Sept. 2, 1958 G. B. HAMBLIN 2,850,181

SCALE FOR LIFT TRUCK OR THE LIKE

Filed Nov. 27, 1953 4 Sheets-Sheet 1

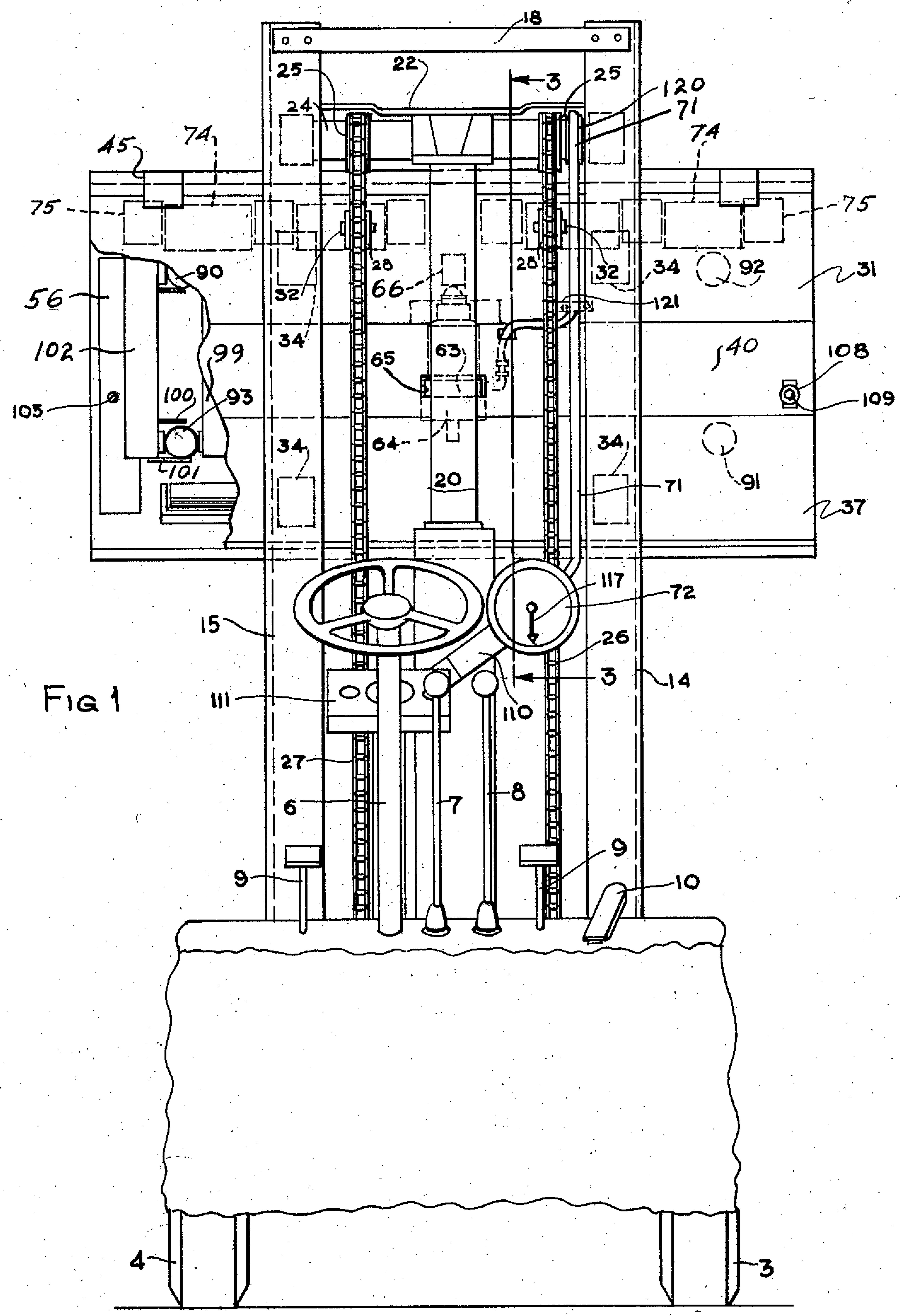

FIG 1

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SCALE FOR LIFT TRUCK OR THE LIKE

Filed Nov. 27, 1953 4 Sheets-Sheet 2

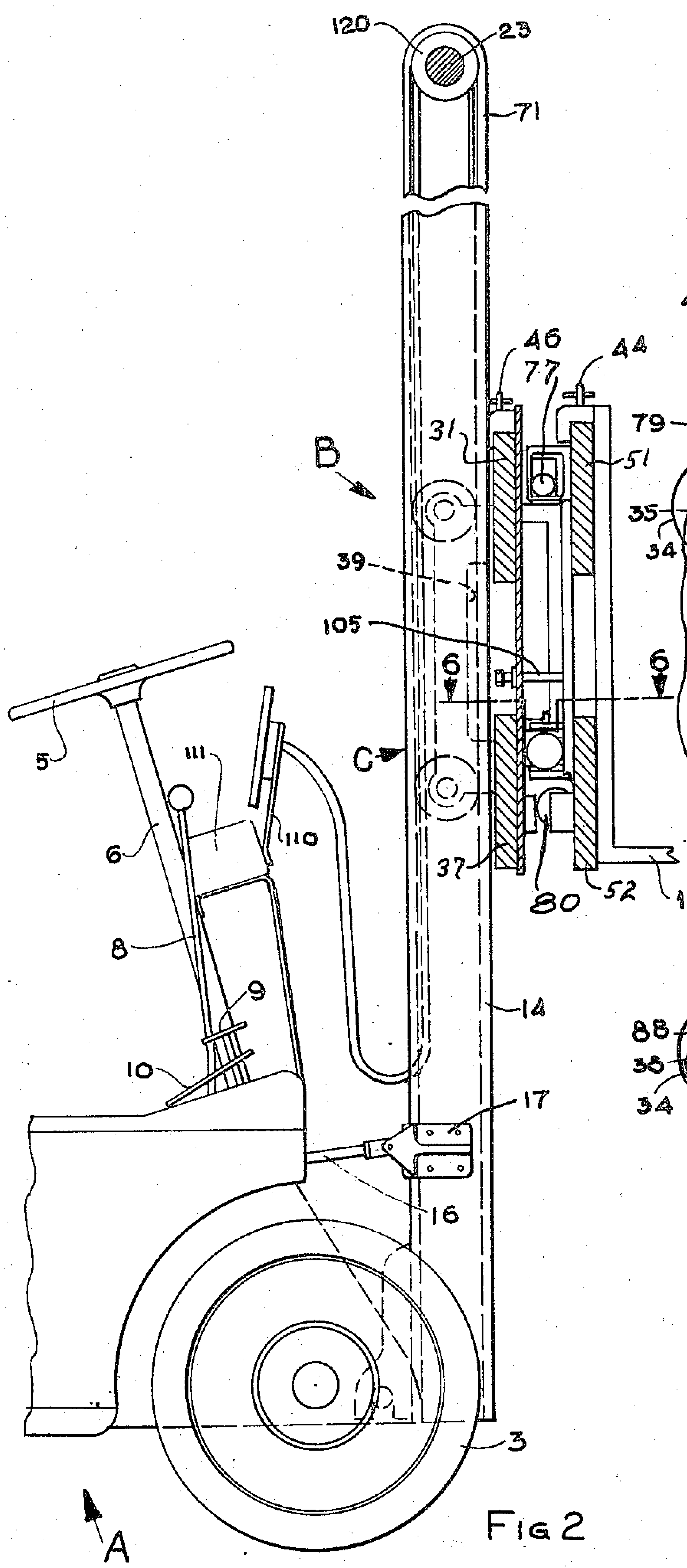

FIG 2

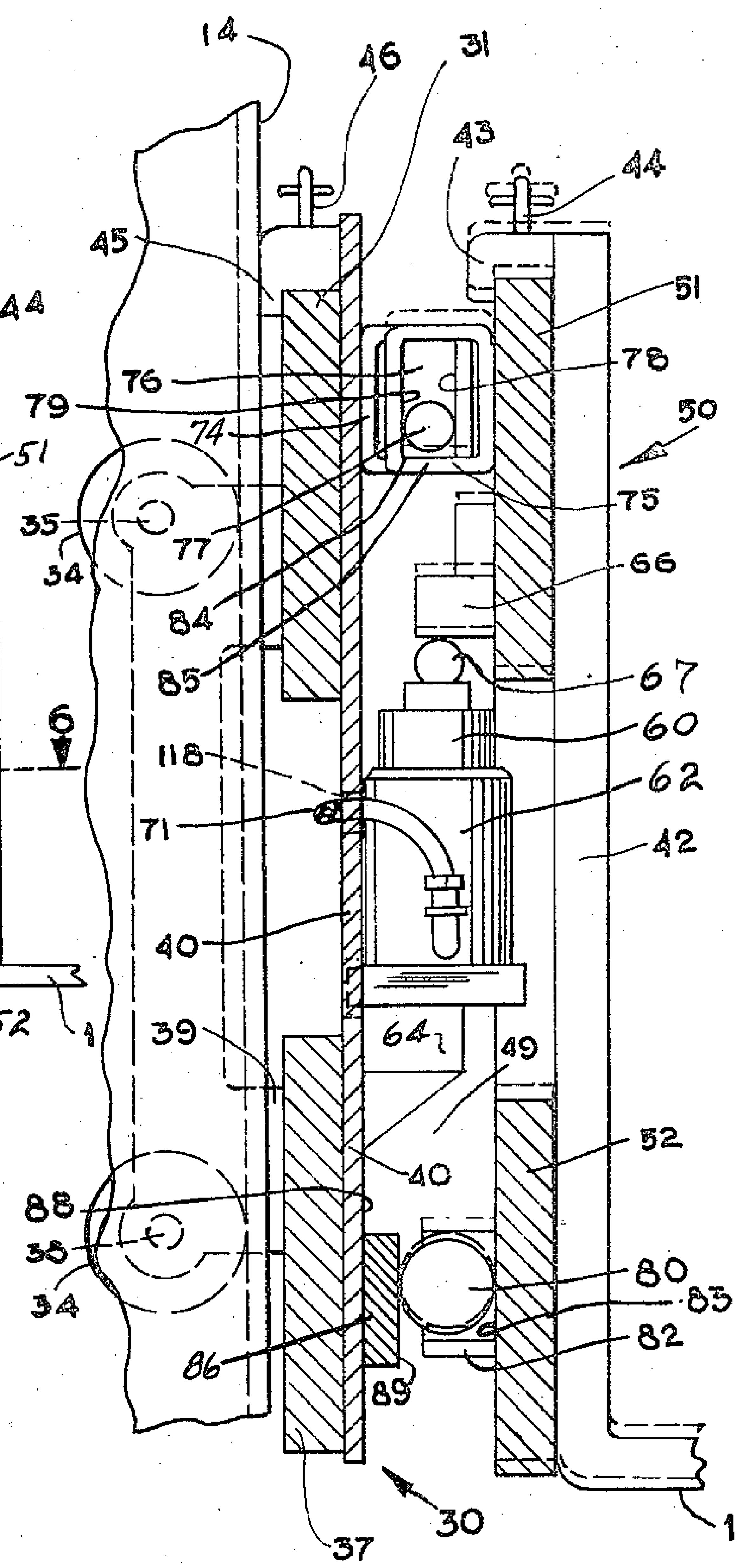

FIG 3

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SCALE FOR LIFT TRUCK OR THE LIKE

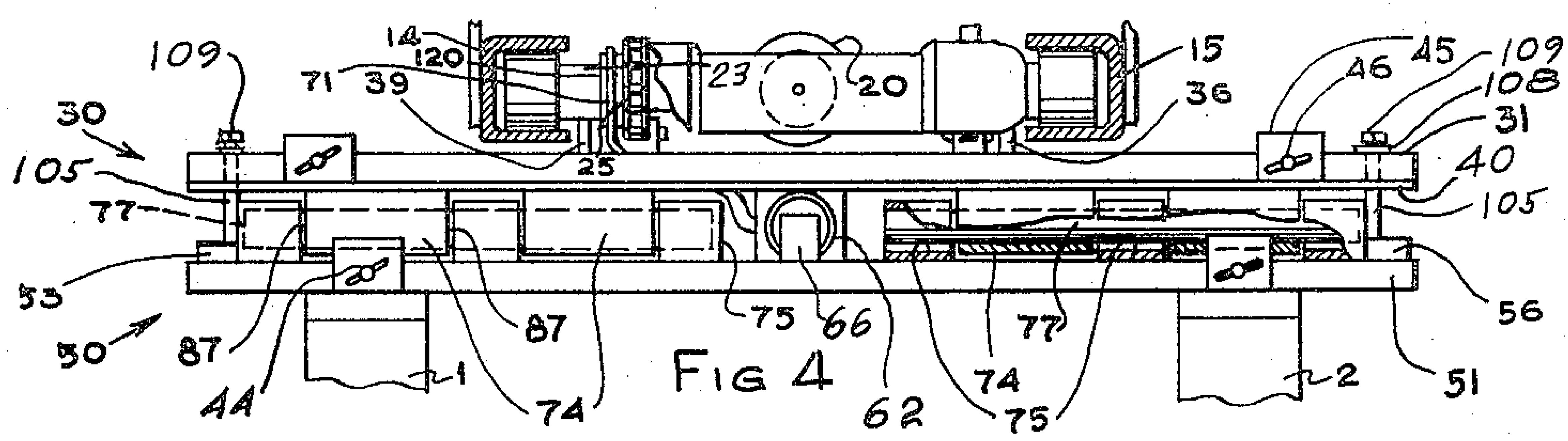

FIG 4

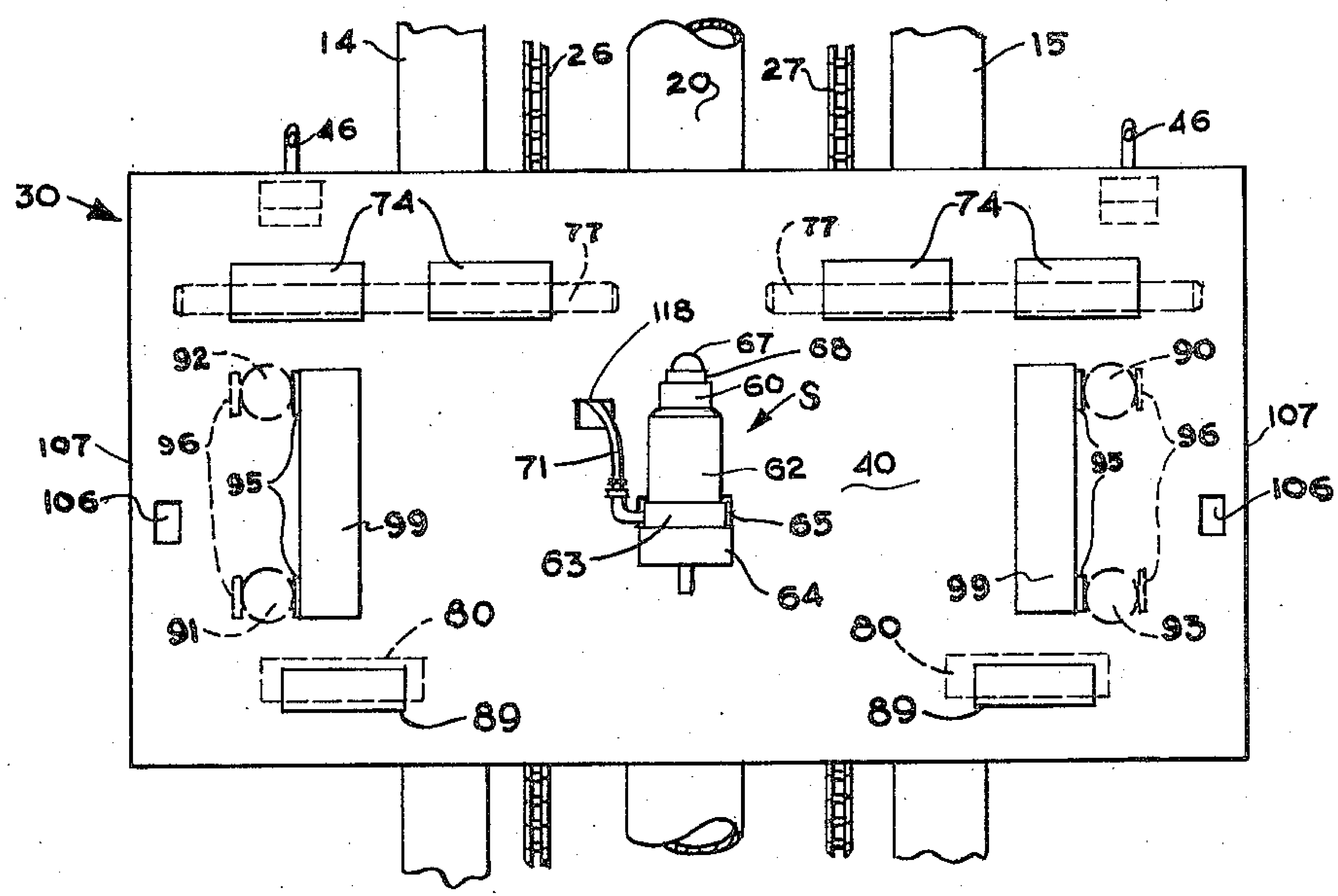

FIG 5

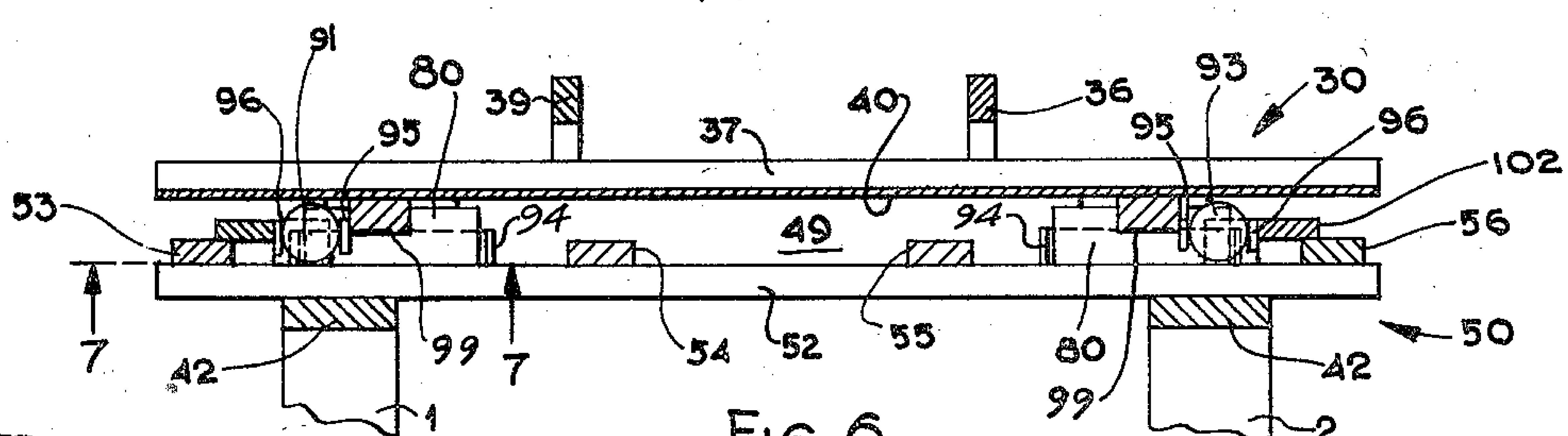

FIG 6

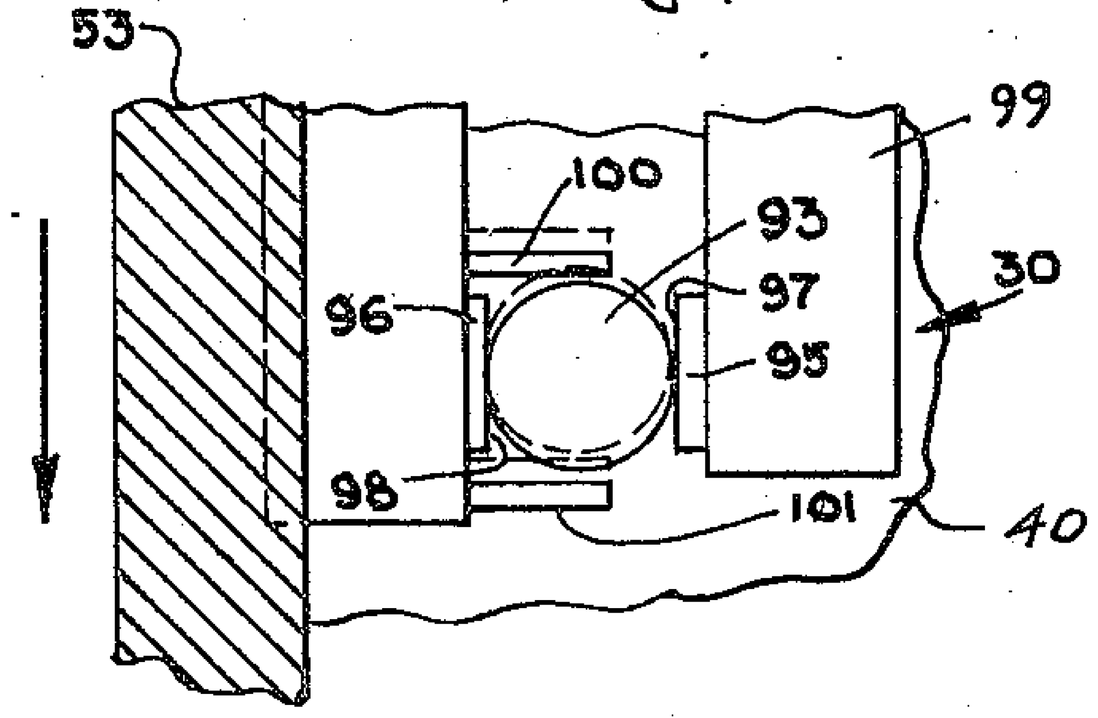

FIG 7

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SCALE FOR LIFT TRUCK OR THE LIKE

Filed Nov. 27, 1953 4 Sheets-Sheet 4

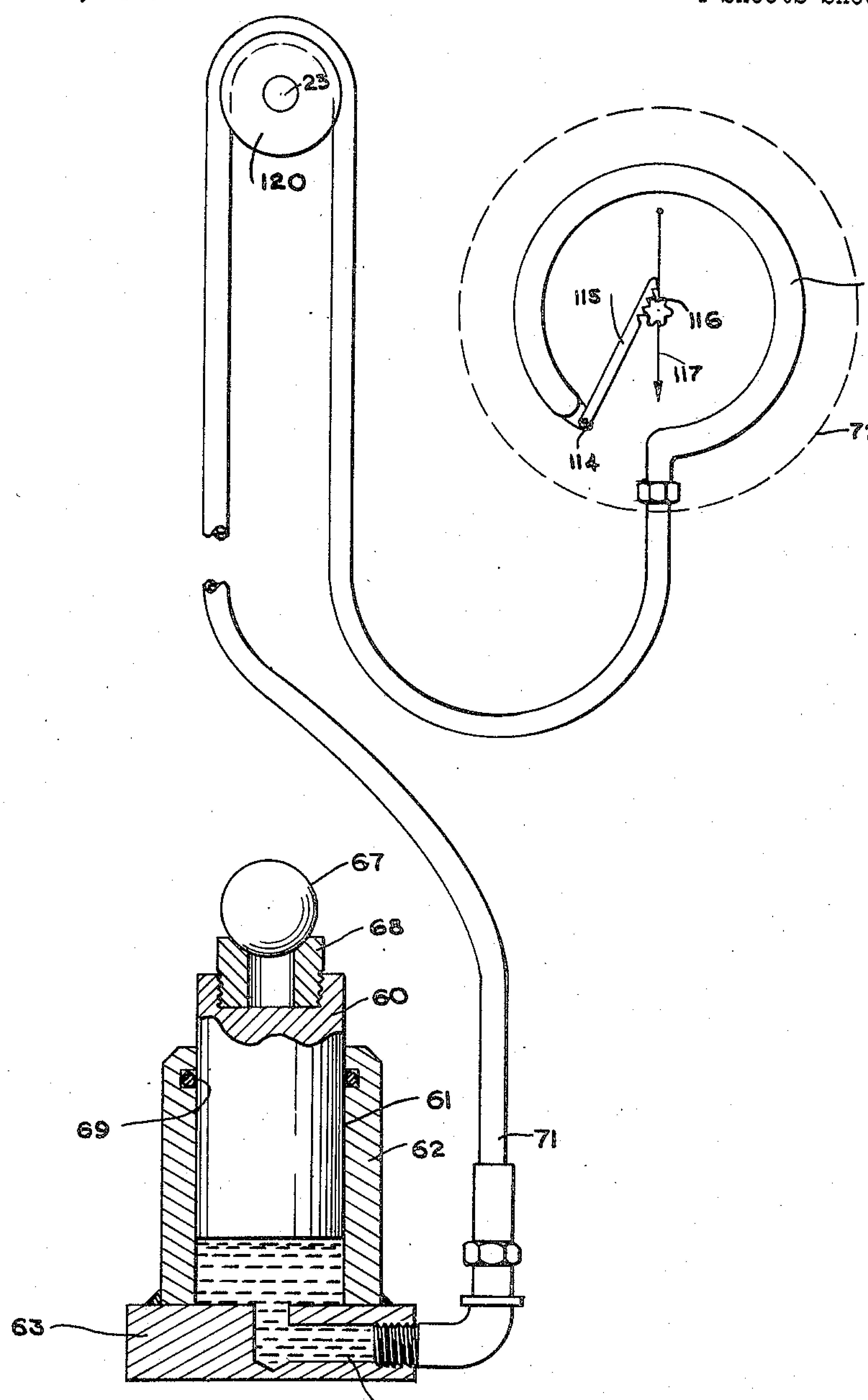

FIG 8

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SCALE FOR LIFT TRUCK OR THE LIKE

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Application November 27, 1953, Serial No. 396,245

16 Claims. (Cl. 214—2)

This invention relates to lifts and scale platforms and the like, more particularly to lifts on lift trucks of the fork lift type having associated therewith scale mechanisms for weighing horizontally offset loads during or at the time of the lifting operations.

The advantages to be derived from a portable scale or scale attachment for use with a fork lift truck have been recognized and efforts have been made to provide suitable lift truck scales, attachments or portable scales for use in association with lift trucks.

Devices heretofore available have not been entirely satisfactory, chiefly because of their inaccuracy in weighing but also because of their complicated character, high cost and their reduction of the utility and capacity of the lift truck which results from shifting of the load center, restricting the movement of the forks and changing the shape or size of the forks. It is, therefore, one of the principal objects of the present invention to provide a generally improved lift truck scale which largely overcomes the objections referred to and which can be readily manufactured in large or small quantities at low cost. More particularly it is sought to provide a lift truck scale of simple design and construction which is rugged and durable so as to withstand severe shocks, impacts and strains such as are customary in the hard usage to which lift trucks are commonly subjected.

Another object is to provide a scale device of the character mentioned which is adapted for incorporation in the truck at the time of manufacture or for fabrication as an attachment to existing lift trucks of different design and manufacture. As a specialized version of this aspect of the invention it is sought to provide such a scale the parts of which can be packaged as a kit to facilitate storage and shipment so as to be readily available for and adapted to easy mounting on a lift truck by the user when needed and at the place of use, thereby facilitating full use of existing lift truck equipment without substantial lay-up or withdrawal from service for modification when it is desired to add the scale.

Another object is to provide a scale device for an industrial truck of the fork lift type wherein the elements or components of the truck interposed between the load and the weight sensing element are minimized in the provision of a low tare arrangement. In a preferred arrangement the weight sensing element is mounted on a main or fixed frame carried by the vertically movable carriage of the lift truck. The cantilever forks of the truck are suspended on the weight sensing element by an intermediate or supplemental relatively movable frame which is located on the main frame by an antifriction system comprising reaction assemblies arranged to provide for transfer of substantially all vertical forces between the main and the supplemental frames through the weight sensing element. Provision is made in the antifriction system for resisting lateral or horizontal forces between the frames, the lateral forces involved being not only those resulting from side thrusts, eccentric loading and like but also from the turning moment

or force couple on the forks resulting from the cantilever lifting characteristic of the forks which necessitates a loading offset or displaced horizontally from the reaction axis of the weight sensing element.

As a refinement and advantageous feature of that aspect of the invention concerned with the antifriction system by which lateral or horizontal forces between the forks and the carriage are resisted and the weigh platform stabilized the present invention contemplates the use of reactive assemblies capable of transmitting forces only in horizontal planes. More specifically the antifriction system comprises circular roller thrust elements held as by cage means fast to a load side component of the device such as the lift forks or the supplemental or intermediate frame. Location of the roller cage on the load side of the sensing means results in freeing of the roller element or elements from their cages for minimal frictional restraint between the parts separated by such roller element or elements by the yielding of the hydraulic or other sensing system upon the application of load to the forks. The platform stabilizing system is a specialized feature of the invention which has utility in scale devices other than those for lift trucks.

In a still further refinement of the antifriction and weigh system of the invention as applied to a lift truck of the engine driven type it is contemplated to provide a main frame for mounting on the vertically movable carriage of the lift truck and an intermediate, supplemental or weigh frame mounted on the main frame. Vertical forces between the frames are substantially wholly transmitted through an interposed hydraulic sensing element and antifriction elements interposed between or interconnecting the main and intermediate frames transfer horizontal forces and force couples from one frame to the other. The antifriction elements are arranged in pairs with the elements of each pair vertically spaced. Vibration incident to engine operation is utilized to overcome friction in the weight sensing system and to settle the antifriction rollers on their bottom rests when unloaded.

Another object is to provide a scale device modification for an industrial truck of the type having a vertically movable carriage and conventional L-shaped forks mounted on the carriage in which modification vertical forces are transferred between the forks and the carriage substantially wholly through the sensing element of the scale device and the horizontal arms of the forks are free and unobstructed for use in normal service.

Another object is to provide such a scale in which an indicator is so connected to the weight sensing element that the indicator can be mounted on the truck in any desired position convenient to the operator. As a refinement of this aspect of the invention the sensing element which is carried by or on the movable lift carriage is connected to the indicator dial of the system, which is mounted on the mast or other relatively fixed part of the truck, by a flexible cable or conduit reeved over the crosshead of the lifting mechanism in the avoidance of slack in the cable or conduit and, in the case of a hydraulic weight sensing system, in the provision of a hydraulic connection between the sensing element and the indicator which is and remains of substantially constant volume in all positions of the lift carriage.

Other objects and advantages pertaining to certain novel features of construction and combinations and arrangements of parts are set forth in the following detailed description of a preferred embodiment of the invention, this description being made in connection with the accompanying drawings forming a part of the specification:

In the drawings:

Figure 1 is a transverse sectional view, partly diagrammatic and with parts broken away and removed, through a fork lift truck incorporating the scale device of the present invention, this section being taken through the operator's station to show the rear of the mast and the movable carriage;

Fig. 2 is a side elevational view, partly in section and with parts broken away and removed, of the lift truck and scale device of Fig. 1;

Fig. 3 is a fragmentary sectional detail taken vertically through the main and intermediate frames associated with the vertical movable carriage, this view being taken substantially along the line **3—3** of Fig. 1 and enlarged with respect to that figure;

Fig. 4 is a top plan view of the mast, carriage and frames, with parts broken away and removed;

Fig. 5 is a front elevational view, partly diagrammatic, showing the main frame of the scale device, the intermediate frame and the forks being removed to show the weight sensing element and the antifriction means for transferring horizontal forces between the frames;

Fig. 6 is a sectional detail with parts broken away and removed, taken substantially along the line **6—6** of Fig. 2;

Fig. 7 is a fragmentary sectional detail, diagrammatic in character to show the freeing of the caged rotary element of the antifriction means upon application of load, this view being taken substantially along the line **7—7** of Fig. 6 and enlarged with respect to that figure; and

Fig. 8 is a diagrammatic view, partly in section, showing the weight sensing element, indicator and connections of the hydraulic weighing system employed in the present scale device.

The illustrative embodiment of the scale device and platform stabilizing system of the present invention is an industrial truck of the fork lift type, the invention being adapted for incorporation either as part of the original structure or as an attachment for modification of an existing lift truck. The particular construction of the lift truck is not critical, since the present scale device and system can be fitted to a number of conventional industrial trucks commercially available.

An industrial fork lift truck of the type to which the present scale device can be applied comprises a chassis A on which is mounted a mast B carrying a carriage assembly C that includes L-shaped lift forks **1** and **2**. The carriage assembly C incorporates the principal components of the present scale device, as will appear.

The chassis A is mounted on power driven and steerable front wheels **3** and **4** and fixed rear wheels (not shown). A suitable engine such as a gasoline motor (not shown) is mounted on the chassis, being connected to drive the wheels through a suitable transmission and being arranged to actuate the pump of the conventional hydraulic system which operates the lift, tilt and other load handling mechanisms. The steering wheel **5** on post or column **6** is conventionally connected to the steerable front wheels **3** and **4**. The transmission and lift mechanisms are controlled through shift levers **7** and **8**, and conventional wheel brakes are actuated by pedals **9**. The engine control or accelerator pedal is indicated at **10**.

The mast B comprises upright channel shaped steel guides **14** and **15** disposed in spaced parallel relation with their open sides directed toward one another in confronting relation. At their lower ends the guides are connected by a base pivotally supported on the front end of the chassis A so that the entire mast assembly can be tilted toward and away from the truck chassis over a small arc. The tilting is effected by suitable mechanism such as an hydraulic piston-cylinder assembly (not shown) connected as by one or more links **16** to a bracket or brackets **17** secured to the mast uprights or guides **14** and **15**. The upper ends of the mast uprights are connected by a cross member **18** which is shown in the plane of the guides but which, in the case of a mast having extension guides in telescoped relation to the guides **14** and **15**, may be offset to permit the extension guides to be projected vertically above the main guides.

Disposed in the space between the guide channels **14** and **15** is a lift column **20** bottomed on the base or cross member of the mast B and parallel to the mast guides so that its thrust axis is located in the plane of the guides and is equidistant from each. At its upper end the lift column **20** carries a cross head **22**, the latter having oppositely directed stub shafts **23** and **24** which are aligned with one another on an axis disposed in the plane of the mast guides **14** and **15**. Each of the stub shafts carries a reeving device in the form of a pulley or sprocket **25** over which are trained lift chains **26** and **27**. The rear runs of the chains extend downwardly and are affixed to the mast at a point below the lower mast limit of travel of the cross head **22**, the lower ends of the chains normally being secured to the mast base or lower cross member.

The front runs of the chains **26** and **27** extend downwardly to brackets **28** secured to main frame **30** of the carriage assembly C. The brackets **28** may conveniently be secured as by welding to cross member **31** of the frame, extending rearwardly from such cross member into the space between the mast guides **14** and **15** and carrying pins **32**, to which the lower ends of the forward runs of the lift chains are secured. When the lift column **20** comprising an hydraulic piston-cylinder arrangement is energized in the usual manner under the control of the lever **8** to raise or lower the cross head **22**, the outer runs of the lift chains **26** and **27** are simultaneously raised or lowered to thereby raise or lower the carriage assembly C. By the reeving arrangement shown the vertical travel or movement of the carriage is twice that of the lift column cross head **22**. In its vertical movement the carriage assembly C is guided by rollers **34** that ride in the guide channels **14** and **15**, the rollers being mounted on stub shafts **35** and **38** carried by vertical brackets **36** and **39** each secured to both the upper and lower cross members **31** and **37** of the main frame **30**.

An upright carriage member **40**, here comprising a flat steel plate, having great rigidity and strength to resist distortion under the forces to which it is subjected when the lift truck forks are loaded, is disposed flatwise against the main carriage cross members **31** and **37** and is suitably supported thereon to carry vertical loads. The carriage member **40** may be bolted or welded to the cross members **31** and **37** or, alternatively, as in the case of a scale incorporated in the original lift truck manufacture, the cross members **31** and **37** may be eliminated and the brackets **36** and **39** which carry the guide rollers may be secured directly to the carriage member **40**. In the preferred arrangement, however, and that which is illustrated, the plate member **40** replaces or is substituted for the lift forks **1** and **2** and is attached to the carriage cross members **31** and **37** by an arrangement which makes the plate member interchangeable with the lift forks. Thus the scale device is provided as a convenient attachment for existing conventional lift trucks—a device that can be removed and replaced as desired by the user of the truck.

In the lift truck illustrated the upright portions **42** of the forks are formed at their upper ends with rearwardly projecting hooks or fingers **43** which, in the normal use of the truck without the present scale attachment, are received over the top edge of the upper cross member **31** in a hanging suspension which permits horizontal sliding movement of the two forks toward and away from one another while so hung and in which the horizontal portions of the forks project cantilever fashion from the vertically movable carriage C. Bolts **44** are received through vertical bores or openings in the hook fingers **43**, the lower ends of the bolts being threaded into sockets in the upper edge of the frame cross member **31**. Shoulders provided on the bolts **44** as by forming them with lower threaded ends of reduced diameter seat against mating shoulders in the hook fingers **43** provided as by counterbores in the bolt receiving apertures so that the hook fingers are locked in place and held against both horizontal shifting movement and inadvertent dislodgment. It is understood, of course, that the locking bolts **44** do not carry any of the pay load stress and are merely to resist accidental displacement and unhooking of the lift forks. The mounting of the carriage plate member **40** on the carriage cross members is effected by rearwardly projecting hook fingers **45** secured to the upper part or edge of the plate member at horizontally spaced points. The hook fingers **45** on the plate member **40**, similar to the hook fingers **43** of the forks, permit the plate to be hung on the carriage cross member **31** in the same manner as and as a substitute for the lift forks **1** and **2**. Locking bolts **46** corresponding to the locking bolts **44** of the lift forks are fitted through sockets in the hook fingers **45** of the plate and are threaded into the sockets in the top edge of the carriage cross member **31** to prevent horizontal shifting and inadvertent dislodgment of the plate member **40** from and relative to the carriage cross member. The hooking of the fingers over the top edge of the cross member and down the rear face of the latter prevents withdrawal of the top of the plate member from the frame cross member when an offset load is applied to the forks, as will appear.

Disposed in front of and in confronting relation to the upright plate member **40** of the main carriage and separated therefrom by a clearance space **49** is a supplemental frame **50** on which is carried a horizontally projecting load receiving element which may comprise the lift forks **1** and **2** hung on the frame **50** in lieu of being carried by the carriage cross member **31**. The supplemental frame may comprise a single plate of steel or cast ferrous metal or, as shown, may comprise upper and lower cross members **51** and **52** connected by upright ribs or bars **53**, **54**, **55** and **56** bolted or welded to the rear faces of the cross members. The top cross member **51** is desirably of the same thickness as the top cross member **31** of the main frame to receive in analogous relation the hook fingers **43** of the lift fork. Suitably threaded sockets are also provided in the top edge of the cross member **51** at different horizontally spaced points to receive the securing bolts **44** that locate and retain the lift forks.

The supplemental frame **50** is so supported on, stabilized and interlocked with the main frame **30** as to move therewith as a carriage unit in raising and lowering of the forks and as to withstand all horizontal forces acting between the frames as a result not only of eccentric or horizontally offset or displaced loading of the forks but such forces as are encountered in bumping and striking of obstructions by the forks in normal operation of the lift truck.

The suspension system or interconnection by which one frame is mounted on the other also includes an arrangement for transmitting all vertical forces through a suitable sensing element S by means of which the vertical load can be accurately measured. The sensing element may be an adaptation of any of the well known weight sensitive devices and here takes the form of an hydraulic system comprising a piston **60** received with a sliding fit in a cylinder **61** formed in a housing **62** (Fig. 8). A base **63** secured to the bottom of the casing **62** and constituting a closure therefor is received for facile removal and replacement on a platform bracket **64** welded or otherwise secured to the upright plate member **40** of the main frame. A cutout or recess **65** in the plate member **40** at the level of the bracket **64** receives one edge of the cylinder base **63**, the latter being of rectangular shape and thereby being interlocked with the frame member **40** to prevent lateral movement on the bracket **64** and also vertical dislodgment therefrom. A load element **66** secured to and projecting rearwardly from the supplemental frame transfers all vertical forces from the supplemental frame to the main frame through the piston **60**. The element **66** may be a steel block welded or otherwise secured to the rear face of the top cross member of the supplemental frame and projecting horizontally from such member into the space **49** between the frames. The load element bears upon the hydraulic piston of the sensing element, a suitable arrangement for transferring the load comprising a hard spherical steel ball **67** which is carried by a hard steel ring **68** threaded centrally into the top of the piston. The piston **60** has a close sliding fit in the cylinder **61** and a fluid seal is provided as by a rubber O-ring **69** received in an annular grove inside the casing **62**. Hydraulic fluid contained in the cylinder **61** below the piston **60** is thus subjected to and carries the entire weight of the supplemental frame, including the lift forks **1** and **2** and any load carried by the forks. Fluid pressure developed in the cylinder **61** by the load on the piston **60** is transmitted through passage **70** in the cylinder base **63** to a tubular conduit **71** which leads to a fluid pressure indicator **72**, as will appear.

The single point contact between the ball **67** and the downwardly directed hardened surface of the steel load element **66** transfers vertical loads between the frames in their entirety and on the axis of the piston-cylinder combination in obtaining an accurate sensing arrangement.

To resist horizontal forces between the carriage frames there is provided a stabilizing system which maintains a predetermined orientation of the supplemental frame **50** and the lift forks, comprising the weigh platform, with respect to the base structure or platform which comprises the main frame **30** and associated supporting structure for the latter. The horizontally offset or forwardly displaced center of gravity of the weigh platform and any load applied thereto with respect to the sensing or load carrying element S produces a vertical plane turning moment on the supplemental frame **50** which tends to rotate it in a clockwise direction as viewed in Fig. 3. To counteract or resist the turning moment the supplemental frame is connected to the main frame **30** at vertically spaced points, the upper connection being designed to resist separation of the frames and the lower connection being designed to resist movement of the frames toward one another. Both connections minimize friction in the vertical direction so that vertical forces between the frames are concentrated in the sensing element S.

Because of the rugged service required of lift trucks and the rough usage to which they are subjected, usually by operators who cannot be expected to exercise much care in the operation of delicate parts such as are customarily used in scales, the connections between the carriage frames as provided by the present invention have unusual characteristics of strength and impact resistance. The upper connection comprises a hinge arrangement in which a series of steel tubes are disposed in horizontal alignment, tubes **74** being secured to the carriage member **40** and tubes **75** being secured to the upper cross member **51** of the supplemental frame. The tubes are of rectangular section each having one side disposed flatwise against the frame member with which it is associated and are secured in place by bolting or welding. Extending through aligned openings **76** of the cages are one or more cylindrical bars **77** which thus constitute centerless roller hinge elements interlocking the tubes **74** on the main frame member **40** with the tubes **75** on the supplemental frame member **51**. As shown in Fig. 4, the carriage frames may be connected by two sets of the interlocked tubes, one set being located on each side of the load axis through the sensing element S. Thus two of the interlocking roller bars **77** are employed, although it is feasible, of course, to use a single bar extending across the entire width of the carriage assembly.

Normally the weight induced turning moment on the supplemental frame tends to separate the tops of the main and supplemental frames. The separating force tends to withdraw the hinge tubes 75 from their interleaved relation to the hinge tubes 74, the withdrawing movement being limited by engagement of the roller bars 77 against the flat vertical inside surfaces 78 and 79 of the tubes 74 and 75, respectively. These flat surfaces, located on the outer portions of the rectangular tubes are preferably ground and polished to permit free rolling movement of the bars 77 in minimizing vertical forces between the frames. The diameter of the circular cross sectioned roller bars 77 is less than the vertical dimension of the clearance inside the tubes 74 and 75 so that in normal operation the roller bars are at the instant of weighing out of contact with all surfaces of the tubes except the smooth vertical surfaces 78 and 79. The tubes 74 and 75, by reason of the fact they surround the bars 77, constitute cages to retain the bars in the desired loosely assembled relation to the vertical surfaces 78 and 79 through which horizontal forces are transmitted between the frames.

The bottom connection between the carriage frames is a thrust resisting arrangement, since the vertical plane turning moment on the weight platform supplemental frame tends to move the bottom portions of the frames toward one another. Thrust assemblies, each comprising a suitably caged steel roller 80 of cylindrical form, are disposed one on each side of the vertical load axis through the sensing element S. These thrust assemblies are located at or adjacent the bottom of the carriage so as to receive directly thrust and impact loads resulting, say, from engagement of the ends of the forks 1 and 2, or one of them, against an obstruction during forward movement of the truck.

The roller 80 of each thrust assembly is provided with an underlying support element 82 which may comprise a steel plate or angle welded or otherwise secured to rear face 83 of the lower cross member 52 and projecting horizontally therefrom. Preferably the rear face 83 is smoothed and hardened or, alternatively, a hardened smooth steeel plate (not shown) may be secured to the cross member 52 to provide the desired smooth flat vertical bearing surface for engagement by the roller bar 80. A similar smooth flat vertical surface 89 is provided on the main frame for engagement by the roller bar 80, as, for example, by a hardened steel plate 86 suitably welded to front surface 88 of the upright frame plate member 40.

While the thrust resisting means between the bottom portions of the main and supplemental frames has been shown and described as comprising separate roller assemblies located one on each side of the load axis through the sensing element, it is feasible, of course, to employ a single thrust assembly either localized under the load axis or extended across the entire width of the carriage. Similarly the interlocking means between the upper portions of the main and supplemental frames, while shown as comprising hinge assemblies located one on each side of the load axis through the sensing element, may be a single interlocking assembly either localized on the load axis or extending across the entire width of the carriage. If, instead of the arrangement illustrated which employs both horizontally spaced interlocking assemblies between the upper parts of the carriage frames and horizontally spaced thrust assemblies between the lower portions of such frames, it is desired to use a single centrally located and localized interlocking assembly at the top, then there should be used at the bottom horizontally spaced thrust assemblies or a single thrust assembly extending across the entire width of the carriage to maintain stability. Similarly, if, instead of the illustrated arrangement, it is desired to use a single centrally located and localized thrust assembly at the bottom, then there should be used at the top horizontally spaced interlocking assemblies or a single interlocking assembly extending across the entire width of the carriage.

To minimize the transmission of vertical forces from the supplemental frame to the main frame through the rollers 77 and 80 of the interlock and thrust assemblies, respectively, the parts are located so that the axes of the rollers are horizontal and parallel to one another. This objective is accomplished with respect to the roller bars 77 of the upper or interlock assemblies by locating the tube cages 75 so that inside surfaces 84 of their bottom elements 85 generate a plane which is either horizontal as shown or intersects the planes of the carriage frames in horizontal lines.

With respect to the lower or thrust assemblies, the axes of the rollers 80 are kept horizontal by locating the bottom cage elements 82 so that the upwardly directed supporting surfaces 86 of such elements are either horizontal as shown or generate planes which intersect the planes of the carriage frames in horizontal lines.

In the normal or unloaded condition of the carriage of the scale device, shown by the full lines of Figs. 1 and 2 and by the broken lines of Fig. 3, the roller supporting surfaces 84 of the tube cages 75 are slightly elevated or spaced above the corresponding surfaces of the tubes 74 on the main frame. Thus the rollers 77 in the normal or unloaded condition rest by gravity on the surfaces 84 of one group of the tube cages, the rollers being supported clear of all horizontal surfaces of the tubes of the other group. Thus the rollers contact only the vertical bearing surfaces 78 located on those components of the interlock assemblies that are carried by the main or relatively fixed frame. Upon the application of a load to the lift forks 1 and 2, or one of them, the yielding of the hydraulic system associated with the sensing element S permits a slight lowering of the supplemental frame 50 relative to the main frame 40.

In Fig. 3 the position to which the supplemental frame is lowered or depressed by an applied load is indicated by the full lines. In this figure the vertical shifting of the supplemental frame has been greatly exaggerated for purposes of explanation, it being understood that in practice the yielding of the hydraulic system or whatever other sensing system is used may result in a shifting of the supplemental frame no more than a few thousandths of an inch downwardly relative to the main frame. The downward shifting of the one frame relative to the other upon the application of a load, even though such shifting be ever so slight or even imperceptible to the naked eye, is significant in that the roller bars 77 (and, as will appear, the roller bars 80) are subjected to horizontal compressive forces only at the instant of weighing. In the case of the rollers 77 the horizontal forces are exerted by the confronting faces 78 and 79 of the two sets of interleaved cage tubes. Thus the rollers, frictionally gripped by the opposed surfaces do not drop downwardly at the same rate as the cage tubes 75 but roll upwardly on the vertical surfaces 79 of such tubes. This relative upward rolling on the cage tube surfaces withdraws the rollers from engagement with the bottom or horizontal supporting surfaces 84 of the cages so that at the instant of weighing, the rollers 77 (and 80) each make single point or horizontal line contact with only one surface of each of the tubes 74 and 75.

It is understood, of course, that the downward shifting or movement of the supplemental frame relative to the main frame resulting from yielding in the hydraulic or other weight sensing system is insufficient to bring the roller bars 77 into contact with the bottom elements of the tubes 74 on the main frame. At the instant of weighing, therefore, the roller bars 77 contact only vertical surfaces of the tubes or cages on the main and supplemental frames and are wholly supported by frictional engagement with such vertical surfaces. Since the roller bars are of circular cross section, they are free to roll on the vertical surfaces and the possibility of transmitting vertical forces through the interlock at the instant of weighing is substantially eliminated.

As a precaution against frictional contact between the ends of the tubes **74** and **75** the tube ends are spaced from one another, providing clearances **87**. Thus the only metal to metal contact in the piano hinge type of interlock at the instant of weighing occurs along single point or line contacts between each roller and the vertical load surfaces of the tubes with which the roller is associated.

The circular sectioned or profiled thrust rollers **80** spacing the bottom portions of the carriage frames are also arranged so that at the instant of weighing they contact only the confronting vertical surfaces of the frames or thrust assemblies and are wholly supported clear of the cage means by point or line frictional contact with such vertical surfaces. In the normal or unloaded condition, as represented diagrammatically by the broken lines of Fig. 3, the circular rollers **80** rest by gravity on the cage bottom elements **82** carried by the supplemental or relatively movable frame. When the forks of the truck are loaded the yielding of the hydraulic or other weight sensing system permits downward shifting of the supplemental or movable frame relative to the main or relatively fixed frame of the carriage, as to the full line position of Fig. 3. In this relative movement of the carriage frames the roller bars **80**, subjected to strong horizontal compressive forces exerted by the confronting vertical surfaces **83** and **85**, roll upwardly on the vertical surfaces **83** away from the horizontal supporting surfaces **86** of the bottom cage elements **82**.

By reason of the freeing of the roller bars **77** and **80** from contact with their respective cages or supports at the instant of weighing it is clear that the stabilizing system for the weigh platform is substantially incapable of transferring vertical forces between the carriage frames. The entire weight of the movable or supplemental frame, the forks carried thereby and any load on the forks is imposed at one point on the single sensing element so that the reaction of the sensing system at such point indicates the true weight.

To withstand torsional or twisting loads applied to the forks or supplemental frame, such as result, say, from non-symmetric loading of the forks or from horizontal side loads applied to the weigh frame, a lateral stabilizing system is provided between the carriage frames. This system comprises antifriction means interconnecting the frames so as to resist, through horizontal reaction forces, twisting, turning and horizontal movement laterally of one frame relative to the other without interfering with or imposing frictional restraint on relative vertical movement of the frames. The arrangement illustrated embodies a number of reaction assemblies each of which is capable of transmitting force only in a horizontal plane. One reaction couple is provided by a first pair of vertically spaced circular rollers or balls **90** and **91** which, as viewed by the driver of the truck (Fig. 1), are located at diagonally opposite corners of the carriage and resist twisting of the supplemental frame in a clockwise direction. Another reaction couple is provided by a second pair of vertically spaced diagonally located balls **92** and **93** which, as similarly viewed, resist turning of the supplemental frame forks in a counterclockwise direction. Each of the balls is located between a bearing plate or element **95** on the main frame **30** and a similar element **96** on the supplemental frame **50**. The bearing elements **95** and **96** are made of hard tool steel or the like and have flat confronting vertical surfaces **97** and **98** disposed in spaced parallel relation so as to receive the stabilizing balls therebetween. The upper and lower balls **92** and **91** on one side of the carriage and the corresponding balls **90** and **93** on the other side may be located in the same vertical plane, as shown, and the bearing elements **95** at one side may thus be secured as by welding to one of a pair of vertical bars **99** welded to the front surface **88** of the frame plate **40**. Similarly at the other side of the corresponding elements may be welded to the other of the

vertical bars **99** on the plate **40**. Suitable ball retaining or caging means such as top and bottom metal plates **100** and **101** are carried by the relatively movable or supplemental frame **50** to retain the stabilizing balls when the latter are not under compression between the bearing elements **95** and **96**. In the arrangement illustrated, the cage plates **100** and **101** in pairs are secured as by welding to vertical steel bars **102** which are part of or are secured to the uprights or connecting members **53** and **56** tying together the upper and lower members **51** and **52** of the supplemental frame. The pairs of stabilizing balls **90—91** and **92—93** and their associated bearing elements constitute reaction means for applying force couples to the movable or supplemental frame that prevent twisting, turning and tilting of the supplemental frame on the support ball **67** of the sensing element. Side thrusts on the supplemental frame are, of course, resisted by the reaction in concert of either the balls **90** and **93** or the balls **91** and **92**, depending upon the direction of such side thrust.

To minimize the transmission of vertical forces between the frames through the stabilizing balls **90—93** the cage for each ball is carried by the relatively movable carriage frame which receives the load, as in the case of the circular rollers **77** and **80**. Thus the action of the stabilizing balls at the instant of weighing is illustrated somewhat diagrammatically in Fig. 7, which shows, in full line, the relative position of the stabilizing ball **93** between the bearing elements **95** and **96** at the instant of weighing a load on the lift forks and when the stabilizing ball is under compression in resisting a side thrust, eccentric load or tilt force applied to the supplemental carriage frame. The same figure, in broken lines, illustrates with some exaggeration the relative positions of the parts in the unloaded condition of the carriage or when the stabilizing ball is relieved of horizontal compression between the bearing elements. In the free or unloaded condition the stabilizing ball **93** rests by gravity on the bottom plate **101** of the cage and may contact one or both of the bearing elements **95—96**.

Upon the application of a load to the lift forks of the truck the yielding of the sensing system results, as previously mentioned, in downward shifting of the supplemental frame **50** relative to the main frame **30** in the direction of the arrow of Fig. 7. The ball **93**, compressed between the surfaces **97** and **98** of the bearing elements, rolls upwardly on the flat surface **98** of the element **96** and is thereby lifted clear of engagement with the bottom cage element **101**. Thus at the instant of weighing, the stabilizing ball is supported wholly by frictional engagement of diametrically opposite points on the ball and the vertical surfaces **97** and **98** of the horizontally opposed bearing elements. By reason of the free roll characteristic of the ball between the opposed flat bearing surfaces the stabilizing connection between the frames of the carriage is, at the instant of weighing, substantially incapable of transferring vertical loads and the true weight of the load is obtained by the hydraulic or other sensing element. It is apparent, of course, that in constructing the stabilizing system the balls **90—93** and their associated bearing elements are so located that clearances are provided for expansion and contraction of the parts with temperature changes and to prevent binding. The cage means of plates **100** and **101** are so spaced that the rolling movement of the stabilizing ball on the surface **98** of the bearing element **96** is insufficient in normal operation to bring the ball into contact with the upper cage plate **100** at the instant of weighing. It is also apparent that all of the stabilizing balls **90—93** do not function simultaneously, the location of the several stabilizing assemblies being such that for any given condition only that assembly or those assemblies react which are called upon to overcome the particular side thrust, twist or eccentric load that may be present. When not functioning to resist or withstand such loading of the supplemental frame, the stabilizing balls remain at rest on the bottom cage plates **101** and, because of the clearances provided between the parts, each contacts only one of the opposed bearing elements **95** or **96**.

In backing the truck to withdraw the forks **1** and **2** from under a load, frictional drag of the load on the forks may tend to swing the bottom of the supplemental frame **50** away from the main frame **40**, the supplemental frame swinging in a counterclockwise direction as viewed in Fig. 3 about the load point on the sensing element ball **67** as a fulcrum. To limit this frame separating movement, suitable tie means is provided to interconnect the frames. The tie means permits free movement of the supplemental frame relative to the main frame of limited amount in all directions and may comprise bolts **105** which extend through openings **106** adjacent side edges **107** of the main frame member **40**. The bolts are screwed tightly into threaded sockets in the uprights **53** and **56** of the supplemental frame **50** and are thus rigid with the latter. Washers **108** received on the tie bolts **105** behind the main frame member **40** are normally spaced from the latter but are arranged to engage it upon predetermined outward swinging movement of the supplemental frame to thereby limit such movement. The washers are retained on the bolts by bolt heads **109**. In the normal and weigh positions of the frames the tie bolts **105** are spaced or separated from the walls of the openings **106** by a surrounding clearance so that the interlocking connections between the frames are effected without metal to metal contact except when the connections are called upon to resist excessive relative movement of the frames.

A forward impact against the supplemental frame **50** such as results from driving the truck so that the forks **1** and **2**, or one of them, ram into an obstruction, imposes impact strains on the cylindrical steel rollers **80**. These rollers and the tough hardened steel planar surfaces between which the rollers are disposed are able to withstand such impacts without damage and to remain in proper working condition for maintaining the friction free suspension of the supplemental carriage for weighing. A forward impact of the character mentioned is not injurious to the upper hingelike friction free interlock comprising the cage tubes **74** and **75** and the roller bars **77**, since the interleaved tubes merely move toward and against the confronting surfaces of the companion frame members. In the case of the sensing element S a forward impact on the supplemental frame merely slides the downwardly directed planar surface of the load element **66** horizontally on the top of the ball **67**, or the cylinder **62** tilts bodily since the base **63** merely rests on the support bracket **64**. Thus the scale device of the present invention is capable of withstanding the rough usage to which lift trucks are customarily subjected and yet to maintain the substantially friction free suspension of the supplemental weigh frame on the main frame of the carriage. The original lift forks **1** and **2** are utilized without modification or alteration so that the lift truck manufacturer can readily meet existing specifications of performance and dimension with the present scale device incorporated in the lift truck.

The pressure developed on the hydraulic fluid in the cylinder casing **62** of the sensing element S is suitably translated into an indication of the vertical load imposed on the sensing element, thus accomplishing the desired weighing function of the device. As previously mentioned, hydraulic fluid is continuous from the chamber in the bottom of the sensing element cylinder through a conduit **71** to an indicator **72**, the latter being located either on the rear side of the mast B or, as shown, on a bracket **110** secured to the instrument panel **111** of the truck.

The indicator **72** is conventional and may comprise a pressure sensitive arcuately curved Bourdon tube **112** (Fig. 8) one end of which is fixed to the casing of the indicator and connected to receive fluid under pressure from the conduit **71**. The other end of the Bourdon tube, being free to move upon distortion of the tube as a result of internally applied fluid pressure is pin connected at **114** to a rack **115** which is meshed with or is otherwise connected to an actuating gear **116** fast on the shaft of a dial pointer **117**. Thus the pointer **117** is actuated by varying pressure in the hydraulic system to move to different positions on the face of the dial (not shown) and to indicate such pressure and thereby the weight of any load applied to the sensing element S.

Because of the variation in the position of the sensing element S relative to the indicator **72** resulting from raising and lowering the lift truck carriage C, the conduit **71** or a portion thereof comprises a flexible tube of rubber or the like. While this tube may be suitably suspended as in a festoon between the sensing element and the indicator, it is preferable to extend it through an opening **118** in the frame plate **40** and thence upwardly and over a free running pulley **120** carried by the crosshead **22** in coaxial relation to the reeving pulleys **25** that carry the lift chains **27**. Thus the reversely bent or looped flexible conduit **71** of the hydraulic sensing system extends in the form of an inverted U upwardly from the carriage C in front of the mast, over the pulley **120** at one side of the crosshead and thence downwardly in rear of the mast B to the indicator **72**. Suitable clamps or bands **121** secure the lower portions of the conduit loop to the carriage and to the mast to maintain a slight tension thereon so that the conduit is held firmly in the groove of the pulley **120**. The flexible conduit is thus maintained at a constant length during raising and lowering of the carriage and for all positions of the carriage and comprises a bent semicircular portion at the top, of constant predetermined length and shape and two straight parallel side portions which individually vary in length but which together aggregate a substantially constant length. Thus the carriage movement does not objectionably affect the hydraulic system and accurate weighing is obtained in all positions of the carriage. It is unnecessary to shut off the truck engine during the weighing operation. The engine vibration has a beneficial effect in overcoming any sticking and inertia effects of the hydraulic sensing system and indicator and also in settling the circular rollers **77** and **80** on their respective bottom supports while the lift carriage or platform is unloaded.

The present invention thus provides a suspension and stabilizing system for a scale mechanism particularly suited to use in a lift truck combination where the applied load is displaced or offset horizontally from the sensing element which receives the weight reaction. There is thus obtained a portable scale which withstands the rigors of hard usage customarily associated with lift truck operation while yet maintaining accuracy and reliability in weighing. The scale device can be provided as an integral part of the lift truck at the time of original manufacture or, if desired, it can be furnished in the form of a kit to be installed on a preexisting lift truck. Whether the scale device is furnished as original equipment or is a subsequent attachment, it can be removed from and replaced on the lift truck as desired without withdrawing the truck from service for an extended period of time and without the use of specialized training on the part of the mechanic doing the job.

A lift truck incorporating the scale device of the present invention can be manipulated and used in substantially the same manner as a conventional truck not having a scale, there being no interference with the lift forks other than a nominal forward shift in the load center. The lift forks can be moved toward or away from one another on the supplemental frame **50** in the same way as they might be shifted on the original truck or, if desired, the lift forks may be replaced by other attachments, such as barrel or roll handling devices.

With such variations and combinations the scale device functions to weigh accurately different items or commodities handled by the truck.

In accordance with the patent statutes the principles of the present invention may be utilized in various ways, numerous modifications and alterations being contemplated, substitution of parts and changes in construction being resorted to as desired, it being understood that the embodiment shown in the drawings and described above is given merely for purposes of explanation and illustration without intending to limit the scope of the claims to the specific details disclosed.

What I claim and desire to secure by Letters Patent of the United States is:

1. In a lift truck of the type having a wheeled supporting structure including a mast, an elevating member mounted on the mast for vertical movement, a crosshead and lowering and raising actuating means therefor, a flexible element reeved over the crosshead and connected at one end to the supporting structure and at the other end to the elevating member for raising and lowering the latter on the mast by raising and lowering the crosshead, a scale attachment comprising a weigh structure having a generally horizontal element for receiving a load, means interposed between the weigh structure and the elevating member for supporting the weigh structure and any load carried thereby on the elevating member in all vertical positions to which the latter may be moved by the crosshead and flexible element, the elevating member and the weigh structure being formed with spaced parallel generally vertical confronting surfaces, rotatable elements of circular profile interposed between the said vertical confronting surfaces to resist normal compressive forces between the elevating member and the weigh structure, said rotatable elements being vertically spaced and arranged to provide a force couple to balance the couple produced by the interposed supporting means and a load on the horizontal receiving element displaced laterally from such supporting means, a hydraulic system connected to the interposed supporting means for indicating the weight supported, the vibrations of the truck incidental to operation of the engine serving to overcome small frictional restraints in the system, said hydraulic system including a gauge fixed on the supporting structure, and a flexible conduit extending between the supporting means and the gauge, said conduit being reeved over the crosshead to retain a reverse bend in the conduit of substantially constant contour in all positions of the movable elevating member.

2. A scale device for attachment to the elevating member of a lift truck or the like, said device comprising a main body member adapted to be secured to such elevating member in lieu of the conventional load carrying forks or the like, a supplemental member disposed in front of the main body member, said supplemental member being adapted to receive and support the conventional load bearing forks or the like of the truck in cantilever relation, means interposed between and supporting the supplemental member on the main body member, said supporting means including a weight sensing element and an indicator responsive to the weight supported, said main body member and said supplemental member each being formed with a generally vertical surface, said vertical surfaces being spaced generally parallel and being confronting surfaces, and rotatable elements interposed between such confronting surfaces, the rotatable elements being in substantially the same vertical plane and being vertically spaced and peripherally engaged by the parallel surfaces of the members to resist compressive forces between such member normal to the surfaces and to resist separation of such members, the forces in the vertically spaced rotatable elements providing a couple to balance that resulting from the application of a load to the cantilevered forks or the like and the reaction of the supporting means.

3. A scale device for attachment to the elevating member of a lift truck or the like, said device comprising a main body member adapted to be secured to such elevating member in lieu of the conventional load carrying forks or the like, a supplemental member disposed in front of the main body member, said supplemental member being adapted to receive and support the conventional load bearing forks or the like of the truck in cantilever relation, means interposed between and supporting the supplemental member on the main body member, said supporting means including a weight sensing element and an indicator responsive to the weight supported, and means for transmitting horizontal forces between the supplemental and body members at vertically spaced points lying substantially in a single plane, said force transmitting means being substantially incapable of transmitting vertical forces between the supplemental and body members whereby the weight of the supplemental member and any load carried thereby is imposed substantially wholly on the interposed supporting means, and the transmission of the horizontal forces through the vertically spaced points providing a couple to balance that resulting from the application of a load to the cantilevered forks or the like and the reaction of the supporting means.

4. In a lift truck or the like having a vertically movable carriage and actuating means therefor, load receiving means connected to and projecting cantilever fashion from the carriage, anti-friction means interposed in the connection between the carriage and the load receiving means, the anti-friction means including vertically spaced elements substantially incapable of transmitting vertical forces between the load receiving means and the carriage while transmitting horizontal forces therebetween and providing a force couple to balance the force couple resulting from the imposition of a load on the cantilevered load receiving means, the anti-friction means including roller elements in outer surface peripheral contact with the carriage and the load receiving means, and an hydraulic weight sensing means interposed between the carriage and the load receiving member to support the latter.

5. In a weighing device, a component constituting a main support, a supplemental component constituting a load receiver and including vertical and horizontal parts, means connecting the vertical part of the load receiver to the main component at vertically spaced points, the connecting means comprising a centerless roller and tubes embracing the roller, one tube being fast to the main support and another tube being fast to the vertical part of the load receiver, the roller being smaller than the interiors of the tubes to permit slight vertical shifting of one component relative to the other with attendant rolling of the roller inside the tubes whereby to transmit horizontal forces substantially without the transmission of vertical forces, and force sensing means interposed between and operatively connected to the main component and the vertical part of the load receiver and being responsive to a load on said load receiver, the horizontal part of the supplemental component extending cantilever fashion from the vertical part to provide a platform for receiving a load displaced horizontally from said vertical part of the supplemental component.

6. A scale device for attachment to the elevating member of a lift truck or the like, said device comprising a main body member adapted to be secured to said elevating member in lieu of the conventional load bearing forks and the like, a supplemental member disposed in front of the main body member, said supplemental member being adapted to receive and support the conventional load bearing forks and the like of the truck in cantilever relation, means interposed between and supporting the supplemental member on the main body, said supporting means including a weight sensing element responsive to the weight supported, said main body member and said supplemental member each being formed with a generally vertical surface, said vertical surfaces being spaced generally parallel and confronting surfaces having upper and

lower portions, rotatable elements interposed between said confronting surfaces at said upper and lower portions, interlocking means connected to the confronting surfaces upper portions peripherally engaging certain of the rotatable elements and resisting separation of the confronting surfaces upper portions while allowing limited vertical movement of said confronting surfaces, certain of the rotatable elements resisting compressive forces between the confronting surfaces lower portions while allowing limited vertical movement of said confronting surfaces, and the forces in the rotatable elements and the interlocking means providing a couple to balance that resulting from the application of a load to the cantilevered forks or the like and the reaction of the supporting means.

7. A scale device as defined in claim 6 in which the interlocking means engaging certain of the rotatable elements includes tubes; in which the rotatable elements engaged by the interlocking means include a centerless roller; and in which the tubes embrace the roller, one tube being secured to the vertical surface of the main body member and another tube being secured to the vertical surface of the supplemental member, and the roller being smaller than the interiors of the tubes to permit limited vertical movement of the supplemental member relative to the main body member with attendant rolling of the roller inside the tubes.

8. A scale device as defined in claim 6 in which the weight sensing element is connected to said main body and supplemental members vertical surfaces and is positioned between said surfaces vertically intermediate said rotatable elements.

9. In a lift truck of the type having a wheeled supporting structure including a mast, an elevating member mounted on the mast for vertical movement, load receiving means having cantilever connection with the elevating member, said connection including vertically spaced elements for transmitting horizontal forces and being substantially incapable of transmitting vertical forces, said vertical spaced elements being positioned in substantially the same vertical plane, at least certain of the vertically spaced elements being rotatable elements, said connection including interlocking means connected to the elevating member and to the load receiving means peripherally engaging said rotatable elements and resisting separation of the elevating member and load receiving means, said connection including weight sensing means for transmitting and responding to vertical forces and substantially incapable of transmitting and unresponsive to horizontal forces, the vertically spaced elements being arranged to provide a force couple to balance the couple which results from a load on the cantilevered receiving means and the reaction of the weight sensing means, and an indicator connected to the weight sensing means.

10. In a scale, a supporting structure, a weigh structure having a generally horizontal element, each of said structures being formed with a generally vertical surface having upper and lower portions, said vertical surfaces being generally parallel confronting surfaces, said weigh structure vertical surface being positioned spaced forwardly from said supporting structure vertical surface with said weigh structure horizontal element extending forwardly for supporting a load in cantilever fashion, means connected to said structures and extending directly between said structure vertical surfaces for resisting separation of the upper portions of said structure vertical surfaces and allowing limited vertical movement therebetween, means connected to said structures and extending directly between said structure vertical surfaces for resisting compressive forces between the lower portions of said structure vertical surfaces and allowing limited vertical movement therebetween, weight sensing means connecting said structures and allowing limited vertical movement therebetween, said means resisting separation of the upper portions of said structure vertical surfaces and said means resisting compressive forces between the lower portions of said structure vertical surfaces being substantially incapable of transmitting vertical forces between said structures, and said weight sensing means being substantially incapable of transmitting horizontal forces between said structures.

11. In a scale, a supporting structure, a weigh structure having a generally horizontal element, each of said structures being formed with a generally vertical surface having upper and lower portions, said vertical surfaces being generally parallel confronting surfaces, said weigh structure vertical surface being positioned spaced forwardly from said supporting structure vertical surface with said weigh structure horizontal element extending forwardly for supporting a load in cantilever fashion, means positioned totally between said structure vertical surfaces resisting separation of the upper portions of said surfaces and allowing limited vertical movement therebetween, means positioned totally between said structure vertical surfaces resisting compressive forces between the lower portions of said surfaces and allowing limited vertical movement therebetween, weight sensing means connected to said structures and allowing limited vertical movement therebetween, said means between said surface upper portions and said means between said surface lower portions being substantially incapable of transmitting vertical forces between said structures, and said weight sensing means being substantially incapable of transmitting horizontal forces between said structures.

12. In a lift truck of the type having a wheeled supporting structure including a mast, an elevating member mounted on the mast for vertical movement, a main body member secured to said elevating member in lieu of the conventional load bearing forks, means securing said main body member to said elevating member, a supplemental member disposed in front of the main body member, the load bearing forks of the truck received on and supported by the supplemental member in cantilever relation, means supporting said forks on said supplemental member, said means securing and said means supporting being substantially the same for providing interchangeability of said forks and main body member, means connecting said supplemental member and main body member, said connection means including anti-friction means for transmitting horizontal forces and being substantially incapable of transmitting vertical forces, said connection means including weight sensing means for transmitting and responding to vertical forces and substantially incapable of transmitting and unresponsive to horizontal forces, the anti-friction means being arranged to provide a force couple to balance the couple which results from a load on the cantilever receiving means and the reaction of the weight sensing means, and an indicator connected to the weight sensing means.

13. In a lift truck of the type having a wheeled supporting structure including a mast, an elevating member mounted on the mast for vertical movement, a main body member, hook means on the main body member securing said member to said elevating member in lieu of the conventional load bearing forks, a supplemental member disposed in front of the main body member, load bearing forks having hook means mounted thereon substantially the same as the main body hook means, the load bearing forks received on and supported by the supplemental member in cantilever relation with the fork hook means engaged with said supplemental member, means connecting said supplemental member and main body member, said connection means including antifriction means for transmitting horizontal forces and being substantially incapable of transmitting vertical forces, said connection means including weight sensing means for transmitting and responding to vertical forces and substantially incapable of transmitting and unresponsive to horizontal forces, the anti-friction means being arranged to provide a force couple to balance the couple which results from a load on the cantilever receiving means and the reaction

of the weight sensing means, and an indicator connected to the weight sensing means.

14. In a lift truck of the type having a wheeled supporting structure including a mast, an elevating member mounted on the mast for vertical movement, load receiving means having cantilever connection with the elevating member, said connection including vertically spaced elements for transmitting horizontal forces and being substantially incapable of transmitting vertical forces, at least certain of the vertically spaced elements being rotatable elements, said connection including interlocking means connected to the elevating member and to the load receiving means peripherally engaging said rotatable elements and resisting separation of the elevating member and load receiving means, said interlocking means including tubes, said rotatable elements including a centerless roller, said tubes embracing said roller with one tube being connected to the elevating member and another tube being connected to the load receiving means, the roller being smaller than the interiors of the tubes to permit slight vertical shifting of the load receiving means relative to the elevating member with attendant rolling of the roller inside the tubes, said connection including weight sensing means for transmitting and responding to vertical forces and substantially incapable of transmitting and unresponsive to horizontal forces, the vertically spaced elements being arranged to provide a force couple to balance the couple which results from a load on the cantilever receiving means and the reaction of the weight sensing means, and an indicator connected to the weight sensing means.

15. In a scale, a supporting structure, a weight structure having a generally horizontal element, each of said structures being formed with vertically spaced upper and lower portions, said weight structure upper portion having a vertical surface positioned spaced forwardly from a vertical surface on said supporting structure upper portion, said weight structure lower portion having a vertical surface positioned spaced forwardly from a vertical surface on said supporting structure lower portion, said weight structure horizontal element extending forwardly for supporting a load in cantilever fashion, means extending directly between and operatively connected to said structure upper vertical surfaces resisting separation of said upper vertical surfaces and allowing limited vertical movement therebetween, means extending directly between and operatively connected to said structure lower vertical surfaces resisting compressive forces between said lower vertical surfaces and allowing limited vertical movement therebetween, weight sensing means connected to said structures and allowing limited vertical movement therebetween, said means between said structure upper and lower portions being arranged to balance forces which result between said structure upper and lower portions from a load on said weigh structure horizontal element, and said weight sensing means being substantially incapable of transmitting horizontal forces between said structures.

16. In a lift truck of the type having a wheeled support including a mast, an elevating member structure mounted on the mast for vertical movement, a weigh structure having a generally horizontal element, each of said structures being formed with vertically spaced upper and lower portions, said weigh structure upper portion having a vertical surface positioned spaced forwardly from a vertical surface on said elevating member structure upper portion, said weigh structure lower portion having a vertical surface spaced forwardly from a vertical surface on said elevating member structure lower portion, said weigh structure horizontal element extending forwardly for supporting a load in cantilever fashion, means extending directly between and operatively connected to said structure upper vertical surfaces resisting separation of said vertical surfaces and allowing limited vertical movement therebetween, means extending directly between and operatively connected to said structure lower vertical surfaces resisting compressive forces between said lower vertical surfaces and allowing limited vertical movement therebetween, weight sensing means connected to said structures and allowing limited vertical movement therebetween, said means between said structure upper and lower portions being arranged to balance forces which result between said structure upper and lower portions from a load on said weight structure horizontal element, and said weight sensing means being substantially incapable of transmitting horizontal forces between said structures.

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