April 14, 1959 H. L. MILLER 2,881,844

TURF PLUG CUTTER

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Fig. 1.

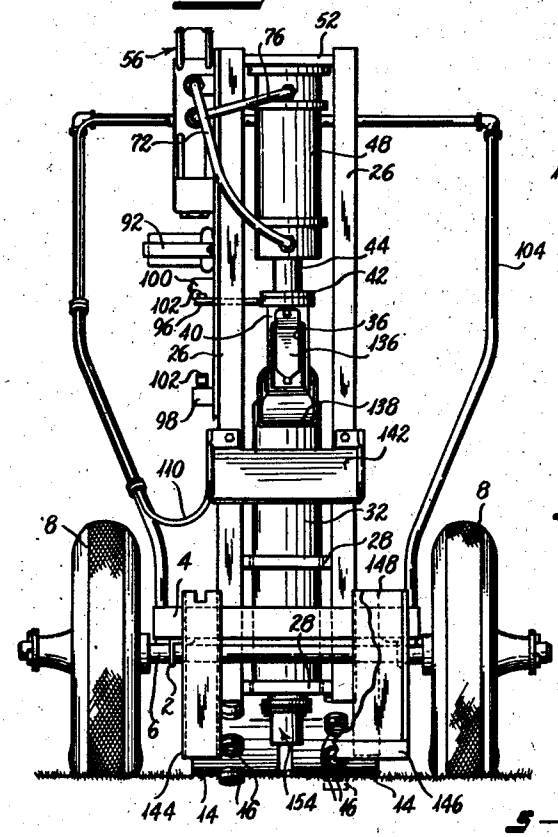

Fig. 2.

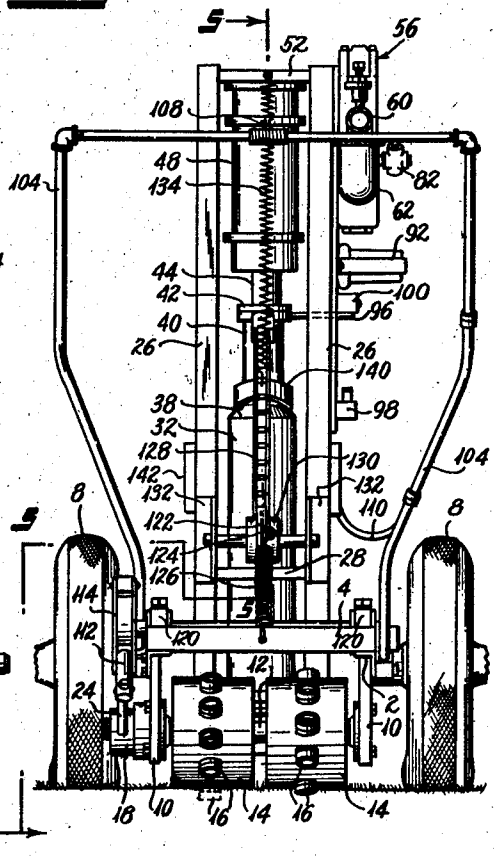

Fig. 10.

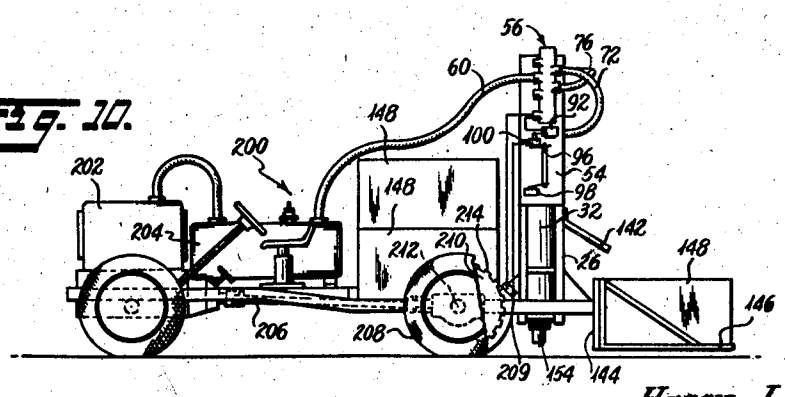

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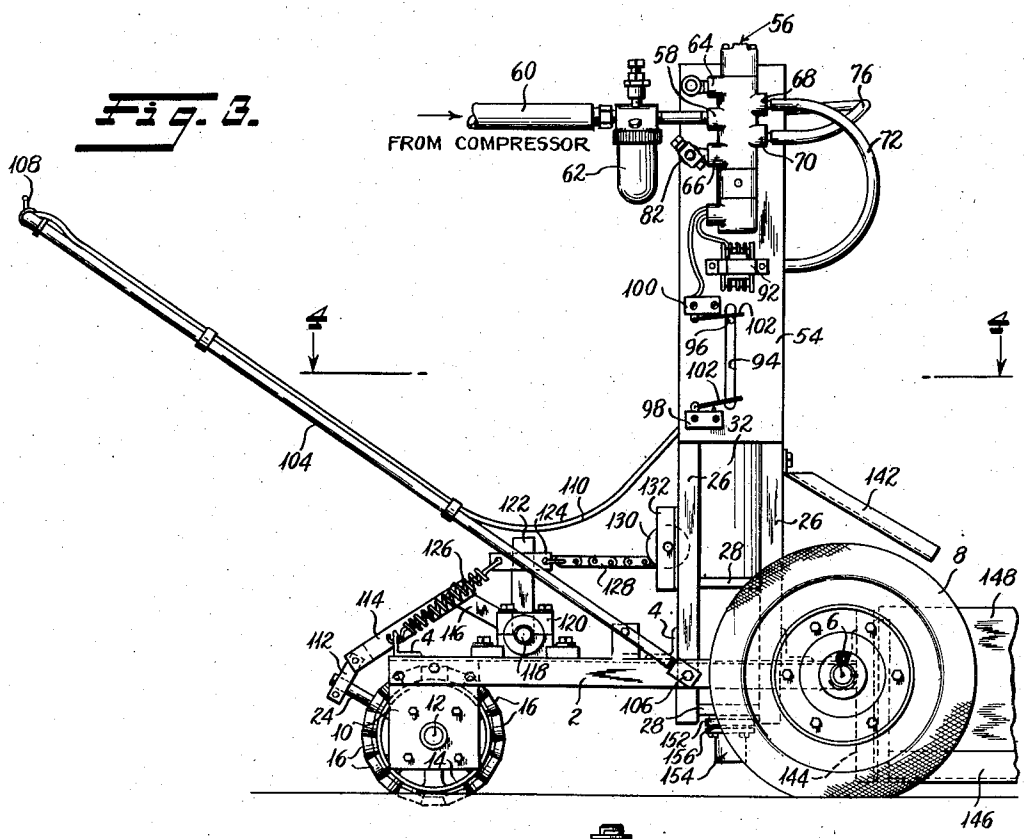
Fig. 3.



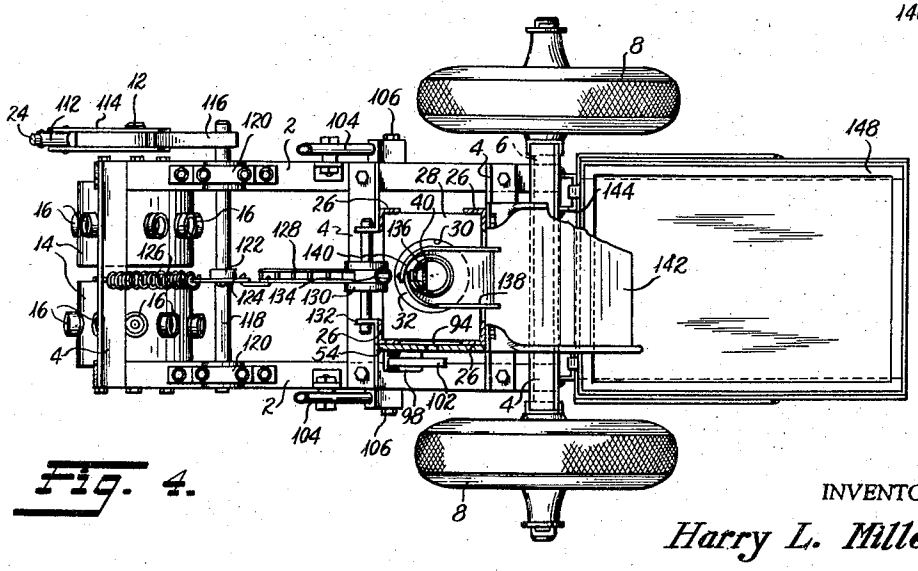


Fig. 4.

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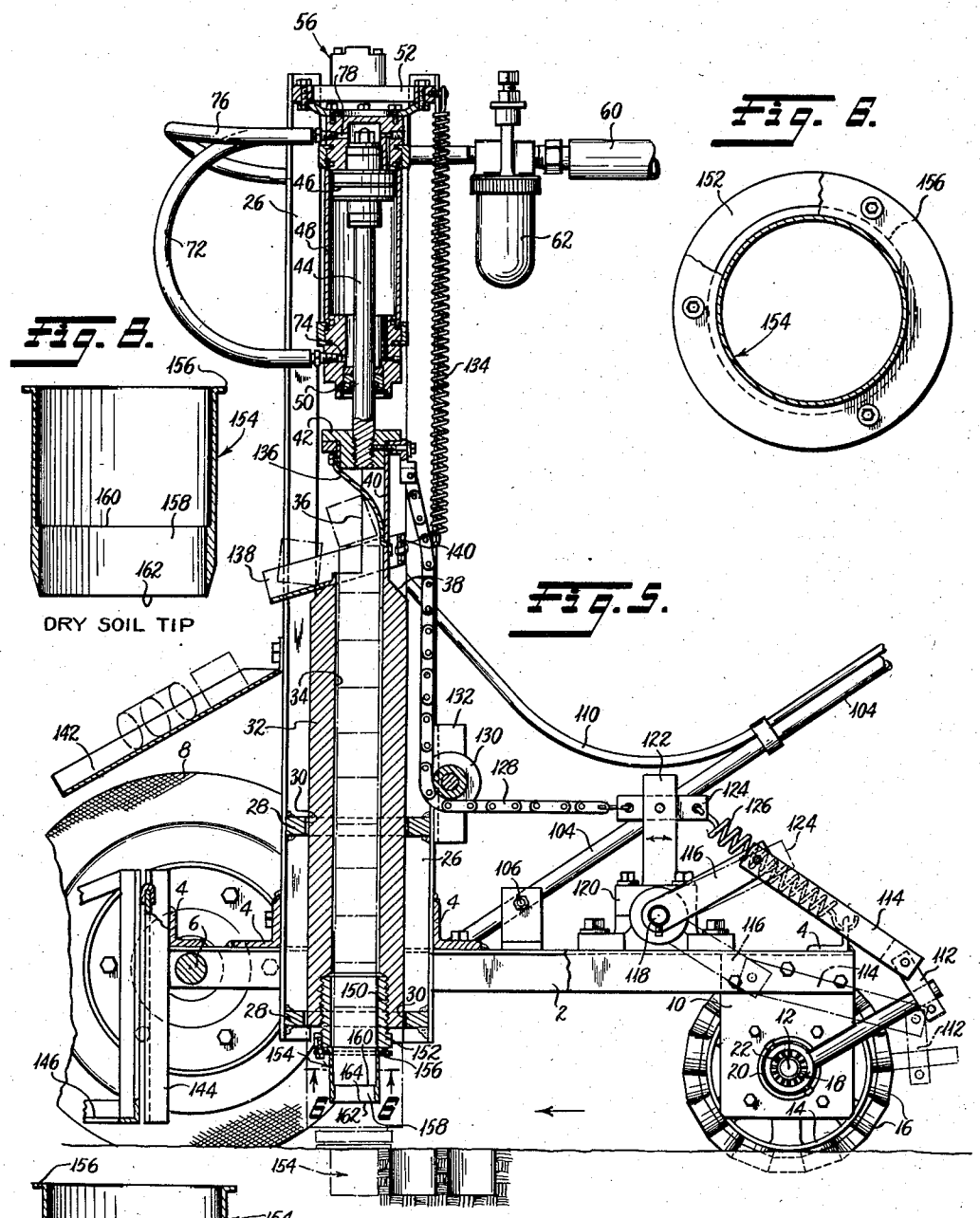
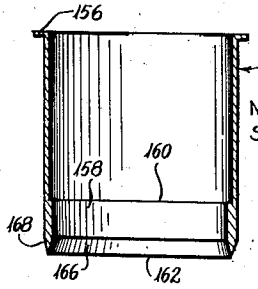


Fig. 6.

Fig. 8.

DRY SOIL TIP

Fig. 5.



MEDIUM WET SOIL TIP

Fig. 9.

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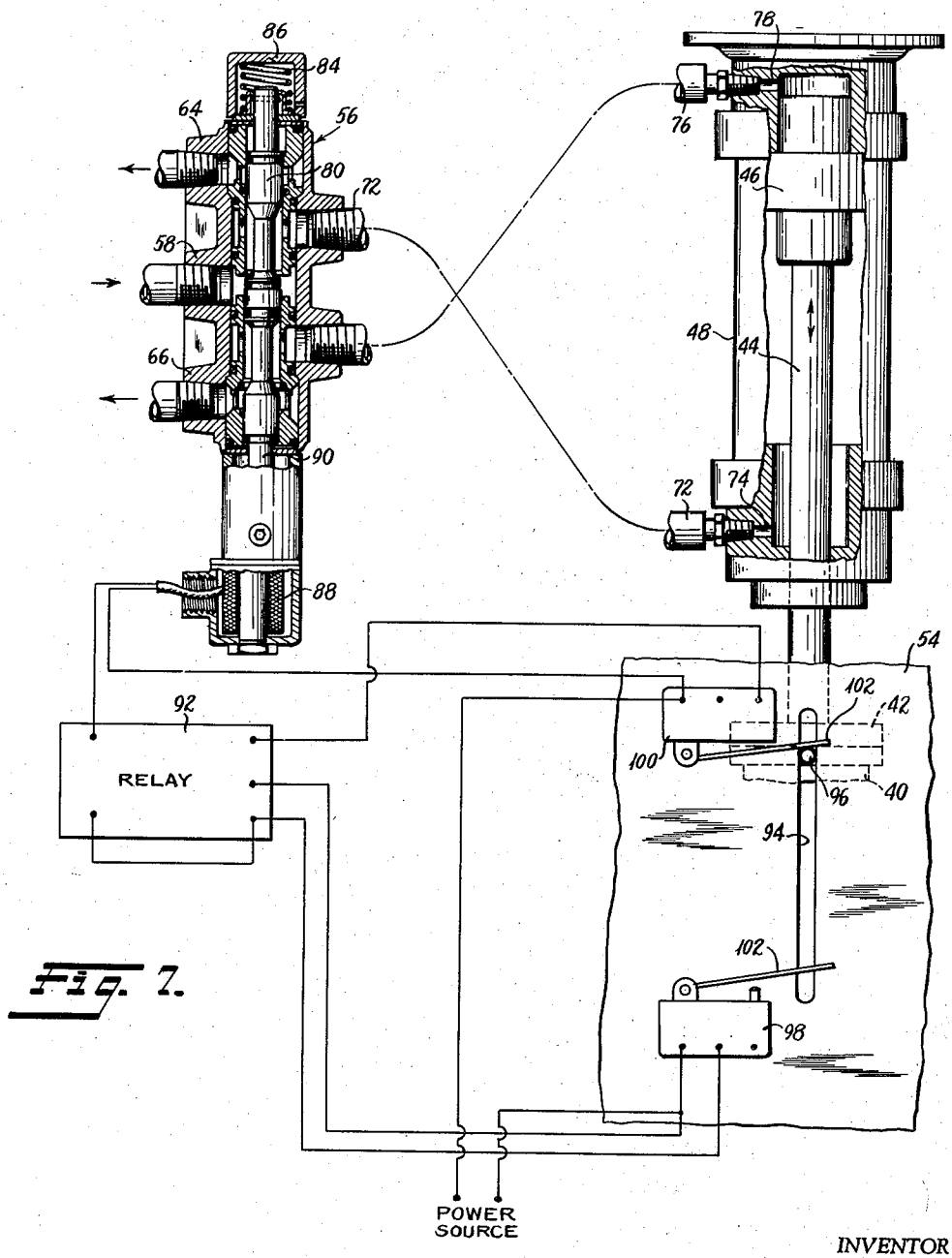

Fig. 7.

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2,881,844

TURF PLUG CUTTER

Harry L. Miller, Long Branch, N.J.

Application October 6, 1955, Serial No. 538,822

5 Claims. (Cl. 172—22)

This invention relates to machines for cutting plugs of turf for transplanting to establish new growths of turf without the necessity of planting seed. Many new grasses recently developed have become valuable turf grasses for lawns or the like but do not produce seeds by which they can be propagated. To establish new lawns of such grasses, it is necessary that an established growth be cut into relatively small plugs for propagation by transplanting. The present invention relates to a machine for rapidly and economically cutting, removing and collecting such plugs from a plot of established turf.

In general, the machine of the present invention consists of a wheeled carriage upon which a vertically reciprocable tubular plug cutter is mounted. The machine is provided with power means for cyclically driving the cutter into the turf to remove a plug therefrom and for advancing the carriage a predetermined distance during the upstroke of the cutter to position the cutter at a new location for cutting the next plug. The means for advancing the carriage, in one form, comprises a connection between the reciprocating cutter and at least one of the carriage wheels so that the upstroke of the cutter itself actually provides power for advancing the carriage. In another form the carriage is provided with an engine or the like to propel the same over the turf, and coordinating means control operation of the cutter to produce a down stroke after the carriage has moved a predetermined distance. In each form a tubular cutter is hollow throughout its height and the plugs cut thereby are forced upwardly through the tubular cutter to be discharged from the upper end thereof and collected in a convenient receiver. The invention further includes novel removable cutter tips for the lower end of the reciprocating member, each specially designed for soils of different moisture content. The invention further includes novel means whereby the vertical strokes of the cutter member actuate control means for the power device driving the cutter in reciprocation and further control means to regulate the rate of the upstroke to thereby control the over-all frequency of operation of the cutter.

It is therefore an object of this invention to provide a turf plug cutter wherein the cutting of the plugs and movement of the cutter over the turf are coordinated whereby plugs are cut at predetermined spaced intervals.

Another object of this invention is to provide a turf plug cutter arranged to elevate and deliver the cut plugs to a convenient collection position.

Still another object of this invention is to provide a vertically reciprocable plug cutter having means thereon for regulating the period of reciprocation whereby to predetermine the rate of operation.

A further object of this invention is to provide a turf plug cutter having interchangeable cutter tips for use in different soils.

A still further object of this invention is to provide a turf plug cutter which is simple in construction, economical to build and perfectly reliable in operation.

Still further objects and advantages will become apparent to those skilled in the art as the description proceeds in connection with the accompanying drawings, wherein:

Fig. 1 is a front elevational view, with parts broken away, of one form of plug cutter embodying the present invention;

Fig. 2 is a rear elevational view of the machine of Fig. 1;

Fig. 3 is a side elevational view of the machine of Figs. 1 and 2;

Fig. 4 is a horizontal sectional view taken substantially along the line 4—4 of Fig. 3;

Fig. 5 is a longitudinal vertical sectional view, on an enlarged scale, taken substantially along the broken line 5—5 of Fig. 2;

Fig. 6 is an enlarged fragmentary sectional view of a cutter tip taken along the line 6—6 of Fig. 5;

Fig. 7 is a schematic diagram showing the circuits for controlling the fluid motor and showing the control valve in vertical section.

Figs. 8 and 9 are, respectively, vertical sectional views through different forms of cutter tips employed with the machine of the present invention; and

Fig. 10 is a side elevational view, with parts broken away, illustrating a different embodiment of the invention.

Referring first to Figs. 3 and 4, the machine is provided with a carriage frame having longitudinal frame members 2 and transverse frame members 4 rigidly secured to the longitudinal members. The frame members may take any desired form but are preferably of angle iron construction as shown. At the forward end of the frame the machine is provided with a transverse axle 6 and suitable supporting wheels 8 while at the rear end of the frame the machine is provided with side plates 10 depending therefrom and in which an axle shaft 12 is rotatably supported by means of suitable bearings (not shown). A pair of roller-like wheels 14 are carried by the shaft 12 and at least one of the rollers is rigidly fixed to the shaft. Each roller wheel 14 is provided with a circumferential series of outwardly extending cylindrical lugs 16 to provide adequate traction for propelling the carriage over the turf.

Referring now particularly to Fig. 5, the axle 12 projects laterally from one side of the carriage and is provided with a suitable one-way clutch 18 comprising a portion fixed to the shaft 12 and an outer annular portion 20. Sprag elements 22, of a well-known type, are interposed between the outer member 20 of the one-way clutch and the portion carried by shaft 12 whereby rotation of the member 20 in one direction imparts torque to the shaft 12 but rotation thereof in the other direction permits the member to rotate freely without transmitting torque to the shaft. A suitable lever 24 is fixed to the outer member 20 for a purpose to be described later.

Referring again to Figs. 3 and 4, upwardly extending angle members 26 are fixed to transverse members 4 of the carriage frame and define a box-like vertical guiding structure. A pair of transverse plates 28 (see also Fig. 5) are fixed within the framework defined by members 26 and are each provided with a central circular opening 30. The openings 30 define guide means for a vertically reciprocating tubular cutter member 32. The tubular member 32 is guided by the aligned openings 30 for vertical reciprocation and has an internal passageway 34 of a size slightly larger than the desired diameter of the plugs to be cut. The upper end of the member 32 is cut away at one side to define a lateral opening 36 and an upwardly facing shoulder 38. A portion 40 of the member 32 extends upwardly a substantial distance above the shoulder 38 and defines a head portion secured to a fitting 42. The fitting 42 is in turn secured to the

lowermost end of a piston rod 44 having a piston 46 thereon slidable in a vertical cylinder 48 through a lower packing gland 50. The cylinder 48 is secured to a bracket plate 52 which is in turn fixedly mounted at the upper ends of the vertical frame members 26. A plate 54 (Fig. 3) is secured to one side of the framework defined by vertical members 26 and supports a control valve 56. The control valve 56 is provided with an inlet fitting 58 to which a compressed air line 60 is connected. The air line 60 supplies compressed air to the inlet of the valve 56 from any suitable source (not shown). If desired, an oiling device 62 may be interposed in the air line 60 and may be of any well-known form, whereby lubricating oil is periodically introduced into the air stream to provide lubrication for the moving parts of the valve and fluid motor. The valve 56 is also provided with means defining vent passageways 64 and 66 and means defining outlet ports 68 and 70. The outlet port 68 is connected through conduit 72 to a port 74 (Fig. 5) in cylinder 48 below the piston 46. Valve outlet port 70 is connected, through conduit 76, to a port 78 in cylinder 48 above the piston 46.

Referring now to Fig. 7, wherein the valve 56 is shown in section, a movable valve member 80 is movable in the valve 56 to selectively provide communication between the inlet 58 and outlet 68 and thence to the cylinder 48 below piston 46 while venting the cylinder 48 through conduit 76 and valve outlet 70 and to the vent passageway 66. The movable valve element 80 provides the described communication with the cylinder 48 when the valve member is in its lowermost position. It will be obvious from the structure shown in Fig. 7 that movement of the valve member 80 upwardly to an upper position will provide communication from the pressure inlet 58 through the conduit 76 to the space above the piston 46 and at the same time vent the space below the piston 46 through the valve to vent passageway 58. The valve shown is a conventional type of valve presently available on the market and need not be described in further detail. A regulating device comprising a manually operable valve 82 (Fig. 3) is mounted in the vent passageway 66 to selectively restrict that vent passageway the desired amount. By means of valve 82 the venting of the upper portion of cylinder 48 may be partially restricted to thereby reduce the speed of upward movement of the piston 46 when pressure is supplied to the cylinder therebelow.

Referring again to Fig. 7, a spring 84 housed in a cap 86 of valve 56 acts against the upper portion of the valve member 80 to normally hold that valve member in its lowermost position. A solenoid 88 constitutes a part of the valve 56 and is so arranged that, when energized, its armature 90 forces the valve member 80 upwardly against the action of spring 84. The solenoid 88 is under the control of a relay 92 which is also mounted on the plate 54 previously described and which normally assumes a position to energize solenoid 88.

The plate 54 is provided with a vertical slot 94 through which a pin 96, secured to the head portion 40 of the cutter member 32, projects (see also Figs. 1 and 2). The slot 94 is of sufficient length to accommodate the movement of pin 96 throughout the entire vertical stroke of the cutter member 32. Suitable control switches 98 and 100 are mounted on the plate 54 adjacent the ends of slot 94. Each switch is provided with an actuating finger 102 normally extending across the path of movement of the pin 96 adjacent the ends of its stroke. The switches 98 and 100 are arranged in a circuit including the relay 92 whereby when the pin 96 reaches the lowermost extremity of its stroke and engages finger 102 of switch 98 the latter actuates the relay 92 to de-energize the solenoid 88 whereupon spring 84 moves valve member 80 downwardly to vent the upper portion of cylinder 48 and admit pressure to the lower portion thereof. When that happens the piston 46 is moved upwardly by the fluid pressure to move the cutter member 32 to the upper end of its stroke, during which time a holding circuit (not shown) in the relay holds its contacts out of their normal position.

When the pin 96 reaches the uppermost end of the stroke and engages finger 102 of switch 100, the switch acts to open the holding circuit and release the relay 92 to its normal condition to again energize solenoid 88 which moves valve member 80 upwardly to vent the lower portion of cylinder 48 and admit pressure to the upper end thereof. The piston 46 and cutter member 32 are then again driven downwardly by fluid pressure. The details of the electrical circuit and the holding circuit are not shown herein since those details form no vital part of the present invention and many alternative arrangements may be devised by those skilled in the art.

The machine illustrated also includes a guiding handle structure 104 secured to the carriage frame at 106 (Fig. 3). A suitable manually operated switch 108 is mounted on the handle structure 104 in a position to be readily accessible to the operator of the machine. The switch 108 is connected through suitable conductors 110 to the electrical circuit shown in Fig. 7 in series with the conductors energizing solenoid 88. Thus when the switch 108 is open the relay 92 is incapable of energizing solenoid 88 whereupon the valve 80 is held in its lowermost position by spring 84 and the cutter member 32 is held stationary in its uppermost position. In that condition the relay 92 is in its "normal" position so that mere closing of the manual switch 108 energizes solenoid 88 and initiates a downward stroke of the piston 46 and cutter member 32. The cutter member 32 continues to reciprocate automatically as long as switch 108 remains closed.

Referring again to Fig. 5, the lever 24, previously described as being fixed to the one-way clutch member 20, is provided with an adjustable connector element 112 thereon which in turn is pivotally connected to a link 114. The link 114 is pivoted to the outer end of a crank arm 116 fixed to an end of a rock shaft 118 journalled transversely on the carriage frame in suitable bearing blocks 120. A further crank arm 122 is fixed to the rock shaft 118 substantially medially thereof in fore-and-aft alignment with the tubular cutter member 32. A rock link 124 is pivoted to the crank 122 adjacent the outer end thereof and serves as an anchor for one end of a tension spring 126 which has its other end anchored to a cross member 4 of the carriage frame, as clearly shown in the drawings. The rock link 124 also serves as an anchor for an end of a flexible chain 128 trained therefrom over a guide roller 130 mounted in suitable brackets 132 on the upright frame members 26. From the guide roller 130 the chain 128 extends vertically upwardly to where it is secured to the upper end of the head portion 40 of the cutter member 32. A tension spring 134 is secured to an intermediate portion of the chain 128 and extends upwardly therefrom to the upper end of the frame members 26 where it is secured thereto in any suitable manner. In Fig. 5 the tubular cutter member 32 is shown in full lines in its uppermost position, in which chain member 128 is taut and has caused rock shaft 118 to rock counterclockwise sufficiently to extend tension spring 126 a substantial amount. As the cutter member 32 moves downwardly to its lowermost position, spring 126 takes up the chain 128 as it is released by the cutter member and at the same time rocks shaft 118 in a clockwise direction. Clockwise rotation of the shaft 118 acts through crank 116, link 114 and lever 24 to oscillate the latter to a lowermost position determined by complete contraction of spring 126. The downward movement of the tubular cutter 32 is of a magnitude greater than the clockwise movement of the upper end of crank arm 122 under the conditions just described so that chain 128 would be considerably slackened by the time the cutter member reaches its lowermost position. The spring 134, however, maintains the chain 128 in a reasonably taut condition. The one-way clutch 118 pre-

viously described is so arranged that clockwise movement of the lever **24** does not impart rotation or torque to the shaft **12**, but counterclockwise movement of the lever **24** (as seen in Fig. 5) will impart torque and rotation to the shaft **12** and consequently to the roller wheels **14**.

In its lowermost position the tubular cutter member **32** holds a cutter tip thereon (to be described later) in the ground a sufficient distance to cut a turf plug of the required depth and at least a portion of the cutter tip remains below the surface of the ground during the initial portion of the upward movement of the cutter member. Forward movement of the carriage, therefore, should not take place until the cutter tip has been completely removed from the soil. From the structure previously described it is apparent that initial upward movement of the cutter member **32** merely takes up the slack in chain **128** and does not begin to apply tension thereto until the cutter tube has cleared the surface of the ground. Thereupon upward movement of the cutter member pulls chain **128** to oscillate rock shaft **118** and lever **24** in a counterclockwise direction. Such movement of lever **24** transmits driving torque through the one-way clutch **18** to the roller wheels **14** and thus imparts forward movement to the entire carriage to position the center of the cutter member forwardly of the position from which the preceding plug was cut. Thus, upon automatic vertical reciprocation of the cutter member **32** the entire carriage is intermittently advanced a predetermined distance before the next downward stroke of the cutter member takes place and the carriage remains stationary during the downward movement of the cutter member and during the initial portion of its subsequent upward movement.

As previously described, the cutter member **32** is provided with a vertical passageway **34** therethrough communicating with the lateral opening **36**. A deflector member **136** is mounted in the cutter member **32** to extend upwardly and laterally outwardly of the passageway **34** and overlying the upper end of passageway **34** in the manner clearly shown in Fig. 5. A plug-directing chute **138** of generally inverted U-shaped construction is provided with side bands **140** loosely encircling and embracing the upwardly extending portion **40** of the cutter member and resting upon the upwardly directed shoulder **38**. Thus the chute member **138** is held in place on the cutter member **32** against removal but is free to vibrate or "jiggle" as the cutter member reciprocates vertically. The chute member **138** is so positioned and directed that it guides plugs deposited therein laterally of the passageway **34** from whence they drop to a guiding chute **142** fixedly mounted on the vertical frame members **26**.

Suitable brackets or frame members **144** are welded or otherwise secured to the forward transverse frame member **4** and a rack or platform **146** is fixedly mounted thereon. The platform **146** is provided for supporting a box **148** or other suitable container for receiving plugs delivered by the directing means or chute **142**.

The lowermost end of the tubular cutter member **32** is provided with a threaded socket **150** adapted to receive a securing member **152**. The securing member **152** is provided with an internal bore of the same diameter as the passageway **34** which is in alignment therewith when the securing means is in place as shown. A plurality of cutter tips **154** are provided for the machine. Each cutter tip is of hollow cylindrical construction and provided with a peripheral flange **156** by which it may be removably secured to the lowermost end of the supporting means **152**. Thus the supporting means **152** may be readily removed from cutter member **32** to facilitate changing the cutter tip **154** and thereafter replaced in the cutter member **32**. The supporting means **152** may be adjusted longitudinally of the cutter member **32** to regulate the depth of penetration of the cutter tip **154** into the turf. The particular cutter tip **154** shown in Fig. 5 has an inside diameter equal to the bore through supporting means **152** and passageway **34**. The lowermost end of the cutter tip **154**, however, is thickened inwardly to provide an inwardly directed annular rib **158** having an upwardly facing shoulder **160** therein. The cutting edge **162** of the cutter tip of Fig. 5 is defined by the intersection of the outer cylindrical surface of the cutter tip and an inner bevelled surface **164**. The particular construction therein shown is intended for use in rather wet soil. With the cutting edge coincident with the outer cutting periphery of the tip, maximum radial compression of the plug occurs during the cutting operation in forcing the plug past the rib **158**. The shoulder **160** then acts to support the cut plug inside the tubular cutter **32** and the next plug cut by the device lifts the previously cut plug upwardly in the larger diameter portion of the passageway. Thus a column of plugs is formed in the passageway up to and through the upper end thereof. Upward movement of the column of plugs caused by cutting subsequent plugs moves the column upwardly to engage the top plug with the deflector **136**, and that plug is pushed by the deflector laterally through the opening **36** onto the chute **138** and thus through the directing chute **142** to the receiver **148**.

Fig. 8 shows a form of cutter tip **154** in which the cutting edge is coincident with the inner surface of the tip portion so that substantially no compression of the plug takes place while it is being cut. This form of tip is particularly well adapted for cutting plugs from dry soil.

Fig. 9 shows a still further form of cutter tip wherein the cutting edge **162** is defined by the intersection of inner and outer bevelled surfaces **166** and **168**. In this form the cutting edge is intermediate the inner and outer surfaces of the tip and only partially compresses the plug. This form is particularly well adapted for cutting plugs in medium wet soil.

The cylindrical lugs **16** secured to the periphery of the roller wheels **14** are of a diameter substantially equal to the diameter of the cutter tips **154** and are peripherally spaced on their respective wheels **14** distances equal to the distance through which the carriage is advanced at each stroke of the cutter member **32**. The lugs **16** provide adequate traction for advance of the carriage by engagement with the surface of the turf when the first row of plugs is being cut. After a row of plugs has been cut from a given area, a row of holes remains in the turf. In cutting the next adjacent row of plugs, the carriage may be positioned and moved along such a path that the lugs **16** on at least one of the roller wheels enters the openings left when cutting the first row of plugs to thereby give positive traction to the machine and minimize the danger of damaging the turf thereadjacent. While a specific form of roller wheel having lugs is shown, it is to be understood that other forms of traction device may be employed with equal facility. For example, one or more traction devices having endless treads may be used.

The pneumatic motor heretofore described as being provided for operating the tubular cutter is so arranged that the weight of the tubular cutter **32** and the piston **46** assist downward movement of the mechanism. The fluid pressure applied to the top of the piston insures an extremely rapid and sharp downward stroke to insure a clean cut without mere destruction of the plug material. It is desirable that a sharp rapid downward stroke be made at all times. However, it is not necessary that the upward stroke be so rapid. In fact, it is desirable that the upward stroke consume more time than the downward stroke to thus relieve the carriage advancing mechanism of a substantial shock load and to prevent undue vibration of the parts and particularly the delivery chute **138** and plugs supported thereby. By regulating the extent of the opening in vent passageway **66** by means of the regulator valve **82** previously de-

scribed, the speed of the upward stroke may be regulated to the desired optimum value.

Fig. 10 shows an alternative form of construction wherein parts identical to those heretofore described bear the same reference numerals. Instead of mounting the vertically reciprocable cutter member on the carriage like that shown in Figs. 1 through 7, the mechanism is mounted on the chassis of a self-propelled vehicle **200**. The vehicle may be provided with the usual engine **202** which may also drive an air compressor (not shown) to maintain a supply of compressed air in a tank **204** for operation of the pneumatic motor. The engine **202** also supplies motive power through a drive shaft **206** to one or more wheels **208** of the vehicle. It is contemplated that the embodiment shown in Fig. 10 be driven at a substantially constant rate over the turf, although a relatively low rate of speed is desirable. Since the vertical reciprocations of the cutter member **32** are governed by the operation of the switches and valves alone it is necessary that some means be provided to properly time the operation of the cutter to the advance of the vehicle. It will be remembered that the mechanism previously described includes an upper control switch **100**, actuation of which initiates the downward stroke of the cutter member. In the embodiment of Fig. 10 a further timing control device **209** is provided and consists merely of a switch in series with the switch **100** so that switch **100** will be incapable of energizing solenoid **88** unless switch **209** is closed. Switch **209** is mounted adjacent a control cam **210** fixed to one of the wheels **208** or to drive axle **212**. The cam **210** is provided with projections **214** spaced apart a distance corresponding to the desired spacing between the cut plugs. Thus, the vehicle **200** may advance at any particular speed and successive downward strokes of the cutter member **32** will always take place a predetermined distance apart. The vehicle **200** also provides storage space for extra boxes or receivers **148**.

While a limited number of modifications of the invention are shown and described herein, it is to be understood that they are merely illustrative of the principles of the invention, which is not limited thereto. It is contemplated that the invention encompass all modifications falling fairly within the scope of the appended claims.

I claim:

1. In a turf plug cutter; a frame, a vertically reciprocable tubular cutter member on said frame, a fluid motor on said frame and having a piston connected to said tubular cutter member for reciprocating the same, a valve on said frame for selectively admitting fluid pressure to one side or the other of said piston, means normally urging said valve to a position to admit pressure below said piston to hold said cutter member in its upper position, solenoid means for moving said valve to a position to admit pressure to said motor to drive said cutter member downwardly, a manually actuable switch in circuit with said solenoid to initially energize said solenoid, and switches on said frame actuable by said cutter member at the ends of its stroke to alternately energize and de-energize said solenoid.

2. In a turf plug cutter, a frame having thereon a vertically disposed tubular member mounted for rectilinear axial reciprocation, a hollow cylindrical cutter tip at the lower end of said member, means at the end thereof of securing said tip to said tubular member, the other end of said cutter tip defining an axially downwardly facing annular cutting edge, the inner diameter of the portion of said cutter tip adjacent said cutting edge being less than the inner diameter of the remainder of said cutting tip, and an upwardly facing annular shoulder at the inner terminus of said portion.

3. A device as defined in claim 2 wherein said cutting edge is defined by the intersection of the inner cylindrical surface of said portion and an outer bevelled surface.

4. A device as defined in claim 2 wherein said cutting edge is defined by the intersection of the outer cylindrical surface of said portion and an inner bevelled surface.

5. A device as defined in claim 2 wherein said cutting edge is defined by the intersection of inner and outer bevelled surfaces at the lower end of said portion.

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