May 10, 1960 S. L. STEWART II, ET AL 2,935,801

ROCK EXCAVATING MACHINE

Filed June 21, 1956 3 Sheets-Sheet 1

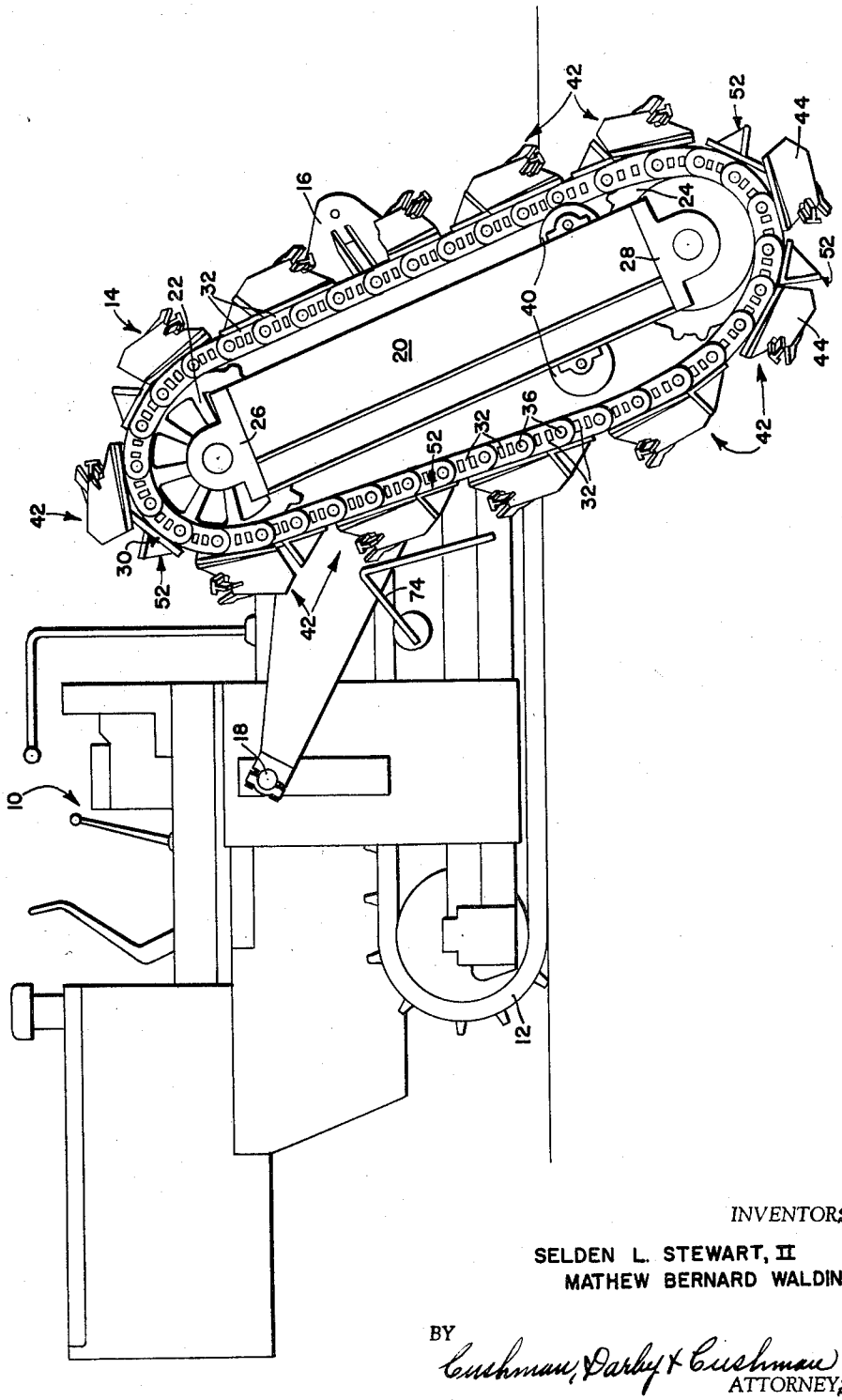

FIG. 1.

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FIG. 2.

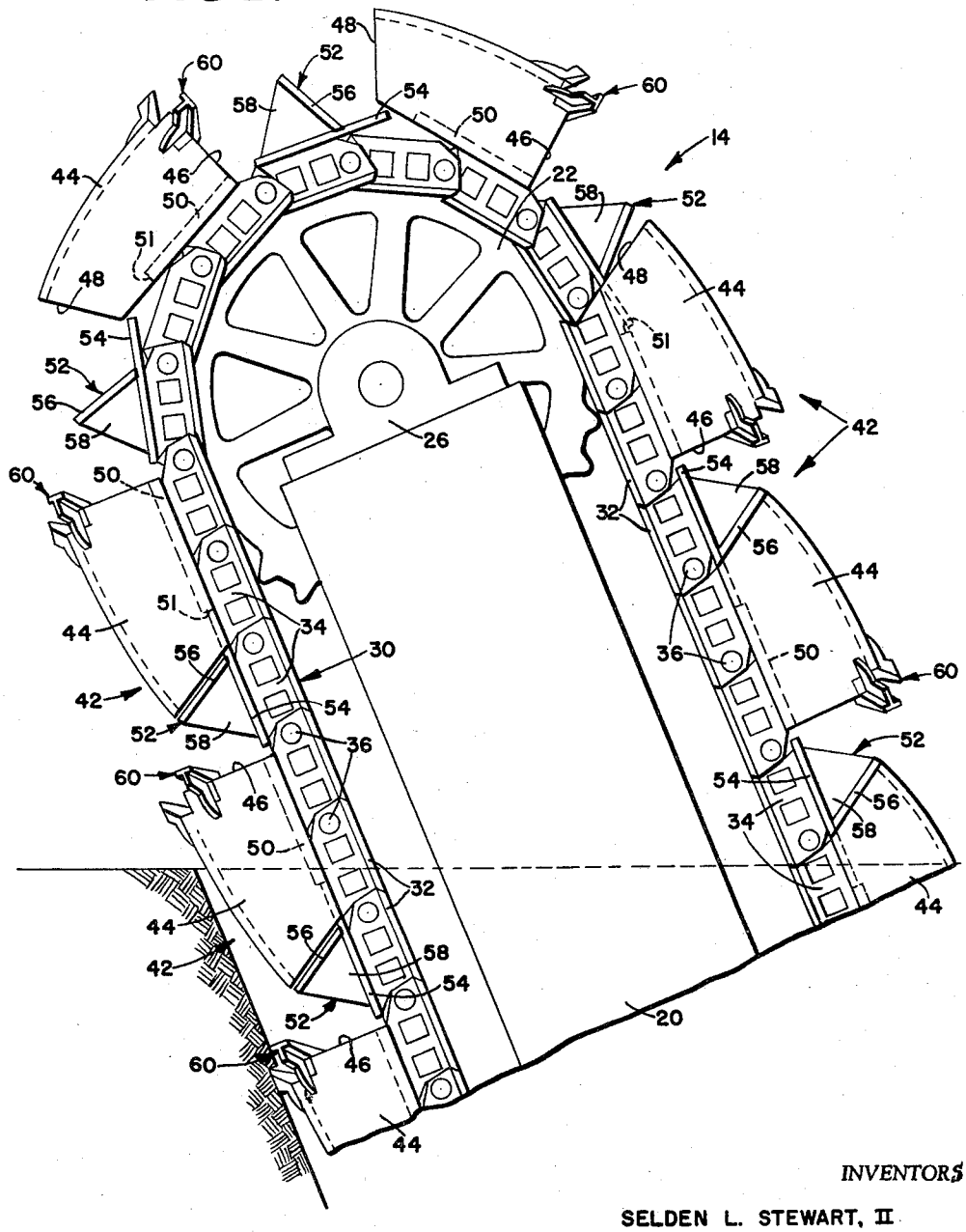

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FIG. 3.

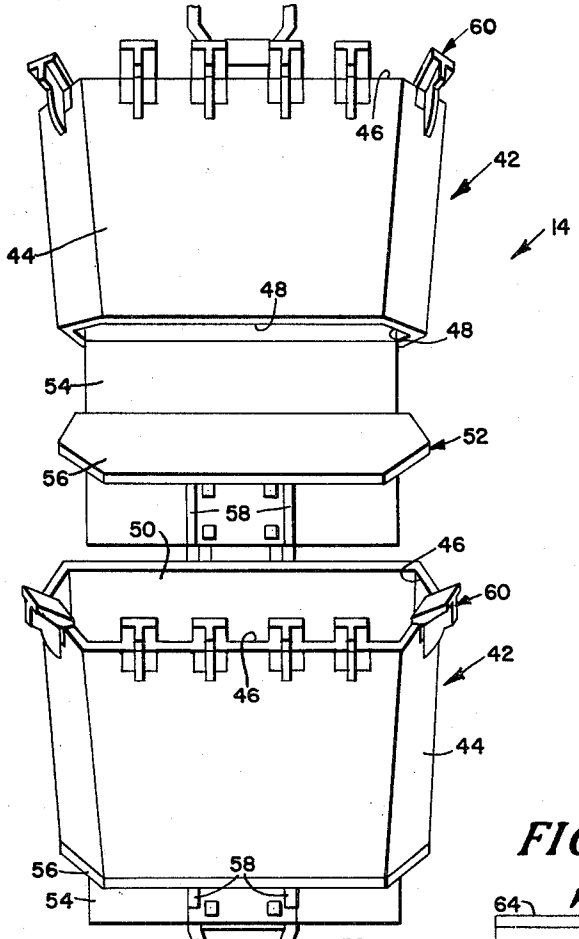


FIG. 4.

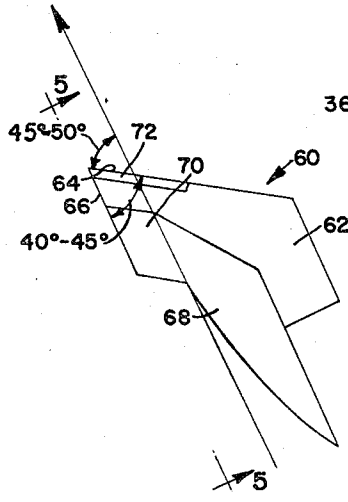
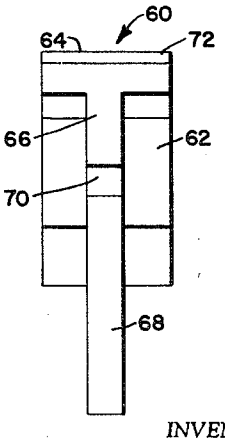


FIG. 5.



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United States Patent Office 2,935,801 Patented May 10, 1960

2,935,801

ROCK EXCAVATING MACHINE

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Application June 21, 1956, Serial No. 592,805

5 Claims. (Cl. 37—86)

This invention relates to excavating machines and more particularly to an excavating machine of the type embodying an endless digging conveyor operable to excavate a trench or the like.

Conventional trench digging machines have their endless digging conveyors mounted on the central portion rear of the traction vehicle and, hence, the width of the trench which can be dug by the conveyor is limited by the lateral spacing between the wheels or track-laying assemblies of the vehicles. It has been proposed to mount the conveyor in lateral offset relation with respect to the propelling vehicle, but this arrangement transmits unequal forces to the vehicle so that steering and other manipulations thereof are rendered difficult, if not impractical.

Accordingly, it is an object of the present invention to provide an excavating machine of the type described in which the endless digging conveyor is mounted in lateral offset relation with the propelling vehicle, which conveyor embodies tooth means on the buckets thereof having a sufficient angle of approach with respect to the material being dug to substantially tend to cause the conveyor during its own movement to move in the direction of travel and an area of contact in a plane parallel to the direction of travel to resist such movement beyond its power provisions to thereby offset the unequal forces transmitted to the vehicle and permit easy manipulation thereof.

The excavating machine of the present invention is particularly adapted for use in digging rock, such as limestone, shale, coral rock and the like, which are recovered in a substantially loose condition. The conventional trench digging machines operable to remove earth from a trench for the purpose of laying pipe or the like embody buckets which must be mechanically cleaned during their travel in order to function properly. However, in dealing with loose granular material, the unloading of the same from the buckets can be accomplished solely through the force of gravity since the looseness of the material does not cause the same to pack within the buckets. Furthermore, with such material it is essential that the buckets be closed so as to carry the material to the dumping station without substantial spilling.

Accordingly, it is another object of the present invention to provide an improved endless digging conveyor of the type described having a series of longitudinally spaced bucket assemblies thereon, which assemblies in operative digging relation are closed so as to dig and convey loose granular material and are operative through a curved portion of their endless path to move apart and effect a dumping of the material to a discharge station.

Another object of the present invention is the provision of a novel material-digging and carrying assembly for an endless conveyor of the type described which embodies separate elements arranged to be mounted on an endless chain so that during a substantially straight operative run thereof the members will be disposed in rigid engagement defining a closed bucket and during the movement of the chain around a mounting sprocket the elements will be moved apart so as to permit dumping of the load.

Still another object of the present invention is the provision of a bucket assembly of the type described having improved tooth means embodied thereon, which tooth means has a substantial angle of approach to the material being dug and a sufficient area of contact in the direction of travel to prevent excessive digging-in of the teeth.

These and other objects of the invention will become more apparent during the course of the following detailed description and appended claims.

The invention may best be understood with reference to the accompanying drawings wherein an illustrative embodiment is shown.

In the drawings:

Figure 1 is a side elevational view of an excavating machine embodying the principles of the present invention;

Figure 2 is an enlarged fragmentary view of the endless diggging conveyor showing the manner in which the buckets are opened and closed;

Figure 3 is a fragmentary front elevational view showing the manner in which the buckets are mounted on the chain of the conveyor;

Figure 4 is an enlarged detailed side elevational view of a bucket tooth; and

Figure 5 is an elevational view taken along line 5—5 of Figure 4.

Referring now more particularly to the drawings, there is shown in Figure 1 an excavating machine embodying the principles of the present invention. The machine includes a self-propelled vehicle, generally indicated at **10**, which preferably is of conventional crawler tractor design. It will be understood that any type of propelling vehicle may be employed, such as conventional farm tractors, trucks or the like. The vehicle **10** illustrated in the drawings, is provided with traction means in the form of laterally spaced track-laying assemblies **12** which are operable to propel the vehicle in the desired direction in the well-known manner.

The present invention is more particularly concerned with a novel endless digging conveyor, generally indicated at **14**, which is arranged to be mounted on the vehicle **10**. The latter is of conventional construction and forms no part of the present invention except insofar as it is combined with the conveyor to form an operative combination. The conveyor **14** may be mounted on the vehicle by any suitable means so as to be disposed in a position laterally offset with respect to the traction means **12**. As shown, this means may comprise a U-shaped yoke **16** having its bight portion disposed at the rear of the vehicle and the free ends of its legs pivoted to the central portion of the vehicle, as at **18**. The yoke **16** may be moved about the pivots **18** by means of hydraulic cylinders (not shown) or other suitable adjusting devices.

The conveyor **14** includes a main frame **20** which is rigidly secured to the yoke **16** in any suitable manner, such as by welding or the like. Thus, the conveyor is mounted on the vehicle for vertical adjustment about the pivots **18** as an axis so that the depth of the cut which the conveyor makes can be adjusted as is well known in the art.

Mounted on opposite ends of the main conveyor frame **20** is a pair of sprocket wheels **22** and **24**. As shown, these sprocket wheels may be suitable journaled in bearing **26** and **28**, respectively, carried by the ends of the main frame **20**. Trained about the sprocket wheels **22** and **24** is an endless chain, generally indicated at **30**. The chain may be of any suitable construction and, as best shown in Figure 3 includes a plurality of intercon-

nected links 32, each of which is made up of a pair of laterally spaced arms 34. The arms are bent so that the lateral spacing between the same at one end is greater than at the other. A pin 36 extends through adjacent ends of the arms of each link and through a sleeve 38 so as to effect interconnection of the links. In the conventional manner, suitable idler rollers 40 may be journaled on the main frame 20 for the purpose of stabilizing the links throughout their endless path of travel.

Mounted on the chain 30 is a series of longitudinally spaced material-digging and carrying assemblies, generally indicated at 42. Each assembly 42 comprises a tubular bucket member 44 which may be hexagonal in cross-section, although it will be understood that other configurations may be employed, if desired. As shown, the tubular bucket member 44 includes a leading open end 46 and a trailing open end 48 of smaller dimensions than the end 46 so as to form an inward taper in the member 44 from its leading end to its trailing end. As best shown in Figure 2, the tubular bucket member also includes a flat inner wall 50, which, adjacent the leading open end 46, is rigidly secured to a chain link 32 by any suitable means, such as bolts or the like. The trailing end of the wall 50 terminates short of the trailing open end of the tubular member, as as 51, as can be clearly seen from Figure 2.

Cooperating with the tubular buck member 44 is a closure means, generally indicated at 52, which together with the tubular member in operative position defines a closed bucket operable during its movement to move apart to permit dumping of the load carried thereby. Each closure means 52 includes an inner wall plate 54, which, in the operative digging position of the assembly 42, is disposed in substantial alignment with the inner wall 50 of the bucket member 44. The plate 54 has its trailing end rigidly secured to a link 32 of the chain by any suitable means, such as bolts or the like. Extending outwardly from the plate 54 is a trailing end closure plate 56. The plate 56 is disposed at an obtuse angle with respect to the direction of travel in operative position and is adapted to engage the open trailing end of the bucket member so as to close the same. In order to add strength to the plate 56, a pair of triangular rib plates 58 may be rigidly secured between the trailing surface thereof and the outward surface of the plate 54.

As best shown in Figures 4 and 5, the leading end 46 of each bucket member has suitably secured thereto a plurality of outwardly and forwardly extending digging teeth, generally indicated at 60. Each tooth comprises a rigid body 62 having a substantially flat material-separating surface 64 which is disposed at an angle with respect to the direction of travel thereof between 45° and 50°. This angle constitutes the angle of approach of each tooth. The rigid body 62 also includes a material-contacting surface 66 which is disposed substantially parallel with the direction of travel and forms with the surface 64 an angle of between 40° and 45°. As best shown in Figure 5, the tooth body 62 also includes a rib portion 68 which is disposed on the outward trailing portion thereof. This rib portion has an outer surface which forms a continuation of the material-contacting surface 66. In this manner, the entire surface 66 is of substantial transverse and longitudinal dimensions, with the length thereof, measured in the direction of travel, including the portion provided by the rib 68, being substantially equal to the width thereof. However, it will be noted that the area of the contact surface 66 is substantially less than the product of the transverse and longitudinal dimensions thereof. The tooth body 62 has its outer end portion, including the ribs 68, formed so as to present a substantially uniform cross-sectional configuration along a plane parallel with the surface 66, as indicated at 70. If desired, the outer end of the material-separating surface 64 may be provided with an insert of a hardened material of any well-known type, as indicated at 72.

Operation

As was briefly noted above, the conveyor 14 of the present invention is particularly adapted for digging loose granular material such as might be employed in the construction of road beds or the like. Thus, in digging such material it is more important to be able to remove the same from a large area rather than to excavate a trench therein. Hence, the conveyor 14 is mounted in laterally offset relation to the propelling vehicle 10 so that the same can make successive transversals through the material and at all times contact a level support for the traction means 12 of the vehicle. This operation obviously cannot be obtained with conventional trench digging machines in which the conveyor is mounted in a position on the vehicle between the traction means thereof. That is, in this case, material cannot be removed over a large area because in subsequent transversals of the area, at least one of the track-laying assemblies of the vehicle must enter within a trench previously dug. Accordingly, it can be seen that due to the position of the present conveyor with respect to the vehicle, all of the material in a large area can be removed by the operation of the present machine.

While the lateral offset positon of the conveyor with respect to the vehicle is not in itself new, operation of machines of this type heretofore proposed have not been practical due to the unequal forces transmitted by the conveyor to the vehicle. The machine of the present invention overcomes this problem by providing the material-digging and carrying assemblies 42 of the conveyor with tooth means which is operable during the movement of the conveyor itself to substantially tend to move the conveyor in the direction of travel. The conveyor teeth of conventional trench-digging machines have a relatively sharp angle of approach of the order of 30° with respect to the direction of travel. The material-separating surface 64 of the present teeth are disposed at an angle of between 45° and 50° with respect to the direction of travel so as to provide a relatively large angle of approach. Thus, as the teeth move through the substantially straight operative run along their endless path, the material-separating surfaces 64 tend to move the assemblies and, hence, the entire conveyor into engagement with the material being dug or in the direction of travel. In other words, the large angle of approach causes the teeth to dig into the material and pull the conveyor therewith. Of course, such a large angle of approach may cause the assemblies to dig-in to an extent such that the power for moving the conveyor will be insufficient and the same will stall. To offset this possibility, the teeth are provided with material-contacting surfaces 66 which are disposed parallel to the direction of travel and, hence, resist the digging-in of the teeth. However, it will be noted that the entire contacting area of the surface is substantially less than the product of the transverse and longitudinal dimensions thereof. In this manner, there is a substantial contact length in the direction of travel so as to resist excessive digging-in movement of the teeth, but the contact area is minimized so as to reduce friction. Thus, it can be seen that the disposition of the teeth is such as to substantially tend to move the entire conveyor in the direction of travel during the movement of the conveyor or stated differently, the operation of the conveyor itself is self-feeding. This action of the conveyor in tending to move itself in the direction of travel by its own operation offsets the unequal forces transmitted thereby to the vehicle as a result of its position with respect thereto and enables the vehicle to be easily handled.

Referring now more particularly to Figure 2, the manner in which the assemblies 42 operate to dig, carry and dump the material will now be described. It will be noted that the endless path which the assemblies traverse is an elongated oval with the upper sprocket wheel 22 defining

a curved upper end and the lower sprocket wheel defining a curved lower end. Between these curved ends are substantially straight runs. The leading substantially straight run constitutes the operative digging run of the endless path and it will be noted that the chain links **32** during this run are in substantial longitudinal alignment. Correspondingly, the bucket member **44** and closure means **52** of each assembly define a closed bucket. That is, the closure plate **56** of the closure means is disposed in interengagement with the open trailing end **48** of its associated bucket member. Preferably, the links with which these members are rigid are spaced apart and, as shown, a single link is interposed therebetween. Thus, due to the engagement between the bucket members and the closure plates, inward deflection of the adjacent links is effectively prevented. In other words, the three links disposed adjacent the assembly are made rigid by the interengagement of the assembly parts and the entire chain is effectively stabilized during the operative run. After the assembly moves around the lower sprocket wheel **24** the parts thereof will assume their closed-bucket defining position and as the same begin their movement upwardly, the teeth **60** thereof will dig into the material and the material loosened will be caught in the closed bucket.

The material thus dug is carried upwardly until the link rigid with the bucket member begins to travel around the upper sprocket wheel **22**. It will be seen that as this link moves around the sprocket wheel, the same will be moved into an angular position with respect to the link rigid with the closure means and thus, the bucket member will be moved into an angular position with respect to the closure plate **56**. This position of one of the assemblies is clearly illustrated in the upper left-hand corner of Figure 2. As the two elements of each assembly move apart, in the manner indicated above, the material carried thereby is permitted to flow out of the open trailing end of the bucket member and directed by the closure plate **56** to a dumping station. As shown in Figure 1, an angle plate **74** is disposed at the dumping station to direct the material forwardly. It will be understood that suitable conveying means may be provided on the vehicle to convey the material received on the plate **74** to a desirable dumping location or to a suitable transporting vehicle. The inner plate **54** of the closure means also serves to rigidify the chain links during their operative digging run and when the assembly moves around the upper sprocket this plate has the effect of initiating the discharge of the material since it moves inwardly of the bucket member within which the material is disposed. As shown in Figure 2, after the assembly has moved around the upper sprocket **22** and begins down the trailing run the elements of the assembly will again move into interengaged position. Normally, however, this run is not utilized to perform any digging action so that the assembly will merely move along this run until the lower sprocket wheel **24** is reached. Of course, as they are moved around this sprocket, they will open but as they begin the upper movement along the operative run they are closed in the manner previously described.

It can thus be seen that there has been provided an excavating machine in which a digging conveyor is mounted in offset relation iwth respect to the traction means of a self-propelling vehicle. The self-feeding operation of the conveyor itself is such as to offset the unequal forces transmitted to the vehicle by reason of its position with respect thereto so that the vehicle may be easily handled and maintained in a straight path of movement.

The material-digging and carrying assemblies of the conveyor are operable to move from a normally closed digging position into an open position solely due to their movement through a curved portion of its endless path. The elements of the assembly are rigid with the conveyor chain and, hence, in their operative digging position serve to rigidify the same and thus stabilize the entire operation. Furthermore, dumping is effectively secured without the necessity of providing movable parts within the assembly itself which must be engaged by cams or the like in the manner heretofore proposed. The present construction is thus simple in operation and requires no moving parts other than the chain itself.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

We claim:

1. In an endless digging conveyor of the type described, upper and lower sprocket wheels, an endless series of interconnected links trained about said sprocket wheels, a plurality of longitudinally spaced material-digging and carrying assemblies carried by said links for movement therewith along an endless path having a substantially straight digging run in which the assemblies move upwardly from said lower sprocket wheel to said upper sprocket wheel, each of said assemblies comprising leading and trailing cooperating members carried by said links so as to be moved into a closed interengaging position defining a bucket having an open leading end and a closed trailing end in response to the movement of said certain links through said digging run and to move into an open separated position in response to the movement of said certain links around said upper sprocket wheel so as to permit dumping of the material carried by the bucket outwardly through the trailing end thereof, said leading member including a tubular body rigid with one of said links and having an open leading end and an open trailing end, said trailing member including a plate rigid with a link spaced from said one link and extending outwardly from said path of travel so as to close said open trailing end during said digging run.

2. An endless conveyor as defined in claim 1 wherein the open leading end of said tubular body has provided thereon tooth means comprising a plurality of digging teeth each of which includes a leading edge of substantial width, an outer surface extending rearwardly of said leading edge parallel with said endless path during said digging run, said outer surface having a longitudinal dimension in the direction of movement substantially equal to the width of said leading edge, the area of said outer surface being substantially less than the product of its transverse and longitudinal dimensions, a leading surface extending rearwardly from said leading edge and defining with said outer surface an angle of between 40° and 45°, the outer portion of each tooth measured in the direction of said outer surface having a substantially uniform cross-sectional configuration in a plane parallel to said outer surface which conforms in shape to the shape of the latter.

3. An endless conveyor as defined in claim 2 wherein said outer surface is T-shaped.

4. An endless conveyor as defined in claim 1 including, in combination, a self-propelled vehicle having laterally spaced traction means and means for mounting said conveyor on said vehicle in laterally offset relation to said traction means.

5. In a rock excavating machine, a self-propelled vehicle having a pair of laterally-spaced ground engaging traction means, a power driven endless conveyor having a series of spaced buckets thereon movable through a substantially straight digging run along an endless path, said conveyor being mounted on said vehicle in laterally offset relation to said traction means so as to dig an excavation substantially parallel with the path of movement of said vehicle and laterally spaced from the path of movement of the

remote traction means a distance greater than the lateral spacing between said pair of traction means, tooth means on the leading end of each of said buckets, said tooth means for each bucket comprising spaced teeth each having a point portion extending forwardly and outwardly from the leading end of the associated bucket, the point portion of each tooth having a leading surface disposed at an angle of the order of 50° with respect to the digging run of the path of movement of said buckets and an outer surface extending rearwardly from the outer edge of said leading surface in parallel relation to the digging run of the path of said movement, the outer surface of each tooth point portion having transverse and longitudinal dimensions substantially equal to the width of said leading surface at its outer edge and an area substantially less than the product of said transverse and longitudinal dimensions defining a rectangle having spaced portions removed from the lower corners thereof, the disposition of the leading surface of said teeth during said digging run being such as to tend to move the entire conveyor in the direction of movement of the vehicle as a result of the movements of the buckets thereof, the disposition and area of the outer surface of said teeth during said digging run being such as to resist such movement beyond the

power limitation of the conveyor whereby the operation of the conveyor tending to propel itself in the direction of travel of the vehicle substantially offsets the unequal forces transmitted to the vehicle as a result of the laterally offset position of the conveyor and permits easy handling of the machine.

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