May 23, 1972 H. J. SAVOIE, JR 3,664,621

UNDERWATER PIPELINE-RISER CLAMPS FOR USE ON OIL AND GAS PIPELINES

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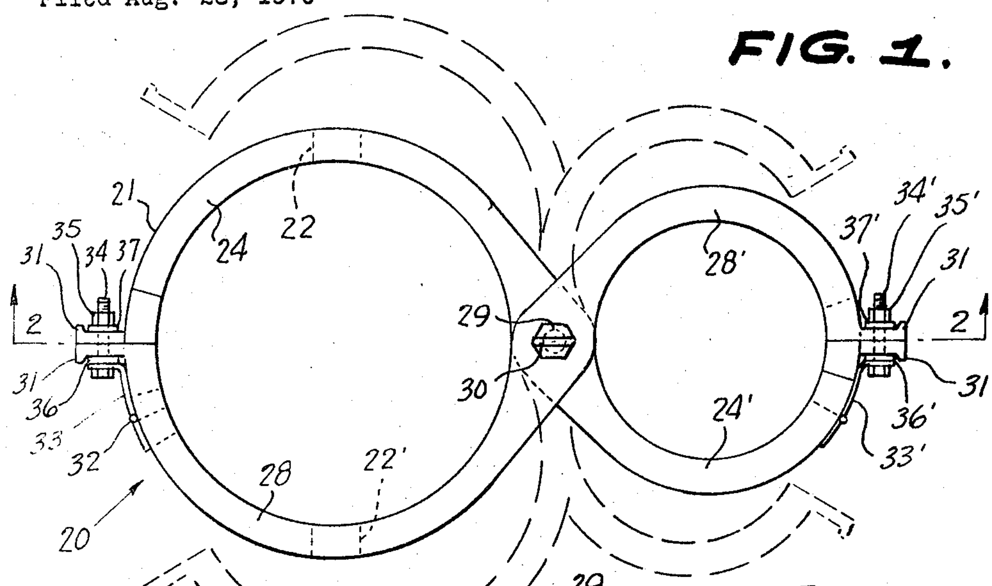
FIG. 1.



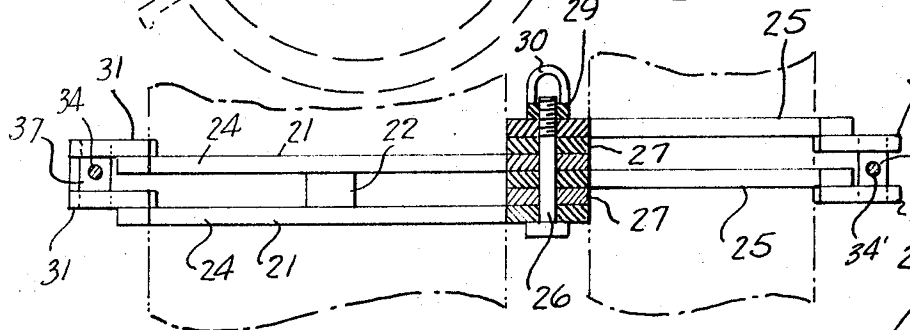




FIG. 2.

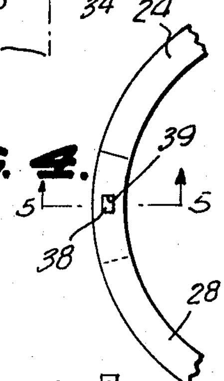
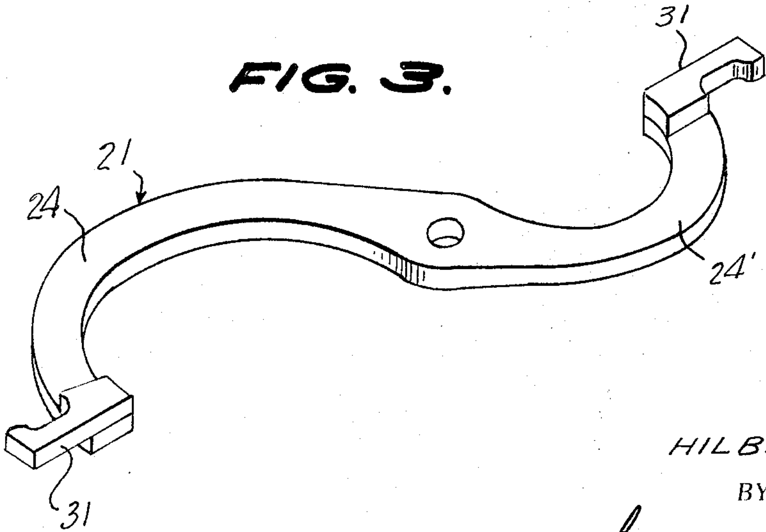



FIG. 4.

FIG. 3.



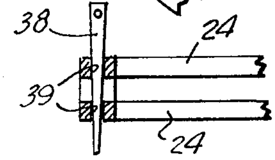




FIG. 5.

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FIG. 6.

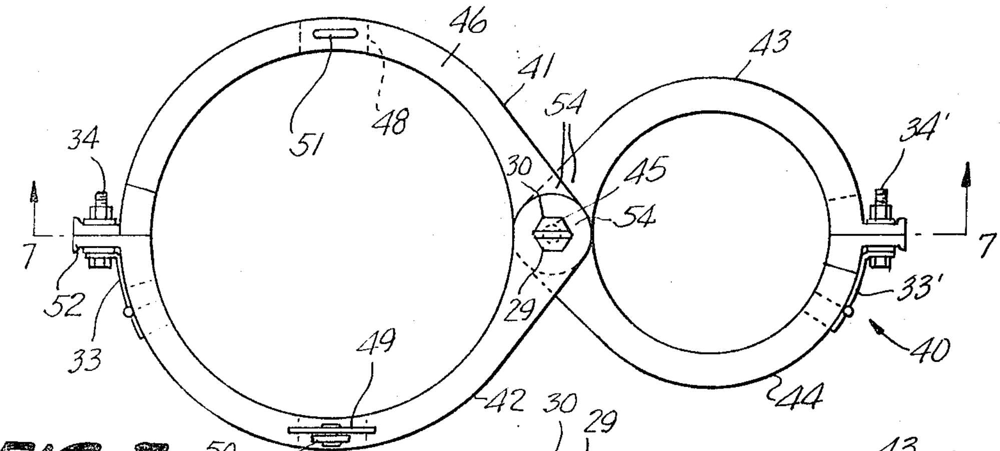



FIG. 7.

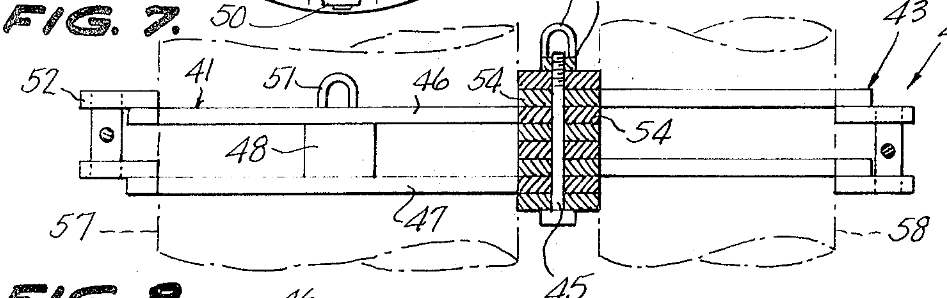
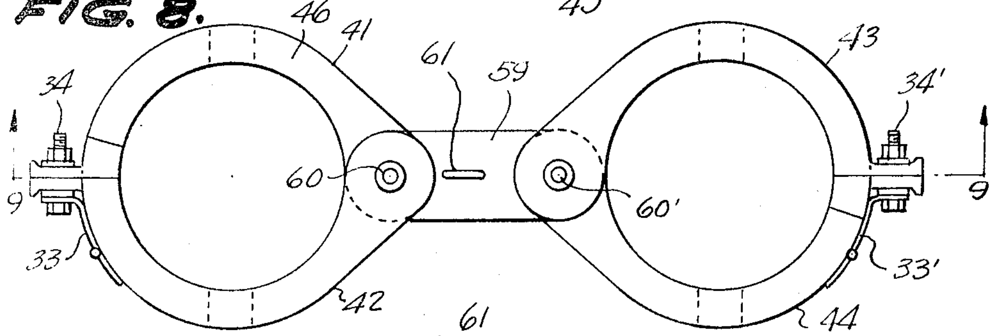



FIG. 8.



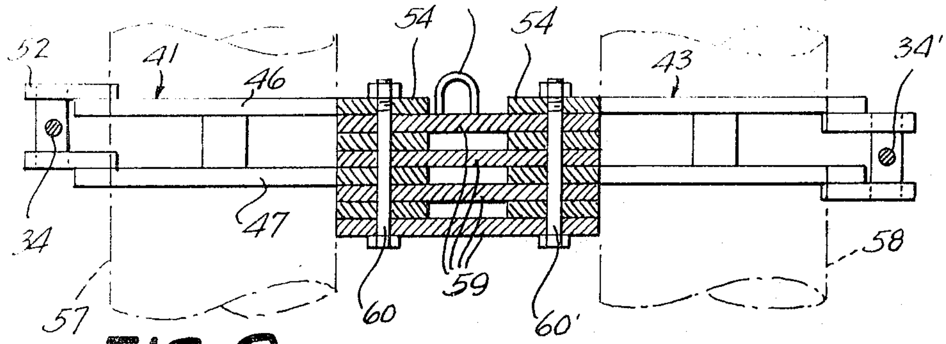




FIG. 9.

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UNDERWATER PIPELINE-RISER CLAMPS FOR USE ON OIL AND GAS PIPELINES

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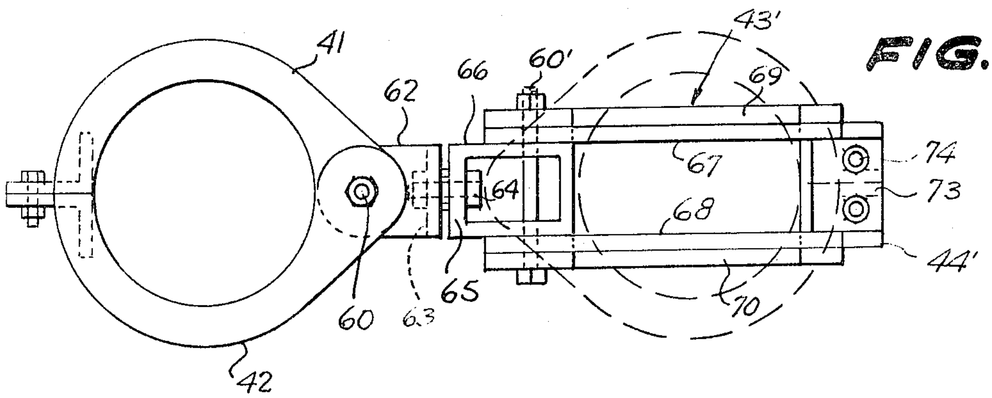


FIG. 10.

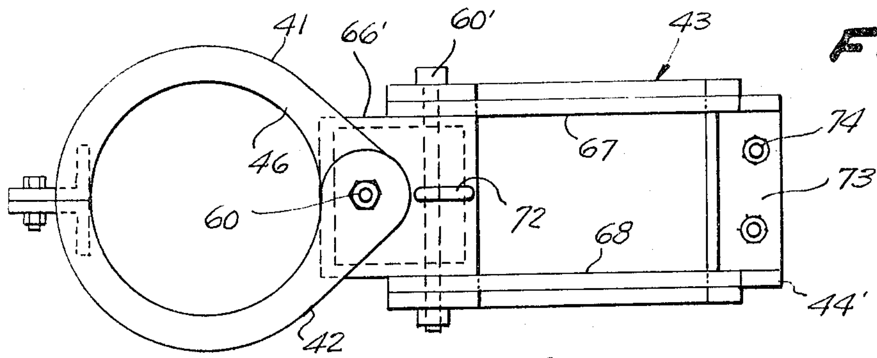


FIG. 11.

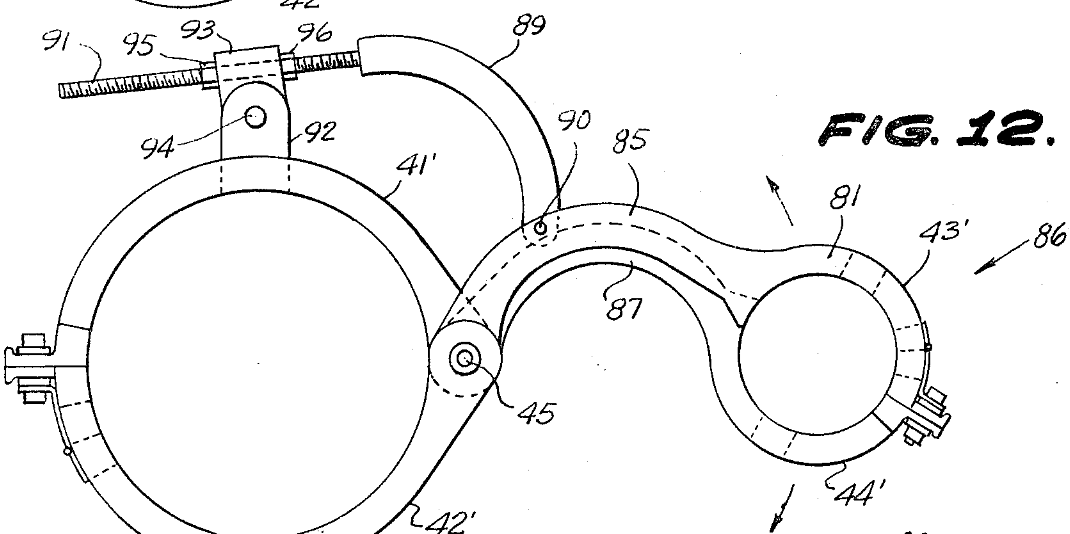


FIG. 12.

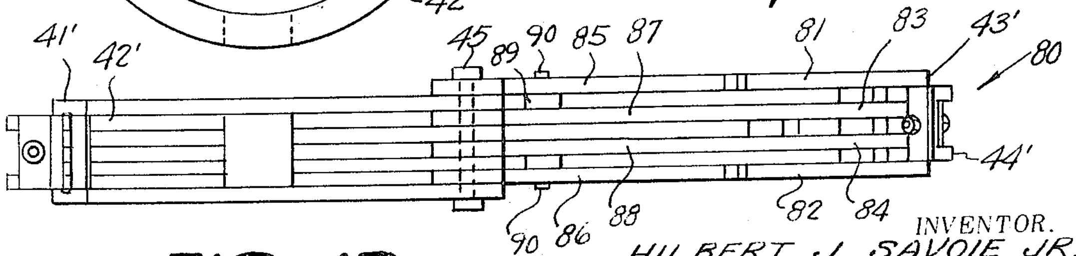


FIG. 13.

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FIG. 14.

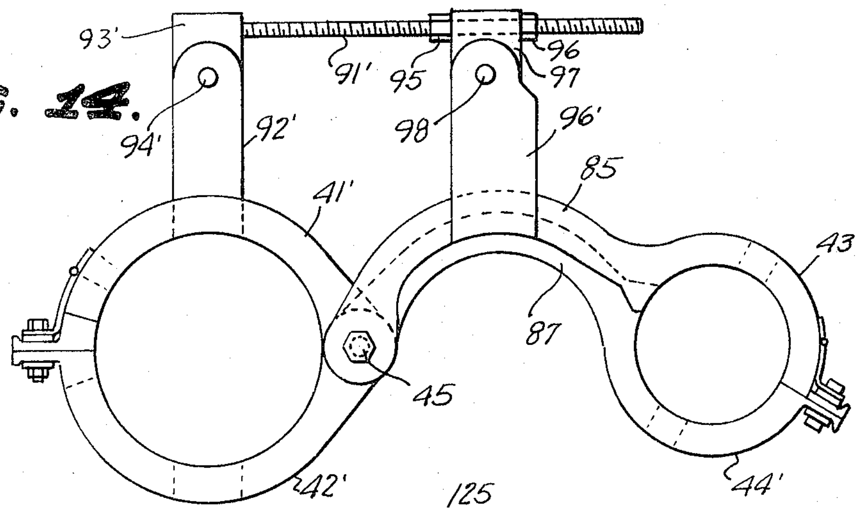



FIG. 15.

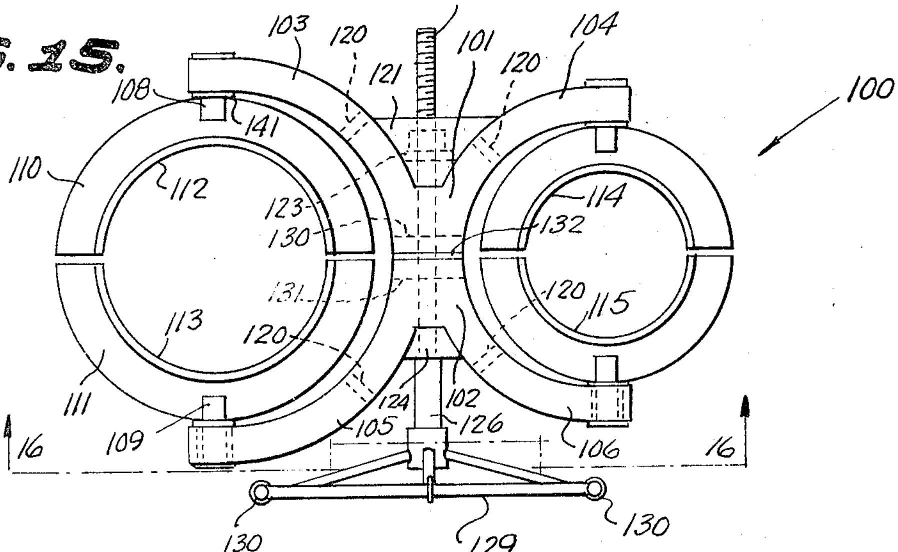



FIG. 16.

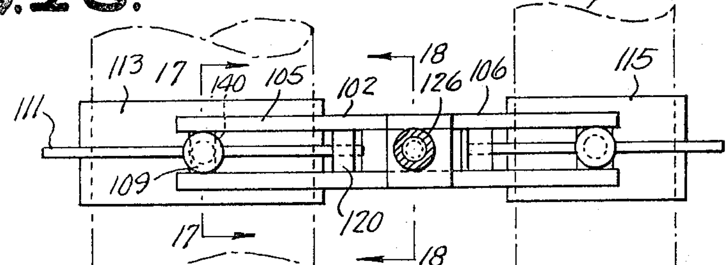
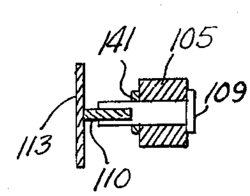



FIG. 17.



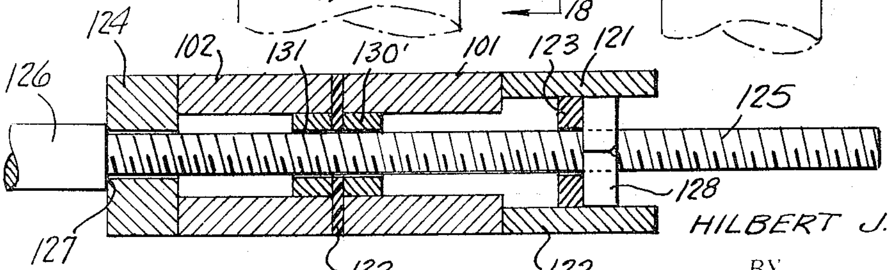




FIG. 18.

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# United States Patent Office

3,664,621
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**UNDERWATER PIPELINE-RISER CLAMPS FOR USE ON OIL AND GAS PIPELINES**

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Int. Cl. F16l 3/10
U.S. Cl. 248—74 R 7 Claims



## ABSTRACT OF THE DISCLOSURE

The invention consists of double clamp assemblies which have segments pivoted relative to each other for attaching gas and oil vertical pipelines to platforms located offshore. The clamps allow swiveling adjustment of a pipe relative to the leg member of a platform to which it is to be attached. The clamps may include screw-adjusted link means for regulating the relative orientation of the clamping segments.


This invention relates to clamping devices, and more particularly to clamping devices for clamping pipes to adjacent supports.

A main object of the invention is to provide a novel and improved clamping assembly especially adapted for clamping gas and oil vertical pipelines to platforms located offshore, the clamping devices being relatively simple in construction, being easy to install, and having segments which are adjustable relative to each other.

A further object of the invention is to provide an improved clamping assembly for attaching gas and oil vertical pipelines, and similar conduits, to adjacent supports, such as leg elements of platforms located offshore, the clamps being relatively easy to manipulate so that they can be readily installed by divers, being durable in construction, and being inexpensive to fabricate.

A still further object of the invention is to provide an improved clamp assembly especially suitable for attaching gas and oil vertical pipelines to platforms located offshore, the clamp assemblies involving relatively few parts, having a high degree of adjustability so that they allow pipes to be secured to their associated supports even when the pipes are skewed relative to the supports, the clamp assemblies being relatively compact in size, being relatively light in weight, and having means for easily and efficiently adjusting the relative orientations of their various segments.

Further objects and advantages of the invention will be apparent from the following description and claims, and from the accompanying drawings, wherein:

FIG. 1 is a top plan view of an improved multiple-segment type clamping assembly constructed in accordance with the present invention.

FIG. 2 is a vertical cross-sectional view taken substantially on the line 2—2 of FIG. 1.

FIG. 3 is a perspective view of one of the sinuously-curved body elements of the clamping assembly of FIGS. 1 and 2.

FIG. 4 is a fragmentary top-plan view of one end portion of a modified form of clamping assembly according to the present invention.

FIG. 5 is a vertical cross-sectional view taken substantially on the line 5—5 of FIG. 4.

FIG. 6 is a top-plan view of another modification of a multiple-clamp assembly according to the present invention.

FIG. 7 is a vertical cross-sectional view taken substantially on the line 7—7 of FIG. 6.

FIG. 8 is a top-plan view of still another modified form of a multiple-clamp assembly according to the present invention.

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FIG. 9 is a vertical cross-sectional view taken substantially on the line **9—9** of FIG. 8.

FIG. 10 is a top-plan view of still another form of multi-clamp assembly according to the present invention which is provided with swivel means allowing the assembly to be utilized to secure a vertical riser to a brace member running at any angle.

FIG. 11 is a top-plan view of another form of multiple-clamp assembly according to the present invention, said form being somewhat similar to that shown in FIG. 10, but without the swiveling feature.

FIG. 12 is a top-plan view of still another form of multiple-clamp assembly, according to the present invention, employing screw-adjustment means for regulating the spacing between the clamp assembly sections.

FIG. 13 is a front elevational view of the clamp assembly of FIG. 12.

FIG. 14 is a top-plan view of still another form of multiple-clamp assembly according to the present invention, employing screw-adjustment means for regulating the spacing between the clamping segments of the assembly.

FIG. 15 is a top plan view of still another form of multiple-clamp assembly according to the present invention, wherein the clamping segments are angularly adjustable relative to each other.

FIG. 16 is a vertical cross-sectional view taken substantially on line **16—16** of FIG. 15.

FIG. 17 is a vertical cross-sectional view taken substantially on line **17—17** of FIG. 16.

FIG. 18 is an enlarged vertical cross-sectional detail view taken substantially on line **18—18** of FIG. 16.

A prime purpose of the present invention is to provide clamps intended to be utilized under water to attach gas and oil vertical pipelines (also called "risers") to platforms located offshore.

Oil and gas platforms located offshore are usually connected together with pipelines of varying sizes. These pipelines are usually laid under the surface of the water below the mud line. When the pipelines are brought from the mud line to the top of the platforms it is necessary to attach them to the platforms with some form of bracing or clamps. The pipeline sections from the mud line to the top of the platform are called "risers." These "risers" are usually attached to the platforms by using clamping devices which attach to the "risers" and usually to the main leg members of the platform.

In some instances, a "riser" when of a small enough size, can be attached to a horizontal bracing member of the platform by a clamping device.

"Risers" in modern use vary in size from a diameter of several inches to a diameter of two or three feet. It is especially difficult to attach the larger "risers" to the platforms because of the necessity for installation under water by divers. Furthermore, it is virtually impossible to compute, prior to installation, the exact distance that the vertical riser will be from the main leg of the platform to which it is to be attached.

In the oil and gas industry, clamps in current use are relatively bulky and are difficult to install. Also, the clamps currently in use must be fabricated to exact specifications for successful attachment of the vertical risers to the main leg members of the platforms. These requirements create further difficulties in the installation of the risers, as will be presently described.

Further evidence for the need for improved clamp assemblies are the following:

(1) Most of the clamps are installed under water, and therefore it is necessary to utilize marine divers; the cost of marine divers is great and the cost increases proportionately with the depth of the water in which the clamp

is to be installed. Additionally, large amounts of expensive equipment are necessary to assist the diver in installation of the clamps.

(2) The time involved from the start to the finish in installing a vertical pipeline or riser adjacent to an existing platform is critical in that the most significant items of expense are the salaries and rental fees paid to divers and owners of marine equipment, such as derrick barges, tugboats, crew boats, supply barges, and engineering and fabricating equipment, and the cost for the administration of the installation of the abovementioned apparatus.

It is therefore apparent that improved clamps which will save time in installation will also save the petroleum companies and installation contractors concerned, considerable amounts of money.

The diver installing the clamps connecting the vertical risers to the adjacent platform usually works alone. The clamps in current use are of considerable size, sometimes weighing hundreds of pounds. The size of the clamp to be utilized is usually determined by the size of the vertical riser and the size of the main leg member of the platform to which the riser is to be attached. Main leg members of platforms usually range in diameter from 36 inches to 60 inches. As previously mentioned, the vertical pipelines or risers may range in size from a few inches to as large as two to three feet in diameter, and in some instances they exceed three feet in diameter.

The clamps utilized to attach the vertical riser to the platform main leg member are placed at intervals starting at the bottom near the mud line, and are placed as required along the vertical pipeline or risers so that the riser is firmly attached to the main leg member of the platform. The depth of the water surrounding the oil or gas platform and the size of the vertical riser will usually determine the size and number of clamps to be installed. The time involved in installing the clamps will vary, depending upon the depth of the water to be worked in and the size of the clamps to be utilized.

The clamps forming the present invention will allow a diver to install all of the necessary clamps on a riser in one dive in water as deep as 200 feet. The various forms of the clamps of the present invention will now be described in detail, with reference to the accompanying drawings.

Referring now to FIGS. 1, 2 and 3, **20** generally designates a typical riser clamp assembly according to the present invention. The assembly **20** comprises two parts each having a generally S-shaped configuration which are pivotally connected together in interleaved relationship at their center portions to define pairs of opposing generally semi-circular jaws. Thus, the first generally S-shaped member comprises a pair of sinuously curved flat bar elements **21, 21**, each having the shape shown in FIG. 3, which are rigidly secured together in parallel spaced relationship, as by means of a spacer block **22** rigidly connected between their respective semi-circular jaw portions **24, 24**. The cooperating generally S-shaped member comprises sinuously curved similar flat bar elements **25, 25** having the respective generally semi-circular jaw portions **28, 28′** which respectively oppose semi-circular jaw portions **24, 24′**, as shown in FIG. 1. Generally semi-circular jaw elements **28** are rigidly connected together by blocks **22′** similar to those employed for the jaw elements **24**. The pairs of members **21, 21** and **25, 25** are interleaved and are pivotally connected at their center portions by a pivot bolt **26**, as shown in FIG. 2, and suitable spacer washers **27, 27** surround the bolt **26** and are located between the crossing portions of the sinuous members as illustrated in FIG. 2. The bolt **26** is provided with a fastening nut **29** having a handle loop **30**.

Each flat sinuously curved member is provided at its end with an outwardly extending notched lug **31**. Hinged at **32** to the pairs of semi-circular jaw elements **28, 28** is a bracket **33** to which is secured a bolt **34** engageable between the lugs **31, 31** of the jaws **24, 24** and being provided with a nut **35**. The bolt **34** is provided with a rectangular bridging washer **36** which is receivable in the notches of the lugs **31** carried by the jaws **28**, and a similar bridging washer **37** is provided beneath the nut **35** and is receivable in the notches of the lugs **31** of jaws **24**. Thus, the jaws **28** and **24** may be clamped around a leg member associated with an offshore platform, as above described, with the opposite pairs of opposing jaws **24′** and **28′** engaged around a vertical riser. Said members **28′** and **24′** are provided with similar locking structure consisting of notched lugs **31** and a hinged bracket **33′** carrying a clamping bolt **34′** provided with a securing nut **35′** and having the bridging washers **36′** and **37′** engageable in the notches of the lugs **31** in the manner illustrated in FIG. **1**.

Thus, the assembly **20** may be used by first swinging the opposing generally S-shaped members thereof to open positions, such as shown in dotted view in FIG. 1, and then engaging the sets of opposing jaws respectively around the vertical platform leg member and the vertical riser to be clamped thereto, after which the generally S-shaped members are swung together in scissor fashion and are fastened by their clamping bolts. The bolts **34, 34′** may be swung into clamping positions between the sets of notched lugs **31** after the jaws have been swung inwardly to embrace the platform leg member and vertical riser, respectively. Due to the two-piece construction of this assembly, which enables the parts to be pivoted in scissor fashion, this design allows the use of horizontally acting power means to close the clamp segments, for example, allows the use of a hydraulic cylinder suitably engaged with the sets of notched lugs of one set of opposing jaws to close the jaws while the diver secures the bolts on the ends of the opposite jaws. The use of hydraulic power allows the clamp to be closed in the event there is a slight variation in distance between the leg member and the riser as compared with the nominal distance between sets of the opposing pairs of jaws. After the jaws at one have been bolted, the hydraulic cylinder device may be removed and the adjacent hinged bolt may be employed to clamp the jaws previously engaged by the hydraulic cylinder device.

FIGS. 4 and 5 illustrate a variation in structure as compared with FIGS. 1, 2 and 3, wherein the interleaved ends of one set of jaws may be apertured to receive a wedge **38**, instead of employing the notched lugs **31** and the hinged bolts. Thus, this enables the diver to secure the clamping assembly closed after it has been closed by the hydraulic cylinder, whereupon he can remove the hydraulic cylinder and complete the securement at that end with the hinged bolt and nut arrangement described in connection with FIGS. 1, 2 and 3. For example, the jaws **24, 24** and **28, 28** may be provided at their ends with registrable apertures **39** adapted to receive the wedge **38**, whereas the jaw elements **28′** and **24′** may be provided with the structure shown in FIG. 1, including the notched lugs **31** and the hinged bracket **33′** carrying the bolt **34′**. With such an arrangement, the hydraulic cylinder device is employed to close the jaws at the ends of the elements **28′** and **24′**, after which the wedge **38** is inserted through the apertures **39** to hold the clamping device closed. The hydraulic cylinder device may then be removed and the securement of the clamp may be then completed by using the hinged bolt **34′** and the parts associated therewith to lock the jaw elements **28′** and **24′** together in the manner previously described.

FIGS. 6 and 7 illustrate another form of the invention designated generally as **40**. The clamping assembly **40** comprises a first pair of generally C-shaped jaws **41** and **42** and a pair of additional generally C-shaped jaws **43** and **44**, the jaws being pivoted together by a common pivot bolt **45** defining a pivotal junction of the jaws. Thus, the generally C-shaped jaw assembly **41** comprises a pair of generally semi-circular flat bar elements **46** and **47**, rigidly secured in spaced parallel relationship by being connected to a spacer block **48** secured between their intermediate portions. The opposing generally C-shaped jaw assembly **42** is similarly formed, but is provided with an upstanding bracket plate **49** to which is journaled a peripherally grooved pulley **50** adapted to be employed with a suspension cable, not shown, to facilitate handling the assembly. The upper generally semi-circular bar member **46** of the opposing jaw assembly **41** is provided with an upstanding loop **51** adapted to be similarly employed with a cable, or the like, for handling the assembly.

The generally C-shaped jaw assemblies are provided at their free ends with notched lugs, shown at **52**, similar to those provided in the previously described forms of the invention, to be employed with pivoted securing bolts **34** and **34′** carried by hinged bracket members **33** and **33′**, utilized in the same manner as in the embodiment of FIGS. 1, 2 and 3.

As shown in FIG. 7, the flat generally semi-circular bar elements of the jaws have interleaved end lugs **54** which are apertured to receive the pivot bolt **45**, being thus pivotally connected together by said pivot bolt. The apertured pivot lugs **54** at the ends of the bars thus cooperate with each other to maintain the flat bars in parallel planes. As in the previously described form of the invention, the pivot bolt **45** is provided with a nut **29** having a handle loop **30**.

The assembly **40** is designed for the purpose of connecting the vertical main leg member of a platform to a vertical riser. Thus, the jaws **42** and **41** are engageable with the platform vertical leg member and the jaws **43** and **44** are similarly engageable with a vertical riser to be clamped adjacent to the platform vertical leg member. The sets of jaws **41** and **42** can be manipulated independently of the jaws **43** and **44**, so that the two sections of the clamp can be securely attached either to the riser or the main leg of the platform independently of each other.

It will thus be seen that the jaws **41** and **42** may be connected to the vertical leg of a platform, shown at **57** in FIG. 7, and the jaws **43** and **44** may be attached to a vertical riser, shown at **58** in FIG. 7, in any desired sequence of operations, because the respective pairs of jaws can be independently manipulated.

FIGS. 8 and 9 illustrate a modified form of the clamp assembly shown in FIGS. 6 and 7 wherein the respective pairs of jaws **41, 42** and **43, 44** are connected together by link bars to define a variable distance stand-off arrangement to allow the assembly to be used to connect a riser to a vertical platform leg member when the exact distance between the riser and the leg member cannot be accurately determined prior to the installation of the clamp assembly. Thus, a plurality of identical flat link bars **59** are interleaved with the apertured end lugs **54** of the clamp bars, respective pivot bolts **60, 60′** being employed to connect respective sets of opposing jaws to the ends of the link bars. The uppermost link bar **59** may be provided with an upstanding handle loop **61**, as shown in FIGS. 8 and 9.

The clamp assembly of FIGS. 8 and 9 is especially designed for use as a first clamp assembly at the mud line. As previously discussed, when pipelines are installed under the mud line, that portion of the pipeline from the mud line to the top of the platform is called "the vertical riser." When installing the pipelines of vertical risers, it is impossible to compute the exact distance the vertical riser will be from the main leg of the platform to which the riser is to be attached. The distance between the vertical riser and the main leg of the platform at the mud line may vary from one to three feet, and in some instances beyond three feet, along the length of the riser. Because of the above-mentioned variations, and because of the size of the risers, some of which have a diameter from two to three feet, and furthermore, because of the great depths at which the vertical riser is installed in some instances, it is nearly impossible to predetermine and prefabricate the size of the clamp necessary to connect the riser to the main leg at the mud line. According to the practice heretofore employed, numerous dives are necessary in order to connect the vertical risers to the main leg of the platform, using the clamps of the prior art. Thus, when using such prior art clamps, the diver must measure the distance between the riser and the main leg at the point of installation and send this information to the clamp fabricator. After the fabrication of the clamp the diver must then proceed to install the clamp on the riser and the main platform leg. If the clamp is not properly fitted and has no means for adjustment, a new measurement must be made and the clamp must be returned to the manufacturer for refabrication. The above process must be continued until the clamps are properly fitted.



The above-mentioned problems are corrected by employing a double pivot clamp assembly of FIGS. 8 and 9. The double pivot assembly allows the clamp to be maneuvered so that it may be fitted to the riser and main leg of the adjacent platform with ample allowance for variation in distance between the riser and the main leg. Thus, the respective sets of jaws **41, 42** and **43, 44** may be maneuvered as required and then be locked in place by their fastening bolts **34, 34′**.

The embodiment illustrated in FIG. 10 is generally similar to that of FIGS. 8 and 9 except that the link bars **59** are replaced by a swivel assembly to permit the cooperating jaw assembly **41, 42** to be swiveled with respect to the other cooperating jaw assembly **43′, 44′**. The cooperating jaw assembly **41, 42** may be similar to that shown in FIGS. 8 and 9 and is pivotally connected by the pivot bolt **60** to a bracket **62** which may be of general U-shape having a transverse bight portion **63** which is pivotally connected by a swivel bolt **64** to an end wall **65** of a box-like member **66**. The member **66** is received between the generally semi-circular top arm **67** and the generally semi-circular bottom arm **68** of the jaw assembly **44′**. As shown in FIG. 10, the generally semi-circular top arm **69** and the generally semi-circular bottom arm **70** of the jaw assembly **43′** are respectively located above and below the arms **67** and **68**, with the inner end portions of the upper arms **67** and **69** superimposed on the top wall of the box-like member **66** and the inner portions of the lower arms **68** and **70** superimposed subjacent the bottom wall of box member **66**. The connecting pin element **60′** extends through said superimposed inner end portions of the arm, as well as the top and bottom walls of the box-like member **66** to define a pivotal connection for the jaw assembly **43′, 44′**. As is clearly shown in FIG. 10, the pivotal axis of the swivel bolt **64** extends perpendicular to both the left pivot pin element **60** and the right pivot pin element **60′**. Thus, the jaw assembly **43′, 44′** may rotate relative to the jaw assembly **41, 42**, which therefore allows the clamp assembly to be utilized to secure a vertical riser to a brace member running at any angle.

The modification illustrated in FIG. 11 is also generally similar to that shown in FIGS. 8 and 9 except that the cooperating pairs of opposing jaw portions are arranged with their jaw axes perpendicular to each other so as to secure a vertical riser to a horizontal brace member. Thus, in FIG. 11, the cooperating generally semi-circular jaws **41, 42**, similar to those of FIGS. 8, 9 and 10, are pivotally connected by the pivot bolt **60** to a rigid box-like member **66′**, the box-like member **66′** being received between the inner end portions of the innermost semi-circular flat bar elements of the jaws **41, 42**, with the pivot bolt **60** extending through the superimposed inner end portions of said flat bar elements as well as the intervening parallel walls of the box-like member **66′**. The opposite end portion of the box-like member **66′** is received between the members **67** and **68** of jaw portion **44′**, as in FIG. 10, and the inner end portions of the jaw members **43′, 44′** are pivotally connected to the box-like member **66′** by a pivot bolt **60′** extending perpendicular to the pivot bolt **60**. The box-like member 66' may be provided with an outwardly projecting handle loop 72.

In the embodiments of FIGS. 10 and 11, the outer end portions of the jaw members may be provided with angle bracket 73 rigidly connected between the outer ends of the flat generally semi-circular bar members thereof to receive the clamping bolts 74.

Although not shown in FIGS. 10 and 11, the clamping bolts 74 may be mounted on swinging arms hinged to the jaws in the same manner as disclosed, for example, in FIGS. 8 and 9.

FIGS. 12 and 13 illustrate an embodiment of the invention adapted to be used to connect a vertical riser to a vertical platform leg with provision for adjusting the distance between the clamping members in accordance with the distance between the vertical riser and the platform leg to which it is to be clamped. Thus, the assembly, shown at 80 in FIGS. 12 and 13 is generally similar to that of FIGS. 6 and 7 in that it employs a pair of cooperating jaw portions 41' and 42' generally similar to the jaw portions 41 and 42 in FIG. 6 and adapted to be clampingly secured to a platform vertical leg.

The cooperating jaw assembly adapted to be clampingly secured to a vertical riser comprises the opposed jaw portions 43' and 44' having arcuately curved support arm portions whose inner ends are pivotally connected to the inner ends of the other pair of cooperating jaw portions 41', 42' by the pivot bolt 45. As shown in FIG. 13, the arms 81 and 82 of the jaw portion 43' receive therebetween the top and bottom arms 83 and 84 of the cooperating jaw portions 44'. The arms 81 and 82 have arcuately curved support portions 85 and 86 and the arms 83 and 84 of the jaw 44' have arcuately curved support portions 87 and 88 received between the support portions 85 and 86, the inner ends of the support portions being pivotally connected to the other cooperating jaws 41', 42' by the pivot bolt 45. The assembly is provided with adjustable tie means connecting the arcuate support members 85, 86 to the jaw portion 41' of the opposite cooperating pair of jaws. Thus, an arcuately curved yoke member 89 has its arms pivotally connected at 90, 90 to intermediate portions of support elements 85, 86, and a threaded shaft element 91 is rigidly secured to the bight portion of yoke member 89. A pivot lug member 92 is rigidly secured to and projects outwardly from the intermediate portion of the jaw 41' and a sleeve member 93 is pivotally connected thereto at 94. The shank element 91 extends through the sleeve member 93 and is provided with respective nuts 95 and 96 located adjacent the opposite ends of the sleeve 93 for locking the shaft element 91 in an adjusted position with respect to sleeve 93. This allows the distance between the clamping axes of the cooperating jaw elements 41', 42' and the jaw elements 43', 44' to be adjusted in accordance with the distance between the riser pipe and the platform leg element to which it is to be clamped.

FIG. 14 illustrates a further embodiment similar to that of FIGS. 12 and 13, wherein the lug member 92' rigidly secured to the jaw 41' projects outwardly in the same manner as in FIG. 12, but a similar lug structure is provided for the support arms of the jaw 43'. Thus, the arcuately curved support arm portions of jaw 43' may be provided with outwardly projecting lugs 96' and a sleeve member 97 may be pivotally connected between their top ends, as viewed in FIG. 4, by a transverse pivot pin 98. One end of a threaded shaft member 91' is rigidly secured to a support member 93' pivoted to the lug structure 92' by transverse pivot pin 94', the threaded shaft 91' extending through the sleeve member 97 and being provided with the fastening nuts 95 and 96 similar to those employed in the embodiment of FIGS. 12 and 13.

In the embodiment illustrated in FIGS. 15 to 18, an arrangement is provided wherein a riser can be clamped to a leg or brace portion of a platform regardless of nonparallelism of the riser with respect to the element to



which it is to be clamped. Thus, the assembly designated generally at 100 comprises a pair of generally V-shaped trunnion segments 101 and 102, the segment 101 having the arcuately curved outwardly extending opposite trunnion arms 103 and 104 and the trunnion segment 102 having the corresponding arcuately curved outwardly extending trunnion arms 105 and 106. The arms 103 and 105 have aligned trunnion pins 108 and 109 at their ends, projecting inwardly and having secured thereto the webs 110 and 111 of respective generally semi-circular opposing clamping jaws 112 and 113. Thus, as shown in FIG. 7, the clamping jaws are of generally T-shaped cross-sectional shape and are secured to the trunnion pins at their mid-portions. The arms 104 and 106 likewise support respective generally semi-circular opposing clamping members 114 and 115 and are similar to the members 112 and 113. The respective clamping elements 112, 113, 114 and 115 are thereby freely pivoted.

The generally V-shaped trunnion segments each comprises a pair of parallel top and bottom plate members of identical shape rigidly connected by spacer blocks 120 and located at the intermediate portions of the arcuate trunnion arms of the segments, as shown in FIG. 15. Top and bottom abutment plates 121, 122 are secured in the vertices of the arms of the trunnion segment 101, the top and bottom plates 121, 122 being rigidly connected by an apertured vertical abutment plate 123. An apertured abutment block 124 is provided in the vertex of the opposing trunnion segmnt 102. A threaded clamping shaft 125 extends through the block 124 and the plate 123. The shaft 125 is provided with an enlarged outer portion 126 defining an abutment shoulder 127 engaged against the block 124, and a nut 128 is provided on the threaded shaft 125 outwardly adjacent the plate 123, the nut nonrotatively fitting between the top and bottom plates 121 and 122, as shown in FIG. 18, whereby rotation of the shaft 125 in one direction causes clamping force to be exerted between the trunnion segments 101 and 102. The end of the enlarged shaft portion 126 may be provided with a hand wheel 129, and the hand wheel may be provided with loops 130 at its periphery which may be employed in conjunction with a suitable cable connected to a power source for providing external torque on the shaft 125 when required.

Thus, the respective pairs of jaw elements 112, 113 and 114, 115 may be respectively engaged around a fixed platform brace member and a riser pipe to be clamped thereto, after which the shaft 125 may be rotated by means of handwheel 129, and perhaps with the assistance of an externally powered cable attached to loops 130, to tighten the assembly so as to cause the members 112, 113 and 114, 115 to tgihtly clamp a platform brace member and a riser pipe, respectively. When the tightening procedure is completed, the diver removes the cable by detaching it from the loops 130.

For remote installation, the threaded shaft 125 may be operated by hydraulic, pneumatic or other mechanical means, and any suitable means may be employed for supervising the setting of the clamp assembly, for example, by the use of underwater television for viewing the assembly as it is operated by such mechanical means.

It will be noted that because of the swivel cooperation between the jaw elements 112, 113 and the arms 103, 105 and between the jaw elements 114, 115 and the arms 104, 106, once the clamp has been installed, the riser may be raised or lowered without the necessity of loosening or tightening of the assembly or of making any adjustments thereto.

As shown in FIG. 18, the vertex portions of the trunnion segments 101 and 102 are provided with centrally apertured bushing blocks 130' and 131 through which the threaded member 125 extends, said blocks serving as guides for said threaded member. An apertured resilient deformable plate 132 may be provided between the apex portions of said trunnion segments, as shown in FIG. 18, serving as a yieldable cushioning filler between the trunnion segments. The threaded member **125** extends through the central aperture of said cushioning filler **132**, as is clearly shown in FIG. 18.

As will be readily apparent, the assembly **100** of FIGS. 15 to 18 can be employed for substantially the same purposes as the clamps illustrated and described previously but may be employed with somewhat more flexibility and ease of installation. The assembly **100** can be maneuvered so as to compensate for variations in distance between the riser and the leg to which it is to be attached. The clamp assembly **100** can be installed at the maximum stand-off distance, whereby the ends of the assembly will be at the same level. When there is a lesser distance between the leg and the riser, the two ends of the clamp may be installed at different levels, the trunnion segments **101** and **102** being then angled relative to the two sets of opposing jaw members. It will also be apparent that in the event that the riser and the leg to which it is to be attached are not parallel to each other, the clamp assembly **100** can be installed and is adjustable for such non-parallelism.

As previously mentioned, the handwheel **129** may be manually operated by the diver, or alternatively, may be driven by an external power source by utilizing a cable attached to the loops **130**. As above mentioned, when the tightening procedure is completed, the diver can remove the cable by disconnecting it from the loops **130**.

The trunnion pins may be secured to the ends of the arms of the trunnion segments in any suitable manner, for example, may be rigidly secured between the arm bars employing vertical retaining plates **140, 140** welded between the bars on opposite sides of the pins. Furthermore, the pins are provided with retaining collars **141** which cooperate with the heads of the pins to retain them against axial movement.

While certain specific embodiments of improved clamp assemblies for connecting a riser to an adjacent stationary element of a platform or similar structure have been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

**1.** A clamp assembly comprising a plurality of body members having substantially semi-circular jaw portions, means pivotally connecting said body members together with said jaw portions in opposing relationship to define two sets of pairs of opposing jaw portions adapted to respectively engage around a fixed support member and an adjacent pipe, and means to secure said pairs of opposing jaw portions in cooperating clamping relationship, wherein said securing means includes at least one threaded member arranged to exert clamping force on at least one of the jaw portions and nut means threadedly engaged with said threaded member and arranged to exert clamping force on a jaw portion opposite said one jaw portion, and wherein said securing means comprises a coplanar pair of trunnion segments, each having a pair of trunnion arms and a connection therebetween, the threaded member extending through the junctions of the trunnion arms and being substantially in the planes of the trunnion segments, said semi-circular jaw portions being respectively pivoted to the ends of the trunnion arms.

**2.** The clamp assembly of claim **1**, and wherein the threaded member pivotally connects the body members together on a pivotal axis located between the two sets of pairs of opposing jaw portions.

**3.** The clamp assembly of claim **2**, and wherein said threaded member has an axis substantially parallel to the planes of the respective pairs of opposing jaw portions.

**4.** The clamp assembly of claim **1**, and wherein said body members each comprises a plurality of parallel flat curved bar elements, and means to maintain the plurality of bar elements of each body member in spaced parallel relationship.

**5.** The clamp assembly of claim **1**, and wherein said threaded member is provided with a hand wheel at one end thereof, said threaded member having shoulder means adjacent the hand wheel abutting the adjacent trunnion junction, the opposite trunnion junction being provided with non-rotatable nut means threadedly receiving said threaded member.

**6.** The clamp assembly of claim **1**, and wherein said body members each comprises a pair of parallel flat curved bar elements, and means to maintain the bar elements in spaced parallel relationship.

**7.** The clamp assembly of claim **6**, and wherein the threaded member extends between the respective flat curved bar elements of each pair and is substantially parallel to the planes thereof.

**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 587,912 | 8/1897 | Atwood | 248—230 |
| 1,280,095 | 9/1918 | Smith | 248—230 |
| 1,852,363 | 4/1932 | Parent | 248—68 X |
| 1,883,935 | 10/1932 | Kelley | 248—74 X |
| 3,207,463 | 9/1965 | Downey | 248—68 X |

FOREIGN PATENTS

| | | | |
|---|---|---|---|
| 23,395 | 5/1930 | Australia | 248—230 |

CHANCELLOR E. HARRIS, Primary Examiner

U.S. Cl. X.R.

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