Feb. 22, 1966 H. M. KENNEDY 3,236,391

COUNTERWEIGHT SYSTEM FOR TRACTORS HAVING SIDE-MOUNTED ATTACHMENTS

Filed Feb. 24, 1964 5 Sheets-Sheet 1

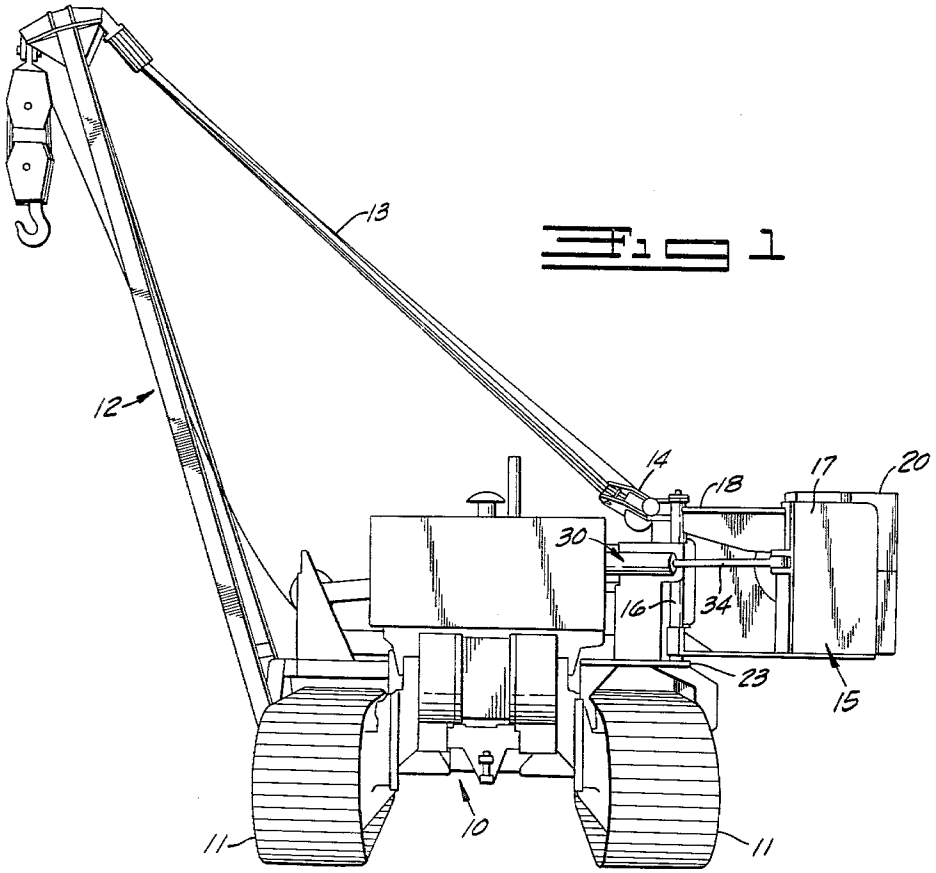

Fig 1

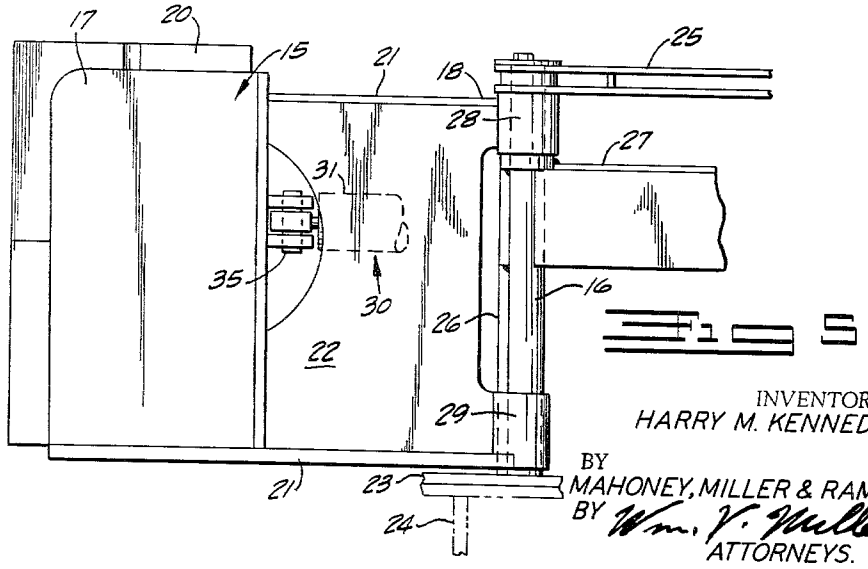

Fig 5

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COUNTERWEIGHT SYSTEM FOR TRACTORS HAVING SIDE-MOUNTED ATTACHMENTS

Filed Feb. 24, 1964 5 Sheets-Sheet 2

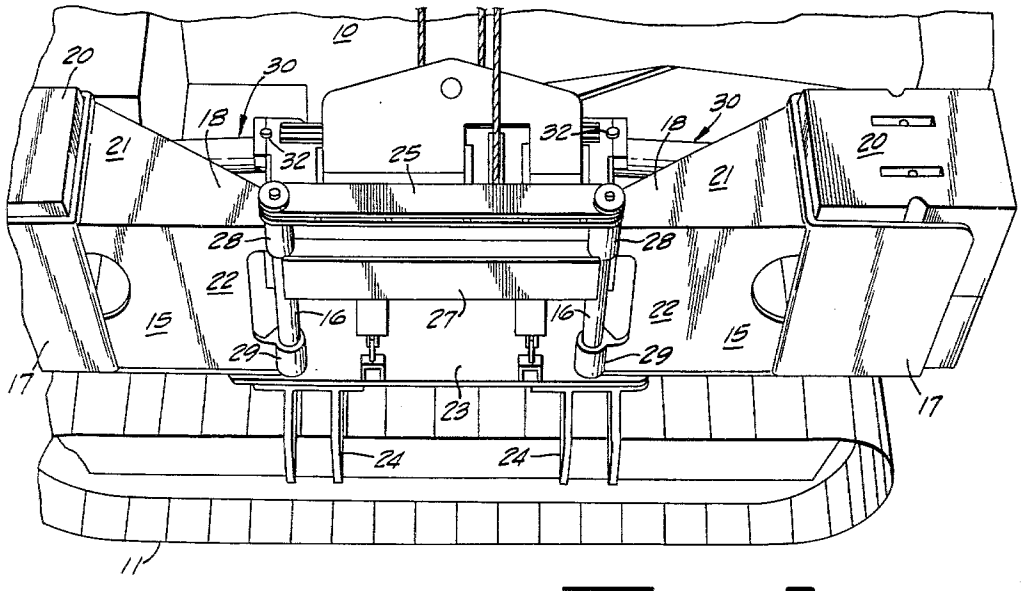

FIG 2

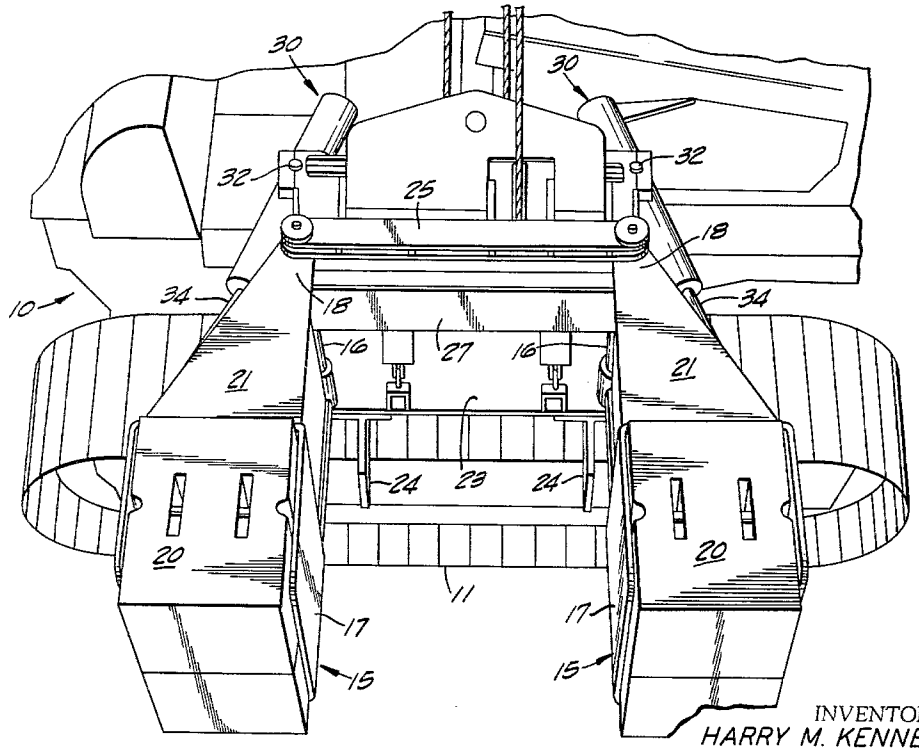

FIG 3

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COUNTERWEIGHT SYSTEM FOR TRACTORS HAVING SIDE-MOUNTED ATTACHMENTS

Filed Feb. 24, 1964 5 Sheets-Sheet 3

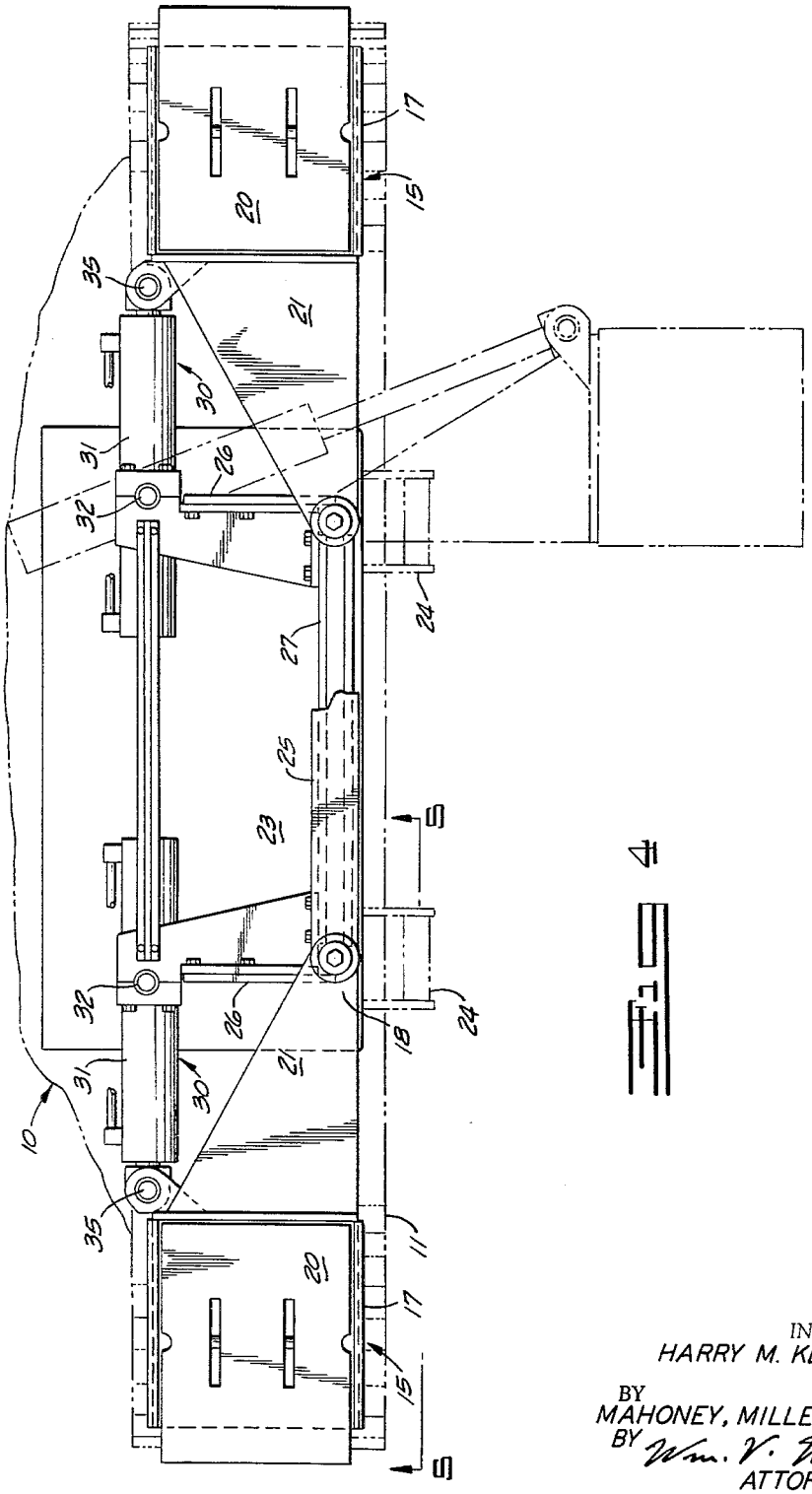

FIG. 4

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COUNTERWEIGHT SYSTEM FOR TRACTORS HAVING SIDE-MOUNTED ATTACHMENTS

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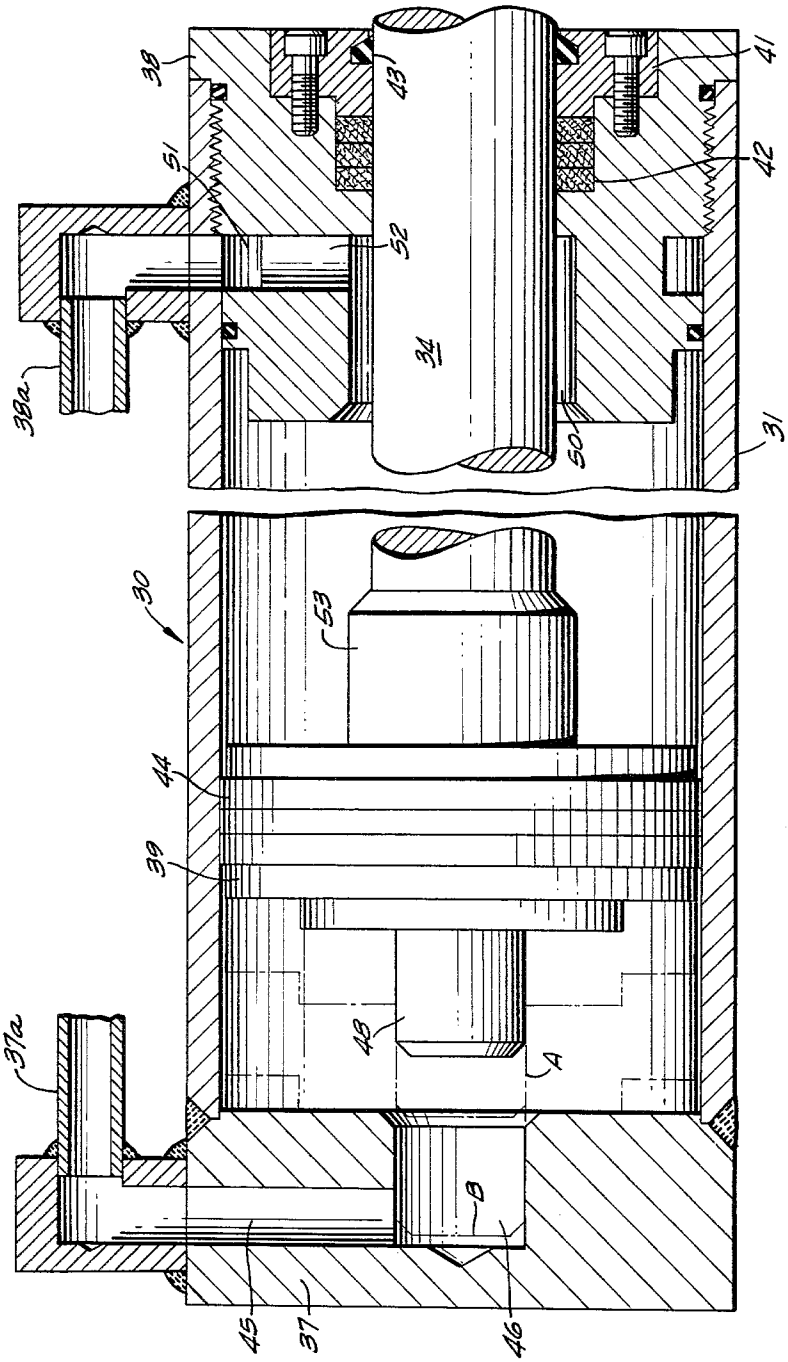

FIG. 5

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COUNTERWEIGHT SYSTEM FOR TRACTORS HAVING SIDE-MOUNTED ATTACHMENTS

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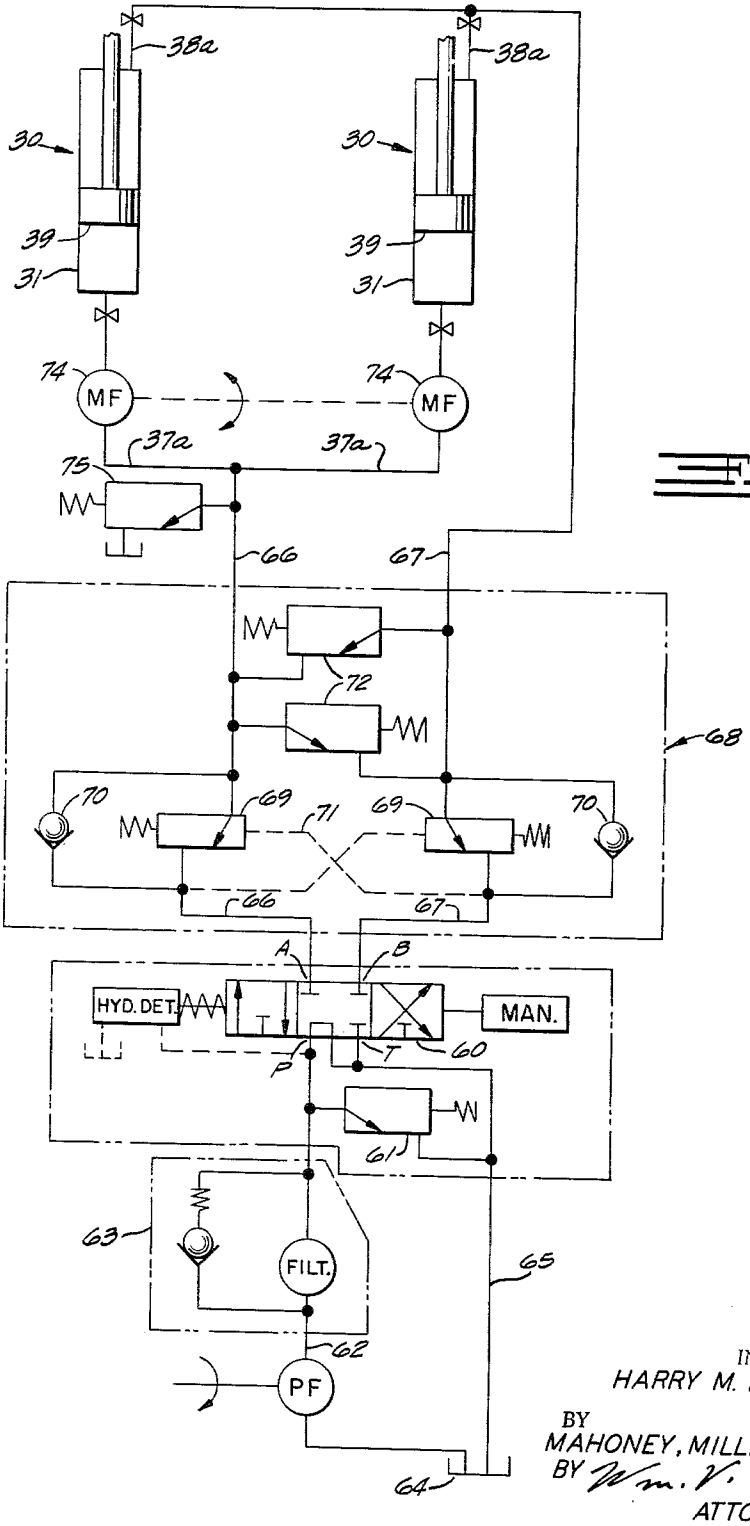

FIG. 7

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3,236,391

COUNTERWEIGHT SYSTEM FOR TRACTORS HAVING SIDE-MOUNTED ATTACHMENTS

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Filed Feb. 24, 1964, Ser. No. 346,963
1 Claim. (Cl. 212—8)

This invention relates to a counterweight system for tractors having side-mounted attachments. The counterweight system of this invention will be described specifically with relation to a tractor of the crawler type having a side-mounted boom attachment but it is to be understood that it is applicable to tractors having other side-mounted attachments which need to be counterbalanced during operation.

According to this invention, the counterweight system is applied to the basic carrying tractor without any substantial alteration of the tractor. The system is applied to the tractor in a most efficient manner to obtain maximum counterweight efficiency so that maximum lift efficiency can be obtained with the side boom. The application to the tractor is also such that maximum retraction of the counterweights within the overall extent of a standard tractor is accomplished even though maximum extension can be obtained when desired to effectively counterbalance the lift at the side boom. These results are further obtained with low weight profile and high clearance and by utilizing a simple construction. Furthermore, movement of the weights between their various positions and synchronization of the movements is accomplished in a novel and efficient manner.

More specifically, the counterweights of this system are mounted at the side of the tractor opposite to the side where the side-boom is mounted. Counterweight racks are hinged in a vertical horizontal plane within the respective side confines of the basic tractor and can be rotated 90° in a horizontal plane about respective vertical pivots or hinge axes spaced longitudinally in that plane. The racks are preferably provided in a pair so that in retracted position of the racks the counterweights are in opposed longitudinally spaced relationship where they are completely within the side and ends of the tractor and are disposed directly over the crawler track thereof in parallel relationship to the longitudinal center line of the the weights carried thereby are revolved about the pivot tractor. When the side boom is to be operated, the racks and the weights carried thereby are revolved about the pivot axes simultaneously to the same extent to fully extended position, each in that extended position being in a plane at a right angle to the pivot axes plane and the said center line of the tractor. In this latter position, the counterweights give maximum counterbalancing effect to any loading applied to the opposed boom side of the tractor.

The counterweights used on the racks are preferably uniform blocks of heavy material which can be placed in selected numbers on the racks and locked securely thereon. The racks are so designed and so mounted, as indicated above, as to give the most efficient counterbalancing effect when extended and maximum tractor mobility when retracted. The motivating force for extending and retracting the counterweight racks and the weights carried thereby in the manner indicated above is a novel system of hydraulic rams and associated hydraulic controls.

In the accompanying drawings, a counterweight system embodying this invention is shown, for example, applied to a crawler-type tractor which has a side-boom attachment.

In these drawings:

FIGURE 1 is a front perspective view of the tractor showing the counterweights in extended positions at one side for balancing the side-boom attachment at the other side.

FIGURE 2 is a top and side fragmentary perspective view showing the side of the tractor which carries the counterweights, the weights being shown in retracted positions.

FIGURE 3 is a view similar to FIGURE 2 but showing the weights in extended or balancing positions.

FIGURE 4 is a fragmentary plan view showing the weight side of the tractor, the weights being shown in full line retracted positions, and indicating by broken lines the extension of one of the weights.

FIGURE 5 is a side elevational view taken along the position indicated at line 5—5 of FIGURE 4.

FIGURE 6 is an enlarged axial sectional view through one of the weight-positioning rams.

FIGURE 7 is a schematic diagram of the hydraulic system used for moving the weights between their retracted and extended positions.

With reference to the drawings, and especially to FIGURE 1, this invention is shown applied to a tractor which is illustrated as being of the crawler type. The tractor shown comprises a main frame or chassis **10** which is carried by the crawlers **11** at its opposite sides. The basic tractor chassis carried by the crawlers and the crawlers are of the usual construction. In the example shown at one side of the tractor attached to one of the crawlers is a side boom attachment **12**. This attachment is useful for various jobs such as laying pipe in a ditch alongside which the tractor moves. This attachment, for example, may be of the type disclosed in Patent No. 3,092,370 which issued June 4, 1963. It includes a cable reeving boom control system **13** which extends from the outer and upper end of the boom of the attachment to the opposite side of the tractor to a yoke **14** which is mounted at that side of the tractor above the associated crawler **11**. The specific structure of the side boom attachment is not important to this invention and, therefore, will not be described in further detail. In fact, other attachments which need to be counterbalanced may be used at that side and be counterbalanced by the weight system of this invention disposed at the opposite side.

The counterweight system of this invention is disposed at the side opposite the attachment and is shown as comprising a pair of counterweight-receiving racks **15**. These racks are mounted for swinging movement in a horizontal plane about the respective vertical pivots or hinge pins **16**. The pair of pivots **16** is disposed in a single vertical plane extending longitudinally of the tractor at one side thereof and located over the associated crawler **11** at the outer edge thereof (FIGURES 1 and 2) so as to obtain maximum counterbalancing effect. This plane is parallel to the center line of the tractor chassis and, as indicated, is outboard as far as possible without having the pivots located beyond the outer edges of the crawler or the width of the tractor. The pivots **16** are disposed in longitudinally spaced relationship.

Each rack **15** is formed to include an outer socket end **17** and an inner mounting end **18**. The socket end has a bottom but opens upwardly and outwardly to readily receive counterweights **20** of rectangular or square cross-section complemental to the horizontal cross-section of the socket. The weights are preferably designed so that they may be disposed in stacked position in any suitable number in the respective sockets. Each rack mounting end **18** comprises upper and lower flat triangular plates **21** and a vertical upright connecting plate **22** which is at the side that will be outermost when the weight racks are retracted and is substantially flush with the corre-

sponding side of the socket end. The plates **21** and **22** are all rigidly welded together and will provide inwardly opening sockets, when the racks are retracted, for receiving portions of actuating rams as will later appear.

The pivot or hinge pins **16** are non-rotatably supported by the tractor frame in upright position as indicated in FIGURES 2 to 5. They are rigidly secured at their lower ends to a horizontal shelf or plate **23** of the tractor frame which is directly above the crawler **11** at that side of the tractor, being located at the outer edge of that shelf and spaced longitudinally thereon. The shelf **23** is suitably rigidly braced by brackets **24** from the crawler itself. The upper ends of the pins **16** are braced longitudinally by multiple longitudinal brace bars **25** which are connected thereto. Lateral bracing of the pins is provided by the rigid brackets or standard **26** (FIGURE 4) which extend laterally of the shelf **23** are rigidly secured thereto in upstanding relationship. Connected rigidly between the standards **26** is the longitudinally extending bracing beam **27**, located adjacent the upper ends of the pins **16**, but spaced below the bars **25**, the brace being rigidly secured to the pins. Between the bars **25** and the brace **27**, the pins **16** receive bearing sleeves **28** on the inner end portions **18** of the racks **15** which are free to rotate on the pins. Additional sleeves **29** are provided at the lower side of the inner end **18** of each rack **15** which are rotatably mounted on the pins. Thus, each rack **15** is pivoted to its respective pin **16** at upper and lower positions for swinging movement about the axis thereof in a horizontal plane.

The racks **15** are swingable about the pivots **16** from a retracted position, shown in FIGURES 1, 2, and 4, to an extended position as shown in FIGURES 1 and 3. In retracted position, the racks **15** and the counterweights which they carry are completely within the overall extent of the tractor both at the corresponding side and its front and rear ends. In extended position, the racks **15** position the counterweights outwardly from the side of the tractor to a maximum extent.

The movement of the racks **15** is controlled by a pair of hydraulic rams **30**. The cylinder **31** of each ram is pivotally carried by the tractor frame for swinging in a horizontal plane about a vertical pivot **32**. The pivot **32** is carried by a bracket which is a rigid extension of the standard **26**.

The piston rod **34** of the ram at its outer end is pivotally connected at **35** to the associated rack **15** at the inner corner thereof, as indicated best in FIGURE 4. When the racks are retracted, the rams **30** are opposed and in axial alignment. At this time, the racks **15** are in opposed alignment longitudinally over the crawler **11**. When the rams **30** are actuated, they are actuated to move the two racks **15** to the same extent. The racks swing outwardly about the pivots **16**, forwardly and rearwardly toward each other, until they are in parallel relationship, as indicated best in FIGURE 3, at right angles to the longitudinal center line of the tractor.

Each of the actuator rams **30** is preferably of the construction shown in FIGURE 6 in order to obtain efficient, simultaneous, and uniform movement of both counterweight racks **15** when the two rams are actuated. Each ram **30** is a double-acting single end rod type cylinder and piston unit. The cylinder **31** of each actuator ram is closed at one end by a head end cap **37** having a passageway formed therein communicating with the interior of the cylinder for the hydraulic fluid and connectable exteriorly with the hydraulic system by the conduit **37***a* which will include a flexible section. The opposite end of the cylinder **31** is closed by a stuffing box **38** which is threaded into the cylinder and forms a fluid-tight seal therewith. Positioned within the cylinder **31** for relative reciprocable movement is a piston **39**. The piston rod **34** is connected to the piston **39** and extends through the stuffing box **38** for connection to the counterweight racks as indicated above. The cylinder **31** is pivotally mounted, as previously described, on the structural framework carried by the tractor. A packing gland **41** is bolted to the stuffing box **38** to form a fluid-tight seal therebetween by means of the packing material **42** disposed in the recess of the stuffing box surrounding the piston rod **34**. A rod wiper seal **43** is also carried by the packing gland **41** for exclusion of foreign material from the cylinder. Carried by the piston **31** is the usual seal and ring assembly **44** which forms a fluid-tight seal between the piston and cylinder wall. Also formed in the stuffing box **38** is a fluid passageway communicating with the interior of the cylinder and connectable exteriorly thereof to the hydraulic system by a line **38***a* which will include a flexible portion.

In accordance with this invention, a novel construction is employed in the fabrication of the actuators to provide an automatic retardation or cushioning of the piston movement when either extending or retracting the counterweights. This construction prevents the imposing of extreme shock loads on the apparatus resulting from suddenly stopping of the counterweight racks **15** in either of the extreme positions. The kinetic energy attained by the counterweights during their movement is dissipated through an orifice of suitable dimensions at the terminal end of each stroke. The orifice, according to this invention, is incorporated with the respective passageway and is variable in effect depending on the position of the piston **39** relative to the ends of the cylinder **31**.

The passageway **45** in the head end cap **37** includes a cylindrical socket **46** which is coaxial with the cylinder **31**. Projecting axially from the piston **39** toward the head end cap **37** is a plunger **48** of cylindrical form and adapted to interfit with the socket **46**. The diameters of the socket **46** and the plunger **48** are relatively proportioned to permit the plunger to readily slide into the socket when the piston **39** approaches the end cap **37** at the terminal end of the stroke. With the piston **39** displaced from the end cap **37**, as shown in full lines, but moving toward the end cap **37**, as in a counterweight retracting cycle, the hydraulic fluid within the cylinder **31** will be displaced through the passageway **45** which is readily entered through the socket **46** which is a relatively large orifice. As the piston **39** approaches the end cap **37**, the plunger **48** will begin to enter the socket **46** and block, at least partially, the flow of fluid by restricting the size of the orifice. The position of the piston for this is illustrated in broken lines at A in FIG. 6. Preferably, the end portions of both the socket **46** and plunger **48** are chamfered as shown to reduce the turbulence and prevent a sharp cut-off or reduction in fluid flow at the instant the plunger begins to enter the socket. Reduction of the cross-sectional area of the orifice in this manner increases the force opposing the movement of the piston **39** and is effective to retard the movement of the piston and associated counterweight which it controls. A further reduction in cross-sectional area of the orifice occurs as the plunger **48** more fully enters the socket **46** where the cylindrical walls of the plunger will be opposed to the adjacent cylindrical wall of the socket. This results in further retardation of the piston **39** until the end face of the piston will have contacted the opposed end face of the cap **37** as illustrated by the broken line position at B in FIGURE 6.

This automatic reduction of the cross-sectional area through which the fluid may exit the cylinder is particularly effective in retarding the movement of the piston **39** and counterweight rack it controls and thereby prevents imposing high shock stresses on the apparatus as the piston reaches the terminal end of the stroke in the retraction stroke of the ram.

Since the actuator **30** is double-acting, the opposite end is similarly constructed. The socket **50** or orifice in this instance is an annular recess formed in the stuffing box **38** adjacent the piston rod **34**. This recess is approxi-

mately of the same cross-sectional area as the socket **46** to permit a similar fluid outflow. An annular collector ring **51** formed in the cylindrical wall of the stuffing box is connected to the socket **50** by a passageway **52**. The conduit **38***a* of the hydraulic system is connected to the cylinder **31** for communication with the socket **50** through the ring **51** and the passageway **52**. The collector ring **51** facilitates assembly of the actuator as the stuffing box **38** is threaded into the end of the cylinder **31** and this eliminates the difficulties of accurate alignment. The plunger **53** in this instance is an enlarged diameter section of the piston rod **34** adjacent the piston **39**. This plunger **53** is adapted to enter the recess or socket **50** and function as previously described to reduce the cross-sectional area of the socket or orifice through which the fluid may flow. Thus, retardation also occurs at the end of the extension stroke of the ram.

The hydraulic circuit for controlling operation of the two actuator rams **30** is illustrated in FIGURE 7 and may be described as follows:

The control valve **60** is a four-way, three-position, spool-type having a hydraulic detent and is manually operated. Incorporated in the construction of the control valve is a relief valve **61** that is connected to the pressure port P for protection of the system. A fixed displacement fluid pump PF is connected to the pressure port P by a conduit **62**. Interposed in the conduit **62** is a filter unit **63** for the system fluid which is preferably of the type including a spring-loaded check valve bypass for protection of the filter element as to excessive pressure. A tank or reservoir **64** is connected to the inlet port of the pump. The relief valve **61** is also connected to the reservoir **64** for return of the fluid to the system. The hydraulic detent feature of the control valve is of well known construction and functions to maintain the spool of the valve **60** in either of the two operating positions and, in this application, automatically returns the spool to the center or neutral position when the pistons **39** in the counterweight actuator rams **30** reach the extreme position (either retracted or extended). When the pistons **39** reach the extreme position, fluid flow ceases and the pump will build up pressure in the conduit **62**. A pressure relief valve built into the hydraulic detent is set to operate at a predetermined pressure and hydraulically effect a release of the detent. After release of the detent, a spring will return the valve spool to the center position. The predetermined operating pressure of the hydraulic detent would be less than that of the system relief valve **61**.

When the spool of the valve **60** is in the center position, the pressure port P is connected to the reservoir **64** by a conduit **65**, thereby eliminating any load on the pump and preventing power loss when the valve is centered. At this time, the tank port T and the discharge ports A and B of the valve **60** are blocked. Movement of the valve spool to either of the operating positions interrupts the pressure port P connection to the reservoir **64** and simultaneously connects the pressure port P to the respective discharge port, A or B. The tank port T would be connected to the opposite port, B or A, as the case may be.

The discharge ports A and B are connected by the respective conduits **66** and **67** to the extending and retracting sections of a counterbalance valve **68**. Each section of the counterbalance valve comprises the same elements which operate to provide cushioning for stopping the movement of the counterweight racks **15** when the pistons **39** of the actuators **30** are at a midstroke position and to restrict or retard movement of the counterweight racks in relation to the capacity of the pump PF. The effect of gravity and momentum are minimized by the latter function.

Each section of the valve **68** includes a remotely operated valve **69** which normally prevents fluid flow through the conduit **66** or **67** it controls and a check valve type bypasses **70** connected around this valve. The check valve **70** is connected to permit free flow from the respective discharge port, A or B, of the control valve **60** through the check valve. The pilot conduit **71** of each remote valve **69** is connected to the conduit, **66** or **67**, of the opposite section of the counterbalance valve **68** at the side of the remote valve connected to the control valve **60**. The remote valves **69** are spring biased and are set to open when the fluid pressure in the pilot conduit **71** reaches a predetermined value. The connections of the remote valves **69** and the check valves **70** provide the necessary control over the movement of the counterweight racks **15** and counterweights carried thereby irrespective of the disposition of the tractor relative to a hill. The operation will be further explained hereinafter.

Interconnecting the two sections of the counterbalance valve **68** are a pair of relief valves **72** that operate to cushion the stopping of the counterweights at an intermediate position. At an intermediate position, the pistons **39** of the actuator rams **30** would be partially extended and the cushioning feature built into the actuators would not be effective, assuming that the dashpot plunger portions **48** or **53** of the pistons **39** are not inserted in their respective sockets of the cylinders at this time. Each relief valve **72** is connected between the conduits **66** and **67** subsequent to the remote valves **69** and check valves **70** to permit fluid flow from one conduit to the other when the pressure in the associated conduit reaches a predetermined maximum value. A more detailed explanation of their operation is included hereinafter.

Connected to the conduits **66** and **67** subsequent to the counterbalance valve **68** are the two ram actuators **30**. The conduits **37***a* of the two rams **30** are connected to the line **66** and the conduits **38***a* of the two rams are connected to the line **67**. The head ends of the rams are connected to one section of the counterbalance valve **68**, which section will be termed "extend section," by the conduit **66** and the rod ends are connected by the conduit **67** to the opposite section of the valve which is termed "retract section." Connected between the extend section of the counterbalance valve **68** and the rams **30** is a flow-divider means which synchronizes the movement of the pistons **39** of the rams and their respectively controlled counterweights. The flow divider means comprises a pair of gear type, fixed displacement, fluid motors **74** that have the shafts thereof mechanically interconnected as indicated. Similar ports of the motors, either inlet or discharge, are mutually connected to the conduit **66** while the opposite port of each motor is connected to one of the rams. The mechanical interconnection of the fluid motors **74** will thus be seen to synchronize the fluid flow to or from the rams.

Connected to the conduit **66** between the counterbalance valve **68** and the flow divider motors **74** is a relief valve **75** which also has a return conduit connecting with the reservoir. This relief valve is effective during the cushioning operation of the valves **72** on retraction of the pistons **39** to accommodate the increased flow from the head ends of the cylinders which results from the volume of the cylinders that may be occupied by the piston rods.

Operation of the system is initiated by actuation of the control valve **60** which results in movement of the counterweight racks **15** and the weights carried thereby. With the counterweights in the retracted position, the control valve **60** would be actuated to connect the port A with the port P thereby pressurizing the conduit **66**. Simultaneously, the port B would be connected to the port T, venting the conduit **67** to the reservoir **64**. After actuation of the control valve **60**, the spool would be maintained in the selected position until the fluid pressure in the conduit **62** becomes sufficient to hydraulically release the detent or the valve when it is manually returned to neutral position. Pressurization of the conduit **66** will cause fluid flow through the check valve **70** and the flow divider motors **74** into the head ends

of the actuator ram cylinders **31**. The pressurization of he head ends of the actuator cylinders will tend to dis-lace the fluid from the rod ends but the fluid flow vould be prevented by the remote valve **69** and the heck valve **70** in the retract section of the counter-alance valve **68**. Increase of the fluid pressure in the onduit **66** as a result of the continued operation of the ump PF to a predetermined value will operate the re-note valve **69** through the conduit **71** and open the onduit **67** to the reservoir **64**. The remote valve **69** vill remain open, permitting fluid to flow from the rod nds of the actuator ram cylinders **31** at all times the luid pressure in the conduit **66** remains above the speci-ied value and the pistons **39** will continue to extend and lisplace the counterweight racks from their retracted osition.

At any time it should be desired to stop the move-ent of the counterweight racks intermediate their fully etracted and fully extended positions, the spool of the ontrol valve **60** is merely returned to its center position y manual operation. This blocks the conduits **66** and 7 at their respective ports A and B and prevents fur-her fluid flow to or from the counterbalance valve **68**. Due to the momentum attained by the heavy counter-veights **20** carried by the racks **15**, and the effect of gravity should the tractor be positioned on a hillside, xtreme pressures may be suddenly built up in the sys-em resulting in damage or destruction of the components nd conduits. The possibility of such pressure surges s eliminated in the present system by the relief valves **2**. Irrespective of the direction of movement of the ounterweights, the pressure within either conduit **66** or 7 will be limited by the relief valves **72** as these valves irect the fluid to the opposite conduit and thereby auto-natically retard the counterweight movement by absorb-ng the energy. The continued movement of the counter-veight racks and counterweights carried thereby after entering of the control valve **60** will normally not be reat and will not result in an undesirable lag in oper-tion.

At any time the tractor should be operating on a illside, the remote valves **69** of the counterbalance valve 8 will prevent loss of control of counterweight move-nent, resulting from the effect of gravity. Assuming hat the tractor would be positioned transversely of the illside and the counterweights would be on the low ide and that it is desired to extend the counterweights, t will be seen that gravity could exert such a force that ontrol of movement may be lost. Merely venting the onduit **67** to the reservoir **64** could cause cavitation n the system resulting in dangerously rapid movement f the counterweights. Any tendency to cavitate would esult in loss of pressure in the conduit **66** and the re-note valve **69** in the conduit **67** would close so as to etard or restrict the movement of the counterweights ntil the pressure has again built up in the conduit **66**.

If it is desired to fully extend or retract the counter-veights, the control valve **60** may be left in the oper-ting position thus permitting the hydraulic detent to unction and return the valve to center. When the pis-ons **39** reach the extreme ends of their stroke in each irection, the pressure at the valve will increase due to ontinued operation of the pump PF until the pressure eaches the value at which the detent will operate.

The counterweight system of this invention surmounts hose problems encountered wherein the basic structure f tractor and side-boom frame are detrimental and re-trictive to maximum retraction, to low center of grav-ty and to most efficient design of rack and weights. This new method permits retraction of weights as far s possible over the tractor tracks and permits the use f block type design of counterweights. The weights nd carrying racks are retracted to positions where they re not subject to damage by contact with various ob-ects such as trees, stumps, boulders, etc. and are at a

high position above the crawlers out of the mud. Block-type design of weights eliminates dead areas.

It is obvious that the further out the center of gravity of the mass of the counterweights is extended, the greater lift at the opposite side they can balance. Due to the magnitude of lift required by this type unit, great amounts of counterweight are required. Unfortunately, the quantity of counterweight required is usually detrimental to movement of tractor when not lifting. The further in the weight can be moved toward the longitudinal center line of the tractor, the beter the unit will steer, turn and move from place to place. Comparison of weight location on prior art units and the present unit indicates the advantage and necessity of swinging weights up and over the track crawlers as with the present unit.

This system of counterweighting eliminates complicated racks, linkage, safety links, etc. It includes one rack, one pivot point, one motivating cylinder or ram for each counterweight rack. The cylinder or ram doubles as a safety link. Pivot point and rack are within overall width and length of the tractor, eliminating necessity of removal of the weights and their racks. Also there is no obstruction below tractor tracks which would interfere with movement and steering.

This system of counterweighting enables use of simple, efficient cast counterweight blocks. Each block is held in place by permanent and adjustable locking devices. Construction of weights, minimum in number, enables quick removal and replacement. There are no dead corners when the weights are extended and they have maximum counterbalancing efficiency in that extended condition.

Counterweight movement and synchronization are accomplished with this invention by special cylinders, plus checks and balances incorporated into a special hydraulic system. The requirements of such a hydraulic power train are complex and varied. The following requirements are met by this system:

(a) Synchronization of weights wherein the front and rear weights are extended and retracted approximately together.

(b) A throttling action when weights are stopped any place within the 90° swing. Cushioning on maximum extension and retraction are accomplished by special cylinders, intermediate stopping is accomplished by cushioning valves. It is obvious that sudden starting and stopping of such a mass of weight could set up extreme shock loading throughout entire structure if this was not guarded against as provided for by this system.

(c) The characteristics of any dual hydraulic application motivation is for the oil to take the path of least resistance which, if the tractor is up or down hill, on side slopes, or externally affected wherein one or both weights are acted upon by gravity, the synchronization of said weights hydraulically is most difficult. Equalization of pressure and flow must be accomplished by special flow dividers and a system of hydraulic checks and balances. Obviously, the action and restriction of space does not lend itself to mechanical synchronization. These factors are effectively overcome with the system of this invention.

This invention obtains, without altering the basic carrying tractor, a most efficient system of obtaining maximum counterweight extension within standard tractor widths, maximum retraction position within standard tractor specifications, low profile, high clearance, safe, synchronized simple construction and maximum lift efficiency. Positioning, movement and synchronization are all accomplished in a totally different manner from any known prior art unit.

According to the provisions of the patent statutes, the principles of this invention have been explained and have been illustrated and described in what is now considered to represent the best embodiment. However, it is to be understood that, within the scope of the appended claim,

the invention may be practiced otherwise than as specifically illustrated and described.

Having thus described this invention, what is claimed is:

In combination with a tractor of the crawler type having first and second crawlers at its opposite sides, each with endless crawler tracks extending longitudinally in parallel relationship to the longitudinal center line of the tractor; a side attachment mounted on the first crawler at one side of the tractor so as to apply a load to the tractor having its center of gravity laterally outwardly of that crawler; counterbalance means at the opposite side of the tractor, said counterbalance means comprising a plurality of weight-carrying means having counterweights positioned thereon, and pivot means for mounting said weight-carrying means on the second crawler at the said opposite side of the tractor for swinging movement in a horizontal plane between a retracted position where they are in fore and aft relationship over the second crawler and within the outermost side extremity of the tracks of the second crawler so that the center of gravity of weights carried by said weight-carrying means will be over that crawler and an extended position laterally outwardly beyond said side extremity of the second crawler tracks so as to increase the distance from the center of gravity of the load to the center of gravity of the weights in order to provide for the weights to exert a maximum effect in counterbalancing the load created by said attachment on the opposite first crawler of the tractor, said pivot means comprising pivot structures with vertically disposed pivot axes supported by the second crawler and spaced longitudinally thereof in a vertical plane disposed parallel to the center line of the tractor and parallel to and inwardly of the said outermost side extremity of the tracks of the second crawler, means for swinging said weight-carrying means between extended and retracted position, said weight-carrying means including horizontal support arms carried by said pivot structures and swingable in a horizontal plane above said second crawler at a right angle to said vertical plane and to which said swinging means is connected, all portions of said operating means and said support arms being within said outermost side extremity of said crawler tracks in retracted position of said weight-carrying means.

References Cited by the Examiner

UNITED STATES PATENTS

2,493,602	1/1950	Sterrett	91—396
2,693,250	11/1954	Barrett	187—9
2,891,681	6/1959	Greivell	212—49
2,960,068	11/1960	Becker	91—396 X
3,033,219	5/1962	Erle	91—413 X
3,071,254	1/1963	Stilley	212—8
3,125,324	3/1964	Vivier	91—420 X
3,153,911	10/1964	Mark et al.	91—413 X

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