No. 659,632. Patented Oct. 9, 1900.

O. HETLESAETER.

EXCAVATOR.

(Application filed Jan. 10, 1900.)

(No Model.) 2 Sheets—Sheet 1.

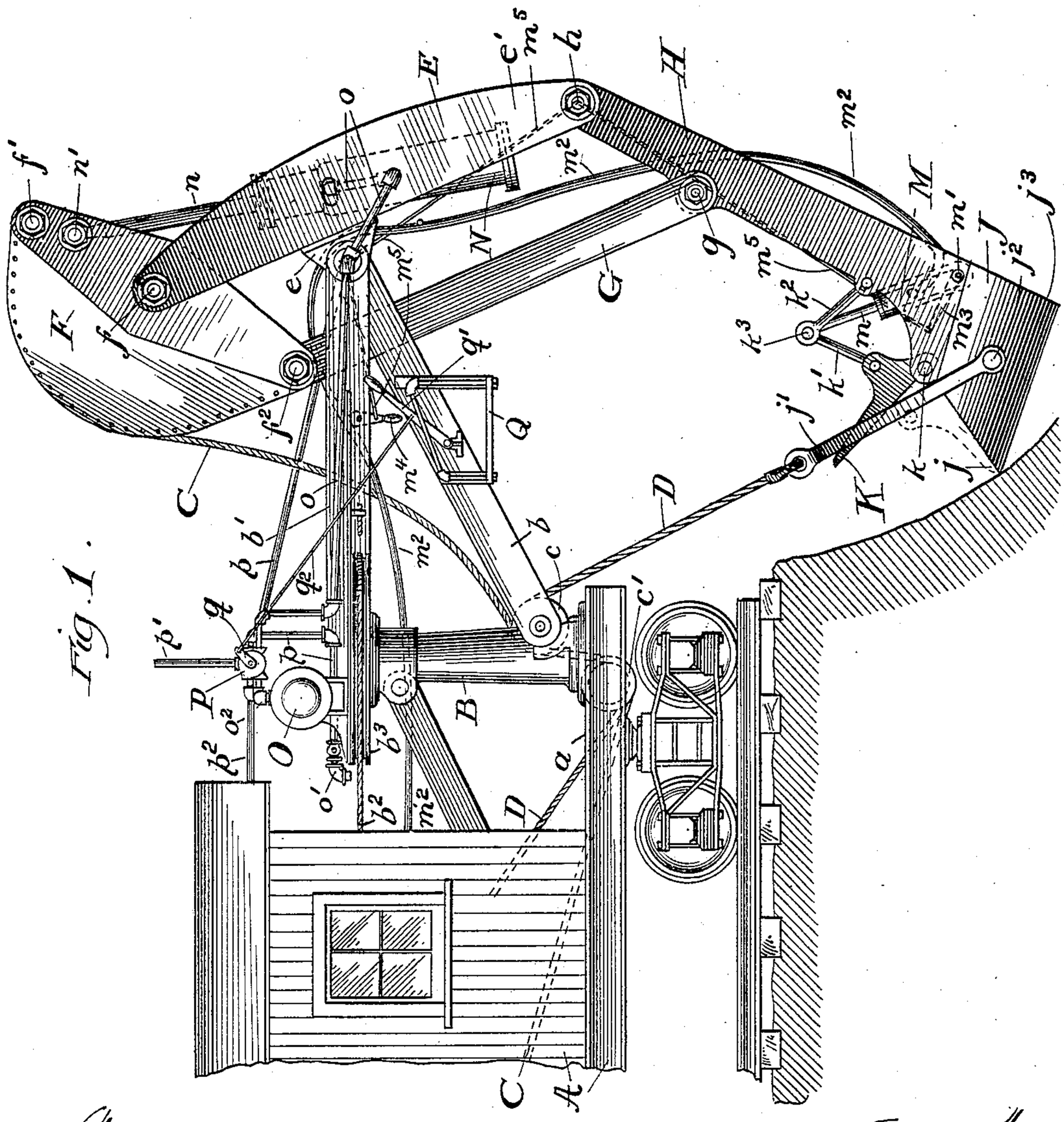

Fig. 1.

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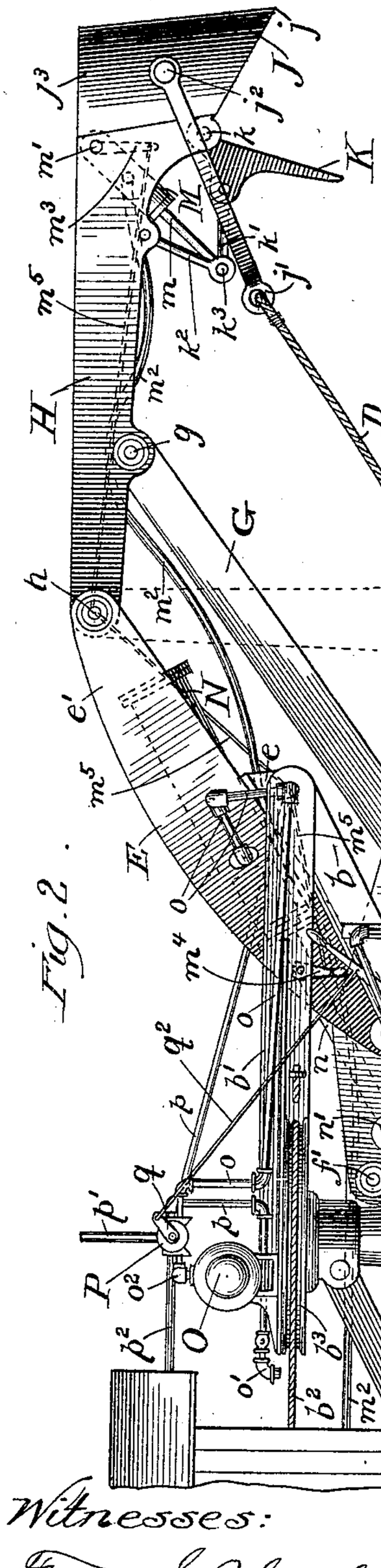

Fig. 2.

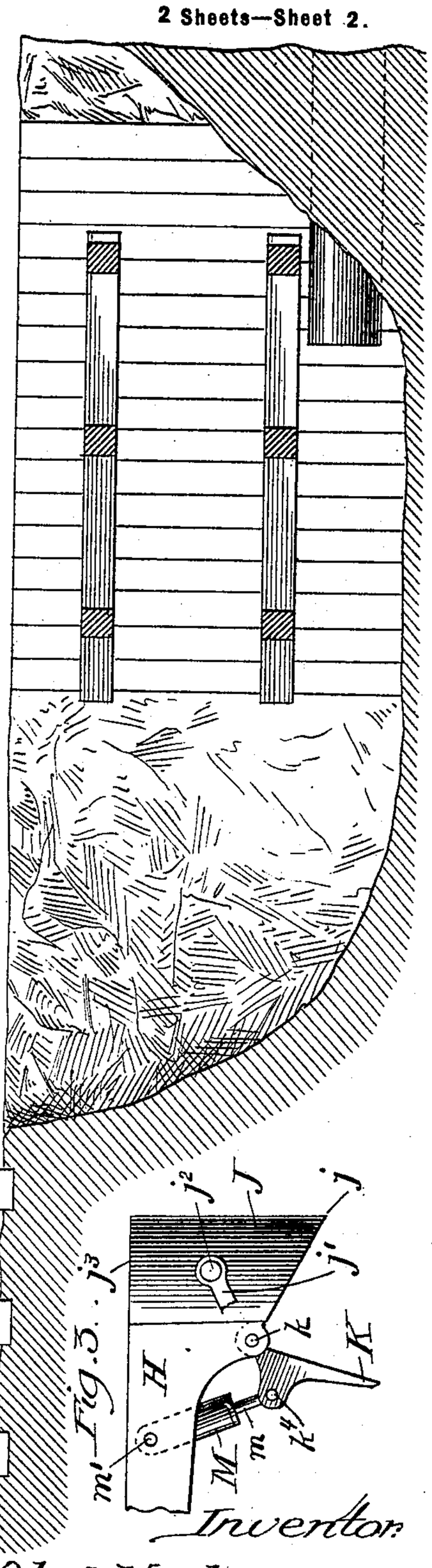

Fig. 3.

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UNITED STATES PATENT OFFICE.

OLAF HETLESAETER, OF CHICAGO, ILLINOIS.

EXCAVATOR.

SPECIFICATION forming part of Letters Patent No. 659,632, dated October 9, 1900.

Application filed January 10, 1900. Serial No. 922. (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 excavators, more particularly of the type having a linkwork bucket-arm and related to the excavators shown and described by me in previous applications for Letters Patent, to wit: Serial No. 729,706, filed September 7, 1899; Serial No. 730,829, filed September 18, 1899, and Serial No. 732,332, filed October 2, 1899.

It is desirable that an excavator shall have a wide-working range both in a horizontal plane and in a vertical direction, and heretofore these conditions have been attained only at the expense of great internal stresses and strains. It is frequently desirable, also, that the cut should be taken at a point near the structure whereon the machine is mounted and that the bucket after being filled should be discharged at a distant point.

The object of my present invention is to attain these desirable features in their highest form and also to provide certain details hereinafter set forth. I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a general view, in side elevation, of an excavator embodying my invention. The excavator-bucket is shown taking a cut in a close proximity to the trucks of the car whereon the mechanism is supported. Fig. 2 is a general view, in side elevation, of the excavator, as in Fig. 1, showing the bucket-arm extended and the bucket in position for discharging. Said Fig. 2 illustrates the operation of my device in ditching and sewer-building and shows the excavating progressing at one extremity of the ditch and the refilling at the other extremity thereof with but a single handling of earth. The dotted lines indicating the bucket and bucket-handle exemplify the wide range of positions and inclinations which the bucket may be caused to assume. Fig. 3 is a side view of the bucket, showing a modification in the method of operating the bucket door or cover.

Similar letters refer to similar parts throughout the several views.

The car A, which forms the supporting structure of the excavator, has the mast B pivotally mounted upon the forward portion of the car-platform *a*. The jib *b* is secured to said mast B near the lower extremity thereof, and at the upper extremity of said mast is attached the backstay *b'*. Said jib and backstay are fastened together at their forward extremities, and, together with the mast B, constitute a swinging crane for supporting the bucket-arm and connected parts. The lateral swinging of the crane is accomplished by means of the cables b^2, which work within the swinging circle b^3. Said circle is attached to the backstay *b'* concentrically with the axis of rotation of the mast B. In the lower portion of said mast are mounted the sheaves *c*, one whereof guides the hoisting-cable C and the other guides the digging-cable D. The sheaves *c'*, mounted within the body of the car A, also guide the said hoisting-cable C and digging-cable D. The oscillating lever E, which constitutes one of the members of the linked bucket-arm, is pivotally supported at the forward extremity of the crane *b b'* by means of the pivot-bearing *e*, attached to said lever intermediate of the extremities thereof.

For the purpose of attaining strength and lightness and affording appropriate means for supporting certain portions of the arm-operating mechanism the lever E is built up of the side plates *e'*, which are similar in form and approximately parallel. The segment F is pivotally attached to the said lever E at the upper extremity of the latter by means of the pin *f*. Said segment is approximately semicircular in outline, and said pin *f* is located near the center of curvature thereof. The curved portion of said segment lies upon the side of the pin *f* opposite to the said bearing *e* and is grooved in its periphery to receive the hoisting-cable C. Said hoisting-cable is attached to the segment F at the point *f'* thereon, which point is forward when the lever E occupies an approximately-vertical position, as shown in Fig. 1. From said point *f'* said cable extends rearwardly within and along the groove in the periphery of the

segment F and thence extends over the guide-sheave c, under the guide-sheave c', and rearwardly to suitable hoisting mechanism provided upon the car A. At the rear extremity of the segment F or at the extremity thereof opposite to the said point of attachment f' is the pin f^2, whereby said segment is pivotally attached to the controlling-link G. Said link G, which also constitutes one of the members of the linkwork whereof the bucket-arm consists, is inflexible, but of preferably light construction, and has in its extremity opposite to the said pin f^2 the pin g, whereby said link is pivotally connected with the bucket-handle H. The said bucket-handle H is preferably a built-up member and is of a length adapted to the class of work for which the excavator is designed. Said handle carries at one extremity the excavator-bucket J, and at the other extremity opposite to said bucket said handle is pivotally attached to the lower extremity of the oscillating lever E by means of the pin h.

The location of the pin g with respect to the bucket-handle H is intermediate of the extremities of the latter. The greater the length of the bucket-handle H relatively to the distance between the said pins h and g the greater will be the motion of the bucket J relatively to the motion of the pin g, reference being had to the rotation of said bucket-handle about the pin h as a center. In regarding said bucket-handle H as a lever the pin h may be considered as the fulcrum, the bucket J as the load, and the pin g as the point of power application. Said handle may be thus identified as a lever of the third class or the class wherein the point of power application lies between the fulcrum and the load. By this construction the change in the relative positions of the links of the bucket-arm is magnified at the bucket. The overhung portion of said bucket-handle—that is, the portion between the said pin g and said bucket J—may, however, be decreased until said bucket and said pin are adjacent without departing from my invention.

The form of bucket best adapted for use in connection with my device resembles the ordinary type of excavator-bucket employed in this class of machines and is provided with an edge or cutter j for facilitating the entrance of the bucket into the bank. The bail j' is attached to said bucket by means of the trunnions j^2, located symmetrically upon opposite sides thereof. A distinctive feature of my bucket, however, is that the swinging door or cover K has a seat upon the forward portion of the bucket or the portion thereof adjacent to the said cutter j. The rear end or bottom j^3 of said bucket is stationary therein, and the contents of the bucket are discharged not through said bottom, but over the said cutter in a direction opposite to the direction of the entrance of the earth or other material into the bucket. Said bucket is therefore closed upon all sides except the one which forms the charging and discharging port or aperture of the bucket and which may be closed by said door K.

The most advantageous construction of the bucket-door and door-operating mechanism is herein shown. Said door K is hinged upon the handle H, adjacently to the upper portion of the bucket J, by means of the hinge-pin k and is positive acting in all positions of the bucket, not depending upon a spring-catch or similar device, for the reason that the contents of the bucket may, under certain conditions, project beyond the mouth of the bucket in such a manner as to prevent said door from completely reaching its seat upon said bucket. Said door K is controllably operated by means of a toggle mechanism consisting of the bars k' and k^2, linked together by means of the pin k^3. The extremity of the bar k' opposite to said pin k^3 is pivotally attached to the door K, and the extremity of the bar k^2 opposite to said pin k^3 is pivotally attached to the bucket-handle H. The said pin k^3 is attached to and operated by the piston-rod m, which works within the door-operating cylinder M: Said cylinder M is supported on the trunnions m', located, preferably, in the bucket-handle H. The operating medium for said cylinder may be steam, air, water, or other suitable fluid and is conveyed to said cylinder through the pipe m^2, which latter leads from a source of supply upon the car A. The valve mechanism of said cylinder M is operated by means of the lever m^3 adjacent to said cylinder. The position of said lever is controlled by means of the hand-lever m^4, located upon the crane. The rods m^5 m^5 m^5 form the connections between said hand-lever m^4 and the valve-lever m^3.

The extremity of the digging-cable D is made fast to the bail j' of the bucket J and extends from said bail over one of the guide-sheaves c, under one of the guide-sheaves c', and thence rearwardly to suitable driving mechanism upon the excavator-car A.

From the above description it is evident that the bucket-handle H, oscillating lever E, segment F, and controlling-link G constitute a pivotally-supported linkwork bucket-arm, the links whereof articulate upon the pins g, h, f, and f^2, the virtual or working length of the respective links being determined by the distances between the centers of said pins. A change in the relative positions of any two of the constituent members of the bucket-arm produces a corresponding change in the configuration of said arm, and said change in configuration results in either a variation in the distance of the bucket J from the pivotal point of support e or a variation in the inclination of said bucket to the horizontal or in both said distance and said inclination.

The controlling mechanism, which constitutes the chief factor in governing the configuration of the bucket-arm, consists of the

controlling-cylinder N and its connections. Said cylinder N is supported upon trunnions having bearings in the side plates e' e' of the lever E. The piston-rod n works within said cylinder and is pivotally attached to the segment F by means of the pin n', located at a forward portion of said segment near the point f' thereon. For reasons hereinafter appearing the best results are obtained by employing steam or other gas in the upper or piston-rod end of the cylinder N and water or other liquid in the opposite end of said cylinder. The travel of the piston within the cylinder N changes the quantity of liquid in said cylinder, and the pressure-tank O, conveniently mounted upon a rear portion of the crane, receives the liquid from and supplies it to said cylinder as required. By means of the piping o o, which is suitably supplied with the necessary swivel-joints, the steam end of the cylinder N is connected with and receives steam through the valve P. The piping p p lies upon the farther side of the crane, looking from the point of view of the drawings, and connects the lower or water end of the cylinder N with the lower portion of the pressure-tank O. Said tank O is designed to hold both steam and water under pressure for the operation of the controlling-cylinder N and is provided with the drain o'. Said controlling-valve P is interposed in the piping p p between said cylinder and said tank and has also a steam connection with the upper portion of said tank by way of the pipe o^2. The exhaust-steam is discharged through the valve P by way of the exhaust-pipe p'. The steam-pipe p^2 supplies live steam for operating said controlling-cylinder and is suitably connected with the said valve P. Said valve P may be constructed in the same manner as is the valve having a similar function shown in my application for patent filed October 2, 1899, Serial No. 732,332. In said valve P the following conditions may obtain, to wit: The supply of live steam may be shut off and the passage of water to and from the water end of the cylinder N be prevented, the live steam may be admitted to the steam end of said cylinder N while the steam in the upper portion of the pressure-tank O is open to exhaust and water may pass through said valve, live steam may be admitted to the pressure-tank O while the steam end of said cylinder N is open to exhaust and water may pass through said valve, or the steam end of the cylinder N and the pressure-tank O may both be open to exhaust while the supply of live steam is shut off and the passage of water in either direction through said valve is permitted. Said valve P is operated by means of the valve-lever q, hand-lever q', and the rod q^2 connecting said levers. Said hand-lever q' is located within reach of an operator standing upon the platform Q', and said platform is supported in a convenient position upon the jib b of the crane.

The operation of my device is as follows: When the bucket is in a position ready to take a cut, as shown in Fig. 1, the door K is opened and the hoisting-cable C paid out sufficiently to exert no pull upon the bucket-arm. The digging-cable D is then put under tensional strain, and the bucket is thereby forced into the bank in a direction toward the supporting structure. As the force of the digging-cable D is applied directly to the bucket, the bucket-arm and the crane are almost entirely relieved of stresses and strains during the taking of the cut. The condition in the controlling-cylinder N during the taking of the cut is dependent upon the nature of the cut to be taken. If it is desired that the cut or the path of the bucket be substantially a circular one about the pivotal point of support e as a center, the valve P is so set that no water may pass therethrough, thus confining the water within said cylinder. As the water is incompressible, its confinement within said cylinder prevents change in the configuration of the bucket-arm due to tension in the cable D. When it is desired to increase the distance of the bucket J from the pivot-bearing e for the purpose of crowding said bucket into the bank or for the purpose of projecting said bucket in order to attain a proper position for discharging, the valve P is so set that the steam or upper end of the cylinder N is open to exhaust, and steam is admitted into the pressure-tank O. The pressure of the steam in the said tank forces the water into the lower end of the cylinder N, thus forcing the piston n outward. The result of the outward motion of said piston-rod is the tendency of the bucket-handle H to become more nearly in line with the oscillating lever E, thus increasing the distance of the bucket J from the pivot-bearing e, and thereby increasing the length of the bucket end of the bucket-arm. Conversely, the bucket is retracted by causing the piston-rod n to be forced into the controlling-cylinder N. Under ordinary circumstances when the bucket is being extended for discharging the digging-cable D is slack, and so exerts no force counter to said controlling-cylinder. If the material and condition of the bank be such that the force exerted on the bucket by the strain of the cable D alone is sufficient to produce the desired depth of cut, the valve P is so set that live steam is shut off, both tank O and cylinder N are open to exhaust, and water may pass in either direction through said valve. The controlling mechanism is then substantially without influence upon the bucket-arm, and the path of the bucket depends upon the bank and the direction of the force of the cable D. After the cut has been taken and the bucket filled the door K is closed by means of the cylinder N and other parts of the door-operating mechanism, the digging-cable D is paid off, and tension is induced in the hoisting-cable C. This causes the segment F to approach the car A, and the resulting rotation of the bucket-arm about its point of support e hoists the

bucket in the manner shown in Fig. 2. The door K is then opened and the contents of the bucket are discharged by gravity, said contents leaving by way of the same portion of said bucket wherethrough they entered. Any desired position of the bucket horizontally is attained by means of the cylinder N and related parts of the controlling mechanism in conjunction with the hoisting-cable C. When the bucket is in a raised position, the force of gravity acting upon the bucket tends to cause the bucket-arm to collapse—that is, said bucket and handle may be caused to closely approach the point of support *e*, as illustrated by the dotted lines, Fig. 2. When hoisting under ordinary circumstances, the valve P is so set that the water is confined within the cylinder N. The collapse of the bucket-arm is then prevented without the use of steam, for the reason that said collapse cannot occur except upon the entering of the piston-rod farther into the cylinder N, and this is prevented by the water confined in said cylinder. Therefore said cylinder and related parts of the controlling mechanism constitute a hydraulic lock, brake, or stop for preventing the collapse of said bucket-arm. When the controlling mechanism is thus set, the bucket-arm becomes a rigid framework and virtually constitutes a single constituent part or member of the excavator. The bucket may be collapsed for convenience during transit or to enable the bucket to enter a location difficult of access.

The form of mechanism for operating the door or cover K of the bucket J (shown in Fig. 3) is similar to the mechanism above described, and shown in Figs. 1 and 2. In said modified form, however, the piston-rod *m* is pivotally and directly attached to said door or cover by means of the pin k^4.

By reason of the great working range of my device it is possible to make excavation for a sewer or similar structure and to replace the excavated material upon the completed structure with a single handling of said material and from a single position of the car or other supporting structure, as shown in Fig. 2.

I have herein shown and described one form of my invention; but I do not limit myself to this form. My device is eminently suitable for deep-water dredging, and manifestly the mounting upon a scow or other structure for dredging would entail great changes—as, for example, in the crane and means for supporting the bucket-arm. I do not restrict myself to a cylinder for effecting change in the relative positions of the members composing said bucket-arm, nor do I restrict myself to any particular means for hoisting or rotating said arm in a vertical plane, nor to any particular form of bucket or method of operating the cover or door thereof.

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

1. In an excavator, the combination of a bucket-arm supported intermediate of its extremities and composed of a plurality of members, two of which are pivotally connected to a third member; said third member affording means for varying the configuration of said arm; and means for operating said arm, attached thereto on opposite sides of the point of support thereof.

2. In an excavator, the combination of a linkwork bucket-arm supported intermediate of its extremities, two of the links of said arm being articulately connected to a third link thereof; arm-operating mechanism attached to said third link on one side of the point of support of said arm, and other arm-operating mechanism attached to said arm upon the other side of said point of support.

3. In an excavator, the combination of a pivotally-supported bucket-arm composed of a plurality of members, two of which are articulately connected to a third member, said third member affording means for varying the configuration of said arm; and an excavator-bucket attached to said arm and having a port or mouth adapted for both receiving and discharging material into and from said bucket.

4. In an excavator, the combination of a crane; a bucket-arm supported on said crane and consisting of a plurality of members, two of which are pivoted to a third member, said third member constituting a thrust-link for varying the relative positions of the members of said arm; and a bucket wherein the charging and discharging are effected through the same portion of said bucket.

5. In an excavator, the combination of a linkwork bucket-arm, one of the links whereof is supported between its extremities and carries at one of its extremities a second link of said arm, said second link forming a thrust member for regulating the depth of cut; a bucket attached to one of the links of said arm other than said first-mentioned link said bucket having a single port or mouth for receiving and discharging material; and a door or cover adapted to close the port or mouth of said bucket.

6. In an excavator, the combination of a linkwork bucket-arm supported intermediate of its extremities; a bucket attached to said arm upon one side of the support thereof, and having a single aperture for charging and discharging; a digging-cable whereby said bucket may be forced into the bank to be excavated, and means attached to said arm upon the other side of the support thereof for hoisting said bucket.

7. In an excavator, the combination of a bucket-arm composed of a pair of longitudinal members connected at one end with the bucket-handle, and at the other connected by a transverse link; a bucket attached to said bucket-handle, and means for filling and discharging said bucket through the same port or aperture thereof.

8. In an excavator, the combination of a

pivotally-supported bucket-arm composed of connected members capable of motion relatively to each other, a hoisting-cable attached to said bucket-arm upon one side of the supporting-pivot, a digging-cable attached to said arm at the other side of said supporting-pivot, a bucket attached to said arm, and means for filling and discharging said bucket through a single port or aperture.

9. In an excavator, the combination of a bucket-arm pivotally supported upon the crane of the excavator and composed of a plurality of members, at least three of which are pivotally connected together, and afford means for regulating the depth of cut; a bucket attached to said arm; means for forcing said bucket into the bank to be excavated; and means for discharging the contents of said bucket through the port or entrance through which said contents entered said bucket.

10. In an excavator, the combination of a bucket-arm composed of a plurality of members, at least three of which are pivotally connected together, affording means for regulating the depth of cut; operating mechanism attached to said arm on opposite sides of the point of support thereof; and means for varying the configuration of said bucket-arm.

11. In an excavator, the combination of a pivotally-supported linkwork bucket-arm, a digging-cable attached to said arm upon one side of the point of support thereof, a hoisting-cable attached to said arm at the other side of said point of support, and a combined gas and hydraulic controlling device for governing the configuration of the bucket-arm.

12. In an excavator, the combination of a bucket-arm composed of a plurality of members, two of which are pivotally connected with a third member, said third member affording means for varying the configuration of said arm; and a bucket supported upon said arm and having its cutting or digging portion nearest the main supporting structure of the excavator when said bucket is in a position for taking a cut.

13. In an excavator, the combination, with a bucket and linkwork bucket-arm, of a bucket-handle constituting one of the links of said arm and forming a lever of the third class wherein the point of power of application lies between the fulcrum and the load, the fulcrum and point of power application being the points of attachment of said handle to the adjacent links of said arm, and said bucket constituting the load.

14. In an excavator, the combination of a bucket-arm supported intermediate of its extremities, and composed of a plurality of members, two of which are articulately connected to a third member; said third member affording means for varying the configuration of said arm; an operating-cable attached to said third member; a second cable attached to said arm at a point thereon opposite to said third link with reference to the point at which said arm is supported, and a bucket carried by said arm and adapted to cut in the direction of the main structure of the excavator.

15. In an excavator, a bucket-arm composed of links articulately connected together, one of said links forming the supporting-link of the arm, a second link being pivoted to said first link and constituting the controlling member of the arm, and a third link forming the bucket-handle; in combination with a pivotal support for said first-mentioned link; a bucket carried by said handle; mechanism connected with said second link for controlling the relative positions of the links of the bucket-arm; means for rotating said bucket in a vertical plane; and other means for forcing said bucket into the bank to be excavated.

16. In an excavator, a bucket-arm composed of links articulately connected together; means upon one of said links whereby said arm is supported, and a bucket-handle constituting one of said links and supporting an excavator-bucket; an excavator-bucket; a port or mouth adapted for both receiving and discharging material into and from said bucket; means for controlling the relative positions of the links of the bucket-arm; means for hoisting said bucket, and other means for forcing said bucket into the bank to be excavated.

17. In an excavator, the combination of a bucket-arm composed of members movable relatively to each other, a bucket upon said arm, a bucket-door, and a toggle mechanism for operating said door.

18. In an excavator, a bucket having a single port or opening for charging and discharging; a hinged door or cover for closing said port or aperture; an operating-cylinder having connections with said door, and means for operating said cylinder.

19. In an excavator, the combination of a bucket-arm composed of a plurality of members three of which are pivotally connected together and afford means for varying the configuration of said arm; a bucket attached to said arm; a door for said bucket, and a toggle mechanism for operating said door.

20. In an excavator, the combination of a linkwork bucket-arm, a bucket upon said arm, a door upon said bucket, a door-operating cylinder, and connections whereby said cylinder may operate said door.

21. In an excavator, the combination of an oscillating lever pivotally attached at a point between its extremities to the crane of the excavator; a thrust-link pivoted to said oscillating lever upon one side of the support thereof; a bucket-handle pivoted to said oscillating lever upon the other side of the point of support thereof; a bucket carried by said bucket-handle, connections between said handle and said thrust-link, the point of attachment of said connections on said handle lying between said bucket and said oscillating lever; and means for operating said oscillating lever, thrust-link and bucket-handle.

22. 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; in combination with a power device connected with said transverse link; a bucket; and a second power device applied to said arm at said bucket.

23. 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; in combination with a power device connected with said transverse link; a bucket; a second power device applied to said arm at said bucket; and mechanism for varying the relative positions of the members of said arm, said mechanism being connected to said pivotally-supported longitudinal member and also to said transverse member.

24. In an excavator, the combination of a bucket-arm suitably supported and composed of a plurality of members, one of said members constituting a thrust-segment and another of said members constituting a bucket-handle, said thrust-segment and bucket-handle lying on opposite sides of the support of said arm; a hoisting-cable attached to said thrust-segment; a digging-cable attached to said arm at a point thereon opposite to said thrust-segment; and a thrust-cylinder connected to said thrust-segment and also to another of the members of said bucket-arm.

25. In an excavator having a bucket-arm composed of members movable relatively to each other, the combination of a bucket attached to said arm, a door for said bucket; and a door-operating device consisting of toggle-levers for operating said door, and a cylinder and piston-rod for operating said toggle-levers, said piston-rod constituting also the toggle-pitman.

26. In an excavator, a bucket-arm consisting of links, one of said links being pivotally supported between its extremities and having a point of power application at the upper extremity thereof and also having pivoted thereto at the lower extremity thereof a second link, said second link constituting a bucket-handle and also having a point of power application.

27. In an excavator, a bucket-arm consisting of links, one of said links being pivotally supported between its extremities and having a point of power application at the upper extremity thereof, and also having pivoted thereto at the lower extremity thereof a second link which constitutes the bucket-handle, said second link also having a point of power application; in combination with means for controlling the position of said second link relative said first link, and means for operating said arm.

28. In an excavator, a linkwork bucket-arm, consisting of a plurality of members; one of said members being pivotally supported between its extremities, a second of said members constituting a bucket-handle, said bucket-handle being articulately supported at the lower extremity of said first member; in combination with means for applying power to the upper extremity of said first member and means for applying power to said bucket-handle.

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