

Nov. 6, 1962

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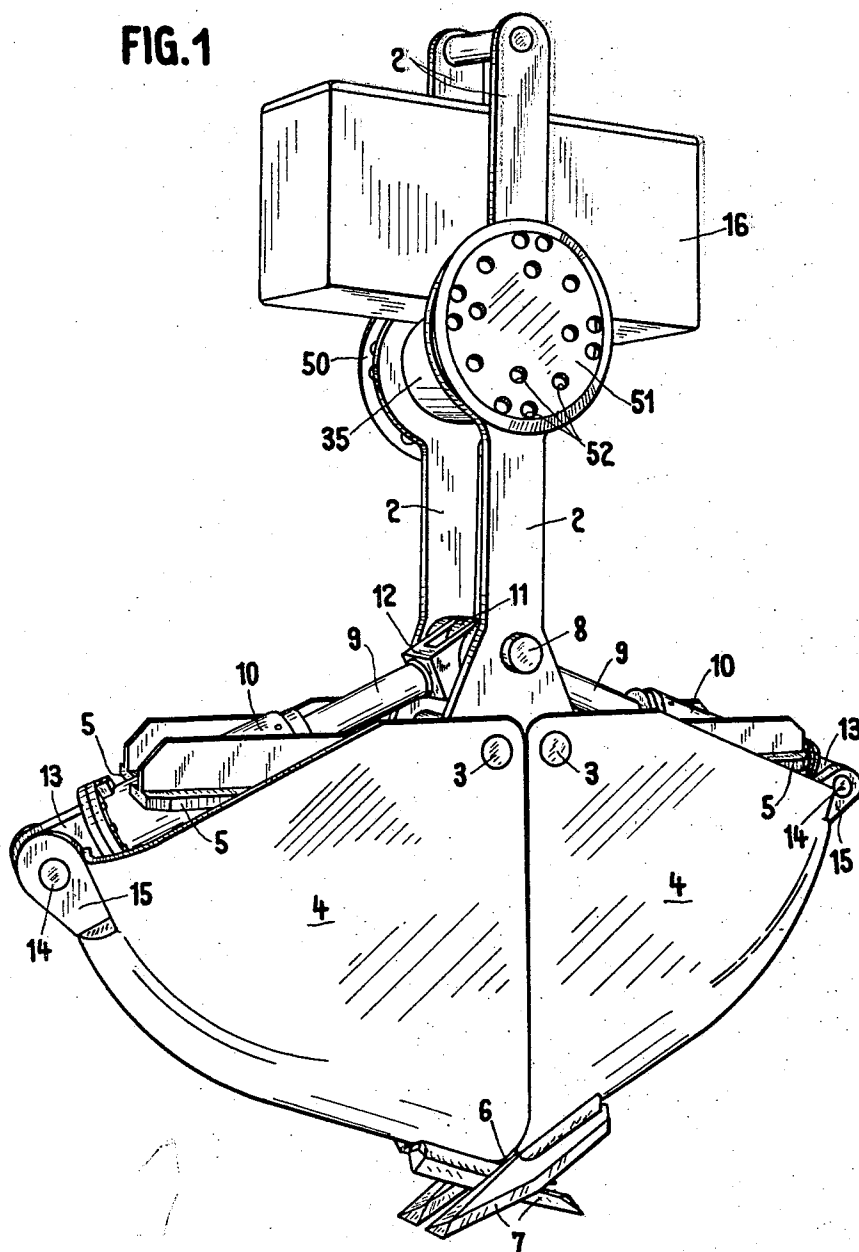
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DEVICE FOR DIGGING AN EXCAVATION

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3 Sheets-Sheet 1

FIG. 1



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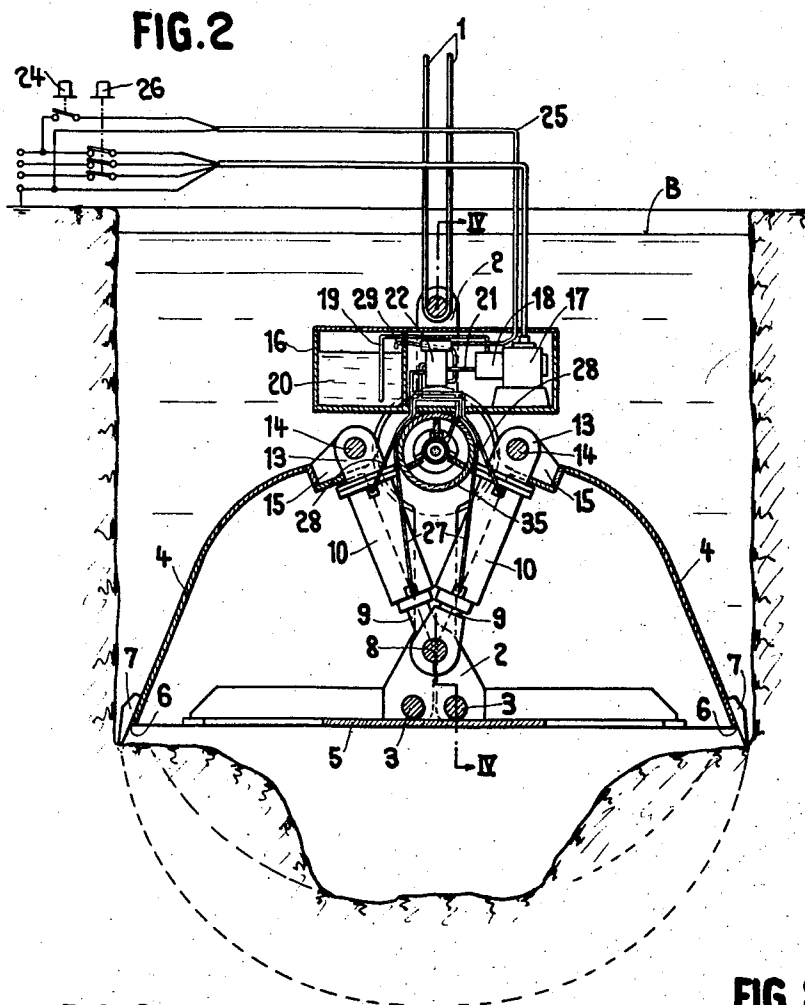


FIG. 3

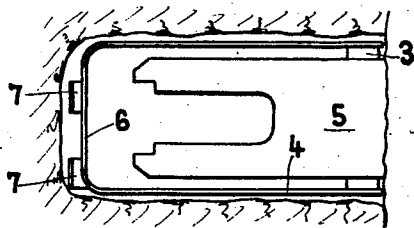
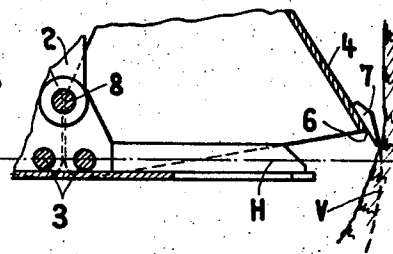


FIG. 8



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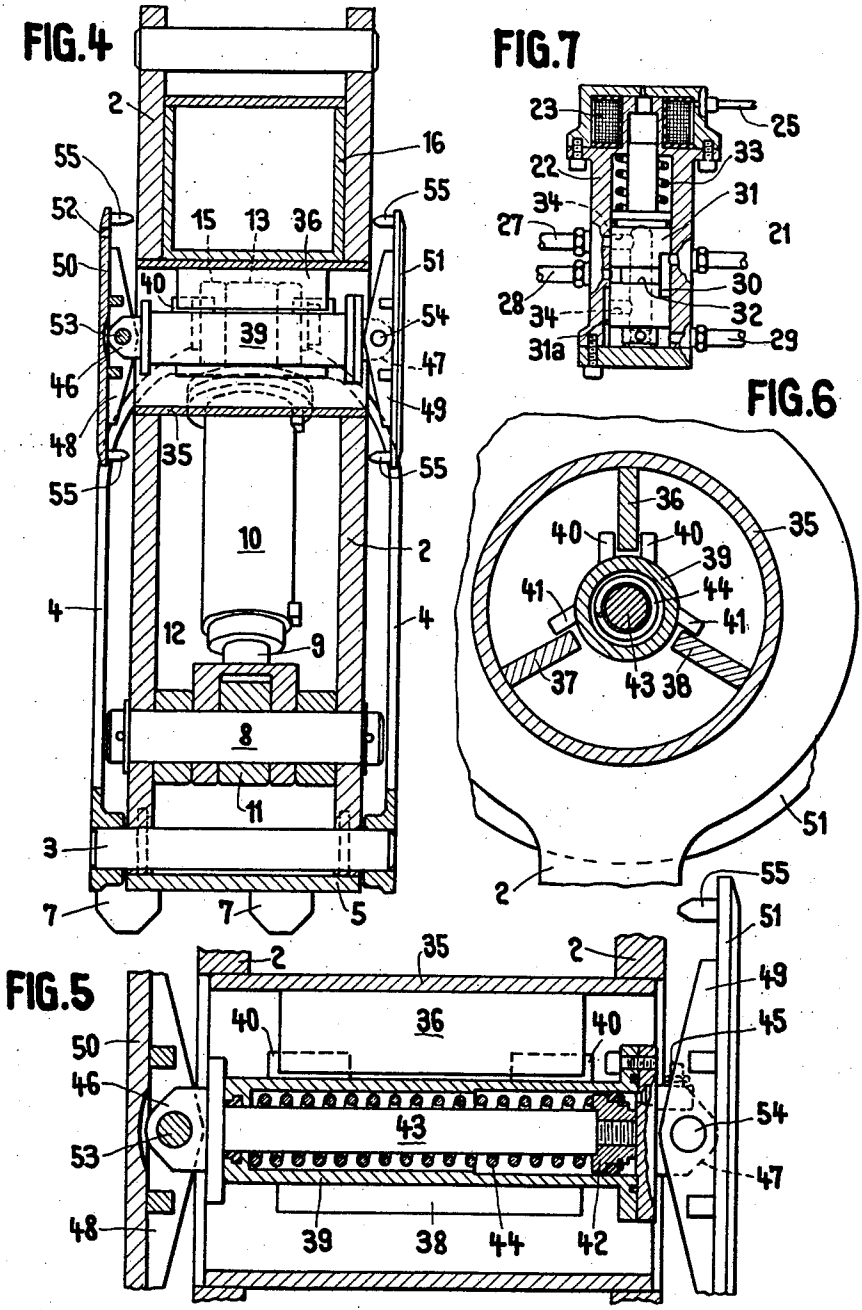
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DEVICE FOR DIGGING AN EXCAVATION

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3 Sheets-Sheet 3



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DEVICE FOR DIGGING AN EXCAVATION

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11 Claims. (Cl. 37-195)

This invention relates to a device for digging an excavation, particularly a deep and narrow slit-like excavation or trench, comprising a trenching grab having movable grab blades, means for completely closing the said grab blades for lifting out loosened material, a clamping device having clamping members adapted to be pressed against the walls of the excavation for taking up the reaction of the downwardly directed working pressure of the grab blades.

Excavating devices of this type are particularly suitable for obtaining working pressures substantially exceeding the own weight of the device, such increased working pressures acting vertically downwards allowing a substantially increased progress of the excavating work. In known devices a separate hydraulic cylinder and piston is arranged between the said clamping device and the tools for producing a relative vertical displacement between such portions of the device and for pressing the tools vertically downward relative to the clamping device. Further, separate hydraulic means have been provided for actuating the tools of the device and therefore, the prior devices are complicated in construction and operation and easily damaged.

It is a first object of this invention to substantially simplify the construction and operation of an excavating device of the type specified above. It is a further object to improve the excavating technique by a particularly favourable design of the device. The device according to the present invention is broadly characterized by a common rigid carrier for the said movable grab blades and for the said clamping device, means for opening the said grab blades, the said grab blades being arranged for alternative closing and opening motion controlled by the said means for closing the grab blades and by means for opening the grab blades, working portions on the said grab blades, the grab blades being shaped and arranged in a manner allowing substantially vertical downward displacement of the said working portions of the grab blades for a portion of the closing movement thereof. Due to the particular design and arrangement of the grab blades or other suitable tools a relative displacement in vertical direction between the clamping device and the carrier of the tools is no longer required, whereby the device is substantially simplified. The rigid carrier for the movable tools and the clamping device allows mounting of the tools and of the clamping device at a relatively small vertical distance from each other, so that the clamping device will be near the working place of the excavating device. When excavating a hard layer of ground the clamping device will be operative in the same layer, that is, substantially at the same level as the tools and it is possible to produce very high clamping forces in hard ground for taking up the reaction of the correspondingly high working forces of the tools. For this and other reasons to be explained later on it is possible to obtain very rapid excavation as compared with any known excavating apparatus in nearly any ground such as gravel, sand, peat, and some types of molasses, sandstone or marly soil.

It is an important condition for an efficient use of the excavating device that the clamping members may always be pressed against the wall of the excavation, this being only possible from a practical point of view if the excavation has substantially constant width measured in the

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moving direction of the clamping members at any level of the excavation. Therefore, it is of particular practical importance that the walls of the excavation do not cave in. Therefore, this invention also relates to a particularly advantageous method of digging an excavation by means of the above mentioned excavating device, this novel method being substantially characterized in that the excavation is filled with bentonite or the like for artificial solidification of the walls of the excavation, thereby avoiding cave-in of the wall material and increasing adhesion of the clamping members on the walls.

Further objects and advantages of the invention will be apparent from the following specification and from the attached drawings, wherein

FIG. 1 is a perspective view of the device,
FIG. 2 is a side view, partially in section of the device,
FIG. 3 is a partial bottom view of the device,
FIG. 4 is a section along line IV-IV in FIG. 2,
FIGS. 5 and 6 are an axial section and a cross section respectively of the clamping device,
FIG. 7 is a section of a control valve, and
FIG. 8 is a partial view of a modified embodiment.

The excavating device is suspended on any suitable hoist, such as a rubber-mounted crane or the like by means of a rope 1 (FIG. 2), the hoist being able to completely lift the device out of the excavation for discharging it and to lower it to the desired depth of the excavation. The rope 1 is laid round a bolt of a rigid carrier having two parallel rigidly interconnected legs 2. Two similar grab blades 4 are pivoted in symmetrical position at the lower end of legs 2 by means of pivot pins 3. The grab blades are of substantially U-shaped cross section. A stripping plate 5 welded to the lower ends of legs 2 extends into the blades 4 for stripping the material out of the blades during discharge thereof. The working edges 6 of the grab blades 4 are equipped with teeth 7. Another pivot pin 8 is fixed between legs 2 above pivot pins 3, and the ends of piston rods 9 of similar hydraulic cylinders 10 are pivoted on this pin 8 by means of bored rod 11 and a bored fork 12 respectively. Lugs 13 of the cylinders 10 are pivotably assembled with forks 15 of the grab blades 4 by means of bolts 14. It is seen from FIG. 2 that with fully open grab blades the line of application of the piston forces passes above the pivot pins 3 of the grab blades 4 so that a turning moment acting on the blades 4 is produced by forces acting in the direction of the piston rods 9.

Below the suspension bolt a tightly closed casing 16 is fixed between legs 2, this casing comprising the means for hydraulically actuating the grab. An oil pump 18, for instance of the gear type, may be driven by an electric motor 17, oil being sucked through conduit 19 from an oil container 20 and pressure oil being fed from the pump through a control valve 22, for instance of the type shown in FIG. 7. Valve 22 is actuated by means of an electro-magnet 23 which may be controlled by a switch 24 through a double-core cable 25. The motor 17 is fed through another cable comprising four cores and may be controlled by means of a switch 26. Valve 22 has two outlets, the one of these outlets being connected by means of schematically illustrated flexible conduits 27 with the lower ends of cylinders 10, whereas the other outlet is connected through schematically illustrated, flexible conduits 28 with the upper ends of cylinders 10 and with an actuating cylinder of the clamping device shown in detail in FIGS. 5 and 6. The valve 22 has an oil return outlet connected to a return pipe 29.

As shown in FIG. 7 the oil pressure conduit 21 communicates with a recess 30 of the displaceable piston 31 of the control valve 22. The piston 31 has a ring groove 32 communicating with the one or other of conduits 28

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or 27 according to whether the valve piston is in its one or other end position. A pressure spring 33 continuously acts against piston 32, tending to shift the piston into the lower end position shown in FIG. 7 when the magnet 23 is deenergized. The piston 31 has two bores 34 communicating with conduits 27 or 28 respectively according to the position of the piston, and further communicating with an axial bore of piston 31 leading to the end space of the valve cylinder to which return conduit 29 is connected. A pin 31a of the piston 31 engages a groove of the valve cylinder thereby preventing rotation of the piston in the cylinder.

The clamping device shown in detail in FIGS. 5 and 6 is accommodated in a substantially cylindrical casing or tube 35 fixed between legs 2 of the carrier. Three flat guide webs 36, 37 and 38 are welded into the casing 35. The guide web 36 engages guide webs 40 of the clamping cylinder 39, and further guide webs 41 of the cylinder 39 engage the guide webs 37 and 38, the clamping cylinder 39 being thus mounted for axial displacement in the casing 35 by means of the guide webs 36 to 38, 40 and 41. A piston 42 having a piston rod 43 is mounted for axial displacement in the clamping cylinder 39. A pressure spring 44 is inserted between piston 42 and one end of cylinder 39, this spring tending to maintain the piston 42 and the parts assembled therewith in the retracted, inoperative position shown in FIG. 5. One of conduits 28 is attached to an angled connection piece 45 of cylinder 39, and pressure oil may be admitted into the cylinder end at the right of the piston 42. Pairs of flanges 46 and 47 are welded to the free end of the piston rod 43 shown on the left in FIG. 5 and to the right-hand end of cylinder 39 respectively. Webs 48 and 49 of pressure plates 50 and 51 respectively laterally engage flanges 46 and 47 respectively. In order to increase the adhesion of the pressure plates such plates may be perforated as shown at 52. Flanges 46 and 47 and webs 48 and 49 respectively are pivotably assembled by means of pivot pins 53 and 54 so that the pressure plates 50 and 51 may slightly be tilted round the horizontal axis of pins 53 and 54 relatively to the axis of the cylinder 39 and the piston rod 43 respectively. This tilting movement is limited by cams 55 fixed on the pressure plates.

Operation of the embodiment of the invention described in the foregoing is as follows:

FIG. 2 illustrates the device with its grab in open position lowered into working position at the bottom of the excavation. During the introduction of the grab into the excavation or trench, switch 24 has been maintained in closed position so that the electromagnet 23 is excited and the conduits 27 are fed with pressure oil. The piston rods 9 are completely retracted into the cylinders 10 so that the grab blades 4 are maintained in open position. When the working position shown in FIG. 2 is attained, switch 24 is opened, whereby the piston of valve 22 is changed over into the position shown in FIG. 7. Conduit 27 is consequently connected to the return conduit 29 and conduits 28 are fed with pressure oil. This pressure oil simultaneously flows to the upper ends of cylinders 10 and into the cylinder 39. The piston rods 9 are thereby urged out of cylinders 10 and the grab blades 4 are turned downwardly, whereby their working edge 6 and the teeth 7 are first moved vertically downwards. Assuming that the resistance of the ground against this vertical downward motion is small, the oil pressure in the blade-actuating cylinders 10 will not rise to a value for which the piston 42 of the clamping device is able to compress the spring 44. Therefore, the clamping plates 50 and 51 remain in their inoperative retracted position. After a partial closing motion of the grab blades 4, by which some material is loosened below the edges 6 and teeth 7 and displaced inwardly, the switch 24 is again closed for reversing the valve 22 and for reopening the grab blades 4. Since during this resetting motion of the blades into open position the lower edges 6 of such blades will re-

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main substantially at the level or depth they reached during the previous closing motion, the carrier of the grab will be moved downwards relatively to the blade edges 6 during the opening motion thereof. At the end of the opening motion of blades 4 the switch 24 is opened again whereby another closure of the blades 4 is initiated during which the working edges of the blades again enter into the ground. The more the grab blades 4 enter into the ground the more the forces opposing closure of the blades increase so that a higher oil pressure will build up in cylinders 10, this higher oil pressure being sufficient for displacing the piston 42 of the clamping cylinder. The pressure plates 50 and 51 are thus urged against the side walls of the excavation with a force corresponding to the forces required for closing the grab blades. Once the grab is lowered to the bottom of the excavation, a substantially automatic digging operation for further lowering the grab and for loosening material is possible by repeatedly partially closing and reopening the grab blades 4 by simply opening and closing switch 24, the clamping plates 50 and 51 being automatically loosened during each opening motion of the grab and being automatically pressed against the walls at a somewhat lower level during the next closing motion of the grab blades. When sufficient material has been loosened at the ends of the excavation and has been accumulated at the bottom of the excavation as indicated in FIG. 2, the grab blades are completely closed for taking up the loosened material. When the blades are completely closed the pump motor 17 is shut down so that the oil pressure drops to a value for which spring 44 retracts the pressure plates 50 and 51 to their inoperative position. The closed grab with the material contained therein may now be lifted out of the excavation and the material may be discharged by opening the grab, whereby the stripper plate 5 completely strips the material out of the blades.

Due to the particular design and operating motion of the grab blades 4, to the rigid connection between the clamping device and the pivot places of the grab blades and to the simultaneous control of the closing motion of the grab blades 4 and the operating motion of the pressure plates 50 and 51 an extremely simple construction and highly efficient automatic operation of the grab are possible. As shown in FIG. 2 the pressure plates 50 and 51 are arranged at a level as near as possible to the pivot places of the blades 4, and consequently the clamping device is arranged at a small distance above the working edges 6 of the grab blades, so that in ground having different layers the clamping device soon enters into the layer wherein the grab edges usually work during the repeated partial closing and opening motion. Therefore, when removing a very hard layer it is soon possible to clamp the device in the same hard layer with very high clamping forces, this allowing correspondingly high working pressures. However, in very loose ground the pressure plates 50 and 51 are not pressed against the walls so that that such weak walls are not damaged and do not cave in due to the action of the clamping device.

As already stated above, the excavating device shown in FIGS. 1-7 is particularly suitable for operation in bentonite-filled trenches. In FIG. 2 the level of the bentonite filling is shown at B.

It is of particular advantage to use tools, for instance grab blades, operating in a common plane as shown in the foregoing embodiment, in order that the clamping members may be located between such tools for operation in a direction transversal to the operating plane of the tools. With this arrangement a particularly small vertical distance between the working level and the level of the clamping device may be obtained.

Since the clamping cylinder 39 is itself displaceable in axial direction, the clamping device as a whole will automatically take a suitable position relatively to the carrier of the device, the position of the grab in the trench being thus substantially independent of the local shape of the

walls whereon the clamping device acts. Therefore, the grab is usually suspended in vertical direction and will dig in a strictly vertical direction.

In a modified embodiment an oil pressure pump may be used producing oil pressure at two different outlets according to its rotating direction. With such a pump opening and closing of the grab may be controlled by simple reversal of the pump motor 17 and the control valve 22 may be dispensed with. For lifting the completely closed grab with the material contained therein the pump motor may be shut down as explained above for allowing retraction of the pressure plates 50 and 51 from the trench walls.

It is also possible to provide for fully automatic control of the above repeated partial closing and opening motion of the grab. To this end hydraulic control means may be associated with the control valve or with a reversible pump as mentioned above. A control piston for valve 22 may be provided, this control piston connected with the piston of control valve 22 being thrown to one side when the pressure in conduits 28 exceeds a certain value and to the other position when the oil pressure in conduits 27 exceeds a certain value. Therefore, when the resistance against the closing motion of the grab blades exceeds a given value, an oil pressure sufficient for reversing the control piston and valve 22 respectively would build up in conduits 28 and the grab would automatically be closed again after reversal of valve 22. At the end of the closing stroke the oil pressure in conduits 27 would rise to a value sufficient for another reversal of the control piston. Of course means would have to be provided for overriding this automatic control system when it is desired to completely close the grab for lifting the material.

In order to obtain a relatively long stroke of the working edge of the grab blades 4 in a substantially vertical direction at the beginning of the closing motion, the working edge 6 of the blades may be arranged above the horizontal plane comprising the blade pivots 3. A modification of this type is illustrated in FIG. 8, wherein the said horizontal plane comprising the pivots 3 is indicated by a dash-dotted line H. As indicated by a broken line V the working edge of teeth 7 will be displaced in substantially vertical direction through two similar slightly curved stretches above and below the plane H. The same applies for the working edge 6 of the grab blades 4.

What I claim is:

1. A device for digging an excavation, particularly a deep and narrow slit-like excavation or trench, comprising a trenching grab having a carrier adapted to be suspended on a hoist, movable grab blades mounted on the said carrier, a clamping device mounted on the said carrier, having clamping members adapted to be pressed against the walls of the excavation for taking up the reaction of the downwardly directed working pressure of the grab blades transmitted to the said carrier, actuating means for closing and opening the said grab blades and for engaging said clamping members against the walls, control means for said actuating means, pivot means for each of said grab blades and working portions on the said grab blades, the said pivot means and working portions being on substantially the same level when the grab blades are in their open position, a substantially vertical downward displacement of the said working portions of the grab blades being thus obtained for a portion of the closing movement thereof.

2. A device according to claim 1, the said clamping members being arranged between the grab blades and adapted for displacement in a direction transversal to the plane wherein the grab blades are displaceable.

3. A device according to claim 1, comprising hydraulic actuating means for opening and closing the grab blades and for actuating the said clamping members, control means for the said actuating means operable for simultaneously admitting pressure fluid to the said actuating

means for simultaneously engaging the said clamping members and closing the grab blades.

4. A device according to claim 3, the said clamping device comprising spring means tending to return and maintain the said clamping members in their retracted inoperative position.

5. A device according to claim 1, the said clamping device comprising a hydraulic cylinder mounted for axial displacement along guides fixed to the said carrier, and a piston axially displaceable in the said cylinder, a pair of clamping plates whereof the one is mounted on the said cylinder and the other is mounted on the rod of the said piston.

6. A device according to claim 5, the said clamping plates being pivotally mounted on the said cylinder and piston rod respectively.

7. A device according to claim 1, comprising strippers fixed on the said carrier and extending into the said grab blades.

8. A device according to claim 1, comprising a motor and pump for producing pressure fluid and valve means interconnected between said pump and said actuating means, the said motor, pump and valve means being accommodated in a tight casing fixed to the said carrier, and electrical connections from the said control means to the said motor and valves respectively.

9. A device according to claim 1, the said lower working edge being above the level of the said pivot pins when the grab blades are in their open condition.

10. A device for digging an excavation, particularly a deep and narrow slit-like trench, comprising a trenching grab having movable grab blades, a clamping device having a pair of clamping members adapted to be pressed against the walls of the excavation, a hydraulic cylinder and a piston having a piston rod displaceable within the said hydraulic cylinder, a source of pressure fluid and control means operable for admitting pressure fluid into the said hydraulic cylinder, one of said clamping members being attached to the said hydraulic cylinder and the other of said clamping members being attached to the piston rod, said clamping members being spaced from each other and pressed against opposite walls of the excavation when pressure fluid is admitted to the said hydraulic cylinder, a grab structure whereon the said grab blades are pivoted and wherein the said hydraulic cylinder is mounted for displacement in the direction of its axis.

11. A method for digging an excavation comprising providing an excavation device having grab blades adapted to be opened and closed by manually operable control means, clamping means adapted for being engaged by manually operable control means against the walls of the excavation, repeatedly and alternatively effecting partial closing and complete reopening of the grab blades for loosening material and gradually lowering the grab while in substantially open position, and effecting engagement of the clamping device during the partial closing cycles of the grab and retracting the said clamping device to inoperative condition during the opening cycles of the grab, the clamping device being thereby allowed to sink to a lower level during each opening cycle of the grab and to be clamped at such lower level for the next closing cycle of the grab, and eventually effecting complete closure of the grab blades for removing the previously loosened material.

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