Oct. 6, 1925. 1,555,907

P. BURKE

REGENERATIVE DRAG LINE EXCAVATOR

Filed Nov. 10, 1924 5 Sheets-Sheet 1

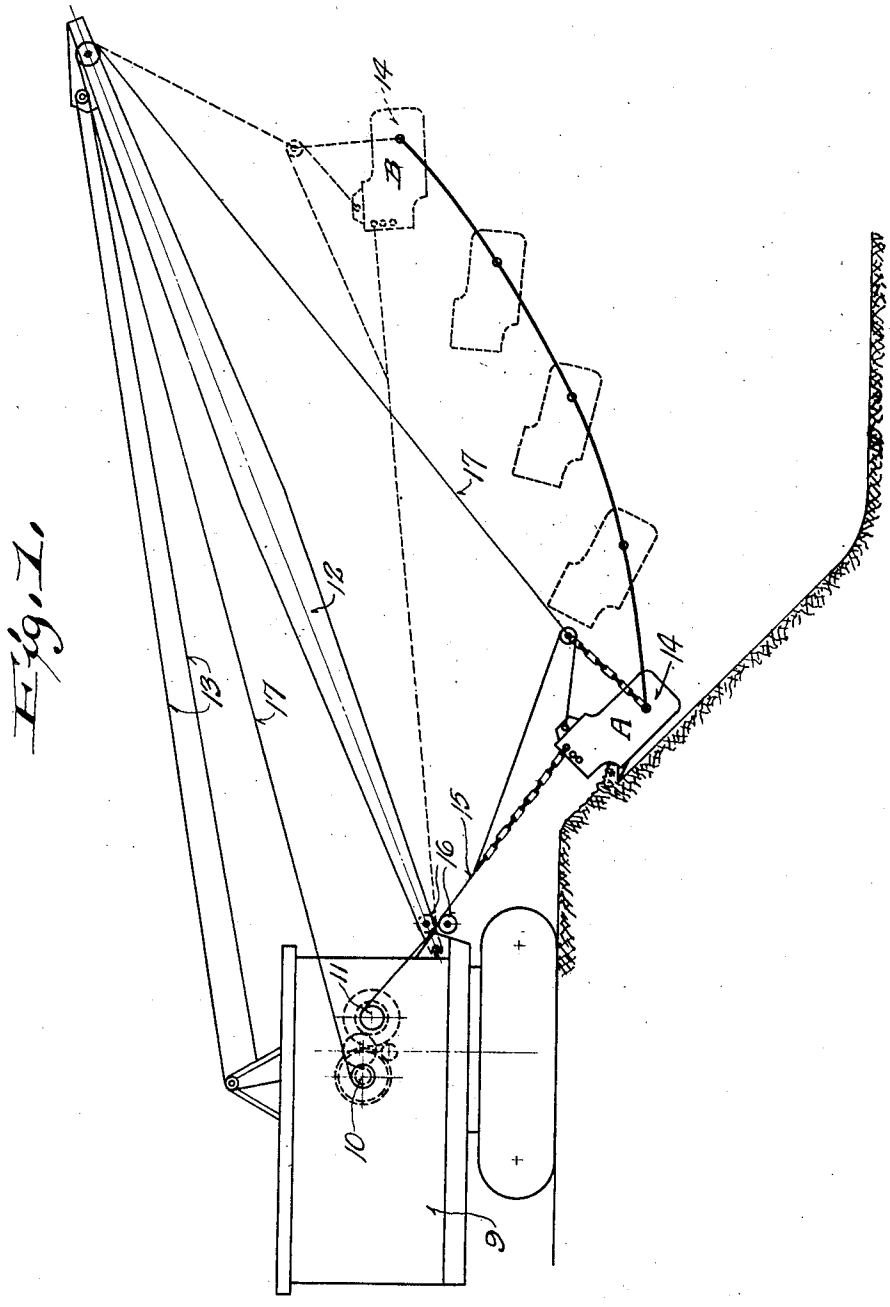


Fig. 1.

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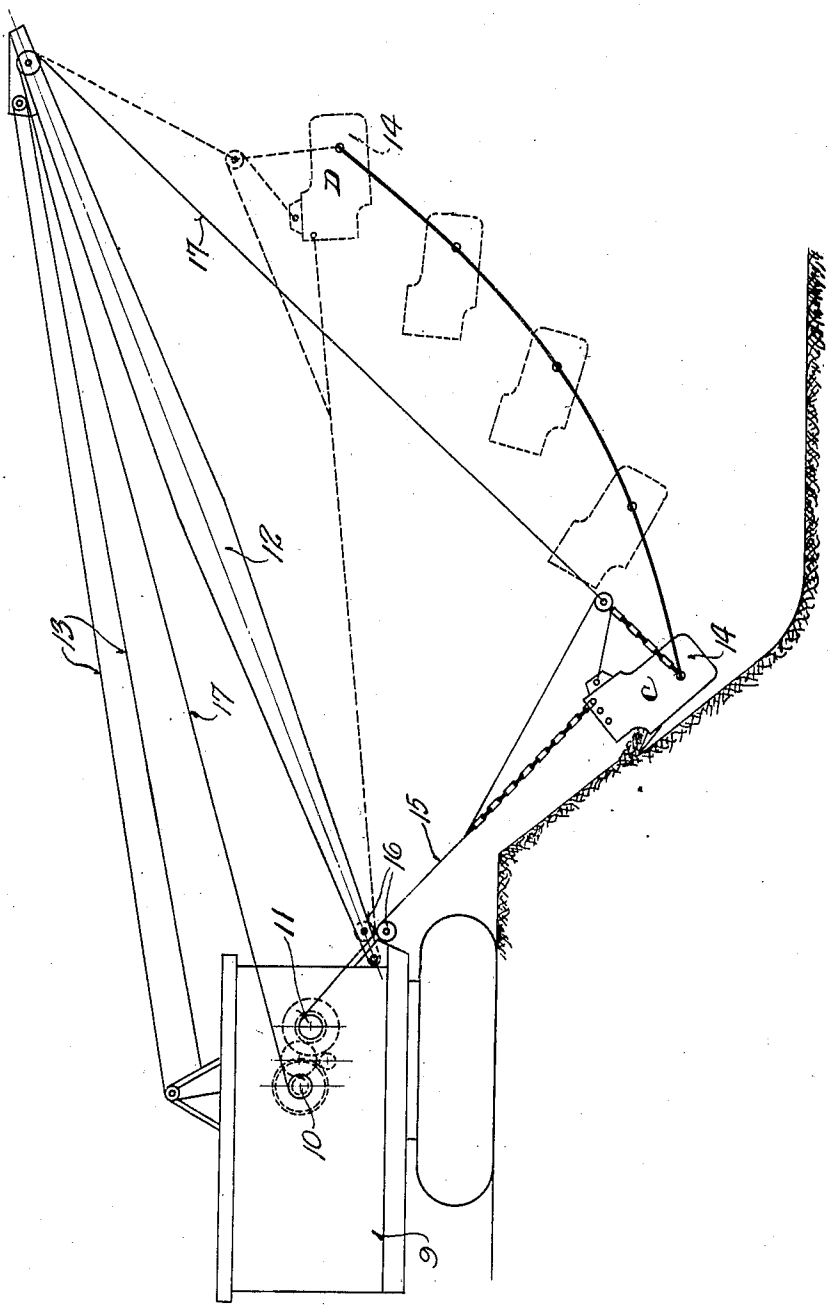


Fig. 2.

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REGENERATIVE DRAG LINE EXCAVATOR

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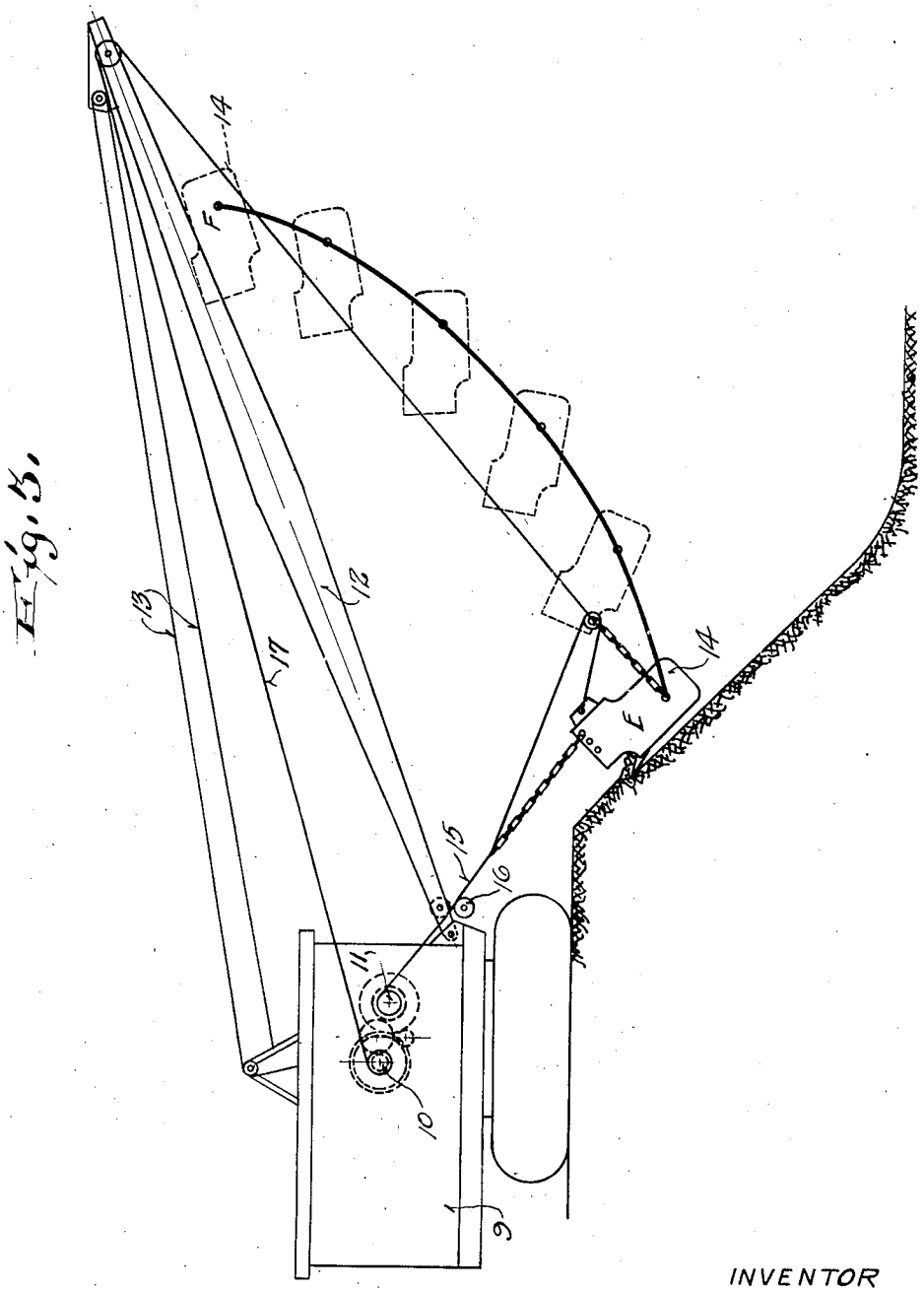


Fig. 3.

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1,555,907

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REGENERATIVE DRAG LINE EXCAVATOR

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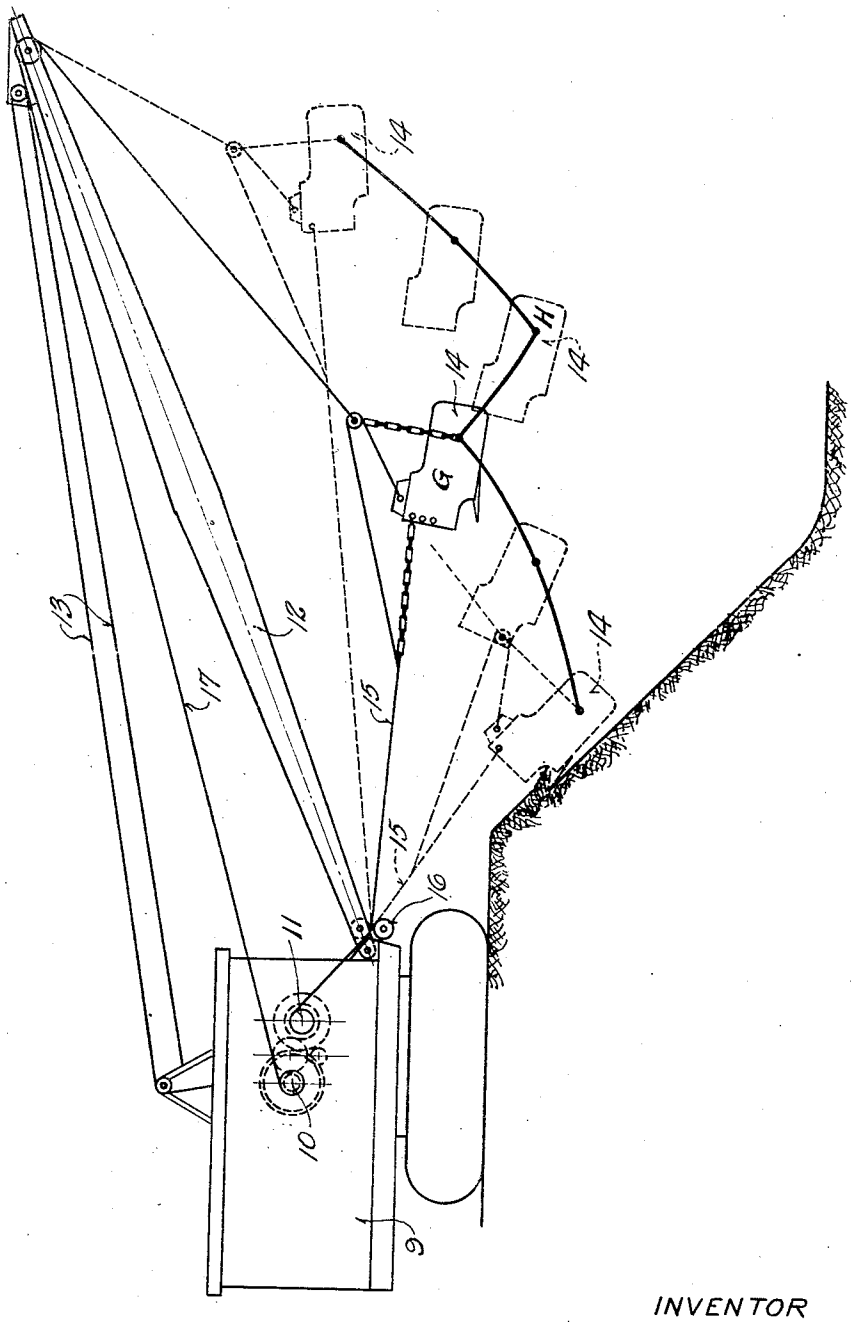


Fig. 4.

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by Charles A French
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REGENERATIVE DRAG LINE EXCAVATOR

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Fig. 5.

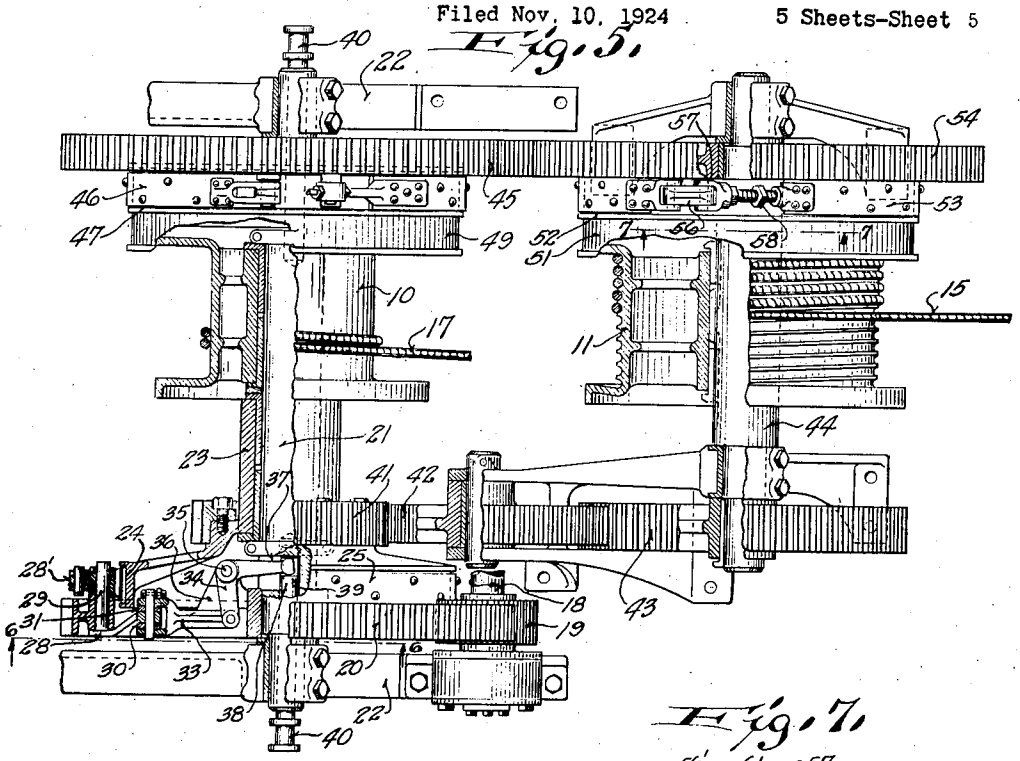


Fig. 7.

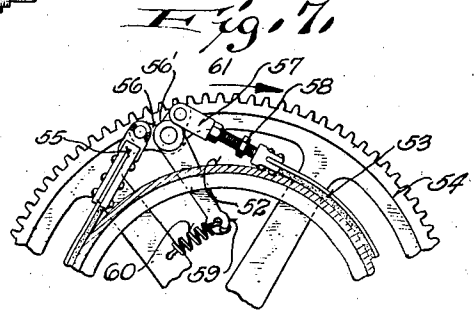
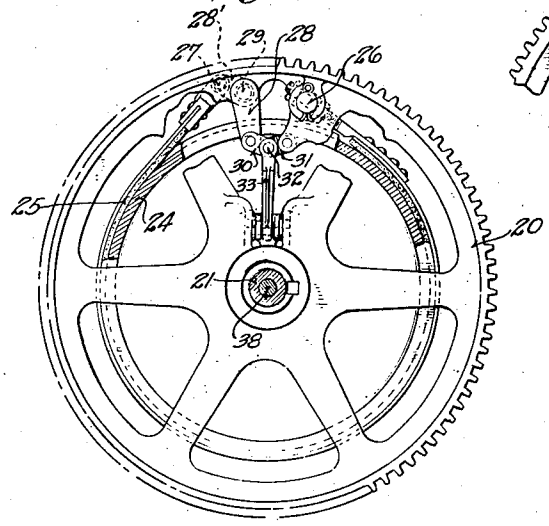


Fig. 6.



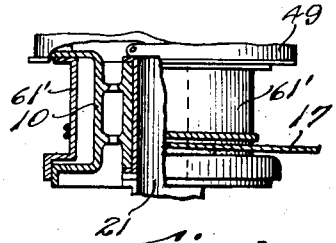


Fig. 8.

INVENTOR.
Paul Burke

BY
Quarles & French

ATTORNEYS

Patented Oct. 6, 1925.

1,555,907

UNITED STATES PATENT OFFICE.

PAUL BURKE, OF GREEN BAY, WISCONSIN, ASSIGNOR TO NORTHWEST ENGINEERING COMPANY, OF GREEN BAY, WISCONSIN, A CORPORATION OF WISCONSIN.

REGENERATIVE DRAG-LINE EXCAVATOR.

Application filed November 10, 1924. Serial No. 748,990.

To all whom it may concern:

Be it known that I, PAUL BURKE, a citizen of the United States of America, and resident of Green Bay, in the county of Brown and State of Wisconsin, have invented new and useful Improvements in Regenerative Drag-Line Excavators, of which the following is a description, reference being had to the accompanying drawings, which are a part of this specification.

The invention relates to drag-line excavators.

In my prior application, Serial No. 713,476, filed May 15, 1924, I have pointed out the desirability of utilizing the regenerative effect of the loaded bucket and tensioned drag-line during paying out to return power to the machine to aid in the hoisting and swinging of the loaded bucket, or either of these operations. Upon further consideration of the problem, I find that marked advantages arise in regenerative arrangements of this type by allowing the regenerative or paying-out speed of the drag-line to exceed, preferably materially, the hauling-in speed of the drag-line. I find that with an increased paying-out speed of the drag-line the hoisting speed may be materially increased while obtaining the best practical operation of the bucket during hoisting, whereas, this would not be possible if the hauling-in speed of the drag-line were equal to its paying-out speed, since the maximum hauling-in speed of the drag-line is limited by digging conditions to a relatively low speed. The principal object of the invention, therefore, is to provide a drag-line excavator in which the drag-line drum may be regeneratively associated with the power system of the machine and when so associated operate at higher speeds than are used by the power system of the machine in hauling in the drag-line.

The invention further consists in the several features hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawings: Figs. 1 to 4, inclusive, are explanatory diagrams to illustrate the advantage derived by the invention, the bucket being shown in different positions, in the various diagrams, under different conditions of operation;

Fig. 5 is a plan view of mechanism embodying the invention, parts being broken away and parts being shown in section;

Fig. 6 is a detail sectional view of the device shown in Fig. 5, taken on the line 6—6, parts being broken away and parts shown in section;

Fig. 7 is a detail sectional view taken on the line 7—7 of Fig. 5.

Fig. 8 is a detail view of the hoist drum provided with lagging, parts being shown in section.

In order to explain the advantages derived by the regenerative arrangement hereinafter described, reference is had to Figs. 1 to 4, inclusive, of the drawings. In each of these figures the numeral 9 designates the rotating base for the drag-line-operating mechanism, which includes the hoisting drum 10 and the drag-line drum 11, and 12 the boom suitably supported on the rotating base by cables 13 extending from the outer end of the boom to a framework on the machine. The numeral 14 designates the bucket, 15 the drag-line associated with the bucket and the drag-line drum and running through a fairlead 16, and 17 the hoist line associated with the bucket, the outer end of the boom and the hoisting drum.

When hoisting and paying out speeds of the bucket are equal, that is, the gear ratios in the regenerative mechanism are so related to the drag-line drum diameter as to bring this about, the path of the bucket during hoisting will be along the line A—B, as shown in Fig. 1, which is obtained by suitable plotting of the successive positions of the bucket during hoisting. However, it is frequently desirable that the hoisting speed exceed the winding-in speed of the drag-line in order to attain reasonable over-all speed of operation, yet the hauling-in speed of the drag-line should not be too fast for efficient digging.

If we assume a machine having a regenerative pay-out arrangement in which the hoisting line speed exceeded the drag-line winding-in speed by 50%, and in which the winding-in and pay-out speeds of the drag-line were equal, then the condition typified by Fig. 2 would occur during the hoisting of the bucket. In this view the lowered position of the bucket 14 is the nearest posi-

tion to the machine that the bucket can be hauled and still be hoisted out in the same ultimate position in relation to the point of the boom as indicated in dotted lines in Fig. 2, with the path of the bucket C—D shown. Inasmuch as it is frequently required to have the bucket drag in closer to the machine than shown in Fig. 2, as, for instance, the position shown in Fig. 1 in full lines, it will be noted from a consideration of Fig. 2 that this is not attainable where the hoisting line speed exceeds the drag-line hauling-in speed by a material amount because, should the bucket be hauled in to the position shown in Fig. 1, as shown in full lines in Fig. 3, and then hoisted, it would travel in the path E—F and assume the dotted line position shown in Fig. 3, which would be undesirable and impractical of attainment on account of enormous tensions which would be imposed upon both the drag-line and hoisting-line. Assuming, however, that this dotted line position shown in Fig. 3 were possible, in order to proceed further with the hoisting to attain the same ultimate position of the bucket with respect to the point of the boom, as shown in Fig. 1, hoisting would have to be discontinued at position G, Fig. 4, the bucket being then subsequently paid out until position H were obtained, from which positions simultaneous hoisting and paying-out could be resumed.

Since the pay-out speed in Figs. 4 and 1 are identical, it is obvious that in the attainment of the ultimate position in Fig. 4 increased hoisting speed has consumed the same time as in Fig. 1, and that, therefore, there has been no appreciable gain in speed of operation, due to the use of a higher hoisting speed, but that there was incurred serious danger of breakage due to the high tension set up in the drag-line and hoisting line and, of course, of all parts associated therewith.

From the foregoing it is apparent that where the paying-out and paying-in speeds of the drag-line are the same and the drag-line drum is regeneratively associated with the power plant, no practical increase in efficiency results in increasing the speed of the hoisting line, with the result that if the advantage of increase in hoisting speed is to be obtained in the regenerative arrangement, I find that the pay-out speed of the drag-line must exceed the winding-in speed, and preferably by a material amount, and the apparatus hereinafter described provides such an arrangement.

Referring to Figs. 5 and 6, a shaft 18 driven by a prime mover (not shown), which is preferably an internal combustion engine mounted on the rotating base of the machine, carries a gear 19 meshing with a gear 20 keyed to the hoist shaft 21, said hoist shaft being supported in bearings carried by suitable framework 22 for mounting on the rotating base of the machine. The prime mover may also be an electric motor or steam engine. The shaft 21 has a sleeve 23 rotatably mounted thereon carrying a clutch surface 24 adapted to be engaged by an outside clutch band 25. One end of the band 25 is anchored by a pin 26 to a part of the gear 20 and the other end of the band is connected by a pin 27 to an arm 28′ of a lever 28 whose pivot pin portion 29 is mounted in a part of the gear 20. The other arm of the lever 28 is connected to a toggle link 30 which is in turn connected to another toggle link 31 pivotally mounted on the gear 20, and both toggle links 30 and 31 are connected by a pin 32 to a link 33. The link 33 is connected to the bifurcated arm of a bell crank lever 34 which is pivotally supported at 35 on a lug 36 on the gear 20, and its other arm extends through a slot 37 in the shaft 21 and has a rounded portion engaged in a slot in a shifter bar 38 which is slidably mounted in an axial bore 39 in the shaft 21, said shifter bar extending out from one end of the shaft and having a collar 40 adapted to be engaged in any suitable and well known manner by a lever, not shown, controlled and actuated by the operator, whereby the shifting of the bar 38 serves to move the free end of the band through the linkages above described so as to bring it into and out of clutching engagement with the clutch surface 24 on the sleeve 23. Any other suitable clutch mechanism than that shown and described may be used to connect the shaft 21 with the sleeve 23.

Bolted to, or otherwise secured to, the sleeve 23, is a driving pinion 41 which drives through an idler gear 42 to a gear 43 keyed to the drag drum shaft 44. Also keyed to the hoist shaft 21 is a gear 45 carrying a clutch 46 similar to that associated with the sleeve 23 and gear 20, and adapted to engage a frictional surface 47 formed as a part of the hoisting drum 10 which is loosely mounted on the shaft 21. The drum 10 also has a friction surface 49 formed thereon with which the usual brake band, not shown, cooperates.

The drag-drum 11 is keyed to the shaft 44 and also has a brake surface 51 for the usual drag drum brake and a clutch surface 52 for an automatic clutch, including a clutch band 53, said clutch being carried by a gear 54 loosely mounted on the shaft 44 and meshing with the gear 45.

The automatic clutch herein shown includes the band 53 having one end 55 pinned to the longer arm of a bell crank lever 56 having its pin portion 56′ pivotally mounted on the gear 54, and its other end 57 mounted on the shorter arm of said lever. Thus there is a difference in tension exerted by

the ends of the band and in accordance with well-known laws this difference in tension is utilized to effect an automatic clutching engagement of the band with its clutch surface when the rotative speed of the latter tends to exceed that of the gear 54.

As a means for determining the speed at which the clutch engagement is to be effected, the tension in the ends of the band may be adjusted by a turnbuckle 58 forming a part of the connection for the end 57 of the band, and as a further means for exerting an initial tension on the band a spring 60 may be used, connected at one end to a spoke or part of the gear 45 and at its other end to an arm 59 associated with the lever 56 or the shaft 57 of said lever where said shaft moves.

With this clutch construction, when the friction band 53 carried by the gear 54 is rotating in the direction of the arrow 61 at a more rapid rate than its coacting surface 52, it will exert but a slight tension upon this friction surface and hence will not restrain it. When, however, the speed of rotation of the drum 11 in the direction indicated by the arrow 61 tends to become greater than the speed of rotation of the band 53 in the same direction, the initial tension exerted by the spring 59 causes the band 53 to wrap itself tightly about the friction surface so that for the time being the drum 11 and the gear 54 constitute practically a rigid unit revolving with the shaft 44, and this, as will be later described, is in a direction to return energy to the power system of the machine.

Considering now the general arrangement of a drag-line excavator, as shown in Fig. 1, with reference to the mechanism just described, when it is desired to hoist the bucket the clutch 46 carried by the gear 45 is engaged or thrown in by the operator, thereby causing the hoist drum 10 to rotate with the shaft 21, since said shaft is being driven through the gears 20 and 19 from the shaft 18, thereby pulling in on the hoist line 17. When it is desired to haul in the drag-line 15, the clutch, including the band 25, is engaged through the operation by the operator of the linkage previously described, causing pinion 41 to rotate with the shaft 21 and thereby transmitting motion through gears 42 and 43 to the drag-drum shaft 44 and drag drum 11, thus causing the drag-line to be wound in.

When it is desired to pay out the drag-line regeneratively, it is simply necessary to release the clutch, including the band 25 and the drag brake associated with the brake surface 51, whereupon the drag drum will, under the influence of the tension of the drag-line produced by the loaded bucket, rotate in a direction to pay out its cable, whereupon the drag drum 11 will accelerate until its speed tends to exceed that of gear 54, whereupon the automatic clutch, including the band 53, will engage and power will be transmitted through the gears 54 and 45 to the hoist drum shaft 21 and consequently to the power system of the machine, since said shaft is connected, as previously described, with the power-driven shaft 18.

The ratio of the gears 54 and 45 is such as to cause the paying-out speed of the drag drum 11 to exceed the hauling-in speed of said drum. In the mechanism shown, the ratio of the hoisting speed to the drag-line speed when winding in is approximately 1.28. The ratio of the drag-line speed, when paying out, to the drag-line speed when hauled in, is approximately 1.93, which means that the ratio of the drag-line speed, when paying out, to the hoisting line speed, is approximately 1.5. I prefer to employ such a higher value of the latter ratio for the reason that it is frequently desirable to make a temporary increase in the hoisting speed by lagging the hoisting drum, which may be simply done by bolting on two split halves of lagging 61′, as indicated in Fig. 8. Using a good margin of pay-out speed above the normal hoisting speed, permits me to use a lagging of good diameter and still be free from danger of encountering the situation shown in Fig. 3.

This higher hoisting speed, obtained by the use of lagging, may be employed on work requiring an unusually long boom which, as a rule, will force the use of a smaller and lighter bucket, thus making a higher hoisting speed available, as far as power is concerned, with a corresponding increase in operating speed.

As the hoist drum is connected to the shaft 21 through operation of the clutch 46, under some conditions of operation the clutch 46 may be thrown out and the hoist drum may be held stationary by the application of the brake to the surface 49 and the regenerative effect from the tensioned drag-line in paying out be used to return force to the system for use in augmenting the power delivered to the rotating base-turning mechanism by which the boom is turned to bring the bucket over to its dumping position. No special turning mechanism is here shown, but it may be of any suitable construction, one form of which is shown in my previously-mentioned prior application.

I desire it to be understood that this invention is not to be limited to any specific form or arrangement of parts except in so far as such limitations are specified in the claims or necessitated by the prior art.

What I claim as my invention is:

1. In a drag-line excavator, the combination, with the bucket, of a hoist drum, a hoisting cable for the bucket associated with said drum, a drag drum, a drag cable for the

bucket associated with said drag drum, a power system including a source of power, means for connecting said drag drum to said source of power for driving it in a direction to wind in said cable, and means for connecting said drag drum with said power system to deliver energy thereto, under the influence of the drag cable tensioned by the bucket and its load and the hoisting cable, at a speed relatively greater than that used in hauling in the drag-line.

2. In a drag-line excavator, the combination with the bucket, of a hoist drum, a hoisting cable for the bucket associated with said drum, a drag drum, a drag cable for the bucket associated with said drag drum, a source of power, means for connecting said drag drum with said source of power to wind in said cable, and means for utilizing the energy derived from the drag drum when rotating in a direction to pay out said cable at a speed relatively greater than that used in hauling in said cable simultaneously with the winding in of the hoisting cable on the hoisting drum whereby the hoisting speed may be increased with efficient bucket operation during hoisting.

3. In a drag-line excavator, the combination with the bucket, of a drag drum shaft, a drag drum adapted to rotate therewith, a power-driven shaft, a hoist drum, means for connecting said hoist drum with said power-driven shaft for driving said drum, a controllable gearing connection between said power-driven shaft and said drag drum shaft, for rotating said drag drum to haul in on the drag-line, and a gearing connection between said shafts of higher ratio than said first-named gearing connection regeneratively associating said drag drum with said power-driven shaft, whereby the paying-out speed of the drag-line is greater than the hauling-in speed.

4. In a drag-line excavator, the combination with the bucket, of a drag drum shaft, a drag drum adapted to rotate therewith, a power shaft, a hoist drum, a clutch for connecting said hoist drum with said power shaft, a clutch and gear drive connection between said shafts for rotating said drag drum to haul in said drag-line, and a clutch and gear drive connection between said shafts for regenerative association of said drag drum with said power shaft and hoisting drum, when said drag-line is being payed out, said last-named gear drive connection being of a higher speed ratio than said first-named gear drive connection.

5. In a drag-like excavator, the combination with the bucket, of a drag drum shaft, a drag drum secured to rotate therewith, a power shaft, a hoist drum, a clutch for connecting said hoist drum with said power shaft, a clutch and gear drive connection between said shafts for rotating said drag drum to haul in said drag-line, a gear drive connection between said hoist drum and said drag drum, and an automatic clutch for effecting the operation of said last-named gear drive connection when the drag drum, during paying out, attains a predetermined speed relative to said gear drive connection, said last-named gear drive connection being of a higher speed ratio than said first-named gear drive connection.

In testimony whereof, I affix my signature.

PAUL BURKE.