FIG. 2

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FLUID POWERED TONGS

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FIG. 4

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A heavy duty lifting tongs is powered by a single acting cylinder and piston motor having its piston rod connected to move pulleys means effective to tension a cable connection to the tongs to cause them to open when a pump discharge applies pressure to the piston end of the motor. The weight of the tongs and the cable is effective to close the tongs and to return the piston in its cylinder at the same time causing hydraulic fluid flow back to a reservoir. This return fluid flow may be throttled to regulate closing movement of the tongs. Fluid flow between the pump and the motor during tong opening movement or between the motor and the reservoir during tong closing movement is in communication with a fluid pressure relief valve so that overload on the hoist mechanism is avoided at all times.

This invention relates in general to tong mechanism and more particularly to fluid power operated tong mechanism.

Tong mechanism for lifting loads, such as ingots, molds, slabs, etc., in both the heated and non-heated condition are known in the art.

Such prior art arrangements of tongs are generally controlled by an electric motor cable hoist which usually includes among other components, a gear reducer, a cable drum, an electric torque motor, brakes, and limit switches. Such prior art arrangements require considerable maintenance, since when a lift is made by the tongs, the main pivot points between the tongs try to separate in a vertical direction due to the load strain, and between these two pivot points, the hoist unit is connected for opening and closing the tongs. If there is no way of allowing the hoist cable to pay out or slacken up during this separation movement of the pivot points, the hoist cables will be stretched until they break. Although electric safety devices are known for use with such tongs, they have a definite length to travel and a definite length of time to operate in and consequently, damage may be done in the process of mechanically actuating them due to the time loss between the electrical impulse and the mechanical release. Accordingly, maintenance on such prior art tong mechanism is usually considerable, resulting in substantial down time for the tongs and high maintenance costs.

The present arrangement provides a novel adjustable tong mechanism so that such tongs can be utilized to lift and move various widths and sizes of loads, such as various widths of slabs, and wherein the tong mechanism is actuated by fluid powered means such as a fluid powered hoist utilizing a reciprocating fluid powered motor unit; and wherein pressure relief means is provided in the fluid circuit for limiting the maximum stress on the hoist cables during the lifting of a load by the tongs. Accordingly, it is an object of the present invention to provide a novel tong mechanism for handling a load.

A further object of the invention is to provide a novel tong construction comprising a head, with link means pivoted to the head and mounting adjustable tong arms, with such arms being actuated by means of a fluid powered cable hoist means including automatic pressure relief hoist mechanism including a single acting reciprocating fluid powered motor unit. Another object of the invention is to provide a novel tong construction which is adapted to be raised and lowered by means of a crane, and wherein the tong mechanism comprises a head frame to which is mounted adjustable tong arms with a self-contained hydraulic powered hoist mechanism carried by the head frame for adjusting the tong arms, and wherein the hoist mechanism includes a single acting, reciprocating, hydraulic powered motor unit.

A still further object of the invention is to provide a tong construction of the aforementioned type wherein the fluid power system includes control means for adjusting the position of the tong arms and wherein such control means includes throttling means for precise control of the movement of the tong arms during adjustment thereof. A further object of the invention is to provide a novel fluid power system adapted for use with an adjustable tong mechanism having a fluid powered cable hoist mechanism associated therewith, wherein the fluid power system includes automatic pressure relief means for protecting the cable hoist mechanism of the tong mechanism. Another object of the invention is to provide a fluid power system of the above mentioned type which includes control means for expeditiously adjusting the position of the tong arms, and including throttling means for precise control of the movement of the tong arms during adjustment thereof.

Other objects and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a front view of a tong construction embodying the present invention, and illustrating in full lines an open position of the tong arms; in dot-dash lines there is illustrated a closed position of the tong arms.

FIGURE 2 is a side elevational, partially broken view of the tong construction illustrated in FIGURE 1.

FIGURE 3 is an enlarged side elevational view of the cable hoist mechanism including a single acting fluid powered motor unit of the hoist mechanism, and a self-contained fluid power system associated therewith for actuating the cable hoist mechanism.

FIGURE 4 is an enlarged sectional view taken generally along the plane of line 4--4 of FIGURE 3 looking in the direction of the arrows, and illustrating in particular the reciprocating fluid powered motor unit which actuates the cable hoist mechanism of the tong mechanism.

FIGURE 5 is an enlarged, front, partially broken view of the head of the tong mechanism and with the cable hoist mechanism mounted thereon.

FIGURE 6 is a top plan view of the components of the fluid power system illustrated in FIGURE 3.

FIGURE 7 is a schematic illustration of the fluid power system which may be used for actuating the cable hoist mechanism.

Referring now again to the drawings, the tong mechanism is illustrated in a form adapted to be suspended as for instance from a hook 10 (FIGURE 1) of a crane or other material handling equipment in a plant, such as for instance a steel mill. The tong mechanism in the em-
bodiment illustrated comprises a support or head 12 which may be in the form of a framework including laterally spaced frame members 14 having at their upper ends a connecting trunnion-like lift member 16, which is adapted for engagement with the aforementioned hook 10 for lifting and lowering the tong. Extending outwardly from frame members 14 may be spaced side plates 18 (FIGURE 2) to which are mounted adjacent the outer ends thereof spaced flanges 20. Right- and left-handed link assemblies 24, 24a (FIGURE 1) are pivoted as at 26 to the spaced flanges 20, and as by means of the bolt and nut assembly illustrated. Link assemblies 24 and 24a may each comprise spaced link members connected together by means of a web 28 (FIGURES 1 and 2) secured thereto.

The distal ends of each link assembly 24 or 24a may be pivotally coupled as by means of a bolt and nut assembly 30, to lever assemblies 32, 34, with such lever assemblies comprising spaced lever members connected together (FIGURE 2) by nut and bolt spacer assembly 38.

Each of the lever assemblies 32, 34 may be pivoted as at 40 in laterally spaced relationship, as best shown in FIGURE 1, to a lever pivot support 42. The levers 32, 34 each merge with generally vertically extending tang arm portions 46, 46a which adjacent their lower ends are adapted to mount load grippers 48 in removable relation, and as for instance by means of the bolt and nut assembly 48a.

Mounted on the head 12 of the tongs is the cable hoist unit 50. Such cable hoist unit in the embodiment illustrated comprises a reciprocating single acting horizontally oriented, hydraulic powered motor unit 56 (FIGURE 3) with the cylinder portion 56a thereof being secured to framework or housing 60 as by means of bolts 62. Framework 60 may be coupled to or supported on the head 12 by means of laterally extending trunnion brackets 63 receiving therethrough pins 63a (FIGURE 2) preferably removably supported on the spaced frame members 14. The piston rod 56b of motor unit 56 is preferably detachably coupled as at 64 (FIGURE 4) to block member 66, which in turn is mounted on a rod or shaft 68.

Block 66 may be secured to the shaft by means of bolt and nut assembly 68a (FIGURE 3). Rod 66 has idler pulleys 70 rotatably mounted thereon as by means of bearings 70a, for rotation of the pulleys with respect to the rod 68.

The ends of the rod 68 may be received in T-block members 72 which in turn ride in guideways 74 in frame 60, and guide the movement of the pulleys 70 and shaft 68 during reciprocation of the piston rod 56b, and eliminate bending stresses on the latter. Wear plates 76 may be provided on the inner side of the frame 60 for sliding obliteration with the T-blocks 72. Shaft 68 also may be provided with openings or passageways 78 therein (FIGURE 4) which communicate with the anti-friction bearing means 70a of the respective pulleys 70 for lubricating the bearing means.

Extending about each of the pulleys 70 may be a flexible element or cable 80, one end of which may be detachably anchored as at 82 to the frame 60 after which the cable passes partially around the associated pulley 70 and extends inwardly to pass partially around idler pulley 84 (FIGURE 3) rotatably mounted in the framework 60 by means of shaft 84a, and in alignment with the respective pulley 70. From pulley 84 the cable 80 extends downwardly to be coupled as at 86 (FIGURES 1 and 2) to the lever pivot mounting member 42.

In the embodiment illustrated, two of the cable elements 80 are coupled to each side of an equalizing bar member 88 which is pivoted as at 88a to central lug ears 89 secured to the pivot lever member 42. Thus it will be seen that equalized force is applied to the lever pivot member 42 by the flexible elements 80. It will be understood that in the event that only a single cable was used, such single cable would be coupled in centralized relation to the lever pivot member so that equalized force would be applied to such member by the lift cable. Thus, it will be understood that the equalizing bar 88 is adapted to be used when more than one cable is used, and as illustrated. Guide shield 89a secured to block 66 (FIGURES 3 and 4) may be provided coacting with pulleys 70, and guide shield 89b secured to block 66 in coacting relation with pulleys 84 may also be provided.

Referring now to FIGURE 3, the hoist unit 50 may embody a self-contained fluid power system 90 which is adapted for mounting in secured relation on the framework 60 as supported by the head structure 12. Such a self-contained unit may comprise an enclosed fluid tight housing providing a reservoir 92 on which may be mounted a drive motor 94, such as an electric motor, operatively coupled as at 94a (FIGURE 6) to a pump 96 which is enclosed in the reservoir tank 92 preferably above the level 98 of the reservoir fluid therein. The intake port 96a of the pump may be coupled, by means of fluid transmission of fluid in a conventional manner 92a to be located beneath the surface 98 of the actuating fluid, such as hydraulic oil, in the reservoir tank 92. As shown in FIGURES 3 and 6, reservoir 92 may comprise three fabricated sections 92a, 92b and 92c together in fluid communicating relation. The output port 96b of the pump may be coupled by means of fluid transmission line 100 to a check valve 102 of conventional construction, which again is disposed within the reservoir tank 92 and more particularly in section 92c thereof. Check valve 102 prevents return flow of actuating fluid through line 100 back to the pump. Check valve 102 may then be coupled via line 104 to pressure relief valve 106 of conventional construction. Pressure relief valve 106 may have its pressure relief port 106a connected by pipe 111 back to the reservoir.

From pressure relief valve 106, fluid transmission line 104 may pass through the side wall of the reservoir tank to the exterior thereof and may be coupled by means of a rigid fluid transmission line section 108 (FIGURE 6) to the piston end of the reciprocating fluid powered motor unit 56. The piston rod end of the single acting motor unit is preferably connected as by means of rigid pipe 110 back to the reservoir tank and coupled thereto as by means of fitting 110a.

Coupled into the fluid pressure line section 104 of the piston end of the motor unit and as by means of line 112 may be a solenoid operated control valve 114. Valve 114 may be of conventional type being a simple on-and-off valve, with such valve being adapted to be off or closed during the tong closing operation. Upon actuation of the valve 114 so as to open the same, the actuating fluid in the piston end of the motor unit 56 and in lines 104 and 112 is permitted to pass through the valve 114 and then through a throttling valve 116, such as for instance a conventional needle-type metering valve, back to reservoir as at 118. Valve 116 may be manually adjusted as at 120 for providing many combinations of speed of the fluid passing from the piston end of the motor unit back to the reservoir.

It will be noted that the pump 96 and all the valves and the piping therefor, except pipe sections 108 and 110 to the cylinder of the motor unit, are inside the reservoir tank 92, thus providing a leak-proof system. The piping lines are short and minimize vibration, and since there are no flexible hoses involved in the system, maintenance thereof is extremely low. Also, the reservoir sections 92a and 92c are preferably provided with openings in the top thereof with removable covers 121, 121a for ready ac-
cessibility to the interior of the tank and the valves and pump therein.

Operation of the tong mechanism may be as follows:

To open the tong levers and grippers so as to adjust the tongs for grabbing a load or in other words to move the pivot points 40 and 26 relatively toward one, electric motor 94 may be actuated by the operator to actuate the pump 96 of the fluid system, thus supplying pressurized fluid to fluid transmission line 100, thence through check valve 102, and then to the piston end of the reciprocal motor unit 56. Control valve 114 will be in the "off" condition. Application of pressurized fluid to the piston end of the motor unit 56 will cause extension of the piston rod 56b thereof, thereby moving the pulleys 70 outwardly with respect to the frame 69 and thus tensioning the cable elements 89 to lift lever pivot or tie beam member 42. Upward movement of beam member 42 causes vertical movement of pivot points 40 toward pivot point 26 and thus causes opening of the tong arm assemblies 45, 46a.

The check valve 102 in the fluid system acts as a brake to hold the tongs in any desired open position upon de-energization of the motor 94 and stopping of the pump 96. The solenoid operated directional control valve 114 is as aforementioned, in off or closed condition during the tong opening operation. Now when it is desired to close the tongs to, for instance, pick up a load, the solenoid of the valve 114 is operated and the valve open, and thus permit the hydraulic fluid to flow into the cylinder 55a. It will be seen that by properly adjusting the throttling valve 116 as by means of its control means 120 (FIGURE 6) a great plurality of speeds can be provided in permitting egress of the fluid from the piston head end of the cylinder back through the directional control valve and through the metering valve 116 to reservoir. Thus the tongs can be closed to grip a load (e.g., L—FIGURE 1) after which valve 114 may be closed, and then the crane or material handling means 10 may raise the tongs and gripped load and move them to the desired location. It will be noted that the pump 96 does not have to be operating during the closing operation of the tongs.

If the load strain during lifting of the load causes relative movement of the pivot points 40 vertically away from the pivot point 26 of the tongs, this of course will put an added pressure on the piston head end of the motor unit due to the transmission of the load strain to the motor unit 56 by the flexible members 56a, and will when sufficient pressure is built up, cause the pressure relief valve 106 to open, permitting exhaust of the pressurized fluid to reservoir. Exhaust of the fluid through relief valve 106 permits slight slackening of the hoist cables to prevent the undue strain thereof. Thus the pressure relief valve 106 protects the fluid system and the cylinder unit 56 and the tong mechanism against any overload condition whether the pump is operating or not. This protects the hoist mechanism against overload in case of failure of the electrical power serving the motor which drives the fluid pump. Such pressure relief valve 106 is preferably set to open with a pressure slightly greater than that necessary to produce a force sufficiently large to support the tong and tie beam weight. The pressure relief valve may be set to open for instance at 1500 psi with the pump 96 having an operating capacity of say for instance 1400 psi. Any overload in the system caused by a jam up of the tong mechanism of the lever travel of the pivot points 26 and 40 because of the load strain at lift, or that the grippers are caught in a slab pile or caught in the load, when the crane or material handling mechanism 10 attempts to move the tongs, is compensated for by the pressure relief valve 106 and the system is protected from excess pressure and distortion or breakage of the hoist mechanism. Thus overload protection is provided for the tongs throughout their range of operation.

The cable connection connecting the hoist motor unit 56 to the tongs provides a very flexible connection between the hoist unit and the tongs, and thereby allows the tongs to operate as efficiently as possible in grabbing a load even when the load is a pile of slabs and there is a size difference between individual slabs, or when the slabs are not parallel to the gripping shoes 48. Since the reciprocal motor unit is a single acting motor unit there is no pump pressure applied to the piston rod end of the cylinder and this eliminates the possibility of leakage through the rod end packing in the cylinder, providing a maintenance free arrangement.

As best shown in FIGURE 1, there is preferably provided a heat resistant shield 124 on the underside of the tie bar 42, for protecting the hoist unit from heat radiation from the load, such as hot slabs, and the self-contained fluid power system 90 may be provided with a removable cover member 126 for protecting the components of the system. The stringer 128 for arranging the cables 80 provides for the use of a short stroke motor unit 56 while still providing for adequate relative movement between the pivot points 26 and 40, for opening and closing of the tongs, and thus provides an extremely compact arrangement. While the motor unit has been shown in a horizontal position, it will be understood that it could be oriented in a vertical position to provide a lesser length tong mechanism. Moreover, while the tong mechanism has been illustrated with two pair of lengthwise spaced tongs mounted on the head and tie bar structure, a tong mechanism utilizing only one pair of tongs, or a tong mechanism utilizing more than two pair of tongs, could be readily provided while still utilizing the novel features of the invention.

From the foregoing discussion and the accompanying drawings it will be seen that the invention provides a novel tong construction having adjustable tong arms and with the tong arms being adapted to be opened by means of a hoist unit powered by a fluid powered motor unit, and with there being provided a fluid power system which includes pressure relief means for preventing overloading of the system. The invention also provides a tong mechanism and associated fluid power system for operating the tongs which includes valve means for expeditiously and precisely controlling the speed at which the tongs may be moved toward closed or gripping condition.

The terms and expressions which have been used are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of any of the features shown or described, or portions thereof, and it is recognized that various modifications are possible within the scope of the invention claimed.

What is claimed:

1. In an adjustable tongs comprising a support, tong arms movably mounted on said support for opening and closing movement, hoist mechanism including a single-acting reciprocating cylinder and piston motor mounted on said support and having a piston rod extending therefrom, pressure fluid power means having an operating connection with said cylinder at the piston end thereof for actuating said motor in tong-opening direction only, said hoist mechanism including an elongated flexible element connected between said support and said tongs means, operatively connected with said piston rod and said flexible element for tensioning the latter for causing said opening or a deflection of the lever travel of the tongs, the weight of said tongs effective upon said flexible element being applied to and operatively connected means for causing return movement of the piston of said motor toward the piston end thereof when said pressure fluid power means is inoperative, a fluid reservoir associated with said pressure fluid power means, a fluid flow line from the piston end of said cylin-
der to said reservoir for return of fluid to said reservoir during tong-closing movement of said piston, and pressure fluid relief means communicating with said pressure fluid power means in operative connection with said cylinder during tong-opening movement of said piston and communicating with said return fluid flow line during tong-closing movement of said piston, whereby excessive pressure of said pressure fluid is prevented at all times.

2. The combination of claim 1 wherein said pressure fluid power means includes a pump discharging to said cylinder and an electric motor driving said pump, whereby said pressure fluid relief means is effective in case of failure of electric power supply to said motor.

3. The combination of claim 1 including an adjustable throttling valve in said fluid flow return line from the piston end of said cylinder to said reservoir effective to control closing movement of said tongs.

4. In an adjustable tongs comprising a support, tong arms movably mounted on said support for opening and closing movement, hoist mechanism operatively coupled to said tong arms for causing at least said opening movement, said hoist mechanism including fluid powered means for actuating said hoist mechanism, said fluid powered means comprising a reciprocating single acting fluid powered motor unit including a piston rod projecting therefrom, said hoist mechanism comprising elongated flexible means coupled to said support and to said tong arms, means on said piston rod coacting with said flexible means to tension the latter and cause said opening movement upon actuation of said motor unit in one predetermined direction, means coacting with said motor unit for limiting the maximum stress applicable to said flexible means during tensioning thereof, and wherein said means on said piston rod comprises rotatable pulley means engaging said flexible means, said motor unit being oriented for reciprocal movement generally horizontally, said flexible means being coupled to said support above said motor unit and extending generally horizontally to pass around said pulley means.

5. In an adjustable tongs comprising a support, tong arms movably mounted on said support for opening and closing movement, hoist mechanism operatively coupled to said tong arms for causing at least said opening movement, said hoist mechanism including fluid powered means for actuating said hoist mechanism, said fluid powered means comprising a reciprocating single acting fluid powered motor unit including a piston rod projecting therefrom, said hoist mechanism comprising elongated flexible means coupled to said support and to said tong arms, means on said piston rod coacting with said flexible means to tension the latter and cause said opening movement upon actuation of said motor unit in one predetermined direction, means coacting with said motor unit for limiting the maximum stress applicable to said flexible means during tensioning thereof, and wherein said means on said piston rod comprises a shaft coupled to said rod and extending generally transverse thereof, a pulley rotatably mounted on said shaft and coacting with said flexible means, and guide means coacting with the ends of said shaft for guiding the movement of said piston rod during reciprocation thereof.

6. An adjustable tongs in accordance with claim 5 wherein said guide means comprises spaced generally vertical walls on opposite sides of said piston rod, slotted guideways in each of said walls extending generally parallel to the direction of movement of said piston rod, and guide members on said shaft and coacting with the guideway in the respective of said walls for guiding the movement of said piston rod during reciprocation thereof.

7. In a fluid power system adapted for use with a hoist mechanism of an adjustable tongs comprising, a source of pressurized operating fluid, a reciprocating fluid powered motor unit adapted for actuating the hoist mechanism, fluid transmission means coupling said source to said motor unit, means coacting with said transmission means for permitting flow of operating fluid only in a direction away from said source toward said motor unit and preventing return of operating fluid from said motor unit through said transmission means to said source, fluid pressure relief means coacting with said motor unit for limiting the maximum pressure in said transmission means, control means coacting with said motor unit for controlling the egress of fluid from said motor unit back to said source, and wherein said source includes a reservoir tank, a pump, and power means for driving said pump, said means coacting with said transmission means for permitting flow of operating fluid only in a direction away from said source comprising a check valve, said pump, check valve and pressure relief means being disposed in said reservoir tank to provide a leakage free system.

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