No. 649,408. Patented May 8, 1900.

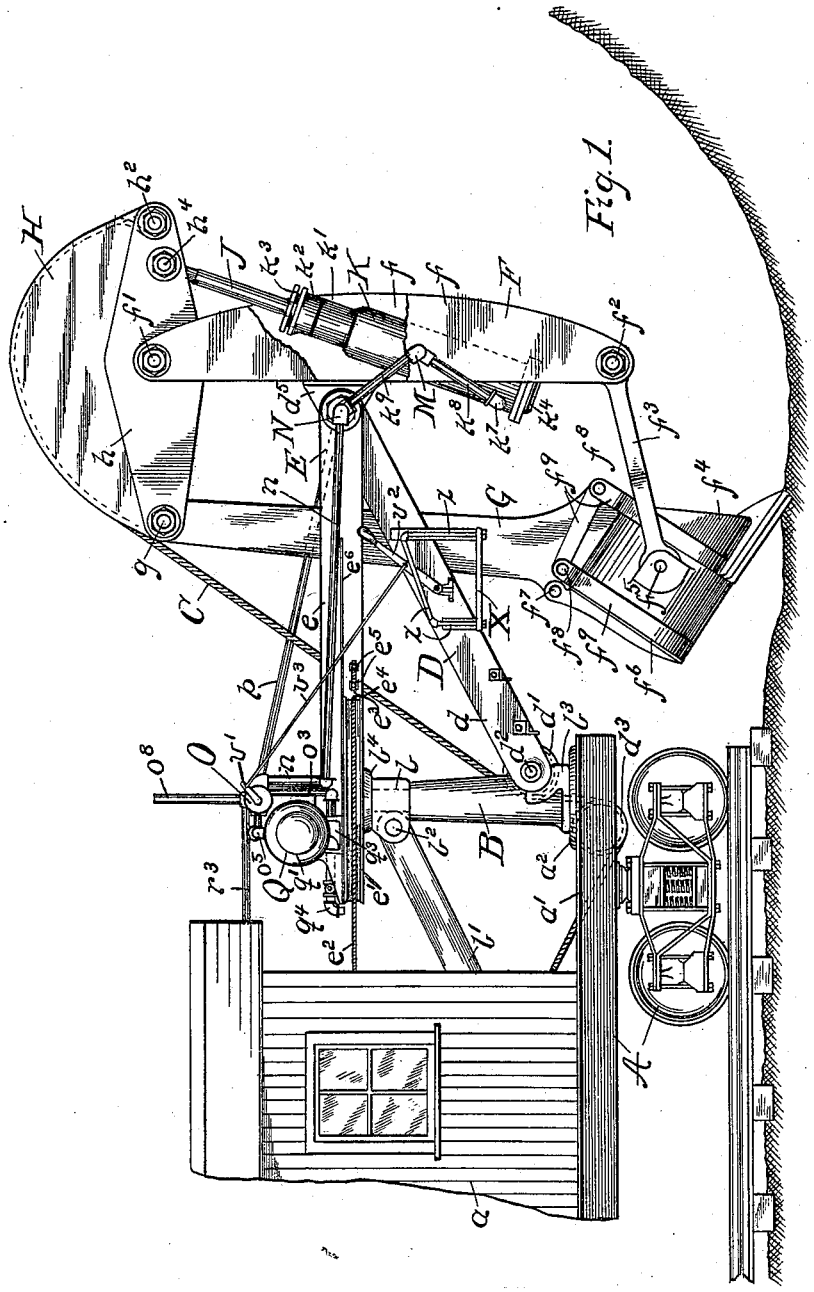
O. HETLESAETER.

EXCAVATOR.

(Application filed Oct. 2, 1899.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.



Witnesses:
Howard M. Cox
Arthur M. Cox

Inventor
Olaf Hetlesaeter
By Jesse Cox
Attorney.

No. 649,408. Patented May 8, 1900.

O. HETLESAETER.

EXCAVATOR.

(Application filed Oct. 2, 1899.)

(No Model.) 5 Sheets—Sheet 2.

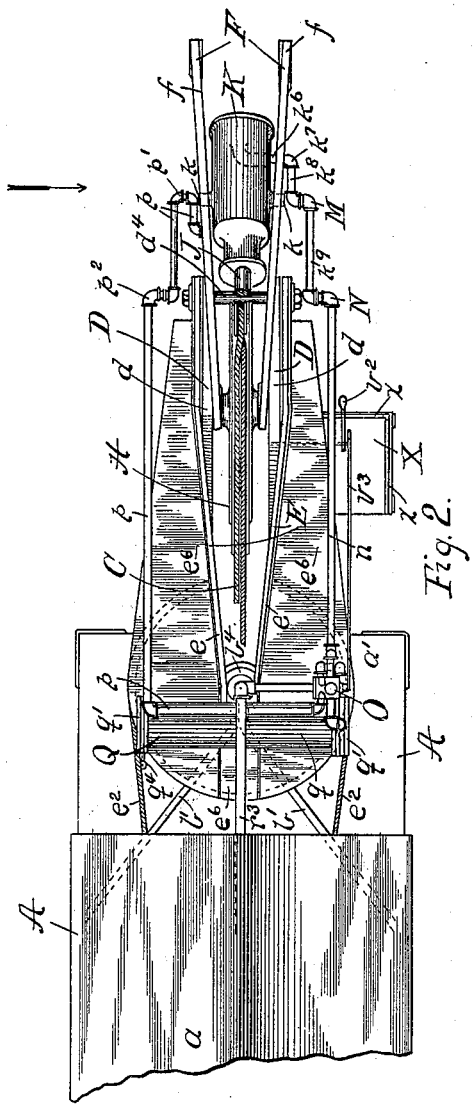


Fig. 2.

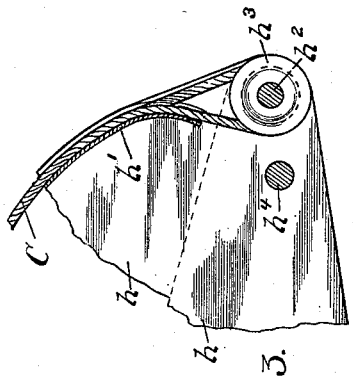


Fig. 3.

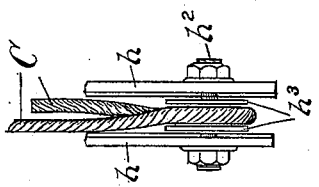


Fig. 4.

Witnesses:
Howard M. Cox
Arthur M. Cox

Inventor
Olaf Hetlesaeter
By Jesse Cox
Attorney

No. 649,408. Patented May 8, 1900.

O. HETLESAETER.

EXCAVATOR.

(Application filed Oct. 2, 1899.)

(No Model.) 5 Sheets—Sheet 3.

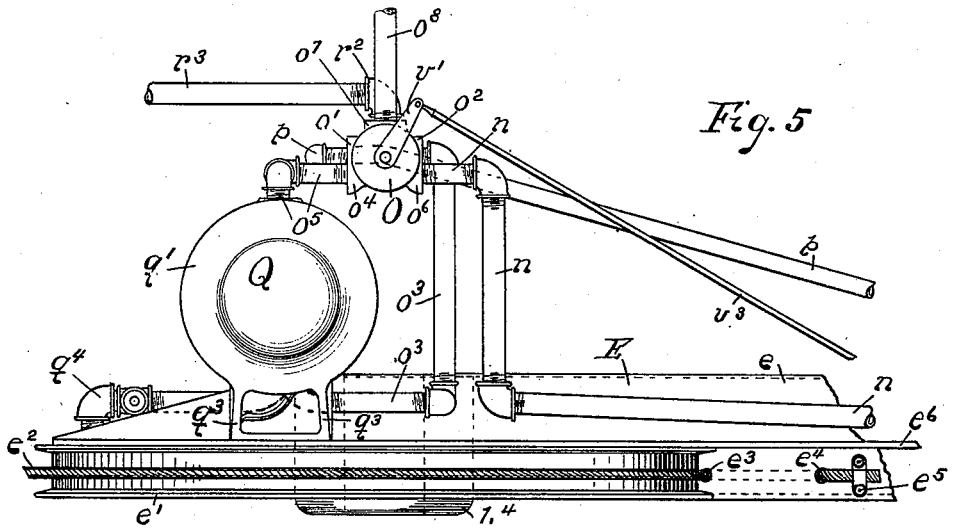


Fig. 5

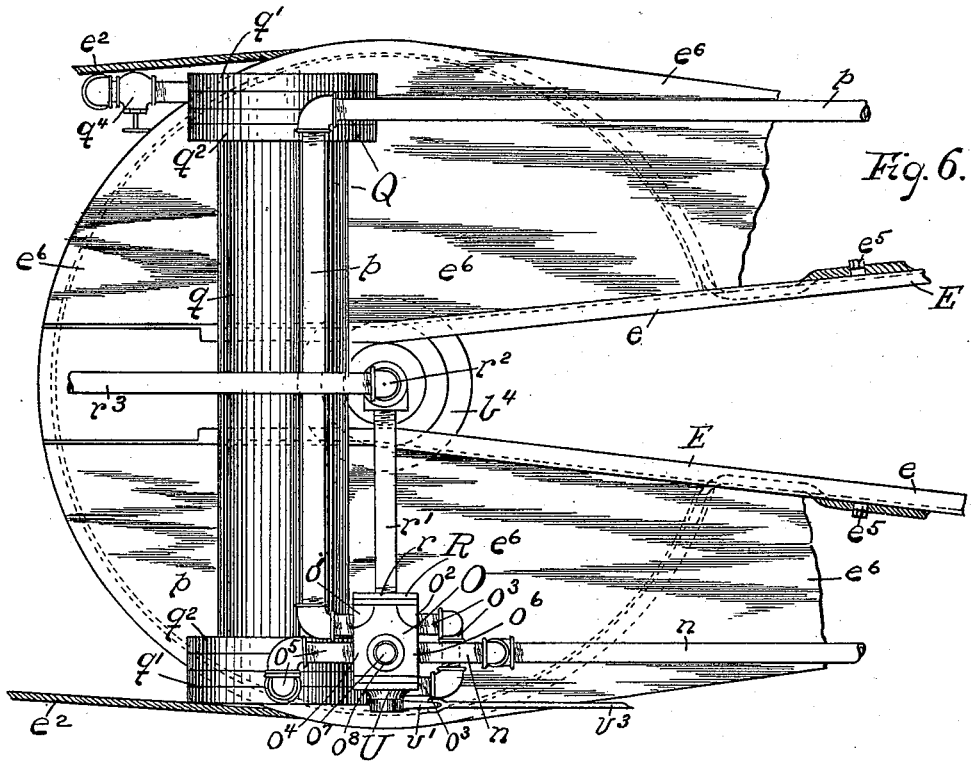


Fig. 6.

Witnesses:
Howard M. Cox
Arthur M. Cox

Inventor
Olaf Hetlesaeter
By Jesse Cox
Attorney

No. 649,408. Patented May 8, 1900.

O. HETLESAETER.

EXCAVATOR.

(Application filed Oct. 2, 1899.)

(No Model.) 5 Sheets—Sheet 4.

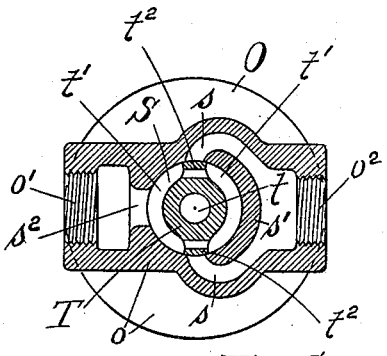


Fig. 8

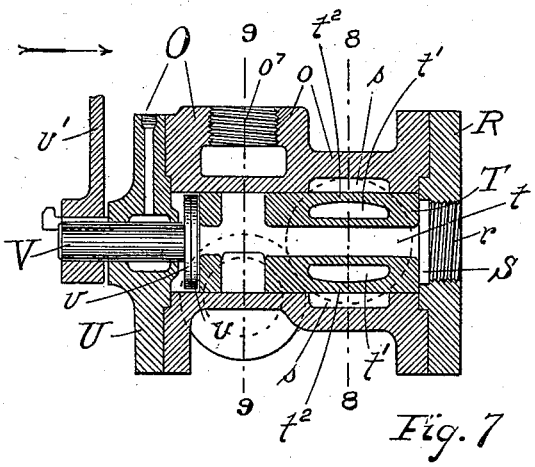


Fig. 7

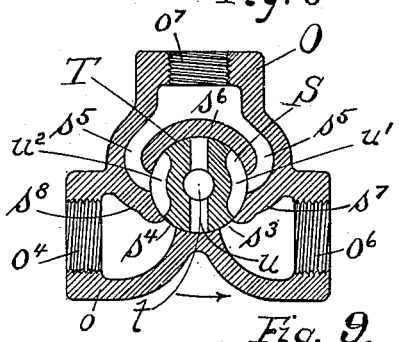


Fig. 9.

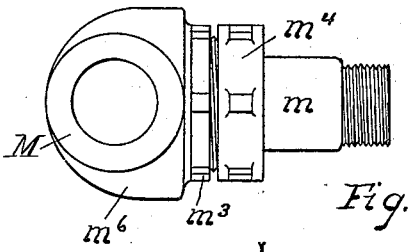


Fig. 11.

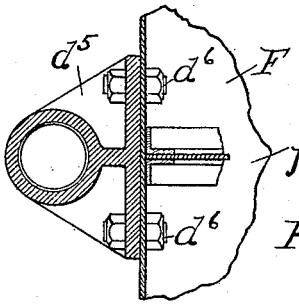


Fig. 12.

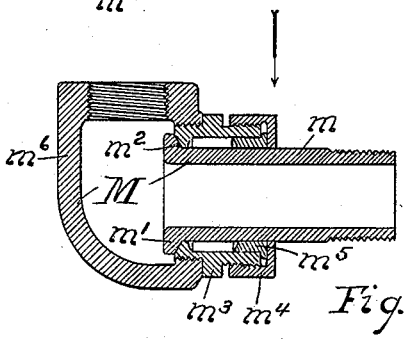


Fig. 10

Witnesses:
Howard M. Cox
Arthur M. Cox

Inventor
Olaf Hetlesaeter
By Jesse Cox
Attorney

No. 649,408. Patented May 8, 1900.

O. HETLESAETER.

EXCAVATOR.

(Application filed Oct. 2, 1899.)

(No Model.) 5 Sheets—Sheet 5.

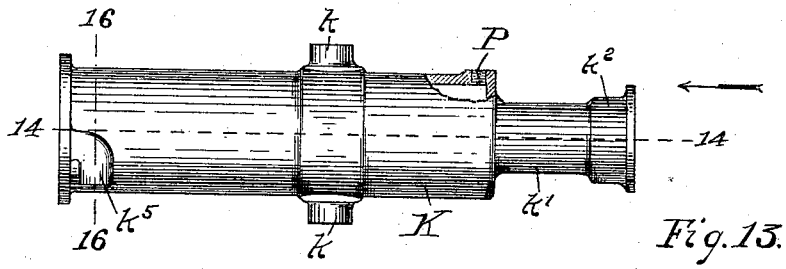


Fig. 13.

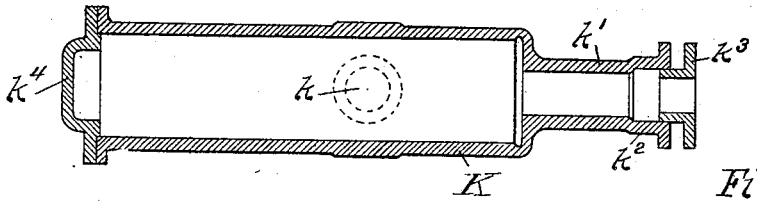


Fig. 14.

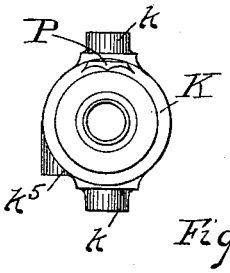


Fig. 15.

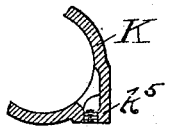


Fig. 16.

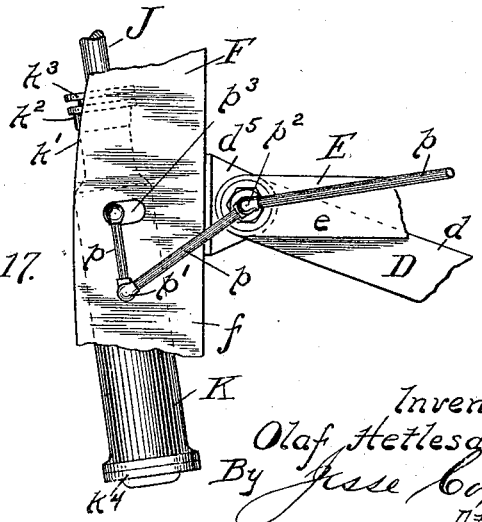


Fig. 17.

Witnesses:
Howard M Cox
Arthur M. Cox

Inventor
Olaf Hetlesaeter
By Jesse Cox
Attorney

UNITED STATES PATENT OFFICE.

OLAF HETLESAETER, OF CHICAGO, ILLINOIS.

EXCAVATOR.

SPECIFICATION forming part of Letters Patent No. 649,408, dated May 8, 1900.

Application filed October 2, 1899. Serial No. 732,332. (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 wherein the bucket-arm is composed of links or members capable of motion relatively to each other. In this class of excavators the position of the bucket in a vertical plane is controlled, first, by swinging the bucket-arm about the pivotal bearing whereon said arm is supported, and, second, by varying the relative positions of the links or members whereof the bucket-arm is composed. The first of said motions is employed to force the bucket forward and hoist it to a position for discharging or to lower it from the discharging position to a point for commencing the stroke. The second of said motions controls the thickness and the depth of the cut taken at any stroke. These motions may occur either separately or simultaneously. If the arm is swung when it is locked—that is, when the members composing it are prevented from moving relatively to each other—the bucket will neither be thrust or crowded into the bank nor be retracted normally therefrom, but will travel in a circular path having the point of support of said arm as a center.

Having in view the operation of the bucket in so far as it is influenced by the second of the above-described motions of the links, the object of my invention is to provide a controlling and locking device whereby the links of the bucket-arm may be controlled so as to assume any desired position relatively to each other, may be substantially free to move relatively to each other, or may be rigidly locked and prevented from moving relatively to each other, said conditions being subject to the will of the operator for all positions of the bucket-arm. I attain 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 linked bucket-arm supported upon the boom and operated by the hoisting-cable. A portion of the oscillating lever is broken away in order to show more clearly the thrust-cylinder and its position in said lever. Said figure also shows the pressure-tank mounted upon the boom, the operating-valve, and the pipe connections between said tank and said cylinder. Fig. 2 is a plan view of the excavator and car and shows the plate whereto the sluing-circle is attached and whereon the pressure-tank rests. The oscillating lever is shown in a position approximately horizontal, thereby showing more clearly the relative position of the thrust-cylinder-pipe connections. Fig. 3 is a side view in detail of the forward portion of the thrust-segment, showing the tension-equalizing sheave and a portion of the hoisting-cable in position. Fig. 4 is a front view of the forward portion of the thrust-segment, the equalizing-sheave, and the hoisting-cable, as in Fig. 3. Fig. 5 is a side view, and Fig. 6 is a plan view, of the rear portion of the excavator-boom on an enlarged scale, showing the pressure-tank, the operating-valve, and adjacent pipe connections. Said figures show the sluing-circle and sluing-cable and also the method of attaching the ends of said cable to said boom. Fig. 7 is a detailed view, in longitudinal section, of the operating-valve whereby the flow to and from the thrust-cylinder is controlled. Said figure shows the valve-core, the valve-body, valve-covers, valve-spindle, and a portion of the spindle-operating lever. Fig. 8 is a detailed sectional view of the operating-valve core and body looking in the direction of the arrow, Fig. 7, and taken on the line 8 8 in said Fig. 7. Fig. 9 is a detailed sectional view of the operating-valve core and body looking in the direction of the arrow, Fig. 7, and taken on the line 9 9 in said Fig. 7. Fig. 10 is a detailed view, in longitudinal section, of the type of swivel-joints employed in the pipe connections of the thrust-cylinder. Fig. 11 is a detailed view of the above-mentioned swivel-joint looking in the direction of the arrow, Fig. 10. Fig. 12 is a detailed sectional view of the pivot-casting whereby the oscillating lever is supported upon the boom. The plane of said section is transverse to the axis of rotation. The adjacent portion of the oscillating lever is also shown. Fig. 13 is a side view of the thrust-cylinder on a scale some-

what enlarged. The trunnions and the lower lug for the pipe connection are shown. A portion of the cylinder near the neck thereof is in section and shows the upper lug tapped to receive a connecting-pipe. Fig. 14 is a sectional view of the thrust-cylinder, taken on the line 14 14, Fig. 13. The lower cylinder-head and the gland are also shown. Fig. 15 is an end view of the thrust-cylinder looking in the direction of the arrow, Fig. 13. Fig. 16 is a sectional view of a portion of the thrust-cylinder, taken on the line 16 16, Fig. 13, and shows the lower lug tapped to receive a connecting-pipe. Fig. 17 is a side view in elevation of a portion of the oscillating lever and adjacent parts looking in the direction of the arrow, Fig. 2, and showing the slot in said lever whereby the piping may connect with the thrust-cylinder without preventing the oscillatory motion of said cylinder upon its trunnions.

Similar letters refer to similar parts throughout the several views.

A represents a railway-car whereon the excavator is mounted. Inclosed within the engine-house a of said car is suitable driving machinery, whereby power is furnished to operate the moving parts of the excavator. On the forward extremity of the platform a' of said car is secured the base-plate a^2, whereon the mast B is stepped in such a manner as to rotate upon a vertical axis. Said base-plate a^2 and mast B are centrally apertured to afford a passage for the hoisting-cable C. Said mast B consists, preferably, of a steel casting tapering slightly toward its upper portion, where it has a bearing in the mast-collar b. Said collar is securely braced by the eyebars b' b', which are attached to said collar by means of the pin b^2 and extend rearwardly to each side of the car A, whereto they are fastened. The lugs b^3, formed near the lower extremity of said mast, constitute socket-bearings for the abutting boom-support D. The cap b^4, attached to and rotating with the mast B, above the said collar b, is preferably of annular form and affords means of attachment for the bars e e of the boom E. Said bars e e extend in the same general direction from said cap b^4, but diverge somewhat toward their forward extremities. A channel-beam e', bent into circular form with the flanges toward the exterior, constitutes the sluing-circle. Said circle e' is securely attached to the said beams e e of the boom E concentrically with the axis of the mast B. The sluing-cable e^2, operated by suitable mechanism upon the car A, extends along the channel of the sluing-circle e' and is fastened at its forward extremities to the boom E in a manner apparent in Figs. 5 and 6 of the drawings. Said cable extends through the apertures e^3, located in the beams e e at the points where the forward extremities of the sluing-circle e' meets the said beams e e. Said cable is then brought forward a short distance and passed through the apertures e^4 in said beams and made fast thereto by means of the clips e^5. The plate or web e^6, consisting, preferably, of sheet metal, extends across the upper surface of the sluing-circle e' and is of such configuration as to conform to the outline of said circle at the rear portion thereof, but extends in a forward direction considerably beyond said circle, lying outside of the beams e e, and becoming gradually narrower toward its former extremity. Said plate e^6 is attached to said beams e e and to the sluing-circle e', thus serving as lateral bracing and as a means of securing said circle to the boom E.

The parallel beams d d, constituting the beam-support D, rest at their lower extremities in the lugs b^3 on the mast B. The sheave d', which serves as a guide for the hoisting-cable C, is mounted upon the shaft d^2 at the lower extremity of the said boom-support D. The sheave d^3 is similarly mounted for the same purpose in the platform a' of the car A. Said sheaves are so placed that the reaches of the cable C between said sheaves shall be approximately coincident with the axis of the mast B, thereby preventing lateral strains in the said sheaves and obviating the tendency of the cable C to become entrained when the boom is swung laterally.

The forward extremity of the boom-support D is attached to the forward extremity of the boom E by means of the shaft d^4, which extends through suitable apertures oppositely placed in the beams e e and d d of the boom and support, respectively. Said shaft d^4 serves as a bearing for the pivot-casting d^5. (Shown in detail in Fig. 12.) The oscillating lever F is secured to said pivot-casting d^5, preferably by means of bolts d^6 d^6. Said lever F forms one of the members of the linked bucket-arm and is composed of the approximately-parallel plates f f, suitably reinforced and attached to said casting d^5 intermediate of their extremities. Said plates are secured in their proper relative positions by means of the pin f' at their upper extremities and the pin f^2 at their lower extremities. The said pin f^2 also acts as a pivot for the bucket-links f^3, whereby the excavator-bucket f^4 and lever F are connected. The links f^3 consist, preferably, of flat eyebars and extend from said pin f^2 to the trunnions f^5, located upon each side of the bucket f^4. Said bucket is of the ordinary pattern, having a discharging-bottom f^6 hinged upon the pin f^7 and is attached to the bucket-handle G by means of the pins f^8 f^8 in the straps f^9 f^9. Said handle G consists, preferably, of plates suitably fastened together and extends from said bucket to the rear portion of the thrust-segment H. The pin g serves to make an articulate connection between said bucket-handle and said segment.

The segment H is preferably a built-up member consisting of the parallel plates h h, resembling half-disks in configuration and having a channel-beam h' fastened thereto in such a manner as to form a groove or guide

for the cable C along the curved periphery of said segment, as shown in Fig. 3. Approximately at the center of curvature of its periphery said segment H has a pivot-bearing upon the pin f' of the lever F. The curved portion of said segment lies above the said pin f' or upon the side thereof opposite to the pivot-casting d^5. The pin h^2 is secured to the forward portion of the segment H and extends between the plates $h\,h$, so as to form a bearing for the tension-equalizing sheave h^3.

The above-mentioned hoisting-cable C, which is preferably of wire, but may consist of a chain of links, is connected to the hoisting mechanism mounted upon the car A. From said hoisting mechanism the cable extends forward under the guide-sheave d^3, over the sheave d', upward to and along the channel h' in the segment H, around the equalizing-sheave h^2, rearward along said channel h', over the said sheave d', under the said sheave d^3, and thence rearward, where the remaining extremity of said cable is also attached to said hoisting mechanism. By thus doubling the hoisting-cable greater power may be transmitted to the segment H, and by means of the sheave h^3 the tension in the two portions of said cable is kept substantially equal. Near the forward portion of the segment H is secured the pin h^4, whereby said segment is pivotally connected with the piston-rod J of the thrust-cylinder K. Said cylinder K is supported by the trunnions $k\,k$, formed thereon intermediate of the extremities thereof, and having a bearing in the side plates $f\,f$ of the oscillating lever F. Said cylinder terminates at its upper extremity in an elongated neck k', which serves as a guide for the piston-rod J. The upper extremity of said neck k' forms a stuffing-box k^2, which receives the stuffing-box gland k^3. The lower extremity of the cylinder K is closed by means of the cylinder-head k^4. The lug k^5, formed near the lower extremity of said cylinder, is tapped to receive the threaded extremity of the pipe k^6. By means of the elbow k^7 said pipe k is connected with the pipe k^8, which lies exterior to the lever F and extends to a point lying preferably on a line through the axis of the cylinder-trunnions $k\,k$. At this last-described point said pipe k^8 is connected with the pipe k^9 by means of the swivel-joint M. The lug k^5, the pipes k^6 and k^8, and the elbow k^7 are so located as to clear the lever F when the cylinder K oscillates upon its trunnions $k\,k$ in the operation of the excavator.

The swivel-joint M (shown in detail in Figs. 10 and 11) consists of a sleeve m, terminating in a flange m', ground so as to make a tight joint with the correspondingly-ground flange m^2 of the stuffing-box m^3. Said stuffing-box m^3 extends from said flange m^2 rearward, so as to inclose a portion of said sleeve m, and is threaded at its rear extremity to receive the swivel cap-nut m^4. Lying between said stuffing-box m^3 and sleeve m is the stuffing-box gland m^5. Said stuffing-box m^3 is threaded at its forward extremity near said flange m^2 to receive the interiorly-threaded swivel-elbow m^6.

The swivel-joint N, identical in its construction with the above-described swivel M, lies outside of the boom E, preferably at a point lying on a line coincident with the axis of the shaft d^4. The said swivel N is connected to the said pipe k^9 and is also connected to the piping $n\,n$, which leads to the cylinder-operating valve O, hereinafter described.

Upon the side of the thrust-cylinder K opposite to the lug k^5 thereon and near the neck k' is the boss P, which is tapped for receiving pipe connections. By means of the piping $p\,p\,p$, extending from said boss P, the upper end of the cylinder K is connected with the operating-valve O in a manner similar to the manner in which the lower end of said cylinder is connected with the said valve. Said piping is provided with a swivel p', preferably at the axis of the trunnions $k\,k$, and a swivel p^2, preferably at the axis of the shaft d^4, said swivels being identical in construction with the swivel M. Said swivels p' and p^2 and the greater portion of said piping $p\,p$ lie upon the exterior of the lever F and boom E. The slot p^3 is provided in one of the plates f, adjacent to the piping $p\,p$, as shown in Fig. 17, in order that said piping may have a passage through said plate f and not interfere therewith when the thrust-cylinder K oscillates upon the trunnions $k\,k$.

For reasons which will hereinafter appear the thrust-cylinder K is operated to best advantage by means of a liquid, preferably water, acting upon the upper surface of the piston thereof or the surface adjacent to the piston-rod J, and a gas, preferably steam, acting upon the lower surface of said piston.

The pressure-tank Q consists, preferably, of a cylinder q, of sheet metal, closed at its extremities by means of the heads $q'\,q'$, attached to the tank-flanges $q^2\,q^2$. Said tank is conveniently located near the rear portion of the boom E, transversely therewith, and is supported upon the plate e^6 by means of the legs $q^3\,q^3$. Said tank Q is designed to hold steam and water under pressure and is provided with a drain q^4, connecting with the lower portion of said tank.

The above-mentioned operating-valve O is placed for convenience slightly above and in front of the extremity of said tank adjacent to the position occupied by the cranesman. The valve-body o (shown in detail in Figs. 7, 8, and 9) has a laterally-tapped opening o', whereby it is connected with the water-piping p, leading to the upper portion of the thrust-cylinder K. In a position opposite to said opening o' said valve-body has an opening o^2, tapped to receive one of the lengths of pipe $o^3\,o^3\,o^3$, leading to and connecting with the lower portion of the pressure-tank Q. Longitudinally removed from said opening o' in said body o is the lateral opening o^4, tapped

to receive one of the lengths of pipe o^5 o^5, whereby said valve-body is connected with the upper portion of the tank Q. The object in connecting the water-pipe o^3 with the lower portion and the steam-pipe o^5 with the upper portion of the tank Q is that said pipe o^3 may receive only water from said tank and said pipe o^5 may receive only steam therefrom. In the valve-body o, opposite to said opening o^4, is the opening o^6, tapped to receive the steam-pipe n, leading to the lower portion of the thrust-cylinder K. The opening o^7 extends vertically upward from the valve-body o at the transverse section whereat said openings o^4 and o^6 are located. Said opening o^7 is for the passage of the exhaust-steam and is tapped to receive the exhaust-pipe o^8. The extremity of the valve-body o lying toward the longitudinal center line of the boom E is closed by means of the valve-cover R. Said cover R has a horizontal opening r, tapped to receive the steam-supply pipe r'. Said pipe r' extends horizontally to a point on the vertical axis of rotation of the mast B, where it is connected to the swivel r^2 in such a manner that the axis of rotation of said swivel is coincident with the axis of rotation of said mast. Said swivel r^2 is identical in its construction with the swivel M, above described, and is connected at its rear extremity with the pipe r^3, leading from the source of steam-supply.

The valve-body o has a longitudinal bore S, wherein rotates the cylindrical valve-core T. By means of the passages s s branching around the wall s' the opening o^2 of said valve-body has communication with said bore S at diametrically-opposite portions thereof, as shown in Fig. 8. The opening o' is connected with said bore S by means of the direct passage s^2. The opening o^6 (shown in section in Fig. 9) has a passage s^3 communicating with said bore S, and the opening o^4 communicates with said bore by means of the passage s^4. The passages s^5 s^5 branching around the wall s^6 connect said bore S with the vertical opening o^7. The walls s^7 and s^8 separate the passages s s from the passages s^3 and s^4, respectively.

From the above description it follows that from the bore S the leads of the passages are as follows: s s, water to the lower portion of the tank Q; s^2, water to the upper portion of the thrust-cylinder K; r, steam from the steam-supply; s^3, steam to the lower portion of the thrust-cylinder K; s^4, steam to the upper portion of the tank Q, and s^5 s^5 to exhaust.

The valve-core T has a cylindrical steam-port t extending longitudinally through its center and communicating with the steam-supply opening r. The water-ports t' t' lie in the periphery of said core T, excepting at the portions t^2 t^2 thereof. Said portions t^2 t^2 are oppositely located on said core T and close the water-passages s s when said core is in the position shown in Figs. 7, 8, and 9. When the core T is in said position, all the water-passages of the valve O are closed, but when the core T is rotated so as to occupy any other position water may pass through said valve in either direction. Near the extremity of the core T and adjacent to the steam-passages s^3 s^4 and s^5 s^5 (shown in section in Fig. 9) is the steam-port u, which communicates with the said longitudinal steam-port t and extends vertically and is closed when the water-passages of the valve O are closed. The steam-ports u' and u^2 are symmetrically located upon opposite portions of the core T, in the periphery thereof, and are so formed that when the core T is rotated a sufficient distance in the direction of the arrow, Fig. 9, the port u^2 connects the steam-passage s^4 with one of the exhaust-passages s^5, and when the core T is rotated in the opposite direction the port u' connects the steam-passage s^3 with one of the exhaust-passages s^5. The passages in the valve-body o and valve-core T are so related that when the passage s^4 is open to exhaust the passage s^3 is open to live steam through the ports t and u and when the passage s^3 is open to exhaust the passage s^4 is open to live steam through the ports t and u.

An important feature in the construction of the valve O is that the lap at the passages where live steam is introduced is larger than the lap at the water-ports or at the ports leading to the exhaust. By this construction the core T may be rotated to such a position that water may pass in either direction and either the cylinder K or tank Q may be open to exhaust while the live-steam passages remain closed.

The valve-cover U closes the extremity of the valve-body o opposite to the valve-cover R and is centrally bored to afford a passage for the valve-spindle V. Said valve-spindle is attached to the valve-core T by means of the flanges v v and projects beyond said cover U sufficiently to afford means of attachment to the valve-operating lever v'. Said lever v' is connected with the hand-lever v^2 by means of the rod v^3 and is located within convenient reach of a cranesman standing upon the platform X. Said platform is preferably secured to the boom-support D and is provided with the guard-rails x x.

The structure hereinabove described is analogous, in so far as the bucket-arm is concerned, to the structures described and claimed by me in previous applications, (Serial No. 729,706, filed September 5, 1899, and Serial No. 730,829, filed September 18, 1899.)

In the operation of the machine both of the rear extremities of the hoisting-cable C are operated together, and the equalizing-sheave h^3 prevents the existence of unequal strains in said cable. When the hoisting mechanism induces tension in said cable, the force thereof induces in the segment H a tendency to rotate about the pin f' as a center and also to rotate or swing, together with the lever F, about the shaft d^4 as a center. These motions may occur separately or simultaneously.

The rotation of the segment H about the pin f' causes the bucket f^4 and bucket-handle G to be thrust or crowded directly toward the bank of earth or other material to be excavated. The rotation or swinging of the segment H about the shaft d^4 causes a corresponding swinging of all of the parts composing the bucket-arm and causes the bucket to describe a forward or cutting motion in a circular path centered at the said shaft d^4. When the thrust-cylinder K is not required to influence the position of the bucket f^4, the valve-core T is so set in the valve O that water is free to pass through said valve in either direction. When the thrust or normal crowding of the bucket f^4 into the bank due to the tension of the cable C is insufficient, the cranesman standing upon the platform X sets the valve O in such a position that live steam is permitted to pass through said valve and through the connecting-piping and enter the lower portion of the thrust-cylinder K. In this position of the said valve the water-ports t' thereof are open, so that the water may pass from the upper portion of the cylinder K through the connecting-piping to the pressure-tank Q, and at the same time the port u^2 connects with the passage s^4, so that the upper portion of the pressure-tank Q is open to exhaust. Thus the live steam exerts pressure upon the lower surface of the thrust-cylinder piston, while the water is free to pass from the uppor portion of said cylinder through the valve O to the tank Q, where the water is freely received, for said tank, being open to exhaust, exerts no back pressure. As the steam forces the piston upward the piston-rod J forces the upward portion of the thrust-segment H upward, and as said segment is pivoted upon the pin f' said pin f' acts as a fulcrum and the rear portion of said segment is lowered. This causes the lowering of the pin g and consequent lowering or thrusting of the bucket and bucket-handle into the bank. Said thrusting of the bucket into the bank may be independent of or may be additional to the downward-thrusting force derived from the cable C. When the operator desires to terminate the downward thrust of the bucket, the valve O is so set that both the water and steam passages are closed, as shown in Figs. 7, 8, and 9. This prevents the exit of water from the thrust-cylinder K, and as water is incompressible the upward motion of the piston is immediately and completely arrested and the members composing the bucket-arm are rigidly held in their same positions relatively to each other. As the rotation of the segment H about the pin f' is prevented the thrusting force of the cable C is rendered inoperative and the force of said cable is exerted in rotating the rigid bucket-arm about the shaft d^4, thus forcing the bucket f^4 in a forward direction. The said bucket may be raised directly from the bank by setting the valve O so that the tank Q receives live steam and the lower portion of the cylinder K is open to exhaust. Such position of the valve O permits the passage of water, and the pressure of the steam upon the surface of the water in the tank Q causes the water to pass through the connecting-piping and into the upper portion of the cylinder K, where it presses upon the upper surface of the piston with a force substantially equal to the pressure of the live steam. The piston and piston-rod J are thus lowered and cause the raising of the bucket f^4. The motion of the piston-rod J within the cylinder K causes said cylinder to oscillate slightly upon its trunnions k k and causes corresponding motion in the swivels M and p'. The motion in the cylinder-piping due to the swinging of the bucket-arm upon the shaft d^4 is provided for in the swivels N and p^2. The swivel r^2 provides for the motion of the steam-supply pipes r' and r^3 due to the lateral swinging of the boom E. When a downward thrust of the bucket substantially equal to the downward thrust due to the tension of the cable C is desired, the valve-core T is rotated in the direction of the arrow, Fig. 9, until the water-ports t' t' are partially open and the piping o^5, leading to the upper portion of the tank Q, is open to exhaust. This condition will occur before the piping n, leading to the lower portion of the cylinder K, is open to take steam. Consequently the water in said cylinder K is free to pass into the tank Q without resistance due to back pressure from said tank, and, except for the friction of the parts, the motion of the members of the bucket-arm relatively to each other will be substantially uninfluenced by said thrust-cylinder K and piston-rod J. At the termination of any motion of the piston-rod J outward from the thrust-cylinder K the pressure upon the lower surface of the piston is substantially equal to the live-steam pressure; but the steam-pressure upon said piston is opposed by the pressure of the water in the upper portion of said cylinder, and as said water has no means of escape and is incompressible the motion of said piston in either direction is effectually prevented. Both the cylinder K and piston-rod J are supported upon and attached to members of the bucket-arm, and therefore move with said arm and are operative in any position thereof. No motion of the boom E or of the bucket-arm relatively to said boom can alter the position of the piston-rod J in the cylinder K nor the position of the members of said boom relatively to each other. It follows, therefore, that said thrust-cylinder K and correlated parts constitute both a controlling and a locking device. When the bucket f^4 has been hoisted to the desired height, the boom E is swung laterally by means of the sluing-cable e^2, working in the sluing-circle e. In order to gain the exact position for discharging, the bucket is then thrust forward or retracted by means of the thrusting or controlling mechanism, consisting of the thrust-cyl-

inder K and its correlated parts. This is accomplished in the same manner as the thrusting and raising are accomplished when the bucket is in a lower position. The bucket-arm and the parts supported thereon are so balanced that gravity will cause the bucket to return to its initial cutting position when the cable C is paid out. The members of the bucket-arm, pivotally connected together, form a linkwork of variable configuration. Upon the configuration of said linkwork depends the height or depth of the excavator-bucket. It is evident that the purpose of the thrust-cylinder K is to furnish means for controlling the configuration of the linkwork, and thereby control the position of the bucket. It is therefore immaterial which ones of the members of the said linkwork are connected by means of the thrust-cylinder and its piston-rod so long as said cylinder and rod control the configuration of said linkwork, and thereby control the position of said bucket.

The location of the pressure-tank Q and operating-valve O is chiefly a matter of convenience for eliminating unnecessary swivel connections and economizing space.

It is evident that other fluids may be substituted for steam and water to operate the thrust-cylinder K—as, for example, compressed air and oil, respectively. It is possible also to employ compressed gases at both ends of said cylinder, but to less advantage.

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

1. In an excavator, the bucket-arm whereof is composed of an articulating linkwork, means for rigidly maintaining and controllably varying the configuration of said linkwork.

2. In an excavator, the combination of a bucket-arm pivotally supported, and composed of linked members the positions whereof, relatively to each other, determine the distance of the excavator-bucket from the point of support of said arm; a power device carried upon said arm for controlling the position of the members thereof relatively to each other; means for controllably supplying power to said power device; and means for supporting and operating said arm.

3. In an excavator having a tandem-linked bucket-arm, the combination, with said arm, of a thrust-cylinder supported upon one of the links of said arm, a piston working in said cylinder, a rod connected with said piston and with another of the members of said arm; and means for operating said thrust-cylinder and related parts.

4. In an excavator wherein the bucket-arm is a linked structure, the combination, with said arm, of a thrust-cylinder supported upon one of the links of said arm; a piston working in said cylinder; a piston-rod connected with said piston and with another of the links of said arm; a pressure tank or vessel; means for supplying fluid under pressure to said tank or vessel and to said thrust-cylinder; and means for controlling the supply of said fluid to said tank or vessel and to said thrust-cylinder.

5. In an excavator wherein the bucket-arm is composed of an articulating linkwork, a hydraulic locking device for rigidly maintaining the configuration of said linkwork.

6. In an excavator wherein the bucket-arm is a linked structure, the combination, with said arm, of a thrust-cylinder supported upon one of the links of said arm; a piston working in said cylinder; a piston-rod connected with said piston and with another of the links of said arm; a closed vessel; connections between the lower portion of said vessel and said cylinder at one end thereof; a conveyer for supplying gas under pressure; connections between said closed vessel and said conveyer; connections between said conveyer and said cylinder at the other end thereof; an exhaust; connections between the upper portion of said closed vessel and said exhaust; connections between said last-mentioned end of said cylinder and said exhaust; and means for controlling the passage of fluids through said connections.

7. In an excavator, the combination of a boom, a bucket-arm pivotally supported on said boom and composed of members articulately joined together; means for rotating said arm about its supporting-pivot; a thrusting device connecting two of the members of said arm and comprising a cylinder, a piston therein and a piston-rod connected with said piston; a pressure-tank, a conveyer for supplying gas under pressure for the operation of said thrusting device; an exhaust; a valve having connections with said gas-conveyer, said exhaust, said tank and both ends of said cylinder of said thrusting device, and having ports whereby the flow of fluids for operating said cylinder may be controlled; and means for operating said valve.

8. In an excavator, the combination of a boom, a bucket-arm pivotally supported on said boom and composed of members articulately joined together; means for rotating said arm about its supporting-pivot; a thrusting device connecting two of the members of said arm and comprising a pivotally-supported cylinder, a piston therein and a piston-rod connected with said piston; a pressure-tank located on said boom; a conveyer for supplying gas under pressure for the operation of said thrusting device; an exhaust; a valve; connections for gas between said valve and said exhaust; connections for gas between said valve and said conveyer; connections for gas between said valve and said tank; connections for gas between said valve and one end of said thrust-cylinder; swivel-joints in said last-mentioned connections; connections for liquid between said valve and the other end of said thrust-cylinder; swivel-joints in said last-mentioned connections; connections for liquid between said valve and said pressure-tank; a rotary valve-core in said valve whereby the

flow of the fluids for operating said thrust-cylinder may be controlled; and means for controlling the position of said valve-core in said valve.

9. In an excavator having a laterally-swinging boom, the combination with said boom of a bucket-arm pivotally supported on said boom and composed of members articulately joined together; a thrust-segment constituting one of the members of said arm and being pivotally supported on the oscillating lever; an oscillating lever as aforesaid, said lever constituting another of the members of said arm and affording the pivotal support for said arm upon said boom, and said lever also pivotally supporting said thrust-segment; a cable connected with and operating said thrust-segment; means for operating said cable; a thrust-cylinder carried by said lever; a piston in said cylinder; connections between said piston and said segment; and a piston-operating mechanism whereby liquid is controllably supplied to said cylinder upon one surface of said piston, and gas is controllably supplied to said cylinder upon the other surface of said piston.

OLAF HETLESAETER.

Witnesses:
ARTHUR M. COX,
HOWARD M. COX.