Sept. 2, 1958 R. C. CHATTIN 2,849,809

DITCHER WITH DIVERGENT WINGS

Original Filed Nov. 15, 1946 4 Sheets-Sheet 1

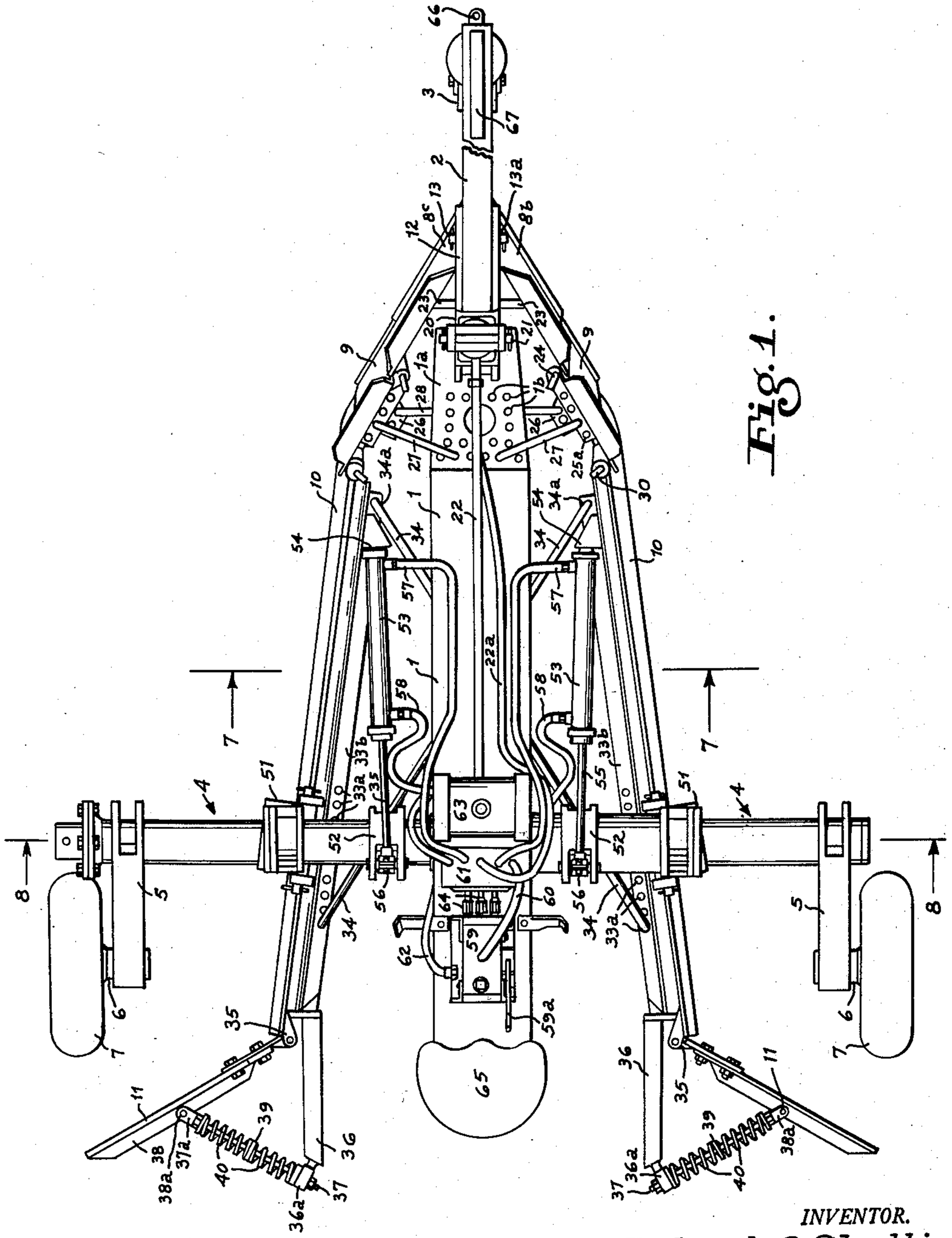

Fig. 1.

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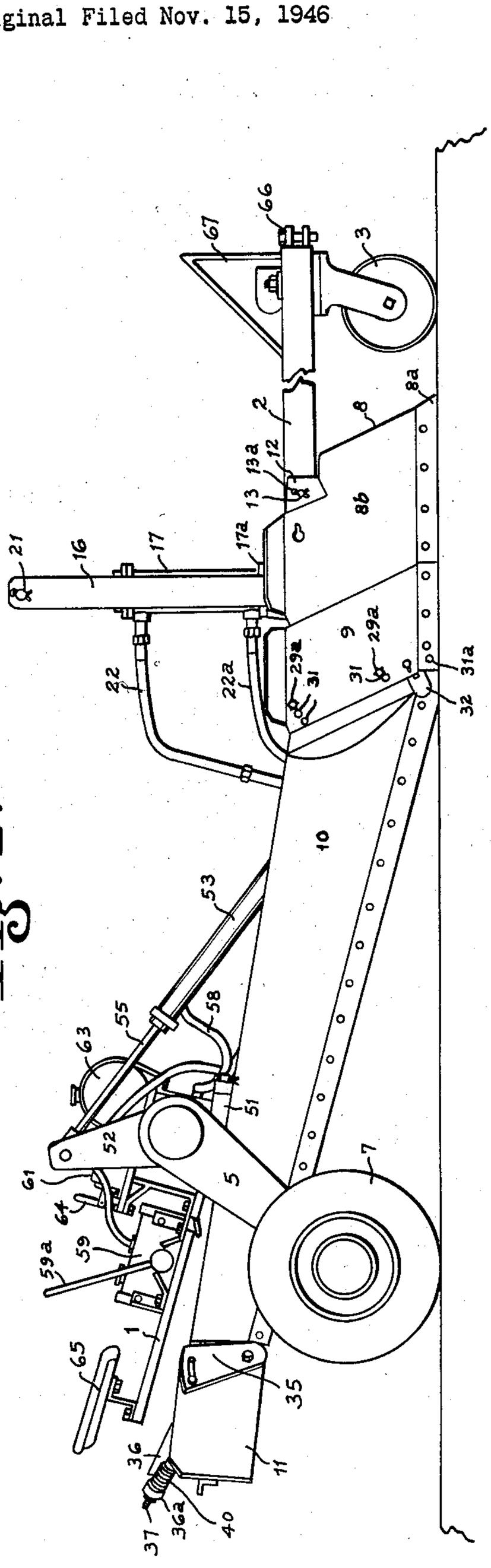

Fig. 2.

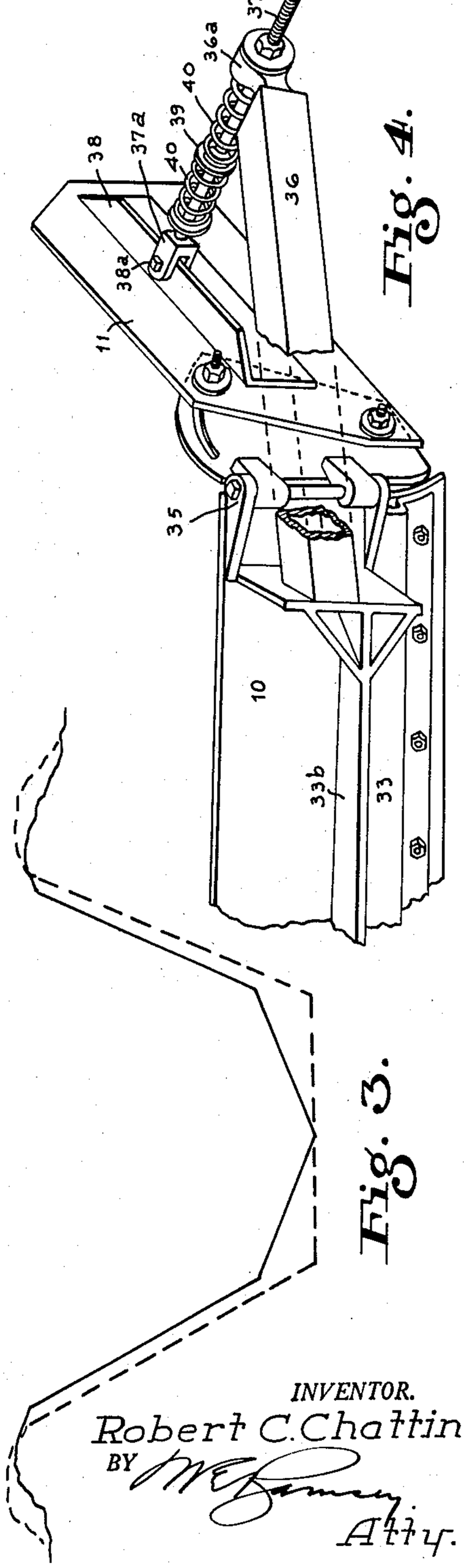

Fig. 4.

Fig. 3.

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DITCHER WITH DIVERGENT WINGS

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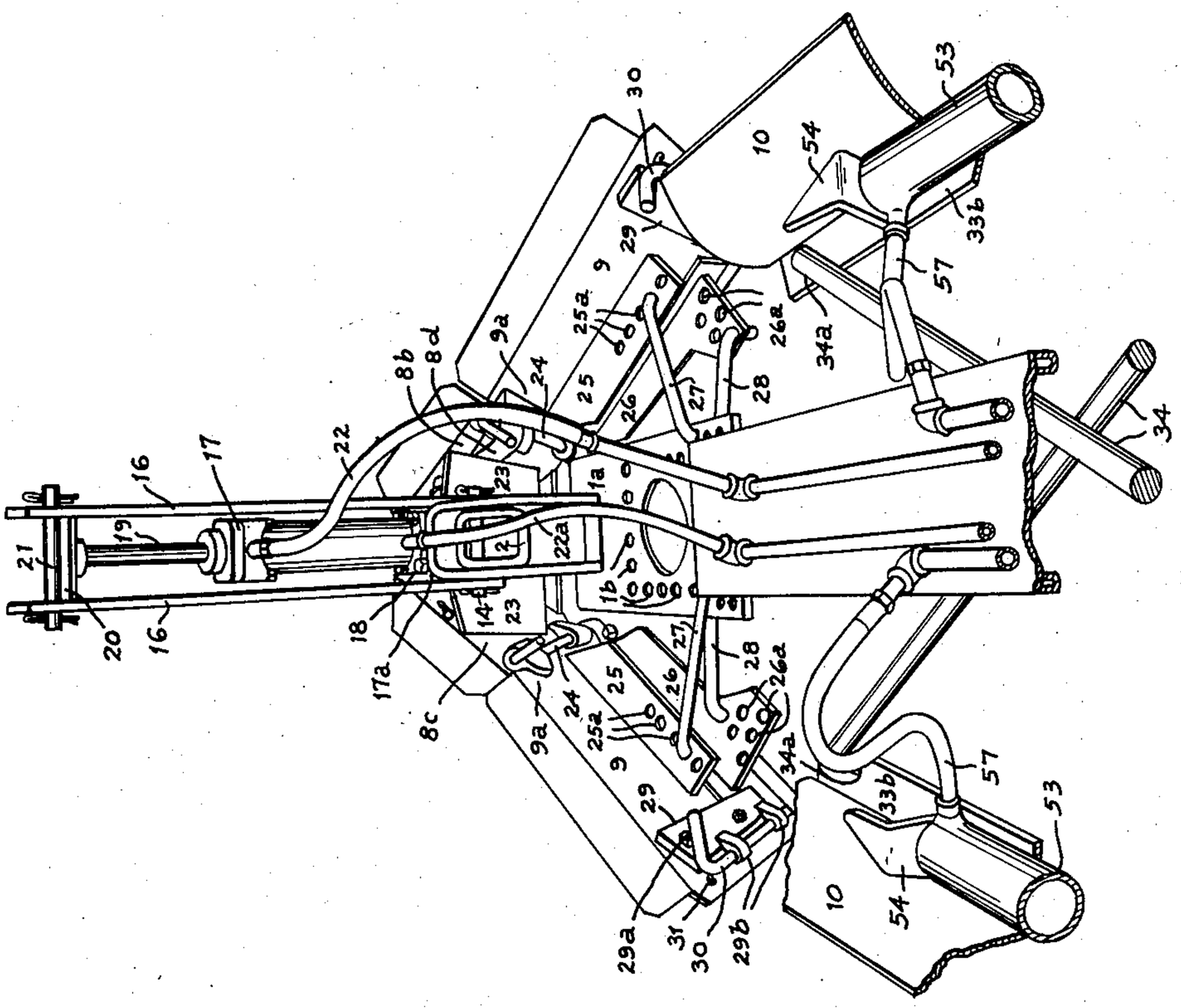

Fig. 7.

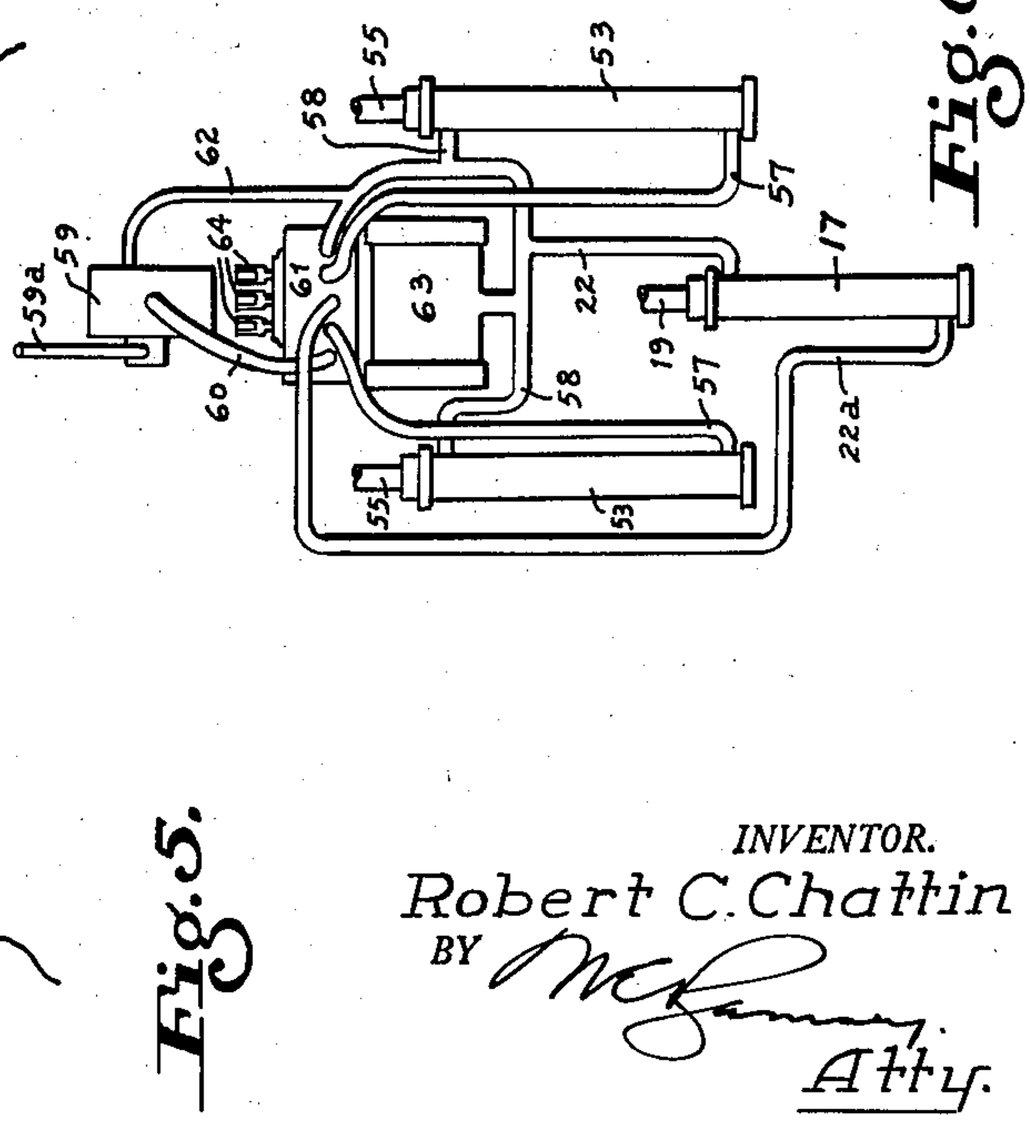

Fig. 6.

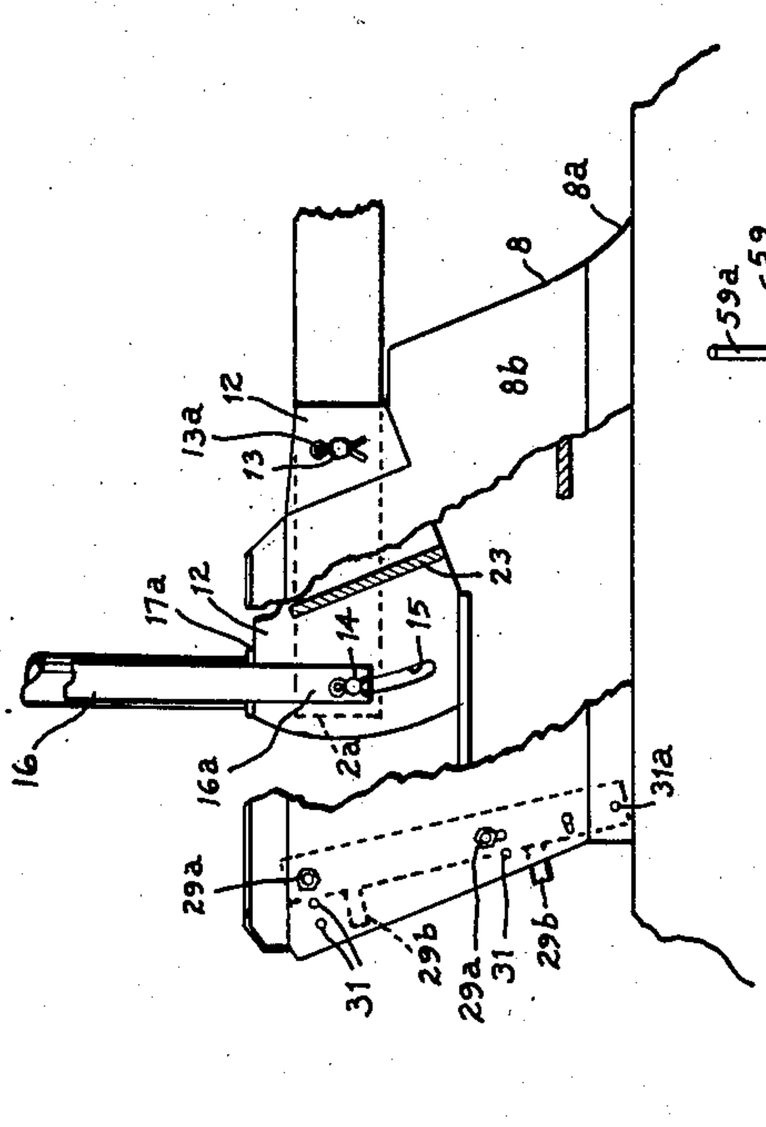

Fig. 5.

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DITCHER WITH DIVERGENT WINGS

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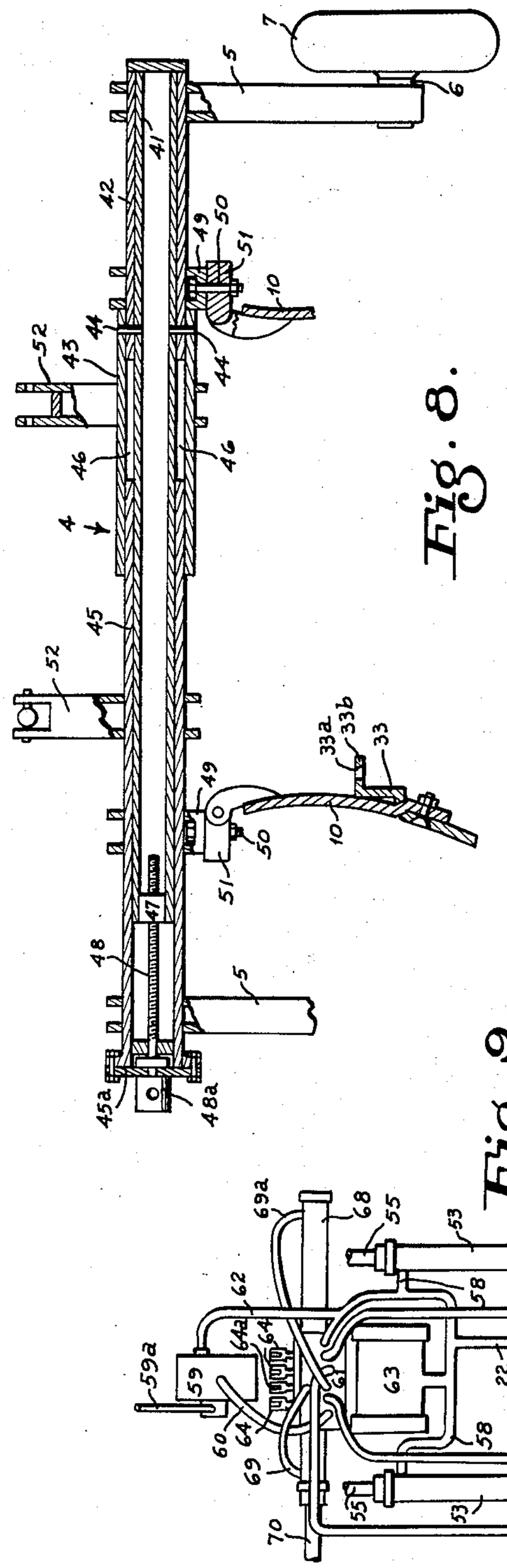

Fig. 8.

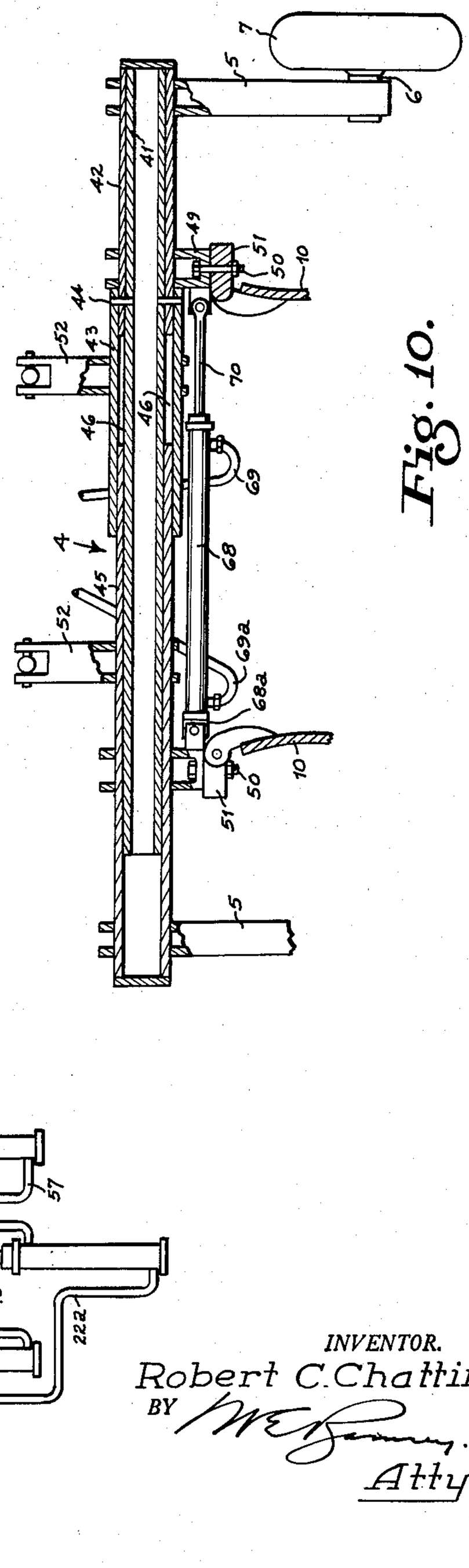

Fig. 10.

Fig. 9.

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DITCHER WITH DIVERGENT WINGS

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Original application November 15, 1946, Serial No. 709,967, now Patent No. 2,662,311, dated December 15, 1953. Divided and this application September 28, 1953, Serial No. 382,521

9 Claims. (Cl. 37—98)

My invention relates to a ditching machine particularly adapted for the construction of irrigation ditches, and has for its particular object the provision of a machine which is sturdily but simply constructed, one which may be made quite large so as to do heavy work, and one which is adjustable to dig ditches of various profiles. It is particularly adapted to construct a ditch having a relatively wide flat bottom and steeply inclined sides, thereby to permit large quantities of water to flow therethrough without interposing substantial frictional resistance to flow.

This application is a division of application Serial No. 709,967, entitled Ditcher With Hydraulic Adjustments, originally filed November 15, 1946, now United States Patent No. 2,662,311, granted December 15, 1953.

A further object of my invention is to provide a ditching machine of this character which may be used to dig in relatively virgin soil. That is, this object of my invention is to provide a sturdily constructed machine having a plow point for entering turf and relatively hard packed soil, and to distribute the dirt thus loosened toward the sides of the ditch to provide a ditch of predetermined profile.

A further object of my invention is to provide a machine of this character with lateral or wing portions which profile the sides of said ditches and maintain said profile and with trailing wings which level the tops of said ditches, but which are yieldingly mounted, so that if they strike an obstruction such as a large rock, or heavy shoulder, or compacted earth or gravel, they will lift over and away from said obstruction without interposing rupturing or breaking strains upon the mechanism.

A further object of my invention is to provide a ditching mechanism of this character which may be used to clean debris and growth in a present ditch, or to change the profile thereof while accommodating itself to the general size and pattern of said ditch.

A further and more specific object of my invention is to provide an axle structure in a ditching machine of this character which is strong and sturdy, is adjustable as to length, and is capable of withstanding unusual stresses produced by severe usage.

A further and more specific object of my invention is to provide a ditching machine of this character which has a plow point which may be lifted or lowered, which may be changed in angular position in a vertical plane, and which may be adjusted with regard to trailing and outwardly diverging wings pivotally secured thereto.

A further object of my invention is to provide a ditcher of this character in which the diverging wings may be set to different levels so that a ditch may be constructed which throws banks higher on one side than on another, if it is desired to operate upon a hillside, for example, without first initially forming a level ledge.

Further and other objects of my invention are hereinafter described with reference to the accompanying drawings, in which:

Fig. 1 is a plan view of a ditcher embodying my invention, showing the wing portions thereof folded toward the median line;

Fig. 2 is an elevation of said ditcher;

Fig. 3 is a schematic drawing illustrating the manner in which various profiles may be constructed and a preferred method of forming a ditch with a wide flat bottom from one which has a trough-like bottom;

Fig. 4 is a fragmentary view, with portions shown broken away, of the trailing, resiliently mounted wing carried by the divergent primary wing at each side of said ditcher;

Fig. 5 is a side elevation of the pointed forward end of a ditcher with portions shown broken away to disclose details of construction thereof;

Fig. 6 is a hydraulic diagram showing the controlling piston-and-cylinder elements for manipulating the several parts of said ditcher;

Fig. 7 is a fragmentary perspective view of the forward part of my ditcher taken substantially on the line 7—7 in Fig. 1;

Fig. 8 is a sectional view taken on the line 8—8 in Fig. 1 of the axle assembly and the parts directly secured thereto, not showing, however, the portions of said ditcher which lie ahead of said axle assembly;

Fig. 9 is a hydraulic diagram of the control mechanism, which is a modification of my invention; and

Fig. 10 is a view similar to Fig. 8 of an axle assembly embodying the modification for which the diagram shown in Fig. 9 is intended.

A ditcher embodying my invention comprises a central beam assembly 1 which extends longitudinally and centrally of said ditcher. Secured to the forward end 1*a* thereof is a hitch beam 2. This is a stiff member and carries a caster wheel 3 at its forward end which provides the forward support for the ditcher. A transverse axle assembly 4 supports the after end of the beam. Lateral arms 5 are secured to the ends of said axle assembly and carry offset axles 6, and have ground-engaging wheels 7 journaled thereon. A plow point 8 is welded to the forward end of beam 1. Hingedly secured to the trailing end of said plow point is a pair of intermediate diverging wings 9. Hingedly secured to the trailing edges of the intermediate wings are primary wings 10. To the trailing ends of the primary wings are hingedly-mounted trailing wings 11. The plow point and the intermediate and primary trailing wings form more or less a continuous ground-engaging surface from the nose 8*a* of the plow point 8 to the rear end of the machine. Each of these successive ground-engaging elements is joined to the immediately succeeding one by articulated connections so that the ditcher is capable of being adjusted to form many diverse cutting profiles. Said wings are also laterally adjustable, by means which will hereinafter be described, so that said ground-engaging elements may be moved laterally to vary the width of a ditch to be dug by a machine embodying my invention.

The connection between te central beam assembly and the hitch beam is as follows: Secured to the forward end of the beam assembly 1 is an upstanding bifurcated fitting 12 which straddles the after end 2*a* of the hitch beam 2. Spaced from the extreme after end of said hitch beam is a pivot bolt 13, which passes through and is journaled in apertures in the sides of the bifurcated fitting. Said pivot bolt provides the pivotal connection between the hitch beam 2 and the beam assembly 1. Cotter keys 13*a* hold the pivot bolt in place and prevent lateral motion thereof. The extreme after end of the hitch beam carries an adjusting shaft 14 which passes transversely through the hitch beam, and the ends thereof pass through arcuate slots 15 in the sides of the bifurcated fitting 12, as is shown in Fig. 5. Said bolt also passes through and is secured to the lower ends 16*a* of

a bridging frame 16, which extends upwardly from the bifurcated fitting. Seated upon said bifurcated fitting is a piston-and-cylinder element 17 for raising and lowering, effectively, the plow point. Said piston-an-cylinder element has a base 17*a* mounted upon the bifurcated fitting which is secured thereto by bolts or studs 18. The cylinder is securely mounted on said bifurcated fitting by said fastening devices. At the other end thereof, a piston rod 19 extends. The upper end of said piston rod carries a plate 20, which is secured in turn by a pivot bolt 21, which passes through and secures the upper end of said bridging frame. The end of the piston rod thus bears against the pivot bolt which acts as a cross member in the bridging frame, and the base of the cylinder rests upon and is secured to the bifurcated fitting 12. The bridging frame is secured to the extreme end of the hitch beam 2 rearwardly of its pivot bolt, and thus when the piston rod is extended, it applies tension to the bridging frame, tending to lift the after end of the hitch beam. When the piston rod is retracted, the weight of the ditcher pulls the bridging frame down with the hitch beam as it rotates counterclockwise about said pivot bolt 13. Said cylinder element 17 therefore need only be single acting, having conduits 22 and 22*a* leading to the ends thereof. Thus hydraulic fluid may be applied to move said bridging structure upwardly and may be removed to move the bridging structure downwardly and therewith vary the angle of the plow point with respect to the hitch beam.

The plow point 8 preferably is made of two plates 8*b* and 8*c*, which join to form a sharp nose 8*a*. Said plates are inclined inwardly toward the top and slope rearwardly so as to provide a true plow contour. The forward end of said plates is braced by welding the bifurcated fitting 12 between them. Intermediate the ends of said plates is a pair of webs 23 which join the bifurcated fitting 12 to said plates. Said plates 8*b* and 8*c* are thus firmly and securely joined together and to the beam assembly 1, and thus the plow point is capable of sustaining substantial stresses without injury or deformation.

The intermediate wings 9 are joined end-to-end with the plates 8*d* secured to the trailing edge of plates 8*b* and 8*c*, respectively, and the intermediate wing plates have similar plates joined to the forward end 9*a* thereof. These are adapted to align and the pintle pins pass therethrough to provide a hinged joint. On the back of the intermediate wings are a pair of adjusting plates 25 and 26. That is, there is one adjusting plate 25 and one adjusting plate 26 on the back of each intermediate wing, respectively. Each is provided with a series of apertures 25*a* and 26*a*, respectively. Said apertures are arranged in predetermined pattern and spacing to accommodate bracing members, hereinafter described. The beam assembly also is provided with a series of apertures 1*b* at the margins thereof, which are arranged in spacing and series to correspond to the apertures 25*a* in the adjusting plate 25. Spanning hooks or braces 27 may selectively be seated with one end in one of the series of apertures 25*a* in adjusting plate 25 and the other end in one of the apertures 1*b* on the beam 1. The selection of a proper aperture will not only control the angle of the intermediate wing at that side, but will also determine the lateral spacing thereof with respect to the beam assembly 1. Joining the two adjusting plates 26 is a longer spanning hook or brace 28. Said spanning hook or brace underlies the beam assembly and is clear thereof. The ends engage selected apertures 26*a* in the two adjusting plates and further brace said intermediate wings and maintain the fixed spacing thereof, as determined by the engagement of the spanning hook or brace with the selected apertures 26*a*.

The trailing ends of the intermediate wings, respectively, have plates 29 secured thereto by bolts 29*a*. Each plate 29 has a pair of apertured ears 29*b* which are adapted slidably to receive a pintle pin or keeper 30.

The angular relationship of said plates 29 may be varied. (See Fig. 2). There are formed in the trailing edge of the intermediate wings a series of holes 31 arranged in arcuate pattern around a pivot pin 31*a*. Thus, when bolts 29*a* are passed through selected holes 31, it will determine the angle at which the plates 29 on the intermediate wings, respectively, are fixed.

The ears 29*b* on the plates 29 determine the pivot axis about which the primary wings 10 swing. That is, ears 32 are secured to the forward edge of each of the primary wings, and the pintle pin or keeper 30 passes through holes in said ears and in the ears 29*b* on the plates 29 secured to the intermediate wings, and the primary wings swing laterally about the axis of said pintle pin or keeper 30. Each of the primary wings on my improved ditcher has a laterally extending brace and bracket 33 secured to the inner face thereof. Said bracket preferably is in the form of a Z-bar, as is shown in Fig. 8, so as to give stiffness to it. Said bracket serves not only to position the primary wing, but also to stiffen and give rigidity thereto. Apertures 33*a* are arranged in the outstanding flange 33*b* of said bracket, and these apertures also are arranged in predetermined spacing to determine the angular position of said primary wings. A pair of crossed brace members 34 are pivotally mounted on their forward end at 34*a*, and the trailing ends of said crossed brace members may engage a selected aperture 33*a* in the bracket 33. I preferably arrange the forward end of said crossed brace bracket in an aperture similar to one of the apertures 33*a* and make the crossed brace members in the form of a spanning hook with dependent ends so that said crossed brace members may easily be removed for replacement, substitution or inspection.

On the rear edge of each primary wing, I mount a trailing wing 11, as has been described. This is secured by a hinged connection 35 (see Fig. 4) which includes both a hinge portion and a plate portion with an arcuate slot secured to the hinge and which thus allows said trailing wing 11 to swing back and upwardly at the same time. Thus, the hinge portion generally lies in the plane of both the trailing wing 11 and the primary wing 10 to allow pivotal movement about a first axis which is parallel to the plane of these wings. The illustrated nut and bolt assembly cooperates with the arcuate slot in the plate to allow pivotal movement in a vertical direction about a second axis which is normal to both the first axis and the plane of the trailing wing 11. To this end, a stiff prop 36 is joined to the trailing end of the bracket 33, as is shown in Figs. 1 and 4, and this serves to steady and determine the angular position of said trailing wing. An eye 36*a* is pivotally secured to the free end of the stiff prop and a rod 37, having a shackle 37*a* at one end thereof, is slidably mounted in said eye. The shackle is secured to a bracket 38 on the rearward face of said trailing wing by a pivot bolt 38*a*. An annular washer 39 is slidably mounted on said rod intermediate the ends thereof, and a pair of opposed compression springs 40 encircle said rod. One of said springs bears adjacent the bracket on one end and against the washer on the other, and the other spring bears against the washer on one end and adjacent the eye 36*a* on the other. Said springs preferably have different strength, and thus the spring of lesser strength will yield to permit the spring to move rearwardly under light obstruction, and the stronger spring will tend to be unyielding to said obstruction but will yield before said trailing wing will be broken or distorted by some larger or immovable obstruction.

The axle assembly is shown most clearly in Fig. 8. I preferably form said axle assembly of a series of encompassing and enveloping tubes. On the right hand side of said axle assembly, as viewed in Fig. 8, I provide three tubes 41, 42 and 43, which are joined together by pins 44 or by welding or other attachment. Inasmuch as said tubes are secured together, they have the effect of a solid, integral structure. I provide them as envelop-

ing tubes, however, because this provides a simple structure but one which can be constructed of standard and easily obtainable materials. The tube **41** extends well past the longitudinal median line of the ditcher and lies within the bore of the tube **45** secured at the opposite side of the ditcher. The tube **42** is short and provides a space **46** between its end and the end of the tube **45** to permit sufficient lateral adjustment of the axle assembly. The tube **43** overlaps the end of tube **42** and provides an encompassing flange over the inner end of tube **45**. That is, tubes **42** and **43** form virtually the bell of a bell-and-spigot joint in which the end of tube **45** would form the spigot end. A nut **47** is fixed in the end of tube **41**, and an adjusting screw **48** is journaled in a cap *45a* in the end of the tube **45**. Said adjusting screw is provided with a noncircular or a perforated end *48a*, so that a pry or lever may be secured thereto. The adjusting screw engaging the nut **47** thus moves the tubes **41** and **45**, respectively, more or less in overlapping relation with each other, and thus varies the overall width of the axle assembly.

The various tubes (comprising group **41—42—43** on one hand and the tube **45** on the other) are rotatably supported one upon the other, and thus the lateral arms **5** secured to the ends of the axle assembly may be adjusted to various angles. That is, in forming a ditch on sloping ground, the wheels **7** may be set to different levels so that the ditcher may ride in a horizontal plane. The primary wings are supported intermediate the ends by bifurcated brackets **49**, which are journaled upon the axle assembly. At the lower ends of said brackets are bolts **50** which are joined to plates **51** secured to the primary wings to support them. Said bolts provide a pivotal connection about a vertical axis between the axle assembly and the blades so as to permit said primary wings to be adjustable laterally and angularly without setting up binding strains. The lateral arms **5** carrying the ground-engaging wheels are welded or otherwise secured to the part of the axle assembly on which they are mounted, and thus form virtually integral structures therewith. Operating arms **52** are also welded or otherwise secured to the connected parts of the axle assembly so that the operating arm at one side of the ditcher is operatively an integral structure with the lateral arm which supports the ground-engaging wheel on that side.

Hydraulic manipulating cylinders **53** are provided, one for each operating arm. That is, a separate hydraulic manipulating cylinder is provided for each of the pair of primary wings. Each cylinder **53** is pivotally supported at one end upon a lug **54** secured to the inside of primary wing **10**. This provides a pivotal support for the forward end of each operating cylinder **53**. The piston rod **55** for each hydraulic manipulating cylinder is secured at its free end to the free end of an operating arm by a ball-and-socket joint **56**, which is provided to eliminate the possibility of binding strains. Thus, as the piston rod **55** is extended from the cylinder, it moves the operating arms counterclockwise, as viewed in Fig. 2, and when the piston rods are retracted, they move the operating arms clockwise. Inasmuch as said arms and the offset lateral arms **5** for the ground-engaging wheels **7** are operatively an integral structure, it will move said lateral arms **5** for the ground-engaging wheels similarly. Conduits **57** and **58** lead to the two ends of each hydraulic manipulating cylinder **53**, which cylinders are individually operable and capable of moving said piston rod outwardly under close control. The several operating cylinders and their conduits are illustrated in Fig. 6.

The hydraulic system is filled with hydraulic fluid maintained under substantial pressure by a pump **59**. Supply line **60** leads a distributing valve **61**, and a return line **62** is connected to a reservoir **63**. The pair of hydraulic manipulating cylinders **53** and the lifting piston-and-cylinder element **17** for the forward end of the machine are shown connected by their conduits. It is to be noted

that all supply lines to the several cylinders are connected directly with the distributing valve and all return lines are connected to or through the reservoir to the return line to the pump. Thus, each cylinder is supplied by a separate line to the pump and through the distributing valve, but yet they are all interconnected by a hydraulic system and receive their fluid from a common reservoir. The cylinders are controlled by separate levers **64**, arranged in a bank immediately forward of the driver's seat **65**. Thus, each cylinder may be selectively actuated in either of two opposite directions by means of a selective operating lever. I preferably provide a manually operable pump, and to this end provide a handle *59a* for operating said pump and maintain the hydraulic fluid at a proper pressure level at all times.

Said ditcher is adapted to be pulled by a tractor, and to this end has a connection **66** at the forward end of the hitch beam **2**. I preferably provide a vertical bump bar **67** at the forward end of said hitch beam. The purpose of element **67** is to provide a vertical bump bar. When the ditcher is in operation, many times the ditcher operator allows the ditcher to take too much cut, which stalls the tractor and in which case the tractor is backed up against the bump bar **67** and the ditcher pushed back to relieve it from the load so that it may be more easily adjusted for depth of cut. The connection between a tractor and the ditcher is susceptible of many different applications. The ditcher may be drawn by two tractors pulling through a pivoted equalizer bar secured to the connection **66**, an offset hitch may be provided secured either at said connection **66** or to some other firm and secure part of the ditcher, or any combination of these pulling connections can be provided which provide sufficient pulling power to move the ditcher along and cause it to operate properly.

In Fig. 3, I have indicated how a ditch is commonly formed. At the outset, and particularly in unbroken ground or in hard pan, it is necessary that the plow point be inclined downwardly at a substantial angle. Thus, the bottom of a ditch would be formed with a V-shaped bottom, as is indicated in unbroken lines in Fig. 3. Thereafter, it is desirable that it be made into a flat bottom ditch, as indicated in dotted outline. This may be done by increasing the angle between the intermediate wing and the primary wing by adjusting the bolts *29a* in the plates **29** and/or the angle of the plow point with respect to the hitch bar, so that the plow point and/or the intermediate wings will lie flatwise in the ditch and the primary wings will extend upwardly and outwardly at a sharper angle. Because of the articulated connections between the several ground-engaging tools of said ditcher, it is quickly adjustable and is capable of being set to form a multiplicity of contours of ditches, ditches in which one side is higher than the other and ditches having various types of bottoms, V-shaped and flat. Because the spanning hooks joining the several wings to the beam assembly and to the wings at the opposite sides are removable and adjustable, it is possible to set the wings at different angles and different spacing, and thus one wing may be arranged at a sharper angle and be less divergent than the other. This is particularly useful in forming a ditch on a hillside.

In Fig. 10, I illustrate a hydraulic cylinder **68** for varying the overall length of the axle, which would be varying the overall width of the ground-engaging or working tools. This comprises a double acting cylinder **68**, having conduits **69** and *69a* leading to the ends thereof. The cylinder is pivotally mounted at one end *68a* and the piston rod **70** is pivotally joined to the axle section at the opposite side of the ditcher. In Fig. 9, the hydraulic system is illustrated. I provide an additional control lever *64a* for operating said cylinder, but otherwise the same reference characters are given to the similar parts as the ones applied to them in Fig. 6. A hydraulic cylinder arrangement at this point provides an easy, quick and

reliable means for varying the overall length of the axles and the lateral span of the ground-engaging wings.

I claim:

1. In a ditcher having a plow point and intermediate and primary divergent wings joined in an articulated series to said plow point, a trailing wing means mounted pivotally on the rearward end of each said primary wing for limited universal movement relative thereto, resilient means interconnecting each said primary wing and the trailing wing companion thereto yieldably to bias the trailing wing pivotally out at an oblique angle to the primary wing, said trailing wings functioning to level the top of a ditch formed by said ditcher.

2. In a ditcher having divergent wings joined in an articulated series, trailing wing means mounted pivotally on the rearward end of said divergent wings and resiliently and yieldably extended therefrom for limited universal movement relative thereto while the ditcher is working, said trailing wing means functioning to level the top of a ditch formed by said ditcher.

3. In a ditcher having a plow point, intermediate and primary divergent wing means joined sequentially in an articulated series to the plow point to form the sides of a ditch, a trailing wing means pivotally mounted upon the rearward end of each of said primary wings and protruding laterally out therefrom for universal movement therewith and with respect thereto while the ditcher is working, and resilient means interconnecting each said primary wing and the trailing wing companion thereto to bias the trailing wing towards said protruding lateral position yet to yield when a lateral force of predetermined magnitude is applied to the trailing wing companion thereto.

4. In a ditcher having a plow point, intermediate and primary divergent wings joined sequentially in an articulated series to the plow point, a trailing wing means pivotally mounted upon the rearward end of each of said primary wings and protruding laterally out therefrom for movement both laterally and vertically with respect thereto, and resilient means interconnecting each said primary wing and the trailing wing companion thereto to bias the trailing wing toward said protruding lateral position yet to yield when a lateral force of predetermined magnitude is applied to the trailing wing, said resilient means including a compression spring element having operative bearing contact with said trailing wing and with a bracket secured to the primary wing companion thereto.

5. In a ditcher, a plow point, an intermediate wing and a primary wing all joined sequentially in an articulated series, a trailing wing means mounted upon the trailing edge of said primary wing and protruding laterally out therefrom for selective pivotal movement with respect thereto about a first axis parallel to the plane of both the trailing and the primary wing and a second axis normal to both the first axis and the plane of the trailing wing, and resilient means interconnecting said primary wing and trailing wing yieldably to bias the trailing wing towards said protruding lateral position yet to yield when a lateral force of predetermined magnitude is applied to the trailing wing.

6. A ditcher as in claim 5 wherein said resilient means includes a pair of aligned compression springs bearing one upon the other, said springs being of different strength whereby said trailing wing will pivot when a force is applied thereto, compressing the spring of lesser strength prior to compressing the spring of greater strength.

7. In a ditcher having a plow point, divergent wings joined together in an articulated series, a pivotal connection between said plow point and each of said series, a telescoping transverse axle assembly supporting said divergent wings, actuating means interconnecting the telescoping parts of said axle assembly for changing the longitudinal dimension of the latter and simultaneously adjusting the lateral spacing of said divergent wings, a lever means interconnecting each end of said axle assembly with the wing companion thereto to adjust the wing vertically relative to the axle assembly, and trailing wings mounted pivotally on the rearward ends of said divergent wings for limited universal movement relative thereto, said trailing wings being positioned to level the top of a ditch formed by said ditcher and being carried for lateral and vertical adjustment with the divergent wings.

8. In a ditcher having a plow point, divergent wings joined together in an articulated series, a pivotal connection between said plow point and each of said series, a telescoping transverse axle assembly supporting said divergent wings, actuating means interconnecting the telescoping parts of said axle assembly for changing the longitudinal dimension of the latter and simultaneously adjusting the lateral spacing of said divergent wings, independent lever means joining each end of said axle assembly with the forward end of the corresponding divergent wing, each of said lever means being adapted to be selectively operated for rotating the axle end and for adjusting the divergent wing vertically relative to the axle assembly, and trailing wings mounted pivotally on the rearward ends of said divergent wings and resiliently extended therefrom for limited universal movement relative thereto, said trailing wings being movable with said divergent wings in both lateral and vertical adjustment.

9. In a ditcher having a telescopic transverse axle assembly, a plow point, a pair of series of articulated wings joined one to another and pivotally connected to said plow point adjacent the front of the ditcher, said wings being supported at spaced points rearwardly from said plow point on said telescopic transverse axle assembly, extensible actuating means interconnecting the telescoping portions of said axle at said spaced points for changing the longitudinal dimension of the axle assembly and the lateral spacing of said pairs of wings, a pair of movable lever means engaging said axle assembly at laterally spaced points which are located inboard of said first mentioned spaced points and engaging said pair of series of wings adjacent the terminal ends thereof, each of said lever means being adapted to be operated independently of the other to effect a vertical adjustment of each series of wings relative to the axle assembly, and a trailing wing means carried pendently on the rearward end of each said series of articulated wings and protruding laterally out therefrom for adjustment laterally and vertically therewith, each said trailing wing being resiliently mounted to yield when a lateral force of predetermined magnitude is applied thereto.

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