Feb. 15, 1938. T. K. RUSSELL 2,108,078

ROTARY ATTACHMENT FOR TRACTOR PLOWS

Original Filed Aug. 8, 1933 5 Sheets-Sheet 1

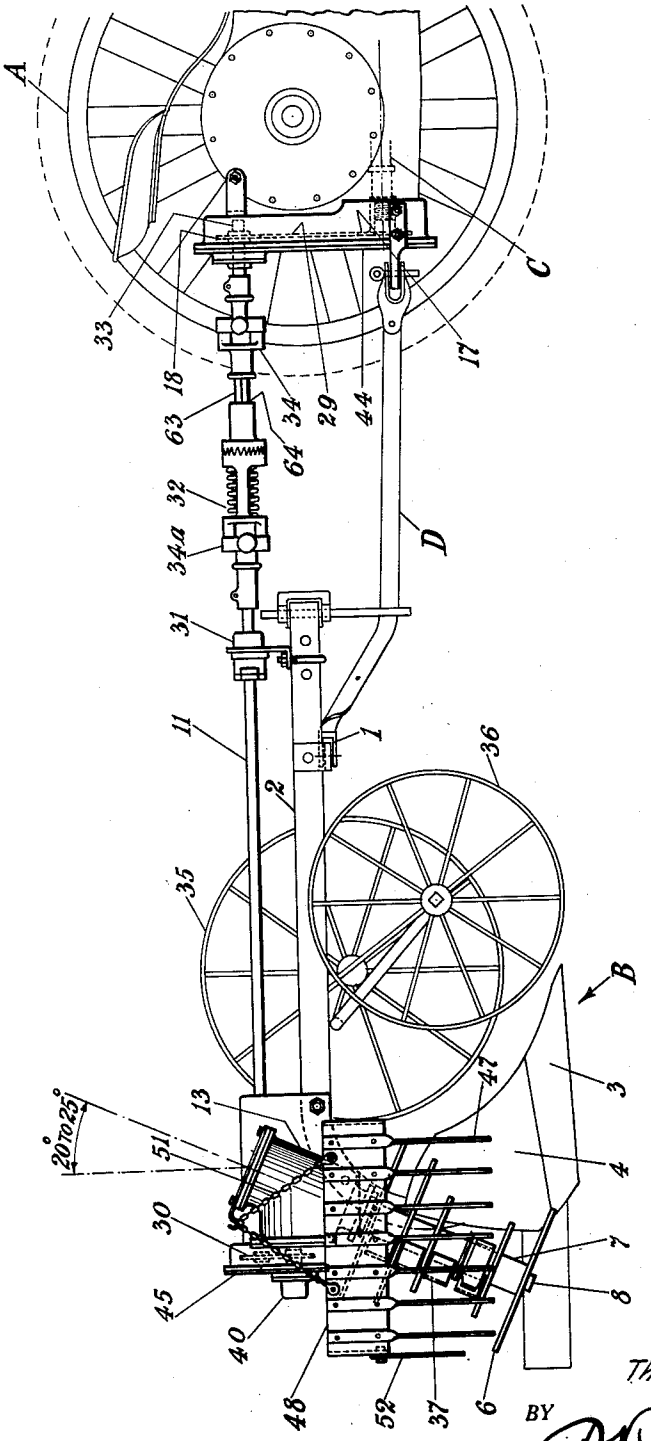


FIG. 1

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ROTARY ATTACHMENT FOR TRACTOR PLOWS

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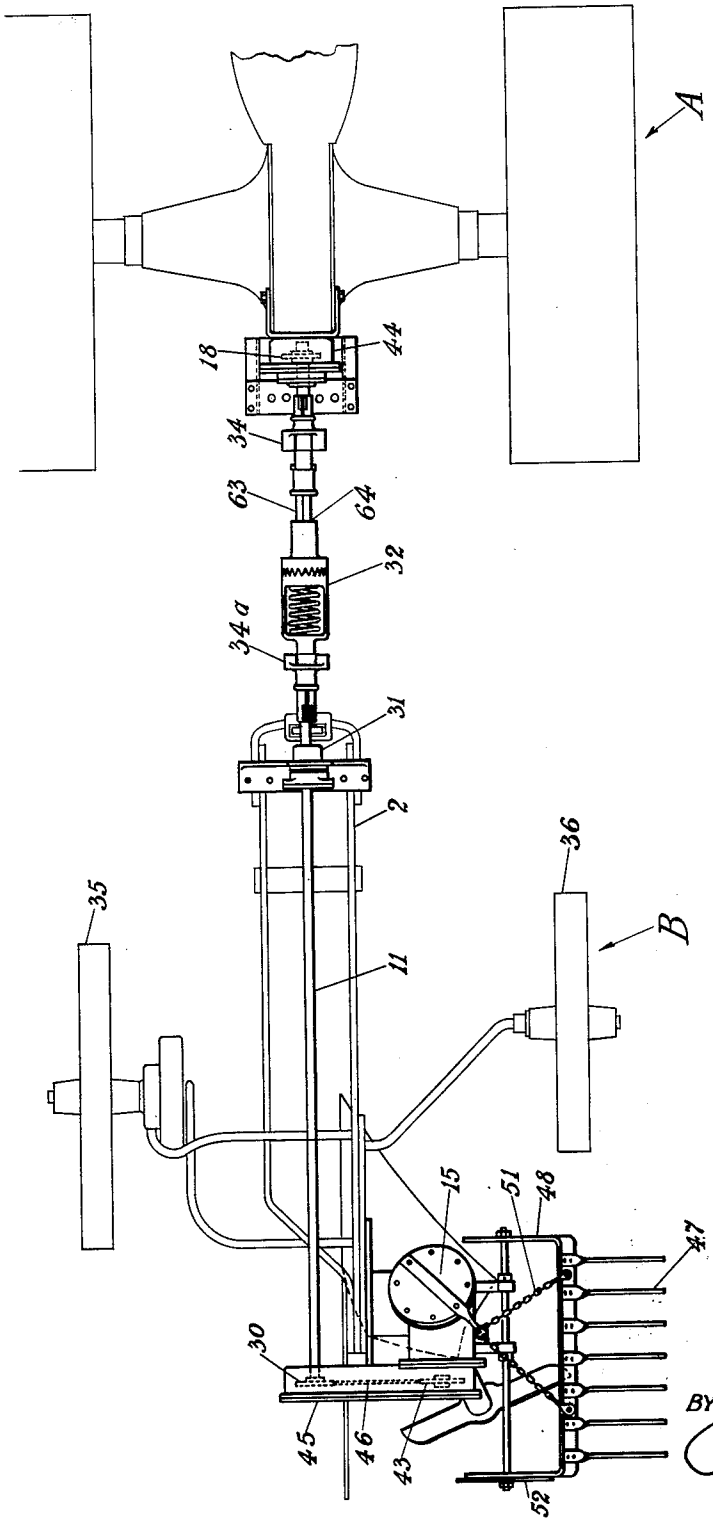


FIG. 2

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ROTARY ATTACHMENT FOR TRACTOR PLOWS

Original Filed Aug. 8, 1933 5 Sheets-Sheet 3

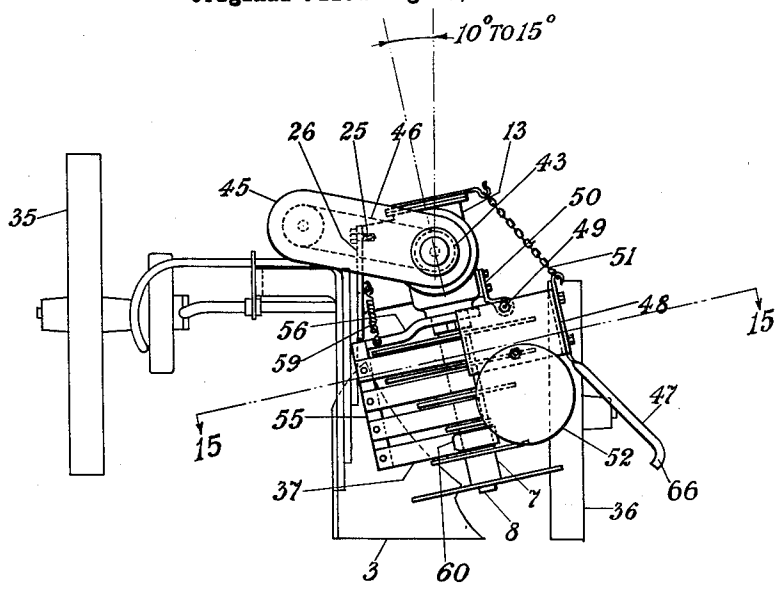


FIG. 3

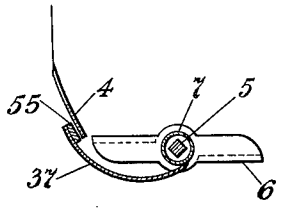


FIG. 15

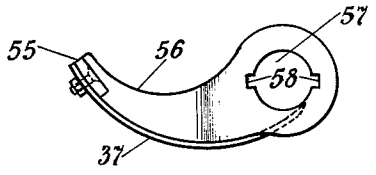


FIG. 14

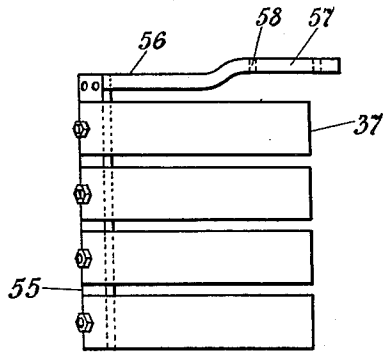


FIG. 13

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ROTARY ATTACHMENT FOR TRACTOR PLOWS

Original Filed Aug. 8, 1933 5 Sheets-Sheet 4

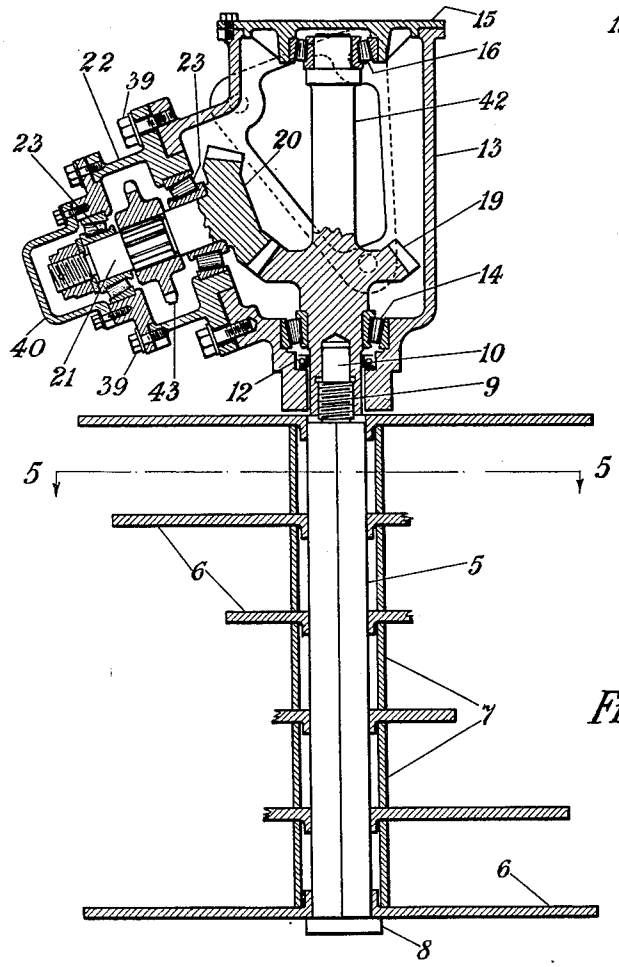


FIG. 4

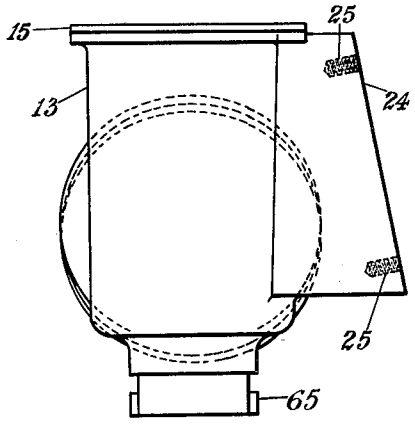


FIG. 6

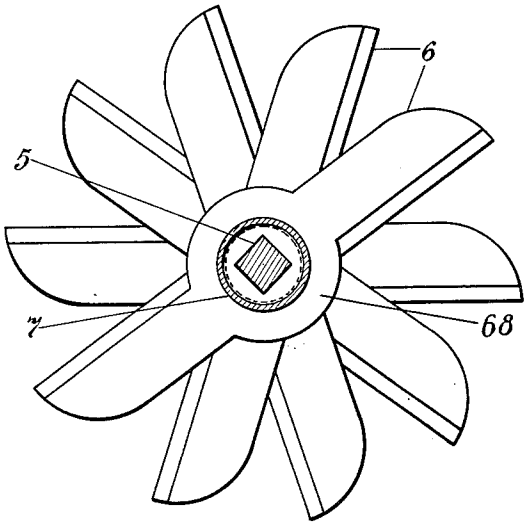


FIG. 5

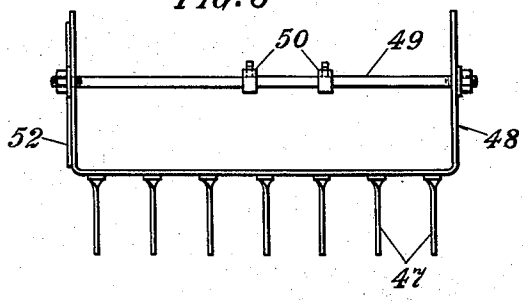
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Feb. 15, 1938. T. K. RUSSELL 2,108,078

ROTARY ATTACHMENT FOR TRACTOR PLOWS

Original Filed Aug. 8, 1933 5 Sheets-Sheet 5

FIG. 8



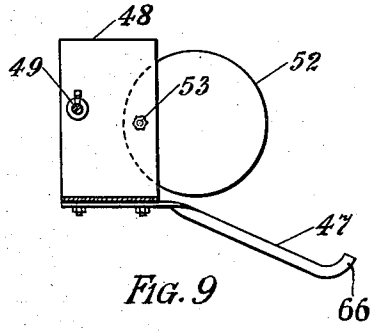


FIG. 9

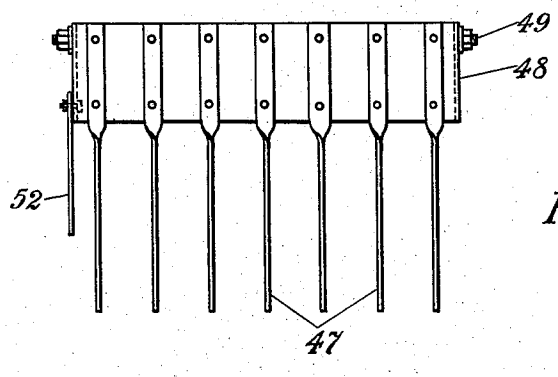


FIG. 7

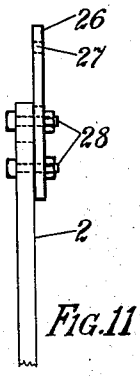


FIG. 11

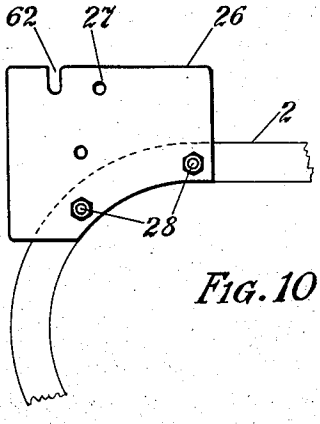


FIG. 10

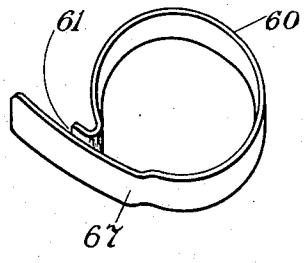


FIG. 12

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Patented Feb. 15, 1938 2,108,078

UNITED STATES PATENT OFFICE

2,108,078

ROTARY ATTACHMENT FOR TRACTOR PLOWS

Thomas K. Russell, New York, N. Y., assignor to The Plow-Wake Corporation, a corporation of Delaware

Application August 8, 1933, Serial No. 684,150
Renewed April 29, 1937

37 Claims. (Cl. 97—43)

This invention comprises certain improvements on the structure disclosed in my co-pending application, Serial No. 358,203, filed April 26, 1929, allowed February 14, 1933, and is in part a continuation thereof. The particular form of power connections here illustrated is designed especially for use with a standard make of low priced tractor, as it then provides a more economical means for directly driving a set of heavy steel blades, of purposeful conformation mounted on a squared steel shaft in a completed spiral relation, from the tractor worm-shaft, instead of from the point where the usual pulley connection is placed for power take-off purposes.

The co-related improvements are, however, so designed as to make the attachment available for use in conjunction with any standard make of modern farm tractor or tractor-drawn plow now in daily seasonal use everywhere. The essential elements of the entire apparatus are flexibly connected together so as to automatically adjust themselves to varying stresses, and are capable of mutual registration under all plowable field conditions.

Another important novel feature of the present invention is the employment of the exact angle of inclination of the rotating assembly of blades with reference to the ground surface, which ensures an even disposal of any green-manure, surface-litter and fertilizer of all kinds, in the condition of an even mixture with the soil throughout the lower part of the thoroughly completed seed-bed produced by the plowing operation, and out of the way of subsequent cultivation operations, adding humus to the soil with available plant-food to the maximum benefit of the growing crop until the harvest maturity. This improved result is sharply distinguished from that obtained in an ordinary plowing operation in which such surface material is deposited flat on the floor of the preceding furrow, there to interfere with subsequent access of moisture from the sub-soil, or deposited in bunches in previously formed portions of the seed-bed, there to generate excessive fertilizer heat detrimental to plant-life. The best form of apparatus embodying my invention at present known to me is illustrated in the accompanying five sheets of drawings in which:

Fig. 1 is a side elevation of the complete apparatus mounted on a plow connected to the rear of a tractor of the type before referred to.

Fig. 2 is a similar plan view.

Fig. 3 is a rear elevation of the apparatus mounted on a plow.

Fig. 4 is an axial section on an enlarged scale of the revoluble blades assembly, parts being broken away.

Fig. 5 is a cross section on a line 5—5 of Fig. 4.

Fig. 6 is a detail front elevation of the gear casing.

Figs. 7, 8 and 9 are respectively a detail side elevation, plan, and front end elevation of a floating soil distributor-member for the materials thrown upward and outward by the rotating blades, which also effectively serves to force stray stalks or vegetation into proper fertilizer position below the seed-bed surface.

Fig. 10 is a detail side-elevation of a supporting bracket-plate with a portion of the plow-beam to which it is attached, and

Fig. 11 is a rear elevation thereof.

Fig. 12 is a perspective detail of a floating yoke or control-clip for supporting the slotted mold-board extension in an easy, flexible contact with the spacing rings carried by the rotating shaft, thus ensuring frictionless clearance of vegetation and freedom from winding up of roots, etc., thereon.

Fig. 13 is a rear elevation and Fig. 14 a plan view of the floating, slotted mold-board extension and its support-members, and

Fig. 15 is a cross section on line 15—15 of Fig. 3.

Throughout the drawings like reference characters indicate like parts.

A represents the rear end of the tractor and B indicates generally a standard form of plow having a swivelled traction connection D to a point at the rear of the tractor, substantially in the line of the longitudinal axis thereof, as is common in the use of tractor plows, the other end of the bar D being connected by shackle 1 to the plow beam 2, which latter is supported by the usual wheels 35, 36. At C is shown in dotted lines the rear end of the worm shaft forming an element of the worm drive used on the particular type of motor tractor here illustrated.

3 is the plowshare and 4 an unslotted portion of the mold-board of the standard plow, the only addition here shown to the standard plow structure consisting in making the rear portion of said mold-board in slotted and flexible form comprising the curved ribs or fingers 37 (see Fig. 3), the forward ends of which overlap the rear edge of the forward rigid section 4 of the mold-board and in effect form continuations thereof.

A revoluble soil-processing and pulverizing assembly of blunt and heavy blades 6, 6 is supported from a gear-housing which is mounted on the plow beam as shown. This assembly consists es-

sentially of the revoluble, squared shaft 5 on which are mounted a plurality of said heavy blades 6 spaced apart by sections of steel tubing 7 fitted over a circular hub or boss cast or forged on each blade. This blades-assembly is held up against the lower end of the gear casing 13, from which the shaft 5 is supported, by means of the forged head 8 on the lower end of shaft 5 coming to a bearing against the lower blade member 6 when the reduced upper end 10 of shaft 5 is screwed into the hub of bevel gear 19 by means of the thread 9. An annular oil-seal or grease retainer shown at 12 surrounds the hub of gear 19 at the point where it enters the centrally bored neck at the lower end of casing 13. This serves to prevent oil or grease escaping from the said gear casing or housing 13. The hub of gear 19 and the free end of its stub shaft 42 are respectively journalled in roller bearings 14 and 16, the latter bearing being carried by the housing cap-plate 15. A beveled pinion 20 is mounted on, or formed integrally with, stub shaft 21 which is journalled in roller bearings 23, 23, carried in the casing extension 22, said pinion 20 meshing with gear 19. This casing extension is held in place by bolts 39, 39. A cap 40 serves for closing the outer opening in housing extension 22. A sprocket pinion 43 is fast on shaft 21 and is driven by sprocket chain 46 which runs over another sprocket pinion 30 on the rear end of main drive-shaft 11. This train of sprocket gearing is enclosed in an oil-tight casing 45. As a result of the above described construction, the earth-pulverizing assembly comprising blades 6, 6, will be caused to revolve whenever main drive-shaft 11 is rotated.

The gear housing 13 has a beveled face or flange 24 formed on one side, as best shown in Fig. 6, and this flange is bolted to bracket plate 26 which is fastened to the plow-beam 2 by the beam bolts 28 (see Figs. 10 and 11) of the particular plow to which the apparatus is designed to be attached. The holes for bolts 28 may be preformed to fit such standard plow. The upper edge of the plate 26 is provided with a notch 62 in which may be slipped a bolt or other projection from the casing face 24 when the parts are being assembled. Holes such as shown at 27 are bored in plate 26 in positions such that when the gear housing 13 is hung from a bolt screwed into one of the upper threaded sockets 25 indicated in dotted lines in Fig. 6 and nested in notch 62, said housing may be adjusted so as to give the revoluble shaft journaled therein a predetermined degree of downward and rearward inclination. Thereupon additional bolts may be inserted through holes 27, and screwed into the other sockets 25, 25 shown in Fig. 6 so that said housing will then be firmly clamped in the desired position with reference to the plow as a whole. This construction facilitates the mounting of the pulverizer unit on the plow by one man. A plate 26 designed to fit a given standard make of plow can be sold to a user of such plow and easily installed by him on the plow beam 2 as shown in Figs. 10 and 11. The user then inserts a bolt in the proper one of the two upper screw holes 25 in the beveled face 24 of the housing 13 and hooks such bolt into notch 62. Said bolt will then support the unit while the user swings it thereon as a pivot until the other screw holes register with holes 27; whereupon the additional bolts can be inserted and screwed up tightly to clamp the unit to the plate 26 in proper position. Similarly, whenever the unit is to be removed for overhauling the bolts are first removed from holes 27, thus leaving the unit suspended by the third bolt engaging notch 62, and thereafter one man can lift the unit with both hands and free it from engagement with said notch. If all the bolts engaged holes in plate 26, one man would have to hold the unit while the last bolt was being removed by another, as the unit is too heavy to be held by the operator with one hand while he unscrews the last bolt with the other.

The rotary assembly of blades being thus properly mounted on the plow beam 2, motion may be transmitted to it from the worm shaft C of the tractor by means of the sprocket wheel 17 made fast on the projecting end of said worm shaft; a sprocket chain 29 running over sprocket wheel 17 and also over sprocket wheel 18 fast on one portion of universal joint 34. This universal joint is connected to the main drive shaft 11 through the clutch shaft 63, the overload release apparatus 32 and another universal joint 34*a*.

The slip joint in this transmission line is indicated at 64 in Fig. 2 where the shaft 63 of square cross section enters a similar longitudinal recess in the sleeve of clutch 32. The chain and sprocket gearing last described is enclosed in an oil-retaining casing 44. At some convenient point in this transmission line a suitable clutch, manually operable from the driver's seat, would be usually inserted which could be opened when it is desired to stop rotation of the blades for any reason.

The conveying and stripping finger-members or ribs 37 forming a floating rear portion of the mold-board 4, preferably have their ends adjacent the mold-board edge bolted to a transversely extending strip 55 which is supported at its upper end by the floating or crane arm 56, the other end of said arm 56 being perforated at 57 and provided with slots 58, 58, so as to slip over the lower end or neck of the gear housing 13 and be held in such position by a bayonet-lock action with the diametrically opposite lugs or ribs 65 on housing 13 shown in Fig. 6. This mounting holds the fingers 37 in proper relation with the unslotted portion of the mold-board 4, the finger unit shown in Figs. 13 and 14 being thus left free to adjust itself circumferentially on housing 13, so that its edge strip 55 rests loosely against the rear edge of the mold-board portion 4, as best shown in Fig. 15. To further assist in supporting this mold-board extension unit, the spring or shock-absorber member 59 is connected to the rearward side of the slotted and floating mold-board portion and anchored on the bracket plate 26, or upon any convenient portion of the plow beam or supporting frame. Similarly, the lower end of the mold-board extension unit is flexibly held in proper relation to the mold-board and the blades-assembly by means of the floating yoke or collar 60, shown in detail in Fig. 12, the ends of which are bent around and extend parallel one to the other to form a slot 61 into which the free end of the next to the lowermost finger 37 may project, and in which it normally rests and oscillates when the machine is operating.

Preferably one end of the strip forming the collar 60 is offset slightly from the adjacent portion, as shown at 67, to form an elongated socket in which the end of the cooperating finger-member 37 may be held, thus maintaining said end in a position closely adjacent to a spacing ring 7, but not bearing heavily upon it. This reduces friction and wear as to all the finger ends and spacing rings cooperating therewith.

The efficient cooperation of the extension fingers 37, with the blades 6, 6, at all times is ensured by giving the latter annular flange-like portions 68 (Fig. 5) on which the edges of the ends of fingers 37 may always rest, thus preventing any of said finger ends from sagging down far enough to engage the edge of a rotating blade and be thereby twisted out of shape.

Preferably the lowermost blade-member 6 is left free from contact with any mold-board strip or finger, as best shown in Fig. 3, the two lower blades being so deeply submerged in the furrow soil that there is little chance of any standing vegetation or surface litter becoming wound up thereon.

Referring to Figs. 7, 8 and 9, the floating soil distributor or screen 47 there shown is composed of a series of parallel fingers fast on a rectangularly shaped housing 48, which is supported by the shaft 49 and the chains 51, 51, said chains being connected to any suitable hook carried by cap plate 15. Shaft 49 is supported, and longitudinally adjustable in, brackets 50, 50, fastened to the side of the gear casing 13. These fingers forming the screen 47 therefore extend downwardly and outwardly in front of the blades unit as well shown in Fig. 3, and dirt thrown up by the blades either strikes the interior of housing 48 or the fingers 47 and drops into the open furrow, or passes between the fingers 47, and is evenly distributed to form an adjacent finished seed-bed. A large part of the vegetation or other fibrous litter pulled up and partly crushed and thrown outward by the rapidly revolving blades is also stopped by this screen assembly and drops into the furrow. Preferably the extreme lower ends of screen members 47 are curved inward to more completely carry out this purpose, as shown at 66 in Figs. 3 and 9.

A rear guard plate 52 is adjustably fastened to the rear end of the screen housing 48 by bolt 53, as shown in Figs. 3 and 9. This may be either dropped down into the position there shown, so as to guard against or intercept the passage of such hard particles as are thrown rearwardly and at the higher elevation by the upper members of the blades-assembly 6, or it may be swung up out of operative position, when desirable, by temporarily loosening bolt 53.

The general mode of operation of the present invention is similar to that described in my before-mentioned prior application, but much more efficient and with less friction and wear on, and deterioration of, the apparatus, while also producing certain new and highly beneficial results. When the soil turned up by the lower unslotted portion of the mold-board 4 slides onto the slotted upper and rear section of said mold-board formed by the extension ribs or fingers 37, the greater portion of it is shattered into small particles which are successively thrown by the rotating blades against or through the screen 47 or against the interior of the screen housing 48, so that only thoroughly pulverized particles pass the screen and consequently are more widely distributed to form a fine mulch which effectively retains moisture within the finished seed-bed. The relative arrangement of the mold-board parts and their relation to the blades 6 is most clearly shown in Fig. 15.

The continuous spray of finer particles passing through screen 47 are, of course, thrown much higher and further away than are the coarser particles or small lumps, and the former therefore fall on the adjacent, previously pulverized surface of the already partly formed seed-bed produced by the turning over of the last preceding furrows and the deposit of other particles over parts of the surface so already formed. Thus the completed seed-bed is sealed by this final layer of finer material forming its surface and closing all air pockets so as to retain below it most of the moisture drawn subsequently syphon-like from the subsoil. The degree of success in obtaining this latter result is often the determining factor to any profitable farming operations.

All stubble, weeds and/or standing vegetation of any height usually encountered by the rotating blades-assembly is automatically and thoroughly disposed of if the position of shaft 5 is within the limits of angular inclination to the vertical shown in the drawings, i. e., a rearward inclination of about 24 degrees which is within the limits indicated in Fig. 1. Such angle, however, might be varied nearly 10 degrees in either direction without entirely destroying the covering-in of the surface litter. The lateral inclination is preferably 10 degrees, though here also minor variations are possible (as indicated in Fig. 3) without entirely interfering with this litter covering-in function, so long as the angle of rearward inclination is correct, but any considerable combined departures from the two preferred angles above given so interferes with the proper action as to render its performance most unsatisfactory. I have found after prolonged experiment that with the blades-assembly shaft adjusted to the above stated preferred position, even standing, dried corn stalks, green manure, or stubborn surface growth of any kind can be completely covered by the pulverized soil, while with any substantial departure from these angular adjustments this result can be only partially attained, if at all. These angles are also important as cooperating with screen 47 to produce a properly restricted field of distribution for the pulverized soil thrown through said screen. If the shaft 5 is too nearly vertical this fine soil will be thrown too far and too widely and an open furrow is the result, which is particularly objectionable as interfering with the finishing, or dead-furrowing operation.

As shown in Fig. 1, the field of rotation of blades 6 is mainly in advance of the rear edges of the mold-board as composed of the part 4 and its slotted extension portion formed by ribs or fingers 37. As a result, the blow of each blade is delivered upon the upturning earth at an early stage of its upward movement, and before it begins to move forward with the plow, as it otherwise would to a certain extent in the ordinary plowing action. This renders the blows of the blades much more effective in their pulverizing action, than those of previous rotary blades assemblies of this general type which have been located behind, or beside, the rear edges of their cooperating mold-boards.

The slotted mold-board extension formed by the fingers 37 operates, as did the similar but rigid construction shown in my co-pending application, to strip from the rotating blades 6, 6, winding vegetation and any spot grown materials or surface litter, which would otherwise soon wind up on shaft 5 and clog the blades-assembly 6 so as to transform the unit into a rotating cylinder of miscellaneous composition which would be totally ineffective for pulverizing the upturned soil and sod. I have found by experience, however, that the blades cannot be kept in proper registry with the rigid fingers shown in

my said prior application. This failure to retain proper clearance occurred because the blades and fingers were often distorted out of mutual adjustment by excessive stresses, and then clashed together in a manner that produced great frictional resistance and destructive wear on both tractor, plow and attachment. The flexible mounting of the slotted mold-board extension best shown in Figs. 13 and 14, and hereinbefore described, has overcome these difficulties. The fingers 37 freely float on their flexible supports now shown and described, and rest only lightly on the upper surfaces of blades 6, 6, with their outer ends held in close proximity to the outer surfaces of spacing rings 7, 7, by the floating yoke or collar 60. Consequently they present a reduced resistance to the rotation of the blades unit and suffer little wear therefrom, but at all times the floating crane or arm 56, the slotted yoke or collar 60 and the spring 59 hold them in correct position to receive the earth forced up over the lower, unslotted mold-board section 4, and so complete the said preparations for planting in one automatic operation. If this slotted continuation of the mold-board were not employed, but only the unslotted, abbreviated portion retained, a large portion of the earth would drop back behind the plow into the furrow being cut thereby, instead of being turned over into the finished seed-bed previously formed, as is the main object of all successful soil tillage operations.

The blades 6, 6, and fingers 37, 37, also act as shears to cut or shred pieces of vines or other vegetation which may not be thrown off against screen 47 but are carried around by the blades until they again begin to pass between fingers 37, at which time such materials are caught between the blades and convex edges of the fingers which then cooperate with the blades as do the members of a pair of shears.

The drive connection from the worm shaft of the tractor here shown saves the greater cost of the usual power take-off from the pulley-drive connection such as is shown in my prior application, and also saves the power absorbed in the internal friction of the parts of such additional power take-off. The practically frictionless chain and sprocket gearing and straight line shafting here shown waste much less power than did the previous arrangement, and the power take-off from the universal joint 34 located at a point right over the swivel of the draw bar D, as now shown, permits the plow to swing freely about its traction pivot without requiring any substantial shortening or lengthening of the power transmission shaft when turning corners. The overload release apparatus 32 takes care of any overload on the transmission and prevents breaking of gear teeth or drive chains if the blades-assembly becomes jammed, or stalled under too great a load.

Various changes could be made in the details of construction of the herein described apparatus without departing from the underlying novel principles of the invention so long as the relative arrangement and operation of parts necessary to secure the novel and improved results indicated are maintained substantially in the manner pointed out in the appended claims. Thus the rotary blades assembly could be advanced further toward the front of the plow than here shown, other forms of gearing and power transmission could be employed, and other minor modifications made.

An important feature of the operation of the device results from the fact that as each of the finger-like members 37, 37, forming practically extensions of the mold-board, extends backward to a point beside and closely adjacent a tubular sleeve 7 on the rotating shaft 5, the beaters, or blunt knives 6, 6, cooperate with said fingers 37, 37, to form in effect pairs of scissors which apply a "drawing cut" action on any vegetation or other fibrous matter which has been carried around by any particular beater and caught between it and the other scissors element,—supplied by the adjacent fingers. This breaks up, or shreds, or cuts up long pieces of originally standing vegetation, such as cornstalks or tall weeds, before they are dropped, and thus enables the limp, or cut up fragments thereof to be more easily and completely covered when the next furrow is run.

As herein previously pointed out the effective mold-board as a whole in the described structure comprises the unslotted, rigid, forward portion 4, and the curved fingers 37 forming in substance a slotted and slightly flexible rear portion; and an important feature of the apparatus comprises so journaling the shaft 5 that when the plow is in the furrow the upper portion of the axis of said shaft immediately below the journal casing 13 shall lie in a vertical, transverse plane located between the transverse vertical planes respectively passing through the front end and rear upper corner of the said rigid, unslotted mold-board section 4. This evidently is necessary to ensure the deposit of the earth thrown by the blades 6, 6, in the desired location previously explained, since even if the inclination of the shaft 5 carrying said blades were correctly adjusted a placing of its journal bearing too far to the rear would interefere with the hereinbefore described and desired functioning of said blades.

Having thus described my invention, I claim:

1. In an attachment for plows adapted to be drawn and operated by a motor tractor comprising a revoluble soil pulverizing unit adapted to be mounted on the plow beam and comprising a gear casing, the combination, with said above described apparatus, of a substantially flat, perforated, vertically-disposed bracket plate bolted to said plow beam with its face more remote from said beam exposed and adapted to fit against a plane surface on the exterior of said gear-casing, and means engaging said plate perforations for fastening said casing thereto.

2. A combination such as defined in claim 1 in which said plate has a marginal notch in its upper edge, and the fastening means comprises bolts screwed into said unit surface, one of which may be hooked into said notch to temporarily support said unit.

3. In an apparatus of the class described comprising a plow having a mold-board, a revoluble shaft structure rigidly supported with reference to said mold-board and a plurality of radially extending blades mounted on said shaft, the combination, with said above described apparatus, of a plurality of curved flexibly supported fingers extending between said blades and constituting skeleton extensions of the rear edge of the plow mold-board.

4. A combination such as defined in claim 3 in which said fingers are curved toward said revoluble shaft structure and have their free ends normally closely adjacent to the surface thereof; whereby said fingers and blades produce a shearing action to cut or shred stringy materials and

prevent their becoming wound around said shaft structure.

5. A combination such as defined in claim 3 in which said fingers have their ends adjacent said mold-board edge mounted on a rigid strip, combined with means for loosely supporting said strip from a point near the upper portion of said shaft structure; whereby proper registry between said blades and fingers is automatically secured.

6. A combination such as defined in claim 3 in which said fingers have their ends adjacent said mold-board edge mounted on a rigid strip, combined with means for loosely supporting said strip from a point near the upper portion of said shaft structure, whereby proper registry between said blades and fingers is automatically secured, together with means carried by the lower portion of such shaft structure adapted to hold the lower end of such strip in such position that it will be substantially parallel with the axis of said shaft.

7. An apparatus such as defined in claim 3 in which all said fingers are connected together to form a unitary structure, combined with spring means for supporting said unit.

8. An apparatus such as defined in claim 3 in which said fingers have their ends adjacent said mold-board edge mounted on a rigid strip, combined with means for loosely supporting said strip from a point near the upper portion of said shaft structure, whereby proper registry between said blades and fingers is automatically secured, together with means carried by the lower portion of such shaft structure adapted to hold the lower end of such strip in such position that it will be substantially parallel with the axis of said shaft comprising a collar loosely mounted on said shaft structure and having a slotted portion in which may rest the free end of one of the lowermost of said floating fingers.

9. An apparatus such as defined in claim 3 in which said fingers have their ends adjacent said mold-board edge mounted on a rigid strip, combined with means for loosely supporting said strip from a point near the upper portion of said shaft structure, whereby proper registry between said blades and fingers is automatically secured, said last mentioned means comprising a floating member having one end perforated to fit around said shaft structure, and a tension spring attached to the other end of said member and anchored at its other end with reference to said mold-board.

10. A combination such as defined in claim 3 in which said fingers project into all spaces between successive blades except that between the lowermost pair thereof.

11. The combination, with a plow, of a device comprising a set of blades mounted on, and projecting radially from, a revoluble shaft which is journalled on said plow and inclined downwardly and rearwardly at an angle of approximately 24 degrees to a vertical line when the plow is in operative position in a furrow, as well as laterally downward and outward from said plow under said conditions at an angle of approximately 10 degrees to such vertical line; whereby all vegetation and litter on the surface of the ground turned up by said plow is beaten down into the lower part of the adjacent furrow or distributed over only a predetermined area of the adjacent seed-bed.

12. In an attachment for tractor driven plows comprising a revoluble shaft carrying radially projecting blades, and gearing for rotating said shaft, the combination, with said above described apparatus, of a screen suspended near the field of rotation of said blades in an approximately vertical plane and in the line of travel of the greater portion of the streams of earth particles thrown therefrom at a sufficient elevation to prevent any portion of it dragging on the ground when the plow is in a furrow.

13. A combination such as defined in claim 12 in which said screen comprises a plurality of parallel fingers with curved lower ends and supported at their upper ends.

14. A combination such as defined in claim 12 in which said screen is hinged so as to swing outwardly from said blades.

15. An apparatus such as defined in claim 12 in which said screen comprises a series of parallel, downwardly and outwardly inclined fingers fastened at their upper ends to a rectangular frame having a longitudinally extending shaft revolubly supported from said plow, combined with a flexible support for the outer edge of said frame; whereby said fingers may swing away from said rotating blades under any stresses overpowering the action of gravitation thereon.

16. In an attachment for tractor driven plows comprising a revoluble shaft carrying radially projecting blades, and gearing for rotating said shaft, the combination, with said above described apparatus, of a substantially flat guard plate supported at the rear of said shaft in a position substantially parallel thereto and in a position to intercept the flight of the upper and more rapidly moving portion of the streams of earth particles thrown from said blades.

17. In a soil pulverizing attachment for tractor drawn plows comprising a revoluble shaft and gearing for rotating it, the combination, with said above described apparatus, of a plurality of radially extending blades mounted on said shaft and each provided with laterally extending portions adjacent said shaft, and of series of finger-like extensions from the mold-board of the plow having their free ends projecting between the said extension portions of adjacent blades so that the lower edge of each of said ends may rest thereon at all times when in operative position and thus be prevented from sagging into the path of the rotating blade beneath it.

18. In an attachment for tractor-drawn plows comprising a revoluble shaft journalled in an overhead housing and provided with a plurality of radially extending blades adjacent the plow mold-board, the combination, with said above described apparatus, of a plurality of parallel fingers connected together, and an arm for supporting said parallel fingers assembly supported from said housing by a bayonet lock therewith.

19. In a power driven plow the combination, with a set of knifelike beaters extending radially from a revoluble shaft, and means for rotating said shaft, of an extension for the mold-board of such plow having a plurality of slots in its rear portion forming a set of parallel fingers each of which extends between two of said knives to said shaft; whereby vegetation forced backward and around said shaft into contact with the rear surfaces of said fingers is there subjected to a scissorslike cutting action.

20. The combination, with a plow having a mold board which extends rearwardly only about half the distance necessary to completely turn over a furrow, of a revoluble shaft which is journaled on said plow at one side of the rear portion of

said shortened mold board and is inclined downwardly and slightly outwardly from the medial, vertical, longitudinal plane of said plow structure at an angle of approximately 10 degrees thereto as well as rearwardly at a considerably larger angle to the vertical line when the plow is in operative position in the furrow, a set of blades mounted on and projecting radially from said shaft, and power-driven means for rotating said shaft.

21. An apparatus such as defined in claim 20 combined with a set of curved fingers extending from the rear portion of said mold board between the paths of rotation of adjacent blades and cooperating therewith to produce a shearing action on any stringy material picked up thereby.

22. An apparatus such as defined in claim 20 combined with a set of curved fingers extending from the rear portion of said mold board to said shaft, between the paths of rotation of adjacent blades and cooperating therewith to produce a shearing action on any stringy material picked up thereby.

23. The combination, with a plow, of a device comprising a set of blades mounted on, and projecting radially from, a revoluble shaft journalled in bearings held in substantially fixed relation to said plow and inclined downwardly and rearwardly at an angle of approximately 24 degrees to a vertical line when the plow is in operable position in a furrow, as well as laterally downward and outwardly from said plow under said conditions at an angle of approximately 10 degrees to such vertical line; whereby all vegetation and litter on the surface of the ground turned up by said plow is beaten down into a lower part of the adjacent furrow or distributed over a predetermined area of the adjacent seed bed or embedded therein.

24. In an apparatus of the class described comprising a plow, a revoluble shaft structure rigidly supported with reference to said plow and a plurality of radially extending blades fixedly mounted on said shaft, the combination, with said above described apparatus, of a plurality of curved fingers flexibly supported with reference to said shaft structure and extending between said blades in such direction that each blade moves from the free ends of the fingers adjacent opposite sides thereof toward their supported ends.

25. In an apparatus of the class described comprising a revoluble shaft structure and a plurality of radially extending blades fixedly mounted thereon, the combination, with said above described apparatus, of a member flexibly supported with reference to said shaft structure, a plurality of curved fingers each rigidly attached at one end to said member extending between said blades and adapted to serve as means for stripping therefrom any foreign material carried thereby while said shaft and blades are revolving in such direction that each of said blades moves from the free ends of the fingers adjacent opposite sides thereof toward said finger supporting member.

26. In combination, a plow having a rigid mold board section, a rotary cutter in cooperative relation to the rear edge of said mold board section, a depending, rearwardly inclined revoluble shaft for said cutter and means for journalling said shaft located at a point above said mold board section such that when the plow is in operative position in a furrow the upper portion of the axis of said shaft immediately below said journaling means will lie in a transverse vertical plane intermediate of transverse vertical planes passing through the front end of said rigid mold board section and the rear upper corner thereof respectively.

27. In combination, a plow having a mold board of considerably less than normal horizontal dimensions with its rear edge extending approximately in a vertical line and a rotary cutter comprising a revoluble shaft journalled on said plow above said mold board, the axis of said shaft intersecting a vertical plane extending through the rear upper corner of said mold board transversely to said plow at a point adjacent the upper edge of said mold board.

28. The combination, with a plow having a mold board, of a rotary cutter adjacent said plow, a revoluble shaft for said cutter, and means for journalling said shaft above and intermediate the front end and rear upper corner of said mold board, said shaft being inclined at a substantial angle to a vertical line when the plow is in operative position in a furrow.

29. The combination, with a plow having a mold board, of a rotary cutter adjacent said plow, a revoluble shaft for said cutter, and means for journalling said shaft located above and intermediate the front end and rear upper corner of said mold board, said shaft being inclined rearwardly of said plow at a substantial angle to a vertical line when the plow is in operative position in a furrow.

30. The combination, with a plow having a mold board, of a rotary cutter adjacent said plow, and a revoluble shaft for said cutter, together with means for journalling said shaft located above and intermediate the front edge and rear upper corner of said mold board, said shaft being inclined laterally of said plow at a substantial angle to a vertical line when the plow is in operative position in a furrow.

31. The combination, with a plow having a mold board, of a rotary cutter adjacent said plow, a revoluble shaft for said cutter, and means for journalling said shaft above and intermediate the front end and rear upper corner of the mold board, said shaft being inclined rearwardly and laterally of said plow at substantial angles to a vertical line when the plow is in operative position in a furrow.

32. The combination, with a plow, of a rotary cutter adjacent said plow, and a revoluble shaft for said cutter journalled in fixed relationship with respect to said plow and inclined both rearwardly and laterally of said plow with respect to a vertical line when the plow is in operative position in a furrow, the angle of rearward inclination being from approximately 20 degrees to approximately 25 degrees and the angle of lateral inclination being from approximately ten degrees to approximately 15 degrees.

33. The combination, with a plow having a mold board, of a revoluble shaft carrying radially arranged blades, and means for journalling said shaft above and intermediate the upwardly extending edges of the mold board so that said blades shall be in operative relationship to the rear edge of said mold board, said shaft being inclined both rearwardly and laterally of said plow with respect to a vertical line when the plow is in operative position in a furrow, the angle of rearward inclination being from approximately 20 degrees to approximately 25 degrees, and the angle of lateral inclination being from approximately 10 degrees to approximately 15 degrees.

34. The combination, with a plow having a mold board, of a rotary cutter having a plurality of blades in operative relationship with the mold board, a revoluble shaft for said cutter journalled in fixed relationship with respect to said plow and inclined both rearwardly and laterally of said plow at substantial angles with respect to a vertical line when the plow is in operative position in a furrow, and flexible fingers projecting between said blades and normally having their free ends touching said shaft, said fingers and blades being parallel to one another.

35. The combination, with a plow of a rotary cutter having a plurality of blades in operative relation with said mold board, a revoluble shaft from which said blades radiate, means for journalling said shaft above and intermediate the ends of the mold board so that said blades shall be adjacent the rear edge of said mold board, said shaft being inclined both rearwardly and laterally of said plow with respect to a vertical line when the plow is in operative position in a furrow, the angle of rearward inclination being from approximately 20 degrees to approximately 25 degrees, and the angle of lateral inclination from approximately 10 degrees to approximately 15 degrees, and flexible fingers constituting extensions of said mold board projecting between said blades in parallel relation thereto.

36. The combination, with a plow having a mold board, of a rotary cutter adjacent said plow, a revoluble shaft for said cutter, means for journalling said shaft above and intermediate the upwardly extending edges of the mold board, said shaft being inclined both rearwardly and laterally of said plow with respect to a vertical line when the plow is in operative position in a furrow, the angle of rearward inclination being from approximately 20 degrees to approximately 25 degrees, and the angle of lateral inclination being from approximately ten degrees to approximately 15 degrees, and a screen supported adjacent said cutter.

37. In an apparatus of the class described comprising a plow, a revoluble shaft structure rigidly supported with reference thereto and a plurality of radially extending blades fixedly mounted on the shaft journaled in said structure, the combination, with said above described apparatus, of a plurality of curved fingers extending between said blades and parallel thereto so as to strip therefrom any foreign material carried thereby while said shaft and blades are revolving, together with slightly yieldable supporting means intervening between said fingers and said revoluble shaft structure whereby the former can have only a yielding pressure contact with said shaft or blades.

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