy particular relative positions, and each of said ring members having hydraulically actuated means for causing movement of said other cylinder over said one cylinder when a higher pressure exits in the portion of said passageway to which it is connected than exists in the other portion of said passageway.

10. A hydraulic cylinder assembly comprising, a plurality of elongated members spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated hydraulic passageway therein, support means dividing each of said passageways into two portions, respectively, each of said support means extending toward said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by a support means to extend outwardly from said surface engaged thereby to slidably engage the adjacent surface of said members having a support secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending from said passageways towards said outermost member, respectively, said second openings extending from said passageways, respectively, away from said outermost member so that said portions of said passageways, respectively, are connected to spaced spaces between adjacent said members, lift members located within said spaces between said members inwardly adjacent said sealing means, respectively, each of said lift members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway.

11. A hydraulic cylinder assembly comprising, a plurality of elongated members spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members having an elongated hydraulic passageway therein, support means dividing each of said passageways into two portions, respectively, each of said support means extending toward said one outermost member and slidably engaging the sur-

face of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by a support means to extend outwardly from said surface engaged thereby to slidably engage the adjacent surface of said members having a support secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending from said passageways towards said outermost member, respectively, said second openings extending from said passageways, respectively, away from said outermost member so that said portions of said passageways, respectively, are connected to spaced spaces between adjacent said members, lift members located within said spaces between said members inwardly adjacent said sealing means, respectively, each of said lift members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway.

12. A hydraulic cylinder assembly comprising, a plurality of elongated members spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated hydraulic passageway therein, said outermost member being shorter than the said member adjacent thereto which in turn is shorter than the other of said members adjacent thereto, each of said members having opposite ends movable to be located laterally adjacent the ends, respectively, of the longest of said members, support means dividing each of said passageways into two portions, respectively, each of said support means extending toward said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by a support means to extend outwardly from said surface engaged thereby to slidably engage the adjacent surface of said members having a support secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending from said passageways towards said outermost member, respectively, said second openings extending from said passageways, respectively, away from said outermost member so that said portions of said passageways, respectively, are connected to spaced spaces between adjacent said members, lift members located within said spaces between said members inwardly adjacent said sealing means respectively, each of said lift members locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other of said passageway.

13. A hydraulic cylinder assembly comprising, a plurality of elongated, concentric, hollow cylinders spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated annular hydraulic passageway therein, annular support means dividing each of said passageways into two portions, respectively, each of said support means extending radially towards said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by a support means to extend radially from said surface engaged thereby to slidably engage the adjacent surface of said members having a support secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending radially from said passageways towards said outermost member, respectively, said second openings extending radially from said passageways, respectively, away from said outermost member so that said portions of said passageways respectively, are connected to spaced annular spaces between adjacent said members, ring members located within said spaces between said members inwardly adjacent said sealing means, respectively, each of said ring members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said ring members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway.

14. A hydraulic cylinder assembly comprising, a plurality of elongated, concentric, hollow cylinders spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated annular hydraulic passageway therein, annular support means dividing each of said passageways into two portions, respectively, each of said support means extending radially towards said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by a support means to extend radially from said surface engaged thereby to slidably engage the adjacent surface of said members having a support secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending radially from said passageways towards said outermost member, respectively, said second openings extending radially from said passageways, respectively, away from said outermost member so that said portions of said passageways respectively, are connected to spaced annular spaces between adjacent said members, ring members located within said spaces between said members inwardly adjacent said sealing means, respectively, each of said ring members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said ring members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway, and each of said ring members having the same effective area whereby all of said members exerts a constant force.

15. A hydraulic cylinder assembly comprising, a plurality of elongated members spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated hydraulic passageway therein, support means dividing each of said passageways into two portions, respectively, each of said support means extending toward said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members, engaged by a support

means to extend outwardly from said surface engaged thereby to slidably engage the adjacent surface of said members having a support secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending from said passageways towards said outermost member, respectively, said second openings extending from said passageways, respectively, away from said outermost member so that said portions of said passageways, respectively, are connected to spaced spaces between adjacent said members, lift members located within said spaces between said members inwardly adjacent said sealing means, respectively, each of said lift members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which is connected than exists in the other portion of said passageway and said other outermost elongated member being cut-shaped and telescopically mounted over a stationary cylinder having hydraulic means for causing movement of said cup-shaped member outwardly therefrom.

16. A hydraulic cylinder assembly comprising, a plurality of elongated members spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated hydraulic passageway therein, support means dividing each of said passageways into two portions, respectively, each of said support means extending toward said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by said support means to extend outwardly from said surface engaged thereby to slidably engage the adjacent surface of said members having said support means secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending from said passageways towards said outermost member, respectively, said second openings extending from said passageways, respectively, away from said outermost member so that said portions of said passageways, respectively, are connected to spaced spaces between adjacent said members, lift members located within said spaces between said members inwardly adjacent said sealing means, respectively, each of said lift members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway, and said other outermost elongated member being cup-shaped and telescopically mounted over a stationary cylinder and said stationary member having spaced hydraulic passageways therein cooperable with said second openings, respectively, in said cup-shaped member for causing an unequal hydraulic pressure in said portions of said passageways, respectively.

17. A hydraulic cylinder assembly comprising, a plurality of elongated members spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated hydraulic passageway therein, support means dividing each of said passageways into two portions, respectively, each of said support means extending toward said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by said support means to extend outwardly from said surface engaged thereby to slidably engage the adjacent surface of said members having said support means secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending from said passageways towards said outermost member, respectively, said second openings extending from said passageways, respectively, away from said outermost member so that said portions of said passageways, respectively, are connected to spaced spaces between said members inwardly adjacent said members, lift members located within said spaces between said members inwardly adjacent said sealing means, respectively, each of said lift members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing relative movement of adjacent of said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway, and said other outermost elongated member being cup-shaped and telescopically mounted over a stationary cylinder, and said stationary member having spaced hydraulic passageways therein cooperable with said second openings, respectively in said cup-shaped member for causing an unequal hydraulic pressure in said portions of said passageways, respectively, and each of said ring members and the base of said cup-shaped member having the same effective area whereby all of said elongated members exert a constant force upon movement thereof.

18. A hydraulic cylinder assembly comprising, a plurality of elongated members spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated hydraulic passageway therein, said outermost member being shorter than the said member adjacent thereto which in turn is shorter than the other of said members adjacent thereto, each of said members having opposite ends movable to be located laterally adjacent the ends, respectively of the longest of said members, support means dividing each of said passageways into two portions, respectively, each of said support means extending toward said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by said support means to extend outwardly from said surface engaged thereby to slidably engage the adjacent surface of said members having said support means secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending from said passageways towards said outermost member, respectively, said second openings extending from said passageways, respectively away from said outermost member so that said portions of said passageways, respectively, are connected to spaced spaces between adjacent said members, lift members located within said spaces between said members inwardly adjacent said sealing means respectively, each of said lift members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway and said members when so located adjacent the ends of the longest of said members having

all of said lift members located to one side of said support engaging said support.

19. A hydraulic cylinder assembly comprising, a plurality of elongated members spaced from each other and adjacent ones of which lie in longitudinal overlapping relationship, each of said members except one outermost member having an elongated hydraulic passageway therein, support means dividing each of said passageways into two portions, respectively, each of said support means extending toward said one outermost member and slidably engaging the surface of the adjacent said member intermediate its ends, sealing means secured to opposite ends, respectively, of said members engaged by said support means to extend outwardly from said surface engaged thereby to slidably engage the adjacent surface of said members having said support means secured thereto, respectively, first openings in said members adjacent each side of said support means, respectively, second openings in said members adjacent each end of said passageways therein, respectively, said first openings extending from said passageways towards said outermost member, respectively, said second openings extending from said passageways, respectively, away from said outermost member so that said portions of said passageways, respectively, are connected to spaced spaces between adjacent said members, lift members located within said spaces between said members inwardly adjacent said sealing means, respectively, each of said lift members being locatable between one of said first and one of said second openings when said members occupy particular relative positions, and each of said lift members having hydraulically actuated means for causing relative movement of adjacent said members when a higher pressure exists in the portion of said passageway to which it is connected than exists in the other portion of said passageway, and said other outermost elongated member being cup-shaped and telescopically mounted over a stationary cylinder and said stationary member having spaced hydraulic passageways therein cooperable with said openings, respectively, in said cup-shaped member for causing an unequal hydraulic pressure in said portions of said passageways, respectively, and said ring members located on the same side of said supports, each having the same effective area whereby said elongated members exert a constant force upon movement in opposite directions.

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