July 9, 1968 R. G. LE TOURNEAU 3,391,810

EXCAVATOR MACHINES

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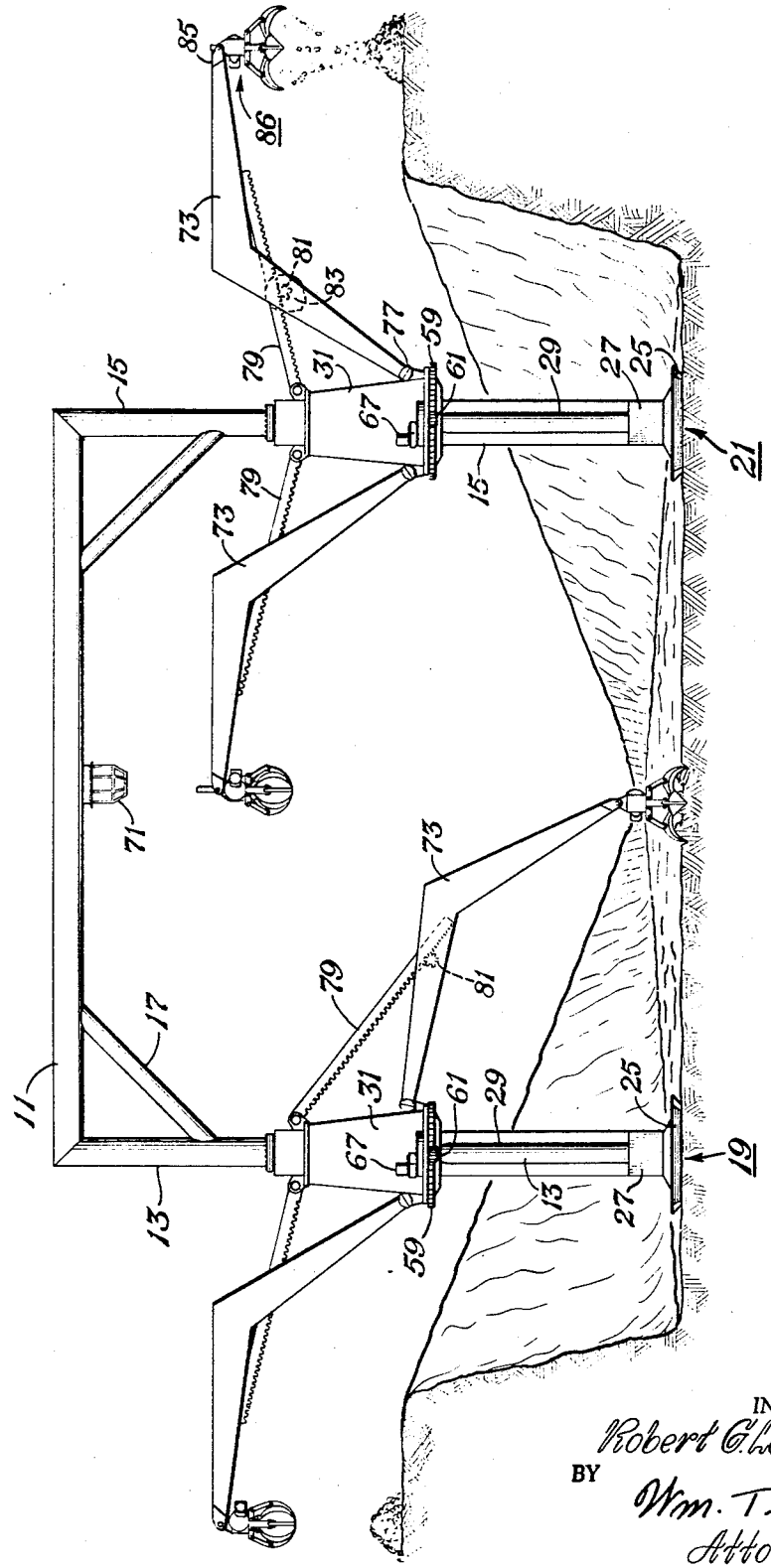


Fig. 1

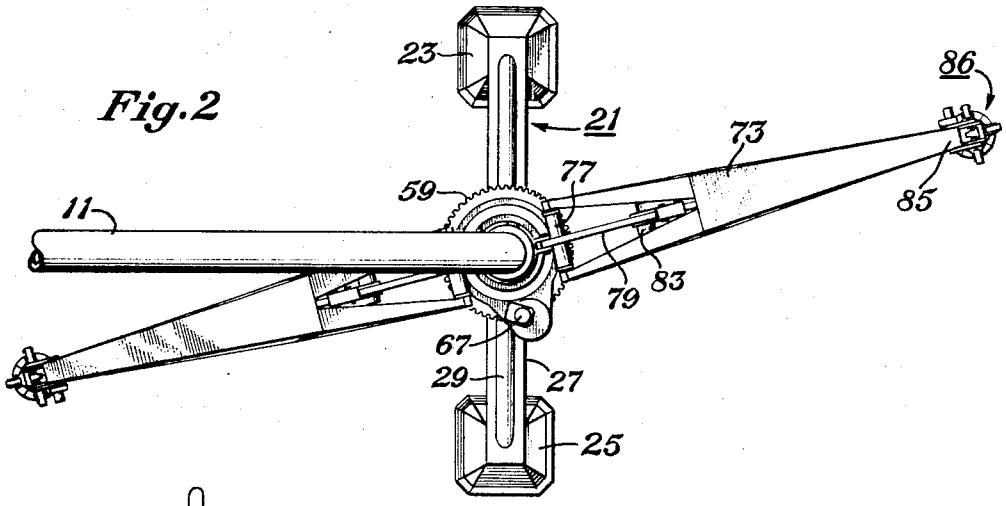
INVENTOR.
Robert G. Le Tourneau
BY
Wm. T. Wofford
Attorney

July 9, 1968 R. G. LE TOURNEAU 3,391,810

EXCAVATOR MACHINES

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Fig. 2



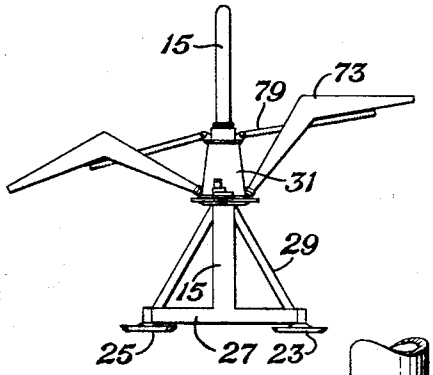


Fig. 3

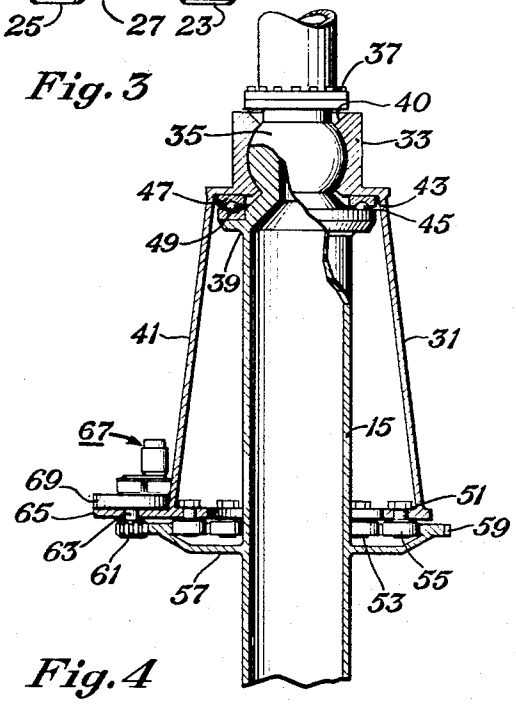


Fig. 4

INVENTOR.
Robert G. LeTourneau
BY
Wm. T. Wofford
Attorney

July 9, 1968 R. G. LE TOURNEAU 3,391,810

EXCAVATOR MACHINES

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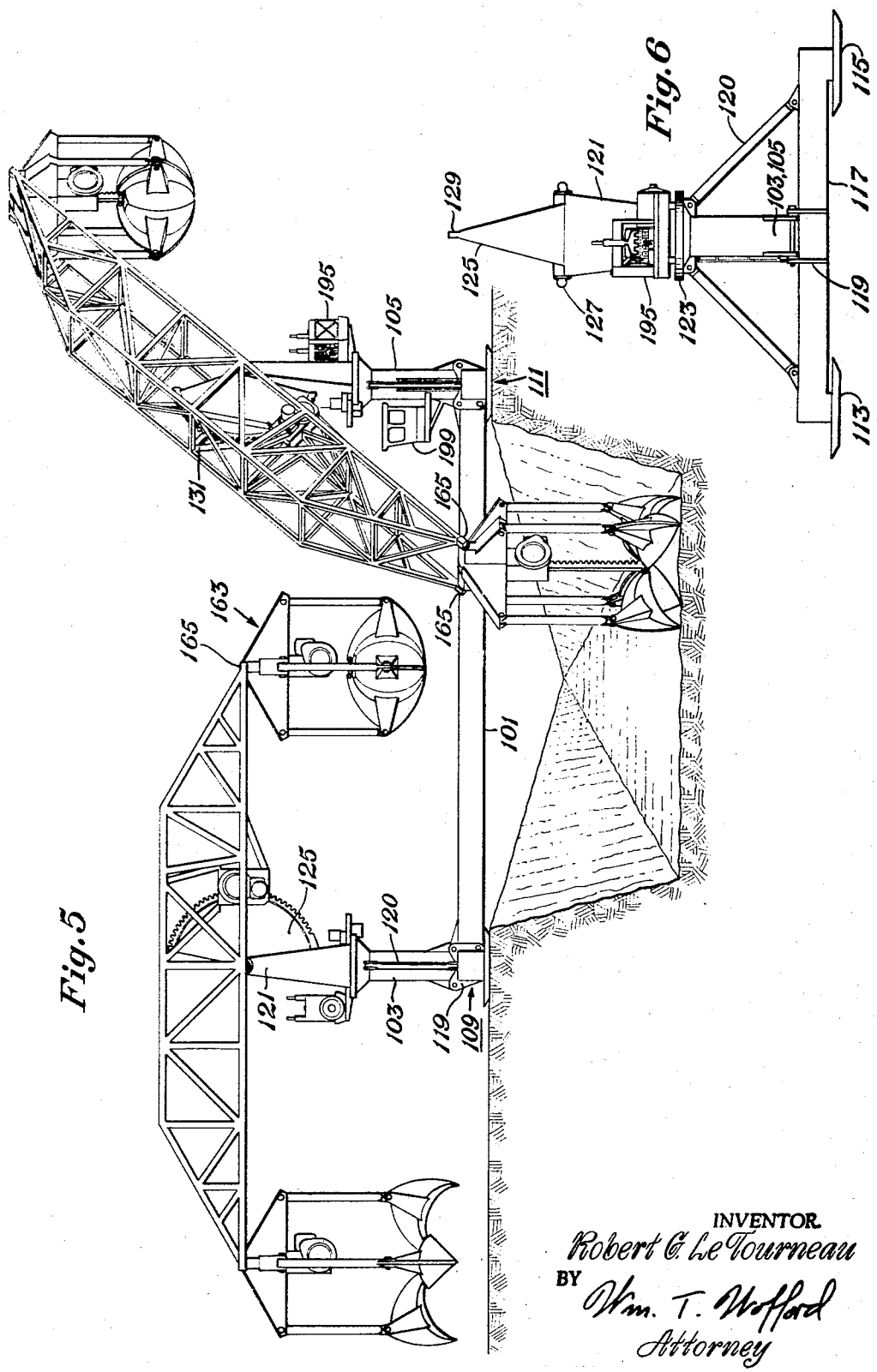


Fig. 5

INVENTOR.
Robert G. Le Tourneau
BY
Wm. T. Wofford
Attorney

July 9, 1968 R. G. LE TOURNEAU 3,391,810

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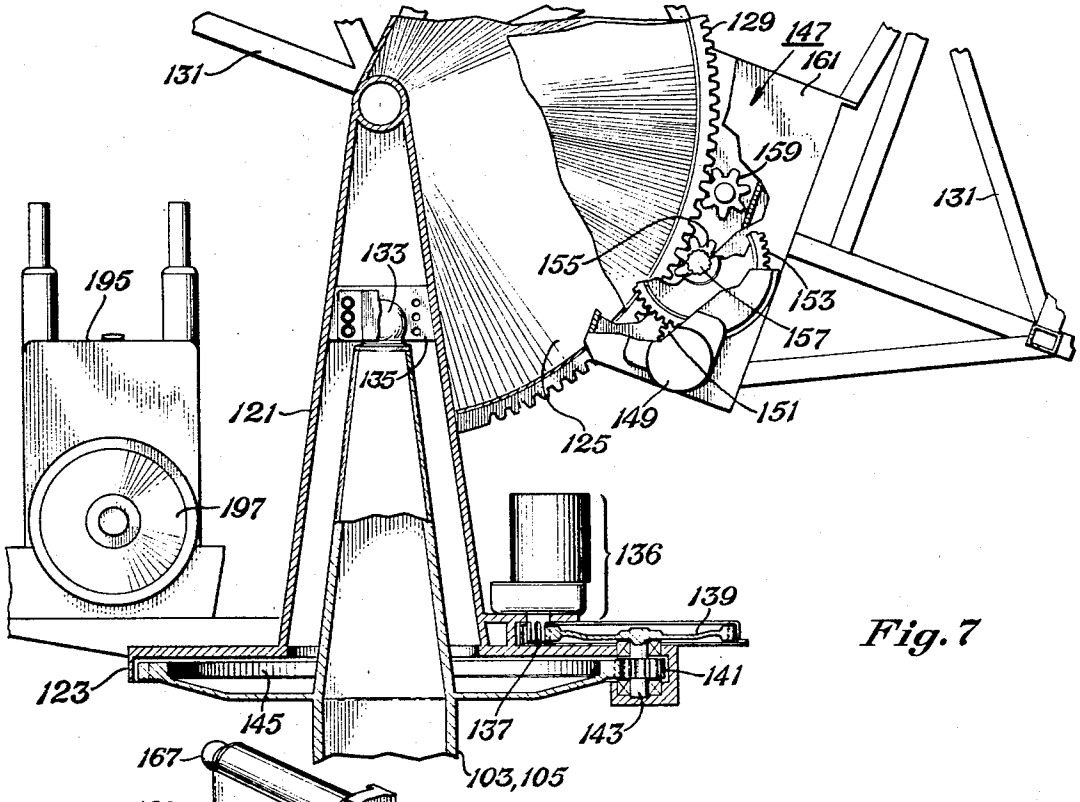


Fig. 7

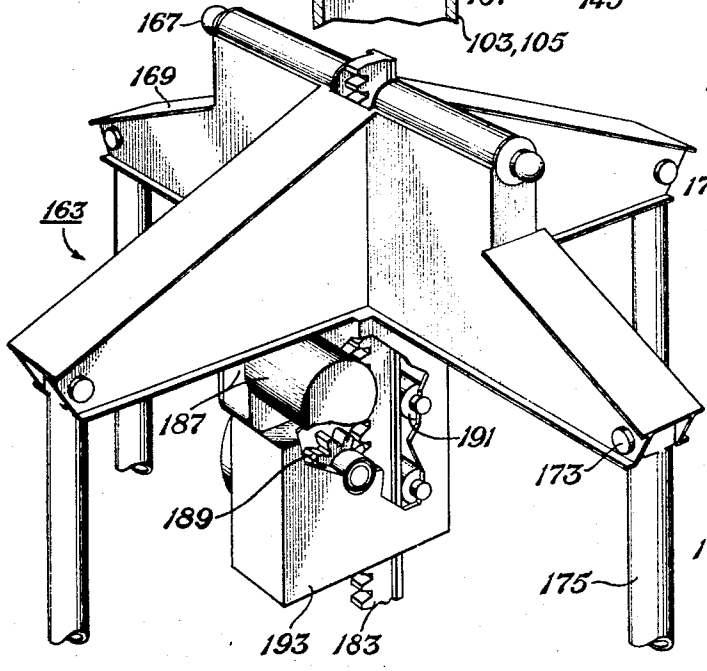


Fig. 9

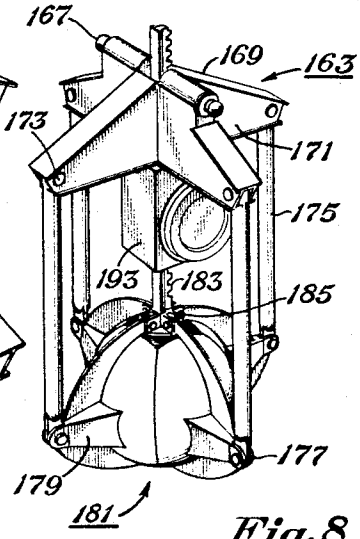


Fig. 8

INVENTOR.
Robert G. LeTourneau
BY Wm. T. Wofford
Attorney

July 9, 1968 R. G. LE TOURNEAU 3,391,810

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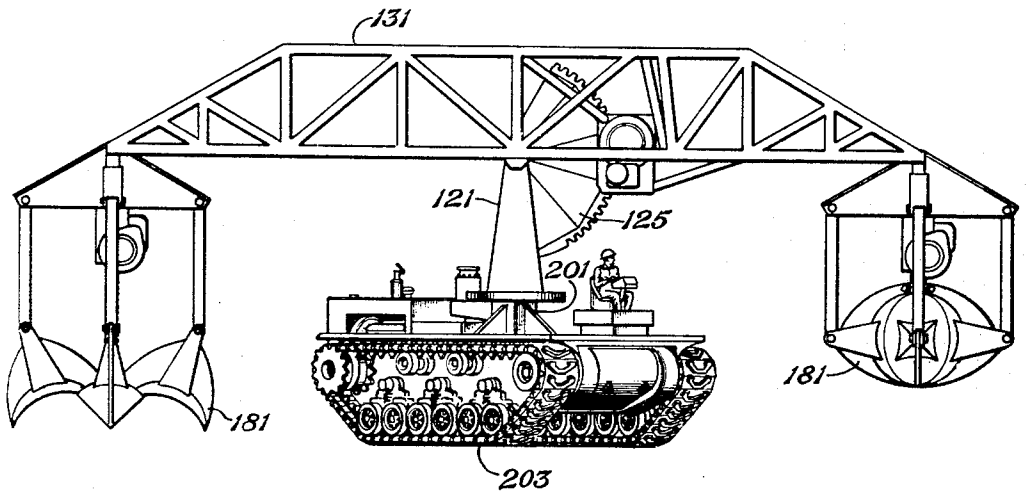


Fig. 10

INVENTOR
Robert G. LeTourneau
BY Wm. T. Woffard
ATTORNEY

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3,391,810

EXCAVATOR MACHINES

Robert G. LeTourneau, P.O. Box 2307,
Longview, Tex. 75601

Filed June 20, 1966, Ser. No. 558,640
5 Claims. (Cl. 214—132)

ABSTRACT OF THE DISCLOSURE

Excavator machines may be made up of a pair of horizontally spaced pedestal structures which are connected together by a beam structure. Each pedestal mounts a powered boom carrying at its outer end an earth digging and load carrying device. The machine can be "walked" along its excavating route by engaging a load carrying device with the earth so as to lift one pedestal structure and then rotating the boom to move the pedestal structure. In some embodiments a plurality of load carrying devices may be carried on a single pedestal structure. A pedestal structure, in another embodiment, may pivotally mount a unitary single boom structure at its midlength region for free movement in a vertical plane, with earth digging and holding means carried at each end of the boom structure.

My invention relates to earthworking machines for excavating earth and particularly to excavating machines of the boom supported bucket type.

The general object of my invention is to provide improved earthworking excavators of the boom supported bucket type.

Another object of my invention is to provide earthworking excavators of the boom supported bucket type with improved means for moving the machine along a selected work route.

Another object of my invention is to provide earthworking excavators of the boom supported bucket type with boom apparatus having improved operational characteristics.

These and other objects are effected by my invention as will be apparent from the following description taken in accordance with the accompanying drawings, forming a part of this application, in which:

FIG. 1 is a front elevational view of excavator apparatus constructed in accordance with a preferred embodiment of my invention;

FIG. 2 is a fragmentary plan view of a portion of the machine shown in FIG. 1;

FIG. 3 is a side elevational view of the machine shown in FIGS. 1 and 2;

FIG. 4 is a fragmentary and sectional view of the apparatus used to support the arms or booms of the FIG. 1 machine;

FIG. 5 is a front elevational view of an alternate form of my invention;

FIG. 6 is a side elevational view of the machine of FIG. 5 with the booms removed;

FIG. 7 is a fragmentary elevational view which shows an arm or boom support member, power means for rotating the arm support member about a vertical axis, portions of one of the booms, and power means for rotating the boom about a horizontal axis;

FIG. 8 is a fragmentary perspective of earth digging and holding means which are attached to the outer extremity of each boom;

FIG. 9 is a fragmentary perspective view showing upper portions of the earth digging and holding means of FIG. 8; and

FIG. 10 is a schematic elevational view of an earthworking excavator in accordance with a further aspect of my invention.

Referring initially to FIG. 1, the number **11** designates a rigid and elongated body member that connects upper regions of a pair of rigid legs **13, 15**. The body member and legs are preferably tubular but may have any suitable geometric form. A pair of braces **17** rigidly interconnect the body member **11** with legs **13, 15** to increase the rigidity and strength of the machine. Each leg has a foot **19, 21**, each of which includes a pair of pods **23, 25** (see FIG. 2) connected by a runner **27** which is transversely aligned with respect to a lower portion of legs **13, 15** and which extends perpendicularly with respect to body member **11**. Braces **29** add rigidity to the feet.

At the approximate midsection of each leg **13, 15** is an arm support structure **31**, which has a socket arrangement **33** (see FIG. 4) that surrounds a spherical section **35** secured to each leg. An upper region of spherical section **35** is joined to the associated leg in this instance by a flange connection **37**, and its lower region is connected with the leg by suitable means, such as welding **39**. The spherical member **35** and the socket arrangement **33** have mating surfaces, with an upper region of the socket arrangement **33** having an aperture **40** that is smaller in diameter than the largest diameter of the spherical member **35**. Thus, arm support structure **31** is supported, at least partially, by the cooperative relationship between ball member **33** and socket arrangement **35**. The socket arrangement preferably has a lower outwardly extending and downwardly facing shoulder **43** that opposes a mating shoulder **45** formed on legs **13, 15**. Ball bearing raceways **47** and ball bearings **49** are inserted between the opposing shoulders **43, 45** to support forces exerted on the arm support member **31** and to reduce friction during rotation.

The arm support structure **31** includes a lower flange **51** that has a plurality of apertures through which are inserted the shanks of inboard and outboard rollers **53, 55**. Inboard rollers **53** engage the outer cylindrical surface of the leg while outboard rollers **55** engage the cylindrical periphery of a lateral support flange **57**. The periphery of lateral support flange **57** has gear teeth **59** formed thereon, and these gear teeth are engaged by a pinion **61** which is mounted on a shaft **63** that extends from arm support structure **31**.

An electric motor gear unit **67** drives a reduction gear **69** and rotates the shaft **63** of pinion **61**. An electric generator is connected with a suitable electric circuit (not shown), which further connects the gear motor **67** with a console in an operator's control station **71** that preferably depends from the body member **11**, as may be seen in FIG. 1.

A pair of arms or boom structures **73** are supported on the arm support structure **31** of each leg **13, 15** by means of bearing members **77**. Pivotally connected to an upper portion of each arm support member **31** are a pair of racks **79** that engage pinions **81** driven by electric gear motor units **83**. Suitable electric circuits (not shown) connect the electric gear motors with a source of electrical power (not shown) and with the console of the operator's control station **71**. By rotating the pinion **81** in the clockwise or counterclockwise directions, the boom structure **73** may be forcefully moved in upward and downward directions.

Secured to the free end portion **85** of each boom structure **73** is a suitable, electrically operated earth digging and holding means **86**. Suitable earth digging and holding means **86** are disclosed in my copending application, Ser. No. 429,548, filed Feb. 1, 1965.

In operation, the electric motor **67** of each arm support structure **31** may be energized by closing an electric

circuit from the console located in the operator's control station **71**. Pinions **61** may be selectively rotated in both the counterclockwise and clockwise directions, and thus the arm support structures **31** and boom structures **73** may be rotated in either the clockwise or the counterclockwise direction. To remove earth from the floor of the channel shown in FIG. 1, one of the earth digging and holding means **86** is opened and the pinion **81** that engages the rack **79** is rotated so that the pinion tends to move toward the outer extremity of the rack. This causes the associated arm to move downward, and ultimately the earth digging and holding means is urged forcefully into the floor of the channel. Then the earth digging and holding means is closed so that earth is retained therein. The direction of pinion **81** is then reversed so that it tries to move rearward or toward the inner region of the associated rack. This causes the arm to move upward and away from the floor of the channel.

When the earth digging and holding means **86** is high enough to clear the bank of the channel, pinion **61** of arm support structure **31** is rotated until the arm is swung to the earth dispensing position. The earth digging and holding means **86** may now be operated in a manner to dispense earth, as is described in my above mentioned copending application.

Eventually, it becomes necessary to move the machine farther down the channel so that additional earth may be removed therefrom. This is accomplished by utilizing the mechanisms previously described that have the additional function of digging earth from the channel. As shown in FIG. 1, one boom structure **73** is lowered until its earth digging and holding means **86** engages the floor of the channel. If the pinion **81** is further rotated such that the pinion tends to move toward the free end of the rack **77**, the earth digging and holding means will be urged forcefully into the ground. If enough force is applied in this manner, the foot **19** can be moved from the floor of the channel. With the foot in an elevated position, the pinion **61** is rotated, and the resulting relative movement between the arm support structure **31** and the leg **13** causes the leg to rotate about the pivot point established by leg **15**. Leg **15** may be "walked" down the channel in a similar manner.

Referring now to the alternate form of my invention shown in FIGS. 5 through 9 of the drawings, the numeral **101** designates a rigid and elongated body member, which is connected at its extremities to a pair of legs **103, 105**. The legs have feet **109, 111**, each of which has a pair of pods **113, 115** secured to a runner **117** that is transversely connected with the body member **101** by clamping means **119**. Braces **120** add rigidity to the legs, each of which has an arm or boom support structure **121** disposed at its upper region.

Each arm support structure **121** includes a rotatable platform **123**, the purpose of which will be explained later. Mounted on each support arm member **121** is a sector gear **125** the central plane of which is vertical and passes through the longitudinal axis of said support arm member **121**. Disposed on the central axis of each sector gear **125** equidistant from said sector gear central plane are two oppositely facing ball arrangements **127** (see FIG. 6).

Sector gear **125** is part of the means associated with each arm or boom for moving same about a horizontal axis in either the clockwise or counterclockwise direction. The details of means for effecting this movement will be explained later.

The arm suport structure **121** associated with each leg **103, 105** is rotatable about the vertically disposed longitudinal axis of the leg. It may be seen with reference to FIG. 7 that the arm support structure **121** is preferably conical, having a socket arrangement **135** that engages a spherical region **133** formed on the upper extremity of the associated leg. An electric gear motor unit **136** is supported on the arm support member **121** and drives a pinion **137**, which engages and selectively rotates a reduction gear **139**. The reduction gear **139** and a pinion **141** are secured to a shaft **143**, and the pinion **141** engages a bull gear **145** that is secured to the leg. By rotating the pinion **137** associated with electric gear motor **136** in either the clockwise or counterclockwise direction, the arm support structure **121** may be rotated about a vertical axis. Pivotally mounted at its mid-length region on each said arm support structure **123**, by means of sockets cooperating with the balls **127**, is an arm or boom structure **131**.

To vary the angular orientation of boom structure **131** with respect to horizontal, power means **147** are provided (see especially FIG. 7). The illustrated power means comprises an electric gear motor unit **149** having a pinion **151** that engages a reduction gear **153**. Another pinion **155** is connected with the reduction gear **153** by means of a splined shaft **157**. A third pinion **159** may also be seen in FIG. 7, but this pinion is driven by an electric gear motor unit (not shown) that is on the opposite side of the support structure **161**. The support structure **161** for the power means **147** is secured by suitable means, such as welding, to the associated boom **131**.

Referring again to FIG. 5, each end of each boom has a pair of oppositely facing and coaxially aligned socket arrangements **165** (see FIG. 5) that engage ball arrangements **167** (see FIG. 8) formed on a head portion **169** of a respective earth digging and holding means **163**. The head portion **169** preferably has four laterally protruding ears **171** to which are pivotally secured connecting rods **175** by means of pins **173**. The lower end of each connecting rod **175** is pivotally connected by a respective pin **177** to a rib **179** on one section of an orange peel type bucket **181**.

To open or close the orange peel sections **181** of the bucket a length of rack **183** is connected to the bucket adjacent the upper regions **185** of each orange peel section. Relative vertical movement of the length of rack **183** with respect to the connecting rods **175** forcefully opens or closes the orange peel sections **181** of bucket. Hence, the earth digging and holding means **163** are opened and closed in the same general manner as are those described in my previously mentioned copending application.

To move the length of rack **183** with respect to the connecting rods **175**, an electric gear motor **187** drives a pinion (not shown) that rotates one or more additional reduction gears and ultimately turns another pinion **189** (see FIG. 9). The length of rack **183** is provided with a smooth rearward surface that is engaged by one or more back-up rollers **191**, which are rotatably secured to the housing **193** that supports the electric gear motor **187** and related apparatus.

To provide electrical energy for the various electrical components, an internal combustion engine **195** is rigidly secured to each arm support structure **121** and rotates the shaft of a generator **197**. Electrical circuits (not shown) connect the generator **197** with the previously described electric gear motors and an operator's control station **199**, which has a console therein, is disposed in a suitable location on the excavator, as is shown in FIG. 5.

In operation of the excavator of FIGS. 5 through 9, the electric gear motor **136** of each arm support structure **121** may be energized by closing an electrical circuit from the console in the operator's control station **199**. The pinion **137** may be rotated in the counterclockwise or clockwise directions, and thus the arm support structure **121** may be selectively rotated about a vertical axis. To remove earth from the floor of the channel shown in FIG. 5, one of the earth digging and holding means **163** is opened by operating the pinion **189** associated with the respective rack **183**. The pinions **155** and **159** (see FIG. 7) are rotated so that the end of the arm or boom structure **131** which supports the now opened earth digging and holding means is urged forcefully into the floor of the channel. Then the earth digging and holding means is

closed by the operation of the electric gear motor **187** so the earth is retained therein. Pinions **155** and **159** are now rotated in the opposite directions from that mentioned above so that the end of the arm or boom structure **131** is raised. When the earth digging and holding means is high enough to clear the bank of the channel, pinion **137** associated with arm support structure **121** is rotated to swing the earth digging and holding means over the bank into an earth dispensing position. The earth digging and holding means **163** is then operated in a manner to open the orange peel sections **181** to dispense the earth.

To move the excavator along the channel, one of the earth digging and holding means **163** is lowered as shown in FIG. 5 until it forcefully engages the floor of the channel. If the pinions **155, 159** are further rotated, the earth digging and holding means **163** tends to move farther into the ground, eventually raising foot **117** from the floor of the channel. With the foot in this elevated position, the pinion **137** associated with the arm support structure **121** is rotated, and the resulting relative movement between the arm support structure **121** and leg **105** causes the leg to rotate about the pivot point established by the other leg **109**. Leg **109** may be "walked" down the channel in a similar manner.

An important feature in accordance with one aspect of my invention resides in the provision of the excavator boom and earth digging and holding means counterbalance arrangement shown in the embodiment of FIGS. 5 through 9 and also in FIG. 10. The apparatus of FIG. 10 may be substantially identical as to the boom structure **131**, the arm support structure **121**, the buckets **181**, power means, drive means, and other components, to that of either half of the excavator of FIGS. 5 through 9, with the exception that the leg **103, 105** is replaced by a pedestal **201** mounted on a support base such as a vehicle **203**. The counterbalance arrangement of the boom structure **131** and buckets **181** as shown by FIGS. 5 and 10 has the advantage that it is only necessary to provide power for lifting the load in the bucket. Since the weight of the boom and bucket structure is considerable, to avoid lifting this weight results in a significant saving of power.

It should be apparent from the foregoing that I have provided an invention having significant advantages. The arrangement of the arms or boom structures and legs of the machine is such that the same apparatus used to effect the earth digging and dispensing functions may be used to propel the machine to new locations in an effective manner. By eliminating the necessity for having separate means for propelling the machine and for effecting the earth digging and dispensing, machine weight and initial cost are reduced. One operator can effectively manipulate the multiple earth digging and holding means. The apparatus arrangements of my invention provide good excavator stability in addition to providing an improved manner of "walking" the excavator. The excavators of FIGS. 5 through 10 have the additional advantage of improved operational and economic characteristics due to the fact that each boom structure and its associated earth digging and holding means are arranged in counterbalance fashion, so that work energy or power need be expended only to lift the weight of earth payload.

While I have shown my invention in only one form, it will be apparent to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

I claim:

1. An excavator apparatus comprising:
(a) two spaced apart legs;
(b) a body member rigidly connecting upper regions of said legs;
(c) at least one boom structure mounted on each leg for rotation about the longitudinal axis of said leg and about an axis transverse with respect to said leg;
(d) earth digging and holding means carried by each boom structure; and
(e) power means for forcefully and independently moving said boom structures about their respective axes of rotation.

2. The excavator apparatus as defined by claim **1**, but wherein the body member rigidly connects lower regions of said legs.

3. An excavator apparatus comprising:
(a) two spaced apart vertically disposed legs rigidly interconnected at lower regions thereof;
(b) a boom structure mounted at its mid-length region on each leg for rotation about both horizontal and vertical axes;
(c) earth digging and holding means carried by each end of each boom structure, with the weight of the earth digging and holding means and each boom structure arranged in counterbalance fashion; and
(d) power means for forcefully and independently moving said boom structures about their respective horizontal and vertical axes.

4. An excavator apparatus comprising:
(a) two spaced apart vertically disposed rigidly interconnected legs;
(b) at least one boom structure mounted on each leg for rotation about both horizontal and vertical axes;
(c) earth digging and holding means carried by each boom structure; and
(d) power means for forcefully and independently moving said boom structures about their respective horizontal and vertical axes.

5. An excavator apparatus comprising:
(a) a pedestal structure;
(b) a unitary single boom structure mounted at its midlength region on said pedestal structure for rotation about both horizontal and vertical axes;
(c) earth digging and holding means carried by each end of said boom structure, with the weight of the earth digging and holding means and said boom structure arranged in counterbalance fashion; and
(d) power means for forcefully and independently moving said boom structure about said respective vertical and horizontal axes.

References Cited

UNITED STATES PATENTS

1,170,654	2/1916	Martin	214—132 X
2,228,447	1/1941	Eveler	214—147 X
3,132,756	5/1964	Thompson	214—132
3,231,114	1/1966	LeTourneau	214—132

HUGO O. SCHULZ, *Primary Examiner.*