United States Patent [19]

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[11] **3,708,152**

[45] **Jan. 2, 1973**

[54] **DRAGLINE FAIRLEAD**

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[22] Filed: **Dec. 4, 1970**

[21] Appl. No.: **95,226**

[52] **U.S. Cl.** .....**254/190 R,** 37/116

[51] **Int. Cl.** **B66d 1/36**

[58] **Field of Search**.....37/115, 116, 125, 135, 136; 214/93; 254/190

[56] **References Cited**

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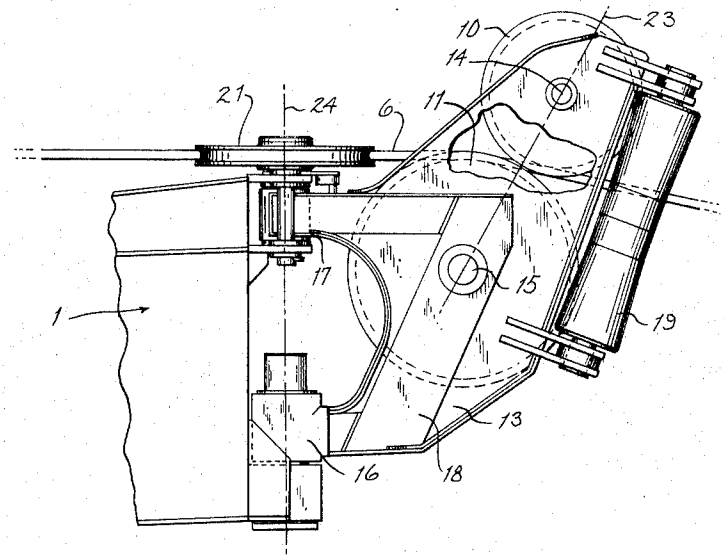
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[57] **ABSTRACT**

The drag rope of a dragline excavator passes over a lower sheave and then under an upper sheave as it is payed out from a drum in the excavator housing. The two sheaves are oriented to deflect the drag rope downward a predetermined angle as it passes between them. This orientation insures that the rotation of both sheaves is controlled by frictional engagement with the drag rope during operation. Such continuous control of the sheaves prevents relative movement between the drag rope and sheaves that may result in increased wear and fatigue of the rope.

1 Claim, 3 Drawing Figures



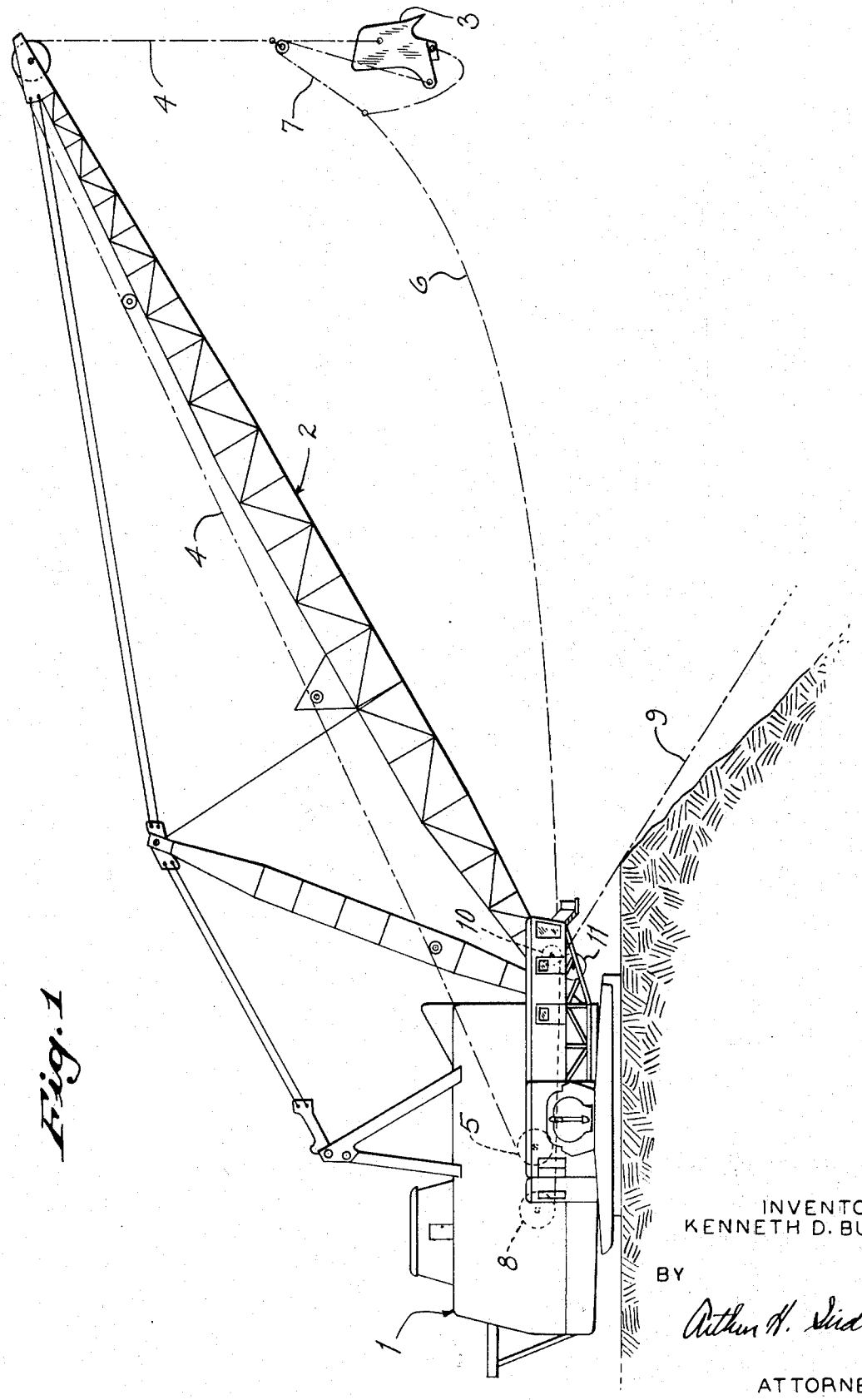


Fig. 1

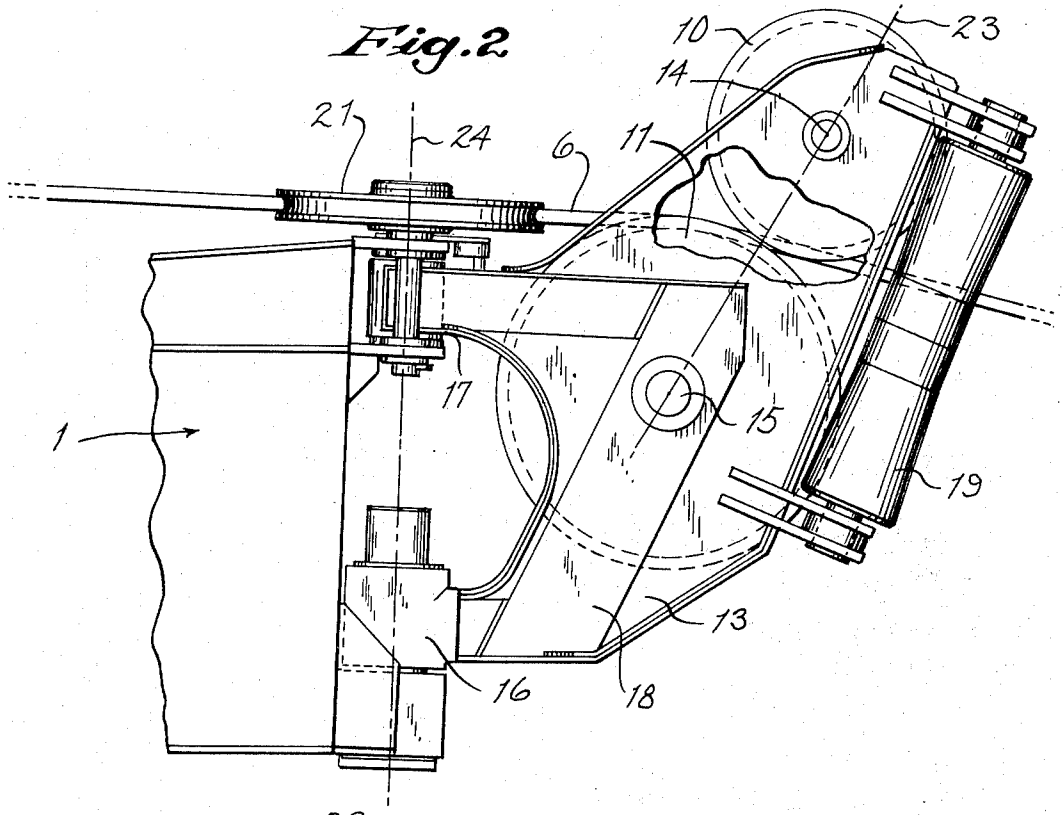
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Fig. 2



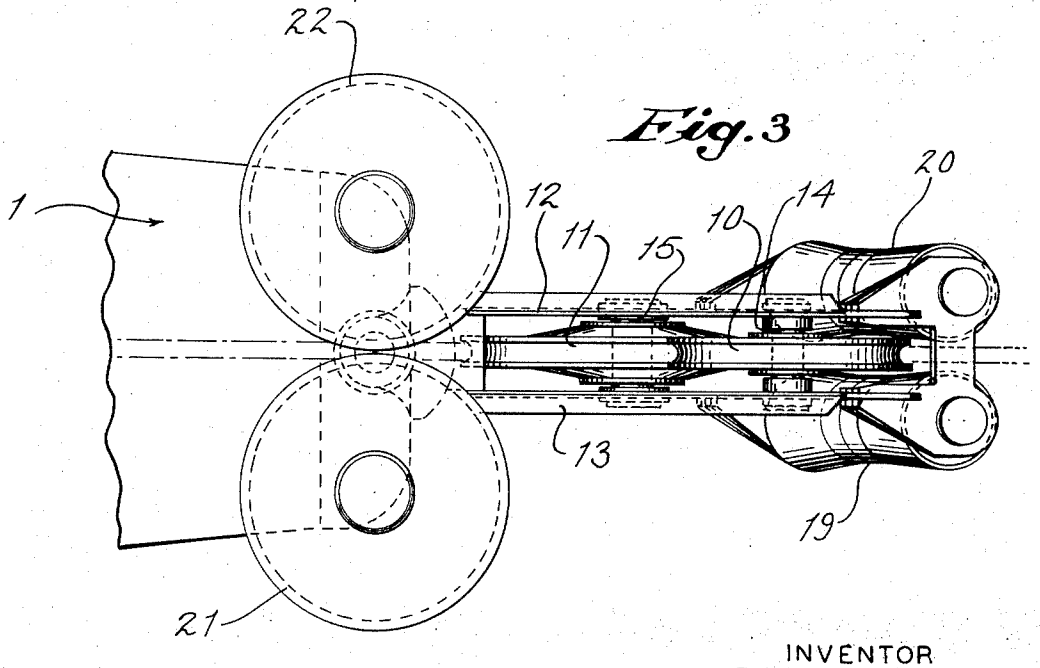


Fig. 3

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DRAGLINE FAIRLEAD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention pertains to fairlead assemblies for large excavating equipment, and particularly to fairlead assemblies for the drag rope on large dragline-type excavators.

2. Description the Prior Art

In a typical dragline-type excavator a large bucket is hoisted at the end of a boom; the bucket is cast outward; set down on the surface of the ground; and then hauled in or dragged across the surface by means of a drag rope attached to a rotatable drum in the excavator house. The drag rope is made of braided steel and on large excavators it has a diameter in the range of 3 inches. A drag rope is subjected to severe punishment from various forces during this operating cycle, all of which act to limit its useful life. Particularly in the case of large excavators, the useful life of the drag rope is very instrumental in determining the operating cost of the machine. Large excavators are normally operated 24 hours a day, for they represent a large capital investment which must remain in operation a substantial portion of the time to become profitable.

To reduce the frictional wear on a drag rope, and thus to extend its life, it is common to provide a fairlead assembly at the front of the excavator house. Such fairlead assemblies are comprised of sheaves and rollers, which confine the drag rope and provide rotatable surfaces against which the drag rope can bear when it is payed out from the excavator house.

Such fairlead assemblies have not been entirely satisfactory. To minimize fatigue in the drag rope caused by the repeated bending as it passes through the fairlead assembly, the sheaves are constructed to have a diameter of at least 20 times the diameter of the drag rope. The consequent large size of the sheaves, 5 to 7 feet, minimizes fatigue caused by bending the rope, but creates still another wear problem. In a large dragline excavator the bucket is cast away from the excavator housing after the dig portion of the operating cycle. During this cast the drag rope is payed out between the sheaves at high speed (800 to 1,000 feet per minute) and the heavy sheaves continue to rotate even after the cast is completed and the bucket dumped. At this point in the digging operation the drag rope is nearly horizontal and it passes between the upper and lower sheave with little or no contact. As a consequence, the stationary drag rope offers very little frictional resistance to slow the large rotating sheaves.

In prior fairlead assemblies the upper and lower sheaves were oriented such that the drag rope passed straight through them, without bending, when the drag rope was near the horizontal. Although the weight of the drag rope bearing against the lower sheave provided a slight retarding force to slow the rotation of the lower sheave while the bucket was being dumped at the end of the cast, the lower sheave continued to rotate as the drag rope was subsequently drawn in. There was even less retarding contact between the drag rope and the upper sheave at the end of the cast and as a consequence, when the drag rope was subsequently drawn in, both sheaves were rotating rapidly in the opposite direction. The drag rope was drawn in contact over the lower sheave and would often bounce upward during digging, making contact with the upper sheave. Severe localized heating resulted in the surface of the drag rope at these contact points with the rotating upper and lower sheaves, and the subsequent rapid cooling of these heated regions resulted in the formation of a microscopically thin layer of martensite. Martensite is a very brittle form of steel which cracks to form metallurgical notches in the rope when it is wound on a drum. Such notches weaken the rope and considerably shorten its useful life.

SUMMARY OF THE INVENTION

The present invention provides an improved fairlead assembly in which the drag rope engages both the upper and lower sheaves to control their rotation during the cast portion of the digging operation. More particularly, the improved fairlead assembly of the invention includes a lower sheave and an upper sheave oriented such that a drag rope, cast from a drum in the excavator house, makes contact with and passes over the lower sheave, and then makes contact with and is deflected downward from the horizontal by the upper sheave.

An object of the invention is to insure that the drag rope tightly engages both the upper and lower sheaves during the cast portion of the operating cycle. Continuous engagement between the rope and sheaves is accomplished by orienting the sheaves such that the drag rope is deflected by them from an otherwise unimpeded path.

Another objective of the invention is to insure engagement of the sheaves and drag rope with a minimal amount of bending to the rope. Excessive bending of the rope work hardens the steel, causing premature fatigue. Also, excessive deflection of the drag rope by the sheaves increases the forces acting radially on the sheaves and necessitates more massive and costly means of mounting the sheaves on the machine.

The foregoing and other objects and advantages of the invention will appear from the following description. In the description reference is made to the accompanying drawings which form a part hereof, and in which there is shown by way of illustration and not of limitation a preferred embodiment of the invention. Such embodiment does not represent the full scope of the invention, but rather the invention may be employed in many different embodiments, and reference is made to the claims herein for interpreting the breadth of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view in elevation of a dragline excavator incorporating the fairlead assembly of the present invention;

FIG. 2 is a view in elevation with parts cut away of the preferred embodiment of the fairlead assembly; and

FIG. 3 is a top view of the preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a dragline excavator having a house 1 and a boom 2 is situated adjacent a dig site. A bucket 3 is supported by means of a hoist rope 4

passing over a boom point sheave at the outer end of the boom 2. A hoist drum 5 is situated in the house 1 and connected to the hoist rope 4 to raise and lower the bucket 3 in a standard manner. As an example, the excavator to which the present invention is applicable may have a boom length greater than 250 feet, and a bucket capacity greater than 40 cubic yards. Attached to the front of the bucket 3 is a braided steel drag rope 6. A conventionally rigged dumpline 7 is attached to the bucket 3 and the drag rope 6. The drag rope 6 passes into the house 1 and is attached to a conventional power-driven drum 8.

The excavator in FIG. 1 is shown with the bucket 3 in a dumping position. In this dumping position the bucket 3 is hoisted relatively high and the drag rope 6 is shown to pass from the house 1 with a slight positive or upward slope. During other portions of the operating cycle, however, the drag rope 6 passes from the house 1 with a substantial negative or downward slope. This latter situation often occurs during the dig portion of the operating cycle when the bucket 3 is dragged from a point below the house 1. This situation is represented schematically by the phantom line 9 extending downward from the front of the excavator.

A fairlead assembly is shown schematically in FIG. 1 by an upper sheave 10 and a lower sheave 11 attached to the front of the excavator housing 1. The sheaves 10 and 11 are rotatably attached to the housing 1 to provide rotatable guiding surfaces above and below the drag rope 6.

The general purpose of the sheaves 10 and 11 is to confine or restrain the drag rope 6 between their rotatable rims. As shown in FIGS. 2 and 3, each sheave 10 and 11 is mounted to rotate on a horizontal axis and both sheaves 10 and 11 are situated in a single vertical plane. Mounting of the sheaves 10 and 11 is accomplished by sandwiching them between two vertical, parallel side frames 12 and 13. An axle 14 is rotatably suspended between the side frames 12 and 13 and connected to support the upper sheave 10. A second axle 15 is rotatably suspended between the side frames 12 and 13 and connected to support the lower sheave 11 beneath and in back of the upper sheave 10. The side frames 12 and 13 join at two points along their back edge to form a lower arm 16 an an upper arm 17. The arms 16 and 17 are pivotally attached to the front of the excavator house 1 along a vertical pivot axis 24. Each side frame 12 and 13 is strengthened by means of a brace 18 which extends along its outside surface from the lower arm 116 diagonally upward and forward through the point to which the second axle 15 attaches, and then horizontally back to the upper arm 17.

As shown in FIGS. 2 and 3, the fairlead assembly also includes a roller 19 rotatably attached to the side frame 13 near its front edge, and a roller 20 rotatably attached to the side frame 12 near its front edge. The rollers 19 and 20 are on opposite sides of the rope 6, parallel to one another and inclined slightly away from the vertical. The rope 6 is retained between the rollers 19 and 20 after being cast through the sheaves 10 and 11.

As shown in FIGS. 2 and 3, the fairlead assembly also includes two rope guides 21 and 22 rotatably attached to the front of the excavator house 1. The rope guides 21 and 22 are located on opposite sides of the drag rope 6 and rotate about vertical axes. The rope guides 21 and 22 form a nip along the pivotal axis 24, but are spaced apart sufficiently to allow the drag rope 6 to pass between them.

The rope guides 21 and 22 constrain the horizontal movement of the drag rope 6 with respect to the excavator housing and the sheaves 10 and 11. The rollers 19 and 20 maintain horizontal alignment of the drag rope 6 with the sheaves 10 and 11, but instead of confining the drag rope 6, the rollers 19 and 20 cause the fairlead assembly to pivot about its pivot axis 24 to bring the sheaves 10 and 11 into alignment with the drag rope 6. The rope guides 21 and 22 and rollers 19 and 20 minimize horizontal forces acting upon the sheaves 10 and 11 thus reducing wear on the drag rope 6 and sheave mounts.

In the embodiment shown the axles 14 and 15 are arranged such that the sheaves 10 and 11 produce a 14° downward deflection angle in the drag rope 6 when it is cast between them. The deflection angle is determined by a number of factors including the outside diameter of the upper sheave 10 which is 54 inches in the embodiment shown and the outside diameter of the lower sheave 11 which is 80 inches. A line drawn between the sheave centers defines what is hereinafter referred to as the inclination line 23 and the distance between sheave centers along this inclination line is 67 to 68 inches. With these dimensions, the inclination line 23 in the embodiment shown is oriented 32° away from the vertical to produce the 14° deflection angle.

It will be apparent to those skilled in the art that the upper and lower sheaves 10 and 11 can be oriented in various relationships to produce the 14° deflection angle in the drag rope 6. The deflection angle is a function of the diameters of the sheaves 10 and 11, the radial distance between the centers of the sheaves 10 and 11, and the slope of the inclination line 23. Generally, the diameters of the sheaves 10 and 11 are determined by the size of the rope used, and the spacing between their centers is kept to a minimum to reduce the size of the supporting structure. In the embodiment shown, the choice was made to keep the rims of the sheaves 10 and 11 less than 1 inch apart. With these constraints, the remaining variable, the angle of the inclination line 23, becomes fixed.

The choice of a desired deflection angle is dependent upon a number of factors. For example, a positive factor for choosing a large deflection angle is the resulting tight engagement between the drag rope 6 and the upper sheave 10 during the casting of the bucket 3. However, a large deflection angle bends the drag rope more and during the subsequent dig portion of the operating cycle, when maximum tension is exerted on the drag rope 6, this increased bending acts to shorten the life of both the drag rope and sheave assembly.

The choice of deflection angle, therefore, is largely a choice which results in a maximum useful life taking into consideration the above two factors. In large dragline excavators a majority of the digging is performed below the level of the house 1 and as a consequence the drag rope 6 wraps over the lower sheave 11 and slopes downward at an angle of at least 10° during a vast majority of the dig portion of the operating cycle. Therefore, the upper sheave 10 will seldom interfere and wear the drag rope 6 during digging when

set for a minimum deflection angle of 10°. Although a minimal 10° deflection angle may maximize rope life in some instances, when large sheaves having high moments of inertia are used, an increased deflection angle to improve control of the upper sheave **10** becomes necessary. In practice, it has been found that a deflection angle of 40° is a practical upper limit at which the advantage gained by deflection of the rope is offset by the increase in wear due to bending. Additionally, operating with deflection angles in excess of 40° subjects the supporting structure to substantially increased forces which act radially on the sheaves **10** and **11** during digging. These increased forces necessitate the use of heavier supporting structures which add to the cost of the machine.

In view of these factors, the invented fairlead assembly described herein substantially improves the useful life of drag ropes on excavators when the sheaves **10** and **11** are oriented for a deflection angle of from 10° to 40°.

I claim:

1. In a fairlead assembly for a drag-line excavator having a house with the fairlead assembly at the front thereof; a boom extending upward from the house; a hoist rope extending from the house to the top of the boom and then downward therefrom; a drag bucket attached to the hoist rope; a drag rope drum in the house; a drag rope traveling in a run from the drum to the fairlead assembly at the front of the house, and hence passing through the fairlead assembly to the bucket, the improvement in the fairlead assembly of:

a lower rope engaging sheave rotatable about a first horizontal axis over which the drag rope passes in its run from the drag rope drum to the fairlead assembly and which continuously supports the underside of the drag rope; and

an upper rope engaging sheave lying in a plane with the lower sheave rotatable about a second horizontal axis that is both forward of and above said first horizontal axis, the bottom of the rope engaging surface of said upper sheave being below the line taken by said run of the drag rope from the drag rope drum to the fairlead assembly, said upper sheave thus bearing against the top of said drag rope to deflect it during payout downward around the lower sheave from the horizontal at an angle of from 10° to 40°.

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