# United States Patent

**Siegwart**

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[54] **TILTABLE LIFTING TONGS**


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[73] Assignee: **Heppenstall Company,** Pittsburgh, Pa.



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[52] **U.S. Cl.** .....**294/103 CG,** 214/658

[51] **Int. Cl.**.....**B66c 1/22**

[58] **Field of Search**.....294/103, 104, 111, 112; 214/658



[56] **References Cited**

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|---|---|---|---|
| 2,945,609 | 7/1960 | Benes et al | 214/658 |
| 3,076,674 | 2/1963 | Anderson | 294/103 R |
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[57] **ABSTRACT**

The specification discloses tiltable lifting tongs of the type having opposing grappling jaws for grasping and releasing a load, such as a coil of sheet steel, and having a power driven cable sling for tilting the tongs through an angle, such as 90°, to correspondingly change the orientation of the load between pick-up and set-down thereof. A toggle linkage is employed whereby the load reaction force acting in the cable sling is applied to one of the tong levers controlling the gripping pressure of the grappling jaws in such a manner as to provide an amplification of the forces exerted on the tong lever and also to maintain a substantially constant and near maximum lever arm ratio therefor throughout the entire angle of change in orientation.


**5 Claims, 6 Drawing Figures**

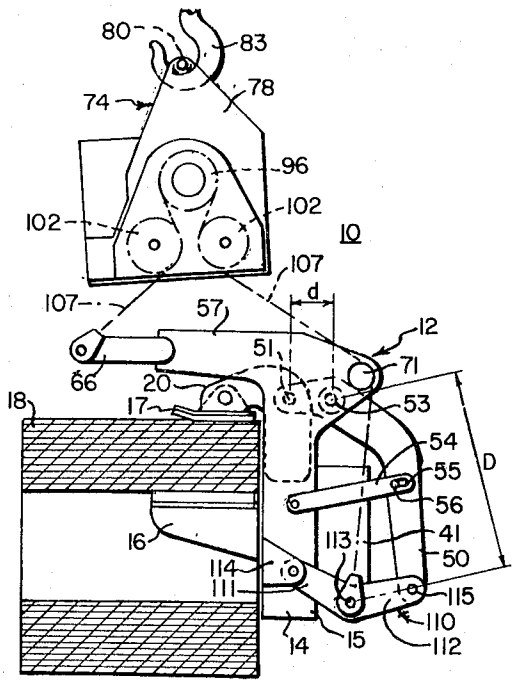


FIG.1

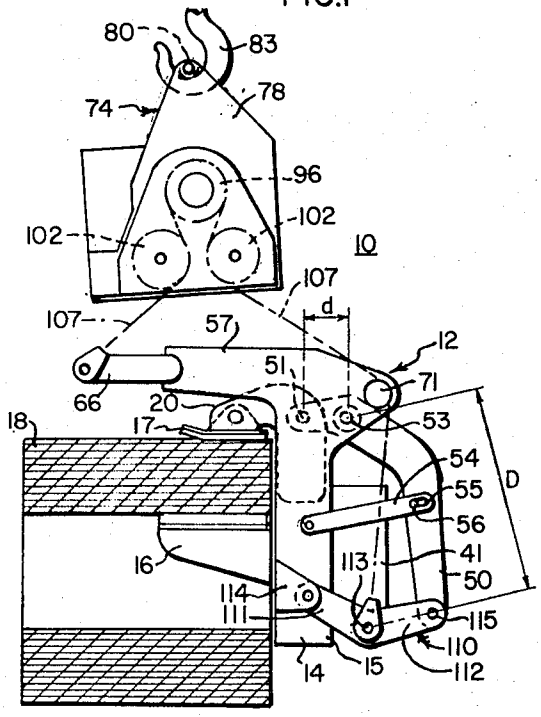
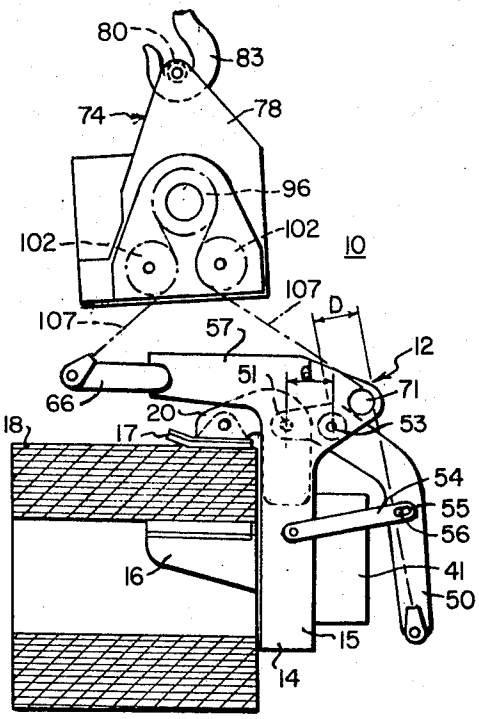



FIG.4



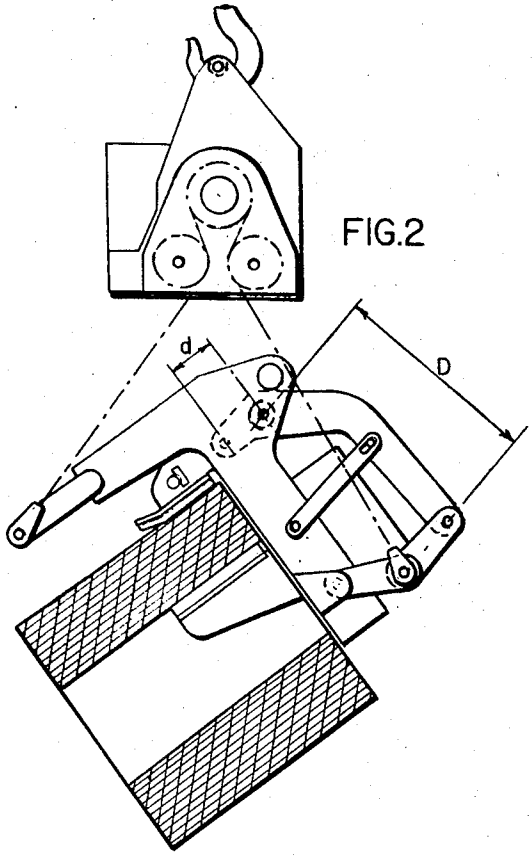




FIG.2

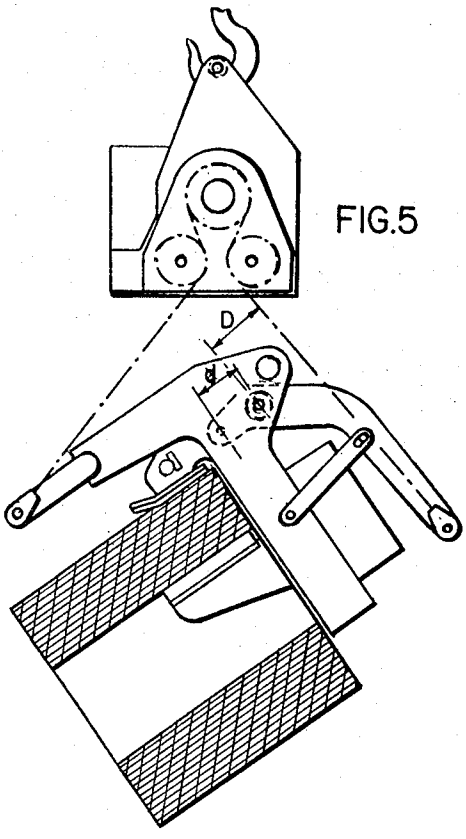



FIG.5

FIG.3

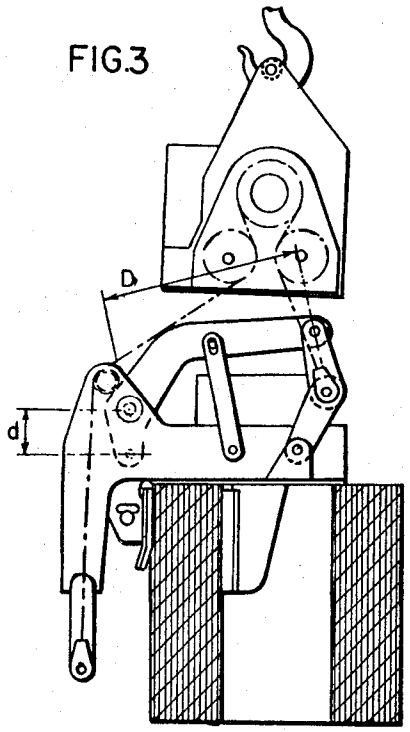
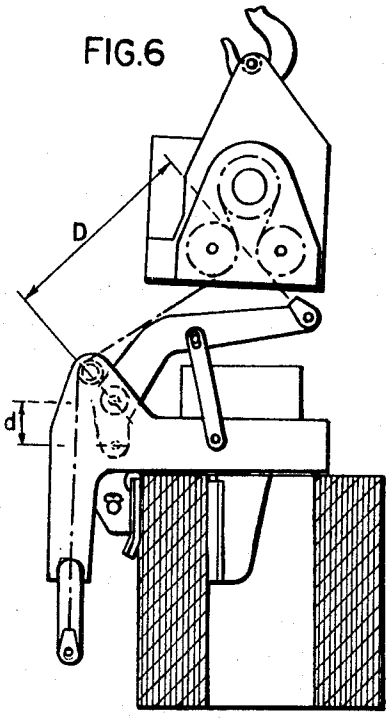



FIG.6



# TILTABLE LIFTING TONGS

This invention relates to tiltable lifting tongs of the type having opposed jaws for grasping and releasing a load, such as a coil of sheet steel or aluminum, and operable to change the orientation of the load between pick-up and set-down.

Tiltable lifting tongs heretofore known, as exemplified by that described in U.S. Pat. No. 3,436,116 issued Apr. 1, 1969 to J. R. Anderson and assigned to the assignee of this invention, are known and used in industries. In the steel industry, by reason of the orientation of strip mills and processing lines, the strip is necessarily coiled on a horizontal axis to form a coil which is ordinarily banded to hold it in the form of a coil. Such coils are of varying weight, and may attain weights as high as one hundred thousand pounds. Although such coils are wound on a horizontal axis because of mill designs, and are wound on a horizontal axis because of mill designs, and are unwound on a horizontal axis for the same reason, the coils are preferably stacked with the coil axis in a vertical position to avoid rolling and possible breaking of the bands.

The tiltable tongs illustrated in U.S. Pat. No. 3,436,116 provided a desirable improvement over the tilting apparatus theretofore employed for the purpose of changing the coils from a horizontal to a vertical orientation.

The existing tiltable tongs are provided with an adjustable outboard tilting leg extension to obtain full capacity or effectiveness of the turning torque designed into the unit. Moreover, variations in the material and gripping area of the outer gripping shoe may be had to accommodate highly finished or soft material type of coils. The inherent design of the existing tiltable tongs with respect to the manner of application of load reaction force to the tong levers is such, however, that the gripping force on a coil during the transition from horizontal axis orientation to vertical axis orientation may not provide the necessary factor of safety under certain conditions, especially when the operating personnel endeavor to employ the lifting tongs under circumstances where the weight of the coil is excessive in relation to the capacity of the unit, or when the gripping jaws are unsuited to the material of which the coils are made.

I provide means for applying the load reaction force to one of the tong levers controlling the gripping force of the movable grappling jaw so as to intensify the effective gripping force and thereby insure an adequate factor of safety.

More specifically there is provided a toggle linkage by which the load reaction force is applied to the tong lever controlling the gripping force of the movable grappling jaw, thereby to effect an amplification of the force to which the tong lever is subject under minimum load reaction force conditions while limiting to a small amount the increase in the force on the tong lever under conditions of greatest load traction force. Moreover, the lever arm ratio by which the tong lever applies force to the movable grappling jaw is maintained substantially constant throughout the entire angle of change in orientation.

In order to more clearly present the essential structural and operational differences between the invention and the existing tiltable tongs exemplified by the prior



design disclosed in U.S. Pat. No. 3,436,116, simplified views of the prior design are included in the accompanying drawings, wherein:

FIGS. **1**, **2** and **3** are elevational views showing tiltable lifting tongs, embodying the invention, in the respective positions assumed by the unit with the axis of the coil in a horizontal, an inclined and a vertical position; and

FIGS. **4**, **5** and **6** are elevational views showing tiltable lifting tongs of the prior design in positions corresponding respectively to the positions shown in FIGS. **1**, **2** and **3**.

In view of the fact that in large part, the internal details of the tiltable lifting tongs embodying the invention and the tiltable lifting tongs of the prior design are substantially alike, it should be understood that corresponding reference numerals will be hereinafter employed in FIGS. **1** and **4** to designate corresponding elements therein, without repeating the description of the prior art design itself. Except as pointed out hereinafter, reference numerals are omitted from FIGS. **2**, **3**, **5** and **6** for simplicity and avoidance of unnecessary repetition.

Referring now to FIGS. **1** and **4**, the common elements of the tiltable lifting tongs shown therein will now be briefly described, it being understood that reference to U.S. Pat. No. 3,436,116 may be had for complete structural details and description of the unit. For convenience, the same reference numerals are used herein, as are used in the patent, to identify a corresponding element. The unit is generally designated by reference numeral **10** and includes a grappling arm portion **12** having a rigid base member **14** made up of two laterally spaced parallel angle plates **15**, only one of which is shown. Base member **14** supports an inner grappling jaw **16** which is suitably fixed thereto. An outer grappling jaw **17** is supported by base member **14** in spaced relation to the inner jaw **16** and is reciprocatively movable with respect thereto for gripping therebetween the wall of a coil **18** of sheet steel.

Outer jaw **17** is pivotally mounted on one end of an L-shaped grappling arm **20**, made up of two parallel spaced plates. The other end of the arm **20** extends between the plates **15** of base member **14** and is suitably slidably arranged therein.

Contained within a housing member **41** detachably fixed to the base member **14** is a power drive assembly including a reversible electric motor (not shown). The power drive assembly also includes a screw and nut arrangement via which movement of the outer grappling jaw **17** with respect to the inner jaw **16** is effected.

A generally L-shaped lever arm **50**, consisting of two laterally spaced identical plates only one of which is shown, has a long leg that extends longitudinally of the base member **14** and to one side of the housing member **41**. Lever arm **50** has a short leg that is pivotally connected to a thrust block (not shown), at a point designated by the reference numeral **51**, the thrust block in turn being slidably supported by a key and slot arrangement between the two side plates of grappling arm **20**. The long leg of lever arm **50** is connected by a link member **54**, comprising two identical laterally spaced plates, to the base member **14**. One end of the link **54** is pivotally connected to the base member and the other end is pivotally connected to the lever arm by

a pin **56** which slides in a longitudinally extending closed slot **55** adjacent the end of the two side plates of link **54**. Slots **55** define the limits of movement of lever arm **50** relative to the base member **14**.

Lever arm **50** has a main pivot pin **53** by which a pivotal connection is formed with a support arm **57**. Support arm **57** comprises two laterally spaced L-shaped plates, one of which is shown. Each of the side plates of support arm **57** has an arm fixed to the inner face of a corresponding one of the angle plates **15** forming base member **14**. Each of the side plates of support arm **57** also has a leg transverse to the base member and paralleling the movable grappling jaw **17**. Suitably secured, as by a key and slot arrangement, between the side plates of the support arm **57** is an adjustable extension member **66**.

Disposed above the grappling arm portion **12** of the lifting tongs assembly **10** is a suspending means **74** in the form of a power-driven sling arrangement. Suspending means **74** comprises a housing which includes two laterally spaced generally triangular plates **78**, only one of which is shown. At the upper end of plates **78** are coaxial openings in which a tubular generally cylindrical shaped spool **80** is fixedly supported. Spool **80** is necked at its midpoint between plates **78** to accommodate a crane hook **83**.

Suitably mounted externally with respect to the plates **78** are a pair of toothed drive sprockets **96**, only one of which is shown. Sprockets **96** are keyed to opposite ends of the output shaft of a speed reducer (not shown) which is, in turn, driven by a reversible electric motor (not shown). The speed reducer and the electric motor are suitably mounted between the plates **78** in parallel relation to each other and operatively connected as specifically described in U.S. Pat. No. 3,436,116.

Rotatably mounted externally of each of the plates **78** are a pair of identically shaped idler sprockets **102**, in laterally spaced coplanar relation to each other and with respect to the drive sprocket **96** on the corresponding side of the suspension means housing plates **78**.

Referring now only to the prior design shown in FIG. **4**, a pair of identical roller chains **107** are provided by which to suspend the grappling portion assembly from the suspension means, one chain for each side of the suspension means. Since the connections and path of each roller chain **107** are in parallel and similar, only the connections and path for one chain will be here described. Thus, one end of a chain **107** is suitably connected to the end of the extension member **66** on support arm **57**, thence it is reaved around the inner surface of one idler sprocket **102**, over the drive sprocket **96**, and returning back on the inner side of the second idler sprocket **102** and outwardly of the suspension means, over a support shaft or pin **71** on the support arm **57**, and back to the end of lever arm **50** where it is suitably pivotally anchored.

While not apparent in the drawings, it should be understood that in addition to the roller chains **107**, there are provided a pair of identical wire ropes similarly connected at opposite ends to support arm **57** and lever arm **50** and reaved around pulleys coaxially mounted and keyed to the same shafts as the sprockets **102** and **96**.

Referring to FIG. **1**, the modifications made in the prior design of tiltable lifting tongs, according to the invention, will now be described. A so-called toggle link **110** is provided between the base member **14** and the free outer end of lever arm **50**. Toggle link **110** comprises two arms **111** and **112**, each arm consisting of two laterally spaced parallel elements only one of which is shown. Arms **111** and **112** are pivotally connected together by a suitable hinge pin **113** extending through cooperating ends thereof. The other end of arm **111** is pivotally connected by a suitable pin to a clevis bracket **114** attached to base member **14**. The other end of arm **112** is pivotally connected, as by a suitable pin **115**, to the outer end of lever arm **50**.

A pair of roller chains **107** and wire cables (not shown) are provided by which to suspend the grappling portion assembly, in a manner similar to that described for the prior design of FIG. **4**. However, as shown in FIGS. **1**, **2** and **3**, the one end of roller chains **107** and of counterpart wire cables are connected pivotally to the hinge pin **113** coupling the two arms of toggle link **110**. The advantages obtained by this manner of applying the load reaction force in roller chains **107** and their counterpart wire cables to the lever arm **50** will be demonstrated hereinafter by a comparison of the forces applied to lever arm **50** and the leverage ratio applicable in each of the different positions of the lifting tong unit for the prior design of unit and for the unit constructed according to the invention.

In order to explain the meaning of the term "leverage ratio" the moment arm for the load reaction force effective on the lever arm **50** is designated by the reference letter D and shown in each of the Figures of the drawings. Similarly, the moment arm of the gripping force applied to grappling jaw **17** is designated by the reference letter d and shown in each of the Figures.

Referring to FIG. **4**, the force moments active may be expressed by the equation:

$$F_{lr} \times D + f_g \times d \qquad (1)$$

where $F_{lr}$ is the load reaction force and $f_g$ is the gripping force exerted by the grappling jaw **17**;

By transposition:

$$f_g = F_{lr} \times (D/d) \qquad (2)$$

The term "leverage ratio" as used herein refers to the ratio of the moment arms $D$ and $d$. As will be evident from equation (2), therefore, the gripping force exerted by the grappling jaw **17** is proportional to the leverage ratio $D/d$.

It will be understood that the connection of the roller chain **107** and wire cables to the toggle link **110** causes an amplification of the force effectively exerted by the load reaction force on the lever arm **50**, by reason of the relatively greater component of force applied normal to lever arm **50** instead of longitudinally thereof as in the case of the prior design shown in FIGS. **4**, **5** and **6**.

Referring now to FIGS. **4**, **5** and **6**, it will be apparent by inspection of the relative lengths of moment arms $D$ and $d$ in these Figures that in FIGS. **4** and **5** the leverage ratio $D/d$ is approximately equal to 1, whereas in FIG. **6** the leverage ratio $D/d$ is equal to a multiple of 1. Thus in the prior design of tilting lifting tongs, the leverage ratio $D/d$ does not begin to increase greatly over **1** until

the inclination of the axis of coil **18** approaches the vertical position shown in FIG. **6**. There is therefore a critical angle of inclination of the axis of coil **18** in which the leverage ratio $D/d$ is sufficiently low that, under certain conditions, the gripping force $f_g$ exerted by the grappling jaw **17** may not hold the weight of the coil **18** against possible slippage with a sufficiently high safety factor.

Referring now to FIGS. **1**, **2** and **3**, it will be apparent by inspection of the relative lengths of moment arms $D$ and $d$, that the leverage ratio $D/d$ is a multiple of **1** regardless of the orientation of the axis of coil **18**. Moreover, the leverage ratio $D/d$ is a substantially uniform value starting with the horizontal position of the axis of the coil **18**, through all angles of inclination of the coil axis up to and including the vertical position of the coil axis shown in FIG. **3**. It will be seen also that notwithstanding the change in orientation of the coil axis, the resultant of the forces exerted on the end of tong lever **50** via the toggle link **110** by the load reaction forces $F_{lr}$ applied to the knee of the toggle link is greater than the load reaction force itself, beginning with the horizontal position of the axis of coil **18** in FIG. **1** and continuing through the various inclined positions of the coil axis, as represented in FIG. **2**, up to and including the vertical position of the coil axis shown in FIG. **3**.

It will be seen, therefore, that by providing the arrangement of toggle link **110** by which the load reaction force is applied to lever arm **50**, the possibility of a critical angle at which slippage of the grip of the grappling jaws **16** and **17** on the wall of coil **18** may occur is obviated.

It should be understood that the characteristic essential to operativeness of the toggle link **110** lies in the arms **111** and **112** always remaining at angle to each other which is less than 180°, for should the arms **111** and **112** become aligned at 180° or pass such point of alignment the effective force on the tong lever **50** is lost or even reversed. The slotted link member **54** thus serves the additional function of insuring the maintaining of the arms of the toggle link **110** always at an angle less than 180° by reason of the fact that the length of the slot **55** in the link member **54** prevents sufficient outward movement of the end of lever **50** to allow the arms of the toggle link **110** to reach an aligned position. Thus toggle link **110** remains constantly effectively to exert an amplified component of the load reaction force on the end of lever **50**.

In operation, the embodiment of tiltable lifting tongs constructed according to the invention functions in exactly the same manner as the prior design so far as pick-up, tilting and release of the coil **18** is concerned. Thus, assuming that the axis of coil **18** is in a horizontal position, pick-up of the coil may be effected by placing the grappling jaws **16** and **17** in straddling relation to the wall of the coil, energizing the motor in housing member **41** to shift grappling jaw **17** toward the fixed jaw **16** to effect a gripping of the wall of the coil, and elevating the suspension means **74** by means of the crane. Upon lift up of the coil **18**, the load reaction force effective in the roller chains **107** and paralleling wire cables on the lever arm **50** causes application of substantially the maximum gripping force by grappling jaw **17** to support the coil. Assuming that the coil is now being transported to the desired location for set-down, energization of the tilting motor in the suspension means **74** causes shortening of one end of the roller chains **107** and lengthening of the other end, thereby shifting the coil axis through a substantially 90° angle to the vertical position shown in FIG. **3**. Reversal of the motor in housing **41** may be effected to move the grappling jaw **17** away from fixed jaw **16**, thus releasing the grip on the coil wall and allowing the lifting tong assembly **10** to be elevated away from the coil.

In conclusion, it will be seen that the tiltable lifting tongs embodying a toggle link whereby the load reaction force is applied to the lever arm of the grappling portion not only provides a greater effective force applicable to the movable grappling jaw for the same weight of load but also maintains a substantially uniform leverage ratio for the grappling portion regardless of the orientation of the axis of the coil being lifted, thereby obviating the possibility of slippage of the grappling jaws on the coil at a critical angle of inclination of the coil axis.

I claim:

**1**. Tiltable lifting tongs comprising a grappling portion having a fixed jaw member and a cooperating jaw member movable with respect to said fixed jaw member to grip a load element therebetween or to release said load element, a support arm,a tong lever pivoted on said support arm so as to activate said movable jaw member, and suspension means including flexible elongated means connected at its opposite ends to said support arm and to said tong lever whereby to support said grappling portion, wherein the improvement comprises toggle linkage interposed between the flexible elongated means and the tong lever.

**2**. Tiltable lifting tongs according to claim **1**, wherein the said grappling portion comprises an elongated base member on which the said support arm is fixed, and wherein said toggle linkage comprises a pair of members, hinged together at an angle less than 180° one member being anchored to said base member and the other member being anchored to said tong lever, the load reaction force in said flexible elongated means being effectively exerted at the hinge of the toggle linkage to intensify the gripping force exerted by the tong lever on the movable jaw member.

**3**. Tiltable lifting tongs according to claim **2**, wherein a slotted link member connected between said base member and said tong lever limits the relative movement of the hinged members so as to maintain the angle between the hinged members always less than 180°.

**4**. Tiltable lifting tongs comprising a grappling portion having a fixed jaw member and a movable jaw member in substantially parallel relation to each other, power means for moving said movable jaw member relative to said fixed jaw member to grip a load element therebetween or to release said load element, a support arm, a tong lever pivoted on said support arm so as to activate said movable jaw member; a suspension portion having flexible elongated means connected at its opposite ends to said support arm and to said tong lever whereby to support said grappling portion, said tong lever being activated responsively to the load reaction force thereon to apply a gripping force to said movable jaw member, and power driven means for shifting said flexible elongated means longitudinally in opposite

directions to effect corresponding tilting of the grappling portion and the load supported thereby, wherein the improvement comprises toggle linkage via which the load reaction force in the flexible elongated means is applied to said tong lever.

5. Tiltable lifting tongs according to claim 4, wherein the said grappling portion comprises an elongated base member on which the said support arm is fixed, and wherein the said toggle linkage comprises two members hinged together at an angle less than 180°, one of said members being anchored to said base member and the other of said members being anchored to said tong lever, the flexible elongated means being connected at the hinged connection between said two members, whereby the gripping force exerted by the tong lever on said movable jaw member is intensified and the leverage ratio of the tong lever is maintained at a substantially uniform value and a multiple of 1 throughout the tilting range of movement of the grappling portion.

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