April 12, 1966 C. E. KILLEBREW 3,245,560

MATERIAL HANDLING MACHINE

Original Filed Dec. 18, 1961 2 Sheets-Sheet 1

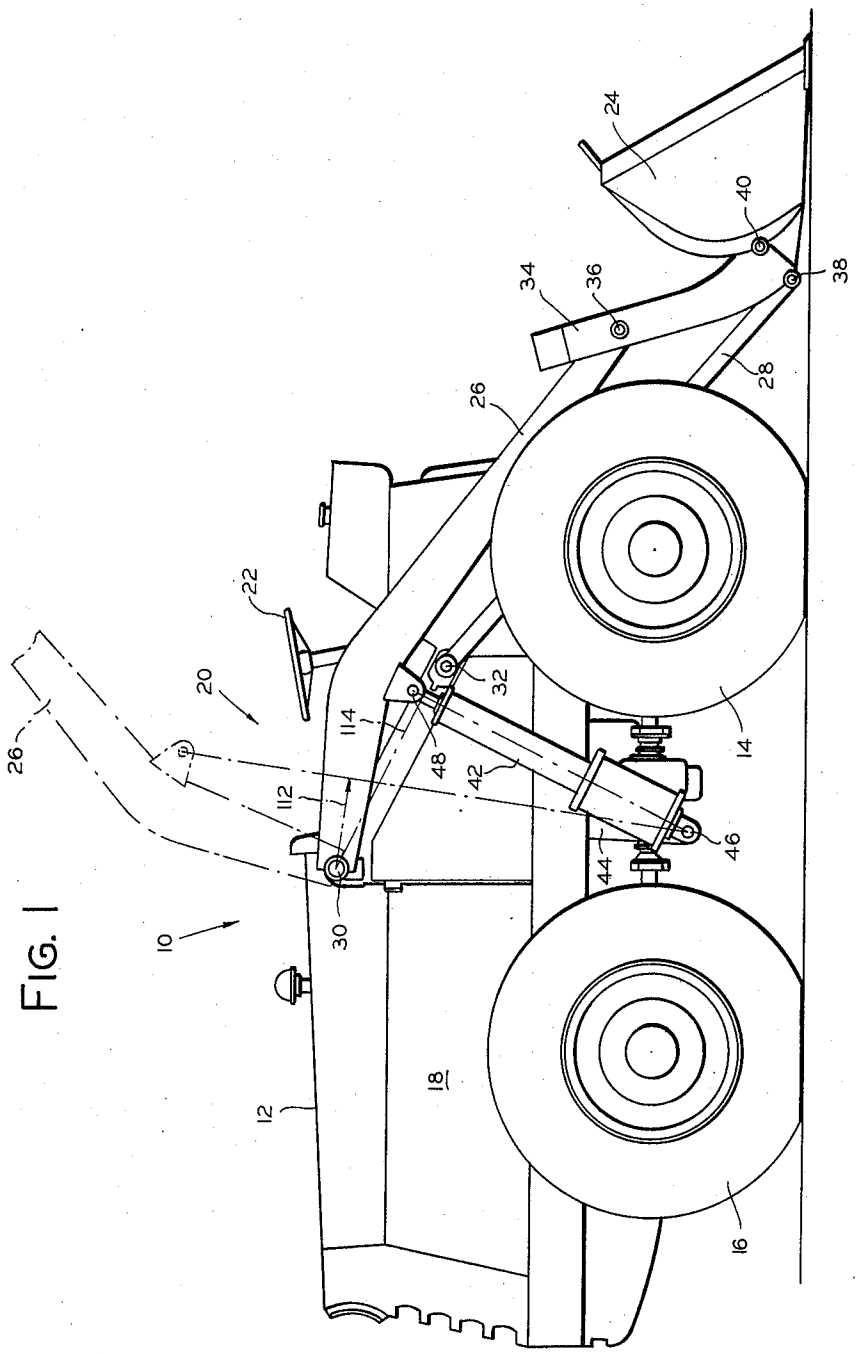


FIG. 1

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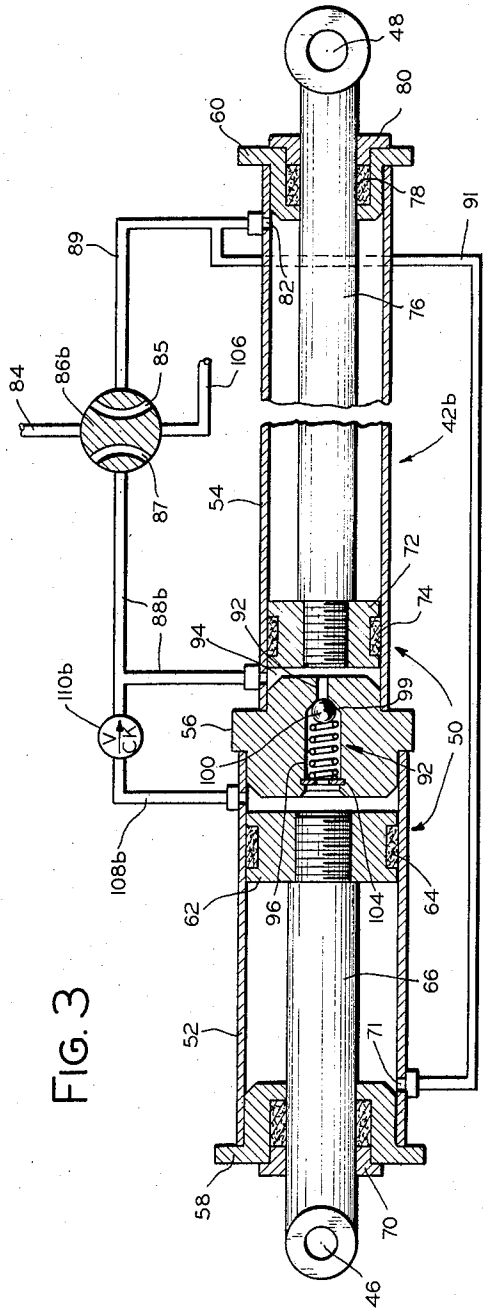


FIG. 3

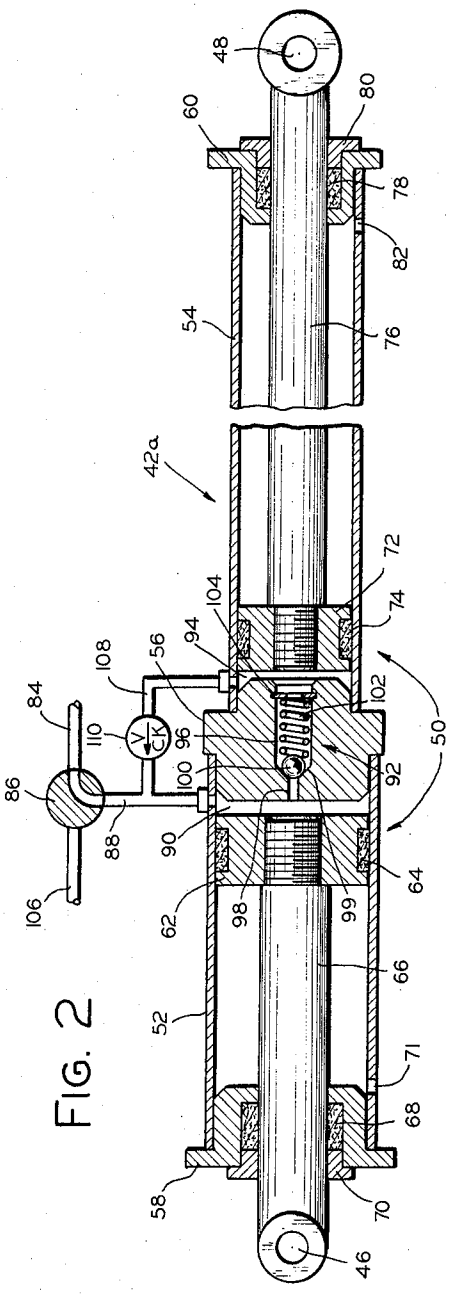


FIG. 2

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3,245,560

MATERIAL HANDLING MACHINE

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Original application Dec. 18, 1961, Ser. No. 160,129, now Patent No. 3,186,309, dated June 1, 1965. Divided and this application Oct. 22, 1964, Ser. No. 405,777

6 Claims. (Cl. 214—140)

This is a division of my copending application, Serial No. 160,129 filed December 18, 1961, now Patent No. 3,186,309, and assigned to the same assignee as this application.

This invention relates to tractor shovels, tractor loaders and other material handling machines having an outwardly projecting boom arm or arms on which a material engaging device is carried.

It is well-known to accomplish the excavating of earth, the loading of bulk materials, and the handling of other materials by means of tractor vehicles which include a material handling bucket or other material engaging device as a portion of the vehicle. Commonly such a bucket or other material engaging device is mounted at the front of the vehicle on boom arms which provide for the raising and lowering of the bucket or other device between a digging or loading position and a dumping or discharge position. Some of such vehicles are adapted to excavate dirt, sand, rocks and the like below ground level and then raise the material and dump it into a truck, hopper or other receptacle, while such excavating machines can also be used merely as loaders if desired for picking up bulk materials such as crushed stone, coal, grain, fertilizer and the like, at or near ground level and loading it into a truck, hopper, or other receptacle. Some such machines are less powerful and are adapted for use only as loaders and not as excavators, while still other machines are equipped with a fork device or other load engaging means instead of a bucket.

In the machines mentioned which are adapted for use as excavators, it is important that the mechanism carrying and controlling the bucket be arranged to tilt the bucket back at ground level in order to provide a break-out or pry-out action. Such an action is important in order to obtain a full bucket load of many kinds of hard-to-excavate materials, and various arrangements have been proposed heretofore to achieve such break-out action. One of the objects of the present invention is to provide an improved construction for increasing or augmenting the break-out action of a tractor shovel.

When a vehicle of the type previously mentioned is adapted for use merely as a loader, that is, for the picking up of bulk or other materials at ground level and raising them to a higher level for dumping or discharging—usually after transporting the material between the pickup point and a discharge location—another problem is presented with conventional loader vehicles. When the boom arms of such machines are raised sufficiently high, it is a characteristic of many such loader vehicles that the moment arm through which the actuators for the boom arms operate becomes so small that the machine is unable to raise to full height the maximum load which it can pick up at ground level, or else the raising speed is reduced significantly when a large load is being raised to the maximum height. It will be appreciated that the inability of such a machine to raise maximum loads to maximum height is a serious deficiency, while even the inability to raise such loads to the maximum height quickly is undesirable because it increases the time required for performing a specific operation thereby cutting down the amount of work which the machine can perform in a certain time and consequently increasing the cost of performing work with such machine. It is a further object of the present

invention to provide a structure which eliminates the mentioned disadvantages of some loader machines.

It is a still further object of this invention to carry out either of the aforementioned objects automatically without requiring any more than the usual amount of operations on the part of the vehicle operator.

In carrying out my invention in one form I provide a tractor shovel machine having outwardly projecting boom arms which carry at the forward end thereof a bucket which is adapted for excavating. The boom arms are adapted to be raised by hydraulic actuators connected between the body of the machine and the boom arms. Each of the hydraulic actuators comprises two elongated coaxially arranged piston and cylinder devices. The two cylinders are of different diameters and the two devices are connected together to form a composite actuator. Hydraulic connections are provided whereby the actuation of a single valve by the operator causes the larger diameter piston and cylinder device to extend first to provide a large break-out force following which the other device extends in sequence to provide for raising the boom arms after the break-out interval.

In another embodiment in a tractor loader machine the construction is similar except that the hydraulic connections are such that the smaller piston and cylinder device extends first after which the larger diameter piston and cylinder automatically extends in sequence, the latter action providing increased raising force near the top of the travel of the boom arms.

For a clearer and more complete understanding of my invention, reference should be had to the accompanying drawing in which:

FIGURE 1 is a side elevational view of a material handling machine embodying the present invention.

FIGURE 2 is an enlarged view in section of the composite actuator utilized in one preferred form of the invention, while

FIGURE 3 is an enlarged view in section of the composite actuator utilized in another preferred form of the invention.

Referring to FIG. 1 of the drawing, the numeral 10 indicates generally a tractor vehicle embodying the present invention. The vehicle 10 includes a body portion 12, a pair of front drive wheels 14, only one of which is visible in the drawing, and a pair of rear drive-steer wheels 16, only one of which is visible. The vehicle is propelled by a suitable prime mover (not shown) housed within the enclosure 18, and the vehicle has an operator's station at location 20 including a suitable operator's steering wheel 22.

The vehicle 10 carries a bucket 24 which is shown in FIG. 1 in a ground level loading position. The bucket 24 is carried by means of a pair of main boom arms 26. Only one boom arm is visible in the drawing but it will be readily appreciated that the bucket and the arms which carry it are symmetrical about a vertical plane through the longitudinal axis of the machine. The bucket carrying mechanism also includes a pair of stabilizing or guide arms 28, one on each side of the machine below the main boom arms.

Each main boom arm is pivotally connected to the body 12 of the vehicle at location 30, while each arm 28 is pivotally connected to the body of the vehicle at 32. The bucket 24 is carried by the boom and guide arms by means of a bucket carrier 34 which is pivotally connected at 36 to the forward ends of the main boom arms and at 38 to the forward ends of the guide arms. The bucket 24 is pivotally movable about axis 40 with respect to the bucket carrier by hydraulic actuating means within carrier 34, not shown on this drawing, whereby the bucket may be pivoted rearwardly from the position shown to an upwardly disposed carrying position.

The bucket is raised and lowered by raising and lowering the main boom arms through the medium of hydraulic actuators 42. Only one of these is visible but it will be appreciated that there is preferably an actuator 42 on each side of the machine in a symmetrical arrangement. The actuator 42 is pivotally connected at location 46 to a bracket 44 which projects downwardly from the body of the vehicle. At the top the actuator 42 is pivotally connected at 48 to boom arm 26.

FIG. 2 shows the internal details of actuator 42 (indicated by the character 42*a* in FIG. 2) arranged to lift bucket 24 first with a large force at relatively low speed followed sequentially by a smaller force at a higher speed. The bucket 24 is shown in FIG. 1 at ground level, which ordinarily would be the loading position for loading stockpiled material or the like. It will be appreciated that the bucket 24 can be lowered below ground level when it is to be used for excavating earth. However, the actuator arrangement of FIG. 2 is useful for loading operations as well as excavating operations when the material being loaded is sufficiently packed or otherwise is of such character that it is difficult to lift the bucket through such material after the vehicle 10 has been moved forwardly into the material in order to fill the bucket 24. As explained previously the bucket 24 may be pivoted counterclockwise as shown in FIG. 1 about pivot point 40 and this provides considerable break-out action. However, in some circumstances with certain materials such break-out action alone is not sufficient and in these circumstances the embodiment of the invention illustrated in FIG. 2 is very beneficial.

As shown in FIG. 2 the actuator 42*a* comprises a two-part cylinder portion which is indicated generally by the numeral 50. At the left as seen in FIG. 2 the cylinder portion 50 includes a larger diameter cylinder 52, and at the right there is provided a smaller diameter cylinder 54. The two cylinder portions 52 and 54 are joined by a solid portion 56 which provides a barrier between the two cylinders and also supports the inner ends thereof to form a single unitary structure. The left end of cylinder 52 is provided with a closure member 58 while the right end of cylinder 54 is provided with a closure member 60.

A first relatively large diameter piston having a working fit inside cylinder 52 is positioned in cylinder 52 for reciprocation back and forth in this cylinder. The piston 62 is provided with packing material 64 to seal against fluid leakage past the piston. The piston 62 is mounted on and operates a piston rod 66 which extends through an opening in closure member 58; packing material 68 and a cap 70 are provided at the left to seal this end of the cylinder, while an opening 71 is provided in the wall of cylinder 52 to drain off any leakage fluid which may collect inside cylinder 52.

A smaller diameter piston 72 having packing material 74 is positioned in cylinder 54 for reciprocation therein. Piston 72 is carried by a piston rod 76 which extends through an opening in closure member 60, and packing material 78 and a cap 80 are provided to seal the outer end of cylinder 54 against dirt. A vent 82 is provided to allow the escape of any fluid which gets by piston 72.

In order to extend actuator 42*a* hydraulic fluid under pressure is admitted from a conduit 84 through valve 86. Conduit 84 preferably receives pressurized hydraulic fluid from a pump operated by the engine of the vehicle in known manner, while valve 86 preferably is operated by the operator of the vehicle from his operator's station thereon also in a known manner. When valve 86 is turned to the position illustrated in FIG. 2, pressurized fluid is admitted from conduit 84 to conduit 88 from which it enters chamber 90 between piston 62 and barrier member 56. The admission of pressurized fluid to chamber 90 forces piston 62 and piston rod 66 to the left relative to cylinder 52, however, the left or lower end of piston rod 66 is anchored at location 46 as shown in FIG. 1, therefore, the effect of such operation is to extend the cylinder 52 and the complete cylinder structure 50 along with piston 72 and rod 76 to the right, that is, upwardly in FIG. 1. Such extension continues if valve 86 remains open and the admission of pressurized fluid continues until piston 62 strikes closure member 58, and such operation partially raises bucket 24 relatively slowly but with a large ultimate force because of the large piston area on which the pressurized fluid acts.

A ball type relief valve indicated generally by the numeral 92 is located between chamber 90 and another chamber 94 between barrier 56 and piston 72. The relief valve structure includes a larger bore 96 entering member 56 from the right, and a smaller bore 98 connecting chamber 90 with the larger bore 96 and forming a tapered seat 99 therebetween upon which a ball 100 is seated. The ball 100 normally is held in place on the seat by means of a spring 102 which is secured in bore 96 in a suitable manner such as by snap ring 104. The spring 102 is selected so that it holds the ball 100 in engagement with seat 99 and thus prevents the passage of fluid from chamber 90 to chamber 94 as long as piston 62 is moving. However, when piston 62 strikes closure member 58 and cannot move farther, the resulting rise in pressure in chamber 90 causes spring 102 to be compressed and fluid to be passed around ball 100 into chamber 94 where it causes piston 72 to move to the right and extend piston rod 76 out the right end of the actuator. As long as the pressurized fluid is continued to be admitted from conduit 84 through valve 86, conduit 88 and chamber 90 and thence through the relief valve the piston 72 continues to move until it strikes closure member 60 which is the limit of operation of the actuator. At this time the boom arms 26 will have moved to the position indicated by the dot-dash lines in FIG. 1 and the bucket 24 will have been elevated to its maximum position. It will be appreciated that the latter increment of motion resulting from the action of piston 72 will be at a faster rate but at a lower force than the initial increment produced by the movement of piston 62 inasmuch as piston 72 is smaller in diameter and the same unit pressure of the pressurized hydraulic fluid thereby produces a smaller ultimate force. It will be appreciated too that the check valve 110 prevents the entry of any hydraulic fluid directly from conduit 88 to chamber 94.

When it is desired to return boom arm 26 to its initial position the operator merely turns valve 86 clockwise 90° to interconnect conduit 88 with a conduit 106 which leads to the sump or reservoir for the hydraulic fluid. The hydraulic fluid then drains from chamber 94 through conduit 108 and check valve 110 to conduit 88, and at the same time drains from chamber 90 directly into conduit 88, and all the liquid drains from conduit 88 to drain conduit 106. Such draining of the chambers occurs by gravity and by the gravitational force exerted by the bucket and boom arms on the actuator. It will be recognized by those familiar with hydraulic devices that actuator 42*a* as illustrated in FIG. 2 is a single-acting device, that is, it is extended by force resulting from the pressurized hydraulic fluid, but it is retracted by gravity.

FIG. 3 shows an actuator which is indicated by the numeral 42*b* to distinguish it from the actuator of FIG. 2. Many parts of actuator 42*b* are the same as actuator 42*a*, and such parts are indicated by the same numerals in FIG. 3 as the same parts in FIG. 2. Certain of the hydraulic circuit elements are different or function differently than the corresponding elements in FIG. 2 and these elements have been indicated either by the same number followed by a letter or by a different number. The actuator of FIG. 3 is arranged so that the hydraulic actuator is double-acting. In addition, it is arranged so that the small piston 72 operates first followed sequentially by the large piston 62, and for this purpose the relief valve 92 is reversed.

A description of the operation of the embodiment of FIG. 3 should suffice for an understanding of the manner

in which this actuator differs from that of FIG. 2. In FIG. 3 pressurized fluid is arranged to be admitted from conduit **84** by valve **86***b* to either a conduit **88***b* corresponding to line **88** of FIG. 2 or selectively to another inlet conduit **89**, depending upon which way valve **86***b* is turned from the position illustrated. If it is turned clockwise approximately 45° then passage **87** in the valve interconnects conduits **84** and **88***b*, while if it is turned counterclockwise approximately 45° then passage **85** interconnects conduit **84** and conduit **89**. Assume first that it is turned clockwise so that conduit **84** is interconnected with conduit **88***b*. In this position pressurized fluid is admitted through conduit **88***b* to chamber **94** to extend the small piston **72** and its rod **76** until piston **72** abuts against closure member **60**. Then the pressurized fluid goes through the relief valve **92** in the same manner described previously for the other embodiment into chamber **90** where it is effective to extend the large piston **62**. Check valve **110***b* in this embodiment prevents pressurized fluid from entering chamber **90** directly from the source. This arrangement produces a sequential operation in which the smaller force occurs first followed by the larger forces as the boom arms approach the top position indicated by the dot-dash lines in FIG. 1. As the boom arms are approaching this position the moment arm through which the actuator is acting is getting smaller until when the upper position is reached the moment arm is indicated by the numeral **112** whereas the moment arm initially is indicated at **114**, being approximately the distance between pivot points **30** and **48**. It will be appreciated that the total load which the machine can lift is determined by the product of the moment arm and the applied force, thus the machine's lifting ability becomes less as the boom arm is raised sufficiently to cause the moment arm to become less. However, by employing the actuator of FIG. 3 it is possible to increase the force near the end of the lifting operation to counteract the reduction in the moment arm and thus increase the maximum lifting ability of the machine without changing any of the other essential parts.

The actuator of FIG. 3 as mentioned previously is double-acting. When it is desired to retract the actuator again the valve **86***b* is turned so that conduit **88***b* is connected by passage **87** in the valve to drain conduit **106** in order to drain the fluid from chamber **94** and also from chamber **90** through check valve **110***b*. At the same time passage **85** of the valve connects conduit **89** with the source of pressurized fluid, conduit **84**. This admits pressurized fluid through opening **82** into the right end of the smaller cylinder, and at the same time admits fluid through an additional conduit **91** to the left end of the larger cylinder through opening **71**. Thus the pressurized fluid is utilized to retract the pistons in the same manner as it was utilized to extend them originally.

With reference to the relief valve **92** in the actuator, it should be understood that the present invention is not limited to the ball type valve described and illustrated herein. Other valves which open only upon the occurrence of a predetermined pressure can be used in place of the relief valve disclosed if desired. Valve **92** as disclosed also acts as a check valve for the direction opposit to the direction of fluid flow through the valve. If it is desired to utilize a valve which acts as a relief valve in one direction but does not act as a check valve in the other direction, such valve may be employed satisfactorily.

While the invention has been described and illustrated herein in conjunction with two different actuators, it should be understood that it is intended to cover by the appended claims all modifications falling within the true spirit and scope of the present invention.

I claim:

1. In a material handling machine having a body portion, the combination of an outwardly projecting boom arm which is pivotally connected to the body portion and carries a material engaging device, a hydraulic actuator connected to the said boom arm for raising the said boom arm, the said actuator including two elongated piston and cylinder devices connected together coaxially to form a composite actuator, and means for extending the said piston and cylinder devices sequentially.

2. The combination as set forth in claim **1** wherein the said two piston and cylinder devices have different lifting capacities.

3. The combination as set forth in claim **1** wherein the sequential extending means includes only a single connection to a source of pressurized hydraulic fluid.

4. The combination as set forth in claim **1** wherein the said piston and cylinder devices are in back-to-back relation with the two cylinders connected to each other and two piston rods are connected respectively to the two pistons of the said piston and cylinder devices and arranged to operate in and out the opposite ends of the said composite actuator.

5. In a material handling machine having a body portion, the combination of an outwardly projecting boom arm which is pivotally connected to the body portion, a material engaging device connected to the boom arm, and a hydraulic actuator for raising the boom arm comprising a two-part cylinder structure having a smaller cylinder interconnected by an intervening support and barrier portion to a larger cylinder, and said barrier having an opening therein, relief valve means located in the said opening permitting the flow of fluid between the cylinders in one direction only upon the occurrence of a predetermined pressure, a smaller piston arranged for reciprocation in the said smaller cylinder and a piston rod connected thereto, a larger piston arranged for reciprocation in the said larger cylinder and a second piston rod connected thereto, means for admitting pressurized fluid to one of the said cylinders between the said barrier and the piston therein for moving the piston in said one cylinder away from the barrier, the said relief valve being arranged to admit fluid therethrough to the other cylinder to move the other piston after the said first piston has completed its stroke.

6. In a material handling machine having an outwardly projecting boom arm on which is carried a material engaging device, and an hydraulic actuator for raising the boom arm comprising a two-part cylinder structure having a smaller cylinder interconnected by an intervening support and barrier portion to a larger cylinder, the said barrier having an opening therein, relief valve means located in said opening permitting the flow of fluid between the cylinders in one direction only upon the occurrence of a predetermined pressure, a smaller piston arranged for reciprocation in the said smaller cylinder and a piston rod connected thereto, a larger piston arranged for reciprocation in the said larger cylinder and a second piston rod connected thereto, means for admitting pressurized fluid to one of the said cylinders between the said barrier and the piston therein for moving the piston in said one cylinder away from the barrier, and the said relief valve being arranged to admit fluid therethrough to the other cylinder to move the other piston after the said first piston has completed its stroke.

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