No. 669,992. Patented Mar. 19, 1901.

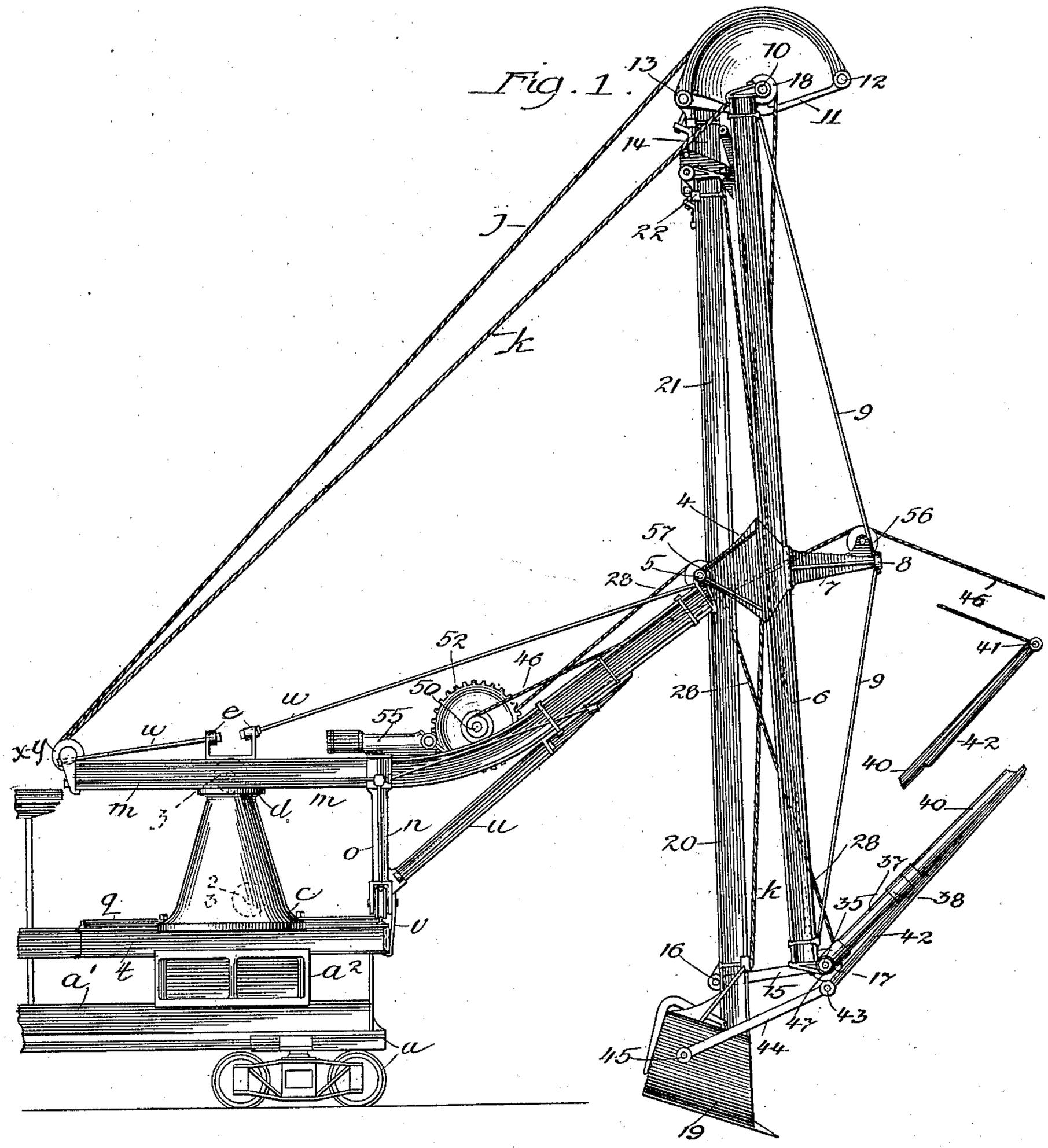
O. HETLESAETER.

EXCAVATOR.

(Application filed June 11, 1900.)

(No Model.) 7 Sheets—Sheet 1.

Fig. 1.



Witnesses:

Frank S. Blanchard

Howard M. Cox

Inventor

Olaf Hetlesaeter

By Jesse Cox

Attorney.

No. 669,992. Patented Mar. 19, 1901.

O. HETLESAETER.

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(No Model.) 7 Sheets—Sheet 2.

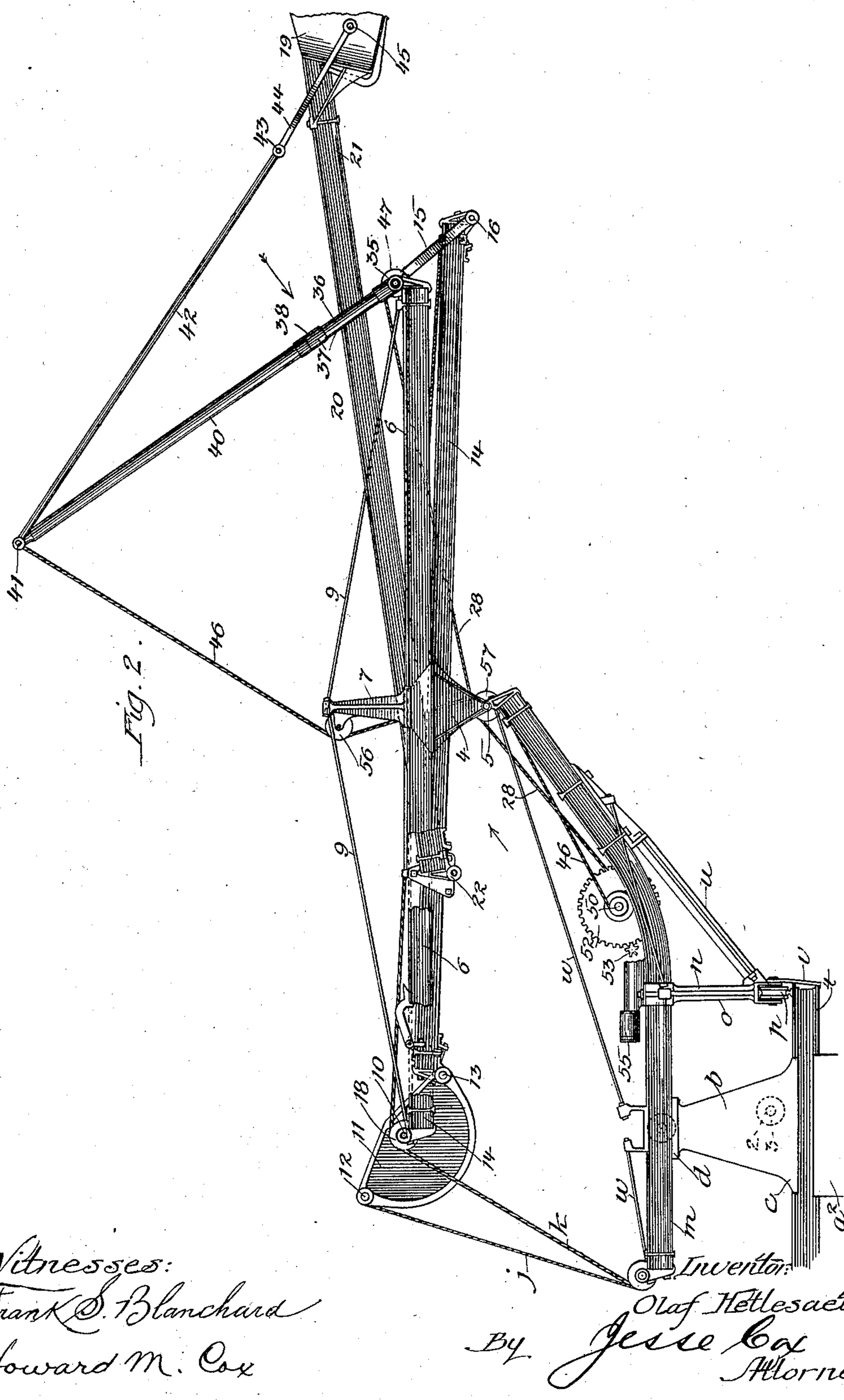

Fig. 2.

Witnesses:
Frank S. Blanchard
Howard M. Cox

Inventor:
Olaf Hetlesaeter
By Jesse Cox
Attorney

No. 669,992. Patented Mar. 19, 1901.

O. HETLESAETER.

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(No Model.) 7 Sheets—Sheet 3.

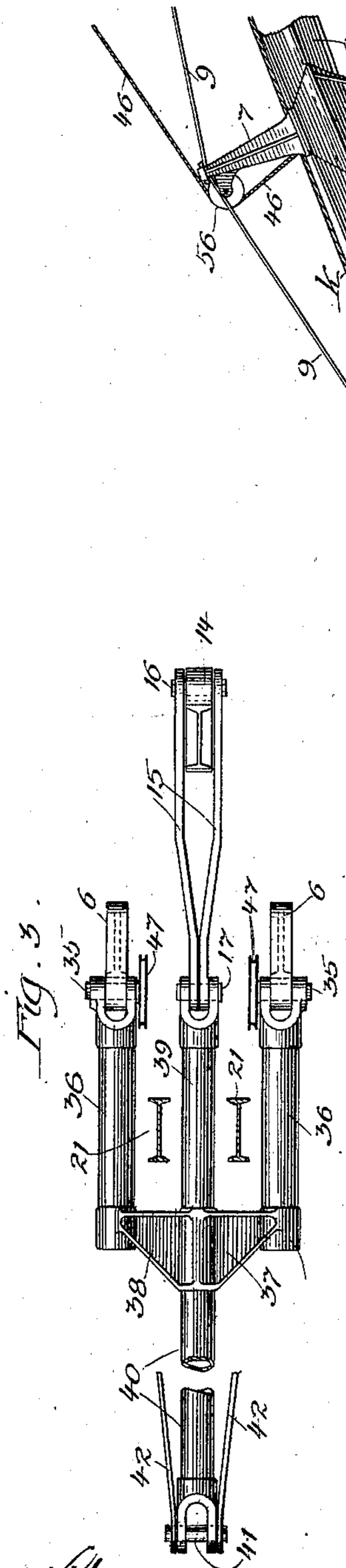

Fig. 5.

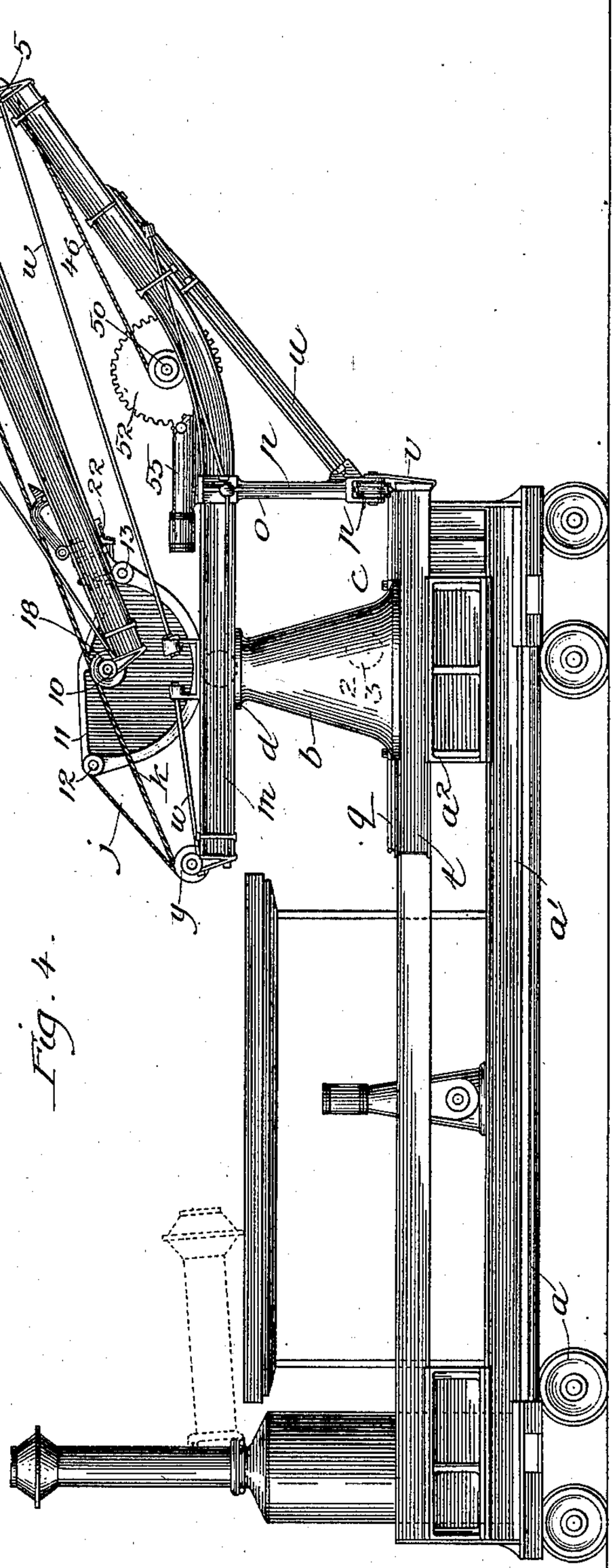

Fig. 4.

Witnesses:

Frank S. Blanchard

Howard M. Cox

Inventor:

Olaf Hetlesaeter

By Jesse Cox

Attorney

No. 669,992.

Patented Mar. 19, 1901.

O. HETLESAETER.

EXCAVATOR.

(Application filed June 11, 1900.)

(No Model.)

7 Sheets—Sheet 4.

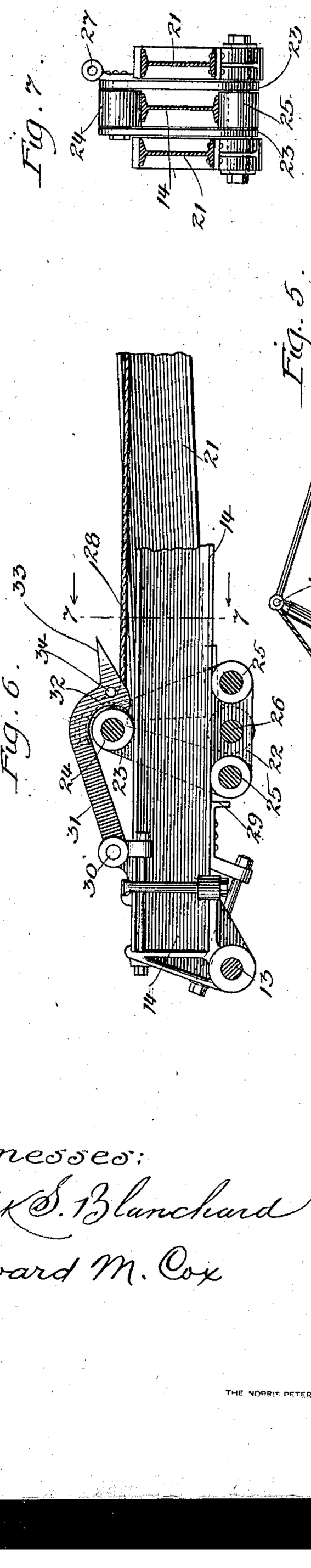

Fig. 7.

Fig. 6.

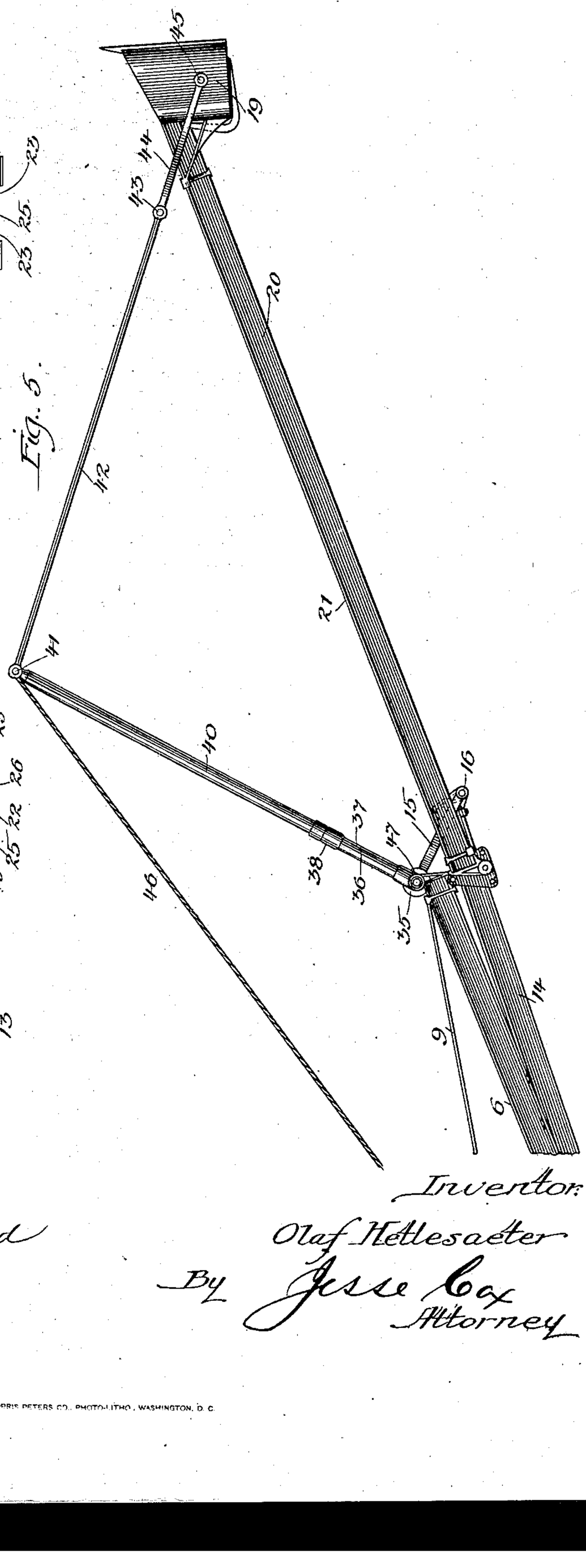

Fig. 5.

Witnesses:
Frank S. Blanchard
Howard M. Cox

Inventor:
Olaf Hetlesaeter
By Jesse Cox
Attorney

No. 669,992. Patented Mar. 19, 1901.

O. HETLESAETER.

EXCAVATOR.

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(No Model.)

7 Sheets—Sheet 5.

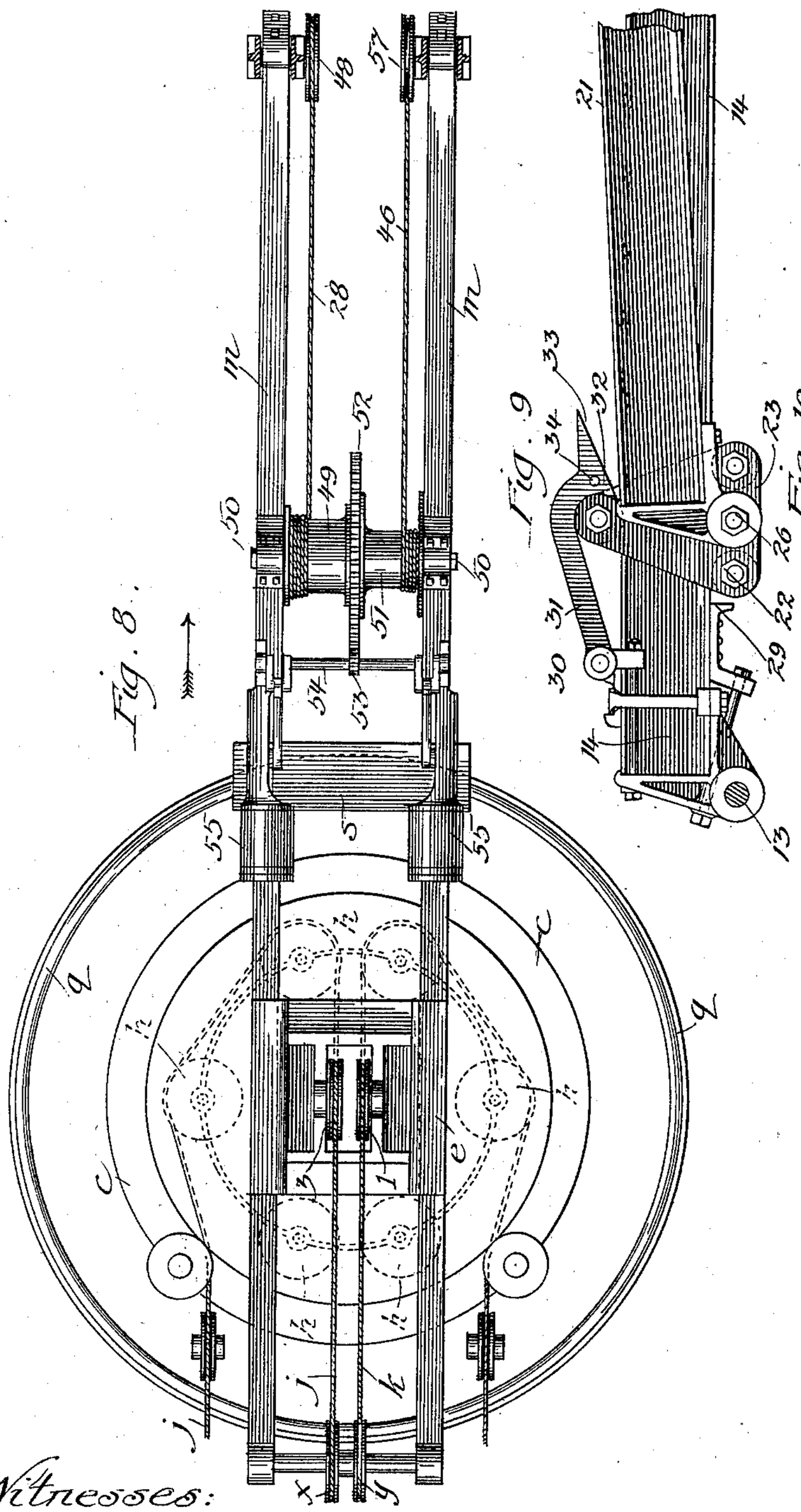


Fig. 8.

Fig. 9.

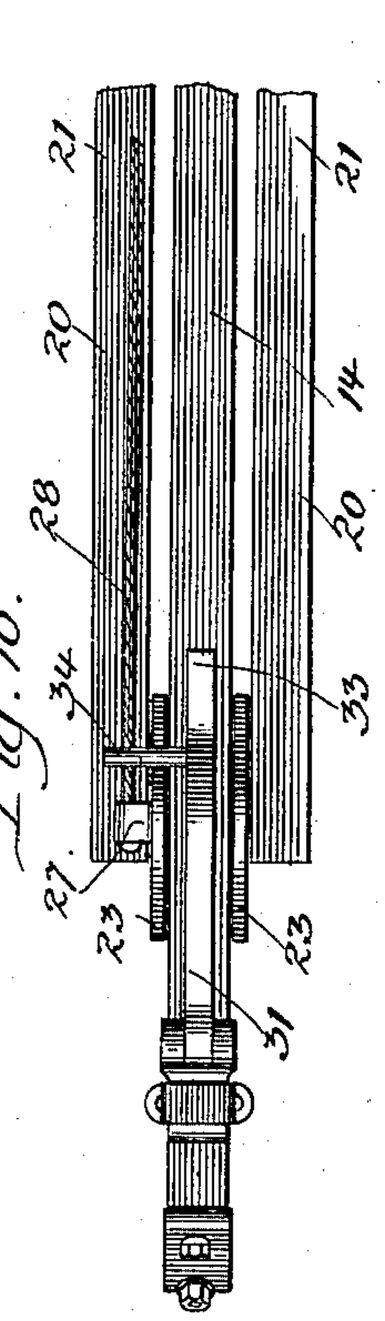


Fig. 10.

Witnesses:

Frank S. Blanchard

Howard M. Cox

Inventor:

Olaf Hetlesaeter

By Jesse Cox

Attorney

No. 669,992. Patented Mar. 19, 1901.

O. HETLESAETER.

EXCAVATOR.

(Application filed June 11, 1900.)

(No Model.) 7 Sheets—Sheet 6.

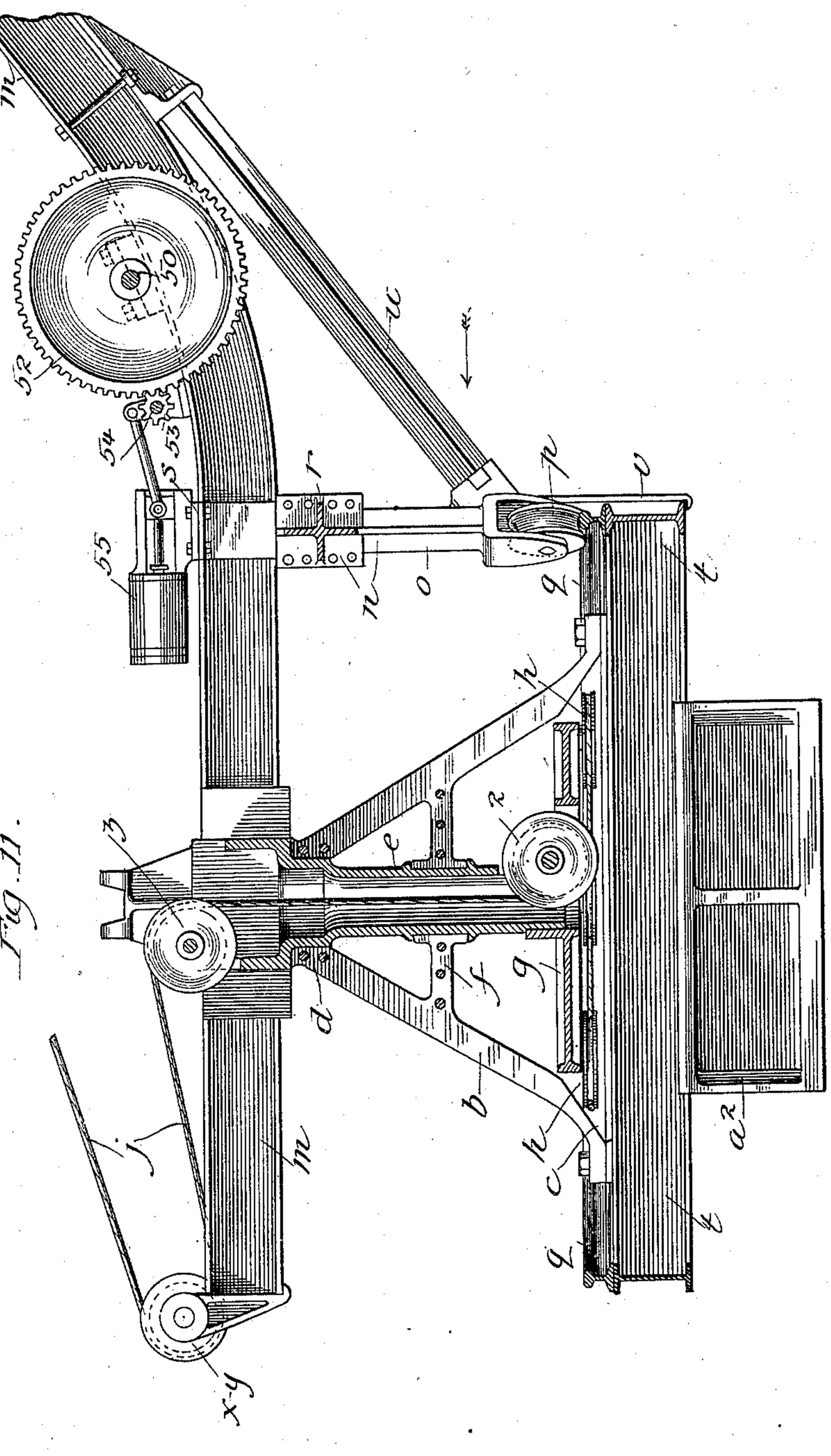


Fig. 11.

Witnesses:
Frank S. Blanchard
Howard M. Cox

Inventor:
Olaf Hellesaeter
By Jesse Cox
Attorney

No. 669,992. Patented Mar. 19, 1901.

O. HETLESAETER.

EXCAVATOR.

(Application filed June 11, 1900.)

(No Model.) 7 Sheets—Sheet 7.

Fig. 12.

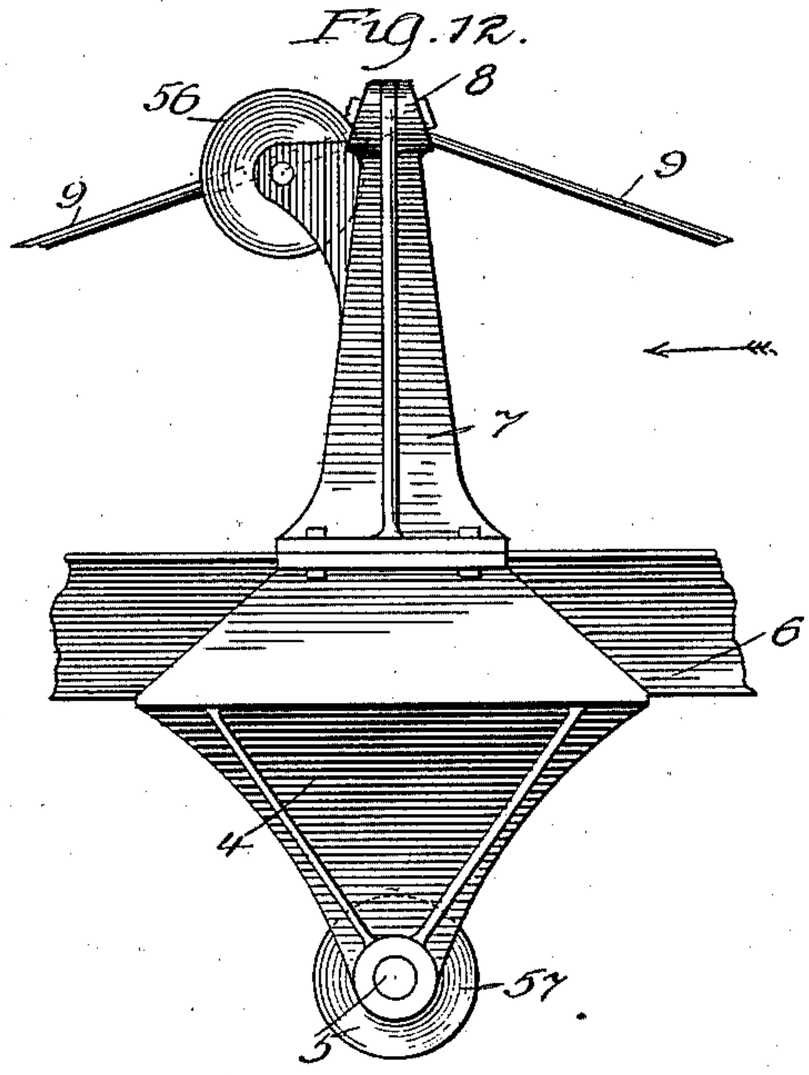


Fig. 13.

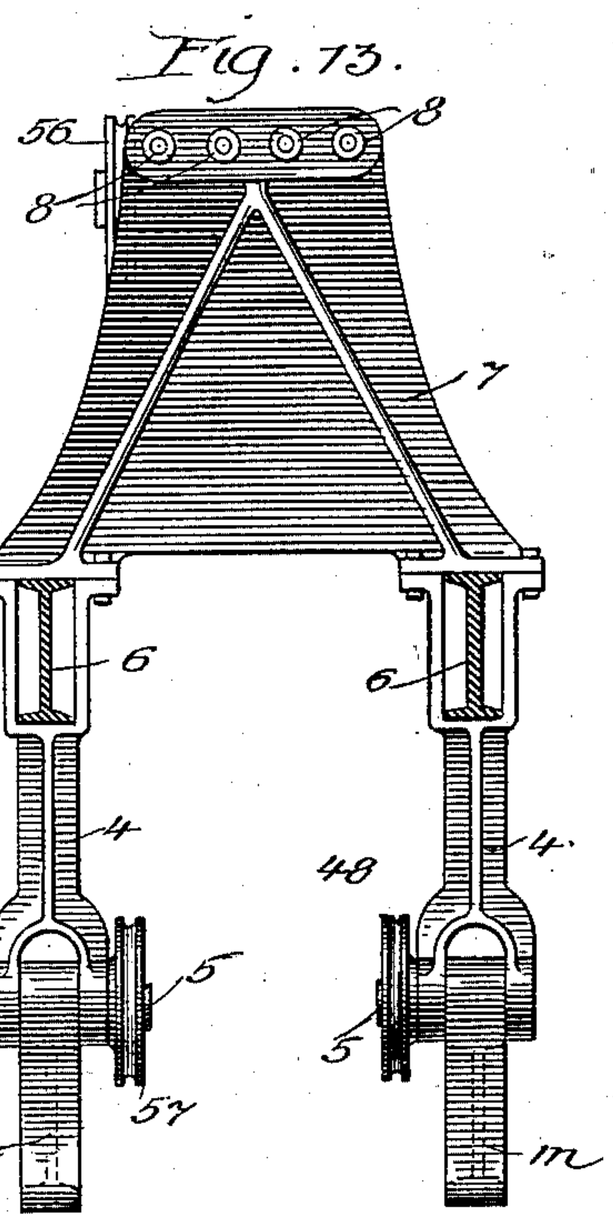
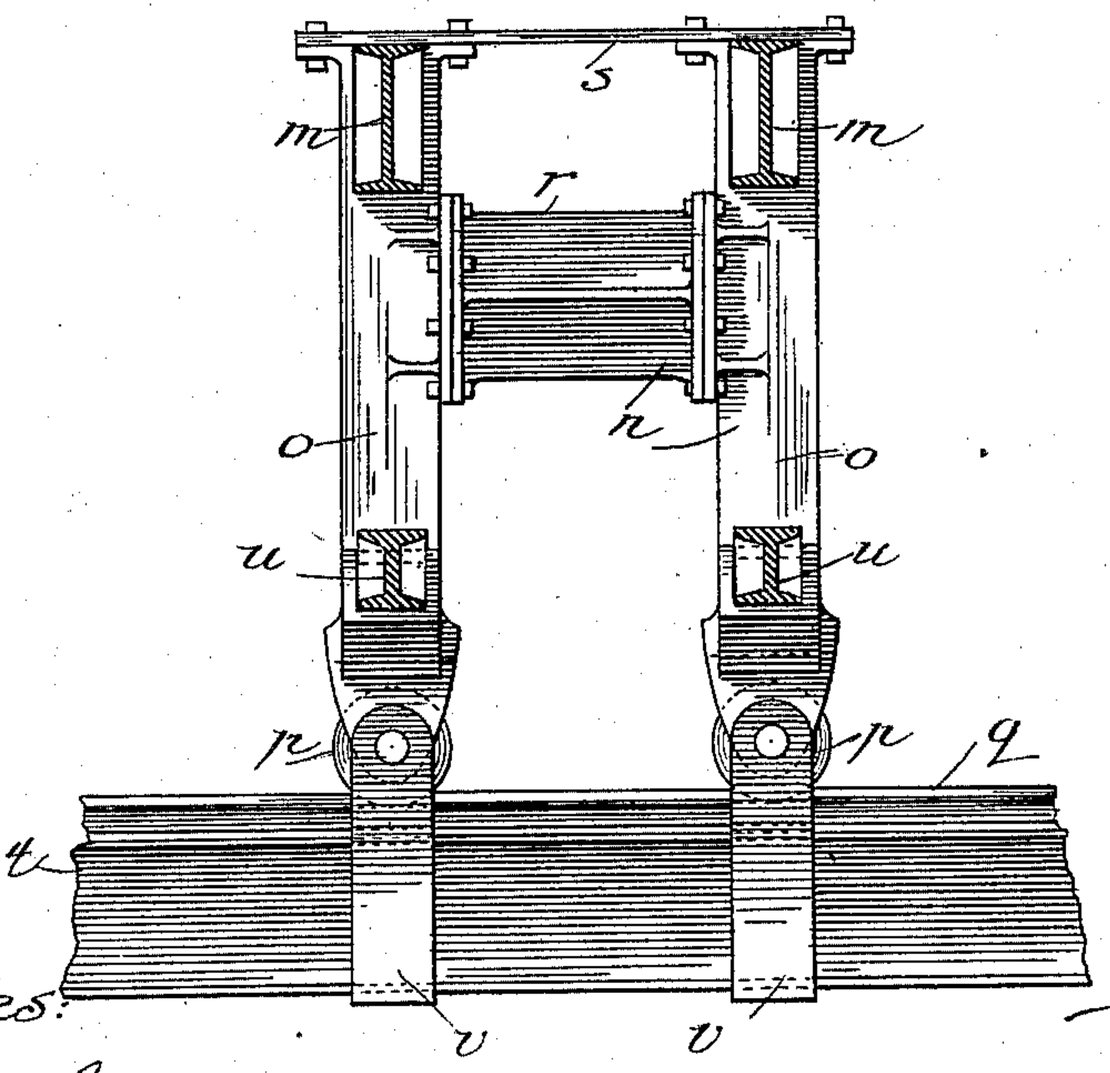


Fig. 14.



Witnesses:

Frank S. Blanchard

Howard M. Cox

Inventor:

Olaf Hellesaeter

By Jesse Cox

Attorney

UNITED STATES PATENT OFFICE.

OLAF HETLESAETER, OF CHICAGO, ILLINOIS.

EXCAVATOR.

SPECIFICATION forming part of Letters Patent No. 669,992, dated March 19, 1901.

Application filed June 11, 1900. Serial No. 19,793. (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 such as dredges, steam-shovels, and like machines, and is of the class having a compound bucket-arm—that is, a bucket-arm composed of relatively movable members—the bucket-arm of the present machine being allied to the bucket-arm shown in Letters Patent of the United States No. 649,244, issued to me May 8, 1900.

It is frequently desirable in excavating to discharge the bucket at a considerable distance from the car or other supporting structure of the machine. For example, in excavating for canals or deep cuts in railway-work it is of great advantage to discharge the bucket at a point high on the side or spoil banks, thus eliminating the use of tram-cars or other conveyers for removing the excavated material from the cut or channel.

It is the chief object of my present invention to provide means whereby the bucket-arm may be controllably extended so that the bucket may be discharged at a considerable height above and distance from the main supporting structure of the machine. To accomplish this object, I have provided various novel devices, more specifically set forth in the description and claims herewith. I attain this object by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a side view of the machine mounted upon a railway-car, showing the bucket-arm in an upright position. The bucket and handle are retracted, and the folding frame is collapsed or folded. Said frame is discontinuously shown in this figure, the apex of said frame being separate to bring the figure within the limits of the sheet. Fig. 2 is a view of the machine in side elevation, showing the bucket-arm in an approximately horizontal position. The bucket and handle are partially extended. Fig. 3 is a front view of the yoke of the post of the folding frame and adjuncts looking in the direction of the arrow, Fig. 2. Figs. 4 and 5 jointly represent the entire machine in side elevation, Fig. 4 showing the car and parts mounted thereon and Fig. 5 showing the forward extremity of the bucket-arm. In said Figs. 4 and 5 the bucket-arm is rotated to its extreme position for discharging and the bucket-handle is extended to the limit of its forward travel. Fig. 5 clearly illustrates the manner of supporting the bucket end of the bucket-handle, the bail and the forward rods of the folding frame being under tension and the frame-post and yoke being under compression. Fig. 6 is a detail view of the trolley, showing the manner in which the extremity of the bucket-handle opposite to the bucket is slidingly supported upon that member of the bucket-arm which forms the track or guide-beam for said trolley. The beam of the bucket-handle nearest the observer is removed in order to show the position of the trolley-rollers upon the guide-beam. Fig. 7 is a sectional view in detail of the bucket-handle, guide-beam, and trolley, taken on the line 7 7, Fig. 6, looking in the direction of the arrows. Fig. 8 is a plan view of the crane and of the turret and circular track whereby said crane is supported. Fig. 9 is a side view in detail of the bucket-handle, trolley, and guide-beam. Fig. 10 is a plan view of the parts shown in Fig. 9. Fig. 11 is a detail view from the side, showing the manner of supporting the crane upon the platform or main body of the excavator. Fig. 12 is a side detail view of the parts whereby the oscillating lever is supported. Fig. 13 is a view of the said supporting parts looking in the direction of the arrow, Fig. 12. Fig. 14 is a front view looking in the direction of the arrow, Fig. 11, showing the frame which forms an auxiliary support for the crane.

Similar characters refer to similar parts throughout the several views.

The car a forms the main supporting structure of the machine and has the turret b mounted at its forward extremity. In order to raise said turret above the platform or car-body a', said car is provided with the raised portion of false bottom a^2. Said turret consists of a preferably metallic frame having a broad base c bolted to said raised portion a^2, said turret tapering toward its upper extremity and having at said upper extremity a col-

lar *d*, which forms a bearing for the crane-pivot *e*, as shown in Fig. 11. For convenience said turret is constructed in sections, which may be bolted together in the completed machine. A lug or web *f* is formed within said turret to afford an auxiliary lateral brace and bearing for said pivot *e*. The pivot *e* consists of a hollow shaft bearing upon said collar *d* and in said lug or web *f* and having rigidly secured at the lower extremity thereof a horizontally-extending plate or turn-table *g*. At the periphery of said turn-table *g* are carried the guide-sheaves *h h*, which lie horizontally and guide the thrusting-cable *j* and controlling-cable *k* in the manner hereinafter described. The crane-beams *m m* are secured to said pivot *e* at a point thereon above the turret *b*, said beams being substantially parallel and coextensive and extending in both rearward and forward directions from said turret. In the forward direction from said turret the beams *m m* bend upward in order to provide an elevated front extremity of the crane, at which latter point the bucket-arm is supported, as will hereinafter appear. At a point between the turret *b* and the said forward extremity of the crane is the frame *n*, which forms an auxiliary support for said crane, as shown in detail in Figs. 11 and 14. Said frame consists of the uprights *o o*, which are recessed at their upper extremities to receive the beams *m m* and are provided at their lower extremities with the flanged wheels or casters *p p*, adapted to travel upon the circular track *q*. The uprights *o o* are held in their proper relative positions by the distance-piece *r* and plate *s*, the latter being secured to said uprights above the beams *m m*, thereby holding said beams within the said recessed uprights. The track *q* is mounted upon the beam *t*, secured to the raised portion a^2 of the car *a*, and both said track and beam are concentric with the axis of the crane-pivot *e*. The beams *u u* are attached to the beams *m m* in front of said frame *n* and are also fastened at their lower extremities to the uprights *o o* near the lower extremities of the latter, said beams *u u* thereby acting as braces to strengthen the crane. By this construction a large proportion of the weight of the crane is carried by the track *q* and car-body directly, thus relieving the turret *b* and pivot *e* from great strain. In order to prevent the possibility of said casters *p* being raised from said track during the operation of the machine, the hooks *v v* are attached to and suspended from said uprights *o o* in such a manner as to engage the lower edge of said beam *t* when said uprights are lifted any appreciable distance. This provision eliminates the danger of straining the crane-pivot and adjacent parts in case the excavator-bucket meets undue obstructions. The crane-beams *m m* are also braced by tension-rods *w w*, extending from the crane-pivot *e* to the front and rear extremities of said beams.

Mounted side by side at the rear extremity of the crane are the sheaves *x* and *y* for guiding the cables *j* and *k*, respectively. The sheaves *z* and 1 are also mounted side by side near the upper extremity of the crane-pivot *e* for guiding said cables *j* and *k*, and the sheaves 2 and 3 are similarly mounted for the same purpose near the lower extremity of the said pivot, (the sheave 3 not appearing in full lines in the drawings.) The sheaves *z*, 1, 2, and 3 are so located that the cables *j* and *k* may extend through the pivot *e* and may thence lead fair onto the forward ones of the sheaves *h h*.

Certain of the features of construction of the crane and turret and their adjuncts herein shown are shown and described in applications for Letters Patent filed by me May 7, 1900, Serial Nos. 15,704 and 15,705.

The bucket-arm which I will now describe is similar in certain respects to the bucket-arm for which Letters Patent of the United States were granted to me May 8, 1900, No. 649,244. In the present machine the blocks 4 4 (shown in detail in Figs. 12 and 13) are pivotally supported upon the shafts 5 5 at the forward extremity of the crane. Said blocks are recessed at their upper or outer extremities to receive the beams 6 6 of the oscillating lever in such a manner that said beams may slide longitudinally in said blocks. Said beams are held in place by the cross-frame 7, which is secured to said blocks above said beams and constitutes a bridge or distance-piece between said blocks. At the upper or outer extremity of said bridge 7 is formed a series of bosses 8, suitably apertured to receive the tension-rods 9 9. Said rods extend in both directions from said bridge to the extremities of said beams, where they are secured. By this construction by changing the lengths of said rods 9 9 upon the respective sides of said bridge 7 and sliding said beams in said blocks the oscillating lever may be adjusted lengthwise in its support in the manner pointed out in an application for patent filed by me May 7, 1900, Serial No. 15,703. At the extremity of the oscillating lever, which will be referred to as the "upper" extremity thereof, is the shaft 10, which pivotally supports the thrust-segment 11. Said segment has a curved and grooved periphery approximately concentric with the said shaft 10. The thrust-cable *j* is connected to said thrust-segment at a point 12 at the forward extremity thereof. At or near the rear extremity of said thrust-segment is secured the shaft 13, which forms a pivotal connection between said thrust-segment and the guide-beam 14. Said guide-beam, which is preferably a single **I**-beam having smooth and flat upper and lower surfaces, constitutes a third member of the bucket-arm and extends from said thrust-segment in a direction approximately parallel with the oscillating lever. The lower extremity of said guide-beam is connected to the lower extremity of the oscillating lever by means of the links 15, said

links being pivoted to said beam 14 by means of the shaft 16 and to said oscillating lever by means of the shaft 17. Said shaft 17 is not supported directly by the beams 6 6 of said oscillating lever, but is so held by one of the members of the folding frame as to be immovable relatively to said beams 6 6, the precise construction being shown in Fig. 3 and hereinafter described. Said links 15 constitute the fourth member of a linkwork, of which the oscillating lever, thrust-segment, and guide-beam constitute the other three members. As the connections between said members are all articulate, it is obvious that the distance of the shaft 16 from the arm-supporting shafts 5 depends upon the positions of the members of the said linkwork relatively to each other. The position of the said shaft 16 in a vertical plane is also dependent upon the position of the bucket-arm with respect to the rotation thereof about the said shafts 5, while the position of said shaft 16 with respect to a horizontal plane is dependent upon the position of the crane with regard to its rotation about the axis of the crane-pivot *e*. The position of said shaft 16 with reference to all three of these last-described movements is completely controlled by means of the cables *j* and *k* in a manner which will be hereinafter described and which has been described in the application, Serial No. 15,705, above referred to.

The thrusting-cable *j* is connected to the segment 11 at the point 12 thereon and extends from said point 12 rearwardly along the grooved periphery of said segment, thence around the sheave *x* at the rear extremity of the crane, thence over the sheave *z*, downward through the crane-pivot *e* beneath the sheave 2, and thence in a forward direction to one of the sheaves *h*, around which it extends toward the left looking toward the front of the machine, as indicated by the arrow, Fig. 8. Said cable *j* extends from said forward sheave *h* to one or more of the other sheaves *h*, located upon the left edge of said turn-table *g*, and then extends over auxiliary guides to drums or other suitable driving mechanism. (Not shown.)

The controlling-cable *k* is fastened to the lower extremity of the guide-beam 14 and extends from said guide-beam to and around the guide-sheave 18, which is mounted at the upper extremity of the oscillating lever, preferably upon the shaft 10 thereon. From said sheave 18 said cable *k* extends to and around the sheave *y* at the rear extremity of the crane, thence around the sheave 1, through the pivot *e* beneath the sheave 3, and thence to the forward one of the sheaves *h* upon the right of the axis of the crane-pivot *e*. From said forward sheave *h* said cable *k* extends rearwardly along one or more of the remaining guide-sheaves *h* upon the right edge of the turn-table *g* and thence rearwardly over suitable guides to a drum or other driving mechanism. (Not shown.)

The excavator-bucket 19, which is of the ordinary pattern, is not suspended directly from the member 14, as in the machine described in the patent above referred to, but is attached to a separate bucket-handle 20. Said bucket-handle consists, preferably, of two parallel I-beams 21 21, which are suitably fastened together and carry at their lower extremity the said bucket 19. At the upper extremity of said handle is the trolley 22, whereby said handle has a sliding connection with the said beam 14. Said trolley (best shown in Figs. 6, 7, 9, and 10) consists of the parallel triangular plates 23 23, which lie on opposite sides of the guide-beam 14. The roller 24 and rollers 25 25 are mounted between said plates in such a manner that said roller 24 bears upon and may travel along the upper surface of said beam 14, and said rollers 25 25 lie a slight distance from and may under certain conditions travel along the under surface of said beam 14 at two different points thereon. By this construction the said trolley encircles the beam and is therefore prevented from becoming dislodged therefrom. Moreover, the single roller 24 will ordinarily guide said trolley; but in case said trolley is forced upward against said beam both of the rollers 25 will come to a bearing thereon. The shaft 26 is secured in and extends between said side plates 23 and forms a pivot, whereby the upper extremity of the bucket-handle 20 is connected to the said trolley 22. As clearly shown in Fig. 7, said trolley has attached thereto, near the upper portion thereof, the eye 27, to which the extension-cable 28 is fastened for drawing said trolley and bucket-handle along said guide-beam 14 toward the lower or forward extremity of the latter. In order to limit the travel of the trolley in an upward direction, the guide-beam 14 is provided with a stop 29 near its upper extremity, adjacent to the thrust-segment 11. Preferably near the upper surface of the guide-beam 14 is mounted the shaft 30, which forms a pivot, whereby the latch 31 is attached to said beam. Said latch consists of a bar having a hook 32 at its forward extremity for engaging the roller 24, and thereby arresting the motion of said trolley downward along said beam 14. At its forward extremity also said latch has a projection 33, which is beveled upon its lower edge in such a manner that when the trolley 22 approaches said latch from toward the lower extremity of the beam 14 the roller 24 strikes the said lower beveled edge and raises said latch, thereby permitting said latch to engage said roller and retain said trolley. The pin 34 is attached to the latch 31 near the forward extremity thereof and projects laterally therefrom in such a manner as to occupy a position in front of and somewhat below the aperture of the eye 27 when said latch is in engagement with the roller 24. The cable 28 extends from the eye 27 toward the bucket 19, and said pin 31 is so placed as to rest upon said cable when the

roller 24 is in engagement with the latch 31. As said cable thus passes below said pin, when said cable is drawn taut said cable raises said pin and latch, and thereby effects the release of the trolley 22 from said latch.

Having described the manner in which the upper extremity of the bucket-handle is supported, I will now describe the manner of supporting the bucket 19 and adjacent extremity of the bucket-handle.

The shafts or pins 35 35 are secured to the lower extremities of the beams 6 6 of the oscillating lever and also to the outer legs 36 36 of the yoke 37, thus forming pivotal connections between the said parts. Said legs 36 are rigidly connected at their upper extremities to the cross-frame 38 and are at a distance apart greater than the distance between the said beams 6 6, thus permitting said beams 6 6 to pass between them. The central leg 39 is rigidly secured to the frame 38 in such a manner as to pass between the beams 6 6, as shown in Fig. 3. The lower extremity of said central leg carries the shaft 17, above mentioned, said shaft 17 being preferably in line with the shafts 35 35 and carrying the links 15 in the manner previously described. Said post 40 projects upward from said frame 38 and carries at its upper extremity the shaft 41, which forms a pivot connection between said post 40 and the bucket tension-rods 42. The length of said rods 42 is preferably approximately equal to the distance between the shafts 35 and 41—that is, equal to the total length of the post 40. The shaft 43 is secured to the lower extremity of the rods 42 and forms a pivotal connection between said rods and the bail 44 of the bucket 19. Said bail is pivotally attached to the trunnions 45, located upon the sides of said bucket. I prefer to so proportion the links 15, bail 44, and connected parts that when the trolley is engaged by the latch 31 the bucket 19 will be in approximately the position it would occupy if attached directly to the lower extremity of the guide-beam, this condition being illustrated in Fig. 1 of the drawings. Under this condition the present bucket-handle and guide-beam together virtually constitute a single bucket-handle operated substantially in the same manner as the bucket-handle shown in the patent above referred to. One of the extremities of the retracting-cable 46 is fastened to the above-mentioned shaft 41 and extends from said shaft toward the pivot-block 4 of the oscillating lever, as will hereinafter be described.

The rods 42 and post 40, with the yoke 37, constitute a folding frame whereby the forces ordinarily acting upon the bucket 19 while the latter is taking a cut or is in a hoisted position will be transmitted to the lower extremity of the beams 6 6 of the oscillating lever.

It is obvious that under usual conditions when the cable 46 is held fast the rods 42 will be in tension and the post 40 and yoke 37 will be in compression. In order to make provision for the strains in a simple manner, I prefer to construct the cross-frame 38 of cast-steel and construct the legs 36 39 and post 40 of suitable piping attached by means of screw-threads to said frame.

The extending-cable 28 and retracting-cable 46 are connected and operated as follows: The extending-cable 28 is attached to the eye 27 on the trolley 22 and extends from said eye around the guide-sheave 47. (Shown in Fig. 3.) Said sheave 47 is mounted upon one of the shafts 35 in such a manner as not to interfere with the beams 21 of the bucket-handle 20. From said sheave 47 said cable 28 extends to and over the sheave 48, mounted upon one of the shafts 5 at the forward extremity of the crane. (Best shown in Figs. 8 and 13.) Said cable 28 extends from said sheave 48 to the drum 49 and is suitably fastened thereto. The shaft 50, upon which said drum is mounted, is provided with bearings upon the beams *m m* of the crane and forms the support also for the drum 51, whereby the cable 46 is operated, and for the spur-gear 52, whereby said drums are rotated. Said gear 52 is preferably located midway between said beams and is driven by means of the spur-pinion 53, secured to the crank-shaft 54. Said crank-shaft is driven by the engines 55 55, located for convenience upon the plate *s* on the crane-beams *m m*. The retracting-cable 46 is fastened to the shaft 41 at the apex of the folding frame and extends thence over the guide-sheave 56, mounted near the upper extremity of the bridge 7 of the pivot-blocks 4. The sheave 57 is mounted upon the second one of the shafts 5 not occupied by the sheave 48, above mentioned, and is so located as not to interfere with the beams 21 of the bucket-handle 20. When the bucket-handle is approximately horizontal, the cable 46 passes under and is guided by said sheave 57; but when the bucket-handle is more nearly in an upright position the cable 46 extends directly from the sheave 56 to the drum 51 in the manner shown in Fig. 1.

To effect the extension of the bucket-handle 20, the cables 28 and 46 must run in opposite directions, and as the drums 49 and 51 rotate together said cables are wound in opposite directions upon said drums. According to the relative proportions of the parts as constructed in the present instance the cable 28 has a greater distance to run during extension and retraction of the bucket-handle than has the cable 46. Therefore the drum 49 is constructed with a diameter larger than the diameter of the drum 51.

Generally speaking, the bucket-arm comprises the parts pivotally supported upon the shafts 5 5 at the forward extremity of the crane, and the center of gravity of said arm is so located with respect to said shafts that gravity tends to rotate said arm in such a direction that the bucket 19 is caused to approach the main supporting structure *a*.

The operation of the machine is as follows: When a cut is to be taken by the bucket 19, the trolley 22 is engaged by the latch 31, and is thereby held fast at the upper extremity of the guide-beam 14. Under these circumstances the beam 14 and beams 21 21 virtually form a single bucket-handle, constituting one of the members of a linkwork bucket-arm, as described in the above-mentioned patent. Moreover, the bail 44 and links 15 will operate substantially in the same manner as if the bucket 19 were connected by single links directly with the lower extremity of the beams 6 6 of the oscillating lever. To place the bucket in position for excavating, the cables *j* and *k* are paid out, and the bucket is thereby lowered and allowed to approach to within any desired distance of the main supporting structure—as, for example, to a position such as that shown in Fig. 1. If now it is desired to thrust or crowd the bucket downward into the bank, the cable *k* is held fast at its rear extremity on the main structure of the machine, while tension is exerted in the cable *j*. The force of the tension in said cable *j* is resolved at the thrust-segment 11 into two components, one of which tends to rotate the bucket-arm about the shafts 5 5 and the other of which tends to rotate said segment about the shaft 10. The said rotation of the bucket-arm forces the bucket in a forward direction to take a cut and at the same time decreases the distance between the sheave 18 upon the upper extremity of the bucket-arm and the sheaves *x* and *y* at the rear extremity of the crane, thereby having virtually the effect of paying out the cable *k* in so far as the effect upon the bucket-arm is concerned. This virtual paying out of the cable *k* permits the lower extremity of the guide-beam 14, and consequently the bucket 19, to increase their distance from said shaft 10—in other words, permits the lowering of the bucket downward into the bank. The rotation of the segment 11 about the shaft 10 causes the lowering of the rear extremity of said segment, with the result that the bucket 19 is thrust downward into the bank, the force of said segment being transmitted to the beam 14 by means of the shaft 13 and the force thus received by said beam 14 being transmitted by the stop 29 thereon to the bucket-handle 20 and bucket 19. Tension in the cable *j* thus tends to force the bucket in a forward direction to take a cut and also in a direction at right angles thereto to increase the thickness or depth of cut. To retract the bucket or raise it normally out of the bank, tension is exerted in the cable *k*, while the cable *j* is held fast. Such tension in the cable *k* has two effects upon the bucket-arm, one effect being to rotate the bucket-arm in such a direction as to force the bucket in a forward direction and the other effect being to cause the lower extremity of the beam 14, and consequently the bucket 19, to approach the sheave 18 upon said shaft 10—that is, to recede directly out of the bank. Said cables when acting simultaneously supplement each other in forcing the bucket in a forward direction, and by suitably varying the relative amounts of tension in said cables the thickness of cut may be regulated. By continuing the tension in one or both of the cables *j* and *k* the bucket-arm may be rotated until the segment 11 or other part of said arm comes into contact with some part of the crane, when the further motion of said arm is prevented and said cables become virtually attached to said crane. Either one of said cables may alone maintain the bucket-arm in this extreme position. (Shown in Fig. 4.) If now the cable *j* is free to run out from the supporting structure *a* and the cable *k* continues to be under tensional strain, the result is that the parts of the turn-table *g* lying to the right of the crane-pivot move toward the rear of the machine, and consequently the forward extremity of the crane, together with the parts thereon, swings toward the right, looking in the direction of the arrow, Fig. 8. Reversedly, if when the bucket-arm is in said extreme position the cable *k* is free to run out and the cable *j* continues to be drawn in upon the car *a* the crane and bucket-arm will be swung toward the left. In so far as the above-described control of the bucket-arm and the swinging of the crane are concerned my present machine is similar to the machine described by me in the application above referred to, filed May 7, 1900, Serial No. 15,705. The rotation of the crane at the time when the bucket is taking a cut is prevented by the bank itself acting upon the sides of the bucket, thereby preventing lateral motion of said crane and bucket even if one cable alone is in tension. When the bucket is free from the bank, however, if one cable only is in tension the weight of the bucket-arm will induce a certain tendency to swing the crane, especially if the bucket is filled. This tendency for the bucket to commence to swing immediately upon leaving the bank is of great advantage, for time is thereby saved in swinging and said swinging motion of the crane and bucket-arm is imparted thereto gradually and without shock or jar. When the bucket has been hoisted and is to be extended for discharging, the drums 49 and 51 are rotated by the engines 55 in such a direction that the cable 28 is wound in upon the drum 49 and the cable 46 is allowed to run out from the drum 51. The resulting tension in the cable 28 causes the same to straighten and raise the pin 34 and latch 31 in such a manner as to release the roller 24 from the hook 32 of said latch. The trolley 22 is thus released and free to travel upon the guide-beam 14, and the continued tension in said cable 28 causes said trolley to move along said beam toward the sheave 47, around which said cable is trained. As the bucket-handle 20 is attached to said trolley, this motion of the trolley toward the lower or outer extremity of the beam 14 causes a corresponding exten-

sion of said handle. The running out of the cable 46 from the drum 51 permits the pin 41 at the apex of the folding frame to move away from the sheave 56 upon the bridge 7, and as the bucket-handle and bucket are positively forced in a direction away from said sheave 56 the said shaft 41 is drawn in a forward direction by the rods 42 42 and bail 44, said shaft 41 swinging about the shaft 35 as a center. The extension of the bucket-handle thus causes the unfolding of the bucket-supporting frame—that is, causes the rods 42 and post 40 to spread apart. The positions of the folding frame consequent upon different positions of the bucket-handle may be clearly seen by referring consecutively to Figs. 1, 2, and 5 of the drawings. The weight of the parts is so distributed as to keep the cable 46 taut at practically all points within the working limits of the bucket-arm, and the folding frame therefore operating in conjunction with the cable 46 forms the support for the bucket and adjacent portion of the bucket-handle in all positions thereof. Said cable and folding frame virtually constitute an adjustable truss, of which the post 40 forms the strut or compression member and the rods 42 and cable 46 form the ties or tension members. When the bucket-arm is to be retracted, the engines 55 are run in such a direction that the cable 28 is unwound from the drum 49 and the cable 46 is wound upon the drum 51. This pays out said cable 28 and permits the trolley 22 to be moved toward the segment 11, while the cable 46 draws the shaft 41 toward the sheave 56, thereby causing the folding or collapsing of the bucket-supporting frame, and consequently a retraction of the bucket. By continuing the winding in of the cable 46 the bucket-handle 20 is brought to such a position that the trolley 22 comes into contact with the stop 29 at the upper extremity of the guide-beam 14. Just before said trolley reaches this extreme position the roller 24 on said trolley comes into contact with the under beveled edge of the projection 33 of the latch 31, thereby raising said latch. When said roller has passed beyond the hook 32 of said latch, the cable 28 being slack, said hook drops over and engages said roller, and thereby automatically prevents the return of said trolley until said latch is again raised by the cable 28 in the manner hereinabove described.

It is evident that the cables 28 and 46 are supplementary in their action and that the extension and retraction of the bucket and handle may be controlled in a positive manner by the operator.

For convenience I have herein referred to the cable *j* as a "thrusting-cable," to the cable *k* as a "controlling-cable," and to the cables 28 and 46 as "extending" and "retracting" cables, respectively. The cables *j* and *k*, however, have important additional functions—namely, the rotation of the bucket-arm about the shafts 5 and the swinging of the crane.

It is obvious that while I have spoken of the beam 14 as a "guide" and the part 20, sliding thereon, as a "handle" nevertheless said guide-beam and sliding part may be considered as together forming an extensible bucket-handle.

Although I have minutely described the various parts of my machine, I do not confine myself to the details of construction herein set forth, for I am aware that various modifications will suggest themselves to those skilled in the art. For example, considerable changes may be made in the crane and manner of supporting the same and also in the manner of guiding and operating the various cables, constructing the trolley, &c., without departing from my invention.

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

1. An excavator bucket-arm comprising a plurality of members, upon one of which is supported a bucket, said bucket-supporting part being movable in the general direction of the length of said arm, and connections between said bucket-supporting part and the other members of said arm, one of said connections being a linked connection at the bucket extremity of said bucket-supporting part, and a second of said connections being a sliding connection at the upper extremity of said bucket-supporting part.

2. In an excavator the combination of a crane, a linkwork pivoted to said crane, and a separate member carrying a bucket, said member being extensibly and retractably supported upon said linkwork.

3. In an excavator bucket-arm, the combination of members forming a linkwork, a bucket-supporting part movable in the direction of the length of said linkwork, a linked connection between the bucket end of said bucket-supporting part and said linkwork; and a sliding connection between said linkwork and the extremity of said bucket-supporting part opposite to said bucket.

4. An excavator bucket-arm consisting of a plurality of members, one of which is pivotally supported and forms the support for said arm; a second member constituting a compound bucket-handle; other members of said arm connected to said pivoted arm-supporting member, said bucket-handle being extensible and retractable upon itself; in combination with means for extending and retracting said bucket-handle.

5. In an excavator bucket-arm, the combination of a pivotally-supported linkwork, the members whereof are articulately connected in tandem, or virtually end to end; a bucket-supporting part traveling longitudinally on said linkwork; connections between said linkwork and said bucket-supporting part whereby the latter is movable upon said linkwork; and cables for moving said bucket-supporting part upon said linkwork.

6. In an excavator, the combination of a pair of longitudinal members, one of which is pivotally supported, means at one extremity of said members for articulately connecting the same, and a transverse power-receiving link connecting said members at the other extremity thereof; a power device connected to said transverse link and exerting its force in a line other than the line through the pivots of said transverse links; a bucket-supporting part; and means whereby said bucket is extensibly and retractably supported upon said longitudinal members.

7. In an excavator, the combination of a pivotally-supported oscillating lever, a thrust-segment pivotally supported upon said lever, other members having articulate connections to said lever and segment, one of said other members forming a guide-beam; in combination with a bucket-supporting part which is extensible and retractable in the direction of the length of said guide-beam, and a pair of cables for varying the positions of the oscillating lever, thrust-segment and guide-beam relatively to each other.

8. In an excavator, the combination of a linkwork comprising a plurality of parts one of which is a pivotally-supported lever, a second of which is a thrust-segment pivoted to said lever, and a third of which is a guide member pivoted to said segment; a bucket-supporting part; means for movably supporting one extremity of said bucket-supporting part on said guide member; and a plurality of links whereby the other extremity of said bucket-supporting part is supported on said pivoted lever.

9. In an excavator, the combination of a linkwork, constituting a portion of the bucket-arm; a bucket-supporting part; means whereby the bucket extremity of said bucket-supporting part is movably supported on said linkwork, and a trolley whereby the other extremity of said bucket-supporting part is slidingly supported on one of the members of said linkwork.

10. In an excavator, a pivotally-supported bucket-arm comprising a structure 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 a second member of said linked structure which constitutes a guide-beam, the periphery of said segment being the locus of the point of application of power to said arm, and said linked structure being provided with a joint between its point of support and point of power application; said bucket-arm also comprising a bucket-supporting part movably supported upon said linked structure; in combination with means for fixing said bucket-supporting part relatively to said guide-beam, said bucket-supporting part thereby receiving the said components of the force acting upon said segment.

11. In an excavator, a pivotally-supported bucket-arm comprising a structure 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 a second member of said linked structure which constitutes a guide-beam, the periphery of said segment being the locus of the point of application of power to said arm, and said linked structure being provided with a joint between its point of support and point of power application; said bucket-arm also comprising a bucket-supporting part movably supported upon said linked structure; in combination with a catch or latch on said guide-beam for engaging a part attached to said bucket-supporting part, thereby retaining the latter.

12. In an excavator, the combination of a linkwork constituting a portion of the bucket-arm; a separate bucket-supporting part; means whereby one extremity of said bucket-supporting part is movably connected to said linkwork; a second plurality of links whereby the other extremity of said bucket-supporting part is supported by said linkwork; a power device the force whereof is applied to said second plurality of links for moving the bucket-supporting part in one direction upon said linkwork; and a second power device the force whereof is applied to said bucket-supporting part for moving the same in the opposite direction.

13. In an excavator bucket-arm, a revolubly-supported structure; a separate bucket-supporting part, connections between one end of said bucket-supporting part and said revolubly-supported structure, and a folding frame whereby the other end of said bucket-supporting part is carried by said revolubly-supported structure; in combination with means for operating said frame.

14. In an excavator, the combination of a linkwork constituting a portion of the bucket-arm; a bucket-supporting part; means whereby the upper extremity of said supporting part is movably connected to said linkwork; a second plurality of links whereby the lower extremity of said bucket-supporting part is supported by said linkwork, one of said second plurality of links being a post pivotally supported upon said first-mentioned linkwork, and said second plurality of links also comprising connections between the upper or outer extremity of said post and the lower extremity of said bucket-supporting part.

15. In an excavator bucket-arm, a revolubly-supported structure, a bucket-supporting part, connections between one end of said bucket-supporting part and said revolubly-supported structure, and a folding frame whereby the other end of said bucket-supporting part is carried by said revolubly-supported structure; in combination with a cable, attached to said folding frame and making contact also with said revolubly-supported structure, thereby constituting in conjunction with said folding frame, an adjustable truss.

16. In an excavator bucket-arm, a revolubly-supported structure, a bucket-supporting part, sliding connections between one end of said bucket-supporting part and said revolubly-supported structure, a folding frame also connecting said bucket-supporting part with said revolubly-supported structure, and a guide-sheave mounted on said revolubly-supported structure; in combination with two power devices, one of which moves said bucket-supporting part, in one direction upon said revolubly-supported structure, and the second of said power devices moves said bucket-supporting part in the opposite direction upon said revolubly-supported structure, said second power device comprising a cable leading from said folding frame to said guide-sheave and thence to suitable driving mechanism.

17. In an excavator bucket-arm, the combination of a pair of longitudinal members one of which is revolubly supported, and the second of which forms a guide beam or track; articulate connections between the lower extremities of said members; a transverse power-receiving link connecting the upper extremities of said longitudinal members; a bucket-supporting part; and means for supporting said bucket-supporting part on said longitudinal members, said means including a trolley connected to said bucket-supporting part and traveling upon said guide beam or track.

18. In an excavator, the combination of a bucket, a pair of beams attached to said bucket, a single beam forming a track or guide, a trolley attached to said pair of beams for traveling upon said single beam, said single and double beams constituting a compound bucket-handle; and means for supporting said beams.

19. In an excavator, the combination of a linkwork forming a portion of a bucket-arm, a bucket-supporting part extensibly and retractably supported on said linked structure, and a pair of cables having connections to opposite extremities of said bucket-supporting part for extending and retracting the same, a drum for operating said cables, and means for operating said drum.

20. In an excavator bucket-arm, the combination of a pivotally-supported oscillating lever, a compound bucket-handle the parts of which are extensible relatively to each other, means for supporting said handle upon said lever, and other means for adjusting said oscillating lever upon its pivotal support.

21. In an excavator, the combination of a crane, a crane-support whereby said crane is revoluble about a vertical axis, a horizontal track concentric with the axis of the crane, an extension on said crane adapted to bear and travel upon said track, thereby forming an auxiliary support for said crane, and a hook attached to said crane and having an extension adapted to project beneath said track, and engage the same when the portion of the crane to which said hook is attached is raised.

22. In an excavator, the combination of a linked structure forming a portion of the bucket-arm, said linked structure comprising an oscillating lever, a thrust-segment pivoted to said lever, a guide member pivoted to said segment, and other connections between said lever and guide member; a bucket-supporting part, carried by said linked structure and movable thereon in the direction of the length thereof; means for moving said bucket-supporting part on said linked structure, and cables for changing the configuration of said linked structure, one of said cables being connected to said thrust-segment, and another of said cables being connected to one of the members of said linked structure, and also being deflected by another of the members of said linked structure.

23. In an excavator, the combination of a revoluble crane, a linked structure revolubly supported on said crane and forming a portion of the bucket-arm, a bucket-supporting part extensibly and retractably supported on said linked structure, means for controllably extending and retracting said bucket-supporting part; a pair of cables connected to said linked structure for varying the configuration of the same and rotating the same about its point of support; and guides for said cables located on the crane or its adjuncts whereby the force of said cables is oppositely directed to said crane with reference to the axis thereof, said cables thereby having a rotative effect upon said crane.

OLAF HETLESAETER.

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