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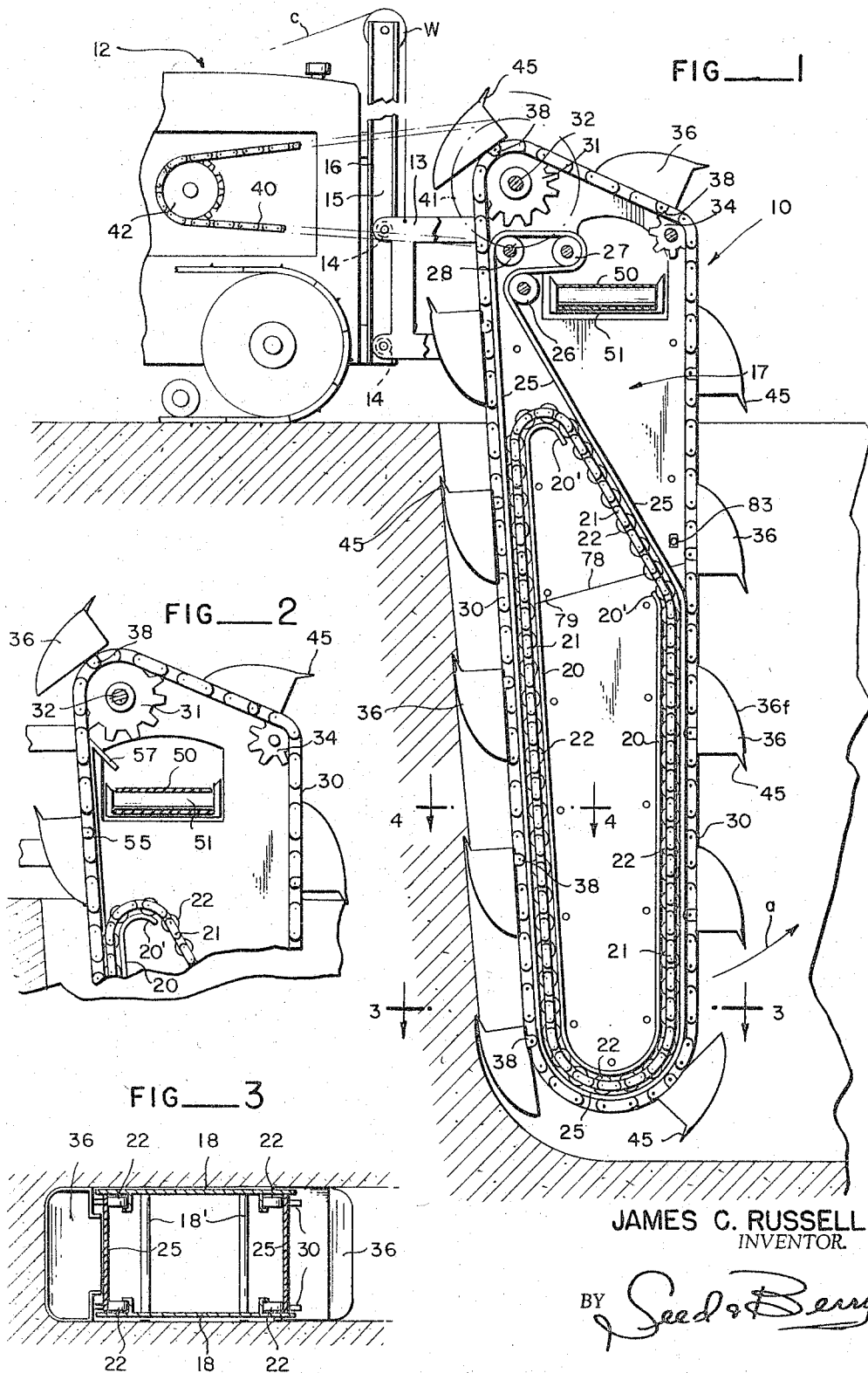
J. C. RUSSELL

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CONTINUOUS DIGGING APPARATUS

Filed March 4, 1964

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG 4

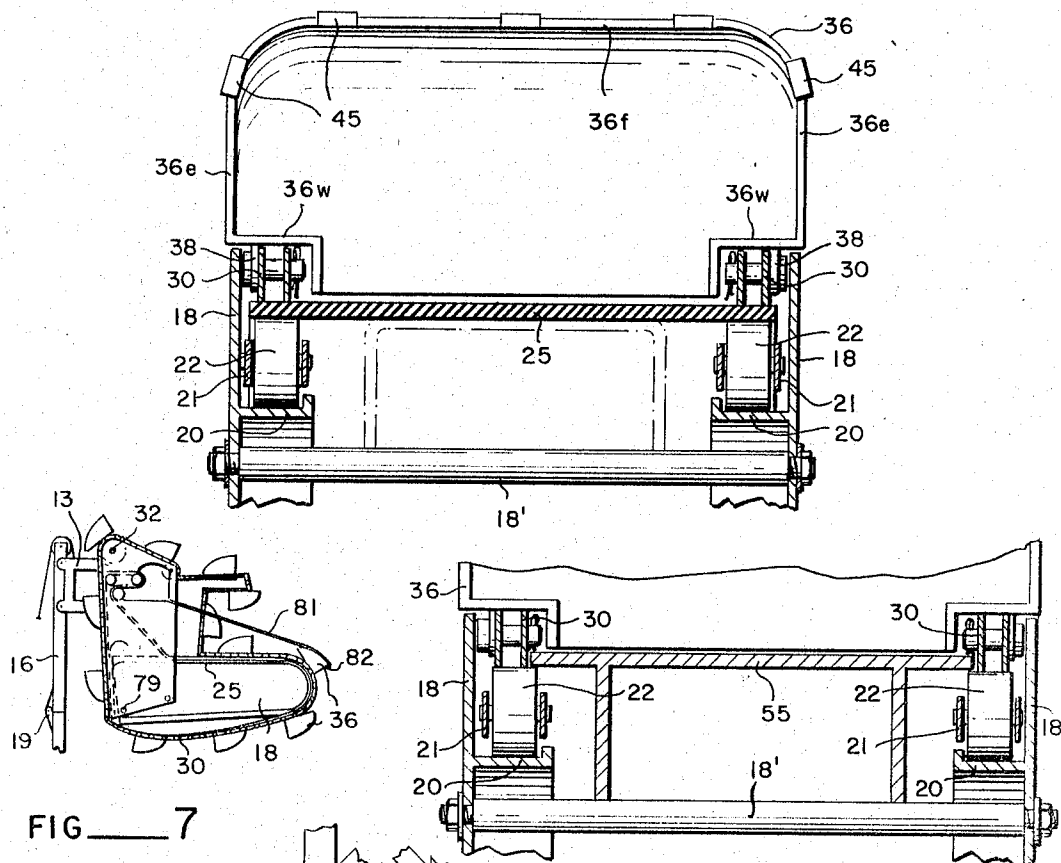
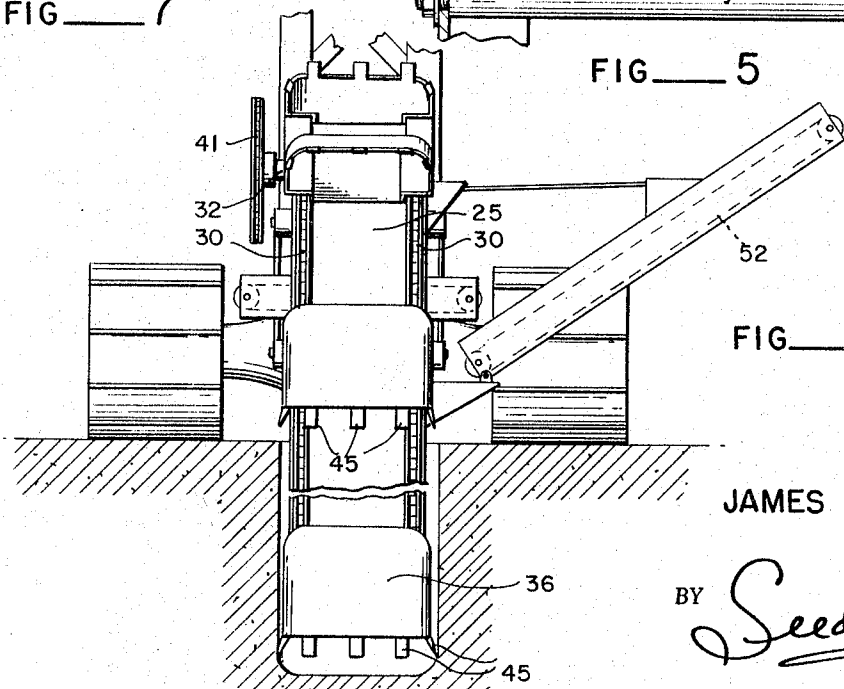


FIG 7

FIG 5

FIG 6



JAMES C. RUSSELL
INVENTOR.

BY

Seed & Berry

ATTORNEYS

1

3,307,276

CONTINUOUS DIGGING APPARATUS

James C. Russell, Yakima, Wash., assignor to Landmark Engineering, Inc., a corporation of Washington
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This invention relates to improvements in ditch or trench digging machines which are of those types employing endless chain belts, equipped at spaced intervals therealong with dirt digging buckets, operating in such manner as to cut free and carry the loosened earth from the trench or excavation being formed by the machine.

One of the principal objects of this invention resides in the simplification of certain features of present day earth digging and conveying means of this character in order to obtain better control and more efficiency from the machine, with a better straightening and smoothing of the trench walls as formed thereby.

It is also an object of this invention to provide improved means in chain and bucket control, for digging a substantially vertical face and cleanly removing the loosened earth from the cut.

A further object of the invention is to provide a digging frame or boom, for carrying the bucket mounting chain belts; which boom can reach to greater depth for a given boom dimension than normally attained and while maintaining a boom of very compact horizontal dimensions, thus avoiding unbalancing effects on the motorized or mobilized carrier from which the boom is adjustably supported.

Yet another object of this invention resides in the provision of a more efficient shape and attitude of the boom equipment in relation to earth contact.

A still further object is to provide a secondary means designed to coact with the buckets and chain belts in conveying the earth, as loosened by the latter, out of the trench, and which secondary means operates to reduce friction and eliminate dirt losses in the trench.

It is also an object of the invention to provide a simple and long-lasting friction reducing support for the excavator chains and buckets, that reduces chain wearing and chain buckling when these parts are subjected to hard digging operations.

In accomplishing the above mentioned and other objects and advantages of the invention, I have provided details of construction, the preferred forms of which are illustrated in the accompanying drawings, wherein

FIG. 1 is a side elevational view of an end portion of a crawler type tractor by which an excavating or trench digging mechanism, embodying the present improvements therein, is operatively suspended in a trench digging operation; showing therein the relationship of the bucket mounting chain belts, the friction reducing chain belts and the flexible dirt retainer belt of this invention, as used in conjunction with the bucket carrying chains.

FIG. 2 is a view showing the upper end portion of the digger boom as equipped, alternately, with a novel form of dirt retainer plate in association with the buckets and their mounting chains.

FIG. 3 is a horizontal, cross-sectional view of the boom illustrating its construction and the mounting tracks for the auxiliary roller chain belts that support the flexible dirt retaining belt and bucket carrying chain belts.

FIG. 4 is an enlarged, cross-sectional detail, taken on line 4-4 in FIG. 1, showing the relationship of the paired bucket mounting chain belts, the flexible dirt retaining belt and the friction reducing roller chain belts and the trackways provided therefor.

FIG. 5 is a cross-sectional view, similar to that of FIG.

2

4, showing an alternative dirt retaining plate as associated with the bucket carrying chains.

FIG. 6 is a rear elevational view of the digging machine of FIG. 1 in a trenching or ditch digging operation.

FIG. 7 is a side elevation, at reduced scale, showing the hinged adjustment of the upper and lower end sections of the boom.

Referring more in detail to the drawings:

In FIG. 1, I have shown the present ditch or trench digging apparatus, designated in its entirety by reference numeral 10 as functionally suspended from the front end of a motorized crawler type tractor which, as shown is designated by numeral 12. The digging apparatus 10 of this invention is operatively mounted on the end of the tractor by means of a rigidly extended carrier frame structure 13, equipped at its mounting end, with upper and lower sets of rollers 14 that are contained for vertical travel of the frame in guideways or channels 15 of two laterally spaced rails that coact to form a mast 16 that is fixed vertically to the end of the tractor 12. This mast may be of sufficient height to facilitate hoisting the digging apparatus 10 free of engagement with the earth. Also, it may be foldably hinged, as at 15, in FIG. 7, to allow lowering the upper part to achieve lower profile while transporting.

The trench digging apparatus 10 comprises as a main element, an elongated belt mounting boom 17 that has a rigidly fixed suspending connection at its upper end, with the outer or rearward end of the frame structure 13. The lower end portion of the boom 17 is pivotally hinged for swinging adjustment as will later be described.

The boom 17, as shown in FIG. 3, comprises paired, laterally spaced and parallel opposite side plates 18-18 that are rigidly joined in their spaced relationship by suitable cross-bracings 18'-18', see FIG. 3, applied across their edges in such manner as to insure a frame structure of sufficient strength to withstand all normal digging strains and forces to which it may be subjected, particularly when the buckets meet hard earth resistance, as drawn by their mounting chain belts through the earth by the tractor 12. The boom 17, as equipped with its appended parts, including the various chain belts and buckets, may be adjustably raised and lowered on the tractor mounted mast 16 by conventional means, that is operable from the tractor, thus to determine the depth of the ditch or trench to be cut thereby; such a means being indicated in FIG. 1 by a cable c that may be extended from a winch carried on the tractor 12, but not herein shown, and passed over a sheave wheel w mounted at the top of mast 16 and then downward and connected to frame 13.

The paired opposite side plates 18-18 of the boom 17 are of substantial length but relatively narrow in width and they taper slightly toward their lower ends to terminate in rounded edges, as observed in FIG. 1. It will presently be explained that the side plates of the boom are divided at their medial areas and are so hinged together as to permit the lower end sections thereof to be swung rearwardly to horizontal positions, as indicated in FIG. 7. Somewhat within the opposite side and lower end edges of the plates 18-18 and on the inner faces thereof, I have secured track forming rails or flanges 20-20 by welding or otherwise, on which rails continuous, friction reducing link belt chains 21-21 are mounted for travel; these belts being equipped on each of the links with friction reducing and supporting rollers 22 that have guided rolling travel on the trackways or rails 20-20, as has been shown in FIG. 1. It is to be noted in FIG. 1 that upper ends of the paired rails 20-20 terminate only slightly above the medial plane between the upper and lower ends of the boom where they have

3

inwardly curved end portions 20' between and across which the upper end runs of the endless belts 21—21 operate. These roller chains 21—21 are the friction reducing means of this invention, as will presently be understood.

The secondary means provided to assist the buckets and chain in carrying the loosened earth from the trench comprises a continuous belt 25 of strong, flexible material, such as, for example, a belt formed of rubber and fabric composition, having a transverse width sufficient to span the distance between and to overlap, at its longitudinal edges, with the laterally spaced roller equipped chain belts 21—21 for support and travel thereon as in FIG. 4. This flexible belt 25 at its lower end is carried about the rounded lower ends of the trackways on the two belts 21—21, but at its upper or discharge end is extended to an elevation near that of the top end of the boom where it is passed over a set of three rollers, designated, respectively, at 26, 27 and 28. That run of the belt which in its downward travel leaves the roller 26, engages in rolling contact with and upon those runs of chain belts 21—21 that extend at an incline between the curved upper ends 20' of the paired rails 20—20.

Applied about the flexible belt 25 for support and travel on its opposite longitudinal edge portions, as has been well illustrated in FIGS. 1, 4 and 5, are continuous paired bucket carrying link chain belts 30—30; these links being passed at the top end of the boom 17 over paired laterally spaced driving sprocket wheels 31—31 fixed on a cross-shaft 32 that is rotatably mounted in suitable bearings in the opposite side plates 18—18 of the boom 17. The belts 30 also pass at the upper end of the boom over paired tension adjusting sprocket wheels 34—34 as shown in FIGS. 1 and 2. The two chain belts 30—30 are confined for travel just within the edge portions of the boom plates 18—18 as in FIGS. 4 and 5, and bear directly upon the corresponding edges of belt 25 as supported on the roller equipped chains 21—21.

Extended transversely of the boom 17 and attached at their opposite ends to the paired chain belts 30—30 at predetermined intervals of spacing, are the dirt digging and conveying buckets 36, each of which has an upwardly and outwardly curved front wall 36f and opposite side closing walls 36e. Each bucket 36 is also provided at opposite sides with inturned wings 36w and mounting ears 38—38 that are pivotally attached to the chain belts 30—30 at pivotal points of their belt forming links; the bucket and belt arrangement being as shown in FIGS. 1, 2 and 6 which shows the forward or cutting edge of the buckets being toward their direction of movement as effected by their driving chains 30—30.

The bucket equipped belts 30—30 are driven by the cross-shaft 32 through the mediacy of a suitable driving connection that may be made with any of the present day power transmission means not herein shown which is embodied in the tractor mechanism and under control of its operator.

It is further to be observed that the front and side wall cutting edges of the buckets 36 are equipped with scarifying teeth 45 and spaced at intervals therealong to aid in the digging operation; these teeth being applied to the successive buckets in staggered relationship for better cutting operation results.

Each bucket 36 in itself is in effect a scoop whereby the wall of dirt against which the buckets are drawn, as shown in FIG. 1, may be sliced loose and then carried by upwardly travel of the buckets in coacting relationship with the dirt retainer 25 to the place of discharge therefrom as each bucket passes across the top end portion of the boom, the depth of each bucket is such that its opposite edge wings 36w span several of the joined links of their carrying chains 30—30, thus to give each bucket the required backing for most effective digging.

It is apparent that, with the boom 17, positioned for digging a trench, as in FIG. 1, when the belts 30—30

4

are set in operation by driving shaft 32 in a clockwise direction, the buckets 36, in engaging the vertical dirt wall will cause their toothed cutting edges to slice off dirt from the wall. The loosened dirt will fall into the space between the bucket walls 36f and belt 25 or plate 55 and be carried upwardly to the point where the retainer plate 55 or belt 25 leaves off contact with the buckets, at which point the dirt is freed of containmant and may fall from the buckets as they continue their travel and become inverted while passing across the top run. As the dumped dirt falls, it is received on an off bearing conveyor belt 50, that operates through a side wall opening of the boom, about a supporting roller 51, mounted in the boom, and as here shown may be delivered from this belt 50, onto an upwardly inclined conveyor belt 52, as in FIG. 6, for its conveyance away from the ditch or trench as the machine advances or may be delivered into a trucking vehicle.

The alternative dirt retainer shown in FIGS. 2 and 5 comprises a flat plate 55 that is fixedly supported in a position to extend along the inside of the upward traveling run of buckets 36, by cross rods 18. At its top end this plate 55 terminates slightly above the level of conveyor 50, as seen in FIG. 2, and at that end has an inwardly and downwardly inclined flange 57 across which dirt, carried upwardly by the buckets and their mounting chain belts, is discharged on to the conveyor belt 50. The plate and flange 57 serve the purpose of the flexible belt 25 of FIG. 4.

It was previously stated that the opposite side plates 18—18 of the boom were divided between their upper and lower ends for rigging. The line of division is designated by the diagonal line 78 in FIG. 1. The means for hingedly joining the upper and lower end sections together is the horizontal hinge shaft 79 and the direction of swinging is designated by the arrow *a* in FIG. 1. This pivotal connection permits the lower end portion of the boom to be swung to the horizontal position indicated in FIG. 7. When this end of the boom has been lifted up to its horizontal position of FIG. 7, by whatever means be employed, it may be temporarily held in that position by a short length of cable 81 shown in FIG. 7 as attached at its top end to the upper part of boom 17 and at its lower end being secured by a hook 82 to a bucket 36 of the chain or any appropriate part of the lower section. This hinged adjustment of the boom section is to adapt the machine for travel and conveyance and not for digging adjustment. When the two hinged sections have been adjusted to digging position, as seen in FIG. 1, the sections may be locked by a latch or bolt 83, applied thereto through those edges of plates 18—18 opposite the hinged shaft 79.

The digging depth of the boom is adjusted by lifting of or lowering the boom on the mast 16 by means of the cable as applied over the sheave *w* and attached to the frame structure 13.

What I claim as new is:

1. A trench excavating apparatus comprising:

an upright supporting boom adapted to be carried by a powered mobile vehicle travelling in a forward direction along a supporting ground surface;

chain support means mounted on said boom:

first endless chain means aligned longitudinally relative to the intended forward movement of said boom relative to the supporting ground surface and movably guided on said chain support means, said first endless chain means including an upright forward flight extending upwardly from the lower end of said boom and leading to a rearwardly directed upper flight;

inwardly open dirt cutting and conveying means mounted on said first endless chain means for motion relative to said boom conjointly with first chain means and protruding outwardly therefrom, said

5

dirt cutting and conveying means being directed upwardly along said forward flight of said first chain means;

power means on said boom operatively connected to said first chain means to impart longitudinal movement thereto in a manner such as to cause the forward flight of said first chain means to move relative to said boom in an upward direction;

and transverse belt means mounted on said boom inwardly adjacent to said dirt cutting and conveying means along the forward flight of said first chain means for motion conjointly with the forward flight of said first chain means, said belt means being of a width sufficient to span the inwardly open width of the dirt cutting and conveying means.

2. An apparatus as defined in claim 1 further comprising:

forwardly facing bearing means mounted along the front of said boom parallel to and inward of the forward flight of said first chain means and in longitudinal alignment therewith;

said belt means being interposed between the forward flight of said first chain means and said bearing means.

3. An apparatus as defined in claim 1 further comprising:

roller support means mounted on said boom along the front edge thereof;

said transverse belt means having the inner surface thereof along the forward flight of said first chain means in movable engagement with said roller support means.

4. An apparatus as defined in claim 1 wherein said chain support means comprises track means extending along the forward edge of said boom parallel to the forward flight of said first chain means;

said apparatus further comprising:

roller means mounted along said track means;

said transverse belt means having inner and outer belt surfaces, the inner belt surface thereof along the forward flight of said first chain means being in movable engagement with said roller means.

5. An apparatus as defined in claim 1 wherein said chain support means comprises:

track means in longitudinal alignment with said first chain means extending along the forward edge of said boom parallel to the forward flight of said chain means and spaced rearwardly therefrom;

and endless roller chain means mounted along said track means in rolling engagement therewith;

said transverse belt means having inner and outer belt surfaces, the inner belt surface thereof along the forward flight of said first chain means being in movable engagement with said roller chain means.

6. An apparatus as defined in claim 1 wherein said first chain means comprises a pair of transversely spaced working chains;

said chain support means comprising a pair of laterally spaced trackways extending along the forward edge of said boom in longitudinal alignment respectively with said working chains, each trackway having a portion thereof parallel to the respective forward flights of said working chains and spaced rearwardly therefrom;

said apparatus further comprising:

a pair of endless roller chains mounted along said trackways in rolling engagement therewith;

said transverse belt means having inner and outer belt surfaces, the inner belt surface along the forward flights of said working chains being in movable engagement with said roller chains and the outer surface of said belt means along the forward flights of said chains being in engagement with said working chains.

6

7. An apparatus as defined in claim 1 wherein said chain support means comprises:

a pair of sprockets mounted coaxially on said boom for rotation about a transverse horizontal axis located adjacent the upper end of said boom;

a second pair of sprockets mounted coaxially on said boom for rotation about a second horizontal transverse axis thereon spaced rearwardly from said first axis;

said chain means comprising a pair of working chains extending over the sprockets of said first and second pairs of sprockets respectively to form the rearwardly directed upper flight of said first chain means;

said apparatus further comprising:

belt guiding and supporting rollers mounted on said boom below said first pair of sprockets, said belt means extending over said rollers and rearwardly therefrom beneath the rearwardly directed upper flight of said first chain means.

8. An apparatus as defined in claim 1 wherein said dirt cutting and conveying means comprises:

a plurality of transverse buckets mounted in longitudinally spaced positions along the length of said first chain means, each of said buckets having an outside digging wall and opposite end walls extending inwardly along the transverse edges of said outside wall, the back side of each bucket being open.

9. A trench excavating apparatus comprising:

an upright supporting boom adapted to be carried by a powered mobile vehicle traveling in a forward direction along a supporting ground surface;

chain support means mounted on said boom including track means aligned longitudinally relative to the intended forward movement of said boom relative to the supporting ground surface extending upwardly along the forward edge thereof;

endless roller chain means mounted along said track means in rolling engagement therewith;

endless bucket chain means located on said boom outwardly of said roller chain means, said bucket chain means being aligned longitudinally parallel to said track means, said bucket chain means including an upright forward flight extending upwardly from the lower end of said boom and leading to a rearwardly directed upper flight;

inwardly open transverse bucket means mounted on said first chain means and protruding outwardly therefrom, said bucket means being directed upwardly along said forward flight of said chain means;

said endless roller chain means having a forward flight rearwardly adjacent to the forward flight of said bucket chain means;

power means on said boom operatively connected to said bucket chain means to impart longitudinal movement thereto in a manner such as to cause the forward flight of said bucket chain means to move relative to said boom in an upward direction;

and transverse means mounted on said boom inwardly adjacent to said bucket means along the forward flight of said bucket chain means to prevent rearward escape of material within said bucket means, said transverse means being of a width sufficient to span the inwardly open width of the bucket means.

10. An apparatus as defined in claim 9 wherein said transverse means comprises a fixed plate member mounted on said boom.

11. An apparatus as defined in claim 9 wherein said transverse means comprises an endless belt movably mounted on said boom including a section thereof parallel and adjacent to the forward flight of said bucket chain means, said belt also being aligned longitudinally relative to the intended forward movement of said boom relative to the supporting ground surface.

7

12. A trench excavating apparatus for attachment to a powered mobile vehicle, comprising:
 a supporting boom adapted to be carried by a powered mobile vehicle;
 a pair of transversely spaced endless chains movably mounted on said boom in upright parallel configurations, each chain having an upright forward flight extending between the lower end of said boom and a pair of transversely spaced sprockets rotatably mounted at the upper end of said boom about a transverse horizontal axis;
 inwardly open dirt cutting and conveying means mounted on said chains and extending transversely across said chains in longitudinally spaced positions along the length of the chains;
 power means operatively connected to said chains to move the forward flights thereof in an upward direction;

8

and movable belt means mounted on said boom inwardly adjacent to said dirt cutting and conveying means along said forward flights of said chains for motion parallel thereto, said belt means traversing the inwardly open width of the dirt cutting and conveying means adjacent thereto.

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ABRAHAM G. STONE, *Primary Examiner*.WILLIAM A. SMITH III, *Examiner*.