April 26, 1966 J. W. PAGE 3,247,607

DRAGLINE EXCAVATING BUCKET AND HITCH

Filed July 27, 1964 4 Sheets-Sheet 1

FIG. 1

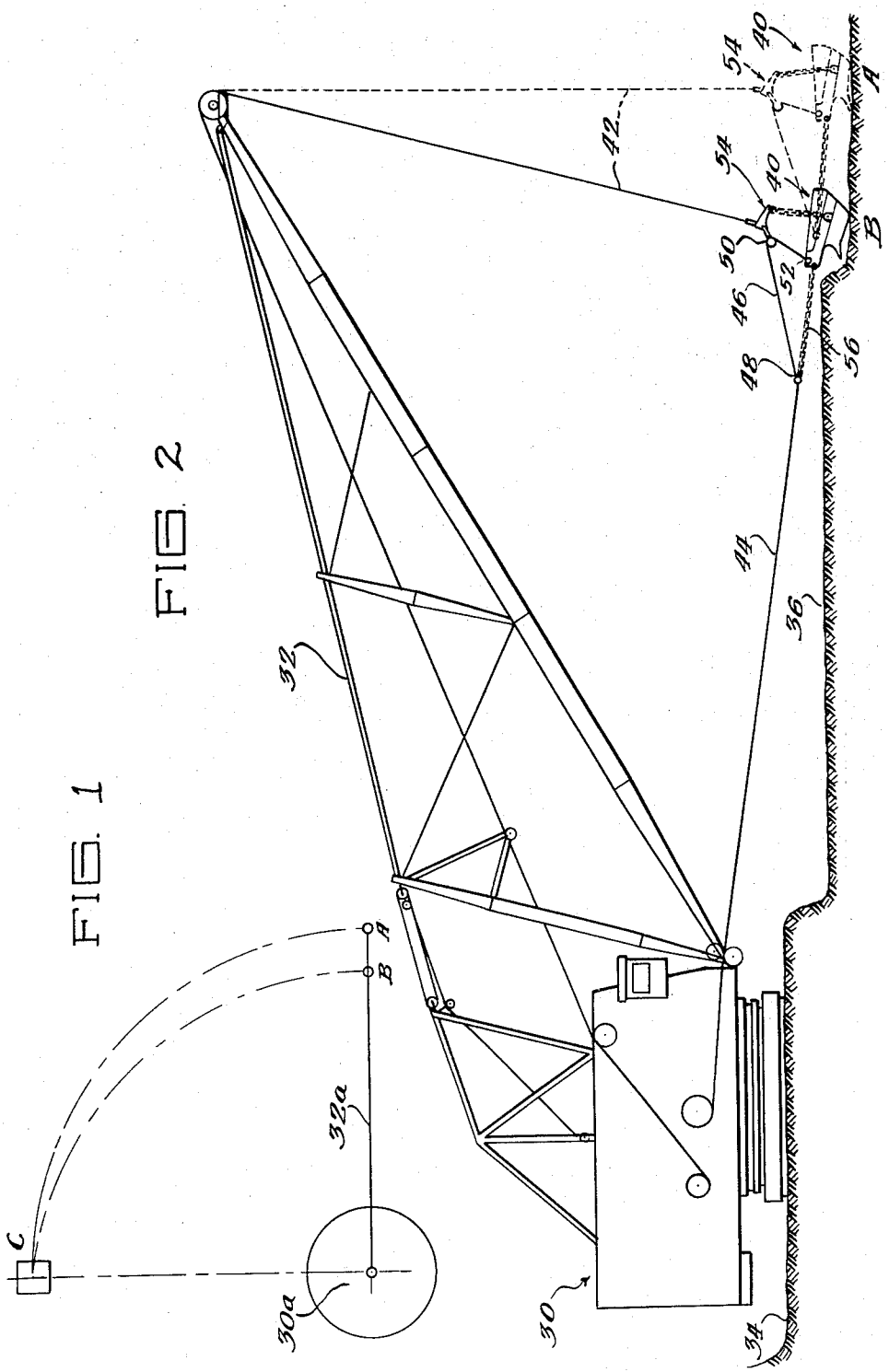


FIG. 2

April 26, 1966 J. W. PAGE 3,247,607

DRAGLINE EXCAVATING BUCKET AND HITCH

Filed July 27, 1964 4 Sheets-Sheet 2

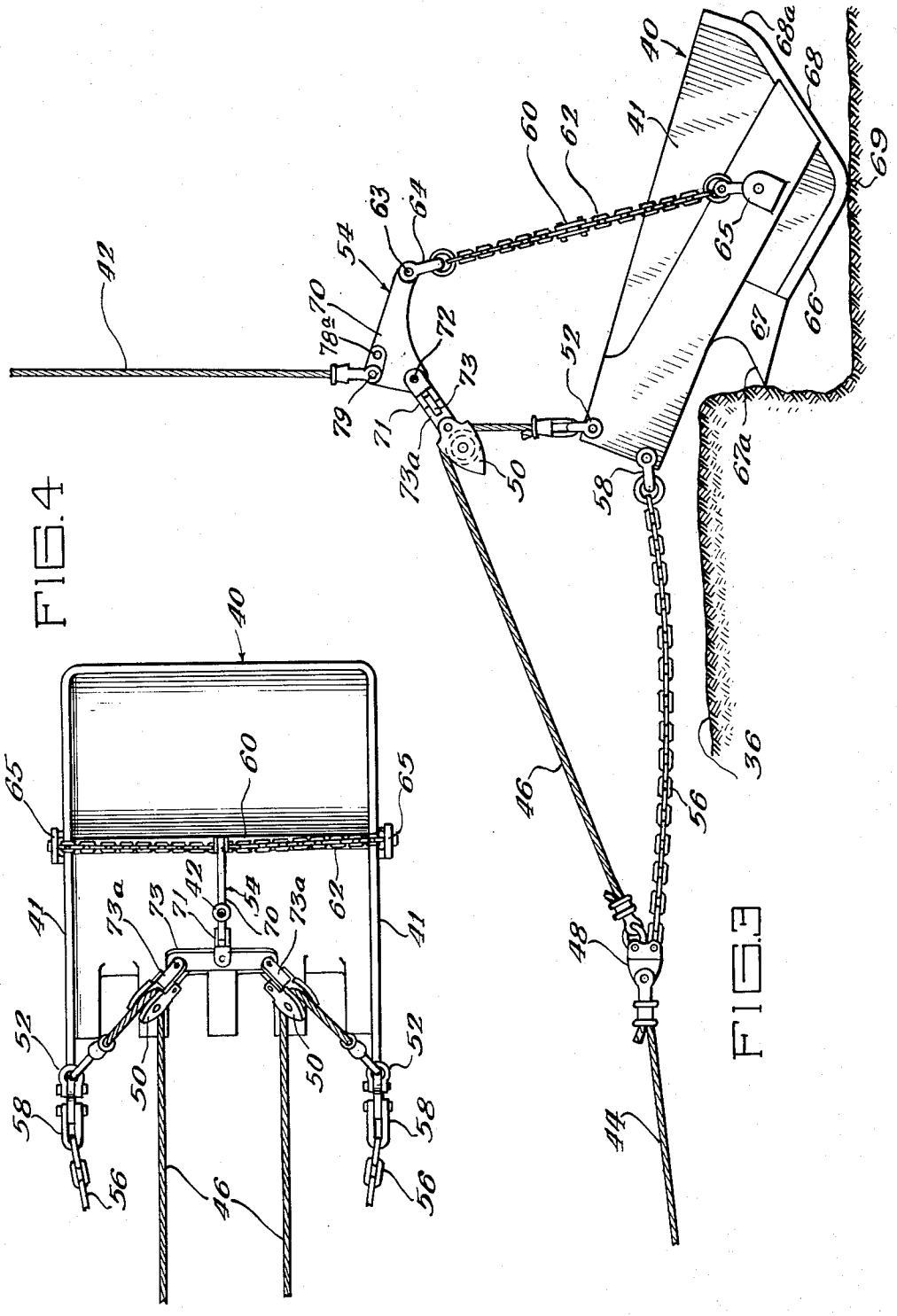


FIG. 3

FIG. 4

April 26, 1966 J. W. PAGE 3,247,607

DRAGLINE EXCAVATING BUCKET AND HITCH

Filed July 27, 1964 4 Sheets-Sheet 3

FIG. 6

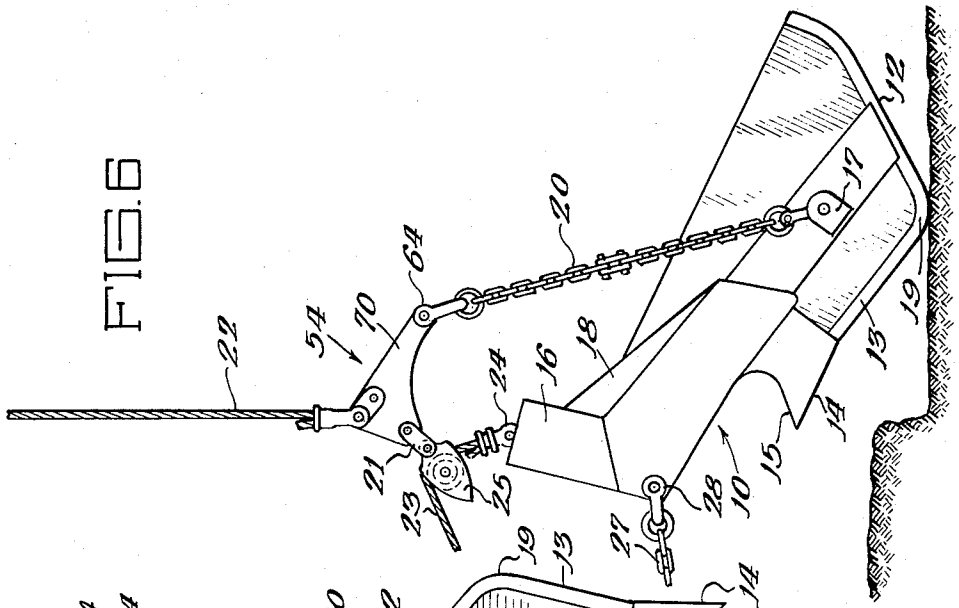


FIG. 7

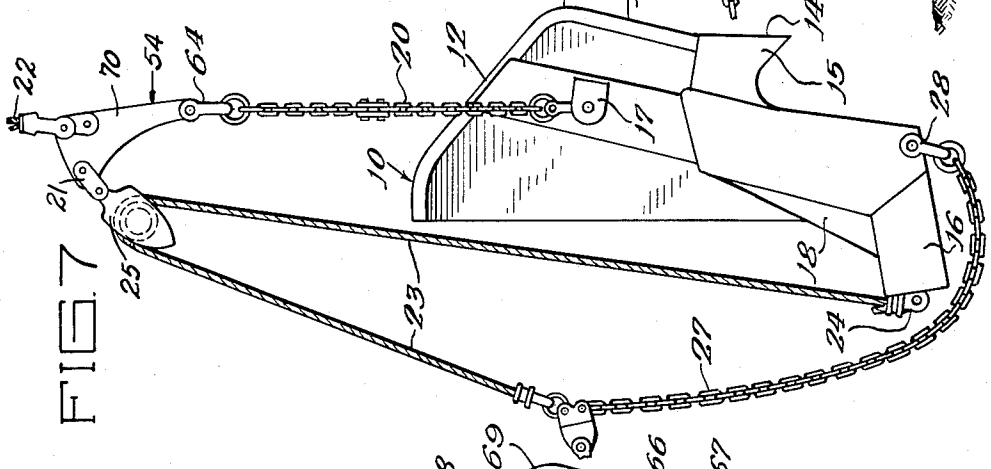
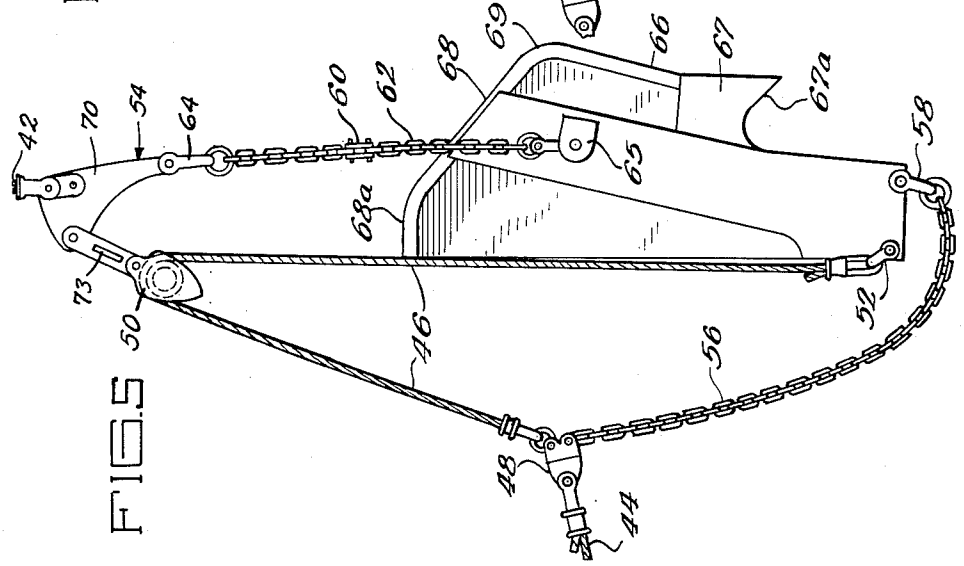


FIG. 5



April 26, 1966 J. W. PAGE 3,247,607

DRAGLINE EXCAVATING BUCKET AND HITCH

Filed July 27, 1964 4 Sheets-Sheet 4

FIG. 8

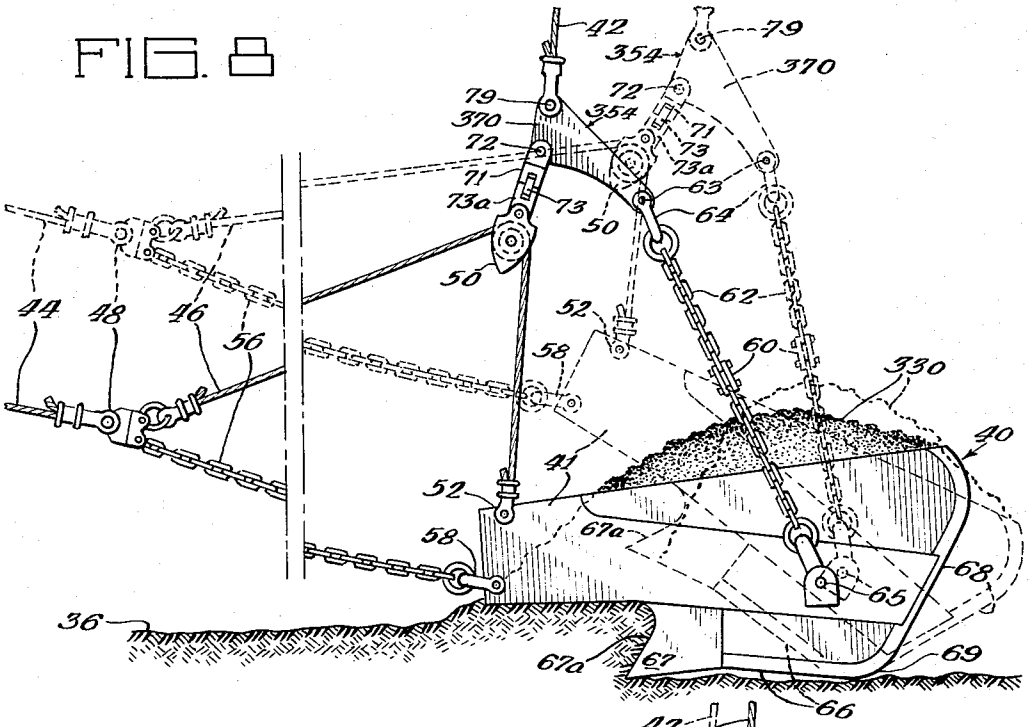
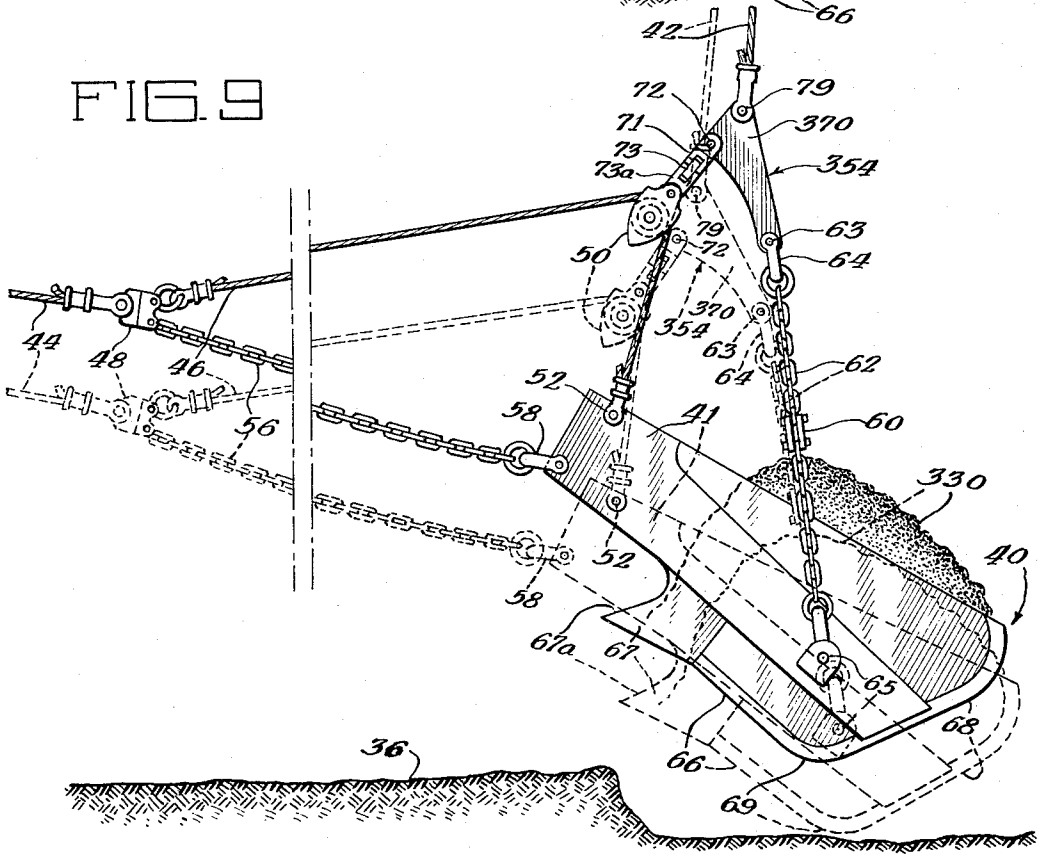


FIG. 9



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3,247,607

DRAGLINE EXCAVATING BUCKET AND HITCH

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Filed July 27, 1964, Ser. No. 385,511
9 Claims. (Cl. 37—135)

This application is a continuation-in-part of my application entitled "Dragline Excavating Bucket and Hitch," Serial No. 352,726, filed March 16, 1964.

This invention relates to improvement in buckets and, more especially, dragline buckets designed for excavating, digging, scraping, dragging, and the like.

Upon loading buckets of conventional design, such as buckets used in dragging operations, when the bucket becomes filled, it is often lifted in a somewhat vertical direction to be carried to an unloading site. Such buckets are usually equipped with one or more holding lines to assist in raising the cutting end of the bucket after the bucket has been lifted from the ground. Such lifting of the cutting or front end of the bucket is for the purpose of decreasing spillage of the load therefrom. Such buckets are sufficiently large, e.g., having a capacity of about 17 tons, that spillage of even a fractional part of the load may result in a tremendous loss of load from the bucket when expressed in terms of weight alone. Although the front end of the bucket is raised to prevent or decrease spillage during carrying of the bucket, such raising is not accomplished until the bucket leaves the ground and during the process of lifting the bucket from the ground substantial spillage can occur.

It is the current practice to load dragline buckets at a point on the ground spaced substantially inwardly toward the digging machine from a point vertically beneath the end of the boom. This is necessary so that upon the initial lifting of the bucket, the control lines will maintain the bucket substantially upright and spillage will be minimized. The bucket must be dumped at a point directly under the free end of the boom. It becomes necessary, once the control lines have lifted the bucket from the ground, to return the bucket to a point directly under the boom end which is commonly called "fishing out the bucket." Once the load is dumped, the digging machine pivots to return to the original digging area. The bucket is returned inwardly and a new digging cycle is started. The time spent "fishing in" the bucket or returning it to the initial digging point is substantially a wasted motion representing a loss in operating time of the machine.

In a digging machine, the bucket can be swung out to a position under the free end of the boom point quite rapidly. In contrast, there is a limit on the speed at which the bucket can be pulled inward toward the machine or "fished in." The bucket can be pulled in at about 200 feet a minute with most machines being limited to 175 feet a minute. Thus, by cutting down the amount of movement of the bucket toward or away from the machine, and especially toward the machine, an increase in the number of trips per hour results. The importance of reducing every second of cycle time becomes most significant when the cost of the operation of the digging machine is considered. For example, a digging machine capable of handling 30 cubic yard buckets operates at a projected cost of about $1,750 an hour. Most such large machines operate 24 hours a day, 7 days a week. Thus, even a 10% reduction in cycle time can result in a savings of $4,200 a day on a 30 cubic yard digging machine.

It is therefore a primary object of this invention to provide a new and improved digging machine which is provided with a bucket of such a design and an associated mounting arrangement for the control lines which, in combination with the bucket design, renders the digging machine capable of digging greater quantities of solid material per unit of time.

Another object is to provide a new and improved hitch means for a dragline bucket which cooperates with the control lines of the bucket so that when a lifting force is applied only to the lift line, a loaded bucket may be lifted from any point under the boom without dumping the load.

A more specific object is to provide, in an archless dragline bucket for a digging machine including a fulcrum portion on the bottom of the bucket on which the bucket may be rocked to raise the front end of the bucket prior to lifting the bucket from the ground a mounting arrangement on the bucket for securing the digging machine control lines to the bucket in such a manner that the bucket may be raised from a position substantially directly underneath the free end of the boom without spillage of the contents of the bucket.

FIGURE 1 is a side elevational view of a digging machine utilizing the bucket and hitch means of this invention showing in phantom outline the starting position for filling the bucket at a point directly under the end of the boom and further showing the bucket in full outline in a position which is closely adjacent to the starting position directly under the boom from which the filled bucket may be lifted without spillage of the contents of the bucket;

FIGURE 2 is a diagrammatical illustration of a digging cycle of the digging machine;

FIGURE 3 is an enlarged fragmentary elevational view of the bucket as shown in FIGURE 1 employing the hitch means of this invention and illustrating the initial tilting of the front end of a bucket when tension is applied to only the lift line prior to lifting the fulcrum portion of the bucket off the ground;

FIGURE 4 is a top plan view of the bucket shown in FIGURE 6;

FIGURE 5 is a fragmentary side elevational view of the bucket and hitch means shown in FIGURES 3 and 4 but illustrating the bucket in a dumping position.

FIGURE 6 is a fragmentary side elevational view of an arch-type bucket utilizing the hitch means of this invention;

FIGURE 7 is a fragmentary side elevational view of the bucket and hitch means shown in FIGURE 6 but illustrating the bucket in a dumping position;

FIGURE 8 is a partially broken side elevational view of the bucket with a modified hitch means, showing the bucket in full outline after it has been pulled along the ground to load the bucket and showing in superimposed dotted outline the position of the bucket upon the initial application of lifting force through the lift line and hitch means; and

FIGURE 9 is a partially broken side elevational view of the bucket shown in FIGURE 8 showing in full outline the attitude of the bucket upon continued force being applied to lift the bucket from the ground and showing superimposed in dotted outline the dotted position illustrated in FIGURE 8.

One means of promoting operational efficiency is to increase the number of digging cycles which can be completed in a given amount of time. "Trips per hour" is a common yardstick for digging machine performance, and the more trips that can be made in one hour, the more dirt that will be hauled by the machine, resulting in a greater return in a monetary investment in the machine.

One previous problem in reducing the cycle time of the digging cycle was that it was necessary to finish the dragging or filling of the bucket at a point spaced substantially inwardly from a point vertically beneath the free end of the boom for if the lift line was generally vertical, the front end of the bucket would drop upon initial lifting, causing spillage of the contents of the

bucket. This meant that the starting point of the digging cycle had to be spaced substantially inwardly from the point directly below the free end of the boom point resulting in wasted time required to pull in or "fish in" the bucket to a point where the digging cycle could be initiated.

FIGURE 1 shows a bucket **40** with an improved novel hitch arrangement **54** which permits the digging cycle to be initiated at a point almost directly under the boom point, increasing the trips per hour capability of the digging machine by reducing the amount of time for each cycle.

Referring now to FIGURE 1, there is shown a digging machine **30** having a boom structure **32** for supporting and controlling a dragline bucket. This digging machine, shown in this figure, has a cab which is approximately 57 feet long by 23 feet high with a 200 foot boom. The bucket **40** is approximately 15 feet in length. Such a digging machine can support and operate a bucket having a capacity of up to 40 cubic yards of soil. The digging machine is stationed on a "bench" or "shelf" of earth **34** for removing soil from a lower level **36**.

FIGURE 2 diagrammatically illustrates one digging cycle. The numeral **30***a* represents the center of rotation of the digging machine, and the boom is represented by the longitudinal line **32***a*. The initial digging point which marks the beginning of the digging cycle is represented by a point A. Point B represents that point at which the bucket is filled and is lifted to be swung over to the dump point represented by C. In order to dump the bucket, the bucket must be brought out to a point directly under the end of the boom, so that as the boom traverses the bucket through the arc BC the bucket is also released or "fished out" to a point where it is directly under the boom point. The arc CA represents that portion of the travel of the boom which brings the empty bucket back to the orignal digging point A.

The bucket **40** includes upright sides **41** and is suspended from the free end of the boom by lift line **42**. A hauling or pull line **44** extends from the digging machine and is connected to dump lines **46** at **48**. Dump lines **46** are reaved over sheave blocks **50**, which are connected to one end of hitch means **54**. From the sheave blocks, the dump lines **46** extend downwardly and outwardly and are connected by link means **52** to either side of the front end of the bucket. The function of the dump line **46** is to control the different positions of elevation of the front end of the bucket between a nearly horizontal position, which is maintained during dragging and filling of the bucket, to a substantially vertical position (as shown in FIGURE 5) for dumping the load of the bucket. Pull chains are also secured at **48** to the end of the pull line **44** and diverged outwardly and are secured to the front end of the bucket at **58**. When the bucket is being pulled or dragged toward the machine, the pull chains **56** transmit the bulk of the tension from the pull line to the bucket.

The bucket is provided with a lifting bail including a rigid spreader bar **60** elevated above and extending across the bucket, and connected to the lift line **42** by diverging lift chains **62**. The diverging lift chains are secured by link means **64** to the hitch means **54** at a point spaced below and to the rear of the point of attachment of the lift line. From link means **64**, the lift chains extend downwardly through the opposed free ends of the spreader bar **60** and are pivoted to trunnions **65** at either side of the bucket. Preferably, the trunnions are located at a point generally laterally spaced from the center of gravity of the bucket and its load.

The bucket **40** is provided with a flat bottom portion **66**, a forward digging portion **67** having teeth **67***a*, an obtuse upturned back portion **68** and an intermediate interconnecting fulcrum portion **69**. In the bucket **40**, the upturned back portion **68** is provided with a substantially upright terminus portion **68***a*.

The hitch means **54** includes the hitch beam **70** which is a substantially triangular-shaped flat metal bar, a hitch beam double clevis **71**, a hitch spreader bar **73** and sheave block clevis means **73***a* connected in spaced relation to each other to the spreader bar **73**. The spreader bar is pivoted to clevis **71** and the sheave blocks are mounted at laterally spaced points on the spreader bar to clevis means **73***a*.

The hitch beam **70**, generally triangular in configuration, includes a forward apex portion having an opening to which the beam clevis **71** is pivoted at **72**, a top apex portion including openings, such as **78***a*, to either of which the end of the lift line is pivoted as at **79**, and a rear apex portion having an opening to which the lift chains **62** are pivoted at **63** by the link means **64**. Preferably, the openings in the top apex portion are spaced less than one-third of the length of the beam **70** to the rear of the connection **72**.

FIGURE 5 illustrates the bucket **40** in a dumping position wherein tension on the pull line has been released to permit the open end of the bucket to tilt downwardly to a substantially vertically upright position for dumping the contents of the bucket. Cable chafing due to the dump lines chafing the back of the bucket as the bucket is moved to the dumping position has become a common problem in dragline buckets. Continued chafing of the cables to a point where the dump lines break necessitates a shutdown of the digging machine, which, as previously explained in terms of hourly cost of operation, can be quite expensive. However, the hitch means of this invention maintains the dump line spaced a sufficient distance from the back and sides of the bucket to eliminate this cable chafing problem.

FIGURES 6 and 7 illustrate the hitch means **54** of this invention in use with the arch-type bucket **10**. From FIGURE 6, it can be seeen that with the use of the hitch means **54**, the sheave block **25** is positioned nearly directly above the arch **16**. When the lift line **22** is substantially vertical, a lifting force applied by the lift line to the hitch means, in combination with the location of the bucket center of gravity and the position of the trunnions **17** and fulcrum portion **19**, permits the bucket to be rocked about the fulcrum portion to enable the bucket to be lifted without spilling the load of the bucket. FIGURE 7 shows the arch bucket **10** in a dumping position wherein the hitch means **54** of this invention serves to keep the dump cables **23** spaced from the back and sides of the bucket to eliminate cable chafing, as previousiy discussed with reference to FIGURE 5.

The hitch means **54** of this invention cooperates with the fulcrum portion **69** to augment the initial lifting of the front end of the bucket when force is applied by the lift line **52** to the hitch means for raising the bucket so that the bucket front end is lifted to an even greater extent before the fulcrum portion is lifted from the ground. The hitch means of this invention places the sheave blocks **50** at a point nearly vertically above the front end of the bucket and laterally spaced from the plane of the beam **70** near the plane of the sides **41** of the bucket. The lift chains **62** are secured to the beam at a point well spaced behind and below the pivot between the lift line and the beam but slightly closer thereto than the connection of the dump line sheave block. The relative positioning of the three points of attachment is such that a large amount of lifting force is applied to the dump line. Since the dump lines are well forward of the lift chains and the fulcrum portion, this added lifting force applied to the dump lines in combination with the fulcrum action obtained by the suitable positioning of the trunnions **65**, and the fulcrum portion **69**, relative to the bucket center of gravity, gives an increased initial tilting of the front end of the bucket when lifting force is applied by the lift line **42** to the beam **70**. This increased initial tilting is such that the bucket may now be lifted fully loaded from a point almost directly vertically below the free end of the

boom without significant spillage of the contents of the bucket. This permits the initiation of the digging cycle at point A, as shown in FIGURE 1, which is almost directly under the free end of the boom. Though the bucket travels only 1½ to 2½ bucket lengths to point B where it is fully loaded (the distance in the drawings being slightly exaggerated for purposes of illustration) the hitch means and bucket design of this invention permits the bucket to be easily lifted from point B without significant spillage of the contents of the bucket. From point B, the bucket is swung through the arc BC and slightly "fished out" to a point directly under the boom point and the tension on the dump line is released, dumping the content of the bucket at the dump point C. From point C, the bucket is returned through the arc to point C and need not be pulled inward to a digging point but may begin digging at the point A. This represents a significant savings in time so that more digging trips may be made per unit of time. For example, it has been found that with a digging machine equipped with a 40 cubic yard bucket, the average digging cycle previously took 90 seconds. With the the digging machine using the same sized bucket of the design of this invention and the hitch means provided therefore, the digging cycle is reduced to 50 seconds.

FIGURES 8 and 9 illustrate a modified embodiment of this invention, hitch means **354**. In these figures, like numbers are assigned to those elements which correspond to the elements associated with the bucket **40** as shown in FIGURES 1, and 3–5. The hitch means **354** is very similar to hitch means **54** shown in FIGURES 2–7 with the exception of hitch beam **370**. The hitch beam **370** differs from the hitch beam **70** in the relative positioning of the points of pivotal attachment **63**, **72** and **79** at which the lift chains, sheaves and lift line respectively, are pivoted to the beam.

In hitch beam **370**, the three points, **63**, **72** and **79**, define a obtuse angle at point **72**, and the point **79** is generally directly above the point **72**. This has the effect, as can easily be seen by comparing FIGURES 3 and 8, of placing the lift line more directly above the front of the bucket and the dump lines and swinging the lift chains toward the front of the bucket at a more acute angle during the initial lifting of the bucket when the dump line remains taut and only a lifting force is applied to the hitch by the lift line. This hitch gives an exceptional lifting action especially when attempting to lift loads from substantially vertically beneath the free end of the boom.

FIGURES 8 and 9 dramatically illustrate the improved performance obtained through the use of the hitch of this invention. The full outline view in FIGURE 8 is representative of a bucket fully loaded with a load of material **330** and positioned substantially vertically beneath the free end of the boom of the excavator machine. With the force on the pull line **44** being only sufficient to maintain the dump line **46**, taut, the hitch means is held sufficiently forwardly of the bucket so that the lift line **42** is almost in vertical alignment with the point of forward attachment of the dump line to the front of the bucket. The lifting chains **62** are pulled forwardly so that the lifting force of the hitch will pass through the front of the bucket far forward of the combined center of gravity of the bucket and its load, which is generally laterally spaced from the dump trunnions **65**.

The dotted outline figure in FIGURE 8 represents the position of the bucket when only the lifting force has been applied to the hitch through the lift line by winding in the lift line winding drum. It is to be noted that the bucket has been rocked about the fulcrum portion **69** and is tilted backward with the front end of the bucket lifted prior to any other portion of the bucket, even though the bucket is substantially directly beneath the free end of the boom. Being so tilted backward, the bucket is in such an attitude as to retain all the contents of the bucket upon further lifting. It is to be noted also that the force application direction of the lift line still passes through the forward end of the bucket well ahead of the combined center of gravity of the bucket and its load.

In FIGURE 9, the bucket, as shown in full outline, has been lifted from the ground and is contrasted with the dotted outline position of FIGURE 8. It can easily be seen that the bucket rises substantially straight upward, maintaining a load retaining attitude approximately the same as the attitude it obtained upon initial lifting. The force application direction of the lift line passes through the bucket at a point closer to the combined center of gravity of the bucket and its load, but it is still sufficiently far ahead of this point so as to maintain the bucket in its rearwardly inclined load retaining position, as long as the pull line is not relaxed. Once the pull line is relaxed to dump the load, the bucket utilizing the hitch means **354**, assumes the dumping attitude shown in FIGURE 8.

The modified hitch means supports the respective dump and lift lines in such a manner as to promote the uplifting of the front end of the bucket and the tilting about the fulcrum portion in response to lifting force applied only by the lift line to the hitch means so that the front end of the bucket is tilted upward before the fulcrum portion is raised from the ground, thus retaining substantially all the load in the bucket and reducing the time required for each digging cycle.

The hitch means disclosed herein provides sufficient lifting force to the front end of the bucket by way of the beam member and dump lines, so that the bucket may be lifted without spilling its load, even when the bucket is almost directly vertically beneath the free end of the boom. The hitch means keeps the dump lines spaced a sufficient distance from the back and sides of the bucket when the bucket is in the dumping position so as to prevent dump line chafing.

Thus, the excavator structure of this invention provides a means for transferring greater quantities of solid material per unit of time. "Down time" due to dump line cable chafing is eliminated and cycle time is reduced by permitting digging to be accomplished at a point substantially directly vertically beneath the free end of the boom as a result of the novel hitch means which affords initial tilting of the front end of the bucket even when the lift line is substantially vertical.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, for some modifications will be obvious to those skilled in the art.

I claim:

1. A dragline excavating bucket hitch providing automatic front end first lifting of a loaded bucket by the manner of connecting existing lift line, bucket bail and dump line sheave components, comprising:

a rigid, unitary beam member above the bucket extending rearwardly and forwardly thereover,

said member having three mutually spaced pivot means for pivotally connecting said components to the beam member,

said spaced pivot means being arranged to pivotally connect respectively said bail component only to one pivot means at the rear of the member, said sheave component only to another pivot means at the front of the beam member and said lift line component only to the remaining pivot means,

said lift line pivot means being located on the beam member forwardly of a mid-plane between said pivot means for the bail and sheave components to provide an immediate lifting force to the dump line sheave at least equal to lifting force in the bail upon initial upward movement of the lift line.

2. A dragline excavating bucket hitch as specified in claim **1** wherein said pivot means are triangularly arranged.

3. The hitch means of claim **1** wherein said beam member comprises a generally flat plate with generally triangularly spaced apart openings to which the lifting bail, dump line and lift line are each respectively pivotal-

ly connected so that a lifting force applied to said beam by only said lift line will swing the beam about its connection with the lifting bail and raise the front portion of the bucket in advance of lifting the entire bucket.

4. The hitch means of claim **1** wherein said beam member comprises a substantially triangular-shaped member having a front forward apex, a top intermediate apex and a rear lower apex with openings in the respective apexes for respectively connecting said dump line sheave, said lift line and said lifting bail to said beam member.

5. The hitch means of claim **4** wherein said beam member is provided with a spreader bar pivotally connected to said front apex opening and extending across the front of said beam member and said spreader bar being provided with spaced apart dump line sheave blocks about which a pair of said dump lines are reeved and extend from the pull line to securement with the front part of the bucket.

6. In a combination including a movable dragline earth excavating machine having lift cables and pulling cables controlled by winding drums for respectively lifting and dragging a dragline excavating bucket and a dragline excavating bucket having a lifting bail extending above the bucket and secured to trunnions at either side of the bucket along an axis slightly rearwardly of the combined center of gravity of the bucket and its load and a dumping control cable and sheave adjacent the front of the bucket, an improved hitch, comprising: an elongate substantially rigid beam member pivoted to the top of the lifting bail, extending generally lengthwise forwardly of the bucket and pivotally connected to said dump sheave, the lifting cable being pivotally connected to the bar between the lifting bail and dump sheave connections, said lift line pivot means being located on the beam member forwardly of a mid-plane between said pivot means for the bail and sheave components, so that when the lifting cable is substantially vertical and a lifting force is applied by the lifting cable to the beam member and the pulling cable is under tension, a loaded bucket may be lifted without dumping the load.

7. The hitch of claim **6** wherein the lifting cable is connected to the bar at a point which is closer to the dump sheave than to the lifting bail.

8. In a dragline machine having lift and load lines and a bucket, a dragline excavating bucket hitch providing automatically, front end first lifting of a loaded bucket by the manner of connecting existing lift line, bucket bail and dump line sheave components, comprising:

a rigid, unitary beam member above the bucket extending rearwardly and forwardly thereover,

said member having three mutually spaced pivot means for pivotally connecting said components to the beam member, the beam member pivot means comprising the sole connection between said components,

said pivot means being triangularly arranged,

each pivot means being constructed to receive a single one of said components, the bail at the rear of the member, the dump line sheave at the front of the member and the lift line at the front upper portion of the member, said lift line pivot means being located on the beam member forwardly of a mid-plane between said pivot means for the bail and sheave components,

whereby tension in the load line rotationally positions said beam member and thus its pivot means so that a desired portion of the lift force in the lift line may be directed to the bucket bail and dump line in amounts as determined by the location of said pivot means on the beam member, said desired portion of the lift force in the dump line being an amount to lift the front of a loaded bucket first upon initial upward movement of the lift line.

9. A dragline excavating bucket and hitch providing automatic front end first lifting of a loaded bucket, comprising in combination:

a dragline excavating bucket having a lifting bail pivoted to the bucket and extending upwardly above the bucket,

a dump line sheave having a dump line freely reeved thereover and connected at one end to the front of the bucket and at the other end having means for connection to a pull line,

a rigid, unitary beam member above the bucket extending rearwardly and forwardly thereover,

said member having three mutually spaced pivot means for pivotally connecting said bucket bail, dump line sheave and lift line,

said spaced pivot means being arranged to pivotally connect respectively said bail only to one pivot means at the rear of the member, said sheave only to another pivot means at the front of the beam member and said lift line only to the remaining pivot means,

said lift line pivot means being located on the beam member forwardly of a mid-plane between said pivot means for the bail and sheave to provide an immediate lifting force to the dump line sheave at least equal to lifting force in the bail upon initial upward movement of the lift line.

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