Jan. 18, 1955 D. L. SHELTON 2,699,715

EARTH FURROWING APPARATUS

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FIG. 1.

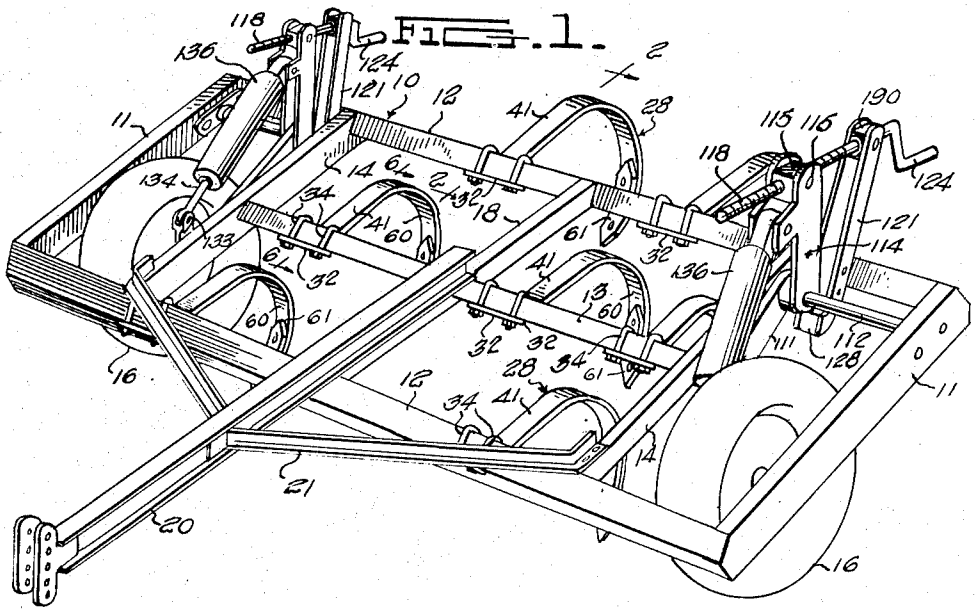
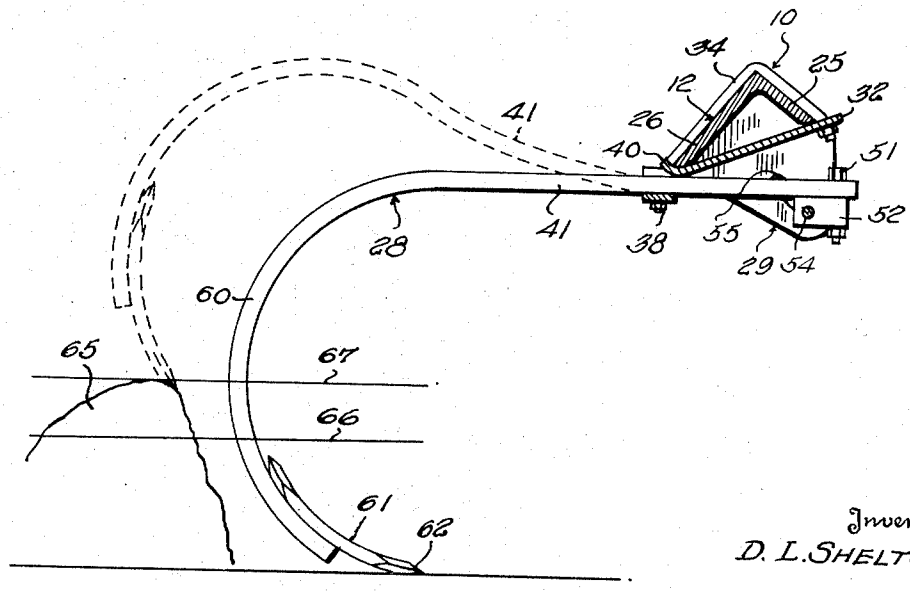


FIG. 2.



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EARTH FURROWING APPARATUS

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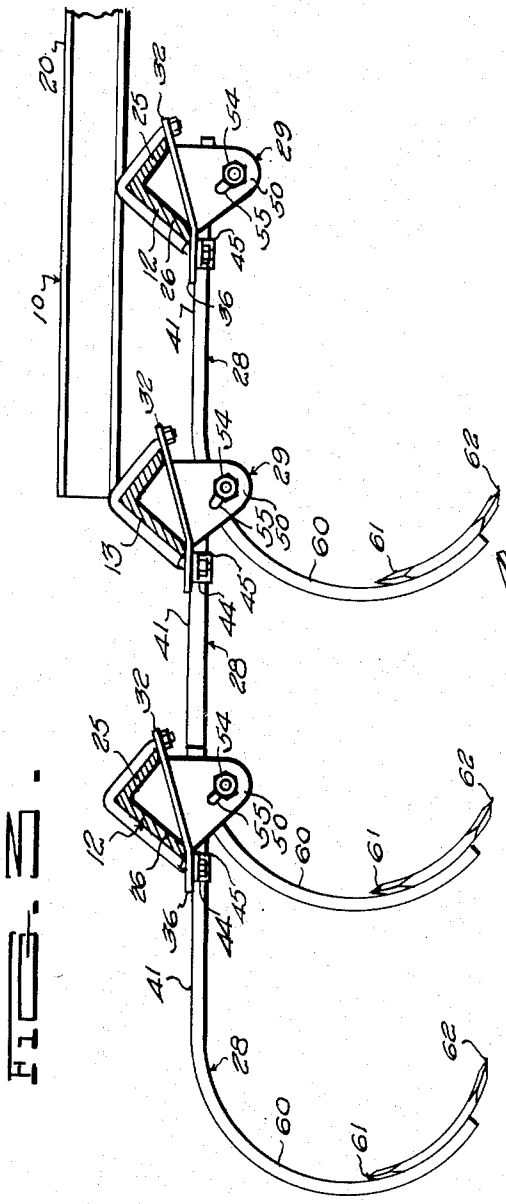


FIG. 3.

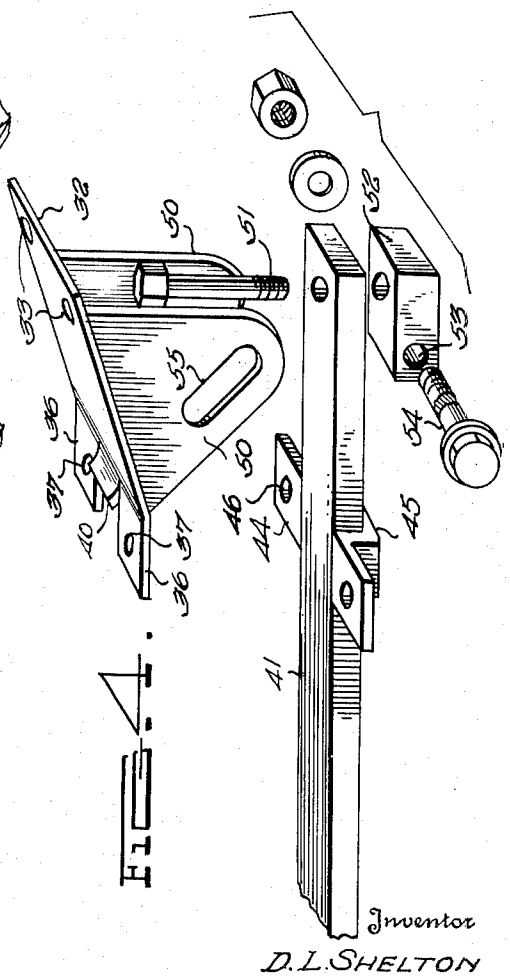


FIG. 4.

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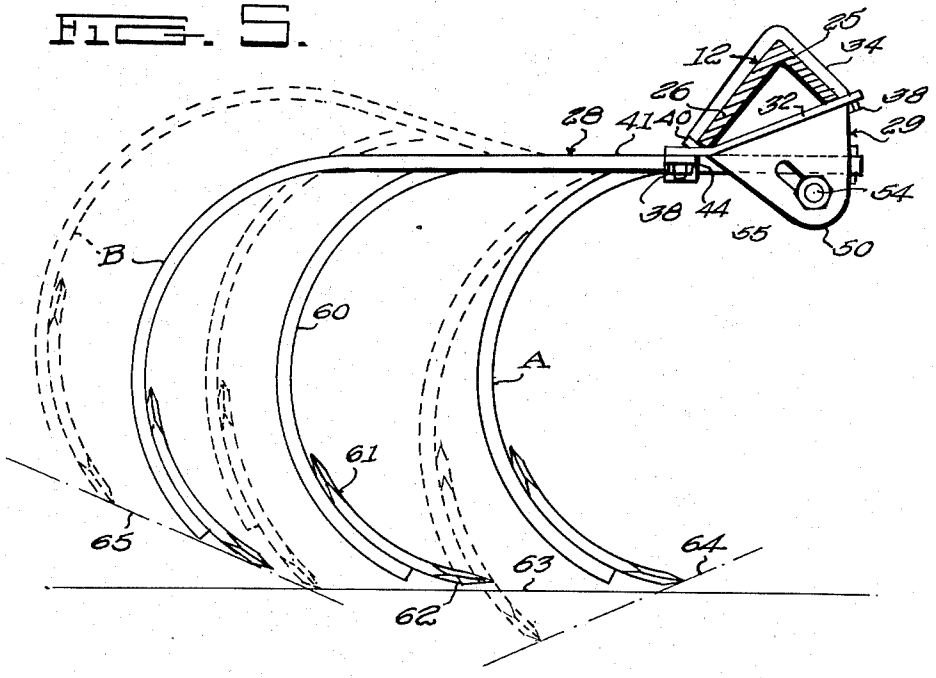
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EARTH FURROWING APPARATUS

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FIG. 5.



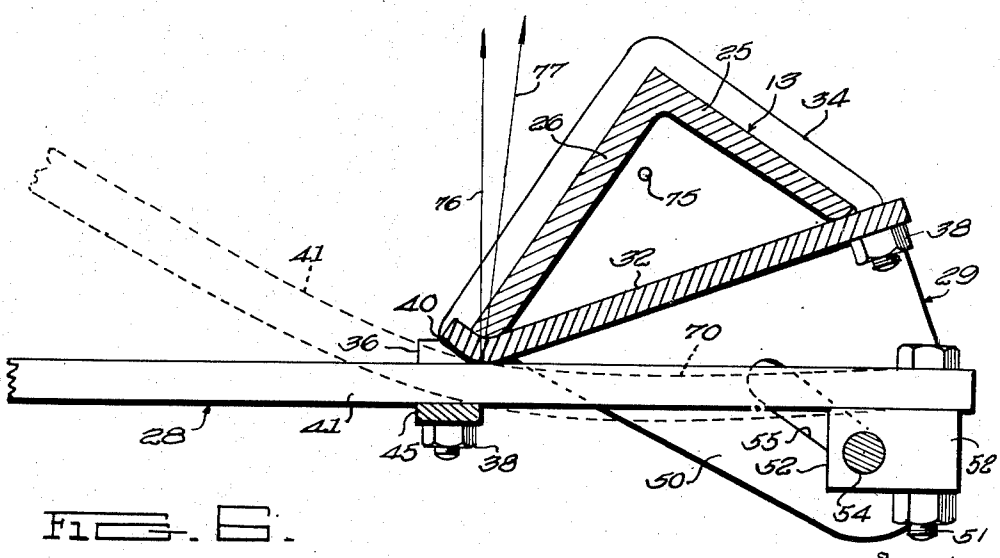


FIG. 6.

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FIG. 7.

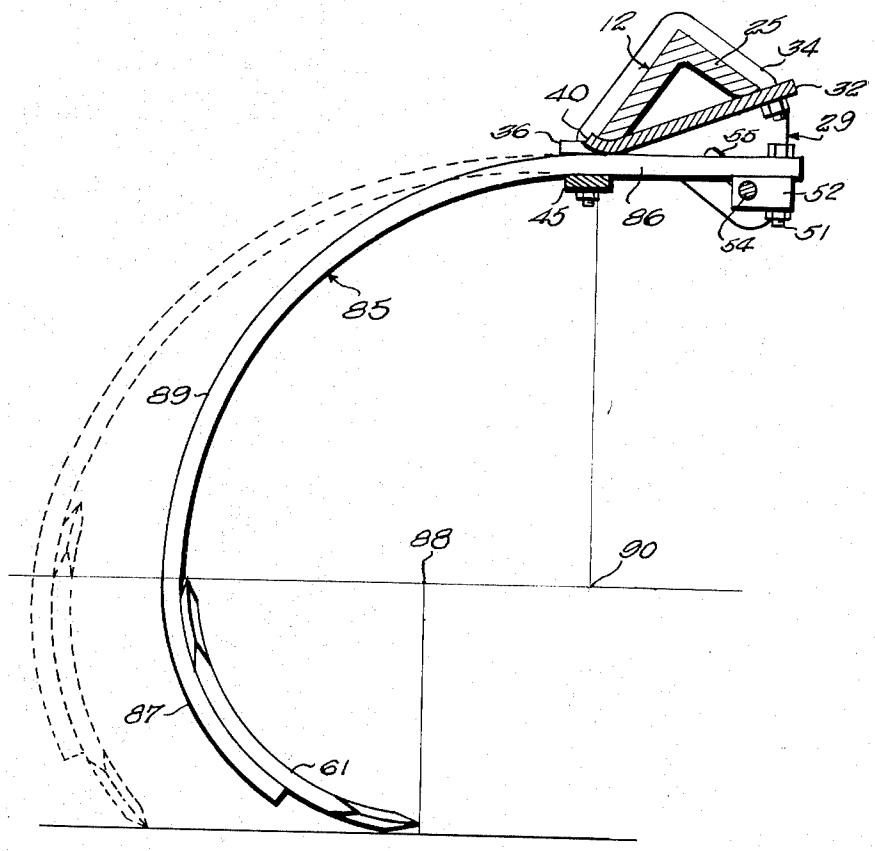
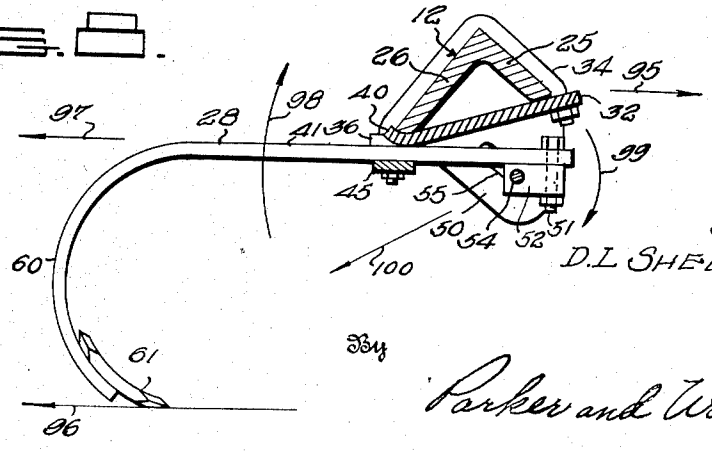


FIG. 8.



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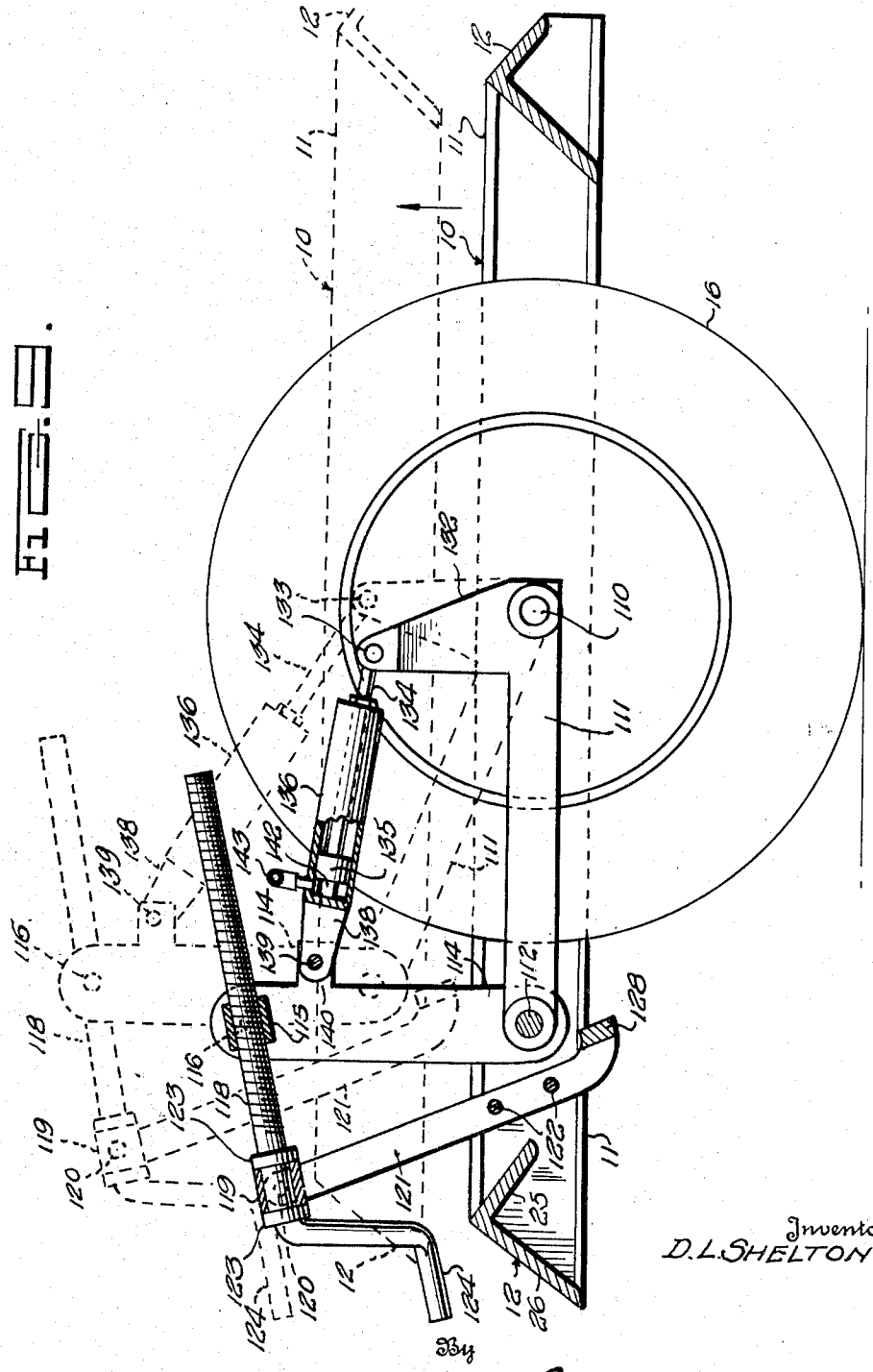
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FIG. 5.



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2,699,715

EARTH FURROWING APPARATUS

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Application February 8, 1949, Serial No. 75,185

13 Claims. (Cl. 97—198.1)

This invention relates to an earth-furrowing apparatus. Various types of chisel tool apparatus for earth furrowing have been in use for many years, such implements involving forwardly and downwardly inclined furrowing tools carried by the lower ends of shanks having their upper ends fixed with relation to the frames of the implements. Such types of apparatus have been subject to numerous disadvantages, particularly where used in rocky soil. For example, the shanks have been so rigidly connected to the frames that substantial forces transmitted to the frames upon the encountering of stones and rocks have had destructive bending effects on the frames or shanks, or both, with the result that such implements often have one or more furrowing tools arranged a substantial distance above the remaining tools, and frequently actually above the surface of the earth.

Moreover, unavoidable inaccuracies in manufacture in an apparatus of this character are such that most implements of this character vary as to the depth of penetration of the furrowing tools into the ground as much as two or three inches, there usually being no means for individually adjusting the tools as to the depth of penetration. The shanks for the tools being almost necessarily formed of spring steel, it is impracticable to bend the shanks to provide for uniform earth penetration of the tools, and if this is done, damage due to strains on the parts disturbs the uniformity of such crude means of adjustment.

It has been proposed to relieve torsional strains on the tool-carrying frame members by interposing some resilient means to absorb shocks and strains. For example, it has been proposed to provide a coil in the metal of each shank in the horizontal portion thereof, and it further has been proposed to pivot the shanks to the frames and oppose pivoting movement by spring means. Devices of this character have been found to be unsatisfactory for the reason that they permit lateral swinging of the furrowing tools with the result that the tools can swing around instead of uprooting thickly rooted clods of earth.

In a certain earlier type of apparatus of this character, it was found that the furrowing tools were self-sharpening, being provided with a whetting action due to the particular oscillatory motion of the furrowing tool. This result occurs when the design and proportions of the parts are such that the flexing of the lower part of the shank tending to move the tool downwardly is substantially compensated for by the tendency of the upper portion of the shank to flex upwardly. Under such conditions, the oscillatory movement is such that the leading edge of the furrowing tool moves back and forth substantially horizontally. Such an arrangement is not only advantageous because of the self-sharpening feature, but the flexing of the shank as distinguished from the use of a rigid shank requires substantially less power for pulling the implement forwardly. Such prior devices, however, do not provide for sufficient flexing of the shank when encountering a stone of substantial size so as to permit the tool to rise and pass over the top of the stone.

In earlier types of apparatus, moreover, unsatisfactory means have been provided for elevating the earth-working tools out of contact with the ground when desired. Where such elevating means has been manually operable, an operator must leave his seat on the tractor in order to operate the manual means in a satisfactory manner. Where the elevating means is purely hydraulic, subject to control by the operator without leaving the tractor, the hydraulic means cannot be operated and the tools

raised from the ground except when a source of hydraulic pressure is available.

An important object of the present invention is to provide a novel beam structure for agricultural implements, which is quite simple in construction and economical to manufacture and which is highly effective as the means for drawing earth-working tools over and through the soil.

A further object of the present invention is to provide a novel agricultural implement wherein the supporting means for the shanks of the earth-working tools is such as to substantially eliminate any possibility of damage to the frame of the implement incident to severe strains, for example, when striking large stones or rocks.

A further object is to provide a novel supporting frame structure and associated elements which is of such type as to increase the degree of flexibility of the shank of an earth-working tool without increasing the length of the shank rearwardly of the supporting means and without the use of cushioning springs of any type.

A further object is to provide such an apparatus wherein the substantially increased flexing action of the tool shanks is accomplished without permitting any greater degree of lateral movement of the furrowing tools than is true of the use of the same type of shanks with conventional supporting means therefor.

A further object is to provide a novel type of supporting frame in combination with an earth-working tool whereby torsional strains on the frame are substantially reduced and the frame is provided with increased ability to withstand the torsional strains to which it is subjected, thereby lengthening the normal fatigue life of the parts and reducing or eliminating repair bills and the loss of the use of the implement while it is being repaired.

A further object is to provide an implement of this character wherein a highly novel type of adjusting means is provided for each earth-working tool whereby such tools are subject to quick and easy adjustment whereby uniform earth penetration is effected.

A further object is to provide an apparatus of the character just referred to wherein the novel characteristics of the adjusting means are such that the adjustment-setting means is subject to substantially negligible strains under forces transmitted thereto in the use of the implement, whereby the implements may be easily caused to remain in proper desired adjusted positions.

A further object is to provide an apparatus of this character which readily lends itself to the use in connection therewith of sub-soil shanks whereby the advantageous results referred to above can be secured while tilling the soil to a depth of twelve inches or more.

A further object is to provide a novel combined hydraulic and manual elevating means for the tools whereby the earth-working tools may be raised hydraulically or manually, depending upon circumstances, wholly within the choice of the operator.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawings, I have shown two embodiments of the invention. In this showing,

Figure 1 is a perspective view of the apparatus,

Figure 2 is an enlarged detailed sectional view on line 2—2 of Figure 1, illustrating the flexing of a tool shank when passing over a large stone or other obstruction,

Figure 3 is a similar view taken transversely through the entire supporting frame showing a plurality of the tools and shanks in normal positions,

Figure 4 is an exploded perspective view of one of the shank-adjusting means and associated elements.

Figure 5 is a view similar to Figure 2 diagrammatically representing a comparison between the oscillatory action of a shank of the present apparatus as compared with other conventional shanks,

Figure 6 is a substantially enlarged sectional view taken substantially on line 6—6 of Figure 1,

Figure 7 is a view taken substantially on the same plane as Figure 6, showing the invention employing a sub-soil furrowing shank and tool,

Figure 8 is a sectional view generally similar to Figure

2, diagrammatically representing the action occurring through the generation of certain lines of force in the apparatus, and

Figure 9 is a side elevation of portions of the apparatus particularly illustrating the tool-elevating means, parts being broken away and parts being shown in section.

Referring to the drawings, and particularly Figures 1 and 3, the numeral **10** designates the frame of the implement as a a whole, shown in the present instance as comprising a pair of end frame members **11**, forward and rear frame members **12**, and an intermediate transverse frame member **13** preferably equidistantly spaced from the members **12**. Inner frame members **14**, spaced from and parallel to the members **11**, extend between and are preferably welded to the members **12**. The intermediate member **13** is welded at its ends to the members **14**. Wheels **16** for supporting the implement are arranged in the spaces provided between the frame members **11** and **14** as shown in Figure 1, and are journaled with respect to the frame in a manner to be described.

The frame members **11** and **14** may be of any desired cross section, and preferably are of channeled section. The frame members **12** and **13** are of inverted angle section preferably of a particular form described in detail below and clearly shown in Figures 2, 3, 5, 6 and 7. The frame members **12** and **13** are the implement-carrying members and they may be, and preferably are, rigidly braced relative to each other by a central frame member **18** which may be of any desired cross sectional shape and is preferably notched to fit the frame member **13**. The member **18** is rigidly welded to the frame members **12** and **13**. A draft connection **20**, which may be of any desired shape, is preferably bolted to the frame member **18** and is suitably braced as at **21**.

A plurality of earth-furrowing units is connected to each of the frame members **12** and **13**. These units being identical, only one need be referred to in detail. Similarly, only one of the frame members **12** or **13** need be described in detail since they are identical. These frame members are of inverted angle cross-section and include a dowwnardly and forwardly extending flange **25** and a downwardly and rearwardly extending flange **26**. Particular attention is invited to the fact that the lower edge of the flange **25** terminates a substantial distance above the lower edge of the flange **26**. Each of the furrowing units comprises a shank indicated as a whole by the numeral **28** and is anchored with respect to the adjacent frame member **12** or **13** by bracket means indicated as a whole by the numeral **29** and forming one of the important features of the present invention.

Each of the bracket means **29** (Figures 4 and 6) comprises a plate **32** adapted to seat against the lower edges of the flanges **25** and **26**, and is therefore inclined upwardly toward the front end of the apparatus. The forward edge of each plate **32** extends beyond the flange **25** and is apertured as at **33** to receive the ends of angle bolts **34**. The lower end of each plate **32** has opposite side portions **36** bent to assume a substantially horizontal position. These portions or lips of the plate **32** are apertured as at **37** to receive the other ends of the bolts **34**, these bolts being attached to clamp the plate **32** in position by conventional nuts **38** in a manner further referred to below.

Intermediate the lips **36**, the plate **32** has its lower rear end extending rearwardly beyond the edge of the flange **26**, as at **40**, and bent into substantially arcuate form. Each tool-carrying shank has a horizontal portion **41** extending beneath and in contact with the plate portion **40**, the latter acting as a bearing face for the shank **41**, as described below. An attaching strap **44** (Figure 4) has its intermediate portion **45** offset downwardly for the passage of the shank **41** therethrough. The ends of the strap **44** are apertured, as at **46**, for the extension therethrough of the bolts **34**, the adjacent nuts **38** serving to clamp the ends of the strap **44** against the plate portions **36** and to fix the position of the shank **41**.

Each plate **32** carries depending spaced flanges **50**, the space between these flanges being approximately equal to the width of the associated shank **41** whereby the latter extends between the flanges **50**. The forward end of each shank is attached by a bolt **51** to a block **52** lying beneath the end of the shank. The block **52** is apertured as at **53** to receive a bolt **54** which extends

through slots **55** formed in the flanges **50**. The slots **55** preferably are arranged at a 45° angle to the vertical and horizontal for a purpose to be described. As will become apparent, the bolt **54** may be loosened and moved longitudinally in the slot **55** to adjust the position of the shank **41** to vary the adjustment of the furrowing tool to be referred to.

As previously stated, each shank **28** has an upper horizontal portion clamped relative to one of the frame members **12** or **13**. Rearwardly of the straight portion **41**, each shank is provided with a downwardly curved portion **60**, usually arcuate in shape and provided at its lower end with a furrowing tool **61**. In practice, it is preferred that the shanks **28** be formed of ¾″ by 2″ spring steel and that the portion **60** of each shank be formed as an arc of a circle having a radius of approximately 9″. Under such conditions, the length of the straight shank portion **41** of each furrowing unit rearwardly of its associated clamping saddle **44** will be approximately 8″ and the length of the curved portion **60** preferably will be between 22″ and 24″.

With the shanks **28** formed in accordance with the preferred proportions referred to, it has been found that the tools **61** will be self-sharpening. Referring to Figure 5, I have diagrammatically represented two other furrowing units represented respectively by the letters A and B from which a comparison of the operation of the present furrowing units can be obtained. With the shanks of such units formed as described, the encountering of resistance as the tool **61** moves through the ground causes the shank **28** to flex. This flexing tends to increase the radius of the curved portion **60**, and this flexing, in itself, would cause the point **62** of the tool **61** to move downwardly. However, the flexing forces cause each straight shank portion **41** to be distorted from its straight shape into an upward and rearward curve tending to lift the point **62**. With properly proportioned shank portions, for example as described, the upward flexing of each shank portion **41** compensates for the tendency of the shank portion **60** to increase its radius of curvature, with the result that the point **62**, during oscillatory movement of the free portion of the shank, moves back and forth in a substantially straight line as indicated at **63** in Figure 5. With a shorter straight shank portion, or with the elimination of such portion, as is the case with the unit A in Figure 5, there is no compensation for the tendency of the curved shank portion to increase its radius of curvature, and as a result, the oscillatory movement of the shank causes the tool point to move back and forth at an angle to the horizontal approximately as indicated by the line **64** in Figure 5.

Conversely, in the use of a straight shank portion longer than the shank **41**, as in the case of the furrowing unit B in Figure 5, the upward flexing of the straight shank portion is excessive with relation to the increasing of the radius of the curved portion with the result that the tool point moves back and forth as suggested by the line **65** in Figure 5.

In this connection, it is pointed out that movement of the tool **61** through the ground necessarily takes place against resistance regardless of the presence of stones or other obstructions. Resistance to forward movement of the point **62** causes it to move horizontally rearwardly along the line **63** until the increased resistance to bending movement of the shank overcomes resistance to the forward movement of the point **62**, whereupon such point moves forwardly along the line **63** back to a position at or adjacent its normal position, pending the building up of further resistance to forward movement. This action is repeated continuously during operation of the implement and the straight back and forth motion of the point **62** along the line **63** continuously whets the point **62** and maintains it in sharp condition.

The shanks A and B are disadvantageous for two reasons. The oscillatory movement causes the tool points to travel angularly with the result that the points are continuously blunted rather than sharpened. Moreover, in the case of the unit A, resistance to movement of the tool point causes the latter to move downwardly and rearwardly relative to the apparatus whereby it digs more deeply into the soil and increases forward resistance to movement of the implement. In the case of the unit B, ersistance to forward movement causes the tool point to be lifted, and accordingly the depth of penetration is substantially reduced once during each oscillatory

movement. Therefore, the furrowing unit **28** is highly advantageous in that it provides for uniform movement of the tool point **62** through the ground in the absence of stones and similar obstructions, and the point **62** is self-sharpening.

In spite of the substantial advantage of the proportioning of the unit **28** rearwardly of the clamping saddle **44**, the extent to which the point **62** can swing upwardly in passing over obstructions such as a stone **65** (Figure 2) without transmitting possibly destructive forces to the frame members **12** and **13** is limited. If the clamped free end of each shank **41** were maintained inflexibly in horizontal position, the tool point, relatively speaking could swing upwardly only to the height indicated by the line **66** without transmitting possibly destructive forces to the frame, whereas in the case of an obstruction such as the stone **65**, it is necessary for the point to swing upwardly to the level of the line **67**, representing the level of the top of the stone **65**.

The mounting of each unit **28** relative to the supporting frame members **12** and **13** is such that increased flexibility for passing over obstructions is provided without appreciably changing the oscillatory action through which are obtained the highly advantageous results described in connection with Figure 5. Referring to Figure 6, it will be noted that a substantial portion of the forward end of each shank portion **41** is free of any clamping means. Accordingly, when the shank portion **41** flexes upwardly as indicated in dotted lines in Figure 6, the portion of the shank lying between the saddle **44** and block **52** is free to flex downwardly as indicated by the dotted line **70** in Figure 6. Thus, upward forces flexing the shank portion **41** to the rear of the saddle **44** are partially absorbed by the downward flexing of the shank as at **70**, accordingly relieving the supporting frame of some of the destructive forces and permitting the tool point **62** (Figure 2) to swing to a higher point without damaging the frame members.

In this connection, it is also particularly pointed out that the use of the inverted angle frame members **12** and **13** is highly effective in reducing the effect of otherwise destructive forces when the tool points pass over obstacles of substantial size. Each curved plate portion **40** (Figure 6) constitutes a bearing through which upward thrusts of the shank **41** are transmitted to the frame members. Such thrusts generate torque in the frame members, and the center of torque is approximately at the point **75**. Forces are transmitted to the bearing **40** on a line perpendicular to the straight shank portion **41**. With such shank portion horizontal, as shown in solid lines in Figure 6, upward forces on the bearing **40** would be vertical, as indicated by the line **76**. This line is at an acute angle to the frame flange **26**. As the shank portion **41** is flexed upwardly, the upwardly exerted line of force, perpendicular to the point of contact of the shank portion **41** with the bearing **40**, swings toward the right as viewed in Figure 6, as indicated, for example, by line **77**.

It will be apparent that the upwardly exerted forces, as they increase, move progressively closer to the center of torque as indicated by the numeral **75**. Therefore, as these forces increase in passing over relatively large obstacles, the movement of the lines of force upwardly against the bearing **40** move progressively closer to the torque center **75** and more nearly parallel to the flange **26** of the frame member **13**, thus tending relatively to reduce the torque on the frame members. Thus the transmission of destructive forces to the frame members is minimized. The construction shown in detail in Figure 6, therefore, is highly advantageous for the reasons stated.

In Figure 7 of the drawings, I have shown a modified form of the invention in the nature of a chisel type sub-soil plow. For many years, manufacturers have sought to devise a satisfactory sub-soil shank, that is, a flexible shank which will support a tillage point to plow at depths of 12" or more. A flexible shank is desirable for the reason that it can be pulled through the ground with considerably less power than is required for the conventional rigid shank.

These efforts have not been crowned with particular success. The standard chisel plow shank is curved on the radius of 9" and experience has shown that this radius will plow more efficiently at depths not exceeding 9", that is, to a point where a tangent to the curved shank at the ground level is approximately vertical.

Under such conditions, the soil, as it is broken loose in plowing, rolls up the shank and sheds off approximately at the ground level, freely passing around and behind the shank. If the shank is moved downwardly to plow to a greater depth, for example an additional 4", the level of the ground is above the center of curvature of the shank, thus causing the dirt to move forwardly above the center of curvature of the shank. Thus the portion of the shank above center is performing substantial work, and much greater tractive power is required. Plowing at such a depth with a device of this character creates a dead space in the shank that will not shed the dirt and, in actual practice, this at least doubles the draft of the plow.

It would appear obvious that the answer to this problem would be to build a shank on a 12" radius, assuming that plowing is to be done at a depth of 12". This has proved wholly unsatisfactory. As previously stated, certain relative dimensions must be observed in order to maintain the proper oscillatory action of the shank. A shank curved on a 12" radius would require at least 8" of free horizontal shank in order to retain the proper oscillatory action, and the curved section would be approximately 33" in length. This would provide a total length of 41" of free flexing shank as compared with a total length of 30" or 31" for the standard shank. To get the proper action from such a shank curved on a 12" radius would require that the weight of the stock from which it is fabricated be increased by approximately seventy per cent. The shanks are made of spring steel, as stated, which is relatively expensive, and the use of heavier shanks would add materially to the manufacturing costs. Moreover, such a shank would further require that the frame members supporting the shank be spaced several inches further apart in order to give the clearance necessary for the proper flexing action as illustrated in and described in connection with Figure 6.

The problems referred to are completely overcome with the arrangement shown in Figure 7. The shank shown in Figure 7 is made from the same or only slightly heavier stock than the shanks described above, being preferably 1" by 2" in cross section. Referring to Figure 7, the shank as a whole is indicated by the numeral **85** and has a horizontal forward portion **86** mounted in the same manner as the shank described above, the supporting elements being designated by the same reference numerals as before. The free portion of the shank **85** is bent on two separate curves of different diameters. The lower portion **87** of the shank has its center of curvature located at the point **88**, the portion **87** being curved preferably on a 9" radius. The upper free shank portion **89** has its center of curvature approximately at the point **90**, the radius of curvature preferably being 15". The centers **88** and **90** are preferably in the same horizontal plane, and the point **90** is preferably arranged vertically beneath the bearing point of the shank against the bearing **40**.

The lower portion **87** of the shank, in operation, will flex downwardly while the portion **89** of the shank will flex upwardly. In the form of the invention previously described, the ratio of the shank portion below the center line to the shank portion above the center line is approximately 2:5. Actual preferred dimensions of the first-described form of shank are about 9" of shank below the center of curvature and 14" of curved and 8" of horizontal shank above the center of curvature, a total of 22". These dimensions relate to the free flexing shank rearward of the frame attaching means. The sub-soil shank illustrated in Figure 7 substantially retains these portions. This shank is formed with 9" of curved section below the center of curvature and 23" above, or a ratio approximating 3:8. By forming the upper 23" of this shank on a curve having a 15" radius with the lower 9" of shank curved on a 9" radius, the shank will retain the proper oscillatory characteristics described above and will plow from 12" to 14" deep with a minimum of draft.

In operation, the shorter curvature of the lower shank section **87** will overcome any tendency for the more gradually curved upper section to roll or move the dirt forwardly. This characteristic keeps the shank active and prevents its becoming a dead pull as in the case of the standard shank set to plow deeper than the intended depth. This shorter curvature of the shank section **87** conforms to the curvature of standard tillage points and

gives the points the proper pitch to cause them to "take" the ground. Because of the length and special relative curvatures of the free shank portions, it can be used on any frame that will carry the standard shank. Employed with the shank mounting as described above, it possesses the highly desirable characteristics of the shank **28**.

There is described above in connection with Figures 4, 5 and 6, the means for adjusting the free length of the shank. The same adjusting means is employed in connection with the form of the invention shown in Figure 7. The advantages of the adjusting means will be apparent from a consideration of Figure 8. The arrangement of parts is such that endwise slipping of the horizontal shank portion is prevented when the implement is in use. When the plow is in motion, the frame member **12** is moved in a forward direction as indicated by the arrow **95**. Engagement of the furrowing tool **61** with the ground will exert a force against said tool in the opposite direction as indicated by the arrow **96**. This transmits horizontal forces to the frame member **12** as indicated by the arrow **97** and at the same time transmits a clockwise torque to the frame member **12** as indicated by the arrow **98**. Since the shank **41** tends to pivot on the bearing **40**, it will be apparent that the forward end of the shank tends to swing downwardly as indicated by the arrow **99**. The combination of the two lines of forces represented by the lines **97** and **99** produce a resultant moment downwardly and rearwardly as indicated by the arrow **100**. This line **100** therefore roughly indicates the direction of forces acting on the bolt **54** when the plow is in use. The slot **55** is at a substantial angle to the line of force **100**, and preferably at an angle of 90° to such line of force. The tendency, therefore, is for the bolt **54** to bear against the sides of the slot **55** rather than to tend to move longitudinally of the slot. It has been found in practice, therefore, that the parts will remain in adjusted position with relatively slight clamping forces exerted by the head and nut of the bolt **54**.

In Figure 9, I have illustrated a novel depth control and power lift mechanism for the earth-working tools. Two of these devices, one for each side of the apparatus, are employed as shown in Figure 1. The supporting wheels **16** of the apparatus are supported respectively on spindles **110**, each of which is carried by the free end of an arm **111**, the other end of which is supported by a shaft **112** extending between and fixed to the adjacent frame members **11** and **14** (Figure 1). The shaft **112** also rotatably supports a pair of spaced upwardly extending arms **114** between the upper ends of which is arranged a crosshead **115** supported in rocking engagement with the arms **114** by suitable trunnions **116**. A screw shaft **118** is threaded in the crosshead **115** and has its rear end portion rotatable in a crosshead **119**. This crosshead is supported by trunnions **120** between the upper ends of stationary arms **121** fixed to the frame members **14** by bolts **122**. Collars **123** on the shaft **118** prevent longitudinal movement of the screw shaft **118** relative to the crosshead **119**, and the screw shaft is provided with an operating crank **124**. It will become apparent that rotation of the screw shaft **118** will rock the arms **114**, which action will relatively move the parts so that the arms **111** swing relatively downwardly about the axis of the shaft **112**. Such movement is limited by a foot **128** carried by the lower ends of the arms **121**.

Adjacent the spindles **110**, the arms **111** are provided with upstanding arms **132** rigidly connected to the arms **111**. At their upper ends, the arms **132** are pivotally connected as at **133** to the piston rod **134** of a piston **135** arranged in a cylinder **136**. This cylinder is provided with a yoke **138** pivotally connected as at **139** to projections **140** carried by the arms **114**. Means is provided for limiting movement of the piston **135** toward the left as viewed in Figure 9, and to this end, the piston has been shown as being provided with a boss **142** engageable with the adjacent end of the cylinder **136**. Hydraulic fluid may be introduced into the left hand end of the cylinder **136** through a pipe **143**.

The pipe **143** leads to the tractor connected to the present implement and on the tractor there is provided a source of hydraulic fluid pressure and a control valve for connecting such source to the pipe **143**. The fluid pressure source and the valve are conventional and have not been illustrated. With pressure released from the cylinder **136**, the piston **135** occupies the position shown in Figure 9. Accordingly, it will be apparent that rotation of the screw shaft **118** to move the arms **114** forwardly will exert a forward force on arms **132**, thus moving the spindle **110** relatively downwardly while moving the frame **10** relatively upwardly to adjust the depth of the earth-working implements or to lift them completely from engagement with the ground. To perform the same functions while the apparatus is in use, the operator may turn the control valve (not shown) on the tractor, thus forcing the piston **135** toward the right in Figure 9 to elongate the distance between the pivots **133** and **139**. When inoperative, the hydraulic motor forms a thrust link between the arms **114** and **132** for manual vertical adjustment of the frame and earth-working tools, this adjustment being possible regardless of the connection of the apparatus to a tractor. The apparatus may be operated from the tractor, as stated, the hydraulic motor ceasing its function as a thrust link and becoming a power source to effect vertical adjustment.

Operation

The operation of the apparatus will be apparent from the foregoing description. The inverted angles **12** and **13** provide implement supporting frame members having the maximum degree of strength in proportion to their weight, and as described, torsional forces are absorbed much more readily by such form of frame than is possible with the conventional I-beam frame or the like. By making the forward flanges of the angles shorter than the rear flanges, ample space is provided for the shank-adjusting means. This adjusting means is highly efficient in operation since, for the reasons stated, thrusts are absorbed laterally rather than longitudinally of the slots **55** thus rendering it easier to keep the parts adjusted for any depth of penetration of the earth-working tools into the ground.

As specifically described in connection with Figure 5, the present invention permits the maintenance of the proper ratio of the portions of the shank **28** to secure the proper oscillatory movement of the earth-working implement, the point of this implement moving back and forth horizontally in normal operation. Thus uniform depth of penetration is provided while at the same time reducing the power required for moving the tractor forwardly. However, while providing for the most effective oscillatory movement of the earth-working tool, the flexibility of each shank is materially increased by spacing the point of contact of the shank portion **41** with the bearing **40** and the point of engagement of the forward extremity of the shank portion **41** with the adjusting block **52**. As the shank portion **41** rearwardly of the bearing **40** flexes upwardly, the shank portion forwardly of the bearing **40** flexes downwardly, thus increasing the degree of flexibility of the shank as a whole. The portion of the shank forwardly of the bearing **40** naturally becomes very slightly elongated as flexing takes place, as indicated by the numeral **70**. The point of contact of the shank **41** with the bearing **40** under such conditions moves slightly to the left as viewed in Figure 6, this action being permitted by slight sliding movement of the shank **41** in the saddle **44**. The increased degree of flexibility provided in the manner stated also permits the point **62** of the earth-working implement to pass over taller obstacles such as stones, as illustrated in Figure 2, without undue strains and resultant damaging of the tool shanks or the supporting frames therefor.

The use of the form of the invention shown in Figure 7 is highly desirable for the reason that it preserves the proper ratio of shank portions to provide the desired oscillatory movement while at the same time preventing the forward piling of the dirt in the manner described. Thus sub-soil plowing is possible with the same oscillatory action and without increasing the power which would otherwise be required for plowing to a greater depth. The mounting of the device in Figure 7 relative to the supporting frame is the same as in the other forms of the invention, increased flexibility being provided as described together with the provision of the same highly desirable adjusting means.

Adjustment of the shank portions **41** is readily accomplished merely by loosening the bolt **54** and moving it upwardly and rearwardly or downwardly and forwardly in the associated slots **55**. This adjustment is provided primarily so that all of the points of the earth-working tools can be easily arranged at the same level so that all

penetrate the earth to the same depth. It is practically impossible to secure such adjustment with present devices of this character.

The depth control and power lift mechanism shown in Figure 9 is highly desirable for the reason that it combines a manual and power adjustment, whereby the mechanism may be operated under any conditions. Vertical adjustment of the supporting frame to adjust the depth of penetration in the ground or to completely lift the earth-working tools is not limited to hydraulic operation when a source of hydraulic power is not available. The operator may turn the two cranks **124** to move the supporting frame vertically even when the implement is not connected to a tractor. On the other hand, when the device is connected to a tractor and a source of hydraulic power is available, vertical adjustment for the complete elevation of the earth-working implements from the ground may be quickly and readily accomplished by connecting the pipe **143** to the source of hydraulic pressure. Relative downward swinging movement of the right hand end of the arms **111** in Figure 9 is limited by the foot **128** of each adjusting mechanism.

While the invention has been illustrated and described for use in connection with an earth-working tool of a particular type, it will be clearly understood that the invention is not limited in its use to any specific type of earth-working tool. Quite obviously, the novel inverted angle shaped cross-members may be employed as the means for pulling any type of earth-working tool or tools.

I claim:

1. An agricultural implement comprising a frame having a tool-supporting member extending transversely of the direction of movement of the implement, said member being of inverted V-cross section, an earth-working tool comprising a flexible shank having an upper forward end substantially horizontally arranged beneath said tool-supporting member, said tool-supporting member having a downwardly and rearwardly sloping flange and a downwardly and forwardly sloping flange, and separate means for fixing the forward end of said shank at spaced points against vertical movement with respect to said flanges, said forward end of the shank between said fixing means being unsupported whereby it is free to flex.

2. An agricultural implement comprising a frame having a tool-supporting member extending transversely of the direction of movement of the implement, said member being of inverted V-cross section, an earth-working tool comprising a flexible shank having an upper forward end substantially horizontally arranged beneath said tool-supporting member, said tool-supporting member having a downwardly and rearwardly sloping flange and a downwardly and forwardly sloping flange, means for connecting said forward end of said shank to said downwardly and rearwardly sloping flange against vertical movement relative thereto, and connecting means forward of said first-named connecting means for fixing said forward end of said shank against vertical movement relative to said tool-supporting member, said two connecting means being spaced from each other and said shank between such connecting means being free to flex.

3. An implement constructed in accordance with claim 2 wherein the second-mentioned connecting means comprises an attaching device secured to said tool-supporting member and provided with an upwardly and rearwardly sloping slot, and a bolt fixed with respect to said forward end of said shank and projecting through said slot for adjustable connection to said attaching device.

4. An implement constructed in accordance with claim 2 wherein the lower edge of said downwardly and forwardly sloping flange terminates above the level of the other of said flanges, the second-named connecting means comprising a pair of ears spaced transversely from each other and spaced forwardly of said first-named connecting means, said forward end of said shank being arranged between said ears and said ears being provided with upwardly and rearwardly sloping aligned slots, and an adjusting bolt fixed with respect to said forward end of said shank and projecting through said slots to be secured in adjusted positions therein.

5. An earth-working implement comprising a frame having a tool-supporting member extending transversely of the direction of movement of the implement over the ground, a tool comprising a flexible shank having a lower rear end adapted to be connected to an earth-working element and having an upper forward substantially horizontal end, and means for fixing the forward end of said shank to said tool-supporting member at spaced points against vertical movement relative to such member, said shank between said spaced points being unsupported whereby it is free to flex.

6. An earth-working implement comprising a frame having a tool-supporting member extending transversely of the direction of movement of the implement over the ground, a tool comprising a flexible shank having a lower rear end adapted to be connectd to an earth-working element and having an upper forward substantially horizontal end, a pair of spaced attaching means for securing the said forward end of said shank to said tool-supporting member against vertical movement relative thereto, said shank between said attaching means being free to flex, one of said attaching means comprising a member having a slot therein arranged at an angle to the horizontal, and a bolt fixed to said shank and adjustable in said slot.

7. An earth-working implement comprising a frame having a tool-supporting member extending transversely of the direction of movement of the implement, said tool-supporting member being of inverted angle section and having a downwardly and forwardly sloping flange and a downwardly and rearwardly sloping flange, a plate secured against the lower edges of said flanges, an earth-working tool comprising a flexible shank having an upper forward end arranged beneath said tool-supporting member and said plate, said plate, beneath said downwardly and rearwardly sloping flange, being curved upwardly to provide a bearing surface against which the adjacent portion of said shank engages, means for maintaining such portion of said shank in engagement with said bearing surface, and means for connecting the forward end of said shank to said plate at a point spaced forwardly of said bearing surface, said shank, between said connecting means and said bearing surface, being free to flex.

8. An implement constructed in accordance with claim 7 wherein said connecting means comprises a pair of depending ears carried by said plate and provided with aligned slots inclined from the horizontal, and a bolt fixed with respect to the forward end of said shank and extending through said slots for adjustable connection with said ears.

9. An earth-working implement comprising an earth-working tool having a resilient shank adapted to have an earth-working element fixed to the lower end thereof, the lower portion of said shank being curved downwardly and forwardly approximately about an arc having approximately a predetermined center and said shank having an upper forward attaching portion, a frame for supporting said tool, and means for securing the attaching portion of said shank to said frame against vertical movement relative thereto at spaced points between which the attaching portion of said shank is free to flex, the ratio of the curved portion of said shank below the horizontal plane of said center to the portion of said shank between said plane and said securing means being within the range from about 2:5 to about 2:8 so that when said earth-working element encounters resistance tending to oppose its forward movement, the tendency of the curved portion of the shank to increase its radius of curvature and cause said earth-working element to move downwardly is approximately compensated for the tendency of the portion of said shank between said plane and said securing means to flex upwardly.

10. An earth-working implement comprising an earth-working tool having a resilient shank adapted to have an earth-working element fixed to the lower end thereof, the lower portion of said shank being curved downwardly and forwardly approximately about an arc having approximately a predetermined center, said shank above said lower portion being curved substantially in an arc of a circle of greater radius than said first-named arc with its center located approximately in the horizontal plane of said first-named center, said shank forwardly of the last-named curved portion thereof having a straight attaching portion, a supporting frame, and means for securing said straight portion of said shank to said frame at spaced points against vertical movement relative to said frame, said straight portion of said shank between said spaced points being free to flex downwardly.

11. An agricultural implement comprising an earth-working tool having a resilient shank adapted to have an earth-working element fixed to the lower end thereof,

the lower portion of said shank being curved downwardly and forwardly for connection to such an element, said shank having an upper forwardly extending attaching portion, and means for supporting said attaching portion comprising an inverted V-shaped frame extending transversely of the direction of movement of the implement, said frame having a downwardly and rearwardly extending flange and a downwardly and forwardly extending flange, bracket means connected to said frame, and securing means connected to said bracket means for securing the forward end of said attaching portion rigidly with respect to said bracket, said supporting means rearwardly of said securing means having a portion forming a bearing for the attaching portion of said shank to fix said shank at said bearing against vertical movement while permitting lengthwise sliding movement of said attaching portion, said attaching portion between said bearing and said securing means being free to flex.

12. Apparatus constructed in accordance with claim 11 wherein said bearing has a normal line of contact with said attaching portion rearwardly of which line said bearing curves upwardly and rearwardly whereby, when said shank rearwardly of said bearing is flexed upwardly, said line of contact moves slightly rearwardly and transmits forces to said downwardly and rearwardly extending flange at a more acute angle relative thereto.

13. Apparatus constructed in accordance with claim 11 wherein said securing means comprises a bolt and said bracket means has spaced depending ears between which the attaching portion of said shank is arranged, said ears being provided with rearwardly and upwardly sloping slots receiving said bolt, said bolt being connected to the attaching portion of said shank and being fixable in said slots by tightening said bolt.

References Cited in the file of this patent

UNITED STATES PATENTS

474,461	Ryder	May 10, 1892
748,466	Bateman	Dec. 29, 1903
1,830,013	Bohmker	Nov. 3, 1931
2,029,249	Noell et al.	Jan. 28, 1936
2,195,631	Post et al.	Apr. 2, 1940
2,385,950	Silver	Oct. 2, 1945
2,464,615	Sawall	Mar. 15, 1949

FOREIGN PATENTS

560,161	Germany	Sept. 29, 1932