Jan. 27, 1959 G. E. SUDEROW 2,870,639

GRIPPER AND JACK ASSEMBLY FOR PLATFORMS AND SUPPORTING COLUMNS

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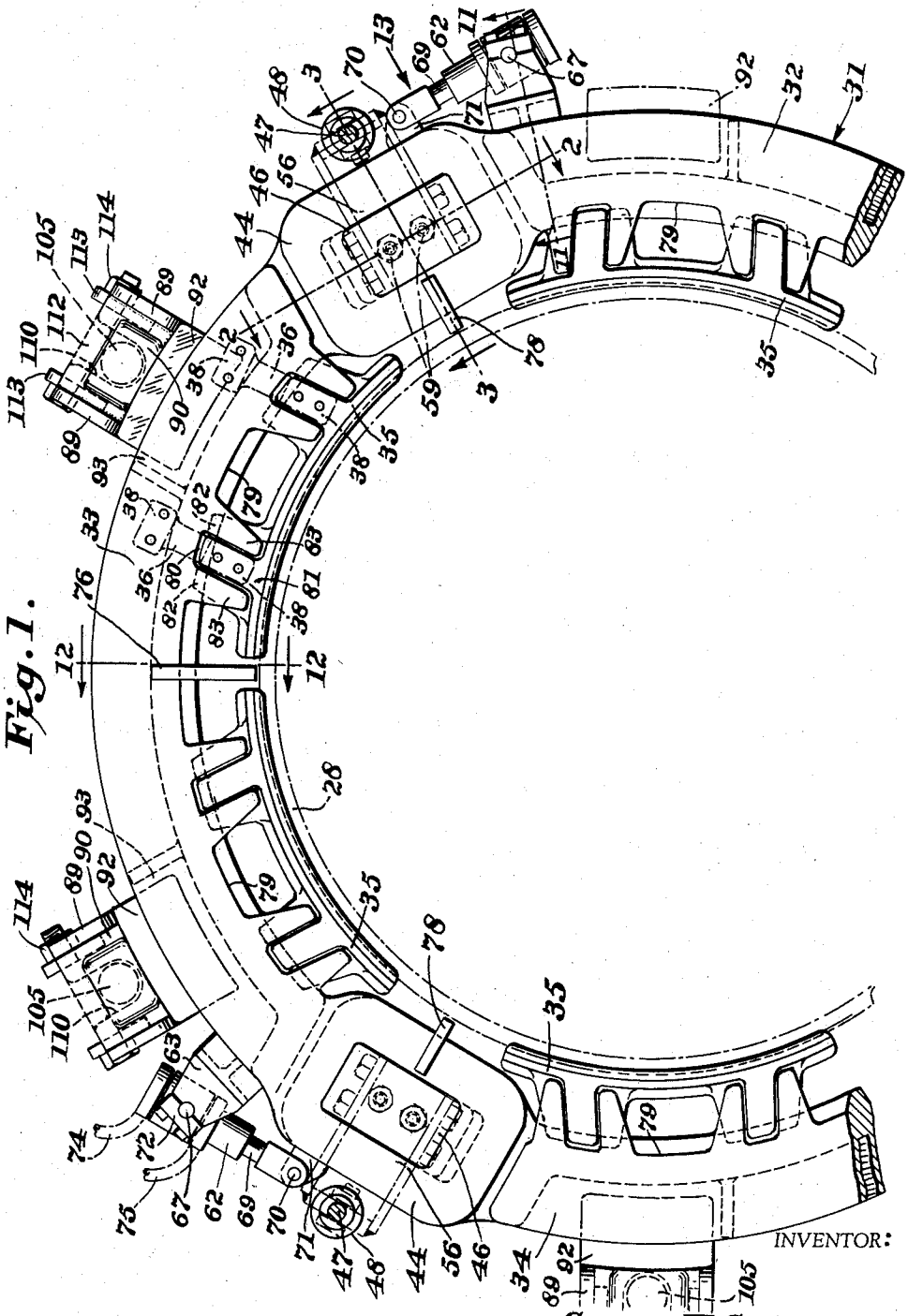


Fig. 1.

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Fig. 2.

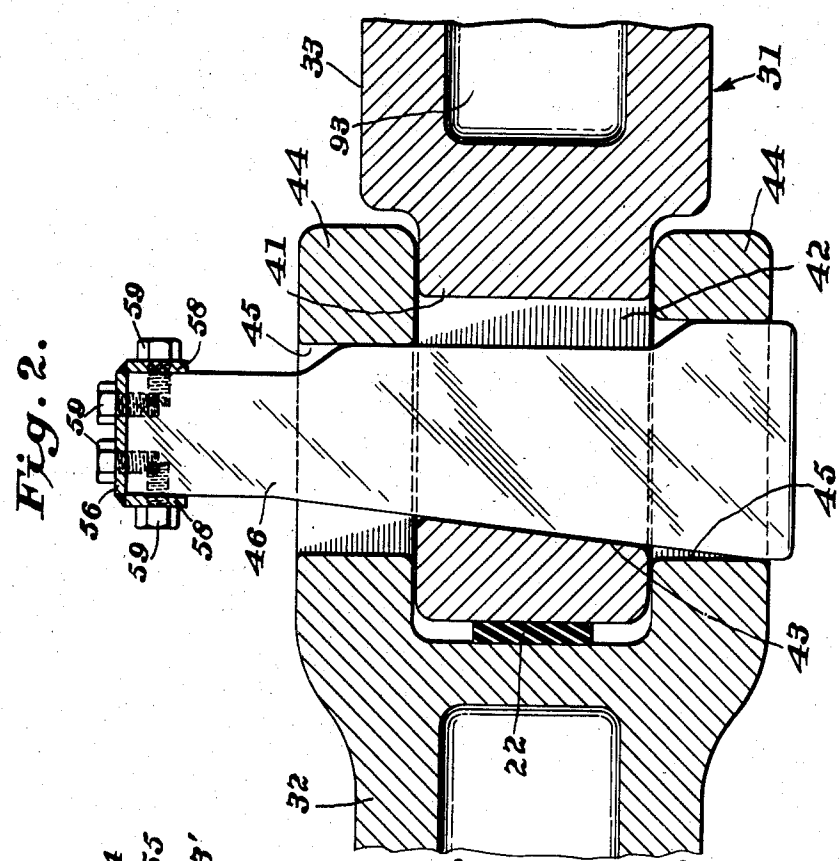
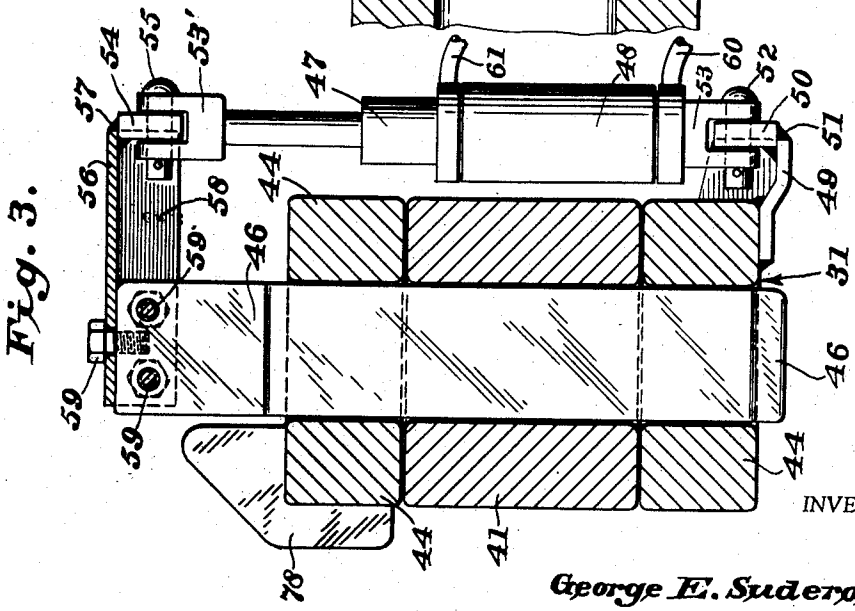


Fig. 3.



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Fig. 4.

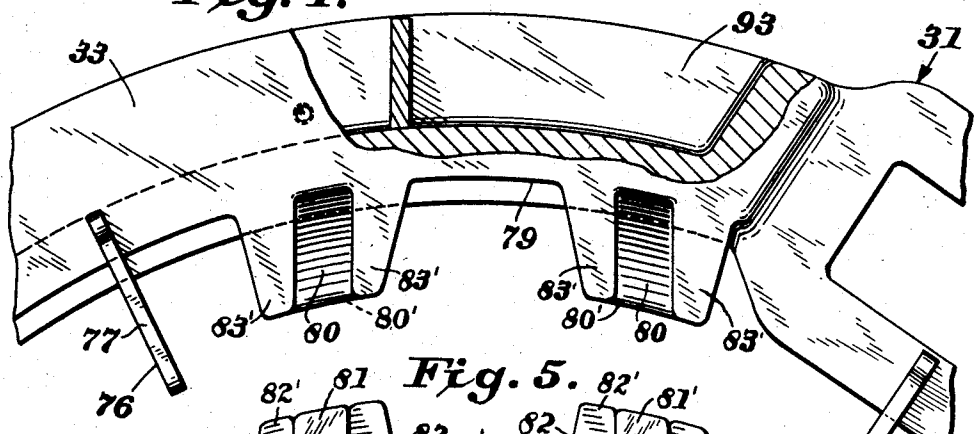


Fig. 5.

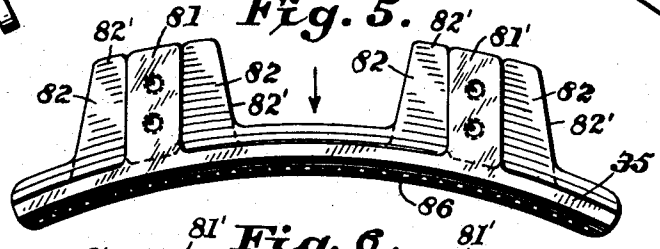


Fig. 6.

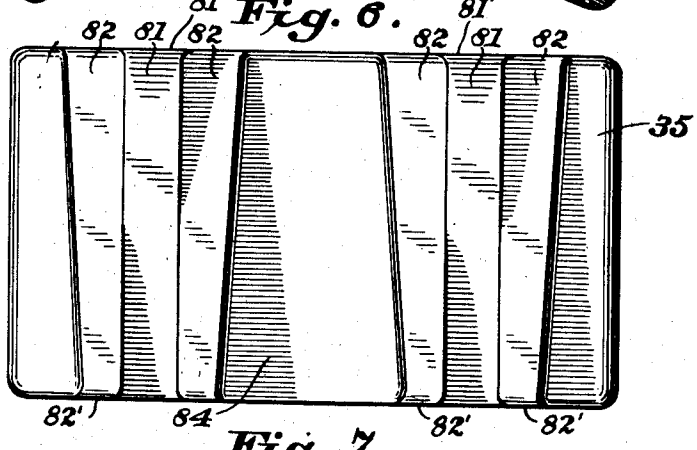


Fig. 7.



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GRIPPER AND JACK ASSEMBLY FOR PLATFORMS AND SUPPORTING COLUMNS

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Fig. 8.

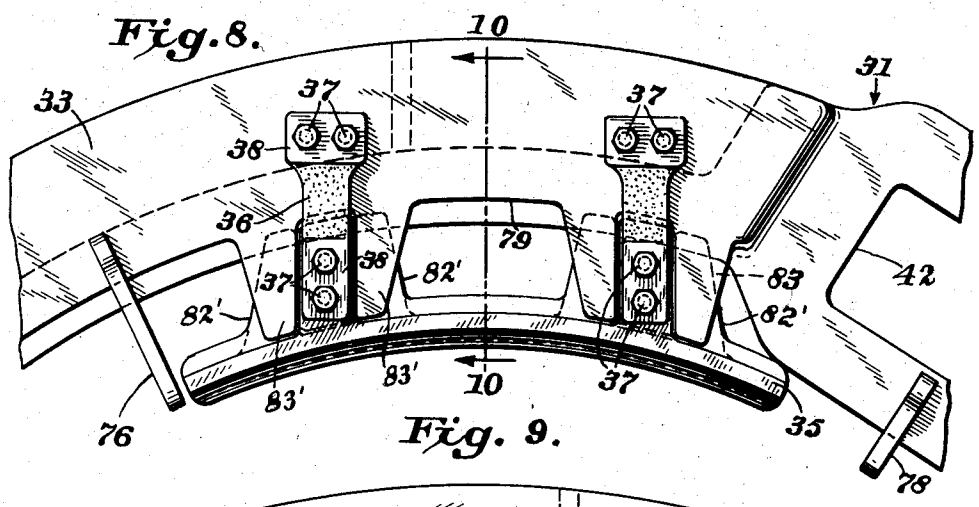


Fig. 9.

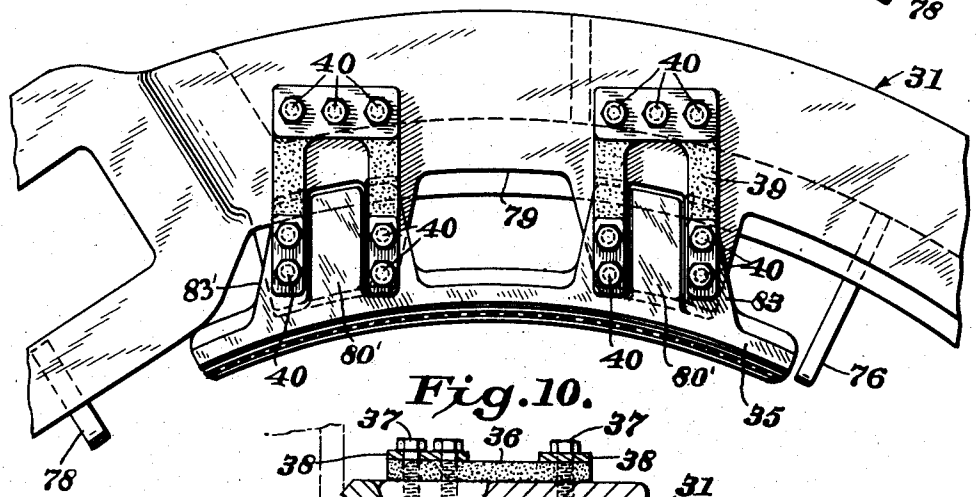
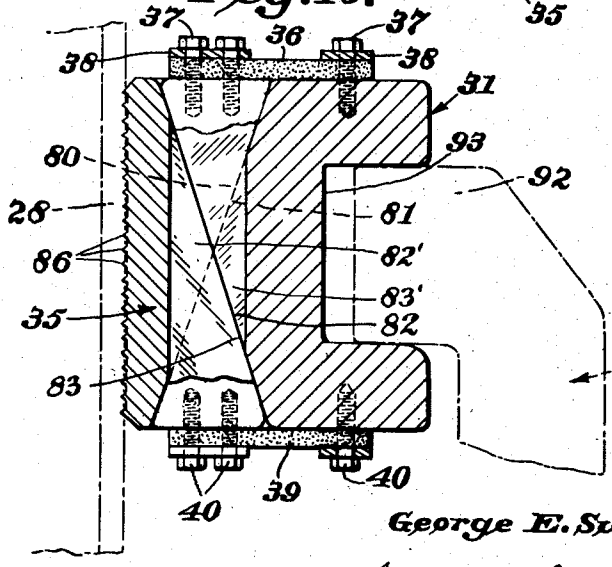


Fig. 10.



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GRIPPER AND JACK ASSEMBLY FOR PLATFORMS AND SUPPORTING COLUMNS

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Fig. 11.

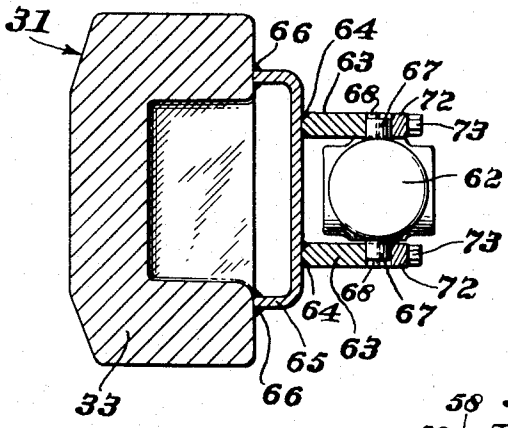


Fig. 12.

UPPER GRIPPER

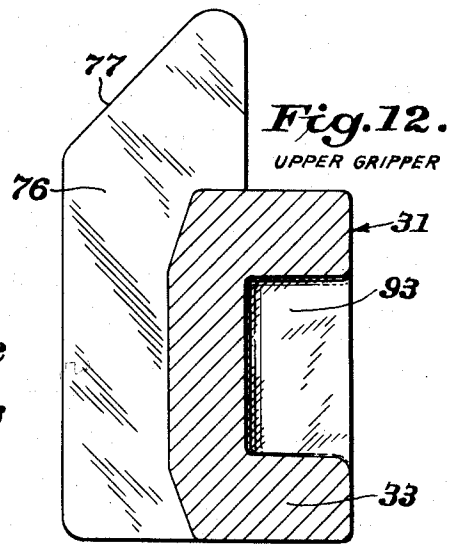


Fig. 12a.

LOWER GRIPPER

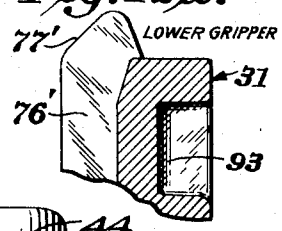


Fig. 13.

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GRIPPER AND JACK ASSEMBLY FOR PLATFORMS AND SUPPORTING COLUMNS

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Fig. 14.

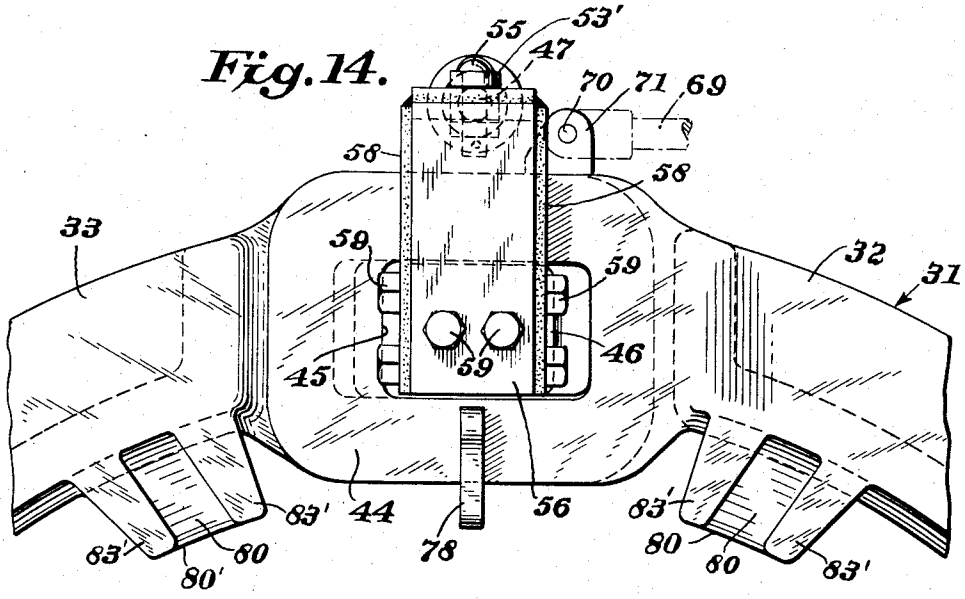


Fig. 18.

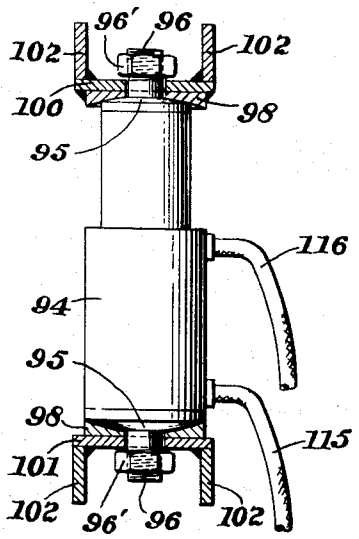


Fig. 19.

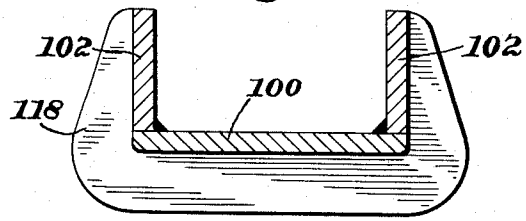


Fig. 20.

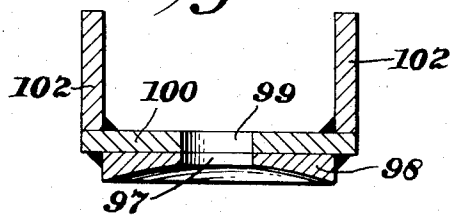
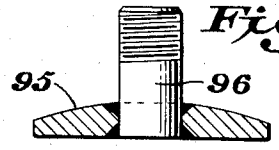


Fig. 21.



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GRIPPER AND JACK ASSEMBLY FOR PLATFORMS AND SUPPORTING COLUMNS

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Fig. 15.

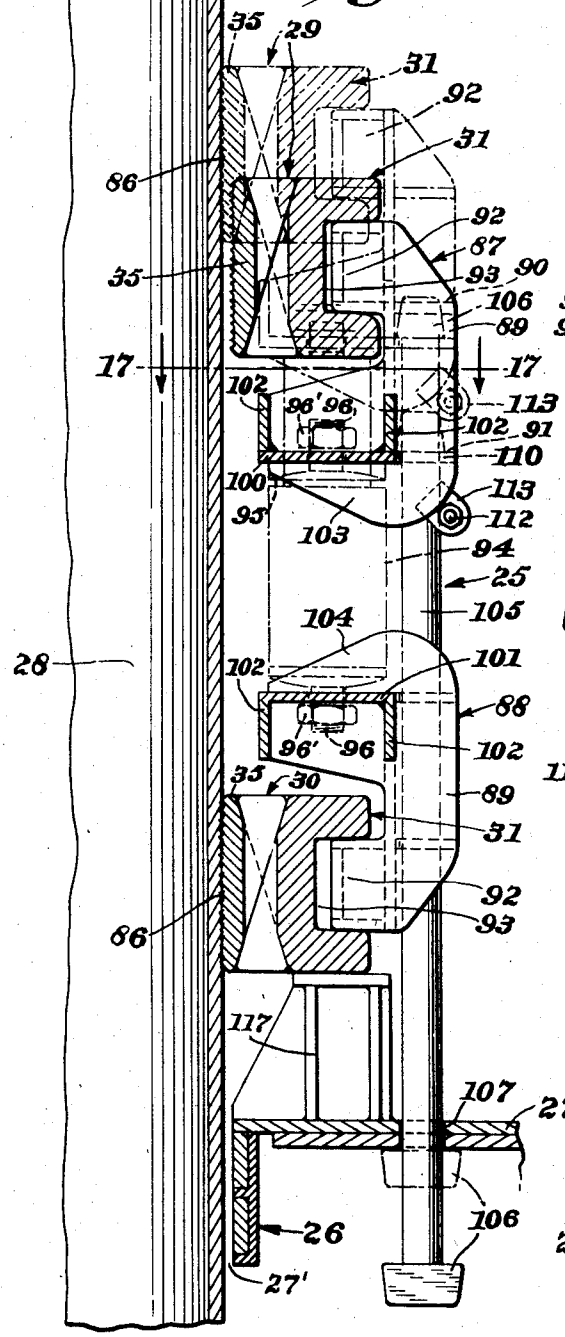
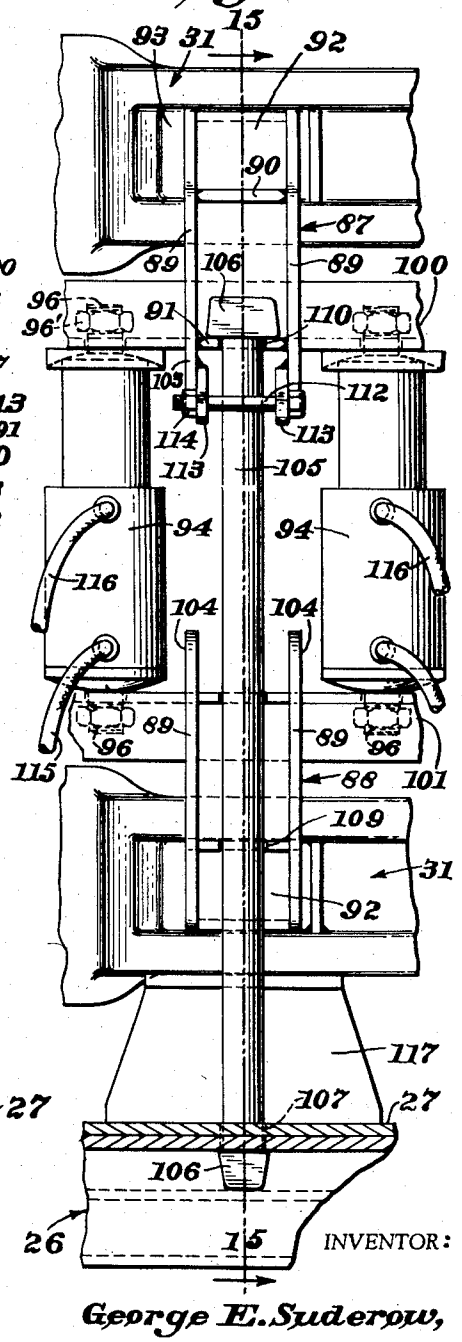


Fig. 16.



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GRIPPER AND JACK ASSEMBLY FOR PLATFORMS AND SUPPORTING COLUMNS

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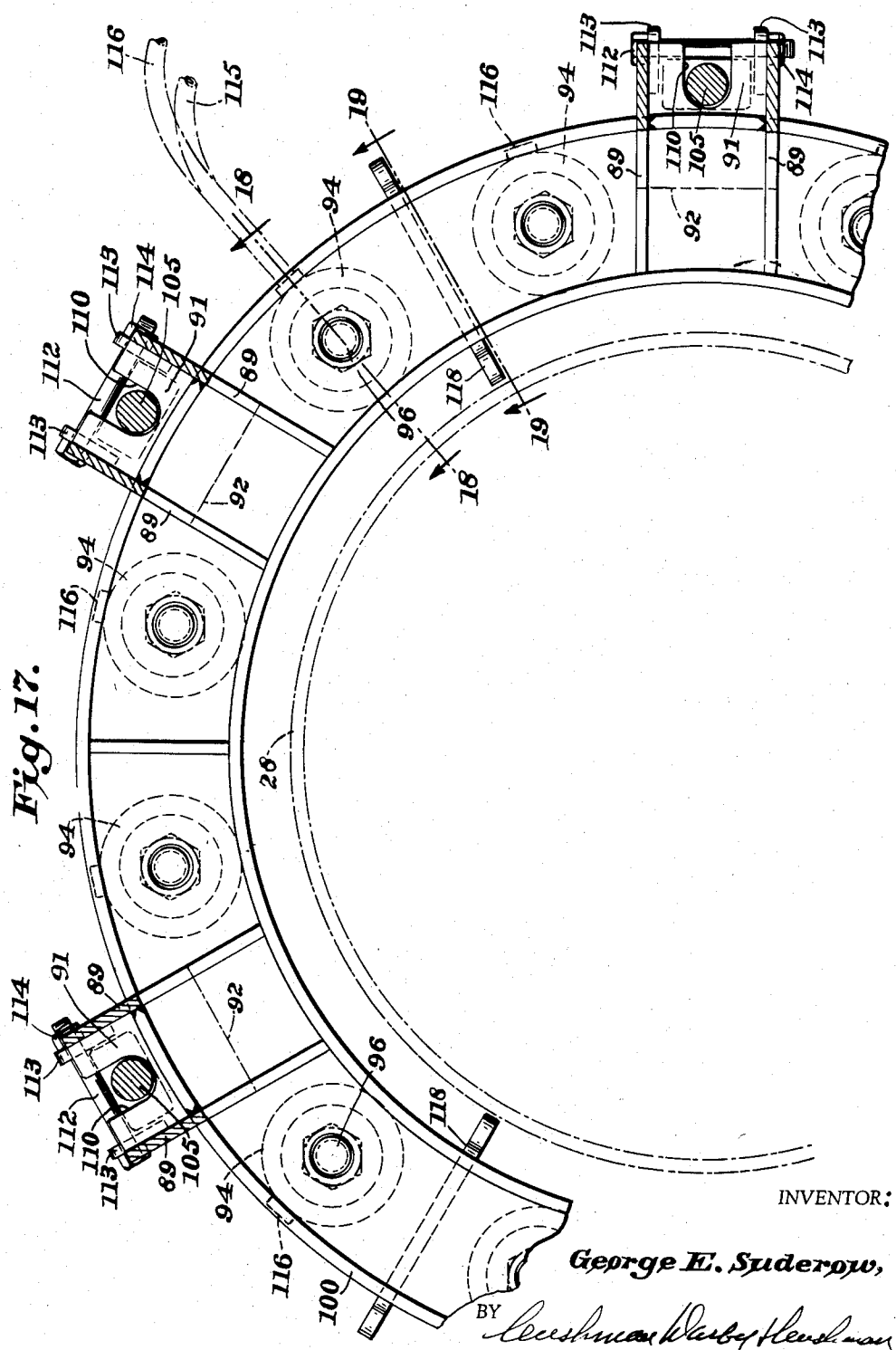


Fig. 17.

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United States Patent Office 2,870,639 Patented Jan. 27, 1959

2,870,639

GRIPPER AND JACK ASSEMBLY FOR PLATFORMS AND SUPPORTING COLUMNS

George E. Suderow, Staten Island, N. Y., assignor to DeLong Corporation, a corporation of Delaware

Application June 2, 1953, Serial No. 359,115

12 Claims. (Cl. 74—162)

This invention relates to improvements in the specific jacking mechanism disclosed in the copending application of Pointer, Serial No. 283,567, now Patent No. 2,775,869.

Although the specific jacking mechanisms disclosed in the aforementioned Pointer application have had very successful commercial usage, such specific mechanisms have certain disadvantages. In particular, the gripping engagement of the Pointer mechanism with a smooth-surfaced supporting leg, usually in the form of a caisson, is one of rubber-to-metal. The load which can be carried by such a mechanism obviously is limited by the friction between the metal and the rubber. In some cases, as when the supporting leg becomes smeared with oil or mud, the frictional engagement between the jacking mechanism and the supporting leg is lessened so that an even lesser load can be carried by the jacking mechanism.

Accordingly, it is an object of this invention to provide an improved jacking mechanism, of the type disclosed in the aforesaid Pointer application, wherein the engagement between the jacking mechanism and a supporting column is effected by metal-to-metal contact.

It is another object of this invention to provide an improved jacking mechanism of the type described in the aforesaid Pointer application which can carry greater loads, with substantially no increase in operating power, than the Pointer type of jacking mechanism.

It is a further object of this invention to provide an improved jacking mechanism of the type disclosed in the aforesaid Pointer application wherein the engagement between the jacking mechanism and a supporting leg is self-energizing so that the greater the load, the tighter the jacking mechanism will grip the supporting leg.

Other objects and advantages of the invention will become apparent from the following description when taken in conjunction with the accompanying claims and drawings.

Referring to the drawings in which are shown preferred embodiments of the invention:

Figure 1 is a fragmentary plan view, with parts omitted or shown in dotted lines, of an improved jack assembly constructed in accordance with the present invention.

Figure 2 is a fragmentary sectional view taken substantially along the line 2—2 of Figure 1.

Figure 3 is a fragmentary sectional view taken substantially along the line 3—3 of Figure 1.

Figure 4 is an enlarged fragmentary plan view, partly in section, of a segment of the gripper assembly shown in Figure 1.

Figure 5 is an enlarged plan view of one of the slip members shown in Figure 1.

Figure 6 is a rear elevational view of the member shown in Figure 5.

Figure 7 is a front or face elevational view of the member shown in Figure 5.

Figure 8 is an enlarged, fragmentary, plan view of a portion of Figure 1 showing a slip or shoe member connected to a segment.

Figure 9 is a bottom plan view of the showing of Figure 8.

Figure 10 is a sectional view taken substantially along the line 10—10 of Figure 8.

Figure 11 is a fragmentary sectional view taken substantially along the line 11—11 of Figure 1.

Figure 12 is a fragmentary sectional view taken substantially along the line 12—12 of Figure 1.

Figure 12a is a sectional view similar to Figure 12 but taken through a lower part of the jack assembly.

Figure 13 is an enlarged fragmentary side elevational view of a portion of the assembly shown in Figure 1 and taken in the direction of the arrow 13 of Figure 1.

Figure 14 is an enlarged fragmentary plan view of a portion of Figure 1.

Figure 15 is a sectional view taken substantially along the line 15—15 of Figure 16.

Figure 16 is a fragmentary side elevational view of the assembly shown in Figure 1.

Figure 17 is a fragmentary sectional plan view taken substantially along the line 17—17 of Figure 15.

Figure 18 is a fragmentary sectional view taken substantially along the line 18—18 of Figure 17.

Figure 19 is a fragmentary sectional view taken on line 19—19 of Figure 17, of the upper jack channel member.

Figure 20 is an enlarged fragmentary view of a portion of Figure 18.

Figure 21 is an enlarged fragmentary view, partly in section, of another portion of Figure 18.

Referring to the drawings and more particularly Figures 15 and 16, the improved jack assembly is generally indicated by the numeral 25, and for the purpose of illustration is shown associated with a base in the form of a floating barge 26 having a deck 27 and guiding wells 27′ through each of which loosely extends a supporting column, upright, or pile 28, here shown in the form of a caisson. At an erection site the jack assemblies 25 may be operated to move the caissons 28 down into engagement with the marine bottom and raise the barge 26 on the caissons, as described more in detail in the aforementioned Pointer application. Each jack assembly 25 comprises an upper gripper 29 and a substantially identical lower gripper 30 (Fig. 15) which are selectively controllable to frictionally engage the outer surface of the column 28 or be readily released therefrom.

Each of the grippers includes a segmental ring or annular member 31 (Figure 1) having a plurality of segments or sections 32, 33, and 34, preferably three in number. Carried on the inner side of each of the segments are a plurality of circumferentially spaced gripper slips or shoes 35 which are movably mounted on each segment by upper and lower flexible members 36 and 39 (Figure 8). The members 36 are connected to the tops of the sections and the slips 35 by screws 37 and washers 38. Similarly, the bottom of each section and an adjacent slip are movably connected together by the flexible members 39 and retaining screws 40. Each of the flexible members is formed of any suitable durable material, such as rubber or the like and permits independent vertical movement of the ring 31 relative to the slips or shoes 35 within predetermined limits and also radial or lateral displacement of the slips relative to the ring 31.

The sections of the ring 31, such as the sections 32 and 33 (Figure 2), are each formed at one end with a reduced shouldered portion 41 having an opening 42 provided with an inclined side 43. The other end of each section is of bifurcated shape so as to form vertically-spaced arms 44 having aligned openings 45 which register

with the slightly larger or wider opening **42** in the adjacent end of an adjacent section or segment so as to receive a connecting pin in the form of a wedge or tapered member **46**. It will be seen that vertical movement of the wedge member **46** in engagement with the opposed vertical and inclined walls of the openings **45** and **42** will move the sections of the ring **31** towards each other so as to reduce the circumference and diameter of the ring. A suitable resilient buffer or stop **22** may be positioned in the space between the arms **44** (Figure 2) to abut and limit the inward movement of the end **41** of the adjacent section.

Each of the wedges **46** is vertically displaceable by suitable operating means such as the piston rod **47** of a double-acting fluid pressure cylinder **48** (Figure 3). At its lower end the cylinder **48** is pivotally connected to the outer side of an adjacent section of the ring **31** by a supporting bracket or plate **49** having an upstanding arm **50** which may be welded thereto as at **51** and to which is pivotally connected by a pin **52** a depending bifurcated arm **53** extending from the cylinder. The upper end of the rod **47** has a bifurcated head **53'** to which is pivotally connected a bar **54** by a pin **55**. The bar **54** is welded to a transverse plate **56** as at **57**. The plate **56** is preferably of channel shape so as to have the depending sides **58** and is secured to the top of the wedge **46** by screws **59**. Fluid under pressure may be introduced into or withdrawn from the opposite ends of the cylinder **48** through flexible supply pipes or conduits **60** and **61** (Figure 13).

In order to assist the wedges **46** in reducing the diameter of the ring **31** and to positively expand the latter when the wedges are released, an auxiliary horizontally disposed, double-acting fluid pressure cylinder **62** connects the adjacent ends of the ring segments (Figure 1). Each cylinder is mounted between a pair of vertically spaced horizontal arms **63** (Figure 11) welded as at **64** to a channel shaped member **65** which in turn is welded as at **66** to the outer side of one of the sections of the ring. The cylinder **62** has trunnions **67** extending from opposite sides thereof and arranged to fit into bearing openings **68** formed in the arms **63**. The piston rod **69** of the cylinder **62** is pivotally connected by a pin **70** to a lug **71** extending outwardly from the reduced end portion **41** of the adjacent ring segment (Figure 13). The cylinder **62** and its associated parts are maintained in position by retaining plates **72** and screws **73** which fit into corresponding threaded openings formed in the arms **63**. Fluid under pressure may be introduced into and withdrawn from the opposite ends of the cylinder **62** through the flexible hose or conduits **74** and **75** (Figure 13). Thus, it will be seen that when the piston rod **69** is moved outwardly relative to the cylinder, it will expand or increase the diameter of the sectional ring **31** and conversely, when the piston rod **69** is moved inwardly, it will contract the ring. The operation of the double-acting cylinders **62** is synchronized with the operation of the cylinders **48** so that when the wedge members **46** are raised, the sections will simultaneously be pulled together so as to reduce the diameter of the ring **21**. Conversely, when the wedge members **46** are moved downwardly to release the sections of the ring, the piston **69** is moved outwardly to positively expand the ring.

Each of the sectional rings **31** preferably is of outwardly-facing channel shape (Figure 12) and is provided on its inner side or periphery with circumferentially spaced guide plates **76** having downwardly inclined upper edges **77** for facilitating the insertion of a caisson or the like **28** within the ring. The guide plates **76** are positioned between adjacent slips **35** of each of the sections of the ring (Figure 1) and coact with similarly formed guide members **78** carried by the bifurcated arms **44** of each of the sections of the ring (Figure 3) so that the caisson **28** or other cylindrical supporting member may be guided into the ring.

As best shown in Figures 4, 5, 6, and 10, the inner surface or side of each of the sections is of increased radius between its ends, as at **79** (Figure 4) and provided opposite each shoe **35** with a pair of circumferentially-spaced, generally radially inwardly-extending lugs or projections **80'** having downwardly and inwardly inclined inner wedging surfaces **80** which are arranged to coact with complementary inclined wedging surfaces **81** on lugs **81'** extending outwardly from each of the slip members **35** (Figure 5). The slip members **35** on opposite sides of each lug **81'** are provided with similar lugs **82'** having outer wedging surfaces **82** of an inclination opposite to that of the surfaces **81** and which coact with complementary wedging surfaces **83** on lugs **83'** on the inner side of the adjacent ring section.

From the foregoing construction, it will be seen that the center lugs **80'** and **81'** interfit between the circumferentially spaced lugs **82'** and **83'** to maintain the shoes **35** against circumferential movement relative to the ring **31**. It also will be seen that relative vertical movement in either direction between a shoe **35** and a ring **31** from the centered position shown in Figures 10 and 15 will cause a mutual wedging action between the surfaces **80** and **81** or between the surfaces **82** and **83** that will be effective to move the shoe radially inwardly. Hence, when the shoes **35** engage a leg **28**, such relative movement will effect a tighter gripping engagement of the former with the latter. The exposed inner face **85** of each of the slips **35** is provided with serrations or teeth **86** so as to provide a firm gripping engagement with the work, such as the caisson **28** or the like, when the gripper is moved into clamping engagement therewith.

The upper gripper **29**, which is composed of a sectional ring **31** and circumferentially spaced slips **35**, is connected to the lower gripper **30**, which is similarly formed of a sectional ring **31** and slips **35**, in part by an upper bracket or connector **87** and a lower bracket or connector **88** (Figures 15 and 16). Each of the bracket members may be formed of spaced, vertical, parallel sides or flanges **89** (Figure 16) which are connected by vertically-spaced horizontal webs **90** and **91**. The upper end of each bracket member **87** extends inwardly as at **92** so as to fit into the channel portion **93** of a section of the ring **31** (Figures 10 and 15), when the parts are assembled. Each of the lower bracket members **88** is similar in form to the bracket **87** so that its end portion **92** fits in the channel portion **93** of an adjacent ring section (Figure 15). Between the upper gripper **29** and the lower gripper **30** are positioned circumferentially spaced, two-way fluid pressure jacks **94**, each of which has convex ends **95** having centrally disposed threaded stems **96** which project through central openings **97** in concave thrust bearings **98** (Figure 20) and aligned openings **99** in vertically spaced jack rings **100** and **101** and are retained by nuts **96'**. Each of the rings **100** and **101** may be provided with side flanges **102** welded or otherwise connected thereto, in order to form annular channel members which face in opposite directions from the ends of the jacks **94**. The bracket members **87** and **88** have inwardly extending arms **103** and **104** (Figure 15) which are secured, as by welding, to the jack rings **100** and **101** so that extension or retraction of all of the jacks **94** in unison is transmitted through the bracket members **87** and **88** to the grippers **29** and **30**.

Circumferentially spaced tie rods **105** having at their opposite ends T-shaped heads **106**, are arranged to extend through openings **107** in the deck **27** of the barge and slots **110** in the lower horizontal webs **91** of the upper brackets **87** (Figures 15, 16, and 17). The webs of the lower bracket member **88** are slotted, as at **109** (Figure 16) to accommodate the rods **105**. Thus, it will be seen that the rods **105** may be readily detachably connected to the jack assembly **25**. The upper ends of each of the rods **105** may be retained in position in the slots **110** by a transverse retaining bolt **112** that extends

through spaced lugs **113** that are welded to the inner opposed sides 89 of the bracket **87**. It will be seen that when each lug **113** is mounted on the bracket member **87** and its nut **114** tightened, it will releasably maintain the tie rod **105** in proper position. Each of the jacks **94** may be operatively connected to any suitable source of hydraulic power through flexible conduits **115** and **116** (Figure 18). Each of the jack rings **100** and **101** may be provided with spaced guide members **118** for both reinforcing the rings and guiding the caisson **28** through the rings **100** during its insertion into the jack assembly.

In operation, it will be understood that the cylinders **48** and **62**, as well as the jacks **94**, are operatively connected through control valves to a source of hydraulic pressure. These valves are initially actuated so that the upper and lower grippers are normally in their full opened or expanded position so that the caisson **28** may be inserted into the jack assembly (Figure 15). With the caisson moved down into engagement with the marine bottom, and both the grippers **29** and **30** in their open position, the jacks **94** are simultaneously operated to raise the upper griper **29** to its uppermost position, as shown in dotted lines in Figures 15, and raise the tie rods **105** to the position shown in Figure 16. The resulting downward thrust of the jacks **94** is taken by pedestals **117** spaced about the well **27'** beneath the lower ring **31** and resting on the deck **27** of the barge **26**. The upper gripper **29** is then clamped in tight frictional engagement with the caisson **28** by actuation of the valves controlling the cylinders **48** and **62**. This movement contracts the upper ring **31** and moves the teeth **86** of the upper slips 35 into tight clamping engagement with the caisson 28. Each of the jacks **94** is now retracted so as to raise the lower gripper **30**. The lower gripper **30** is then closed so that the lower slips **35** engage the caisson. The upper gripper **29** is then released by the reverse operation of the cylinders **48** and **62**. The lower gripper **30** now firmly engages the caisson and the lifting jacks **94** are operated to raise the upper gripper **29** which pulls the barge **20** along therewith. Consequently, a downward thrust is imparted to the caisson **28** so that the latter is driven to a bearing in the marine bottom, and thereafter the barge is raised on the caisson by continuing to recycle the jack assembly. By appropriate manipulation of the jack assembly, the barge may be lowered so as to float on the water and the caissons raised so that the barge and the equipment thereon may be easily transported to another point of use.

The lifting jacks **94** are circumferentially spaced so as to uniformly distribute their forces around the caisson **28** in order to efficiently raise or lower the same. Each of the jacks **94** is retracted after each expansion stroke so as to move the upper and lower grippers towards each other. The tie rods **105** are slidably mounted in the openings 107 of the deck **27** and are limited in their upward movement by engagement of the head **106** with the underside of the deck. Instead of a two-way jack, other suitable means may be provided, such as a single or ram type jack, to move the grippers apart, and a separate jack or mechanical operating means may be used to move the grippers toward each other.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

I claim:

1. A gripper assembly for selectively engaging or disengaging a smooth-surfaced, elongated, cylindrical element against relative movement in either direction longitudinally of the element, comprising: a segmental ring adapted to surround the element; movable wedge means interconnecting the adjacent ends of each pair of adjacent segments of said ring and effective on movement in one direction to contract said ring and force said segments radially inwardly into tight gripping engagement with the element and on movement in the opposite direction to release said segments for expansion of said ring; and power-operated means interconnecting said adjacent ends of each pair of adjacent segments for moving said ends circumferentially apart to expand said ring and move said segments radially outwardly on release of the latter by said wedge means.

2. A gripper assembly for selectively engaging or disengaging a smooth-surfaced elongated element against relative movement in either direction longitudinally of the element, comprising: contractible ring means adapted to surround the element; at least one gripper shoe carried by said ring means on the inner side thereof; and means defining two oppositely inclined sets of wedging surfaces on said ring means and said shoe effective on relative movement therebetween in either direction longitudinally of the element, from a centered relative position wherein the surfaces of both sets are engaged, to force said shoe radially inwardly of said ring means.

3. A gripper assembly for selectively engaging or disengaging a smooth-surfaced, elongated, cylindrical element against relative movement in either direction longitudinally of the element, comprising: a circularly arranged series of gripper shoes for surrounding the element; means carrying said shoes and movable generally radially inwardly toward the element to engage said shoes therewith; and means defining two oppositely inclined sets of wedging surfaces on said carrying means and each shoe effective on relative movement therebetween in either direction longitudinally of the element, from a centered relative position wherein the surfaces of both of said sets are engaged, to force said shoe radially inwardly of said carrying means.

4. The structure defined in claim 3 including resilient means fastening each shoe to the carrying means for normally maintaining the surfaces of both sets in engagement.

5. A gripper assembly for selectively engaging or disengaging a smooth-surfaced, elongated, cylindrical element against relative movement in either direction longitudinally of the element, comprising: a circularly arranged series of radially-movable members adapted to surround the element; means interconnecting said elements against relative movement therebetween longitudinally of the element; at least one gripping shoe carried by each of said members for engagement with the element; and means defining two oppositely inclined sets of wedging surfaces on each of said members and its corresponding shoe effective on relative movement therebetween in either direction longitudinally of the element, from a centered relative position wherein the surfaces of both of said sets are engaged, to force said shoe radially inwardly of said member.

6. The structure defined in claim 5 including power-operated means for selectively restraining or effecting radial movement of the members in either direction.

7. In a jack mechanism releasably engageable with a smooth-surfaced, elongated, cylindrical element, the combination comprising: a pair of spaced, coaxial segmental rings adapted to surround the element; means for selectively contracting or expanding each of said rings to move said segments thereof radially inwardly into, or outwardly out of, gripping engagement with the element; a pair of rigid rings coaxial with said segmental rings and positioned therebetween; means connecting each of the segments of each segmental ring to one of said rigid rings for movement therewith in either direction longitudinally of the element and for radial movement relative thereto; and power-operated means connected to said

rigid rings for selectively moving them axially toward or away from each other.

8. The structure defined in claim 7 in which the power-operated means includes a plurality of uniformly spaced fluid pressure motors interposed between the rigid rings, and including means defining a pair of opposed, substantially spherical thrust bearing surfaces between each end of each of said motors and each of said rigid rings.

9. The structure defined in claim 7 in which the contracting or expanding means includes wedge means interconnecting the adjacent ends of each pair of adjacent segments.

10. The structure defined in claim 7 including at least one gripper shoe carried by each segment and means defining two oppositely inclined sets of wedging surfaces on said segment and said shoe effective on relative movement therebetween in either direction longitudinally of the element, from a centered relative position wherein the surfaces of both sets are engaged, to force said shoe radially inwardly of said segment.

11. The structure defined in claim 7 in which each segment has a radially-outwardly facing recess therein, and the connecting means includes members rigidly secured to the rigid rings and projecting into said recesses.

12. In a jack mechanism releasably engageable with a smooth-surfaced, elongated, cylindrical element, the combination comprising: two spaced, circularly-arranged, coaxial series of radially-movable members adapted to surround the element; means interconnecting the elements of each of said series against relative movement therebetween longitudinally of the element; at least one gripper shoe carried by each of said members for engagement with the element; means defining two oppositely-inclined sets of wedging surfaces on each of said members and its corresponding shoe effective on relative movement therebetween in either direction longitudinally of the element, from a centered relative position wherein the surfaces of both of said sets are engaged, to force said shoe radially inwardly of said member; power-operated means for selectively effecting or restraining radial movement of all of the members of each of said series in unison; and power-operated means connected to both of said series for selectively moving them axially toward or away from each other.

References Cited in the file of this patent

UNITED STATES PATENTS

26,261	Ehrenfeld	Nov. 29, 1859
175,401	Williams	Mar. 28, 1876
531,014	Barnes	Dec. 18, 1894
555,841	Adams	Mar. 3, 1896
779,656	Kirk	Jan. 10, 1905
1,194,209	Middaugh	Aug. 8, 1916
2,035,242	McCann	Mar. 24, 1936
2,208,747	Campbell	July 23, 1940
2,308,743	Bulkley	Jan. 19, 1943
2,352,370	Carruthers	June 27, 1944
2,555,145	McKinney	May 29, 1951
2,592,448	McMenimen	Apr. 8, 1952
2,612,671	Martin	Oct. 7, 1952
2,700,201	Bannister	Feb. 8, 1955

FOREIGN PATENTS

424,557	Great Britain	Feb. 22, 1935