No. 649,244. Patented May 8, 1900.

O. HETLESAETER.

EXCAVATOR.

(Application filed Sept. 7, 1899.)

(No Model.) 3 Sheets—Sheet 1.

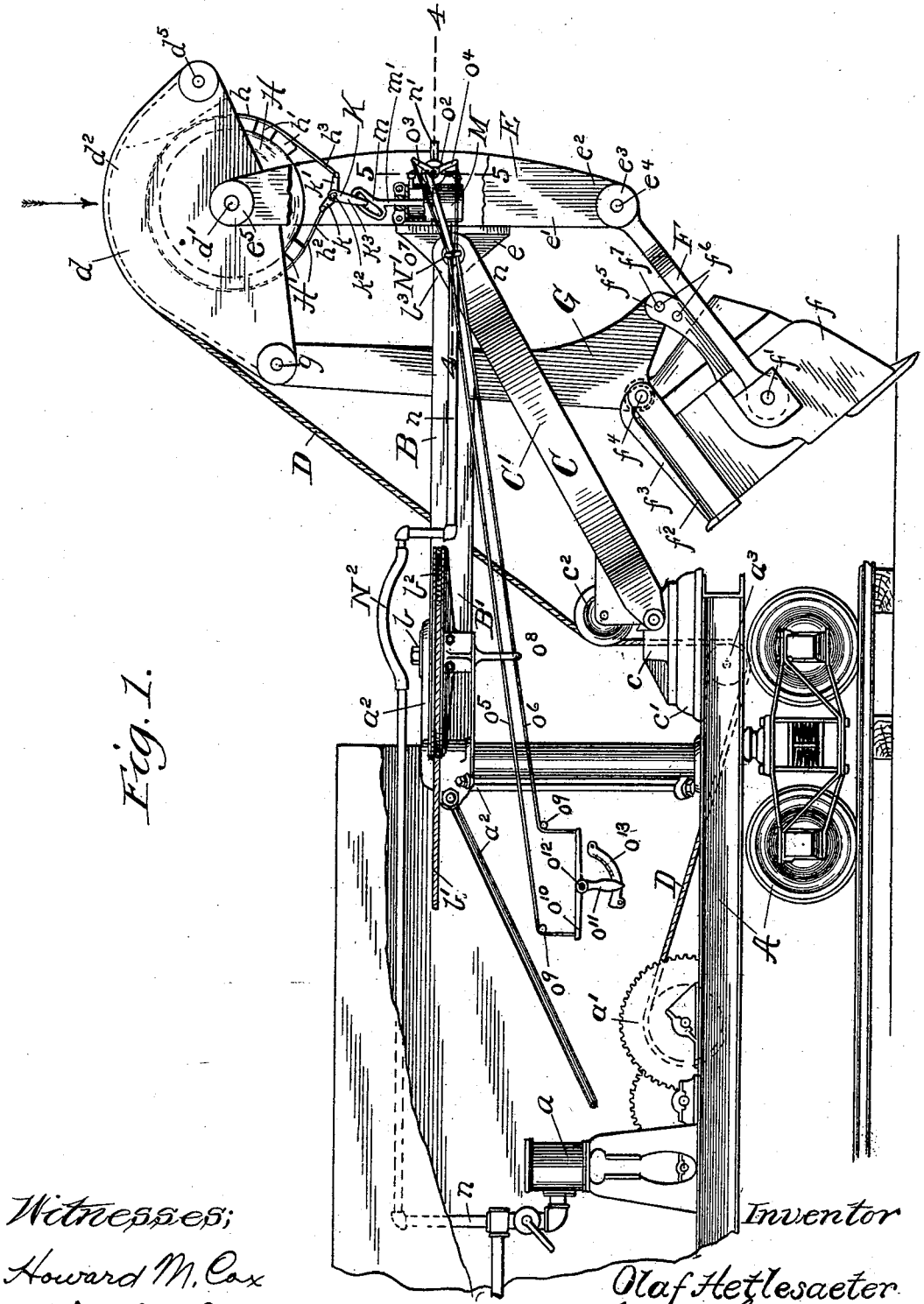

Fig. 1.

Witnesses;
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(Application filed Sept. 7, 1899.)

(No Model.) 3 Sheets—Sheet 2.

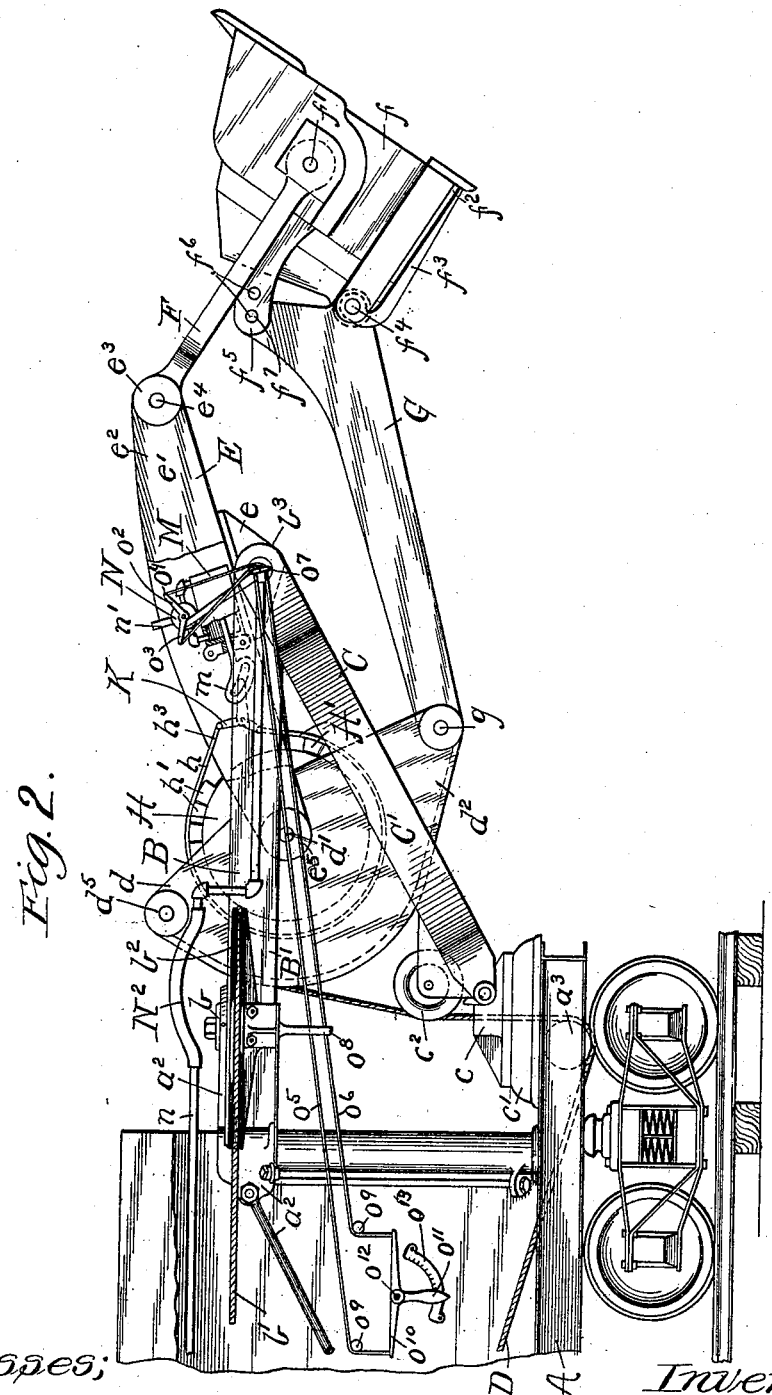

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

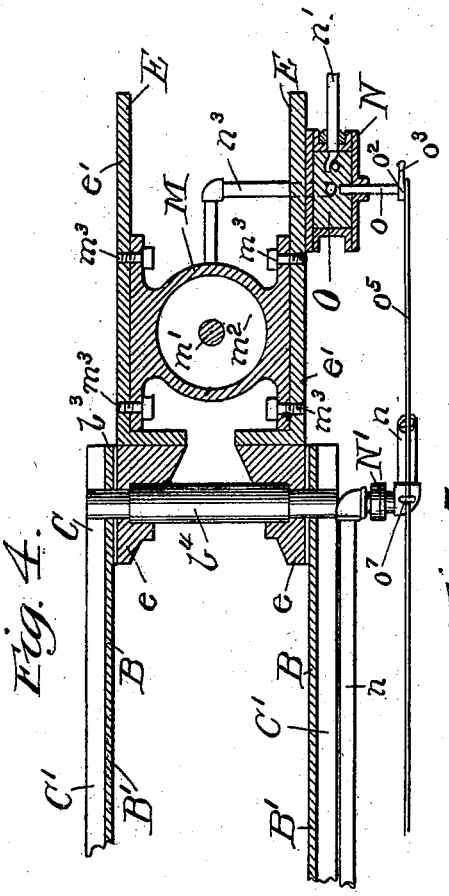

Fig. 4.

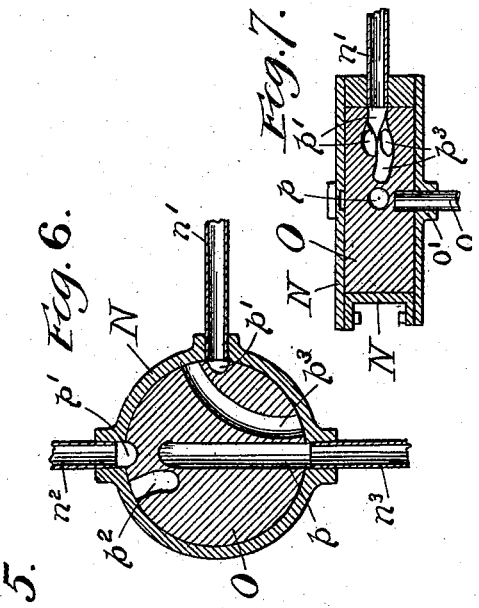

Fig. 6.

Fig. 7.

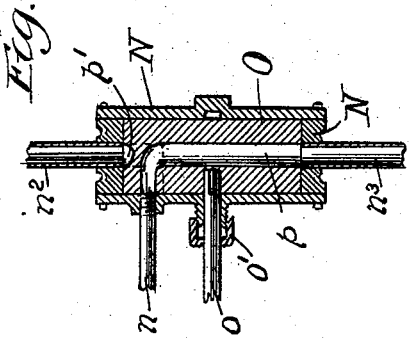

Fig. 5.

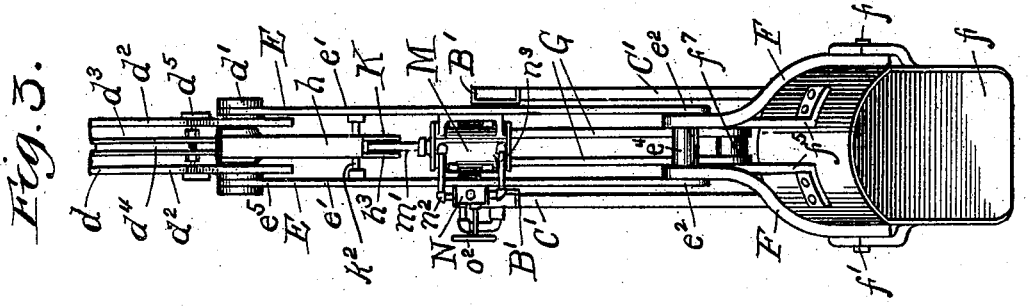

Fig. 3.

Witnesses;
Howard M. Cox
Charles L. Merrick

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UNITED STATES PATENT OFFICE.

OLAF HETLESAETER, OF CHICAGO, ILLINOIS.

EXCAVATOR.

SPECIFICATION forming part of Letters Patent No. 649,244, dated May 8, 1900.

Application filed September 7, 1899. Serial No. 729,706. (No model.)

To all whom it may concern:

Be it known that I, OLAF HETLESAETER, a citizen of the United States, residing in the city of Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Excavators, of which the following is a specification.

My invention relates to improvements in excavators, particularly dredges, ditching-machines, and steam-shovels; and the objects of my invention are, first, to provide an improved bucket-arm consisting of a series of links connected in tandem, whereby the bucket may be quickly and easily operated; second, to provide means whereby the loss of the force of the driving or hoisting mechanism due to internal strains in the coöperating parts may be reduced; third, to provide means whereby the thrust of the bucket normally into the bank and also in a forward direction to excavate material from the bank and to raise the bucket into a position for dumping may be simultaneously accomplished by a single driving or hoisting mechanism; fourth, to provide means whereby the position of the links of the bucket-arm may be fixed relatively to each other, and, fifth, to provide the other details hereinafter set forth. I accomplish these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a side view of the excavator mounted upon a railway-car and shows the bucket, the linked arm for supporting the bucket, the brake-operating mechanism, and the brake, whereby the relative positions of the links composing the said arm may be rigidly fixed. A portion of the side of the oscillating lever is broken away to expose the said brake-operating mechanism. Said figure also shows the thrust-segment, the hoisting-cable attached thereto, and also indicates the hoisting engine and gear. Fig. 2 is a side view of the excavator and car as in Fig. 1, showing the bucket in a raised position. Fig. 3 is a front view of the bucket and linked bucket-arm in the position shown in Fig. 1. Fig. 4 is a detailed sectional view of the outer portion of the boom and adjacent parts looking in the direction of the arrow, Fig. 1, and taken horizontally on the broken line 4 4, Fig. 1. The oscillating lever, the lever-bearing, the brake-cylinder and operating-valve, and a portion of the boom and boom-supports are shown. Fig. 5 is a sectional view of the brake-cylinder operating-valve, taken on the line 5 5, Fig. 1, transversely to the sides of the oscillating lever. Fig. 6 is a sectional view of said operating-valve, taken on a vertical plane through the center thereof, parallel to the sides of the oscillating lever. Fig. 7 is a sectional view of the operating-valve, taken horizontally through the center thereof on the line 4 4, Fig. 1.

Similar letters refer to similar parts throughout the several views.

A represents a car whereon are mounted the operating-engine a and gear a'.

The boom B, consisting of the parallel beams B′ B′, suitably and rigidly held in their proper relative positions, has a swing-bearing b in the framework a^2 of the car A. The boom-support C, consisting of the beams C′ C′, is secured at its lower extremity to the pintle-plate c, said plate c having a bearing in the base-plate c' on said car. Said bearings b and c' have vertical axes lying in the same line and permit the boom B and boom-support C to swing horizontally. Said pintle-plate c and base-plate c' are suitably apertured at their axes of revolution to afford a passage for the hoisting-cable D. The idler a^3, having a bearing in the body of the car A, and the idler c^2, having a bearing upon the lower extremity of the boom-support C, are so placed as to guide the said cable D vertically through the apertured pintle-plate c and base-plate c', and thereby convert the lateral motion of the forward extremity of said cable into torsion confined within said cable between said idlers a^3 and c^2. The lateral position of said boom and support is governed by means of the cable b', working in the peripherally-grooved sheave or sluing-circle b^2, attached to said boom B.

The boom-support C is securely attached to the boom B at the forward extremity b^3 thereof, where the shaft b^4, supported in said boom and boom-support, forms a pivot for the bearing e of the oscillating lever E. Said oscillating lever E is composed of the plates e' e', suitably fastened together and attached to said bearing e.

The oscillating lever E is provided at its

lower extremity e^2 with the bearings e^3 for receiving the pin e^4, whereby said lever is pivotally connected with the bucket-links F F. Said links consist of bars suitably bowed to extend to opposite sides of the excavator-bucket f, whereto they are connected by means of the trunnions f' f'. Said bucket f is of the ordinary pattern, having the discharging-door f^2 at the bottom thereof hung upon the hinges f^3. The shaft f^4, which extends transversely across said bucket, serves as a bearing for said hinges f^3 and also serves as means for pivotally connecting the said bucket to the bucket-handle G. At the forward portion of the bucket f and rigidly attached thereto are the lugs f^5 f^5, having the apertures f^6 f^6. When the pin f^7, which is attached to the bucket-handle G, is inserted into corresponding apertures f^6 in said lugs f^5, the bucket f is rigidly connected with said bucket-handle. By inserting the pin f^7 into different pairs of the said apertures f^6 the angle of inclination of the bucket to the handle may be adjusted. Said handle is pivotally connected at the extremity g thereof, opposite to said bucket, with the thrust-segment d.

At the upper portion e^5 of the lever E is the thrust-segment d, having the pivot-bearing d', whereby it is revolubly supported on said lever. Said segment consists of the parallel plates d^2 d^2, suitably fastened together and having attached thereto at and conforming to the periphery thereof the part d^3, having a groove d^4 therein for receiving the cable D. The periphery of said segment d is preferably approximately circular, with the center of curvature at or near the bearing d'. The said cable D is attached to the segment d at the point d^5 thereon in any suitable manner, and takes over said segment d, lying in the groove d^4. From said segment said cable takes between the beams B' B' of the boom B, then over the idler c^2 through the pintle-plate c and base-plate c', around the idler a^3 and rearward to the driving-gear a', whereby said cable is operated. The portion of said cable D between said idler c^2 and said segment d lies in the common plane of rotation of said segment about the bearing d' and of the lever E about the bearing e on the shaft b^4. On account of the curvature of the grooved periphery of the segment d and owing to the relative positions of the point of attachment d^5 and idler c^2 the cable D will be tangent to said periphery in all positions of said segment within the reasonable working limits of the machine. Moreover, the relative positions of the said point d^5 and idler c^2 and the pivotal points d' and g are such that the force of said cable will always be exerted in a line other than the line joining the said points d' and g. The leverage of the cable upon said segment will be substantially equal to the distance between said bearing d' and the point of tangency of said cable to said periphery.

The segment d, lever E, links F, bucket f, and handle G are so proportioned and balanced that when said bucket is raised to its extreme height, although the cable D is held fast, the force of gravity acting upon all of said parts will cause said bucket to approach the bearing e, thus shortening the effective length of the bucket-arm below said bearing; also, the weight of said bucket and said linked parts below the bearing e is greater than the weight of said parts above said bearing, and therefore when not prevented by the cable D the bucket will drop backward by gravity to such a position that the oscillating lever E and bucket-handle G are approximately vertical, as in Fig. 1. Moreover, when said lever E and handle G are in a position approximately vertical gravity will cause the linkwork bucket-arm to elongate and lower the bucket to its extreme depth. It is the object of the brake or locking device hereinafter described to so operate in conjunction with the peculiar overbalancing features of the articulating linked bucket-arm that the operator may control the position of the bucket when discharging, raise the bucket clear of the bank when said bucket is returning to its initial position for taking a cut, and also when the bucket is taking a cut regulate the amount of thrust of said bucket normally into the bank.

The brake-drum H is securely attached to the side plates d^2 d^2 of the segment d concentrically with the bearing d' thereof. Encircling said drum H is the brake H', consisting of the flexible brake-band h, having attached thereto the preferably wooden brake-shoes, some of which are marked h'. Said brake-band h is securely attached at its extremities h^2 and h^3 to the arms k and k', respectively, of the brake-lever K. Said lever K is pivotally supported upon the shaft k^2, securely attached to the oscillating lever E and forming a fulcrum for said lever. Said lever K has also an arm k^3, the free extremity whereof has means for engagement within the obliquely-slotted link m of the piston-rod m'. The piston m^2, attached to and operating said piston-rod m', works within the cylinder M. Said cylinder M is provided with suitable steam-ports and is attached to the oscillating lever E by means of the bolts m^3 m^3. The parts of said lever K, piston-rod m', and cylinder M are so arranged that the motion of said piston within said cylinder operates said brake H'. As said brake H' is attached to the oscillating lever E and the drum H is attached to the segment d, when said brake H' is securely set the motion of said segment relatively to said oscillating lever is prevented.

As the bucket f is adjustably but rigidly connected to the handle G, as shown in Figs. 1, 2, and 3, the parts forming the supports for said buckets—namely, the lever E, links F, handle G, and segment d, together with said bucket f—constitute four virtual links whose effective lengths are from d' to e^3, from

e^3 to f', from f' to g, and from g to d', respectively. When the brake H′ is set and the said parts E and d relatively fixed, all of said parts E, d, G, f, and F are relatively fixed and form a rigid trussed bucket-arm pivotally supported at the bearing e on the shaft b^4. Each one of said links is connected at its virtual extremity with the virtual extremity of the next adjacent link, thereby forming an "end-to-end" construction, the said links being connected at length or "in tandem." A convenient form of valve mechanism for controlling the position of said piston m^2 in said cylinder M is shown in detail in Figs. 5, 6, and 7, in which N represents the cylindrical valve-casing, to which are connected the supply-pipe n, the exhaust-pipe n', the pipe n^2, leading to the upper extremity of the cylinder M, and the pipe n^3, leading to the lower extremity of said cylinder. Said supply-pipe n extends rearward to the source of steam-supply and is provided with a swivel-joint N′ at the axis of rotation of the lever E upon the boom B, and a flexible hose N^2 at the axis of rotation of said boom upon said car A. The rotary valve O inclosed within said casing N is controlled by means of the valve-spindle o, attached to said valve and extending from said valve outward through said casing N and stuffing-box o' thereon. In said valve O the passages p, p', p^2, and p^3 are so arranged that when said valve occupies the position shown in said figures the passage p connects the supply-pipe n with the pipe n^3, leading to the lower extremity of the cylinder M, and the passage p' connects the exhaust n' with the pipe n^2, leading from the upper extremity of said cylinder, the said valve being thus set to allow the piston m^2 to be forced in an upward direction. When said valve O occupies the position above described, the extremities of the passages p^2 and p^3 are adjacent to blank portions of the interior surface of the casing N, and therefore render said passages p^2 and p^3 inoperative. The said passages p^2 and p^3 are so designed that when the valve O is rotated until one extremity of the passage p^2 is in juxtaposition to the pipe n^2 the other extremity of said passage will be in juxtaposition to the supply-pipe n, thus forming a connection between said pipes, and the passage p^3 will similarly form a connection between the pipe n^3 and the exhaust n'. In said last-mentioned position of the valve O the passages p and p' will be out of connection with any and all of the pipes connected with the valve-casing N and will therefore be inoperative, and said valve will be so set as to allow the piston m^2 to be forced downward. The lever o^2 is attached to the valve-spindle o in such a manner as to rotate the valve O and is provided with two arms o^3 and o^4, whereto are attached the operating-lines o^5 and o^6, respectively. Said lines o^5 and o^6 consist, preferably, of flexible wire ropes of small diameter and pass from said lever-arms o^3 and o^4 through the eye or guide o^7, placed at the axis of rotation of the lever E upon the boom B, and also pass through the eye or guide o^8, placed at the axis of rotation of the boom B upon the framework a^2 of the car A. The object in employing flexible guides o^5 and o^6 and placing said guides o^7 and o^8 in the manner described is to prevent the motion of the lever E or boom B from causing motion in said valve O. Said lines o^5 and o^6 are brought rearward to the car A, where they pass over the guides o^9 o^9 and are suitably attached to the hand-lever o^{10}, provided with the handle-bar o^{11} and bearing on the pin o^{12} on said car. By means of the notched segment o^{13} said handle-bar o^{11} may be adjustably secured in any desired position, thereby controlling the operation of the valve O.

In operation the brake H′ is released from the drum H by means of the hand-lever o^{11}, controlling the brake-operating mechanism. The segment d is thus free to rotate upon the bearing d', and therefore the lever E, links F, and handle G are also free to rotate on their respective pivotal bearings. When the engine a and gear a' induce tension in the cable D, the effective force of said cable is transmitted to the segment d and acts thereon at the point of tangency of said cable to the periphery of said segment and acts in the direction of said cable from said point of tangency toward the idler c^2; but between said point of tangency and the vertically-fixed point b^3 of the boom B, whereon said segment d and lever E are supported, there are two joints permitting rotation in a vertical plane—namely, the bearing d', about which as a center said segment may rotate upon said lever, and the shaft b^4 in the boom B, about which as a center said lever and segment may rotate upon said boom. Therefore the tension in said cable, which also acts in a vertical plane, will induce in said segment a tendency to rotate about the point d' as a center and simultaneously to swing, together with the lever E, about the shaft b^4 as a center; but the rotation of the segment d about the point d' will be transmitted by the bucket-handle G to the bucket f, and said bucket will be thrust in a downward direction, guided by the links F, while the swinging of the segment d and lever E about the shaft b^4 will impart to the bucket f a forward motion in an approximately-horizontal direction. The thrust of the bucket normally into the bank may be terminated at any point in the cut by securely setting the brake H′, and from such point forward the path of the bucket will be a circular one about the shaft b^4 as a center. In the latter case the force tending to thrust the bucket normally into the bank will not be lost, but will be geometrically added to the forward force of the bucket, for the reason that the effective leverage offered to the cable D for swinging the bucket-arm will be greater when the segment d and lever E are relatively rigid than when free to move relatively to each other. When the bucket f has been

raised by means of the cable D to any desired position and the contents thereof discharged, the said bucket is further raised until it reaches a position such that the force of gravity acting upon the vertically-moving parts causes the bucket to approach the bearing *e* on the shaft b^4. The brake H′ is then set, so that the parts of the bucket-supporting arm are relatively fixed and the bucket is prevented from increasing its distance from the said bearing *e*. When the said parts are thus relatively fixed, the cable D is paid out, and gravity causes the return of the bucket downward and rearward in a circular path about the shaft b^4 as a center. As the bucket is nearer the shaft b^4 on the boom B during the return than during the forward motion, said bucket will during its return be raised clear of the bank. When the bucket has returned to a point above the place in the bank where the next succeeding cut is to be taken, the cable is stopped and the brake H′ released. The releasing of the brake permits the relative motion of the bucket-supporting parts, and the bucket drops normally into the bank into a position for taking the next cut.

Although the oscillating lever, the thrust-segment, the bucket-handle, and the connection between the bucket-handle and the oscillating lever constitute a tandem four-linked structure and the links thereof are so proportioned as to constitute substantially a "parallel motion," I do not limit myself to a structure having precisely four links. Any linked bucket-arm wherein power is applied to a transverse link and said transverse link is connected at one articulate joint with a link whereby the bucket-arm is supported and at the other articulate joint with a link connected with the bucket would lie within the spirit of my invention; nor do I wish to be limited to the use of a cable, chain, rope, or similar flexible mechanism for operating the bucket-arm, as any means of applying power to the transverse link *d* would be within the scope of my invention.

As the periphery of the thrust-segment *d* is approximately circular and the cable D is always tangential thereto, the downward thrust of the bucket or the thrust thereof normal to the bank will be substantially uniform for all positions of said bucket, except when raised to its highest position for discharging.

One of the special advantages of my machine is that it accomplishes simultaneously, by means of a single simple mechanism, the two distinct operations of thrusting or crowding and of hoisting, a result commonly requiring two or more separate devices; but it is evident that a mere increase in the number of power devices for the accomplishment of the two described motions of the bucket would not be beyond the comprehension of the present invention; also, any locking device that will controllably prevent the motion of the links relatively to each other is, in general, within contemplation.

The feature of constant effective power, due to constant leverage about the pivotal point of support b^4, (which feature is referred to in the Letters Patent No. 563,857, issued to me July 14, 1896,) is approximated in the present machine, for the reason that the pivotal point of support b^4, while not at the center of curvature of the periphery of the segment *d*, is, nevertheless, always on the concave side thereof. The constant leverage effect may be increased by so proportioning the segment *d* and lever E that the center *d′* of said segment lies relatively nearer the bearing *e* of said lever upon said shaft b^4.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an excavator, a pivotally-supported bucket-arm composed of articulating links, one of which constitutes a segment whereby the force of a single power device is resolved into two components operative upon the excavator-bucket, the periphery of said segment being the locus of the point of application of power to said arm, and said arm being provided with a joint between its point of support and point of power application.

2. In an excavator, a bucket-arm consisting of articulating links of fixed lengths, said links being movable relatively to each other and to the structure whereon said arm is mounted, in combination with means for locking and means for operating said arm.

3. In an excavator, a linked bucket-arm pivoted to a suitable support and provided with a joint between its supporting-pivot and a point of power application, said point of power application lying upon a member of said arm other than the member to which the excavator-bucket is attached; in combination with a single power device for operating said arm.

4. In an excavator, an articulating linkwork, forming a bucket-arm, said linkwork comprising a pair of longitudinal members, one of which is pivotally supported; said members being connected at one end with the excavator-bucket, and at the other joined by a transverse link; and a power device connected with said transverse link and exerting its power in a line other than that of the line through the pivots of said transverse link.

5. In an excavator, a bucket-arm composed of articulating links, a locking device carried upon said arm for rigidly fixing the links thereof relatively to each other, a bucket attached to said arm, and means for operating said arm.

6. In an excavator, the combination of a bucket, a tandem four-linked bucket-arm, means for locking the links thereof relatively to each other, a support for said arm, and mechanism for operating said arm.

7. In an excavator, a pivotally-supported bucket-arm having a plurality of inflexible

members at least three of which are pivotally connected together, said arm having a fulcrum between the point of support and the point of power application; in combination with a supporting structure, a bucket attached to said arm, and a single apparatus for transmitting power to said arm.

8. In an excavator, a pair of links articulately connected at one extremity with a power-receiving link, and at the other extremity with a bucket and bucket connections, thereby forming substantially a parallel motion for the manipulation of said bucket; in combination with a pivot-bearing on one of the said pair of links, a support for said bearing, and a mechanism for applying power to said power-receiving link.

9. In an excavator, a pair of links articulately connected at one extremity with a power-receiving link, and at the other extremity with a bucket and bucket connections, thereby forming substantially a parallel motion for the manipulation of said bucket; in combination with a pivot-bearing on one of the said pair of links, a support for said bearing, and a controllable locking device for transforming said parallel motion into a trussed bucket-arm.

10. In an excavator, a linked bucket-arm wherein the link receiving the motive power for said arm, forms the connection between the bucket-handle and the link furnishing the sole means of support for said arm; in combination with a controllable locking device for preventing the motion of the links of said arm relatively to each other, a bucket attached to said bucket-arm; a boom for pivotally supporting said arm, and means for supplying motive power to said arm.

11. In an excavator the combination of a bucket; a bucket-handle; an oscillating lever pivotally supported between its extremities; at one extremity of said lever, connections with said bucket; at the other extremity of said lever, a bearing for a transverse link; a transverse link pivotally connected with said lever and said bucket-handle; and a pulling device connected with said transverse link and acting in a line other than that through the pivots thereof.

12. In an excavator, the combination of a bucket-arm consisting of a plurality of members of constant lengths, one of said members being pivotally supported upon a vertically-fixed portion of the excavator, a second of said members being pivotally supported on said first-mentioned member, and a third of said members being articulately connected with said second member, and forming the bucket-handle; a bucket, and other connections between said bucket and said first-mentioned member.

13. In an excavator, the combination of a boom; an oscillating lever pivotally supported between its extremities on said boom; a bucket; an articulating link connection between said bucket and the lower extremity of said oscillating lever; a thrust-segment having a curved periphery suitably grooved for a cable, an articulate joint between said thrust-segment and the upper extremity of said oscillating lever; a bucket-handle connected to said bucket at one end thereof, and at the other end thereof, articulately jointed to said thrust-segment; a cable attached to said thrust-segment and lying in the groove therein; an engine and gear for operating said cable; and means for fixing the positions of the said thrust-segment, oscillating lever, bucket-handle, bucket, and bucket connections, relatively to each other.

14. In an excavator, a bucket-arm consisting of a series of articulating links of constant lengths, in combination with a bucket pivotally attached at one portion thereof to one of the links of said arm, and having at another portion thereof lugs suitably apertured to receive a pin secured to said link, whereby the angle of said bucket relatively to said link may be adjusted; and means for operating said bucket-arm.

15. In an excavator, the combination of a tandem four-linked bucket-arm, one of the links whereof forms a thrust-segment having a curved and grooved periphery for receiving a portion of the driving-cable, a boom consisting of parallel members connected at their extremities by means of a shaft; a bearing whereby said bucket-arm is supported upon said shaft, a bucket carried by said bucket-arm, a cable attached to the forward portion of said thrust-segment and extending rearward over said groove therein, and between said parallel members of said boom rearward on said excavator; a driving engine and gear on said excavator, whereto said cable is connected; and means for relatively fixing the links of said bucket-arm.

16. In an excavator, an oscillating bucket-arm consisting of an articulating linkwork having a locking device for preventing the motion of the links of said linkwork relatively to each other, in combination with a bearing whereby said bucket-arm is supported intermediately of the extremities thereof; a boom whereon said bearing is supported, said boom consisting of beams extending in the same direction and suitably supported, said beams and the supports therefor being at a distance from each other greater than the width of any portion of said bucket-arm above said bearing; a bearing whereby said boom and supports are supported upon the main body of the excavator, said last-mentioned bearing having a vertical axis; a cable for oscillating said bucket-arm; a sluing circle and cable for controlling the lateral position of said boom; and an engine and gear for operating said cable.

17. In an excavator, the combination of a bucket-arm composed of articulating links of fixed lengths; a bearing on one of said links; a bucket connected with a second link of said arm whose motion, relatively to said first-

mentioned link, is approximately parallel to said first-mentioned link; a support for said bearing, and means for operating said bucket-arm.

18. In an excavator, the combination of a bucket-arm composed of inflexible articulating links of fixed number and lengths, pivotally supported at a fixed point on said arm; a laterally-swinging structure pivotally supported upon the body of the excavator, and supporting said arm; a cable attached to said arm and connected with the driving engine and gear; and idlers whereby said cable is guided, in part, in a direction approximately coincident with the axis of rotation of said swinging structure upon the body of the excavator, one of said idlers being supported upon said swinging structure, and the other of said idlers being supported upon the body of the excavator.

19. In an excavator, the combination of an oscillating lever pivotally supported at a fixed point thereon; a thrust-segment pivotally supported upon said lever; a drum rigidly attached to said segment concentrically with the bearing thereof; a brake suitably attached to said oscillating lever and acting upon said drum; means for controlling the action of said brake upon said drum; a bucket; links whereby said bucket is connected with said lever and said thrust-segment; a cable attached to said segment and to the driving engine and gear, and a boom for supporting said lever.

20. In an excavator, a bucket-arm consisting of a plurality of members, not less than three of which are pivotally connected together, said bucket-arm being pivoted to a suitable support and being provided with a joint between its supporting-pivot and a point of power application, whereby a single power-applying device may effect both a downward and a forward movement of the bucket.

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