Jan. 24, 1967 L. C. RENFROE 3,300,242

PLATE LIFTING CLAMPS

Original Filed Feb. 19, 1962 6 Sheets-Sheet 1

Fig. 1.

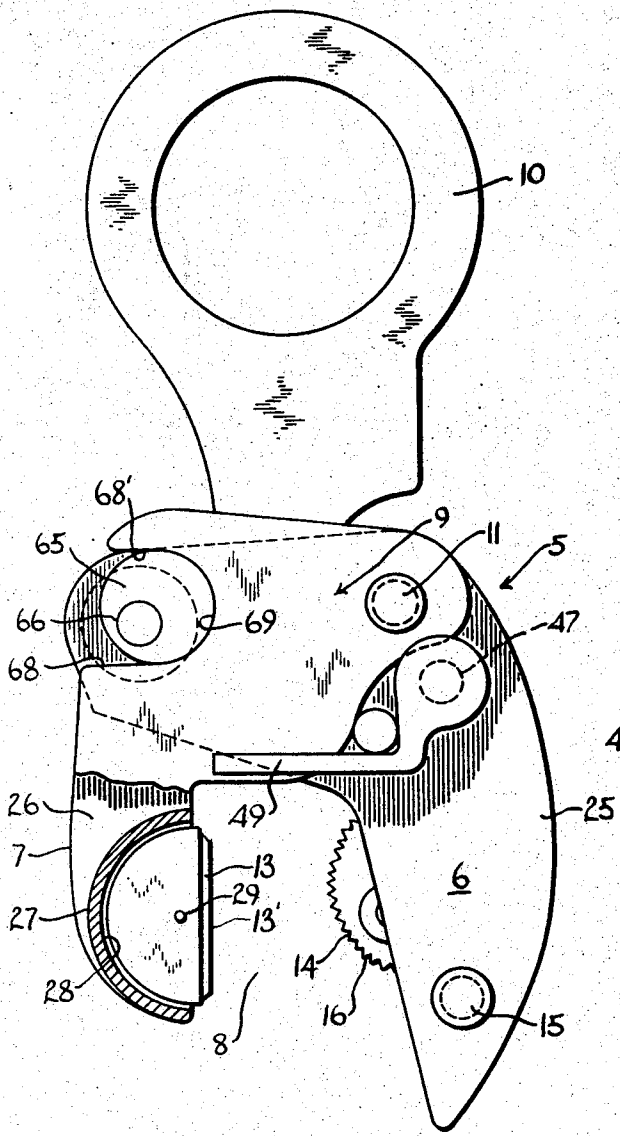

Fig. 3.

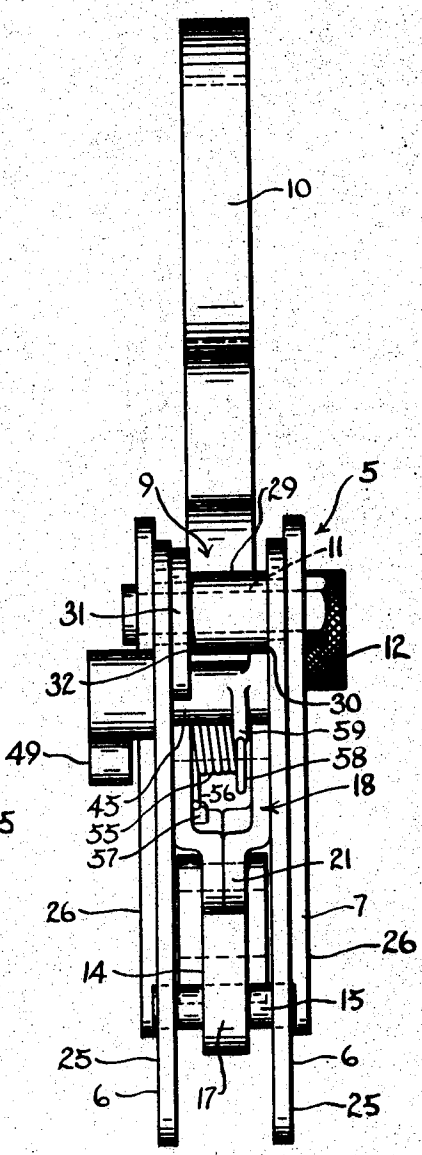

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PLATE LIFTING CLAMPS

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Fig. 2.

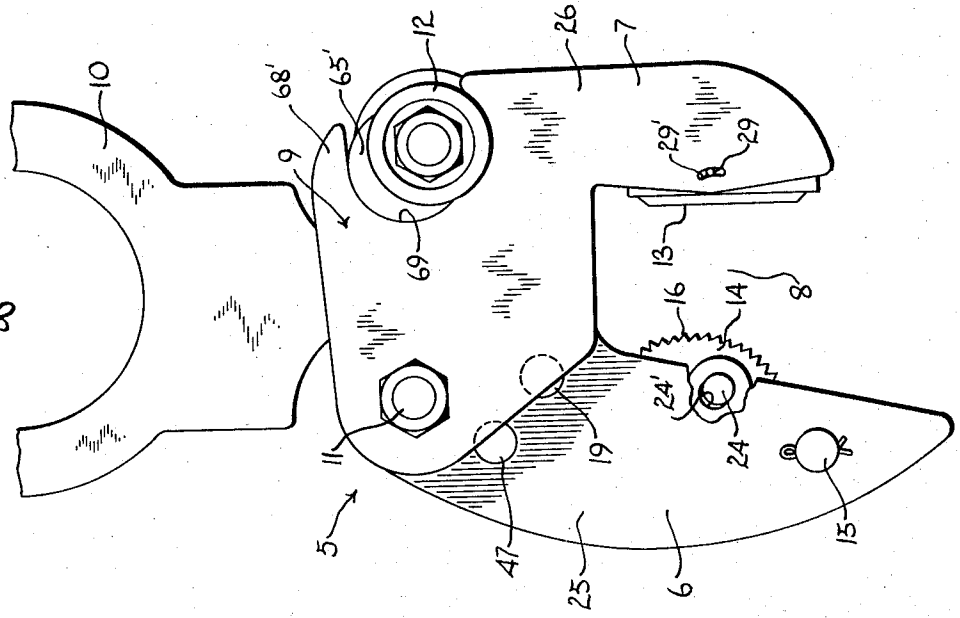

Fig. 5.

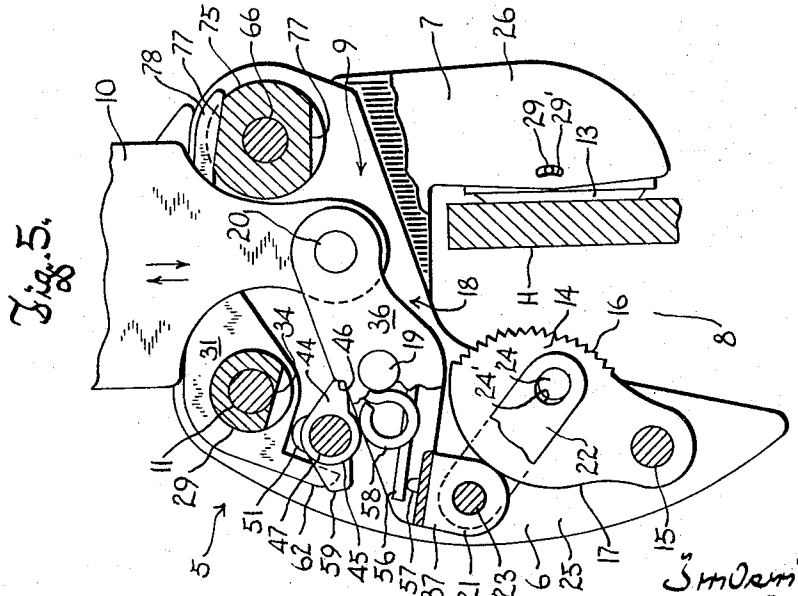

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PLATE LIFTING CLAMPS

Original Filed Feb. 19, 1962 6 Sheets-Sheet 3

Fig. 6.

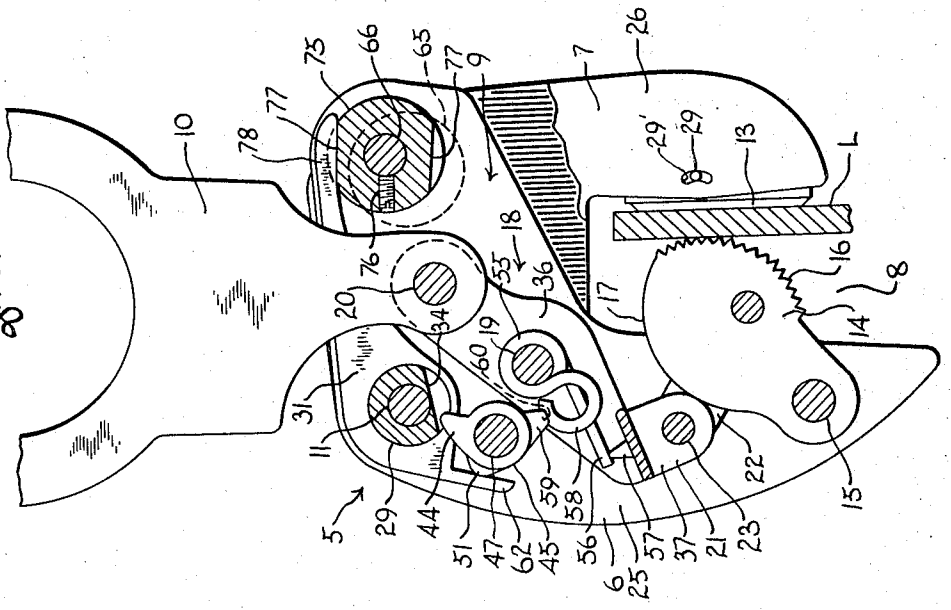

Fig. 4.

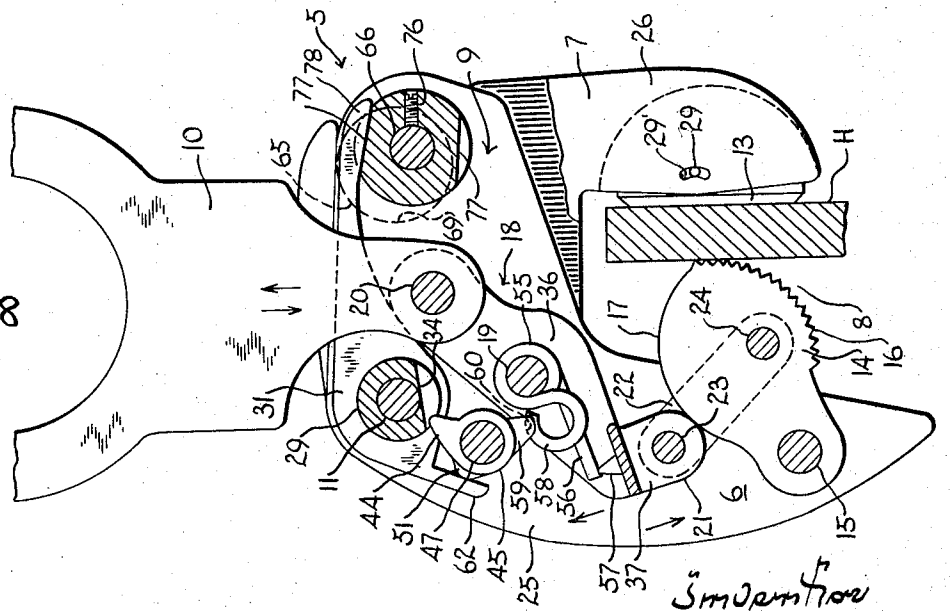

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PLATE LIFTING CLAMPS

Original Filed Feb. 19, 1962 6 Sheets-Sheet 4

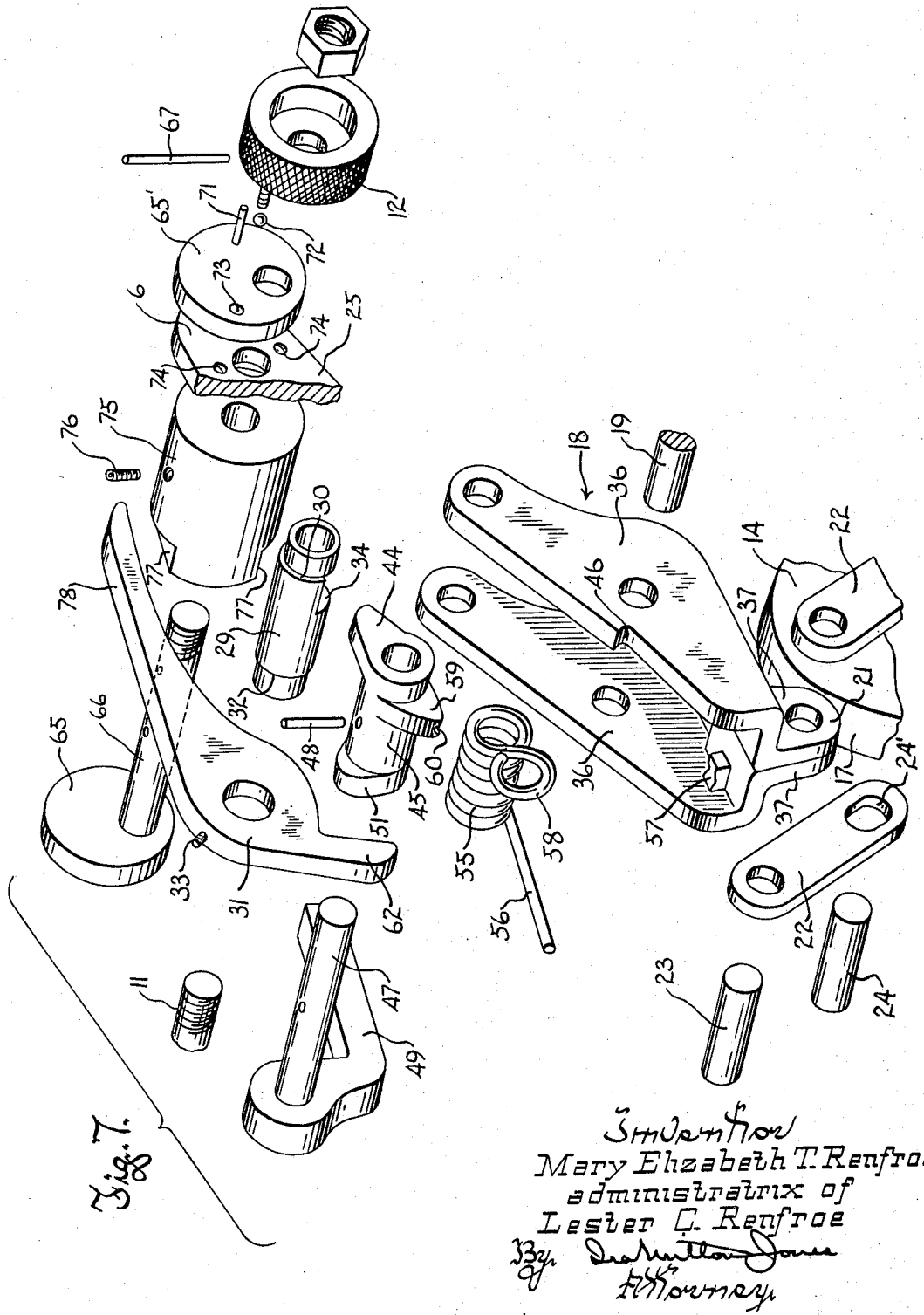

Fig. 7.

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PLATE LIFTING CLAMPS

Original Filed Feb. 19, 1962 6 Sheets-Sheet 5

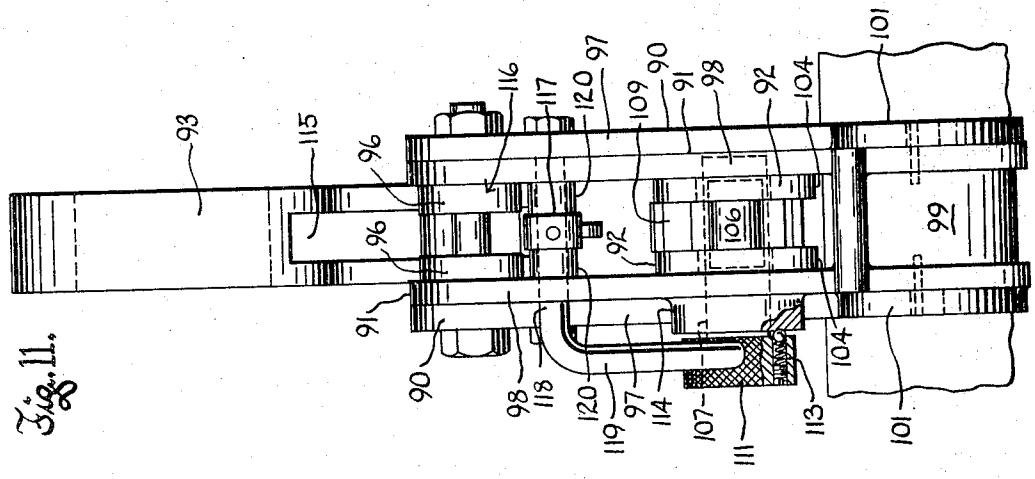

Fig. 11.

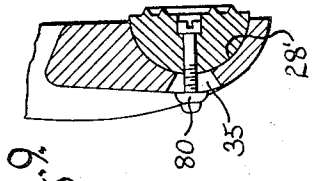

Fig. 9.

Fig. 10.

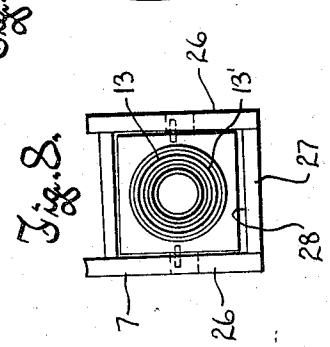

Fig. 8.

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PLATE LIFTING CLAMPS

Original Filed Feb. 19, 1962 6 Sheets-Sheet 6

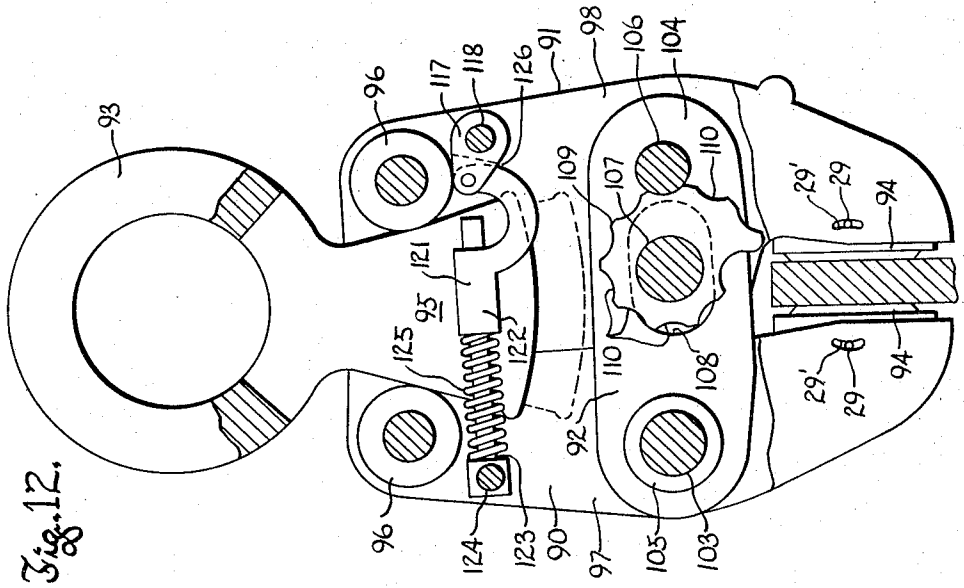

Fig. 12.

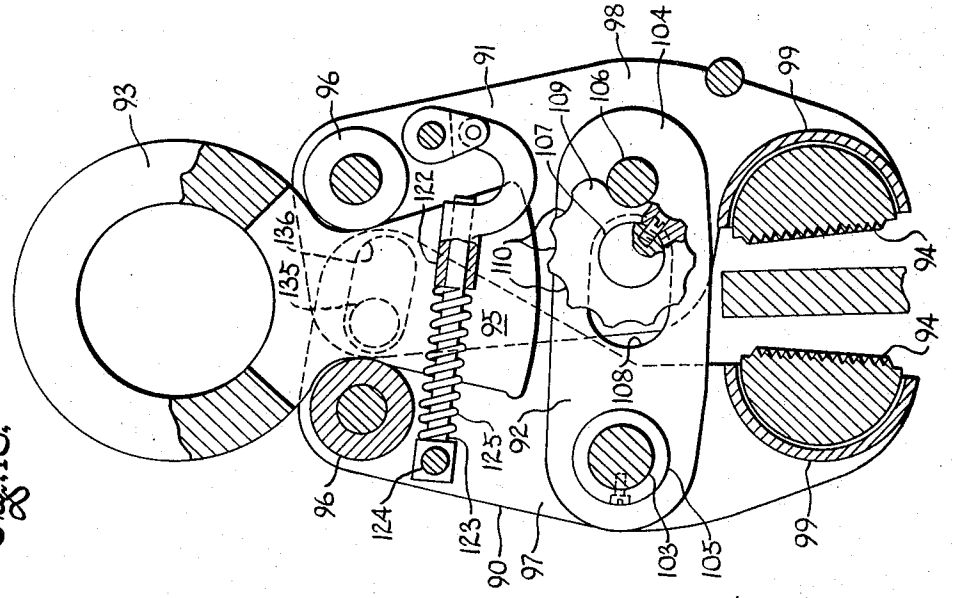

Fig. 13.

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United States Patent Office 3,300,242 Patented Jan. 24, 1967

3,300,242

PLATE LIFTING CLAMPS

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Continuation of abandoned application Ser. No. 400,598, Sept. 30, 1964, which is a continuation of abandoned application Ser. No. 173,998, Feb. 19, 1962. This application May 27, 1966, Ser. No. 553,580

20 Claims. (Cl. 294—101)

This application is a continuation of the abandoned copending application, Serial No. 400,598, which in turn was a continuation of an earlier abandoned application, Serial No. 173,998. The invention disclosed herein relates to plate lifting clamps used in lifting heavy steel plates and the like.

Clamps of this type generally consist of body structure defining a pair of jaws between which the plate to be lifted is received, and gripping elements on the jaws to grip the opposite sides of the plate as a consequence of the application of lifting force on a shackle by which the clamp is attached to a crane hook or other lifting device. In one embodiment of this invention, the jaws maintain a fixed spacial relationship during the lifting operation and the plate is gripped by the pivotal motion of a gripping element or cam on one jaw coacting with a self-adjusting gripping element mounted on the other jaw. In another embodiment of the invention, the jaws are pivotally connected and move bodily towards and from one another to cause their respective plate-gripping elements to grip or release a plate therebetween.

In either event, the lifting force applied to the shackle is translated into gripping pressure on the plate-gripping elements of the opposite jaws by actuating mechanism operatively connected with the shackle. One of the objects of this invention is to improve and simplify this actuating mechanism.

Another object of the invention is to provide a simple latching device by which the gripping elements of the clamp may be releasably secured or locked in either an open relationship permitting free movement of the clamp to and from engagement with a plate, or a closed relationship in which the plate is tightly gripped by the clamp.

Heretofore, only a limited range of plate thicknesses could be safely handled by a plate lifting clamp of given capacity. This was because the jaws of the clamp had a fixed nominal spacing. To overcome that disadvantage, the present invention has as another of its objects to provide a plate-lifting clamp wherein the nominal spacing of its jaws can be adjusted to a plurality of defined positions to accommodate plates of different thicknesses.

Another object of this invention resides in the provision of a safety interlock between the mechanism by which the nominal spacing of the jaws is adjusted, and the mechanism by which the clamp—or, more accurately, its plate-gripping elements—are locked closed to prevent the occurrence of the latter unless the mechanism that adjusts the nominal spacing is in one of its defined positions.

Another object of this invention is to provide a plate-lifting clamp in which the plate engaging or gripping elements of the jaws are free to align themselves to the surfaces of the plate therebetween. Such self-alignment of the plate gripping elements has the advantage of preventing excessive marring of the plate surfaces, which often occurred in the past—especially when the clamp was out of alignment with the plate when lifting force

was applied thereto, as for instance when the plate was being lifted from a horizontal position.

With a view towards further minimizing the likelihood of marring or scratching the surfaces of polished plates as they are lifted, it is another object of this invention to provide a plate lifting clamp wherein the plate gripping elements of both jaws not only have planar plate-engaging faces with all of the teeth of each lying in a common plane, but in addition are free to adjust themselves to the surfaces of the plate as clamping pressure is applied thereto.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate several complete examples of the physical embodiments of the invention, constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

FIGURE 1 is a front elevational view of a plate lifting clamp made in accordance with that embodiment of this invention wherein one of the jaws has a pivotal gripping element or cam, said view illustrating the gripping element secured or locked in its open position and having portions thereof broken away and others in section to illustrate the self-aligning plate gripping element that coacts with the pivotal gripping element in this embodiment of the invention;

FIGURE 2 is a rear elevational view of the clamp shown in FIGURE 1;

FIGURE 3 is a side elevational view of the clamp shown in FIGURE 1;

FIGURE 4 is a rear elevational view of the clamp shown in FIGURES 1–3, but with the pivotal plate gripping cam secured or locked in a closed position tightly gripping a plate to be lifted, parts of said view being removed or broken away and others being shown in section to better illustrate the structure;

FIGURE 5 is a view similar to FIGURE 4, but showing the pivotal gripping cam locked open;

FIGURE 6 is another rear elevational view of the clamp, similar to FIGURE 4 but with the nominal spacing of the jaws adjusted to accommodate plates thinner than those for which the clamp is adjusted in FIGURES 1 to 5;

FIGURE 7 is an exploded perspective view of the main components of the mechanism shown in FIGURES 1–6, certain of which are but partially illustrated;

FIGURE 8 is a view of the front face of the self-aligning gripping element that opposes and coacts with the pivotal gripping element;

FIGURE 9 is a fragmentary detail view illustrating another way of mounting the self-aligning gripping element on its jaw;

FIGURE 10 is a front elevational view of a plate lifting clamp embodying the invention in the form thereof that is particularly well adapted for lifting highly polished plates, said view illustrating the clamp in its closed plate gripping condition;

FIGURE 11 is a side elevational view of the clamp shown in FIGURE 10;

FIGURE 12 is another front elevational view of the clamp shown in FIGURE 10, but with parts thereof re-

moved or broken away and others in vertical section, to better illustrate the various elements of the structure, and especially the mechanism by which the nominal spacing of the jaws is adjusted; and

FIGURE 13 is a view similar to FIGURE 12 but with the jaws of the clamp held open.

Referring now particularly to the accompanying drawings, and especially to FIGURES 1–8, inclusive, which illustrate that embodiment of the invention that employs a piovtal self-energizing cam or gripping element, the numeral 5 designates generally the body structure of the clamp and which comprises a pair of jaws 6 and 7 defining between them a downwardly opening mouth 8 for the reception of a plate to be lifted.

The jaws 6 and 7 project from a bight portion 9 at opposite sides of a median plane which passes through the bight portion and generally through a shackle 10 extending upwardly from the bight portion for attachment to a crane hook or other lifting instrumentality with which the clamp may be used. Although the jaws 6 and 7 maintain a defined spacial relationship during the lifting of plates by the clamp, they are relatively movable to permit adjustment of their nominal spacing. For this purpose, the jaws 6 and 7 are pivotally connected by a hinge pin 11 which passes through their bight portions at one side of the aforesaid median plane of the clamp.

Mechanism to be later described, but which includes a knurled handle 12, provides means for adjusting the jaws about their hinged connection 11, and for locking or securing them in either of two predetermined defined relative positions. As will be seen from a comparison of FIGURES 4 and 6, the adjustability of the nominal spacing of the jaws increases the range of plate thicknesses that can be safely handled by a clamp of given capacity. Thus, as shown in FIGURE 4, when the jaws 6 and 7 are adjusted to their widest nominal spacing, relatively thick plates H can be safely gripped, while—as shown in FIGURE 6—when the jaws are adjusted to their narrowest nominal spacing, the clamp is better suited to the handling of thinner plates L.

In either case, the plate to be lifted is received in the mouth of the clamp and clamped solidly against a self-adjusting gripping element or friction pad 13 mounted on the jaw 7, by a piovtal self-energizing gripping element or cam 14 mounted on the jaw 6. The pivotal gripping element or cam 14 which is connetced to the jaw 6 by a pivot pin 15, has a convexly curved toothed front edge 16 and a smooth arcuately shaped back edge 17. Because of its weight distribution, the pivotal cam, when free, rotates towards its companion gripping element or friction pad 13 to engage its toothed front edge with a plate between the jaws of the clamp, if the clamp is in an upright position.

When the clamp is suspended by its shackle 10, the mechanism operatively connecting the shackle with the pivotal gripping element or cam 14 forces the latter toward the friction pad 13 to clamp a plate thereagainst, if one is present; whereas inward or downward movement of the shackle with respect to the body of the clamp effects retraction of the pivotal gripping element or cam away from the pad 13. The mechanism by which such upward or downward force imparted to the shackle is translated into plate-gripping or releasing force on the pivotal cam, comprises an actuating lever 18, medially pivoted to the body portion of the clamp and, more specifically, to the upper or inner part of the jaw 6 by means of a pivot pin 19. One end of this actuating lever is pivoted, as at 20, to the shackle, and its other end has a downwardly projecting rounded pressure-applying lug 21 positioned to bear against the curved back edge 17 on the pivotal cam and thereby press the cam toward the friction pad 13 in consequence of torque being imparted to the actuating lever by the application of a lifting force on the shackle 10.

The downwardly projecting rounded pressure-applying lug 21 is also linked to the cam or gripping element 14 by a pair of links 22 which embrace the lug and the cam and are pivoted at one end to the lug by a pin 23. At their opposite ends the links 22 have a lost motion connection with the cam formed by a pin 24 fixed in the cam with its end portions projecting therefrom into slots 24' in the links. By virtue of the lost motion in the connection between the cam and the links, plate-gripping force can be directly applied to the cam by the lever 18. This relieves the links 22 of this force, while—upon downward or inward movement of the shackle 10 to cause the actuating lever 18 to rock in a clockwise direction about its pivot 19 (as viewed in FIGURES 4–6, inclusive)—the pivotal gripping element or cam is drawn away from the friction pad 13 toward its fully open position shown in FIGURES 2 and 5.

The jaws 6 and 7 each consist essentially of a pair of spaced apart parallel steel plates, the plates 25 that form the jaw 6 being spaced apart less than the plates 26 that form the jaw 7. The jaw 6 is thus embraced by the sides or plates 26 of the jaw 7, and the hinge pin 11 by which the jaws are pivotally connected, passes through the overlying portions of the plates 25 and 26.

The plates 26 that form the jaw 7 are rigidly connected and thus securely held in their proper spaced relationship by a web 27 welded thereto. This web, which is substantially semi-cylindrical in cross section, provides a concave socket 28 in which the friction pad 13 is received.

The plates 25 that form the jaw 6 are held against relative inward movement, i.e. towards one another, by a sleeve 29 which freely rotatably encircles the hinge pin 11 and has its opposite ends reduced in diameter and received in appropriately sized holes in the plates 25. The shoulder 30 formed at one end of the sleeve as a result of the reduction in diameter of that end of the sleeve, bears directly against the inner face of one of the plates 25; but at the opposite end of the sleeve, the reduced diameter end portion is longer and—in addition to being received in the adjacent plate 25—also passes through the hub of an L-shaped lever 31. The length of the reduced diameter end portion which is received in the hub of the lever 31, is such that the shoulder 32 formed by the reduction in diameter of the sleeve, bears against the inner face of the lever 31. Accordingly, the hub of the lever 31 is confined between the shoulder 32 and the inner face of the adjacent plate 25.

For a purpose to be later described, the lever 31 and the sleeve 29 are secured against relative rotation, as by a set screw 33, and the sleeve 29 at its end opposite the lever 31 is slabbed off, as at 34. Inasmuch as the lever 31 and the sleeve 29 are secured against relative rotation, rocking movement of one will always be accompanied by the same rocking movement of the other, and vice versa.

As will be hereinafter more fully explained, the L-shaped lever 31 provides an interlock between the mechanism by which the nominal spacing of the jaws is adjusted and the mechanism by which the pivoted gripping element or cam 14 is locked in its closed position.

The actuating lever 18, like the jaws 6 and 7—and as best seen in FIGURE 7—is formed of two pieces of steel plate, each having an elongated flat main portion 36 and an inwardly offset end portion 37. The offset end portions are welded together and provide the rounded lug 21.

As noted hereinbefore, movement of the shackle outwardly with respect to the body of the clamp, as when the weight of the clamp is suspended by the shackle, rocks the actuating lever 18 in the counterclockwise direction (as viewed in FIGURES 4–6, inclusive) and, in so doing, first permits the pivoted gripping element or cam 14 to swing by gravity toward the friction pad 13, and then forces the same in that direction, the force being applied by the lug 21 on the lower end of the actuat-

ing lever against the upper smooth curved surface 17 of the cam. Conversely, if the shackle is moved inwardly with respect to the body of the clamp, which would be downwardly in the normal position of the clamp, the actuating lever 18 is rocked in a clockwise direction and, as a result, the pivoted gripping element or cam is pulled away from the friction pad 13 to open the clamp.

The clamp may be releasably locked in its open condition by securing the actuating lever 18 against counter-clockwise rotation about its pivot 19, away from the position it occupies in FIGURE 5, at which time the pivoted cam is retracted. To hold the actuating lever in that position, a pawl or dog 44 on a rock shaft 45 is moved into engagement with a shoulder 46 on one of the two plates that comprise the lever 18.

The rock shaft is fixed on a pin 47 journaled in aligned holes in the plates 25 that form the jaw 6. Any suitable means may be employed to secure the rock shaft 45 to its pin 47, as for instance a dowel pin 48 driven through aligned holes in the hub of the rock shaft and the pin; and a handle 49 on the pin 47 provides means for turning the rock shaft from one position to another.

The end of the rock shaft opposite its pawl or dog 44 mounts a radially projecting blocking cam 51 to swing in the plane of the lever 31. The blocking cam 51 in coaction with the lever 31 forms part of the interlock between the mechanism by which the nominal spacing of the jaws is adjusted and the mechanism by which the pivoted cam is locked in its closed condition, so that the latter function cannot be effected unless the nominal spacing of the jaws is at one or the other of its two defined settings.

Upon the assumption that the spacing of the jaws has been set, the pivoted gripping element or cam 14 may be releasably locked in its active plate-gripping position by rotating the rock shaft 45 in the counter-clockwise direction (FIGURES 4 and 6) by means of its handle 49. Such rotation of the rock shaft increases the tension of a coiled torsion spring 55 and thereby releasably secures the cam in its active plate gripping position. The spring encircles the pin 19 by which the actuating lever 18 is pivoted to the jaw 6, and is located between the two plates that form the actuating lever. One end portion 56 of the spring extends tangentially therefrom and bears against a spring seat 57 on the adjacent end of the actuating lever. The other end portion of the spring is formed into a loop 58 which is so positioned as to lie substantially in the plane of an arm 59 projecting radially from the rock shaft and to be engaged by the outer end of that arm when the rock shaft is rotated in the counter-clockwise direction (FIGURES 4 and 6). Upon such engagement, which is guided by a groove 60 in the end of the arm 59, the tension of the spring is substantially increased beyond its initial preload. It is this increased spring tension which holds the clamp closed, regardless of the thickness of the plate to which the clamp may be attached.

It will be seen from FIGURES 4 and 6 that counter-clockwise rotation of the rock shaft during tensioning of the spring 55, will be limited by the engagement of the notched arm 59 with the side of the adjacent endmost coil of the spring, and that by the time that engagement is reached, the point of contact between the arm 59 and the loop 58 will have crossed dead center, i.e., a line passing through the axis of the rock shaft and the center of the loop 58; and from FIGURE 5 it will be seen that when the rock shaft is turned in a clockwise direction to release the tension on the spring and permit the clamp to open, the loop 58 of the spring engages the underside of the rock shaft and thus maintains the spring under its desired initial tension.

For the rock shaft to be rotatable to its position locking the clamp closed, the swing of the pawl or dog 44 must not be blocked. It is for this reason that the sleeve is slabbed off, as at 34. Likewise, the blocking cam 51 must be free to swing through its orbit. As long as the spacing of the jaws is in one of its set positions of adjustment, nothing interferes with such swinging of the blocking cam. However, if perchance the mechanism by which the spacing is adjusted is in an intermediate position, the short arm 62 of the L-shaped lever 31 will block the required movement of the cam 51. This follows from the fact that during adjustment of the jaw spacing, the lever 31 is moved out of its normal position.

The nominal spacing of the jaws is maintained and also adjusted by a pair of eccentric cams 65–65′ which are fixed to a shaft 66 that is journaled in aligned holes in the plates 25 of the jaw 6, and has the knurled handle 12 fixed thereto, as by a dowel pin 67. The cams 65–65′ overlie the outer faces of the plates 25 and are received between the arms 68–68′ of bifurcations 69 in the plates 26 of the jaw 7. Hence, as the shaft 66 is turned, the swing of the cams moves the jaws about their pivotal connection 11 toward or from one another, the maximum adjustment of the jaw spacing being determined by the throw of the eccentric cams, and involves 180° of rotation of the cam shaft.

While the cam 65 may be press-fitted to the shaft 66, to facilitate assembly, the other cam 65′ must be freely slideable onto the shaft ahead of the handle 12. It is secured against rotation with respect to the shaft, and in coaxial alignment with the other cam by being pinned to the handle, as by a dowel pin 71.

A detent consisting of a spring pressed ball 72 received in a hole 73 through the cam 65′ and engageable in one or the other of two sockets 74 in the outer face of the adjacent plate 25, identifies the two positions or settings of the jaw spacing adjusting mechanism.

In each of the two settings of the mechanism which adjusts the nominal spacing of the jaws, the L-shaped interlocking lever 31 occupies a normal position in which it does not interfere with actuation of the mechanism by which the clamp is "locked" closed, but during rotation of the handle 12 to change the spacing of the jaws, the lever 31 is moved from its normal position into a position in which its short arm 62 blocks movement of the cam 51. This movement is imparted to the lever 31 by rotation of a collar 75 that is fixed to the cam shaft between the plates 25 of the jaw 6, as by a set screw 76. One end portion of this collar has diametrically opposite portions thereof slabbed off, as at 77, each of which accommodates the adjacent end portion of the long arm 78 of the lever 31 and permits it to occupy a position closer to the cam shaft axis than would be the case if the arm 78 engaged the cylindrical side of the collar. Thus, with the collar in a position presenting either of its slabbed off portions to the arm 78, which is the case when the cam shaft is at either of its two detent-defined positions, the lever 31 is in its normal position; but when the cam shaft is turned, the arm 78 in riding up onto the cylindrical side of the collar, rocks the lever 31 and projects its short arm 62 into the path of the cam 51.

The friction pad 13 is substantially a semi-cylindrical block with concentric teeth 13′ on its flat front face to engage one side of a plate received in the mouth of the clamp. The convex back surface of the pad 13 and the concave bottom of the socket 28 cooperate in establishing an axis about which the friction pad has limited free rotation. This freedom facilitates getting a secure grip on the plate; and so that the friction pad may retain its grip on the plate and still be free to rock in its socket, the toothed face of the pad protrudes beyond the marginal edges of the socket.

The pad is retained in the socket by pins 29 driven into the ends of the pad and received in arcuate slots 29′ in the end walls of the socket, the slots being spaced from and concentric to the axis about which the pad rocks.

Another way of retaining the friction pad 13 in its socket is illustrated in FIGURE 9. In this case, the con-

vex bottom of the socket 28' has a slot 35 transversely of the axis about which the pad rocks, and a bolt or other fastening member 80 passes through the pad and the slot. With this way of retaining the pad in its socket, removal or replacement thereof, if needed, is more readily effected.

In the modified embodiment of the invention illustrated in FIGURES 10–13, inclusive, the jaws of the clamp are provided by the lower portions of a pair of rigid body members 90 and 91 that have their medial portions connected by a link 92. Spreading apart the upper ends of the rigid body members thus forces the jaws together, and such spreading is produced by outward or upward movement of a shackle 93 with respect to the body members.

The jaws formed by the lower end portions of the body members are substantially alike, and each has a gripping element or friction pad 94 mounted therein. These gripping elements or friction pads preferably are like the element or pad 13 in the previously described construction, so that each is somewhat free to adjust itself to the surface of a plate being gripped by the clamp.

To translate the outward motion of the shackle 93 resulting from the application of lifting force thereon into spreading movement of the upper ends of the rigid body members and thereby force the jaws toward one another, the shackle 93 has a wedge portion 95, the divergent edges or surfaces of which are received between rollers 96 journalled in the upper ends of the body members. Obviously, therefore, any upward movement of the wedge 95 spreads the rollers 96 and since the medial portions of the body members are connected by the link 92, such outward displacement of the rollers 96 forces the jaws toward one another.

As in the previously described construction, each of the jaw forming members 90–91, consists of a pair of similar steel side plates or cheeks, held in fixed parallel relationship, with the side plates 97 of the member 90 spaced apart farther than the plates 98 of the member 91, the upper portion of the member 91 being embraced by the side plates 97 of the member 90. In each case, the side plates are connected and secured in their proper spaced relation by a substantially semi-cyclindrical web 99 which forms the bottom of the socket for the gripping element or friction pad 94 of that jaw.

Despite the fact that the side plates or cheeks 98 are not spaced apart as much as the side plates or cheeks 97, the gripping elements or friction pads 94 are of exactly the same size. This desirable condition is made possible by having the substantially semi-cylindrical web 99 of the member 91 extend to the outer faces of its side plates or cheeks 98 and closing the ends of this socket by end caps 101 that are welded to the outer faces of the plates 98.

The link 92 by which the body members are connected, is pivoted at one end to the member 90 by a pin 103. Preferably the link is formed by two straps 104 held in spaced relation by a sleeve 105 on the pin 103.

At the opposite end of the link, a pin 106 connects the straps 104, being held against endwise displacement by the confinement of that end of the link between the side plates or cheeks 98 of the member 91. It should be noted, however, that the pin 106 does not connect the adjacent end of the link 92 to the jaw 91. Instead, it simply serves as an abutment at this end of the link.

So that the link can serve its function of pivotally connecting the body members, the member 91 has a shaft 107 journalled therein and passing through elongated slots 108 in the straps 104 of the link. Fixed to the shaft 107 between the straps 104 is a cam 109, the periphery of which is shaped to provide a plurality of notches 110 spaced different radial distances from the axis of the shaft and each selectively engageable with the pin 106, to thereby interpose a rigid adjustable force transmitting connection between the pin 106 and the shaft 107.

As the distance between the pin 106 and the shaft 107 is changed by rotation of the cam 109, the nominal spacing between the jaws of the clamp is correspondingly adjusted; and to facilitate such adjustment, one end of the shaft 107 has an actuating knob 111 fixed thereto. A spring pressed ball detent 113 mounted in the knob 111 and coacting with a plurality of depressions in the outer face of a boss 114 welded to the adjacent side plate 98, provides means for identifying the different settings of the jaw spacing mechanism.

As best seen in FIGURE 11, the lower end portion of the shackle 93 is bifurcated, as at 115, to provide space for a jaw locking mechanism indicated generally by the numeral 116. This mechanism comprises essentially a toggle device consisting of a lever 117 pivotally mounted on the jaw 91 by means of a cross shaft 118 which has one end portion thereof bent at right angles to provide a handle 119. Spacing collars 120 fixed to the cross shaft at opposite sides of the hub of the lever 117 hold the cross shaft against axial displacement with the lever substantially centrally disposed between the two side plates.

The outer end of the lever 117 is bifurcated and embraces one end of a yoke-shaped arm 121 which is pivoted to the lever. The opposite end portion of this yoke-shaped arm has a tubular boss 122 which is slideably mounted on the adjacent end portion of a stem or rod 123. The opposite end of this rod is pivotally connected, as at 124, with the other jaw 90; and a compression spring 125 is confined between the boss 122 and the anchored end of the stem to apply an outward thrust on the yoke-shaped arm.

With the parts in their positions shown in FIGURE 13, the jaw locking mechanism is in its inactive condition, but when the handle 119 is swung from its position shown in dotted lines in FIGURE 10 to its full line position, the mechanism assumes its active condition shown in FIGURE 12. In doing so, the pivotal connection between the yoke-shaped arm 121 and the lever 117 crosses dead center, that is, it crosses a line connecting the axes of the shaft 118 and the pivotal connection 124. When the parts come to rest, the yoke-shaped arm 121 bears against the bottom of the bifurcation in the end of the lever 117, as at 126, so that the thrust of the spring 125 yieldingly tends to spread the upper ends of the body members apart to releasably lock the clamp in its closed condition.

Although it may appear in FIGURE 12 that the connected ends of the lever 117 and the yoke-shaped arm 121 collide with the adjacent roller 96, as seen in FIGURE 11, this roller actually consists of two axially separated wheels with space therebetween to accommodate the connected ends of the lever and arm.

Since it is undesirable to permit the plate-engaging surfaces of the gripping elements or friction pads 94 to collide, relative outward displacement of the upper ends of the body members is limited. For this purpose, an Allen head screw 135 is threaded in one of the side plates 98 of the member 91, with the head thereof in a slot 136 in the adjacent side plate 97 of the member 90. Obviously, of course, the slot 136 must be long enough to permit the full range of relative motion between the upper ends of the jaw forming members needed during opening and closing of the clamp; but in the absence of a plate between the jaws, the head of the screw 135 engages the innermost end of the slot 136 before the gripping elements or friction pads 94 come into contact.

From the foregoing description taken with the accompanying drawings, it will be apparent to those skilled in this art that the plate clamp of this invention has many advantages over plate clamps heretofore available. By the same token, persons experienced in the use of plate clamps will readily understand the manner in which the clamps of this invention are used.

What is claimed as the invention is:

1. A plate-lifting clamp comprising a substantially flat body structure defining:

(A) a plate-receiving mouth having spaced apart jaws projecting from and substantially coplanar with a bight portion,

with the inner opposing faces of the jaws at opposite sides of a median plane perpendicular to and passing through the bight portion;

(B) means on one of said jaws defining a semi-cylindrically bottomed socket opening to the inner face of the jaw with the axis of its curved bottom parallel to said median plane and perpendicular to the general plane of the body structure,

the bottom of the socket having an elongated slot therethrough disposed transversely of the axis of the curved bottom;

(C) a semi-cylindrical friction pad having a substantially flat side and an opposite convexly curved side,

said friction pad being seated in the socket with its convexly curved side in mating sliding engagement with the curved bottom of the socket;

(D) retaining means extending from the convexly curved side of the friction pad and into said slot in the bottom of the socket, to hold the pad in the socket while allowing the pad to rock about the axis of the semi-cylindrical bottom of the socket;

(E) frictional gripping means on the flat side of the friction pad projecting beyond the adjacent inner face of the jaw to engage one side of a plate received in the mouth of the clamp;

(F) a self-energizing gripping cam pivotally mounted on the other jaw to swing between an extended operative position in which it coacts with the friction pad to grip a plate therebetween, and a retracted inoperative position;

(G) a pivot pin on the bight portion of the body structure near its junction with the jaw on which the gripping cam is mounted;

(H) a cam actuating lever medially journalled on said pivot pin and having one end portion thereof projecting over the inner closed end of the mouth and its other end portion projecting toward the pivot axis of the gripping cam and extending far enough in said direction to have a portion of the gripping cam disposed between it and the friction pad,

said lever being operable to effect motion of the cam to its extended operative position in consequence of rocking motion of the lever in one direction; and

(I) a shackle pivotally connected to said first named end portion of the actuating lever, with the axis of the pivotal connection therebetween substantially on said median plane,

the weight of the clamp when suspended by the shackle automatically causing the actuating lever to rock in the direction to effect movement of the gripping cam towards its extended operative position.

2. A plate-lifting clamp comprising

(A) body structure defining a plate receiving mouth having a pair of spaced apart jaws,

(B) a self-energizing gripping cam pivotally mounted on one of said jaws to swing between an extended operative position in which it coacts with the other jaw to grip a plate, and a retracted inoperative position,

(C) a pivot pin on the body structure,

(D) an actuating lever medially journalled on said pivot pin and having one end portion thereof projecting over the inner closed end of the mouth and its other end portion overlying said identified jaw and projecting towards the pivot axis of the gripping cam thereon, far enough to at all times have a portion of the gripping cam disposed between it and the opposite jaw,

(E) means forming a motion imparting connection between said other end of the actuating lever and the gripping cam through which rocking movement of the actuating lever in one direction effects motion of the gripping cam towards its extended operative position and movement of the actuating lever in the opposite direction effects motion of the gripping cam toward its retracted inoperative position,

(F) a shackle connected to said first named end portion of the actuating lever and by which the clamp may be suspended,

the weight of the clamp when suspended by the shackle automatically causing the actuating lever to rock in the direction to move the gripping cam towards its extended operative position when such motion is not restrained, and

(G) means for releasably securing the gripping cam in an extended operative position comprising:

(1) a torsion spring having a medial coiled portion encircling said pivot pin and outwardly extending end portions;

(2) abutment means on the actuating lever engaged by one end portion of the spring and through which the spring when loaded imparts torque to the actuating lever in the direction to move the gripping cam toward its extended operative position;

(3) a rock shaft mounted on the body structure for rotation about an axis parallel to the pivot pin axis;

(4) an arm projecting radially from the rock shaft;

(5) means providing a motion imparting connection between said arm and the other end portion of the spring through which rotation of the rock shaft in one direction acts to load the spring; and

(6) handle means on the rock shaft by which the rock shaft may be turned.

3. The plate clamp of claim 2, wherein said motion imparting means is arranged to pass across dead center when the rock shaft is turned far enough in its spring loading direction.

4. The plate lifting clamp of claim 2, further characterized by means for releasably restraining the actuating lever against moving to a position it occupies when the gripping cam is in its extended operative position, comprising:

an abutment on the actuating lever to swing in an arc as the actuating lever rocks on its pivot; and

a finger on said rock shaft movable into the path of said abutment upon rotation of the rock shaft away from its spring loading position.

5. In a plate-lifting clamp having a body structure defining a pair of opposite jaws, and a plate gripping cam pivotally mounted on one of said jaws for swinging movement toward and from an operative plate gripping position clamping a plate against the other jaw,

(A) a locking device for releasably locking the plate gripping cam in its operative position comprising a torsion spring having a coiled medial portion and end portions extending laterally from its endmost coils;

(B) support means on the body structure extending through the coiled medial portion of the spring to mount the same;

(C) means providing a force transmitting connection between one end portion of the spring and the pivoted plate gripping cam through which the spring, when loaded, imparts torque to said cam in the direction to move it toward its operative position; and

(D) means for loading the spring comprising
(1) cam means movably mounted on the body structure and engageable with the other end portion of the spring to move the same in the direction to load the spring, and
(2) manually operable means for moving said cam means into and out of engagement with said other end portion of the spring.

6. In a plate lifting clamp having a body structure defining a pair of jaws between which a plate to be lifted is received, and a plate gripping cam pivotally mounted on one of said jaws for swinging movement between an inoperative non-clamping position and an operative position in which it coacts with the other jaw to clamp a plate therebetween, locking means for releasably locking the plate gripping cam selectively in either of its said positions, said locking means comprising:
(A) a lever member mounted on the body structure to rock about an axis fixed with respect to the body structure and parallel with the pivot axis of the gripping cam;
(B) means providing a force transmitting connection between said lever member and the gripping cam and through which the gripping cam and the lever member are constrained to move together;
(C) an abutment on the lever member to swing in an arc as the lever member rocks on its pivot;
(D) a rock shaft mounted on the body structure to rotate about an axis fixed with respect thereto and parallel with the pivot axes of the lever member and the gripping cam;
(E) a projection on said rock shaft movable by rotation of the latter, into the path of the abutment to thereby restrain the lever member against moving in the direction incident to movement of the gripping cam towards its operative position;
(F) another projection on the rock shaft;
(G) a yieldable force transmitting connection between said other projection and the lever member through which rotation of the rock shaft in the opposite direction yieldingly imparts torque to the lever member in the direction to urge the gripping cam towards its operative position; and
(H) handle means for the rock shaft.

7. The plate lifting clamp of claim 6, wherein said yieldable force transmitting connection comprises:
a torsion spring having a coiled medial portion and extended end portions; and
means mounting the torsion spring with one of its end portions bearing against the lever member and its other end portion operatively connected with said other projection.

8. A plate lifting clamp comprising:
(A) a pair of rigid members having jaw forming portions;
(B) means pivotally connecting said rigid members and establishing a pivot axis about which said members may be moved relative to one another to adjust the distance between the jaw portions thereof;
(C) a locking device for locking said members in different selected relative positions;
(D) plate gripping elements on the jaw portions of said rigid members for gripping the opposite sides of a plate received therebetween,
each of said elements being mounted on a respective one of said jaw portions,
one of said elements being pivotally mounted on its jaw portion for pivotal movement between an operative plate gripping position and a retracted inoperative position;
(E) movable suspension means for suspending the clamp; and
(F) means operatively connecting said pivotally mounted plate gripping element with the suspension means, and through which movement of said suspension means relative to the connected rigid members effects movement of the pivotally mounted plate gripping element from one position thereof to the other.

9. The plate lifting clamp of claim 8 wherein the other of said plate gripping elements has a planar plate engaging face and is movably mounted on its jaw portion to align its plate engaging face with the side of a plate in contact therewith.

10. The plate lifting clamp of claim 8 further comprising another locking device for releasably locking said pivotally mounted plate gripping elements in its operative plate gripping position.

11. The plate lifting clamp of claim 8, further comprising another locking device for releasably locking said pivotally mounted plate gripping element in its inoperative position.

12. A plate lifting clamp comprising:
(A) a pair of rigid body members each having a part forming one jaw of the clamp;
(B) means connecting said body members for relative movement with their jaws opposing one another and spaced apart a distance depending upon the relative positions of said body members;
(C) a jaw locking device for locking said body members in different selected relative positions to secure the jaws in predetermined spaced relation;
(D) a plate gripping cam pivotally mounted on one of said jaws and movable between an operative plate gripping position and a retracted inoperative position;
(E) a plate gripping element having a planar plate gripping face movably mounted on the other jaw for self alignment with the side of a plate in contact therewith;
(F) suspension means for suspending said clamp, said suspension means being movable with respect to the body members;
(G) a leverage mechanism interconnecting said movable suspension means and said plate gripping cam for pivotally moving said gripping cam from one to the other of its positions in consequence of movement of said suspension means relative to the body members; and
(H) a cam locking device for selectively locking said gripping cam either in its operative plate gripping position or in its retracted inoperative position.

13. The plate lifting clamp of claim 12, further characterized by means for interlocking said cam locking device and said jaw locking device.

14. A plate lifting clamp comprising:
(A) a pair of rigid members each having a jaw portion;
(B) means connecting said members and establishing a pivot axis for relative pivotal movement of their jaw portions toward and away from each other;
(C) manually manipulatable means for effecting relative movement between said rigid members about said pivot axis to adjust the distance between their jaw portions;
(D) means cooperating with said manually manipulatable means for selectively locking said rigid members in different relative positions;
(E) a plate gripping cam pivotally mounted on one of said jaw portions and movable between an operative plate gripping position and a retracted inoperative position;
(F) a plate gripping element mounted on the other jaw portion having a planar gripping face adapted to align itself with the side of a plate in contact therewith;
(G) suspension means for suspending the clamp, said suspension means having limited movement with respect to said rigid members; and

(H) means operatively connecting the suspension means with said pivotally mounted plate gripping cam and through which movement of said suspension means relative to said rigid members effects pivotal movement of the plate gripping cam from one of its positions to the other.

15. The plate lifting clamp of claim **14**, further comprising

a locking device for releasably locking said plate gripping cam in its operative plate gripping position.

16. The plate lifting clamp of claim **14**, further comprising

a locking device for releasably locking said plate gripping cam in its retracted inoperative position.

17. The plate lifting clamp of claim **14**, further comprising

manually operable means for selectively locking said plate gripping cam either in its operative plate gripping position or in its retracted inoperative position.

18. In a plate lifting clamp the combination of:

(A) first and second body forming members,

each of said members including spaced rigidly connected parallel side plates shaped to provide a lower jaw portion and an upper head portion,

the upper head portion of said first member being received between the upper head portions of the side plates of said second member,

the jaw portions of said members being spaced apart to form a plate receiving downwardly opening mouth;

(B) pivot means above the jaw portion of one of said body forming members pivotally connecting said members for relative pivotal movement to enable adjustment of the distance between their jaw portions;

(C) means for effecting relative pivotal movement of said body members comprising

a shaft journalled in and extending between the side plates of and at the upper head portion of said first member,

(D) a cylindrical cam eccentrically fixed on said shaft, one of the side plates of said second body forming member having a recess in which said cylindrical cam is snugly received so that upon rotation of the shaft and the cylindrical cam thereon, said body forming members are pivotally moved relative to one another; and

(E) handle means connected to said shaft for turning the same.

19. The plate lifting clamp of claim **18**, further characterized by:

manually operable means for preventing unintentional cam adjusting rotation of said shaft, comprising

a lever arm pivotally mounted on said member with its end portion positioned to be swung towards and from said shaft, and

a part fixed on the shaft to engage the end portion of the lever arm and by such engagement prevent rotation of the shaft.

20. In a plate lifting clamp having a pair of rigid body-forming members, each of which has a lower jaw portion and an upper portion,

adjustable length link means connecting said rigid body-forming members medially of their upper and lower portions,

thrust receiving members on the upper portions of said rigid members,

suspension means disposed between said thrust receiving members and having opposite downwardly divergent side edges arranged to bear thereagainst and force the same apart upon the application of lifting force on the suspension means,

whereby the lower jaw portions of said rigid members are forced toward one another to grip a plate positioned therebetween,

the improvement which resides in the structure of the link means and by which its length may be adjusted to adapt the clamp to plates of different thicknesses, and which comprises:

(A) a strap member pivoted at one end to one of said rigid members, and having its free end portion overlying the medial portion of the other rigid member; and

(B) means forming an adjustable connection between the free end portion of the strap member and the medial portion of said other rigid member, said means comprising

an abutment on one of said overlying portions, and

a cam rotatably mounted on the other of said overlying portions,

the cam having notches in its periphery, the bottoms of which are spaced different radial distances from the axis of the cam,

and said notches being selectively engageable with said abutment so that upon rotation of the cam the effective length of the link means connecting said rigid members is adjustable.

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