

[54] EARTH SURFACING APPARATUS

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[22] Filed: **Nov. 25, 1974**

[21] Appl. No.: **526,849**

[52] U.S. Cl. **37/97; 37/DIG. 16**

[51] Int. Cl.² **E02F 5/04; E02F 5/08**

[58] Field of Search **37/80 A, DIG. 16, 87, 91,
37/94-97**

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[57] **ABSTRACT**

A self powered earth surfacing apparatus for cutting a

swath of desired transverse cross-section, which apparatus includes a horizontal platform that by angularly adjustable pairs of arms is supported from two parallel, laterally spaced crawler assemblies. First means in the form of an engine and associated hydraulic pump are mounted on the platform, and by control means supplies hydraulic fluid to actuate the apparatus. A transversely positioned frame assembly depends from the platform and serves as an anchor for a number of longitudinally adjustable struts. The struts on the lower ends may support up to three frames, with each frame rotatably supporting an earth cutting and lateral earth cuttings moving means that cooperate to move cutting to the forward center portion of the apparatus. The frame supports an upwardly and rearwardly extending first conveyor that receives the cutting. A second transverse angularly adjustable conveyor receives the cuttings from the first conveyor and delivers the cuttings to one side of the swath. The movable components above-identified are actuated by hydraulic fluid under pressure from the pump. The control means may be manually operated, or operated automatically by a sensor that slidably contacts a longitudinally extending wire that is supported by stakes at a predetermined elevation above grade.

9 Claims, 10 Drawing Figures

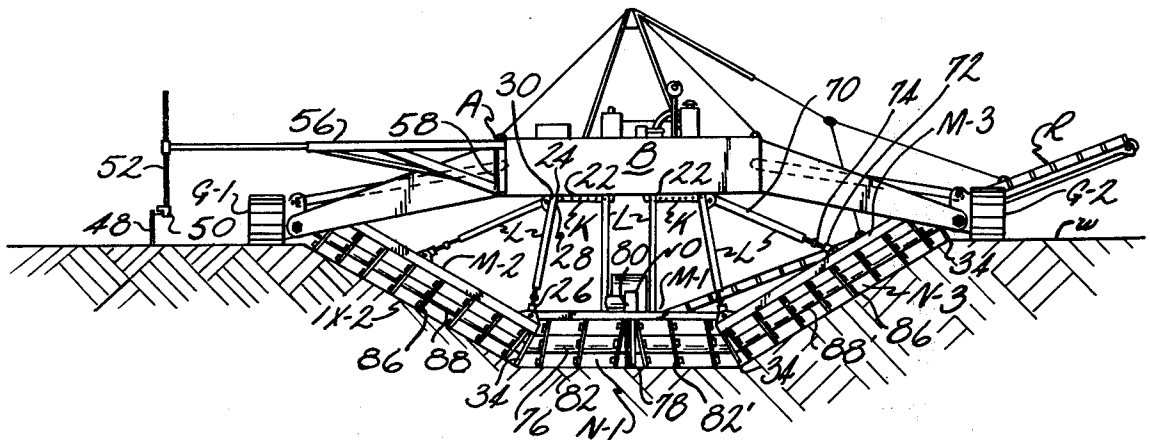


FIG. 1

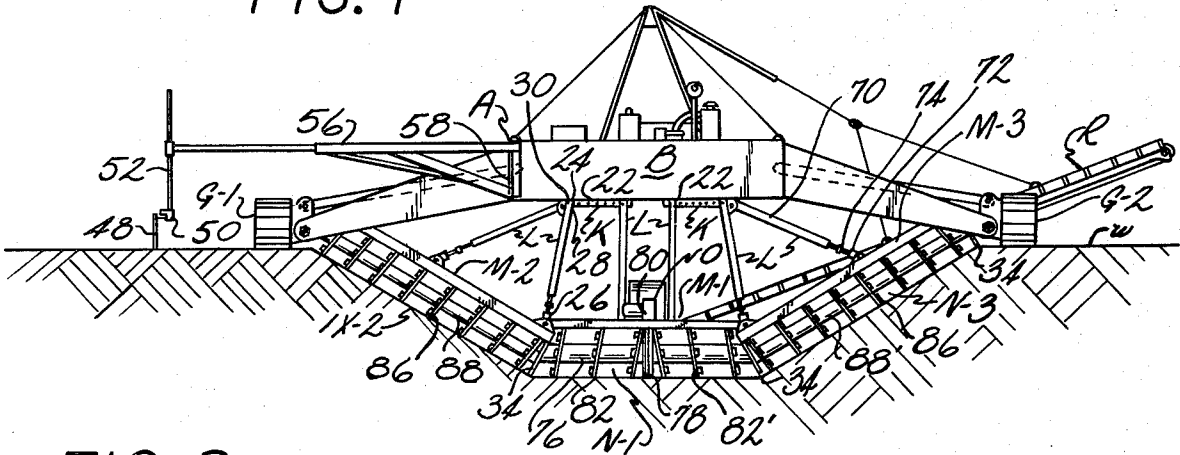


FIG. 2

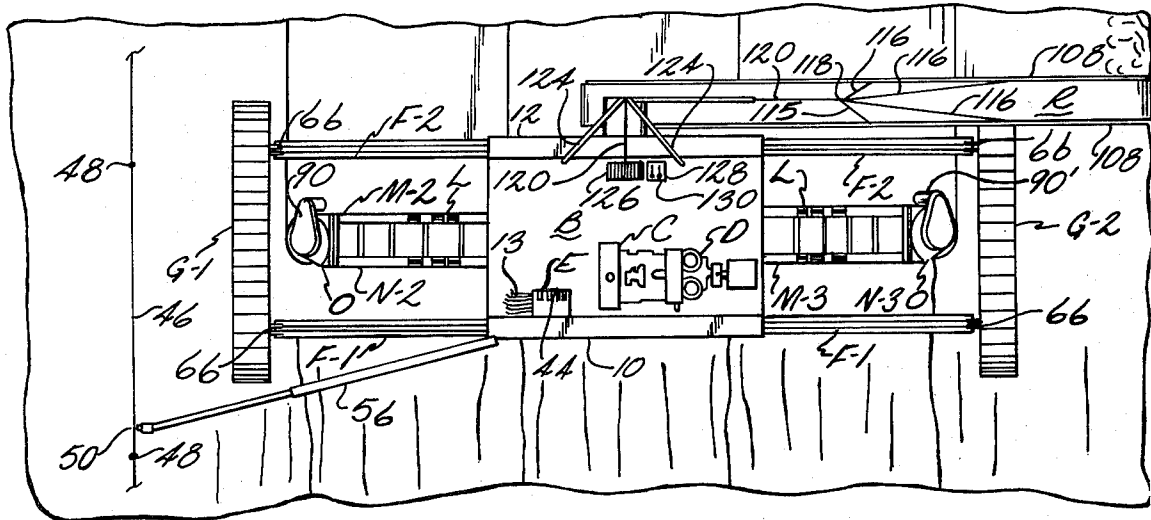


FIG. 3

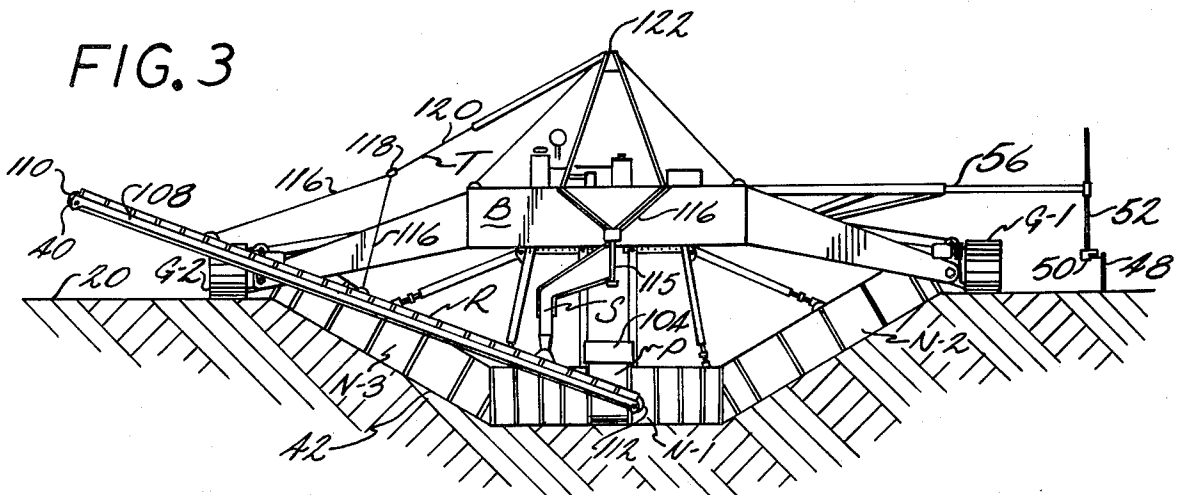


FIG. 7

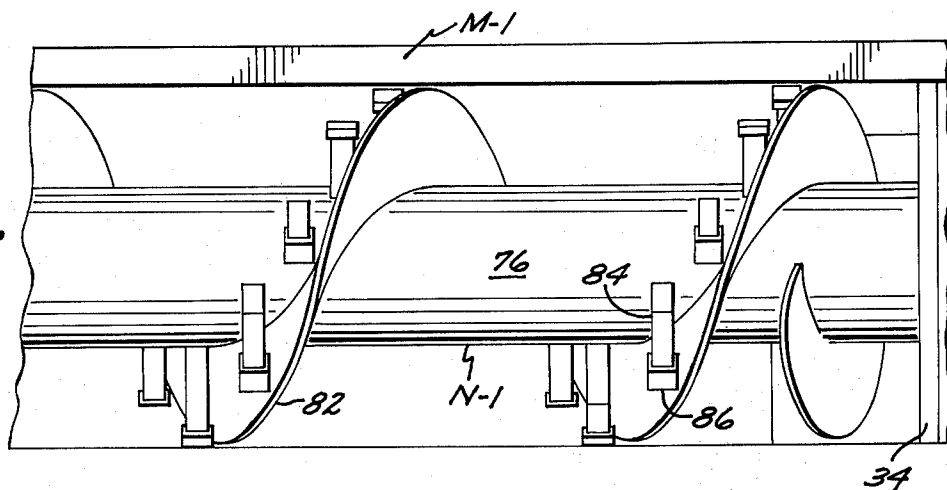


FIG. 8

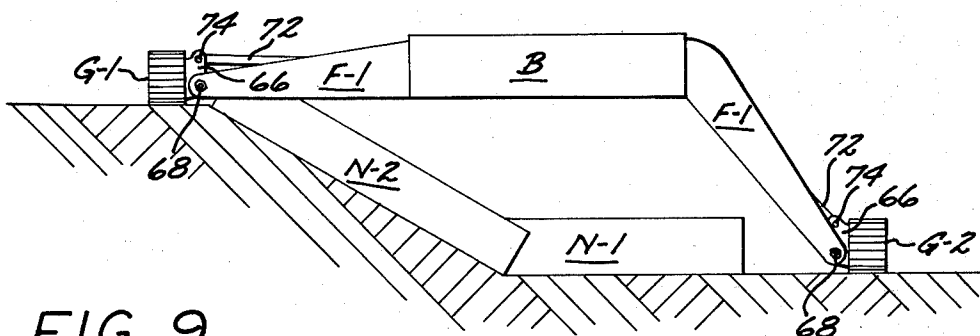


FIG. 9

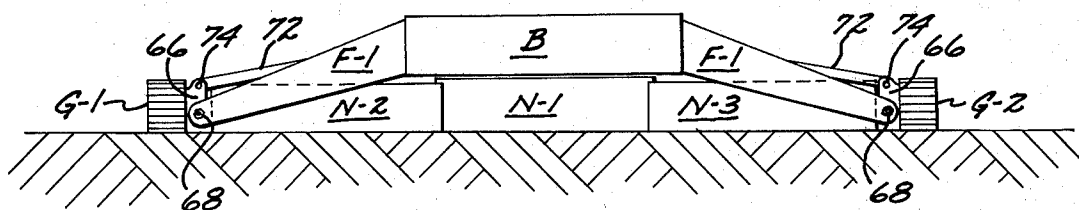
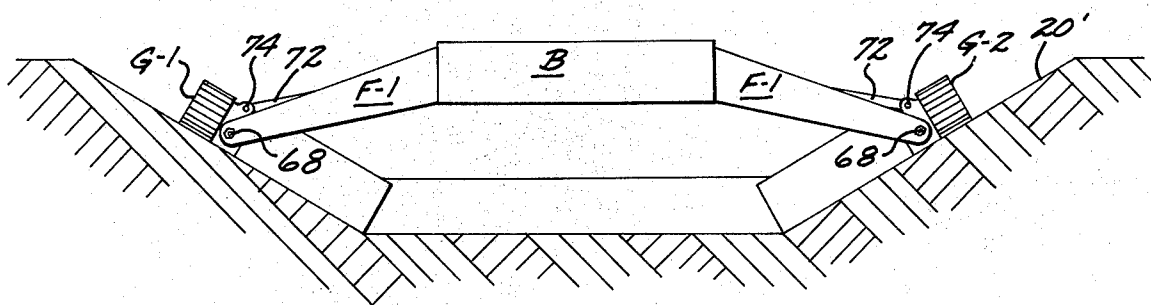


FIG. 10



EARTH SURFACING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

Earth surfacing apparatus.

2. Description of the Prior Art

The digging of irrigation canals having a flat bottom and oppositely disposed upwardly extending angular side walls presents a serious construction problem when dug with conventional prior art equipment. The maintenance of a true inverted trapezoidal shaped transverse cross-section in such a canal is particularly difficult with prior art excavating equipment as well as being unduly expensive.

The primary object in devising the present invention is to supply a self-propelled apparatus for selectively forming a canal of the cross-section above described, as well as a flat swath, or a swath that has a flat bottom from which a single angularly disposed sidewall extends.

Another object of the invention is to supply an earth surfacing apparatus that permits the cutting of canals into the earth surface in a minimum of time and at a minimum of expense and one that minimizes the construction difficulties previously experienced in excavation of this nature.

SUMMARY OF THE INVENTION

The earth surfacing apparatus includes a horizontal platform that supports an engine, a hydraulic pump driven by the engine, and a control unit for directing the hydraulic fluid under pressure to a number of locations as required. First and second pairs of longitudinally spaced arms are pivotally connected to the platform and extend outwardly from opposite sides thereof. The arms on the free ends are pivotally connected to first and second parallel laterally spaced crawler track assemblies. Second hydraulically operated means pivot the arms relative to the platform, and third hydraulically operated means pivot the track assemblies relative to the arms to permit the lower reaches of the track assemblies to fully engage the ground surface irrespective of whether the latter is horizontal or on an angle.

A transverse frame assembly depends from the platform and serves as an anchor to have a number of longitudinally adjustable struts supported therefrom. The lower ends of the struts may be connected to first, second and third rotatable earth cutting and lateral earth cuttings moving means which are power rotated by hydraulically operated motors.

A first conveyor that is hydraulically operated receives the earth cuttings from substantially the forward center end of the apparatus and transfers the cutting upwardly and rearwardly to be dumped onto a second transverse hydraulically operated conveyor. Swivel means adjustably support the second conveyor relative to the platform. Cable means are provided to angularly adjust the second conveyor relative to the platform. All of the movable components of the apparatus are preferably driven by hydraulic motors, and the hydraulic fluid for actuating the same being selectively supplied thereto from the control means. The control means may be manually operated, or automatically operated by a sensor that is in slidable contact with a longitudinally extending wire that is supported by stakes at a desired elevation above the grade that is to be attained by use of the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of the earth surfacing apparatus in the process of forming a canal of inverted trapezoidal transverse cross-section;

FIG. 2 is a top plan view of the apparatus;

FIG. 3 is a rear elevational view of the apparatus;

FIG. 4 is a front elevational view of the apparatus in a position to move under its own power to a job site;

FIG. 5 is a fragmentary elevational view of one of the platform supporting arms that illustrate the pivotal connection between it and one of the crawler assemblies;

FIG. 6 is a fragmentary side elevational view of one of the rotary cutters and the first and second conveyor belts;

FIG. 7 is a front elevational view of a portion of one of the rotary cutters and the lateral cuttings moving means associated therewith;

FIG. 8 is a front elevational view of the apparatus adjusted to cut a flat bottom and a single upwardly extending angular side wall in the earth;

FIG. 9 is a front elevational view of the apparatus adjusted to cut a flat swath in the earth; and

FIG. 10 is a front elevational view of the apparatus with the first and second crawler tracks angularly disposed to fully engage the sloping side walls of a canal.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The earth surfacing apparatus A as may be seen in FIGS. 1 and 2 includes a horizontal platform B having forward and rearward ends 10 and 12 respectively. An engine C is supported on platform B and drives a pump D for supplying hydraulic fluid under pressure to a control unit E, from which the hydraulic fluid may be selectively discharged through a number of conduits 13 to movable components later to be described to actuate the same.

First and second pairs of longitudinally spaced, transversely disposed arms F-1 and F-2 are pivotally supported from walls 14 of platform B by pins or stub shafts 16. First and second elongate crawler track assemblies G-1 and G-2 are disposed on opposite sides of platform B in parallel relationship and pivotally connected to track assemblies G-1 and G-2. Track assemblies G-1 and G-2 are preferably driven by hydraulic motors (not shown) that are supplied with hydraulic fluid under pressure through conduits 13.

Second hydraulically operated means H are provided to pivot the first and second pairs of arms F-1 and F-2 to various positions relative to platform B as may be seen in FIGS. 1, 4, 8, 9 and 10. Third means J are shown in FIG. 5 that are hydraulically operated and when actuated serve to pivot first and second crawler assemblies G-1 and G-2 relative to first and second pairs of arms F-1 and F-2 to permit the lower reaches 18 of the crawler tracks to fully engage the ground surface 20 irrespective of whether the ground surface is horizontal as shown in FIG. 1 or angularly disposed as illustrated in FIG. 10.

A horizontal frame assembly K depends from platform B, with the frame assembly having the number of longitudinally spaced openings 22 therein. A number of elongate longitudinally adjustable struts L are furnished that have upper ends 24 and lower ends 26. The upper ends 24 have openings 28 therein through which pins 30 may be extended to selectively engage desired ones of the openings 22.

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First, second and third frames M-1, M-2 and M-3 are supplied that by pins 32 may be secured to the lower ends of struts L as shown in FIG. 1. However, in FIG. 8 it will be seen that only the first and second frames M-1 and M-2 are used.

In FIG. 1 it will be seen that a first earth cutting and lateral earth cutting moving means N-1 is rotatably supported by hangers 34 from first frame M-1, with the means N-1 when rotated not only cutting the earth, but moving the cutting 36 to the center of apparatus A where they are subsequently forced rearwardly as shown in FIG. 6.

The second and third earth cutting and lateral earth cutting moving means N-2 and N-3 are located on opposite sides of the first cutting and lateral earth cutting moving means M-1, and serves to feed cutting 36 to the ends of the latter. The second and third earth cutting and lateral earth cutting moving means N-2 and N-3 are supported from second and third frames M-2 and M-3 by hangers 34, one of which is shown in FIG. 7.

A first conveyor P extends upwardly and rearwardly as may be seen in FIG. 6 and is adapted to receive and transport cuttings 36 to a rearward elevated position 38. The cuttings 36 upon reaching position 38 drop downwardly by gravity onto a second transverse conveyor R that is pivotally supported on a swivel 3 that is secured to platform B. Cable means T permit the second conveyor R to be angularly adjusted relative to the platform. The second conveyor R extends outwardly from the apparatus A that cuttings 36 discharged from the outer end 40 thereof drop by gravity to one side of the swath 42 of trapezoidal transverse cross-section being cut into the earth by apparatus A as it operates.

The movable components of apparatus A are supplied with hydraulic fluid under pressure from control unit E by manually manipulating levers 44 shown in FIG. 2 which levers control the flow of hydraulic fluid to the conduits 13. Should it be desired a wire 46 may be extended longitudinally along the area to be excavated, and supported on stakes 48. The wire 46 is at a predetermined elevation above grade. The wire 46 is slidably engaged by a sensor 50 that is mounted on the lower end of a vertical rod 52, which rod is adjustably supported by conventional means 54 on the outer end of a boom 56. The boom 56 is of telescopic structure and is adjustably and pivotally supported on a rod 58 that is secured to platform B. The sensor 50 is operatively associated with conventional automatic control means (not shown) that form a part of unit E and cause hydraulic fluid to be discharged to those movable components of the apparatus as is necessary for the apparatus to cut to grade.

The second means H that pivot the first and second pairs of arms F-1 and F-2 relative to platform B are four hydraulically operated assemblies, with one assembly being provided for each arm. One of the assemblies is shown in FIG. 5 in which it will be seen to include a hydraulic cylinder 58 that a first end 58a thereof pivotally connected by a pin 60 to plate 14, a piston rod 62 slidably mounted in cylinder 58 has the free end thereof pivotally connected to a pin 64 that projects outwardly from the arm with which the cylinder 58 is associated. In FIG. 5 the hydraulic assembly as shown operatively associated with one of the arms F-1. Hydraulic fluid is discharged into and out of each cylinder 58 through conduits 13 to pivot the pairs of arms F-1 and F-2 to raise and lower the platform B relative to the ground surface 20.

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Each of the crawler track assemblies G-1 and G-2 includes a stationary side piece 66. Each side piece 66 has two longitudinally spaced plates 68 extending transversely therefrom. The plates 68 are pivotally connected to the outer ends of the pairs of arms F-1 and F-2 by pins 68, one of which connections is shown in FIG. 15.

The third means J are four hydraulic assemblies that are operatively associated with the pairs of arms F-1 and F-2. Each assembly J as may be seen in FIG. 5 includes a hydraulic cylinder 70 that has a first end 70a thereof rigidly connected to an elongate rigid bar 72. Each bar 72 has the free end thereof pivotally connected by a pin 74 to an upper portion of one of the plates 66. A piston rod 76 projects from each cylinder 70. The free end of each piston rod 76 is pivotally connected to one of the plates 14 as shown in FIG. 5.

Hydraulic fluid is discharged into and out of each of the cylinders 70 through conduits 13. By discharging hydraulic fluid into and out of the cylinders 70 through the conduits 13, the bars 72 are caused to move transversely relative to the platform B to maintain the crawler track assemblies in such relationship thereto that the lower reaches of the crawler track assemblies fully engage the earth surface on which they rest irrespective of whether the surface is horizontal as shown in FIG. 1 or angular as illustrated in FIG. 10.

Each of the struts L as can best be seen in FIG. 1 includes an upper portion 70, a lower portion 72, and an intermediate threaded portion 74 that may be rotated relative to the upper and lower portions to vary the overall length of the struts. The first earth cutting and lateral earth cuttings moving means N-1 includes a transverse horizontal shaft 76 that is driven through a centrally disposed gear box 78. The gear box is operatively connected to a hydraulic motor 80. Shaft 76 is rotatably supported on the ends by hangers 34. Two elongate strips 82 and 82' are spiral wound in opposite directions on the shaft 76 on opposite sides of the gear box and when rotated in a first direction act as augers to move cuttings 36 to the center of apparatus A, with the cuttings subsequently being engaged by the first conveyor as shown in FIG. 6.

The second and third earth cutting and lateral earth cuttings moving means N-2 and N-3 as may be seen in FIG. 1 include shafts 86 and 86' respectively, that are rotatably supported on hangers 34. The shafts 86 and 86' support spiral wound strips 88 and 88' that are so oriented that as they are rotated in a first direction they serve as augers to move the cuttings longitudinally relative to the shafts to the ends of first earth cutting and earth cuttings moving means N-1. Two hydraulic motors 90 and 90' are provided as shown in FIG. 2 for rotating the shafts 88 and 88'. The hydraulic motor 80 and hydraulic motors 90 and 90' comprise the fifth means O previously mentioned.

The first conveyor P as best seen in FIG. 6 includes two laterally spaced, upwardly and rearwardly extending side pieces 94 that rotatably support upper and lower rollers 96 and 98 therebetween. Upper roller 96 is driven by a hydraulic motor (not shown) that is actuated by hydraulic fluid from one of the conduits 13. Rollers 96 and 98 rotatably support a flat endless belt 100. As the first, second and third earth cutting and lateral earth cutting moving means N-1, N-2 and N-3 are driven, cuttings 36 are delivered to the lower end of the first conveyor P as shown in FIG. 6, and carried up by the first conveyor to be discharged from the upper rear-

ward end thereof. Cuttings 36 as they discharge from first conveyor P fall by gravity onto the second conveyor R.

The sixth means Q for supporting the first conveyor P is conventional framing attached to the side pieces 94 and suspended from the platform B. An arcuate member 102 is mounted from hangers 34 and is disposed adjacent to the first earth cutting and lateral earth cuttings moving means N-1 to prevent cuttings 36 from being carried around by cutters 86 and also for directing the cuttings onto the forward end of the first conveyor P. A guide 104 is mounted on the upper rearward end of first conveyor P to direct cuttings 36 carried by the first conveyor downwardly onto the second conveyor R.

The second conveyor R as shown in FIGS. 3 and 6 includes two parallel laterally spaced side pieces 108 that rotatably support first and second rollers 110 and 112 between the ends thereof, and these rollers rotatably support an endless belt 114. The first and second conveyor belts P and R are driven by hydraulic motors that are supplied with hydraulic fluid under pressure through conduits 13.

The portion of second conveyor R most adjacent the second roller 112 is pivotally secured to the swivel S that is pivotally mounted on a vertical rod 115 attached to platform B by a frame 116 as shown in FIG. 3. The outer end of second conveyor R has two sets of cables 116 secured to the side pieces 108 thereof, with these cables meeting at an apex 118. Cables 116 at apex 118 are connected to a second cable 120 that extends over a sheave 122 rotatably mounted on the upper end of a frame 124 secured to platform B. The cable 120 after passing over sheave 122 extends downwardly to a drum 126 on which it is wound that is power driven. Rotation of drum 126 is controlled by a unit 128 that has manually manipulatable levers 130 extending upwardly therefrom. The swivel S and the cable arrangement previously described permit the second conveyor R to be disposed at a desired angle relative to platform B, and one at which the outer end of the second conveyor R is above the earth surface 20 in which the excavation is being made as shown in FIG. 3.

In operation, the arms F-1 and F-2 are pivotally adjusted to dispose the platform B a desired elevation above the earth surface 20, with the struts L then being adjusted to support the first, second and third earth cutting and lateral earth cuttings moving means N-1 and N-2, and N-3 in a configuration to effect a cut of a desired transverse cross section in the earth as the apparatus A moves forwardly. As the first, second and third earth cutting and lateral earth cuttings moving means N-1, N-2 and N-3 rotate, cuttings 36 are directed onto the forward end of the first conveyor P to be transported by the latter rearwardly and dumped onto the second conveyor R. The second conveyor R transports the cutting 36 to one side of the cut being effected by the apparatus A, and discharges the cuttings onto the ground surface 20.

It will be particularly noted that the apparatus A when effecting a cut of inverted trapezoidal transverse cross section as shown in FIGS. 1 and 10 may have the crawler assemblies G-1 and G-2 pivotally adjusted to fully engage the ground surface irrespective of whether the latter is horizontal or angularly disposed.

In FIG. 8 it will be seen that the apparatus A may be adjusted to use only the first and second earth cutting and lateral earth cuttings moving means N-1 and N-2 to

effect a cut in the earth that has a flat horizontal surface and a side surface that slopes upwardly from one end of the latter. In FIG. 9 the apparatus A is disposed to cut a flat longitudinal swath in the earth.

The use and operation of the apparatus A has been described previously in detail and need not be repeated.

I claim:

1. An earth surfacing apparatus capable of excavating a flat longitudinally extending swath in the earth or a swath that includes a flat section that has at least one side section extending upwardly at an angle from one end of said flat section, said apparatus including:

- a. a platform having a forward and rearward end;
- b. first means on said platform that is power operated for supplying hydraulic fluid under pressure;
- c. control means for supplying said hydraulic fluid from said first means;
- d. first and second laterally spaced parallel crawler track assemblies disposed on opposite sides of said platform that are actuated by said hydraulic fluid supplied thereto from said control means;
- e. first and second pairs of parallel, longitudinally spaced arms that are pivotally connected to said first and second crawler track assemblies and to said platform;
- f. second means operated by said hydraulic fluid from said control means for pivoting said first and second pairs of arms relative to said platform;
- g. third means operated by said hydraulic fluid from said control means for pivoting said first and second crawler track assemblies relative to said first and second pairs of arms to permit lower reaches of said crawler track assemblies to fully engage the earth surface on which they are supported;
- h. a transverse frame assembly that depends from said platform intermediate said forward and rearward ends thereof;
- i. a plurality of struts that are longitudinally adjustable as to length, said struts having first and second ends;
- j. fourth means for removably connecting said first ends of said struts in desired transverse spacing to said frame assembly;
- k. first and second frames supported from said second ends of said strut, said first frame being disposed under said platform in a substantially horizontal position, and said second frame disposed outwardly from said first frame and extending upwardly at an angle relative thereto;
- l. first rotary earth cutting and lateral earth cutting moving means rotatably supported from said first frame, said first rotary cutting and lateral earth cutting moving means when rotated delivering said cutting rearwardly substantially the center thereof;
- m. second rotary earth cutting and lateral earth cutting moving means rotatably supported from said second frame and when rotated delivering cuttings cut thereby to a first end of said first rotary earth cutting and lateral earth cutting moving means to be moved by the latter rearwardly from substantially the center thereof;
- n. fifth means actuated by said hydraulic fluid from said control means for rotating said first and second rotary earth cutting and lateral earth cutting moving means;
- o. a longitudinally disposed upwardly and rearwardly extending first conveyor for receiving said cutting

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- from said first rotary earth cutting and lateral earth cutting moving means on a first end thereof and discharging said cutting from a second end thereof;
- p. sixth means for supporting said first conveyor from said frame assembly;
- q. a transversely positioned angularly disposed second conveyor having first and second ends, said cuttings being delivered from said second end of said first conveyor onto said first end of said second conveyor, and said cuttings when said second conveyor is operating being conveyed thereon to said second end thereof from which they drop by gravity;
- r. swivel means for movably supporting said second conveyor adjacent said first end thereof from said platform;
- s. movable cable means supported from said platform and secured to said second conveyor adjacent said second end thereof for angularly adjusting said second conveyor relative to said platform; and
- t. seventh means for driving said first and second conveyors, with said device as it moves forwardly on said first and second crawler track assemblies cutting said swath in the earth and delivering said cuttings to one side thereof from said second end of said second conveyor.
2. An apparatus as defined in claim 1 which in addition includes;
- u. a third frame supported from said second ends of said struts, said third frame being disposed outwardly from said first frame and extending upwardly at an angle from the end of said first frame opposite that from which said second frame extends;
- v. third rotary earth cutting and lateral earth cutting moving means rotatably supported from said third frame and when rotated delivering cutting cut thereby to a second end of said first rotary earth cutting and lateral earth cutting moving means to be moved by the latter rearwardly from substantially the center thereof, with said device when moved forwardly cutting a swath of inverted trapezoidal transverse cross-section.
3. An apparatus as defined in claim 1 in which said first means includes:
- u. an engine; and

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- v. a hydraulic fluid supplying pump driven by said engine, said engine and pump being mounted on said platform.
4. An apparatus as defined in claim 2 in which said control means includes:
- w. a plurality of valves that are connected to the discharge of said pump; and
- x. a plurality of conduits that extend from said valves to said first crawler track assemblies and said second, third, fifth and seventh means to supply said hydraulic fluid thereto when said valves are opened to actuate said apparatus to effect a cut in the earth surface.
5. An apparatus as defined in claim 4 in which a wire is extended in a direction parallel to the cut that is to be made, said wire at a predetermined elevation above grade, and said apparatus in addition including:
- y. a boom that extends outwardly from said platform;
- z. a sensor adjustably supported from the outer end of said wire and in slidable contact with said wire; and
- a.a. means responsive to said sensor for automatically opening and closing said valves to cause said apparatus to cut a swath of desired transverse cross-section to a desired depth in the earth.
6. An apparatus as defined in claim 2 in which said struts have first and second separate sections that are connected by threaded intermediate sections to permit the overall lengths of said struts to be adjusted to support said first, second and third earth cutting and lateral earth cuttings moving means a desired distance below said platform to effect a cut in the earth of a desired depth.
7. An apparatus as defined in claim 2 in which said fourth means are bolts that engage openings in said first ends of said struts and desired longitudinally spaced openings in said frame assembly.
8. An apparatus as defined in claim 2 in which said fifth means are first, second and third hydraulic motors that drive said first, second and third earth cutting and lateral earth cuttings moving means.
9. An apparatus as defined in claim 2 that in addition includes:
- w. a power operated spool mounted on said platform on which said cable may be wound or unwound to move said cable to angularly adjust the position of said second conveyor.

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