May 14, 1940. R. S. WEIMER 2,200,315

EXCAVATOR

Filed June 5, 1937 2 Sheets-Sheet 1

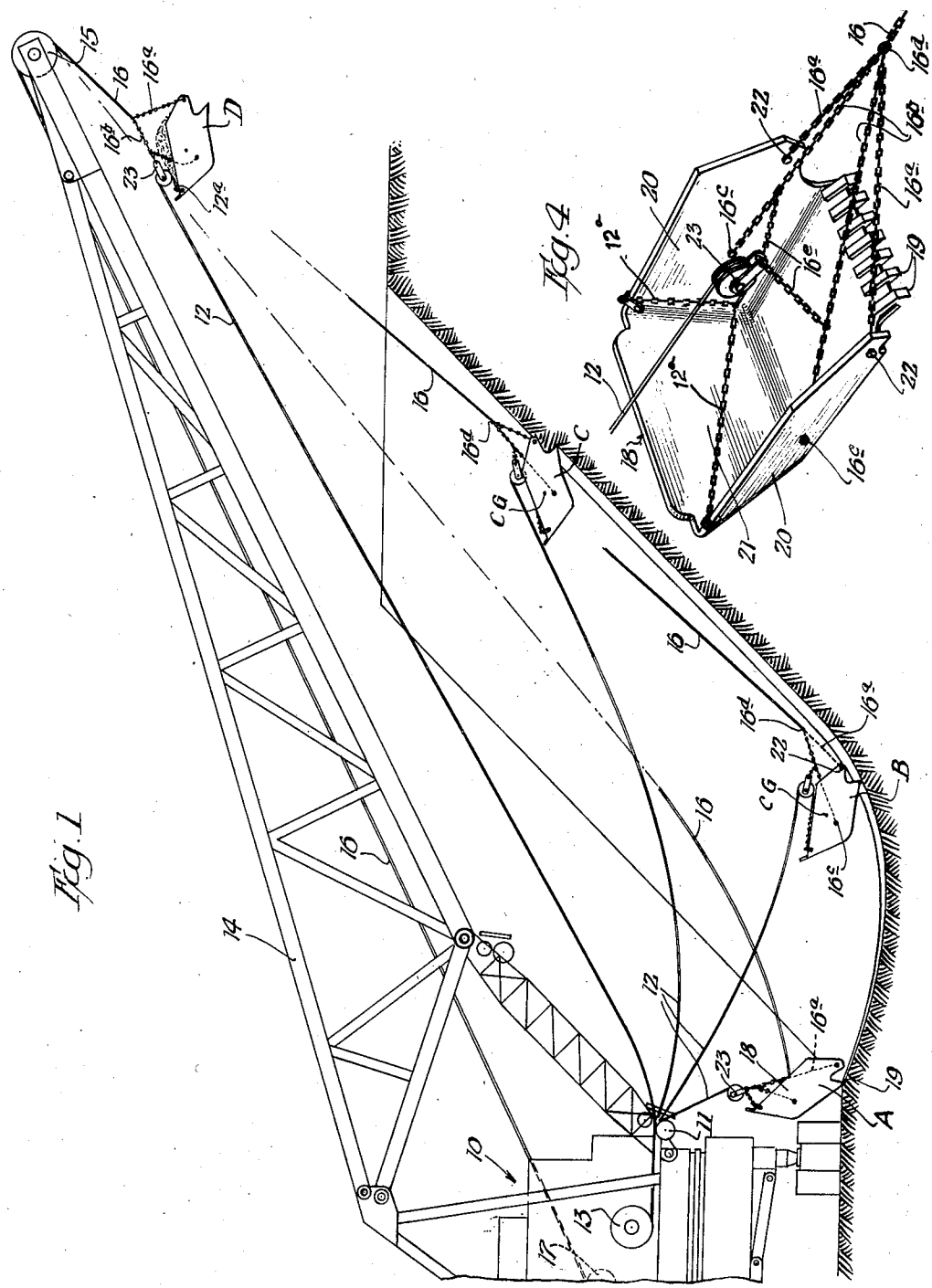

Fig. 1

Fig. 4

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Fig. 2

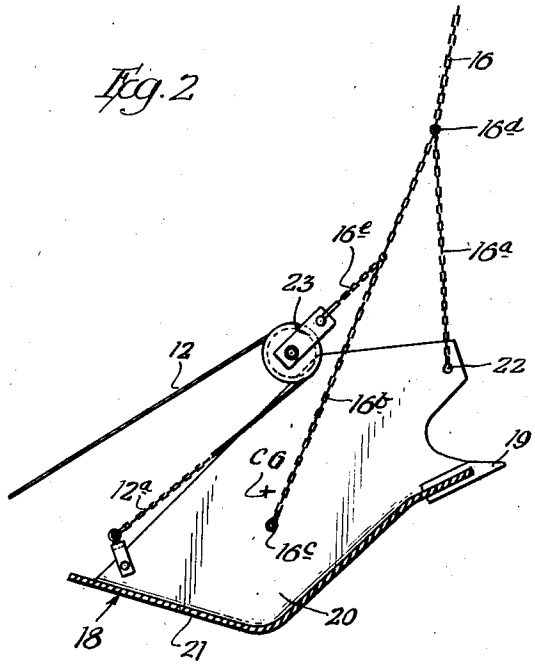


Fig. 3

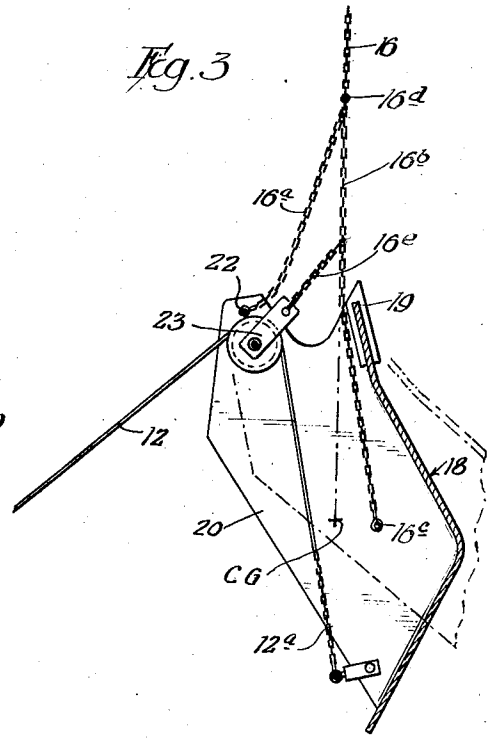
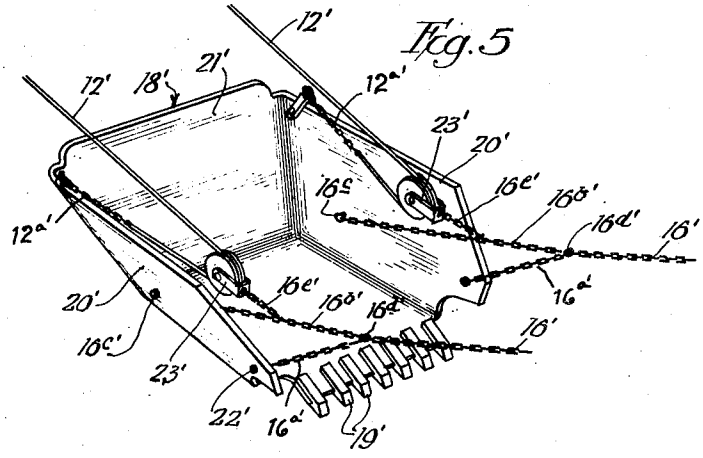


Fig. 5



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UNITED STATES PATENT OFFICE

2,200,315

EXCAVATOR

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8 Claims. (Cl. 37—135)

This invention relates to excavating apparatus, particularly of the drag line type. In conventional drag line equipment, the bucket is drawn from positions beneath the outer end of the boom toward the center of the machine and it is then elevated by the hoist line and moved to dumping position. Where the bucket moves down an incline during the loading operation, the efficiency of the machine is lessened due to the fact that the bucket tends to push the material along ahead of it since the material must flow relatively uphill into the bucket. There is a given incline dependent upon the friction angle of each material, up which such material will not flow. It will be seen, therefore, that as the surface being excavated approaches such angle, the operating efficiency of the machine is reduced.

With excavators of the steam shovel type, the scoop or bucket is moved away from the machine and this type of excavator has certain advantages over the conventional drag bucket type especially in taking on the load while the bucket moves through an upward curve or in a vertical plane.

In the present improvement, the advantages of the shovel type excavator are obtained in that the scoop or bucket moves outwardly from the machine toward a position under the point of the boom and thus takes on its load readily while moving upwardly as well as when moving horizontally. In the shovel type excavator employing a boom and dipper stick, a high digging efficiency is attained but within relatively narrow limits since the weight of the stick and the dipper or scoop, which is enclosed on five sides, necessarily limits the horizontal and vertical range of the apparatus.

With the present invention, a dipper stick is not employed and consequently a saving in weight thereof may be taken advantage of by utilizing a longer boom, thus increasing substantially the effective excavating range of the apparatus, or by employing a scoop of greater load carrying capacity.

One object of the invention is to provide an excavator of the drag line type wherein the scoop or bucket moves outwardly from the machine and is sustained in excavating position primarily during the loading operation by a novel drag line arrangement supplemented, however, by a control line which cooperates with the drag line in varying the angle of the bucket, if desired, during the loading operation and in supporting the bucket during the elevation and transportation of the load to discharging position.

In excavating by means of drag lines, it generally is desirable to maintain the bucket at a constant angle with respect to the surface being excavated. In conventional drag line equipment, the bucket ordinarily can oscillate from a position wherein the bottom rests on the material through an arc of about sixty degrees about the point of the teeth as a center, thus varying the angular disposition of the teeth and impairing the operating efficiency of the apparatus.

It is a further object of the present invention, therefore, to provide means which reduce the frequency and amplitude of the oscillations of the bucket and thereby effect stabilization of the same at effective digging positions within angular limits.

In the accompanying drawings, wherein an embodiment of the invention is disclosed for the purpose of illustration:

Fig. 1 is a broken elevation of drag line excavating apparatus embodying the present invention, said figure illustrating the bucket or scoop in several of its operative positions;

Fig. 2 is an enlarged vertical longitudinal section of the improved bucket and control rigging in a position intermediate its usual load carrying position and load discharging position;

Fig. 3 is a vertical longitudinal section of the bucket in load discharging position;

Fig. 4 is a perspective view showing a single drag line and a single haul line but having branches, by means of which the force is applied to the bucket in the desired directions; and

Fig. 5 is a perspective view of a bucket illustrating the attachment thereto of the various lines in twin arrangement.

In the drawings, 10 indicates generally an excavating machine provided with a conventional fairlead 11 over which a control cable or cables 12 are trained and from which the same pass to a power operated winding drum 13. The machine is also provided with a boom 14 carrying a boom sheave or sheaves 15 at its outer end, over which one or more drag lines 16 pass to a conventional power operating winding drum 17 carried by the machine.

The bucket shown in Fig. 4 and indicated generally by the numeral 18 may be provided with teeth 19 at its excavating edge or lip and is provided with side walls 20 and a rear wall 21, all of which walls preferably flare outwardly as illustrated. The drag line 16, as shown in Fig. 4, is attached to the bucket by means of two lower flexible branches such as chains 16a, the ends of the branches being pivotally secured at 22 to the forward ends of the side walls 20. Upper branches 16b are also provided and are attached at points

16c to the side walls 20 or bottom preferably to the inner faces thereof. The point of attachment of the branches 16a, 16b to 16 is indicated at 16d. The points 16c preferably are located rearwardly of and below the center of gravity of the normal load of the bucket which is indicated at CG. The center of gravity of a normal load of the bucket, which corresponds approximately also to the center of gravity of the bucket when empty, lies preferably in a vertical plane between the two axes determined by points 16c—16c and 22—22. Attached to the branches 16b are short convergent flexible lines 16e such as chains, which are attached to the block of a sheave 23, around which extends the control line 12 which, as shown in Fig. 4, is attached to upper rear portions of the bucket 18 by branch lines 12a.

In Fig. 1 of the drawings, the bucket 18 is shown at A in the position which it may take when lowered by the control and hoist lines to start a loading operation. Position B illustrates the bucket as it is being drawn outwardly by the drag line 16. In this position, it will be noted that the branch lines 16a and 16b are taut, that the bucket is sustained in substantially horizontal position with the teeth of the bucket penetrating the soil and that the center of gravity CG of the bucket is in a vertical plane disposed between the points 16d and 22. The weight of the bucket tends to swing it downwardly or counter-clockwise as will be seen, while the resistance offered the teeth by the soil resists the forward movement of the bucket under the action of the drag line 16. The weight of the load acting at the center of gravity (CG) tends to swing the bucket counter-clockwise or rearwardly as it takes on its load. This movement tends to bring the bottom of the bucket into substantial parallelism with the line of force exerted by the haul line 16, which tendency would be augmented should the teeth be deflected from the soil by a rock or otherwise be freed of the normal digging resistance. This approach toward the non-loading position is indicated by position C of Fig. 1 wherein it will be noted that the bucket bottom has assumed a more acute angle with reference to this line of movement due to the weight of the load. As the position shown at C is reached, however, the branch lines 16d will have become taut and the force of the drag line will, therefore, be applied to the bucket at axis 16c—16c which is to the rear of the center of gravity of the normal load. The weight of the load, therefore, instead of tending to reduce the cutting angle tends to increase the forward tilting effect imparted to the bucket by the digging resistance during the time the drag line force is applied at the axis 16c—16c. Hence, should the teeth of the improved bucket be thrust from the soil by a rock or should the digging resistance at the teeth points be suddenly relieved while the hauling force is being applied at points 22—22, thus permitting the bucket to tilt rearwardly from the normal digging angle, the branches 16b—16b immediately become taut and since they are located rearwardly of the center of gravity, the teeth are again forced into digging position. The return movement to such digging position is, of course, limited at the angle wherein the haul line force is again applied by the branches 16a. It will be seen, therefore, that the oscillating movement of the bucket about the points of the teeth due to variations in resistance is checked or damped by the shifting of the application of the hauling force from axis 22—22 to axis 16c—16c or vice versa and that the bucket, therefore, is maintained at an adequately stable digging angle.

In position B of Fig. 1, it will be noted that the clockwise movement of the bucket is limited at angular positions wherein the points of the teeth and the pivot points 22 are aligned with the direction of force exerted by the drag line 16. This is true also in conventional drag line equipment but special lines must be employed with such apparatus to restrain counter-clockwise movement of the bucket by gravity from effective digging angles whereas with the present improvements, the force exerted by the drag line is applied to the bucket by the drag line branches at such points and in such directions as to effect stabilization of the bucket automatically within an effective digging arc or segment.

It is apparent that as the angle between the bucket and the drag line 16 becomes greater, more of the pulling force of the drag line is transferred to the branches 16b and the load on the branch 16a is reduced. Note that in Fig. 1, position B, drag line 16 and branches 16a are practically in a straight line, in which position branches 16b, as in the case of an empty or only partially filled bucket, carry a relatively small portion of the force exerted by the drag line. In position C, the drag line 16 and branches 16b are practically in a straight line due to the larger angle between the bucket and the drag line induced by the weight of the load. Branches 16b take an increasing amount of the force exerted by the drag line 16 as the angle of the bucket increases. Before the bucket bottom can become parallel with the direction of the drag line, branches 16b must receive all the force exerted by the drag line. Such position of the bucket cannot be attained, however, while the teeth are in digging position and adequate tension is applied to the drag line provided the center of gravity is located forwardly of the axis 16c—16c. This backward or counter-clockwise movement of the bucket, therefore, is positively limited under the conditions just mentioned at the angle wherein the points 16c—16c fall in the line of force exerted by the drag line, at which angle the bucket bottom may be disposed at approximately thirty degrees to the plane of the excavated surface or to the drag line. Since the bucket, as stated above, may swing clockwise until the points of the teeth and axis 22 lie in the line of the force exerted by the drag line, in which position the bucket bottom may be disposed at an angle of about sixty degrees to the plane of the excavated surface, it is seen that within the arc or segment defined by those two limits of angular movement, the bucket is controllable by the force applied thereto by the drag line and the drag line branches.

On either side of the said controlled segment within which the bucket is maintained in digging position by the drag line, the bucket is controllable by the control line 12. For example, from a position wherein the bucket rests on its bottom, it may be tilted clockwise by the control line 12 to a position wherein the teeth will penetrate the material as the drag line is taken in. The bucket, upon being drawn forwardly by the drag line with the teeth embedded in the material, will seek a position within the digging segment referred to as the control line is released. It will be seen, therefore, that the bucket is controlled automatically by the drag line within predetermined limits but may be tilted beyond those limits by the control line when necessary.

In the event the center of gravity of a loaded

bucket moves to the rear of the axis 16c—16c during a loading operation, backward tilting of the bucket is reduced due to the fact that upon initial rearward tilting, the digging resistance on the point of the teeth is diminished and the center of the moment of the hauling force moves from axis 22—22 to axis 16c—16c. This instantaneous rearward shifting of the center of rotation to axis 16c—16c decreases the magnitude of the moment tending to tilt the bucket rearwardly, thus instantly producing a dampening effect on the counter-clockwise angular oscillation of the bucket while digging.

It will be noted that the arrangement described is in effect a three-point attachment, the points being the axes 16c—22 and point 16d, the first two being rigidly held apart due to their attachment to the bucket itself while point 16d is shiftable with respect to said axes.

To restrain tilting movement of the bucket from the excavating or digging angle under unusual conditions, such tension may be maintained on the control line 12 as will prevent excessive counterclockwise movement of the bucket. By taking in the control line, the rear end of the bucket can be elevated to cause the teeth to maintain a proper angle with respect to the surface being excavated not withstanding the presence of stones or other hard formations which may tend to deflect the bucket from proper digging position.

While the three-point attachment means above described tends to stabilize the bucket throughout its loading range during normal operation, it is at times desirable to effect oscillation of the bucket about the points of the teeth as an axis or about the axis 22 or axis 16c or about the point 16d in order to provide a prying action in the material being cut. This may be accomplished by applying tension to line 12 which elevates the rear end of the bucket and then releasing such tension. This may be repeated as the bucket moves throughout the loading range and as will be seen, will facilitate breaking loose hard material in which the bucket may be operating.

It will be apparent, therefore, that the bucket can be operated without using the upper drag line branches 16b for balancing the bucket if adequate tension is maintained on the control line to retain the bucket in proper excavating position. However, the lifting effect exerted on the rear of the bucket by the control line is in opposition to the weight and load thrust of the bucket, which thrust has a forward component which tends to force the teeth into the material being excavated. This increases the digging efficiency of the bucket, as will be seen, and hence, during the digging operation, tension is applied to the control line 12 preferably only when necessary, such as in restoring the teeth to the earth penetrating angle after expulsion by a rock, or the like, or when a sharper angle is necessary due to the nature of the material being excavated.

As the bucket approaches the end of its upward movement through the loading range, the operator applies tension to control line 12 to retain the bucket in the load carrying position such as is indicated at D in Fig. 1. In this carrying or transporting position of the bucket, it will be noted, sufficient tension has been exerted on line 12 to retain the bucket in substantially horizontal position, the bucket being supported in that position by the branches 16a, the control line 12 and branches 12a and by the forward portions of the branches 16b and the branches 16e.

The boom and loaded bucket may now be swung to load discharging position over the dumping place for discharging the load. In Fig. 2, the bucket is shown in a position intermediate the position D of Fig. 1 and the discharging position of Fig. 3. By releasing the tension on control line 12, the rear end of the bucket will be lowered. During this unloading movement, the weight of the bucket which has been suspended by the branch line 16a and the control line and its branches will be shifted to line 16b and the center of gravity will move counterclockwise to the left of the pivotal axis determined by the point 16c whereupon the bucket is self-dumping and moves by gravity to the load discharging position shown in Fig. 3.

It will be noted that the bucket is free to swing beyond the pendent position shown in Fig. 3. In fact, it may swing well beyond that or until the bottom reaches approximately the dotted line position indicated. The material of the load flowing over the inclined rear wall also tends to swing the bucket beyond the full line position of Fig. 3, thus enabling the bucket to shed or clear its entire load. As the bucket approaches the full line position of Fig. 3 during the counter-clockwise movement, the upper edge or lip of the bottom will strike chains 16b, jarring the bucket and tending to free it of any clinging portions of the load. This facilitates clearing the bucket, even when wet and sticky materials are being handled and improves the operating efficiency of the apparatus. The bucket comes to rest in the full position of Fig. 3 wherein the bottom is inclined to the vertical and the rear wall is sharply inclined, thus precluding the retension of any substantial portion of the load. The bucket is righted by hauling in the control line 12, and by simultaneously paying out the hoist line 16. The bucket may be returned to the position A shown in Fig. 1 for the next loading operation.

As stated above, the control line 12 and the drag line 16 may be but single cables having the chain branches above described. However, if desired, these lines may be twin lines arranged in parallelism as shown in Fig. 5. Thus, the control lines 12' may each be provided with a sheave 23' and each attached to the rear upper portion of the bucket. The drag lines 16' may have the upper and lower branches 16a' and 16b' to which are attached the sheaves 23' by the short lines 16e' the upper and lower branches being connected to the bucket 18' at points 16c' and 22', respectively. In other respects, the apparatus will correspond to that above described except that the boom will carry two sheaves corresponding to sheave 15 of Fig. 1 and the winding drums will by known means accommodate the twin lines instead of the single lines.

The excavating apparatus above described operates with improved efficiency when the scoop or bucket moves at an angle to the horizontal toward the point of the boom. In Fig. 1, the surface of the material to be excavated is shown as approximately forty-five degrees but by raising or lowering the boom, like efficiency may be maintained where the surface lies at greater or less angles than that shown. It will be noted also that in the region well under the boom, the bucket will also dig as it moves horizontally outwardly or outwardly and downwardly as indicated by the curved excavated area adjacent the machine shown in Fig. 1.

Due to the spacing of the pivotal axes 16 and 22 preferably rearwardly and forwardly respectively of the center of gravity of the bucket, the force applied by the drag line branches resists the weight moment of the bucket and the load which tends to swing the rear end of the bucket about the ends of the teeth in a counter-clockwise direction as viewed in Fig. 1, and also moves the bucket forwardly with the teeth at the desired digging angle. It is only when the material being excavated is of such character that it tends to expel the teeth from digging position that the control line need be employed to increase the digging angle by elevating the rear end of the bucket.

Comparing position A of Fig. 1 with the position of the bucket in Fig. 3, it will be seen that it is swingable on its horizontal axes through an arc of approximately one hundred eighty degrees. Thus, in the load discharging position, the bucket hangs pendent with the bottom and rear walls favorably inclined for shedding all portions of the load, while in position A, the teeth are lowermost and may in fact be forced into the earth as by the lowering of the bucket into that position by the control line, thereby enabling the bucket to operate efficiently at levels beneath the base of the machine. The teeth may also be forced into the material at any point on the digging plane by holding drag line 16 and taking in on control line 12, thus lifting the bucket clear of the material; then by releasing the control line 12, the bucket will enter the material teeth first.

By shortening the branch lines 16*b*, the bucket will be tilted more in a clockwise direction during the digging operation than is shown in positions B and C of Fig. 1. Such tilting increases the cutting or digging pitch of the teeth with respect to the surface of the material to be excavated but the relative lengths of the branch 16*a* and 16*b* must be such that the center of gravity of the loaded bucket can move to the left of the axis 16*c*—16*c* (Figs. 2 and 3) to effect completely the dumping action as the control line 12 is released.

I claim:

1. Excavating apparatus comprising power means, a boom, a branched drag line carried by the point thereof and operable by said means, a bucket attached to the branches of said line on axes disposed forwardly and rearwardly of a vertical plane through the center of gravity of the bucket for sustaining the same at a digging angle with respect to the plane of the material being excavated as the bucket moves through the loading range thereof, and a control line attached to a rear portion of the bucket and cooperable with said branches for sustaining the bucket in load carrying position as the same passes beyond the loading range toward the point of the boom.

2. Excavating apparatus comprising a boom, a drag line carried thereby, a bucket, front and rear branch lines attaching said bucket to said line on axes disposed rearwardly and forwardly of the center of gravity of the bucket for sustaining the same at a digging angle with respect to the surface being excavated as the bucket moves through the loading range, and a line attached to said bucket rearwardly of said center of gravity thereof for cooperation with said branches for sustaining said bucket in load carrying positions as the same moves beyond the loading range and controlling the dumping thereof.

3. Drag line apparatus comprising a boom, a bucket, flexible supporting lines suspended from the boom and attached to the bucket at points so located forwardly and rearwardly of the center of gravity of the loaded bucket as to provide two axes upon which the bucket turns successively from load carrying to load discharging position, and a control line cooperating with said supporting lines for sustaining the bucket in load carrying position and controlling the load discharge movement of the bucket about the first axis.

4. Excavating apparatus comprising a boom, a drag line suspended therefrom, a tiltable bucket, branches attaching said bucket to said line on axes forwardly and rearwardly of the center of gravity of a loaded bucket, said axes being so related to said center of gravity that the bucket when suspended by said drag line tends to tilt rearwardly in succession on said front and rear axes respectively to load discharging position, and a control line for controlling the dumping action of the bucket and cooperating with said branch lines for supporting the bucket when elevated in load carrying position.

5. The combination with a drag bucket having front and rear drag line attaching means secured to said bucket on axes so located respectively forwardly and rearwardly of the center of gravity of a normal load of the bucket as to effect control of the digging angle of the bucket during loading operations, and a control line secured to rear portions of the bucket whereby variation in the digging angle of the bucket can be effected independently of said haul line attaching means during loading operations and cooperating with said haul line attaching means for supporting said bucket in load sustaining positions during elevation and transportation thereof.

6. Drag line apparatus comprising a boom, a common haul and hoist line carried thereby and depending from the outer end thereof, a drag bucket having an inclined rear wall over which the load is adapted to be discharged when the bucket is tilted to dumping position, haul line attaching means pivotally securing said haul and hoist line to forward portions of the bucket for moving the latter toward said end of the boom during loading operations and enabling said bucket to tilt about the pivotal axis to dumping position, a sheave carried by said haul line attaching means above the bucket, control line tensioning means positioned adjacent the base of the boom, and a control line operatively attached to the rear of said bucket and to said tensioning means and passing around said sheave for cooperating with said haul and hoist line when the control line is tensioned by said tensioning means for varying the digging angle of the bucket during loading operation and supporting the bucket in load sustaining position during elevation and transportation, and permitting said bucket to tilt about said pivotal axis upon release of tension on said control line while the bucket is suspended by said haul and hoist line.

7. Drag line apparatus comprising a boom, a line depending from the outer end thereof for hauling a drag bucket to load the same and for elevating such bucket, a drag bucket having an inclined rear wall over which the load is adapted to be discharged when the bucket is tilted to

dumping position, line attaching means securing the bucket to said line for hauling said bucket toward said outer end of the boom during loading operations, said attaching means being secured to the bucket on an axis whereby the bucket tends to tilt rearwardly to load discharging position when elevated by said line, a sheave carried by said attaching means, and a control line secured to the rear of said bucket and passing around said sheave and cooperating with said line attaching means for supporting said bucket against tilting rearwardly from load sustaining position during elevation and transportation thereof.

8. Excavating apparatus comprising a rearwardly dumping drag bucket comprising a line for hauling and elevating the same, attaching means therefor secured to the bucket on an axis located forwardly of the center of gravity of a normal load whereby the bucket tends to tilt rearwardly when elevated by said line, a control line, and control line attaching means secured to the bucket at the rear of the center of gravity thereof, a sheave carried by said first mentioned attaching means and engaging said control line for supporting said bucket in load sustaining position during elevation and transportation thereof by said first mentioned line and enabling said bucket to tilt rearwardly about said axis and to load discharging position when released by said control line.

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