

June 10, 1969

F. J. HAYNES

3,448,535

BACK HOE APPARATUS HAVING MOVABLE TEETH

Filed April 22, 1968

Sheet 1 of 2

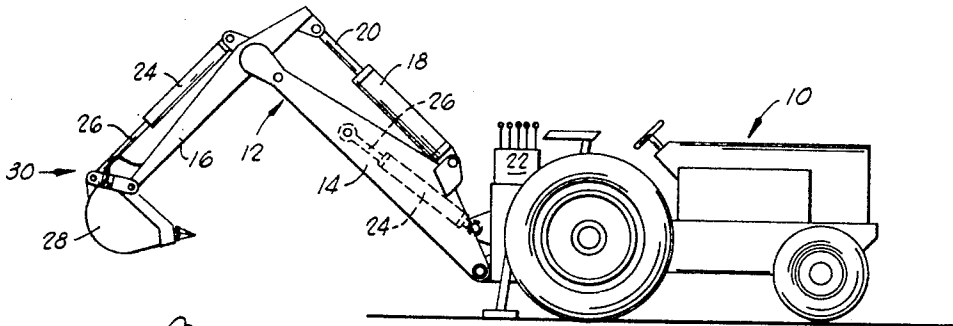


Fig. 1

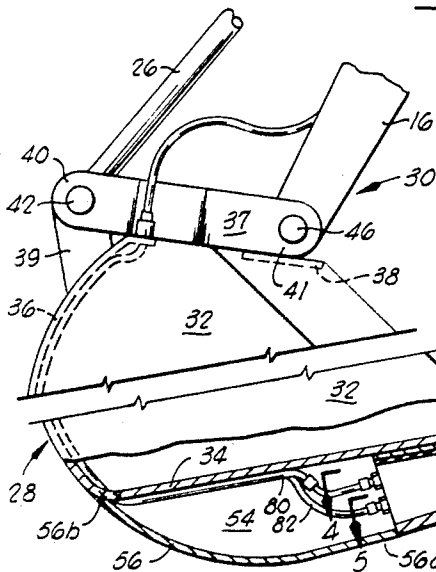


FIG. 2

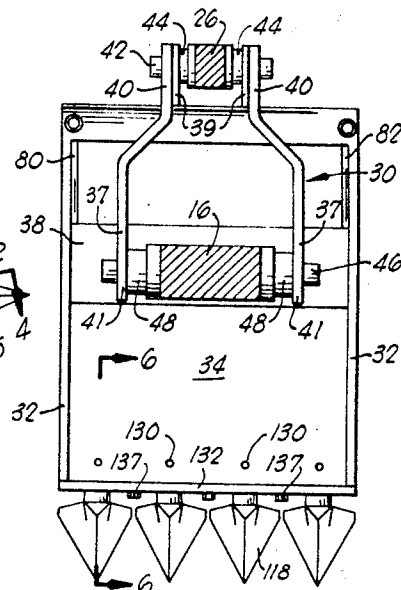


Fig. 3

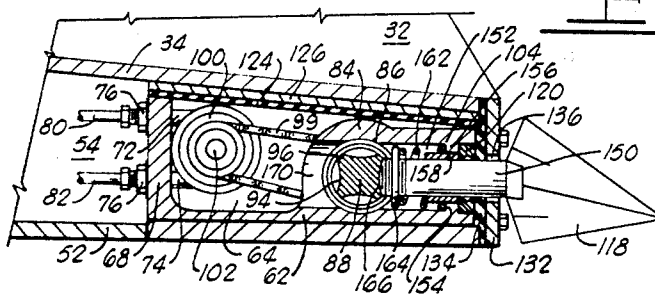


Fig. 1

INVENTOR.
FREDDIE J. HAYNES

BY

BY *Dumlap, Lugo & Hession*
ATTORNEYS

June 10, 1969

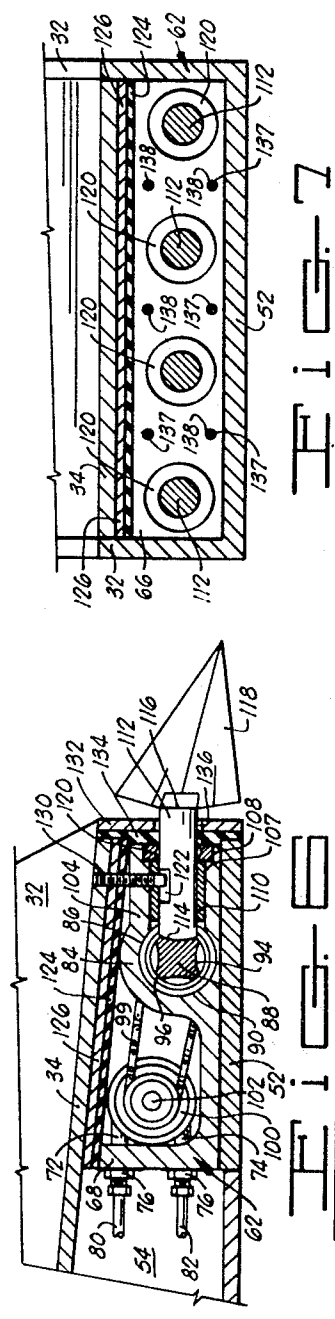
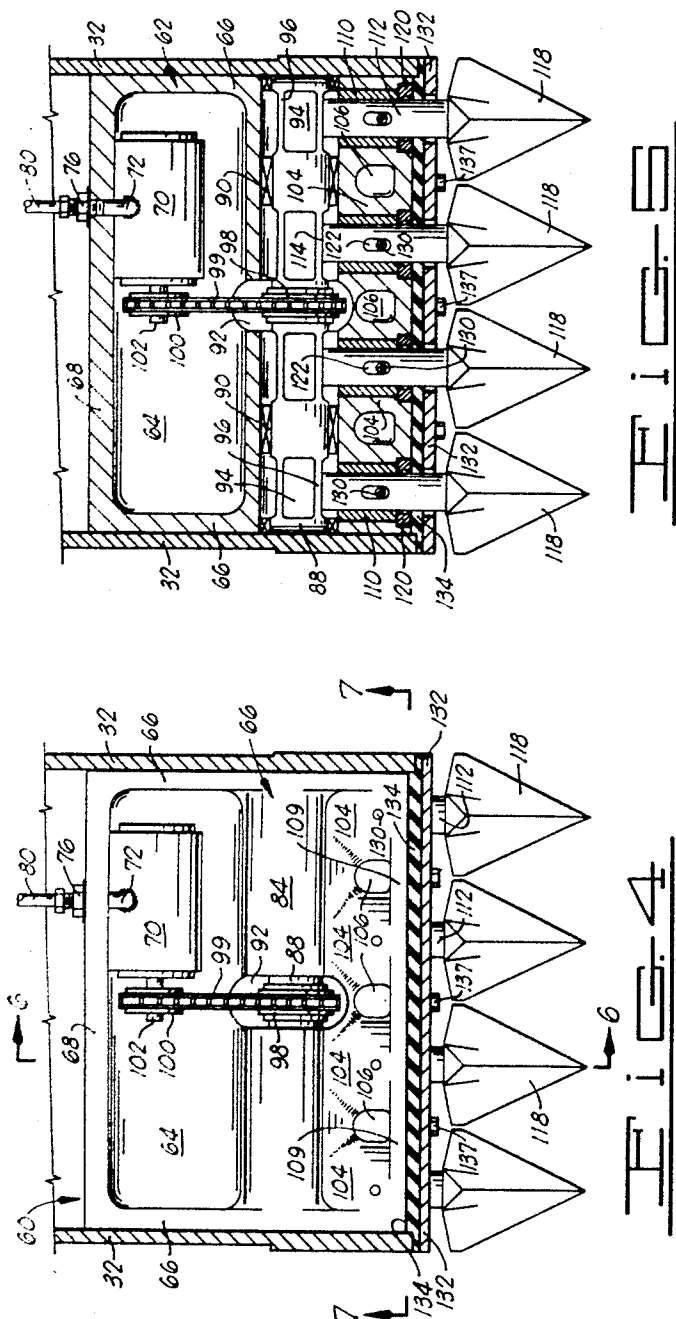
F. J. HAYNES

3,448,535

BACK HOE APPARATUS HAVING MOVABLE TEETH

Filed April 22, 1968

Sheet 2 of 2



INVENTOR.
FREDDIE J. HAYNES

BY

Dunlop, Lang & Hession
ATTORNEYS

1

3,448,535

BACK HOE APPARATUS HAVING MOVABLE TEETH

Freddie J. Haynes, Oklahoma City, Okla., assignor to
Rockmaster Tools, Inc., Oklahoma City, Okla., a
corporation of Oklahoma

Continuation-in-part of application Ser. No. 514,817,
Dec. 20, 1965. This application Apr. 22, 1968, Ser.
No. 722,990

Int. Cl. E02f 3/28, 5/02, 5/18

U.S. Cl. 37-141

20 Claims

ABSTRACT OF THE DISCLOSURE

A back hoe apparatus including an articulated boom having a bucket affixed to one end of the boom, and hydraulic power fluid conveying lines extending along the boom to the bucket. Mounted in the bottom of the bucket are a hydraulic motor, a plurality of reciprocally mounted teeth, and means drivingly interconnecting the motor and the teeth. The means drivingly interconnecting the motor with the teeth includes a cam shaft carrying a plurality of lobes which bear against cooperating surfaces of rods secured to the teeth to drive the several teeth in reciprocation, and in out-of-phase relationship with each other. The motor, driving means and teeth are all mounted in a casting or solid block which can be quickly removed from the bottom of the bucket.

BACKGROUND OF THE INVENTION

Related prior application

This application is a continuation-in-part of my patent application Ser. No. 514,817 filed Dec. 20, 1965, and entitled, "Back Hoe Apparatus Having Movable Teeth."

Field of the invention

This invention relates to earth excavating apparatus, and more particularly, to back hoes of the type having movable teeth which can be moved in reciprocation to enhance the digging effectiveness of the apparatus.

BRIEF DESCRIPTION OF THE PRIOR ART

It has heretofore been proposed to provide so-called back hoe apparatus which includes an articulated boom secured at one of its ends to a powered vehicle, and at its other end to a digging bucket which carries teeth along one edge of the bucket so that the teeth are forced into the ground to load the bucket with dirt when the articulated boom is properly manipulated by hydraulic or air power. Recently, it has been proposed to impart vibratory or reciprocating movement to the teeth of the back hoe bucket so that their penetrating efficiency is improved, particularly in very hard soils.

In U.S. Patent 3,328,904 issued to Voigt et al. on July 4, 1967, there is disclosed a back hoe apparatus in which the teeth are secured to drive rods which are connected at their ends opposite the ends carrying the teeth to a sleeve eccentrically surrounding a crank shaft. As the crank shaft is driven in rotation by the hydraulic motor, the eccentric sleeve transmits an oscillating motion to the rods and to the teeth which they carry, and this motion is alleged to improve the digging effectiveness of the back hoe.

In U.S. patent application Ser. No. 514,817 filed Dec. 20, 1965, of which the present application is a continuation-in-part, a back hoe apparatus is disclosed which includes a plurality of teeth mounted at the leading edge of the bucket and secured to the forward ends of a plurality of drive rods. These drive rods pass into a sealed chamber secured beneath the bucket, and are there

2

connected through wrist pins or knuckle joints to crank arms which are connected to offset throws carried by a crank shaft which extends transversely in the back hoe bucket. This crank shaft is rotatably journaled in the bucket, and is driven in rotation by a hydraulic motor which receives hydraulic power fluid from a feed conduit and a return conduit extended along the articulated boom of the back hoe apparatus. In the cited application, a substantial portion of the driving connection between the teeth and the hydraulic motor is mounted in the sealed chamber so that the entire moving parts are bathed or immersed in lubricant.

An advantage which is afforded by the construction of the back hoe apparatus depicted and described in the cited application with respect to the apparatus described in U.S. Patent 3,328,904, is the ability of the former apparatus to provide effective seals surrounding the rods which are connected to the teeth, and which pass through the wall of the sealed chamber supported beneath the back hoe bucket. In the apparatus depicted in the patent, the oscillating motion of the connecting rods makes it extremely difficult to maintain effective seals preventing ingress of dirt to the moving parts of the drive system.

Despite the various proposals which have been forthcoming relative to the manner in which a back hoe having movable teeth, and therefore being much improved in digging efficiency, should be constructed, within my knowledge no device of this type has been marketed to the present date. I have investigated fairly extensively the problems and difficulties encountered in attempting to make a device of this type operative while avoiding undue construction expense. I have concluded that several of these problems have not been adequately or completely solved by prior proposals, and I believe that the present invention constitutes the most satisfactory solution for these problems, and provides the nearest approach to an entirely workable and satisfactory back hoe apparatus of this type which has been yet advanced. Prior to discussing the construction of the present invention, a brief review of these problems will be helpful in better understanding the invention, and in appreciating its merits.

In the types of excavating and digging where movable teeth provide the greatest advantage in a back hoe construction, extremely hard soils or rock are encountered. Thus, though the movable tooth type back hoes will give an accelerated rate of excavation in substantially any type of soil, there are instances where back hoe excavation with conventional buckets having fixed teeth thereon is virtually impossible. It is here that the provision of movable teeth constitutes the most significant improvement.

Where digging in rock or extremely hard soil is to be carried out with back hoes having movable teeth, it is necessary to provide a very strong and mechanically rugged drive system in order to withstand the shock forces imposed through the teeth upon the tooth driving mechanism. Severe wear forces come into play during this type of digging, and the driving connections which have included the wrist pins or knuckle joints and offset throws on the crank shaft, or an eccentric sleeve mounted between the oscillating blade carrying rods and the cam shaft have all suffered a severe reduction in trouble-free service life as a result of these severe wear forces.

It will also be apparent that by the very nature of the environment in which a back hoe apparatus is employed, it is essential that efficient, high integrity seals be provided around the rods which connect the teeth to the driving apparatus utilized to drive the teeth in reciprocation or oscillation. Unless such seals are provided, dirt, water and mud will soon be forced between these rods and into the space which accommodates the driving motor and all of the interconnecting driving parts, including crank shafts, cam shafts, connecting rods, wrist pins, etc.

The provision and maintenance of adequate seals at the required locations is extremely difficult when it is attempted to oscillate the entire blade or tooth assembly, including the tooth proper, the connecting rod, and the member which is itself connected to the crank shaft. In this arrangement, the portion of this assembly which passes through the seals is necessarily moving up and down, as well as in reciprocating and, in some cases, sideways (transversely with respect to the direction of movement of the bucket into the soil) and effective sealing is rendered very difficult.

Another difficulty which is related to the severe wear imposed upon the moving parts utilized in a movable tooth back hoe apparatus is the requirement for constant and thorough lubrication of these parts. Although some types of this apparatus undertake to provide sealed bearings around individual parts, the development of any leak or rupture of the lubricant retaining seal can result in destruction of the lubricated part. Arrangements providing exposed grease zerks or external lubricant fittings are also less than optimum, since such fittings interfere with the proper operation of the bucket of the hoe, and are also soon destroyed or packed with dirt and cannot be used as an instrumentality for introducing the lubricant or grease to the lubricated parts of the assembly.

Finally, it is essential in any structure of the type under discussion that access means be provided by which proper maintenance of the moving parts of the apparatus may be performed. Thus, quick and relatively simple or easy access to the hydraulic or pneumatic motor must be available, as must access to the crank or cam shaft and other moving parts which drivingly interconnect the motor with the teeth. It is also desirable that the teeth be quickly replaceable when they have become dulled or broken.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

Testing under severe conditions of a back hoe apparatus which I have now developed for the purpose of overcoming or more nearly completely solving the problems described in the preceding section has now convinced me that the back hoe of the present invention affords a significant advance over other generally similar constructions as heretofore proposed. In the apparatus of the invention, there is no positive interconnection between the rods or bars carrying the digging teeth and a shaft which is driven by a hydraulic motor and which, in turn, drivingly contacts these rods or bars. This construction affords an improvement in the mechanical durability of the structure, and reduces the structural failures which occur in relatively short periods of hard and severe usage. Moreover, in the back hoe of the present invention, a sealed unit containing all of the movable parts of the apparatus, except the teeth per se is provided and is quickly attachable to the underside of the back hoe bucket. This sealed unit permits all of the moving parts to be constantly bathed in lubricant, and also permits quick removal of the unit from the back hoe bucket, and easy servicing and maintenance after such removal. The present invention further provides highly effective seals around tooth carrying bars or rods which move only in reciprocation and undergo no other motion, so that the seals are retained in good condition over an extended period of service of the back hoe device.

Broadly described, the back hoe apparatus of the present invention comprises a self-powered vehicle, an articulated boom having one end secured to the vehicle, an open-topped digger bucket pivotally secured to the second end of the articulated boom, and a plurality of teeth which are mounted along the digging edge of the bucket, and are movable with respect to the bucket by means of novel apparatus hereinafter described in greater detail.

The back hoe apparatus of the invention further in-

cludes a receiving chamber positioned below the bottom, earth carrying plate in the bucket. The receiving chamber is open at its forward end and at its rear end and is trapezoidally shaped in cross-section so as to matingly receive a trapezoidally shaped sealed driving unit which can be inserted in the rear end of the open-ended receiving chamber and forced forwardly until it is wedged or fits snugly in the receiving chamber adjacent the front end thereof. The sealed driving unit is an important aspect of the present invention, and, when it is secured in place within the open receiving chamber by bolting a face plate at the front end thereof, it provides a means by which the moving parts of the driving mechanism used to reciprocate the teeth carried at the front edge of the bucket can be constantly immersed in lubricant during the operation of the back hoe apparatus.

The sealed driving unit includes an integrally formed casting block in which is mounted a hydraulic motor which, through a suitable drive chain, drives a cam shaft mounted in an elongated bore in the casting. The cam shaft has a plurality of lobes and depressions formed along the length thereof and extends transversely of the bucket. The cam shaft drives the teeth in reciprocation by contact of the cam lobes and depressions with radiused ends on rods extending into the sealed driving unit from the teeth. By means of this type of driving arrangement, no positive interconnection between the tooth-carrying rods and the cam shaft is required, wrist pins and knuckle joints are eliminated, and the rods and teeth are driven in pure reciprocating movement which permits a much more efficient and effective seal to be maintained around the rods.

From the foregoing brief general description of the invention, it will have become apparent that the present invention provides an improved back hoe apparatus which achieves a major objective of the invention, i.e., provision of a relatively economically constructed back hoe apparatus having reciprocating teeth thereon which can function over extended periods of time in an effective manner without mechanical failure.

A more specific object of the invention is to provide a back hoe apparatus having movable teeth mounted at the digging edge of the back hoe bucket, with driving force imparted to the teeth by a cam shaft-tooth rod arrangement in which the rods carrying the teeth are not directly and positively connected to the cam shaft.

An additional object of the present invention is to provide a back hoe apparatus which includes a sealed driving unit utilized for the purpose of driving in reciprocating motion, a plurality of teeth disposed at the digging edge of the back hoe bucket, with such sealed driving unit sealingly retaining lubricant around all moving parts of the driving apparatus during use of the back hoe apparatus.

An additional object of the present invention is to provide a back hoe apparatus having movable teeth located at the digging edge of the back hoe bucket, with the mechanism used to drive these teeth in reciprocation being completely sealed against the ingress of dirt and other deleterious materials to the moving parts of the mechanism.

Additional objects and advantages will become apparent as the following detailed description of the invention is read in conjunction with the accompanying drawings which illustrate the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a view in elevation of the back hoe apparatus of the invention.

FIGURE 2 is a side view, partially in section and partially in elevation, of the back hoe bucket and universal hitch forming a portion of the invention. A central portion of the back hoe bucket has been broken away.

FIGURE 3 is a plan view of the bucket shown in FIGURE 2.

5

FIGURE 4 is a horizontal sectional view taken through the back hoe bucket along line 4—4 of FIGURE 2.

FIGURE 5 is a sectional view taken along line 5—5 of FIGURE 2.

FIGURE 6 is a sectional view taken along line 6—6 of FIGURE 3.

FIGURE 7 is a sectional view taken along line 7—7 of FIGURE 4.

FIGURE 8 is a sectional view similar to that shown in FIGURE 6, but illustrating a modified embodiment of the invention.

Detailed description of preferred embodiments of the invention

Referring to the drawings in detail, and particularly to FIGURE 1, reference numeral 10 designates generally a self-propelled vehicle of the type conventionally employed in back hoe devices. The self-propelled vehicle 10 has secured to the rear end thereof, an articulated boom 12 which includes a first boom member 14 and a second boom member 16. The second boom member 16 is pivotally connected to the first boom member 14 and its movement is controlled by a suitable hydraulic cylinder 18 and piston 20 which are controlled by suitable controls 22 located on the vehicle 10. The first member 14 is pivotally secured to the vehicle and its movement is controlled by means of a suitable cylinder 24 and piston 26.

A bucket 28 is pivotally connected to the free outer end of the member 16 by means of a universal hitch connection designated generally by reference numeral 30 later described in greater detail. The bucket 28 is of conventional general shape and thus includes substantially parallel side walls 32, a dirt-carrying bottom wall 34 and an arcuate or curved back wall 36 which is preferably formed integrally with the bottom wall 34.

The universal hitch connection 30 includes a pair of bracket plates 37 which are secured to a transverse brace 38 extending between the upper edges of the side walls 32 and to vertical braces 39 secured to the upper back side of the back wall 36. The bracket plates 37 are formed to a shape such that parallel rear portions 40 thereof are relatively closely spaced, and parallel forward portions 41 thereof are relatively widely spaced. The rear portions 40 have aligned apertures formed therethrough and the forward portions 41 also have aligned apertures formed therethrough. A pivot pin 42 is extended through the apertures in the rear portions 40 thereof, and the piston rod 26 is pivotally connected to the pin 42. This piston rod 26 is centered between the rear portions 40 by means of spacer sleeves 44. A pivot pin 46 is extended through the apertures in the forward portions 41 and carries spacer sleeves 48 which center between the bracket plates 37 and the lower end of the arm 16.

The bucket 28 is actuated in the conventional manner, but the universal hitch connection 30 affords the advantage of permitting substantially any type or size of articulated boom structure to be secured to the bucket 28. This is accomplished by providing a plurality of interchangeable spacer sleeves 44 and 48 of varying lengths which can be used to accommodate any size of piston rods 26 and arms 16 to the bucket. Thus, the improved bucket of the invention can be separately manufactured and mounted on existing back hoe machines of almost any type now made.

The bucket 28 further includes, in addition to the side walls 32, the dirt-carrying bottom wall 34, and the arcuate or curved back wall 36, a lower chamber wall 52 which, with the bottom wall 34 and the lower portions of the side walls 32, forms an open receiving chamber 54 which is open at its front end and at its back end. A removable arcuate closure plate 56 is constructed with a curvature and transverse dimension which permits it to be fitted to the lower portion of the bucket 28 in the manner best depicted in FIGURE 2. Thus, the arcuate closure plate 56 has its forward edge 56a secured to the rear edge of the lower chamber wall 52, and has its rear edge 56b secured to the lower edge of the back wall 36 of the bucket.

6

Positioned within the open chamber 54 is a removable sealed driving unit designated generally by reference numeral 60. The sealed driving unit 60 includes a casting block 62 which is an integrally cast element constructed to accommodate a prime mover or driving unit, drive rods connected to the digging teeth and a cam shaft, all as more specifically hereinafter described. Thus, the casting block 62 has a transversely extending well 64 formed in the rear portion thereof and defined by a pair of side walls 66 and a rear wall 68. Positioned within the well 64 is a hydraulic motor 70 which has a pair of rigid conduits 72 and 74 extending to and through the rear wall 68 for conveying hydraulic power fluid to and away from the motor. The conduits 72 and 74 extend through apertures and sealing elements in the rear wall 66 of the casting block, and take-up nuts or fittings 76 are tightened on the conduits to draw the motor 70 firmly against the rear wall 68 of the casting block. Flexible power fluid conduits 80 and 82 are connected to the rigid conduits 72 and 74, respectively, for conveying power fluid to and from the motor 70.

Along its central portion, the casting block 62 is built up to provide a transversely extending cam shaft housing 84. The cam shaft housing 84 is bored 86 over its length (that is, from one side of the casting block 62 to the other) to receive an elongated generally cylindrical cam shaft 88. The cam shaft 88 will be described in greater detail later in the description of the invention. The bore 86 through the cam shaft housing 84 is of sufficiently large diameter to accommodate a plurality of annular needle bearings 90 which are spaced axially from each other in the bore, and surround the cam shaft 88. It will further be noted that the central portion of the cam shaft housing 84 is cut away as indicated at reference numeral 92 in the drawings so that the portion of the cam shaft 88 which is positioned in the bore 86 is exposed through the casting block 62.

The cam shaft 88 is a cylindrical member which is ground down at axially spaced intervals along its length to provide a plurality of circumferentially spaced alternating depressions 94 and cam lobes 96. It will be noted that the locations at which the cam shaft 88 is ground down to provide the circumferentially aligned depressions 94 and lobes 96 are spaced from each other so that the needle bearings 90 and are alternated along the cam shaft with the cam lobes and depressions thereon. The cross-sectional appearance of the cam shaft 88 at one location of the cam lobes 96 and depressions 94 is best illustrated in FIGURE 5. In referring to this cross-sectional view, it will be noted that four of the lobes 96 are provided around the periphery of the cam shaft, and that these lobes are equally spaced from each other. The particular arcuate shape of the depressions 94 is of some importance in the construction of the back hoe of the invention, and will be described further in a later part of the discussion. It should be further pointed out that the cam lobes 96 and depressions 94 in each circumferentially aligned series along the cam shaft 88 are positioned in a staggered or offset relation with respect to the next adjacent circumferentially aligned series of lobes and depressions on the two opposite sides thereof. In other words, at the time, say, when a particular cam lobe 96 passes through a vertical plane extended through the axis of the cam shaft 88, other cam lobes along the shaft on opposite sides of the one under consideration will be circumferentially offset from, or not located in, this vertical plane.

At a medial portion of the cam shaft 88 which is aligned with the cut-away portion 92 of the cam shaft housing 84, circumferential teeth are formed around the periphery of the cam shaft to provide a drive sprocket 98. A drive chain 99 is extended through the cut-away or open portion 92 of the cam shaft housing 84, around the sprocket 98 on the cam shaft 88 and around a drive sprocket 100 keyed to the end of a shaft 102 driven in

rotation by the hydraulic motor 70. In this way, the cam shaft 88 can be driven in rotation from the motor 70 by the chain 99.

Extending between the cam shaft housing 84 and the forward edge portion of the casting block 62, and forming a further integral portion of the casting block are a plurality of transversely spaced rod housings 104. The rod housings 104 are separated by cavities 106 in the casting block 62 which permit substantial amounts of material to be saved in the fabrication and construction of the back hoe device of the invention. The cavities 106 extend to a forward wall 109 of the casting block 62. The rod housings 104 each extend substantially normal to the cam shaft housing 84 and each defines a rod receiving bore 107 which communicates with the cam shaft bore 86. At the forward end of the casting block 62, a plurality of hollow counterbores 108 are formed in the end faces of the rod housings and communicate with the rod receiving bores 107.

Positioned in each of the bores 107 through the respective rod housings 104 is a bronze bushing or sleeve 110. A drive rod 112 having a radiused end 114 adjacent the cam shaft 88 is slidably positioned in each of the bushings 110 and has a second end 116 which projects out of the casting block 62 for a substantial distance and is secured to a digging tooth 118. Securement of the digging teeth 118 to their respective drive rods 112 may be by a detachable connection, or, may be by integral molding or casting with the respective rods. Pressed into each of the counterbores 108 at the forward end of the casting block 62, and sealingly positioned around each of the drive rods 112 is a suitable annular sealing ring or element 120. It will be noted in referring to FIGURES 5 and 6 that an axially extending slot 122 is formed in a medial portion of the top or upper side of the outer periphery of each of the drive rods 112. It will be noted that the radius of curvature of the radiused inner end 114 of each of the drive rods is matched to the radius of curvature of the concave depressions 94 on the cam shaft. This is clearly illustrated in FIGURE 6.

The casting block 62 is configured in a trapezoidal configuration in vertical cross-section so that its upper surface and lower surface converge toward each other in a direction looking from the rear wall 68 toward the forward end of the casting block 62. In a horizontal cross-sectional plane, the casting block 62 may be any of several configurations, but is illustrated as of substantially rectangular cross-sectional configuration. Secured to the top side of the casting block 62, and extending from the rear wall 68 to the forward end thereof is a sealing gasket 124 and a cover plate 126. When the sealing gasket 124 and cover plate 126 are secured in place on top of the casting block 62, the sealed driving unit 60 is sealed, and the well 64 can be completely filled with a lubricant so as to immerse and bathe all the moving parts of the assembly during its use. The plurality of retainer pins 130 are extended through the bottom wall 34 of the bucket 28, through the cover plate 126, and the gasket 124 into axial slots 122 in the top side of the several drive rods 112. The pins 130 may carry any suitable type of head which will permit them to be easily removed when the system is to be disassembled in a manner hereinafter described. In assembling the apparatus, the sealed driving unit 60 with the teeth 118 and rods 112 removed is mounted in the bucket 28 by inserting it through the open rear end of the open receiving chamber 54 after the removable arcuate closure plate 56 is removed. The sealed driving unit, by reason of its trapezoidal configuration, can slide forwardly in the open receiving chamber 54 until it becomes lightly wedged in this chamber at the forward end thereof in the manner depicted in FIGURE 5.

At this point in assembling the back hoe apparatus, a face plate 132 and a sealing gasket 134, which are superimposed and provided with a plurality of horizontally spaced, relatively large, aligned openings 136 there-

through, and also with a plurality of horizontally spaced, relatively small diameter aligned openings therethrough (not visible), are passed around the drive rods 112 so that these drive rods extend through the relatively large openings in the face plate and gasket. This mounting of the drive rods 112 through the face plate 132 and gasket 134 occurs, of course, prior to the time that the drive rods 112 and the teeth 118 which they carry are mounted in the rod housing 104 of the casting block 62 in a manner hereinafter described.

It will be noted in referring to the face plate 132 and sealing gasket 134 that these elements have a width or transverse dimension (as measured in a vertical direction) such that they span or bridge across the open forward end of the open receiving chamber 54 at the bottom of the bucket 28. When the sealed driving unit 60 is seated in the open receiving chamber 54, bolts 137 are extended through the relatively small diameter openings in the face plate 132 and gasket 134 and into aligned, threaded bolt holes 138 formed in the forward end face of the casting block 62 (see FIGURES 5, 6 and 7). This completes the wedged seating of the sealed driving unit 60. The sealing gasket 134 is wedged or sandwiched between the bottom wall 34 of the bucket, and the upper edge portion of the face plate 132, and is also sandwiched or wedged between the lower chamber wall 52 and the lower edge portion of the face plate. An effective seal preventing passage of dirt into the receiving chamber 54 is thus provided so that the sealed driving unit 60 is maintained in a clean and protected environment.

Prior to bolting the face plate 132 to the casting block 62, the drive rods 112 are mounted through the seals 120 and have their radiused ends 114 extended through the bushings 110. With the drive rods 112 in this position, the retainer pins 130 are threadably extended through the earth-carrying bottom wall 34 and the aligned openings in the gasket 124 and cover plate 126 into the slots 122 in the top side of the drive rods 112. The drive rods are thus prevented from being driven out of their respective bores 107 as they are reciprocated by the cam shaft 88 in a manner hereinafter described.

When the sealed driving unit 60 has been drawn against the face plate 132, the hydraulic motor 70 can then be firmly seated against the rear wall 68 of the casting block 62, and its position can be adjusted to some extent as may be required to tension the chain 99. Upon completion of the positioning of the motor 70, a suitable lubricant plug (not shown) preferably located in the back wall 68 of the casting block 62 can be removed to permit the well 64 to be filled with a lubricant. The lubricant thus introduced to the sealed driving unit 60 can pass into the cutaway 92 of the cam shaft housing 84 and pass along the bore 86 therein to lubricate the needle bearings 90 and the entire length of the cam shaft 88. The lubricant will also lubricate the radiused ends 114 of the drive rods 112 and will pass between the drive rods and the respective bronze bushing 110. Thus, the entire assembly is well lubricated, and lubricant is maintained in contact with all moving parts during the operation of the apparatus.

60 Operation of the embodiment of the invention shown in FIGURES 1-7

In the operation of the back hoe apparatus of the invention, the articulated boom assembly 12 and the back hoe bucket 28 are hydraulically manipulated in the conventional manner. During the digging operation using the back hoe bucket 28, the teeth 118, which are diamond-shaped in vertical cross-section, are driven in reciprocating motion, and each of the teeth is driven in out-of-phase relation to the other teeth by reason of the angular offset of its particular, associated cooperating cam lobes 96 from the other cam lobes disposed in axially spaced relation therefrom along the cam shaft 88. Hydraulic power fluid is delivered to the hydraulic motor 70 through the flexible conduits 80 and 82, which are preferably extended along

the inside of the bucket 28 in the corners thereof where the back plate 36 intersects the two side plates thereof. Suitable metallic shielding for these cables can be provided in the bucket corners so that they are protected from dirt and rocks forced into the bucket during digging.

As the power fluid reaches the hydraulic motor 70, this motor is driven in rotation to, in turn, rotate the sprocket 100 carried on the shaft 102. Rotation of the sprocket 100 drives the chain 99 to drive the sprocket 98 formed on the medial portion of the cam shaft 88. As the cam shaft 88 is rotated in the needle bearings 90, the cam lobes 96 and concave depressions 94 are alternately brought into contact with the radiused end 114 of the respective drive rods 112. It is important that the radiused ends 114 of the drive rods 112 be made on the same radius of curvature as the concave depressions 94, since the wear of the driven radiused end of each of the drive rods 112 is greatly reduced when this geometric configuration is utilized.

As the cam lobe 96 bears against the radiused end 114 of the respective drive rod 112, the drive rod is pushed forwardly in the surrounding bronze bushing 110, and thus the tooth 118 secured to the rod is driven forcibly into the soil ahead of the leading edge of the bucket 28. The teeth 118 do not penetrate the soil ahead of the bucket 28 simultaneously because of their out-of-phase movement with respect to each other. In the embodiment of the invention illustrated in FIGURES 1-7, the drive rods 112 and the teeth 118 can progress forward with respect to the bucket 28 until the retaining pins 130 strike the trailing end of the slots 122 in the respective drive rods. Return of each tooth 118 to a position where it is struck by the cam lobes 96 of the rotating cam shaft 88 is effected by pressure of the soil ahead of the bucket. Thus as the bucket is driven further into the soil by the use of the hydraulic mechanism normally associated with back hoe devices, the several teeth 118 are effectively caused to be consecutively retracted into the several rod housings 104 by the acting pressure of the soil. Thus, as soon as the radiused end 114 of each drive rod 112 again moves into an interfering position with respect to the cam lobes 96 on the cam shaft 88, it is again driven forward into the soil. In this manner, a very effective digging action is obtained, and the wear usually inherent in wrist pins and knuckle joints which are used to provide a positive interconnection between a rotating crank shaft and the teeth driving rods is obviated.

At such time as it might be desired to disassemble the back hoe apparatus in order to replace or repair the moving portions of the drive mechanism, or to replace the teeth 118, the procedure is essentially the reverse of the assembly procedure which has been described. Thus, the removable plate 56 is initially removed from the lower back portion of the bucket 28, either by use of a cutting torch, or when such plate is bolted in position, by removing the bolts which secure it in the illustrated location. With the plate 56 removed, access can be had to the sealed driving unit 60.

In order to disconnect the sealed driving unit 60 from the bucket, the retaining pins 130 are first extracted so that they no longer engage the slots 122 in the several driving rods 112. The bolts 136 which are used to secure the face plate 132 to the forward face of the casting block 62 are then removed so that the face plate and gasket 134 can be pulled, along with the teeth 118 and the driving rods 112 secured thereto. Once the face plate 132, gasket 134, teeth 118 and rods 112 have been removed from the forward end of the bucket 28, the sealed driving unit 60 can then be pulled through the open rear end of the open receiving chamber 54. This removal is facilitated by pulling on the connections or fittings 76 mounting the hydraulic motor 70 to the rear wall 68, and simultaneously pushing on the forward face of the casting block 62 where it is exposed between the

dirt-carrying plate 34 and the bottom plate 52 of the bucket.

When the sealed driving unit 60 has been removed from the bottom of the bucket, the sealing gasket 124 and cover plate 126 can be removed from the top of the casting blocks 62 to permit access to the motor 70 and, if desired, removal of the cam shaft 88 through openings formed in the ends of the casting block.

It will be apparent, of course, that in instances where damaged teeth 118 require replacement or rebuilding, this may be accomplished without the removal of the sealed driving unit 60 by merely pulling the face plate 132 and gasket 134 with the teeth 118 and their respective driving rods 112.

It should be further pointed out that the fact that the driving rods 112 are always driven solely in reciprocating motion through the seals 120 permits these seals to be made simpler, and yet to efficiently and effectively seal around the driving rods over an extended operating life of the apparatus.

A modified embodiment of the invention is illustrated in FIGURE 8. Since several of the structural elements of this embodiment are identical to those which have previously been described in referring to the embodiment illustrated in FIGURES 1-7, identical reference numerals have been utilized to reflect such identity. Thus, a sealed driving unit is provided in the embodiment under discussion, and is designated generally by reference numeral 60. This unit also employs a hydraulic motor 70 for driving a cam shaft 88 through the use of a chain 99 in the manner hereinbefore described.

The main difference between the embodiment of the invention depicted in FIGURE 8 and that hereinbefore discussed is in the manner in which the drive rods connected to the teeth 118 are mounted in the casting block 62, and the method by which these drive rods are caused to reciprocate. Thus, in the FIGURE 8 embodiment, the drive rods to the several teeth, designated by reference numeral 150, extend through a face plate 132, gasket 134 and seals 120, as do the drive rods 112 of the earlier described embodiment. The drive rod housings 104, however, are provided with transversely spaced enlarged bores 152 which extend into the drive rod housings from the cam shaft bore 86. Each enlarged bore 152 defines a shoulder or abutment 154 at its inner end, which shoulder or abutment forms one face of a radially inwardly extending flange 156 which surrounds and retains in position, a bushing 158. The relative dimensions of the bushing 158 and the enlarged bore 152 are such that an annular space is defined between the driving rod housing 104 and the bushing 158. In this space, and abutting the shoulder 154, is positioned a compression spring 162. At the end opposite its end which abuts the shoulder 154, the compression spring bears against a radially outwardly extending washer 164 which is threaded on the driving rod 150 from the radiused end 166 thereof.

It will be noted that the size of the threaded washer 164 is such that it can be positioned within the enlarged bore 152. It will further be noted in referring to FIGURE 8 of the drawings that the cam shaft housing 84 is bored or provided with large, axially spaced apertures 170 each located on the opposite side of the cam shaft housing from one of the bores 152 through one of the drive rod housings 104. A corresponding aperture 170 is provided opposite each of the respective enlarged bores 152 through the drive rod housings 104 spaced transversely across the bucket. The function of each aperture 170 is to permit the compression spring assembly to be installed in the manner illustrated in FIGURE 8. Thus, with the face plate 132 and gasket 134 bolted in position, and with each tooth 118 and its associated drive rod 150 partially extended from the sealed driving unit 60, the respective bushing 158, spring 160 and threaded washer 164 may be mounted on the drive rod 150 in the illustrated position. Each spring 160 is loaded in slight compression so that it

tends to force its respective drive rod 150 inwardly in the sealed drive unit 60 as far as the respective tooth 118 will permit. Each tooth 118 is then wedged outwardly by inserting an appropriate wedging implement between the tooth and the face plate 132, so that the drive rods 150 are pulled outwardly to a position in which their radiused ends 166 are spaced from the cam shaft bore 86 through the cam shaft housing 84. The needle bearings 90 and cam shaft 88 can then be inserted in the positions illustrated in FIGURE 5 of the drawings, followed by a release of the several teeth 118 to permit their driving rods 150 to be driven inwardly within the sealed driving unit 60 by release of the compression in the springs 160. This will bring their radiused inner ends 166 into contact with the machined portions of the cam shaft 88, and the apparatus is then ready to commence operation. It will be understood of course, that the apertures 170 are spaced transversely along the back side of the cam shaft housing 84, and that these apertures alternate with the location within the cam shaft housing of the needle bearings 90.

The embodiment of the invention depicted in FIGURE 8 has the advantage of providing automatic, spring returned, reverse travel of the drive rods 150 and teeth 118, rather than depending upon earth impact to effect this return stroke. With this arrangement, therefore, the radiused end 166 of the drive rods 150 are maintained in constant contact with the machined depressions 94 and cam lobes 96 on the cam shaft 88, and wear due to shock impact of the cam shaft on these radiused ends is reduced.

From the foregoing description of the invention, it will be apparent that various changes and innovations can be made in the described and depicted embodiments without departure from the basic principles of the invention. Changes and modifications of this type are therefore deemed to be circumscribed by the spirit and scope of the invention except as the same may be necessarily excluded by the appended claims or reasonable equivalents thereof.

What is claimed is:

1. Back hoe apparatus comprising:

- a self-powered vehicle;
- an articulated boom having one end secured to said vehicle, and having a second end;
- an open-topped digger bucket pivotally secured to the second end of the articulated boom and having a leading, digging edge thereon, said digger bucket comprising:
 - a pair of substantially parallel side walls;
 - a bottom wall secured between said side walls;
 - an arcuate back wall secured between said side walls; and
 - a lower chamber wall secured between said side walls and spaced below said bottom wall, said lower chamber wall defining with said bottom wall, an open receiving chamber;

digger teeth means movably mounted on said bucket and including a plurality of teeth spaced transversely from each other across said bucket, and extending from the digging edge thereof; and

- a sealed driving unit detachably mounted on the lower side of said bucket in said open receiving chamber and including driving means drivingly contacting said digger teeth means and forcing said teeth outwardly from the digging edge of said bucket in a linear movement, said digger teeth means being movable with respect to said bucket independently of said driving means, and not secured to said driving means, said sealed driving unit including a casting block enclosing said driving means and defining a lubricant well.

2. Back hoe apparatus comprising:

- a self-powered vehicle;
- an articulated boom having one end secured to said vehicle, and having a second end;
- an open-topped digger bucket pivotally secured to the second end of the articulated boom and having a leading, digging edge thereon;

digger teeth means movably mounted on said bucket and including a plurality of teeth spaced transversely from each other across said bucket, and extending from the digging edge thereof; and

- a sealed driving unit detachably mounted on the lower side of said bucket and including rotary driving means drivingly contacting said digger teeth means and forcing said teeth outwardly from the digging edge of said bucket in a linear movement, said digger teeth means being movable with respect to said bucket independently of said driving means, and not secured to said driving means.

3. Back hoe apparatus as defined in claim 2 wherein said digger teeth means further includes a plurality of drive rods each secured at one of its ends to one of said digger teeth, and having its other end positioned in juxtaposition to said driving means.

4. Back hoe apparatus as defined in claim 3 wherein said driving means includes a cam shaft having a plurality of lobes thereon adapted to sequentially contact said drive rods, and wherein said apparatus is further characterized by the inclusion of means for limiting movement of each of said drive rods to linear reciprocating movement in a direction substantially normal to the digging edge of said bucket.

5. Back hoe apparatus as defined in claim 2 wherein said sealed driving unit includes

- an integrally formed casting block;
- a motor mounted in said casting block;
- a cam shaft journaled in said casting block and contacting said digger teeth means; and
- means drivingly interconnecting said motor and said cam shaft.

6. Back hoe apparatus as defined in claim 5 wherein said casting block includes a plurality of spaced drive rod housings having bores extending substantially normal to the leading edge of said bucket, said bores communicating with said cam shaft; and wherein said digger teeth means further includes drive rods each secured at one end to one of said teeth, said drive rods each extending through one of the bores in said drive rod housings and each having a second end positioned in juxtaposition to said cam shaft for contact with said cam shaft.

7. Back hoe apparatus as defined in claim 6 and further characterized in having

- a counterbore in said casting block at the end of each of said bores remote from said cam shaft and concentrically surrounding one of said drive rods; and
- sealing means in each of said counterbores and sealingly surrounding the drive rods concentrically surrounded by the respective counter bore in which said sealing means is located.

8. Back hoe apparatus as defined in claim 7 and further characterized to include springs between and casting block and each of said drive rods resiliently urging said drive rods toward said cam shaft.

9. Back hoe apparatus as defined in claim 6 wherein said cam shaft is characterized in having a plurality of series of circumferentially aligned alternating cam lobes and depressions, each of said series being aligned with the second end of one of said drive rods, and said series being spaced axially along said cam shaft with the lobes in each series being angularly offset around the cam shaft from the lobes in axially adjacent series.

10. Back hoe apparatus as defined in claim 9 wherein said second end of each of said drive rods is convexly radiused, and each of said depressions is concave and formed on a radius of curvature equivalent to the radius of curvature of the radiused second end of each drive rod.

11. Back hoe apparatus as defined in claim 6 wherein said casting block includes a well in which said motor is disposed and a bore around said cam shaft, and wherein said cam shaft bore, rod housing bores and well com-

13

communicate with each other to facilitate distribution of lubricant in said well to said cam shaft and drive rods.

12. Back hoe apparatus as defined in claim 7 wherein said digger bucket comprises:

- a pair of substantially parallel side walls;
- a bottom wall secured between said side walls;
- an arcuate back wall secured between said side walls; and
- a lower chamber wall secured between said side walls and spaced below said bottom wall, said lower chamber wall defining with said bottom wall, an open receiving chamber, and said sealed driving unit being located in said open receiving chamber.

13. An open-topped earth-carrying bucket structure adapted for securement to the articulated boom of a back hoe apparatus, said bucket structure comprising:

- parallel side walls;
- a bottom wall secured between the side walls and having a forward edge;
- a back wall secured between the side walls;
- a lower chamber wall secured between the side walls and spaced below the bottom wall, said lower chamber wall having a forward edge and defining with said bottom wall an open receiving chamber;
- a sealed driving unit removably positioned in said open receiving chamber, and including
 - a cam shaft; and
 - means for driving said cam shaft in rotation;
- a plurality of spaced drive rods each having one end portion extending into said sealed driving unit into juxtaposition to said cam shaft, said drive rods being driven by said cam shaft and not connected to said cam shaft, and each having a second end portion extending between the forward edges of said bottom wall and said lower chamber wall;
- a digging tooth secured to said second end portion of each of said drive rods outside said open receiving chamber; and
- means closing said open receiving chamber and retaining said sealed driving unit therein.

14. A bucket structure as defined in claim 13 wherein said closing means comprises:

- a face plate receiving said drive rods through apertures therein and positioned between said teeth and said sealed driving unit, said face plate being wider than the space separating the forward edge of said bottom wall and the forward edge of said lower chamber wall and extending across said space;
- a gasket positioned between said face plate and the forward edges of said bottom wall and lower chamber wall;
- securing means securing said driving unit against said gasket; and
- a removable closure plate extending between said lower chamber wall and said back wall.

15. A bucket structure as defined in claim 13 wherein each of said drive rods is slotted in an axial direction; and said bucket structure is further characterized to include pin means extending through said bottom wall and into the slots in said drive rods for limiting the movement of said drive rods relative to said cam shaft.

14

16. A bucket structure as defined in claim 13 wherein said cam shaft has a plurality of cam lobes formed thereon for cooperating with said drive rods, said lobes being arranged to bring at least four lobes into contact with each drive rod during each revolution of said cam shaft, and to contact adjacent drive rods with cam lobes at different times during the revolution of the cam shaft.

17. A bucket structure as defined in claim 13 wherein said sealed driving unit comprises:

- a casting block rotatably journaling said cam shaft and having a well formed therein;
- a motor seated in the well in said casting block; means drivingly interconnecting said motor and cam shaft;
- a closure plate secured across the top of said casting block and closing said well; and
- gasket means sealingly interposed between said closure plate and casting block.

18. A basket structure as defined in claim 17 and further characterized as including a plurality of rod housings formed integrally in said casting block and slidably receiving said drive rods for linear reciprocating movement in said casting.

19. A bucket structure as defined in claim 18 and further characterized to include seal means in each of said rod housings and around each of said drive rods.

20. A bucket structure as defined in claim 19 wherein said well and the interior of said rod housings communicate through a bore journaling said cam shaft whereby said cam shaft and drive rods can be continuously lubricated with a lubricant initially disposed in said well.

References Cited

UNITED STATES PATENTS

1,067,375	7/1913	Proctor	37—141 XR
1,878,037	9/1932	Vodoz	37—141 XR
2,228,445	1/1941	De Velbiss.	
2,245,544	6/1941	Miller	299—37
2,393,432	1/1946	Turner	37—118
2,443,492	6/1948	Austin	37—141
2,619,748	12/1952	McIntosh	37—141
2,657,480	11/1953	Armington et al.	
2,704,613	3/1955	Biedess	37—141 XR
2,777,680	1/1957	Robb	299—37
2,850,815	9/1958	Edwards	37—141
3,065,557	11/1962	Pewthers	37—141 XR
3,084,817	4/1963	Lovrenich.	
3,145,488	8/1964	French	37—141
3,219,388	11/1965	Haynes	299—37
3,269,039	8/1966	Bodine	37—141 XR
3,272,559	9/1966	Haynes	37—141 XR
3,293,778	12/1966	McAuliff	37—141
3,328,904	7/1967	Voigt et al.	37—141

EDGAR S. BURR, *Primary Examiner.*

U.S. Cl. X.R.

37—103; 214—138