No. 824,531. PATENTED JUNE 26, 1906.

A. J. DUCELLIER.

EXCAVATING MACHINE.

APPLICATION FILED NOV. 8, 1904.

7 SHEETS—SHEET 1.

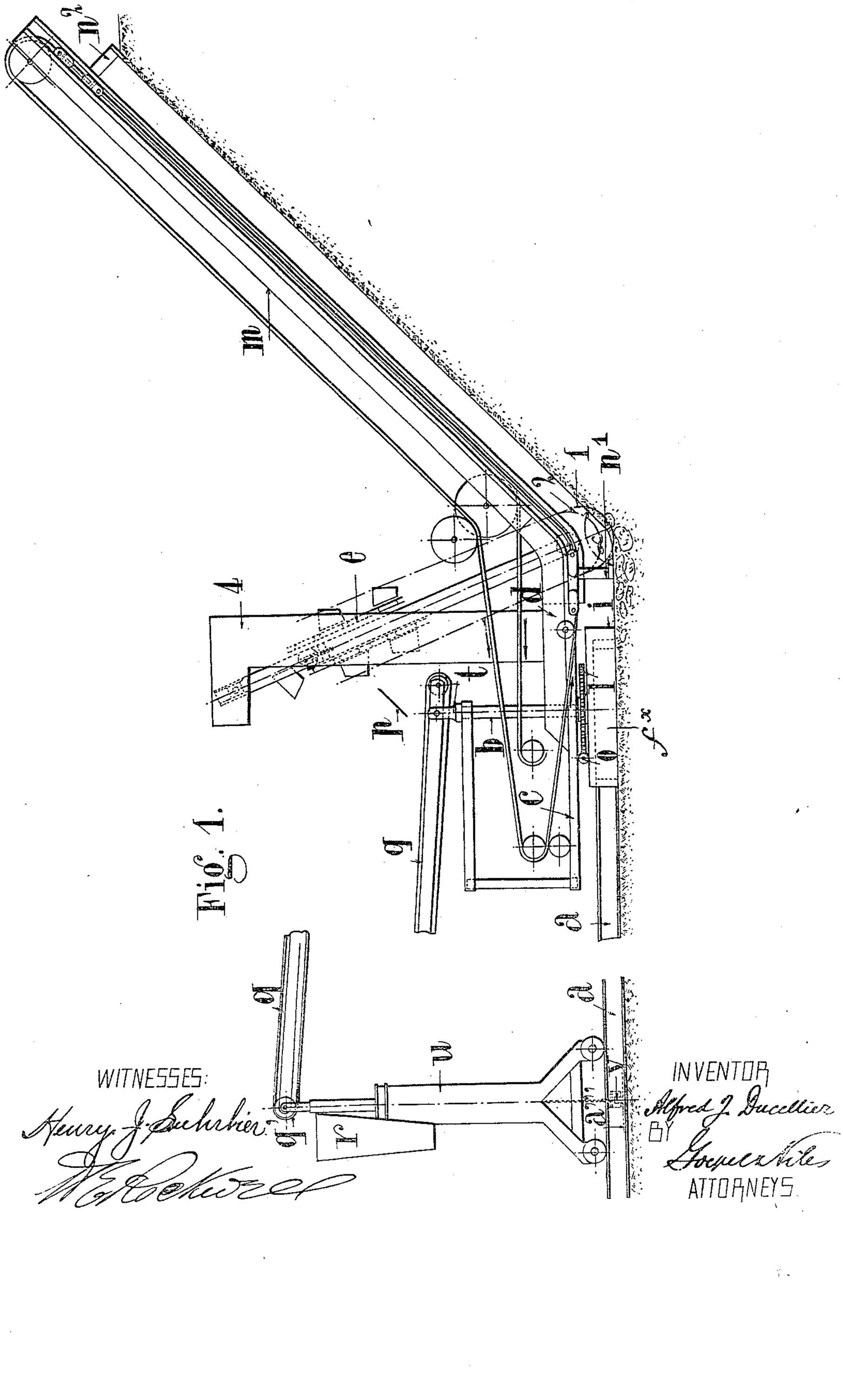

Fig. 1.

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Fig. 2.

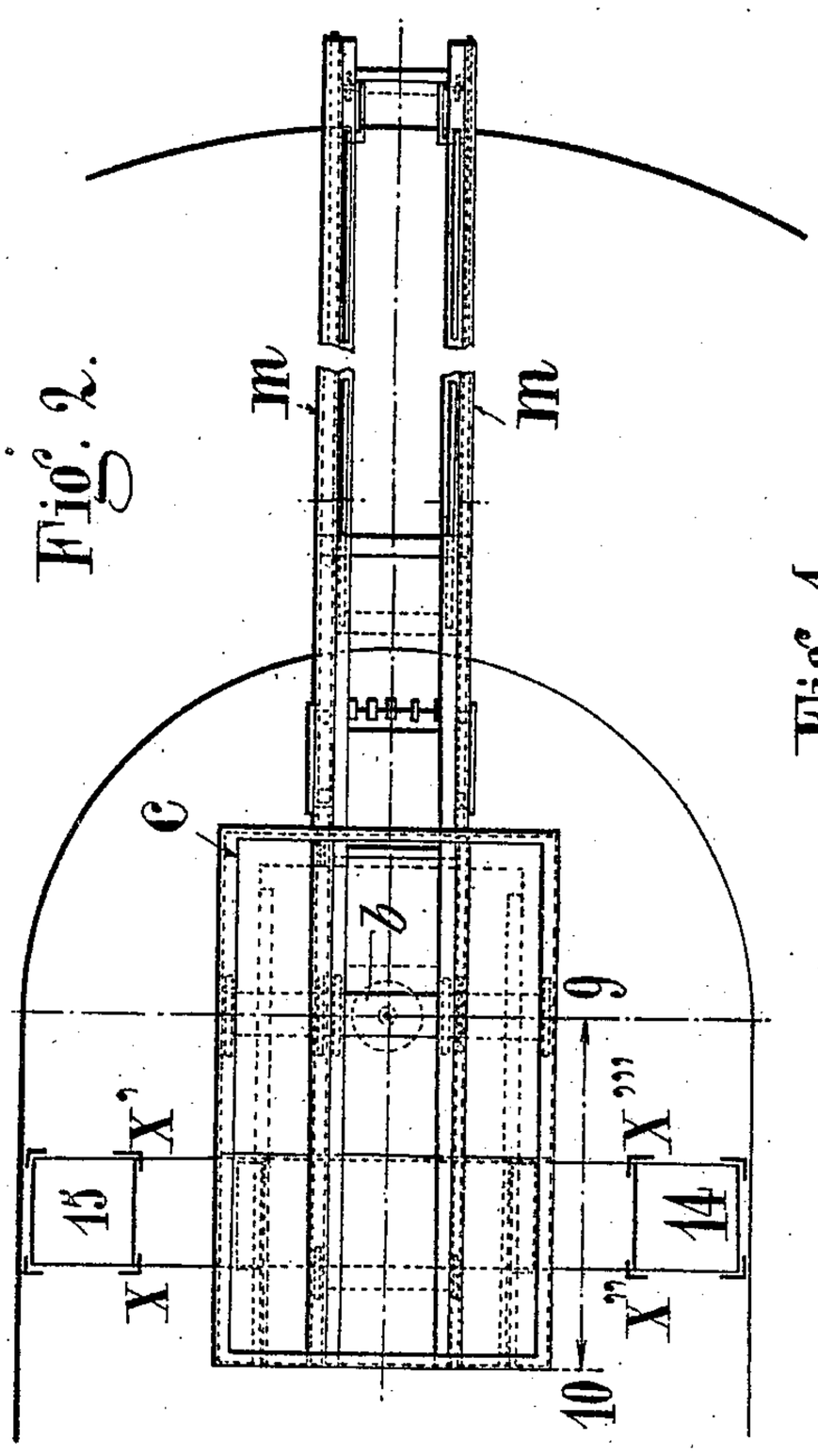


Fig. 4.

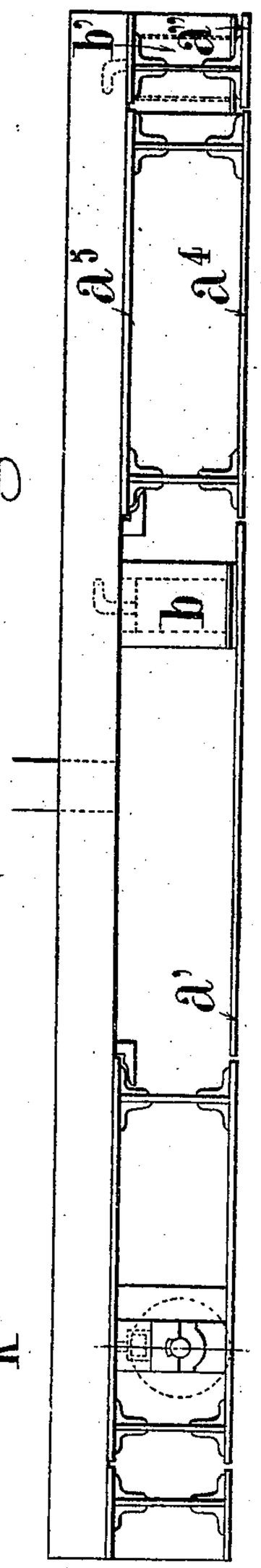
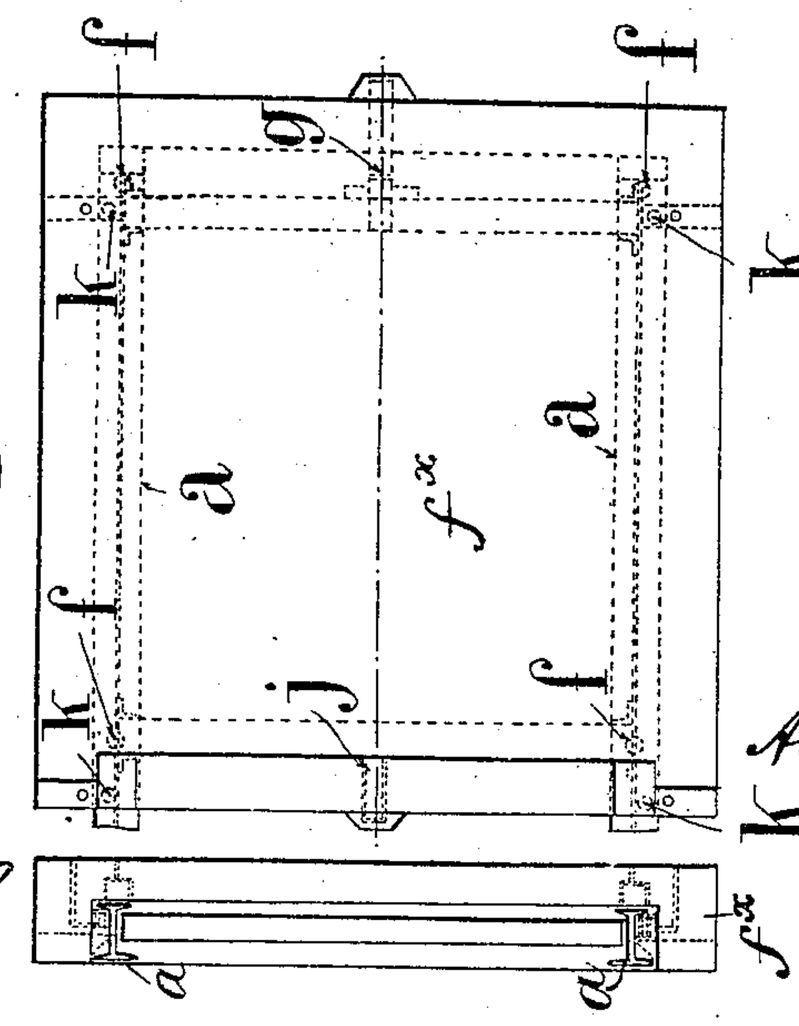


Fig. 3.



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7 SHEETS—SHEET 3.

Fig. 5.

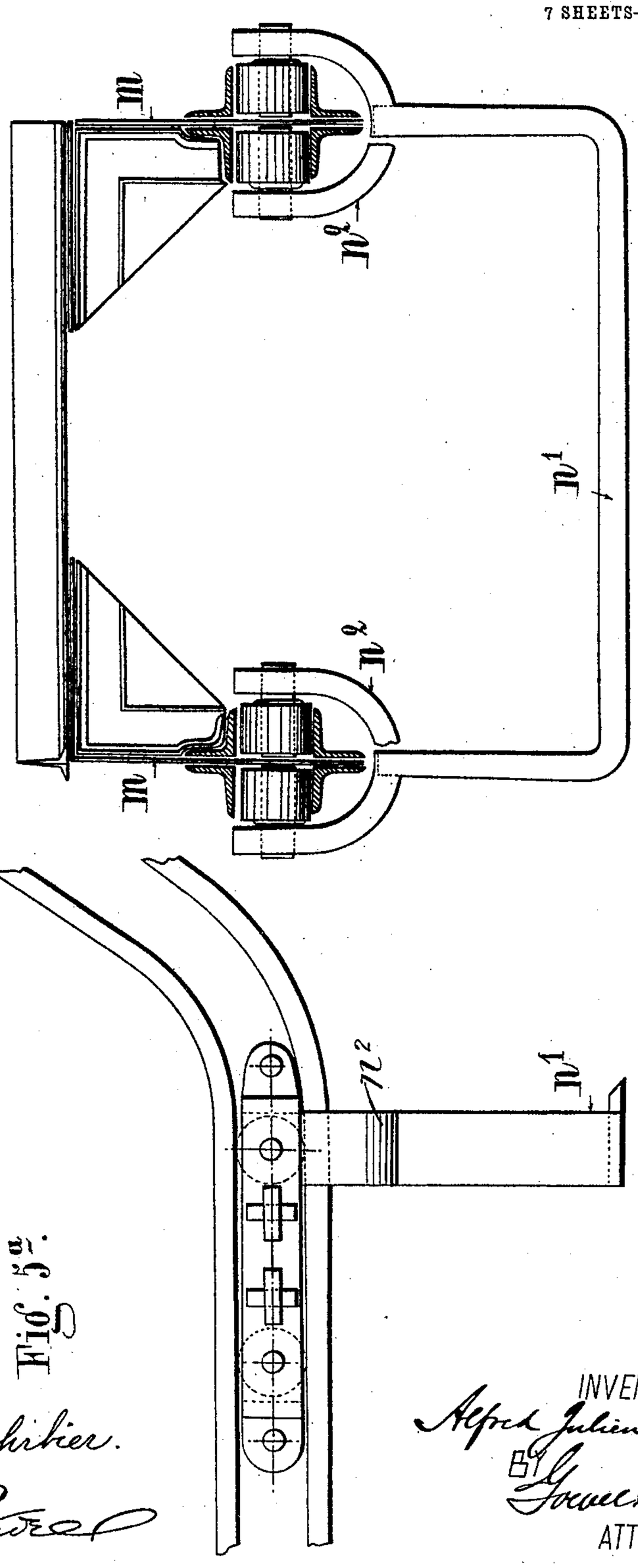

Fig. 5a.

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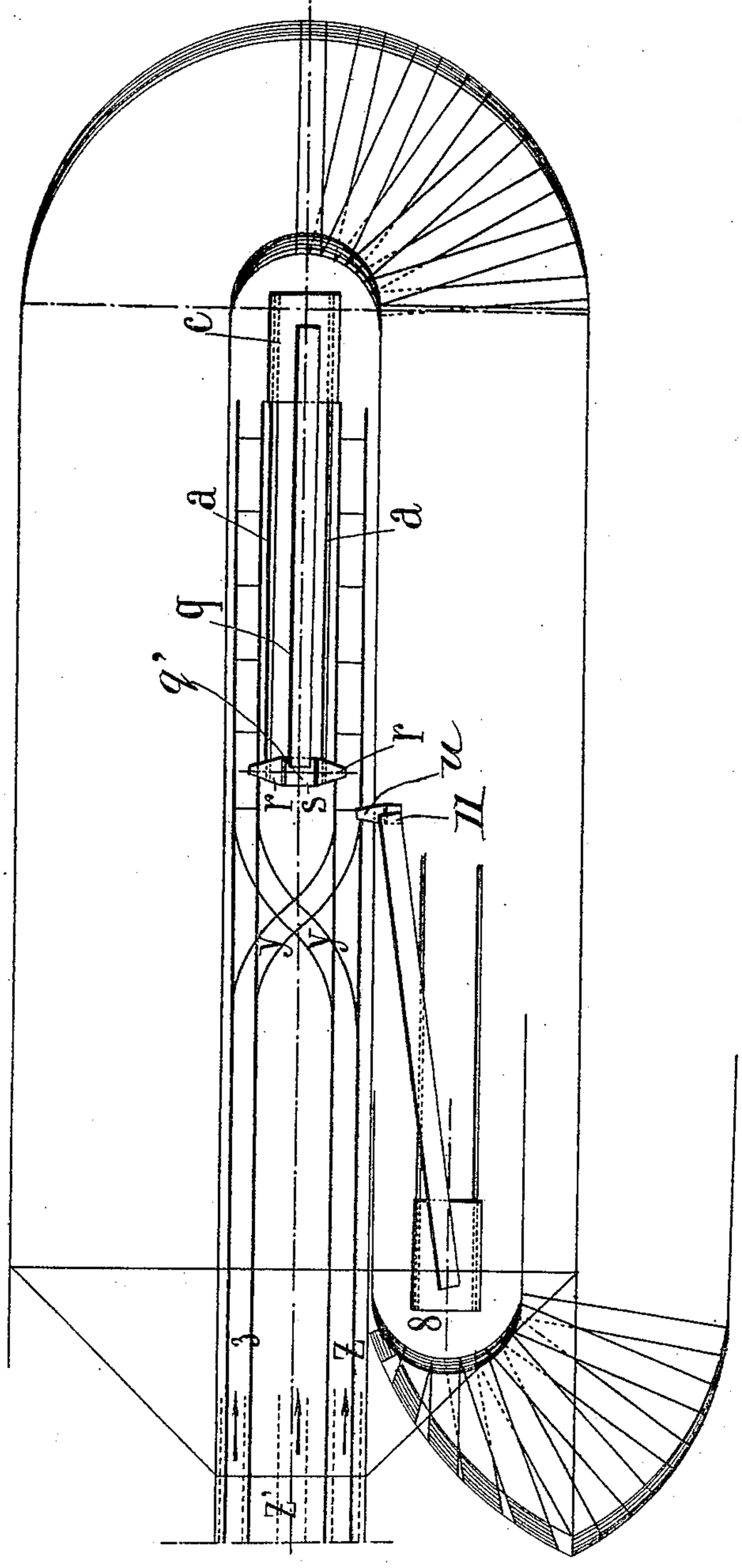
7 SHEETS—SHEET 4.

Fig. 6



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7 SHEETS—SHEET 5.

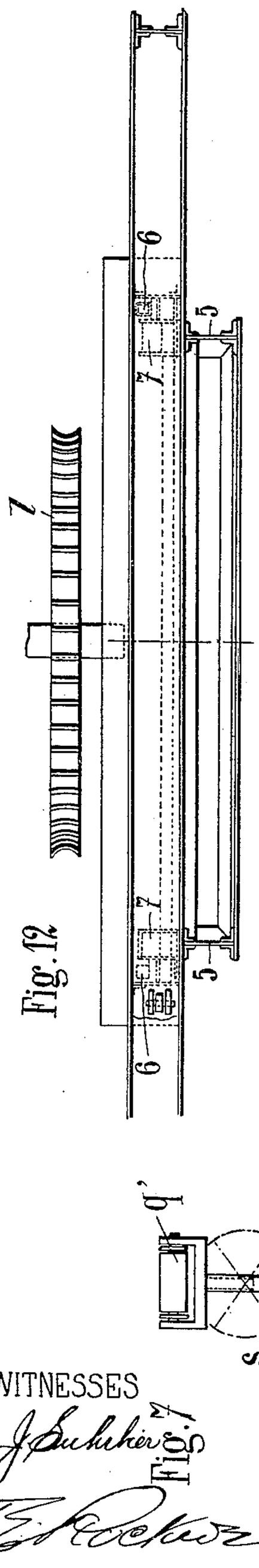

Fig. 12

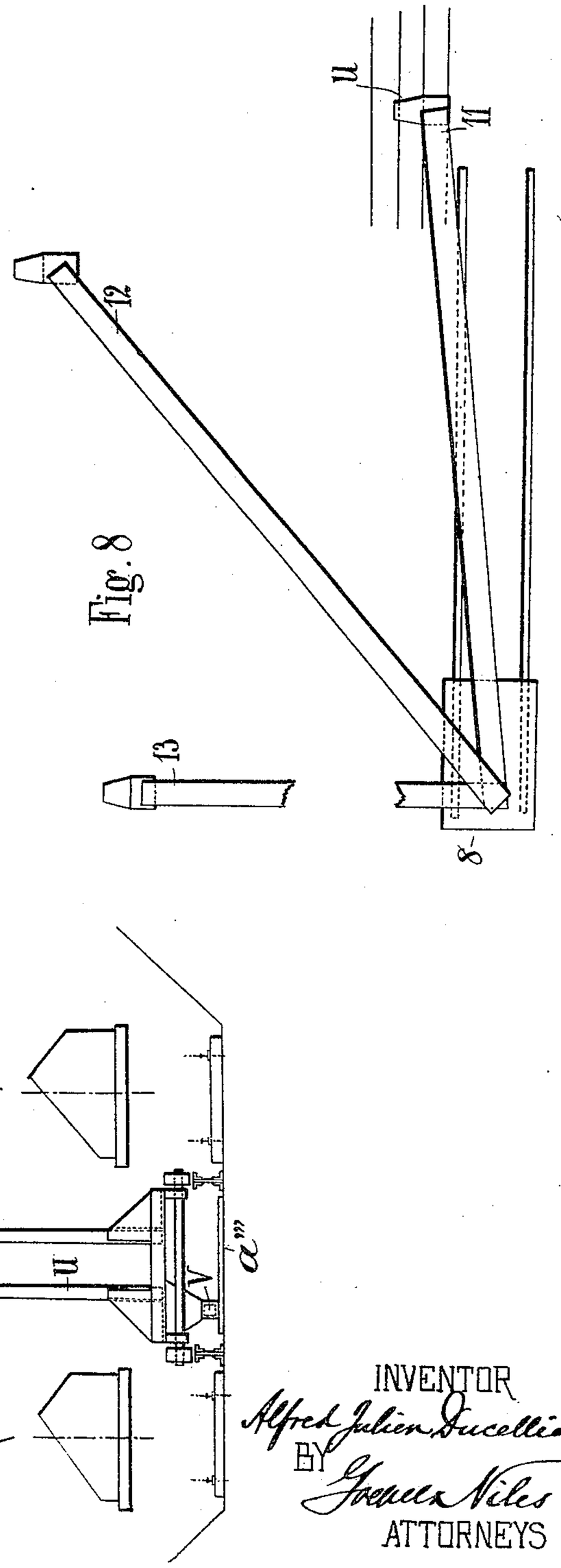

Fig. 8

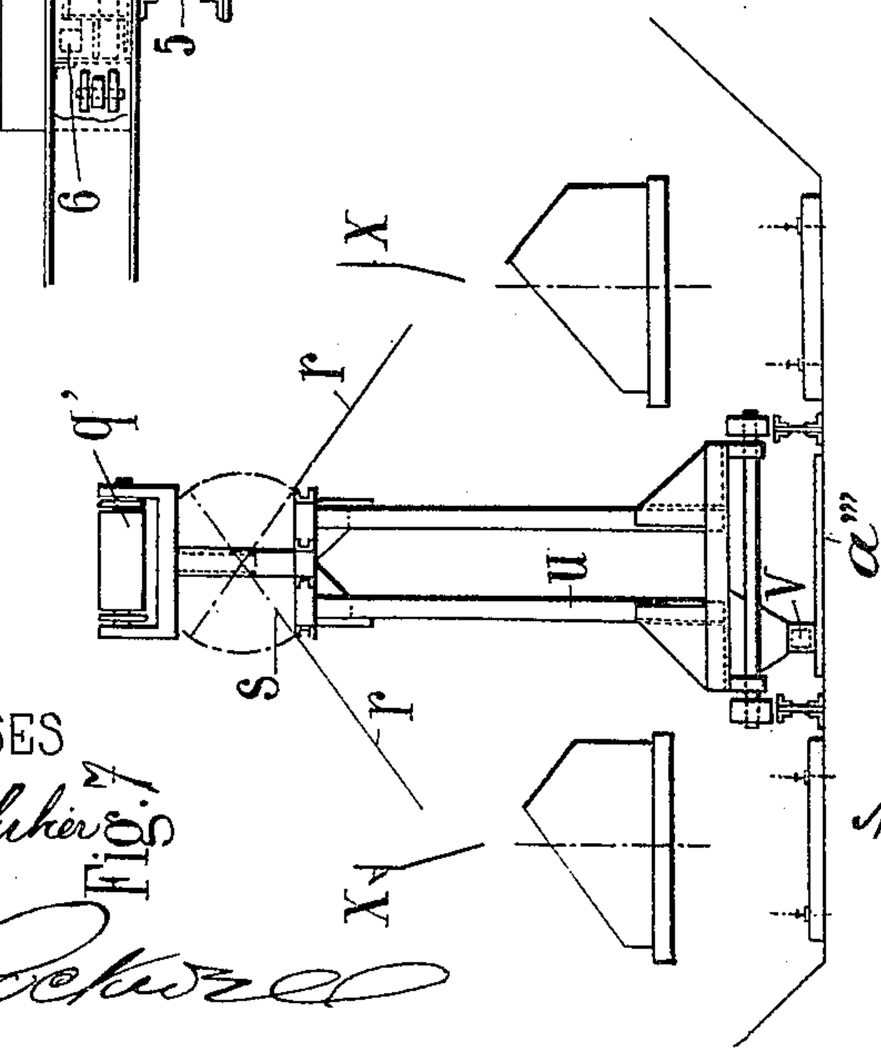

Fig. 7

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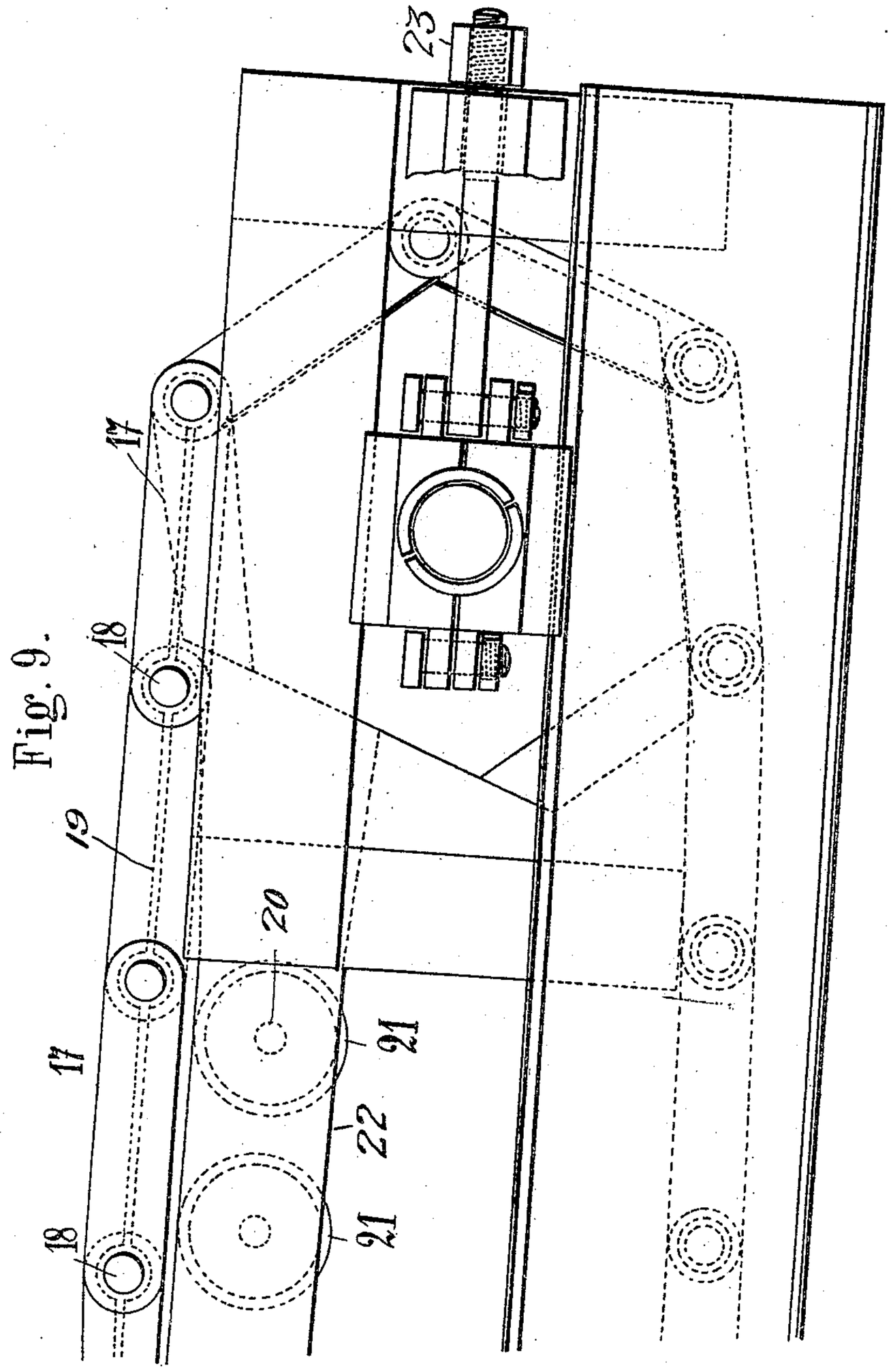
Fig. 9.



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7 SHEETS—SHEET 7.

Fig. 10.

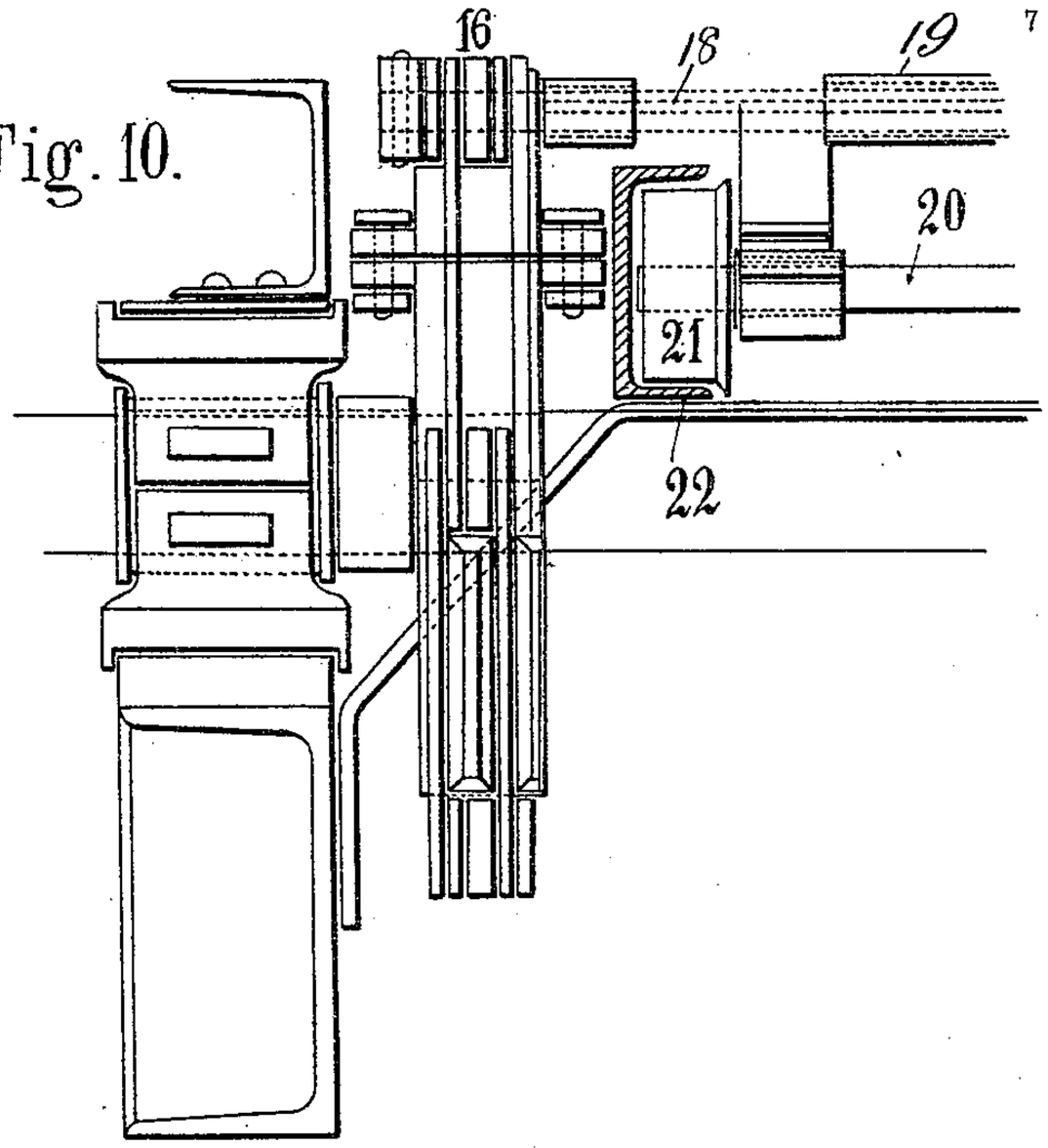
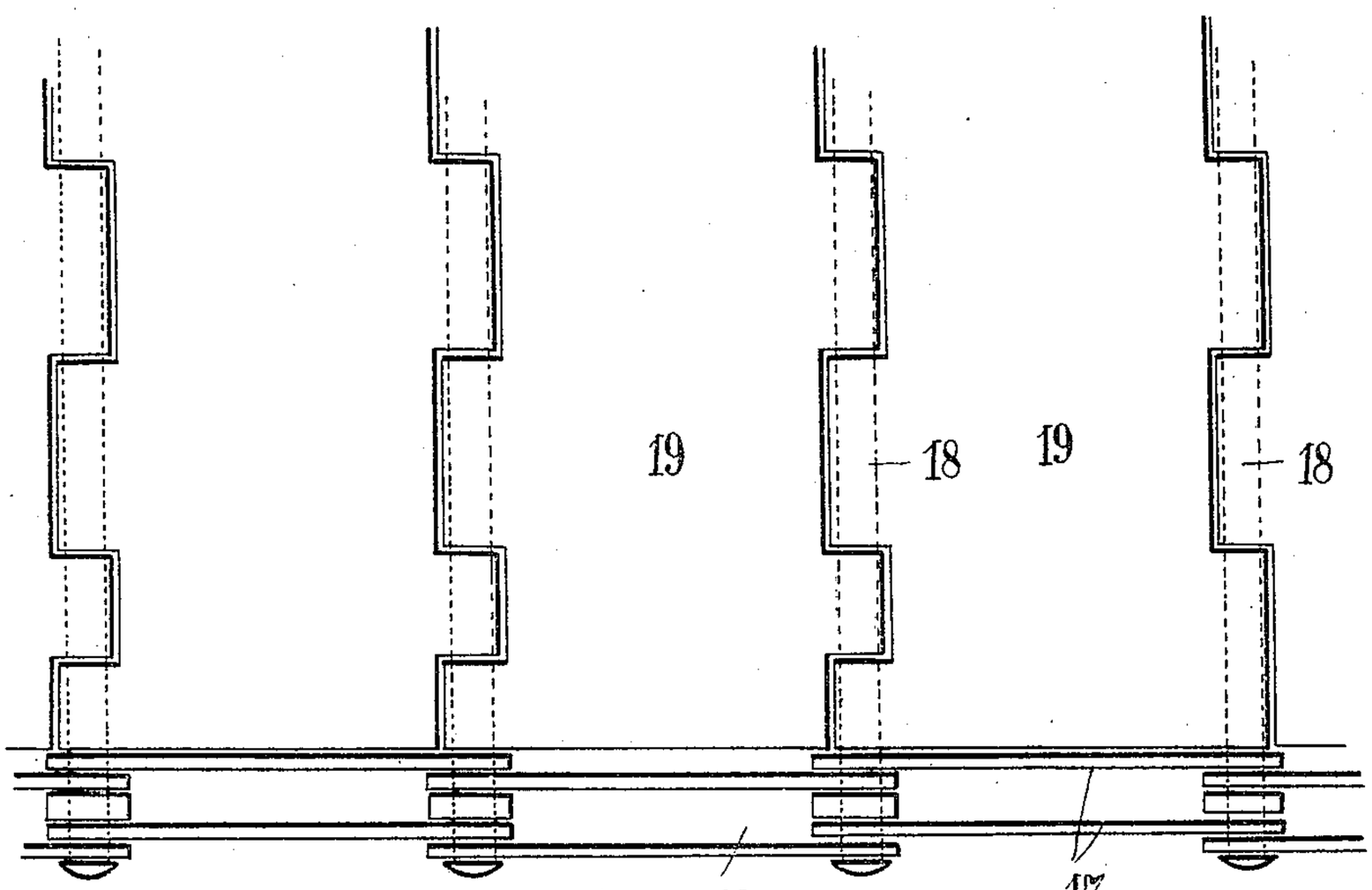


Fig. 11.



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UNITED STATES PATENT OFFICE

ALFRED JULIEN DUCELLIER, OF PARIS, FRANCE.

EXCAVATING-MACHINE.

No. 824,531. Specification of Letters Patent. Patented June 26, 1906.

Application filed November 8, 1904. Serial No. 231,917.

To all whom it may concern:

Be it known that I, ALFRED JULIEN DUCELLIER, a citizen of the Republic of France, and a resident of Paris, France, have invented a new and useful Improvement in Excavating-Machines, which improvement is fully set forth in the following specification.

This invention relates to excavating-machines for use in forming earthworks, digging trenches, and cuttings of any depth and cross-section, removing embankments and mounds, and for other similar purposes.

One of the objects of the invention is to provide a mounting for the excavating mechansim proper, whereby the latter may be advanced with facility as the work progresses, and which is also capable of adjustment in a transverse direction, such adjustments being readily effected by the manipulation of certain instrumentalities embodied in such mounting.

A further object of the invention is to provide a particularly convenient and efficacious arrangement of parts by which the excavated material is conveyed directly from the excavating mechanism to the cars by which it is carried to the point of dumping.

The invention also purposes to provide an excavating mechanism in which the excavating tools or scrapers are disposed and operated in such a manner as to enlarge the capacity of the machine and facilitate the removal of the excavated material by the conveying apparatus just mentioned.

With these and other advantages in view the invention consists in an excavating apparatus of which the novel features and combinations of parts will be hereinafter described, and finally pointed out in the claims.

An excavating-machine constructed according to this invention is illustrated, by way of example, in the accompanying drawings.

Figure 1 shows the whole machine, including the conveyer for removing the material excavated. Fig. 2 is a plan view of the same. Fig. 3 is a plan of the sliding or rolling frame. Fig. 4 shows another construction of the base. Fig. 5 shows, on a larger scale, details of the tool-supporting arrangements. Fig. 5^a is a side elevation of Fig. 5. Fig. 6 is a diagrammatic view in plan intended to show the method of working when this machine is used. Fig. 7 is an end view of the conveyer and of the frame supporting it. Fig. 8 is a diagrammatic view in plan of the apparatus when used for "widening" trenches or cuttings. Figs. 9, 10, and 11 are details, on a larger scale, of the conveyer-band. Fig. 12 shows the arrangement for causing the machine to move laterally.

The base *a* is constituted by two or four longitudinal girders firmly secured together and having ample bearing-surface for resting on the ground. To the longitudinal girders are secured on the right and on the left hand side two cross-girders X X′ and X″ X‴, Fig. 2, arranged outside and toward the rear of the machine-frame and forming at the ends platforms, the lower portions of which rest on the ground and are adapted to receive ballast for steadying the machine in use.

The frame $f^{\times}$, which carries the main driving shaft or mast *b*, is arranged so that it can be raised a few centimeters above the base *a*—for example, by means of four vertical hydraulic or other lifting jacks *f*, Fig. 3. When the frame has been thus raised, a horizontal jack *g*, Fig. 3, acting against a stay or part of the base *a*, is operated to cause the advance to a certain extent—say 0.20 centimeters—of the said frame, together with the apparatus upon it. During this advance movement the heads of the pistons of the lifting-jacks *f* are adapted to slide or roll upon the horizontal upper faces of the longitudinal girders of the base *a*, which thus form a sliding track. This advance having been effected, the jacks are released and the frame $f^{\times}$ lowered to rest on the ground, on which it bears with as large a surface as possible. During the advance of the frame an angle-iron *i*, Fig. 1, levels, if necessary, the part of the ground along which the advance takes place.

When the vertical jacks have ceased to act and the frame $f^{\times}$ is resting on the ground, a horizontal jack *j*, Fig. 3, carried on the frame, is caused to press on a stay of the base *a* and when operated acts on the latter and on the whole system of which it is a part. The result of this operation is that the whole base part constituting the sliding track advances to the same extent as the frame $f^{\times}$ has previously advanced.

The operations of raising and lowering the frame and the advance of the frame and of the sliding track are effected successively; but each of these operations is effected quickly and the whole takes a very short time. The working of the other parts of the apparatus

must not, however, be interrupted during the execution of the said operations. Consequently a firm and solid working connection between the frame $f^{\times}$ and the base must not cease to exist, and to this end the frame is made to engage under the flanges of the girders of the base, as indicated in dotted lines in Fig. 3. When, finally, the frame is resting on the sliding track after the advance of the base, the two parts are connected together by means of hydraulic or other jacks *k*, Fig. 3, acting upward and bearing against the flanges of the sliding track.

The frame carries the swiveled mast or shaft *b*, Fig. 1, which carries the whole upper system. This mast is hollowed out in the center in order to give passage for electric or other conductors, pipes, and the like required for the motors, compressors, lighting arrangements, &c., of the whole machine. To the lower portion of the shaft or mast *b* is secured a toothed wheel I, Fig. 1.

The pivoted part or jib, Fig. 1, of the machine comprises a part *c*, forming a platform, Figs. 1 and 2, on which are arranged the winches and their motors, and two metallic upwardly-inclined girders *m*, Figs. 1 and 2, connected to each other and to said platform *c* and forming rolling tracks for the parts carrying the excavating-tools, Figs. 1, 2, and 5.

There are two excavating or cutting tools working simultaneously in opposite directions, the tool n', Fig. 1, working upward and the tool n^2 downward, so that (1) the strain on the ends of the girders is neutralized, and (2) provision is made for the occurrence of large stones or blocks in the earth being excavated. In the latter case if the machine had only a single tool on said tool meeting a stone or block of such size or in such position that it could not move it nor could pass over the block in order to continue its travel it would be necessary to leave the layer of earth being operated upon unfinished and to start a new cut. If the said stone or block could not be broken up by the time the tool returned to its level and became again obstructed, the same thing would happen again, and the work of the machine would be interfered with. When, however, such a case happens with a machine constructed according to this invention, with two tools working in opposite directions, the tool first meeting the stone or block that it cannot move is prevented from moving farther, and therefore stops, as permitted by the driving mechanism, until the return movement is commenced, and the other tool, continuing its travel up to the stone or block tries in its turn to dislodge it and cause it to fall within the space (about 0.80 meters) which exists between the outermost points of the girders and the slope or bank formed by the passage of the tools. The machine can thus effect three successive cuts of about 0.20 meters—that is to say, 0.60 meters—before being stopped altogether by the stone or block, owing to the continued advance of the machine and contact of the stone or block with the girders of the machine, and during the time occupied in making these three cuts the block can be blasted by means of explosives.

The tool or scraper n^2 is mounted by means of rollers on flanges extending inwardly from the girders *m*, while the tool or scraper n' is similarly mounted on outwardly-disposed flanges of said girders, as shown in Figs. 5 and 5ª. The rollers of the two scrapers are connected by chains or other suitable transmission elements with the winches or other operating mechanism mounted on the platform *c*, and said operating mechanism is so arranged as to drive the chains of said two scrapers in opposite directions. The use of two tools enables also the speed required for the same output to be reduced by half, so that a speed of 0.25 meters per second may be assumed as the minimum speed of each tool.

When work is commenced, the tools are in the positions shown in Fig. 1. If they do not meet any large stones or blocks, they travel toward each other and meet at the point in the center of the distance separating them, and it is from that point that they return. When the tools have returned, the jib is moved to the right or to the left hand side to the extent corresponding to the width of the tools, the lateral movement being effected by means of a worm *o*, Fig. 1, engaging with the wheel *i*. This movement having been completed, the tools recommence a working movement, and so on.

The bucket conveyer is mounted on the horizontal portion *d* of the jib, and the material excavated is lifted by the buckets of the said conveyer and delivered onto a chute *p*, Fig. 1, by which it is guided onto the band conveyer *q*. The axis of the bucket conveyer is arranged on a line bisecting the angle $\propto$, Fig. 1, and the whole of the bucket conveyer can be moved axially. The outermost edge of the traveling buckets passes tangentially to the rounded off summit of the angle $\propto$ when the tool n' has passed that angle during its forward movement—that is to say, when the tool n' is working on the slope of the excavation—and the relative positions are preserved during all the time required for the forward movement of the tool in question. To enable the tool n' to return to its starting position, the whole conveyer is lifted axially at the moment required, and thus the tool n' is enabled to take up its starting position again. The two positions are indicated by the lines 1 and 2, respectively, in Fig. 1. The required movement is obtained by means of a hydraulic or other jack, the ends of the frame of the conveyer being held, in order that the movement in question may take place, by means of shoes and slides in

the framing supporting them. The arrangement of the buckets is a well-known one; but they must be arranged so that their edges or lips project beyond the chain.

The band conveyer *q*, which receives the material excavated, brings it to the chute *r*, Figs. 1 and 7, and discharges it alternately to the left and to the right by the folding movements of its upper portion *s*, Fig. 7. The length of the conveyer *q* is fixed, Fig. 6, by the distance required to deal with five trucks or wagons, each about 3.50 meters in length, running on railway-tracks and which are placed successively underneath the chute at the delivery end.

In practice five trucks or wagons are arranged at each side, and the chute *r* discharges alternately into a truck or wagon on the right and on the left hand side, the trucks or wagons being fed along as required until all have been filled.

The conveyer-band for carrying the material excavated may be of metal and of the construction shown in Figs. 9, 10, and 11—that is to say, constituted by two chains 16, arranged about one meter apart and formed by a double series of links 17, the chains being connected together by bolts 18, on which are mounted plates 19, of, say, cast steel. Each pair of consecutive plates 19 is hinged about the same bolt 18. Each alternate plate 19 is provided with two spindles 20, Fig. 10, on which are mounted wheels 21, traveling on a flange of a channel-iron 22, so as to reduce to a minimum the wear of the parts in contact and do away with excessive oscillation and vibration at the higher speeds. A stretching device 23, Fig. 9, acts on the chains 17 at one end of the conveyer, so as to make up for any sagging or looseness that might occur between the movable parts. The conveyer *q* is operated at the end *q'*. The chutes *r* may be raised or lowered to a certain extent, according to the nature of the material being excavated.

In order to reduce the speed of falling of the material, baffle-plates may be arranged and are preferably suspended at their upper ends on spindles *x*, Fig. 7, so as to be capable of oscillation in order to allow any large blocks or stones to pass.

Besides the construction described the arrangement of the frame on the sliding track of the base may be as follows: The sliding track is constructed in the same way as previously described; but the frame and the support for the back end of the conveyer are adapted for engagement with the track and fit it so that they can slide on it in the same way as the slide-rest of a lathe slides on its bed. The parts in question may also be made to engage with the top flanges of the girders of the base, so as to maintain constant connection between those parts. The frame and the support are arranged so as to rest on the ground at any desired moment, the frame, by means of its feet *a''*, arranged outside the sliding track and made as wide as will be rendered possible by the length of the horizontal portion of the girders *d* and by means of feet arranged at *a'*, Fig. 4, and the support by the feet *a'''*, Figs. 1 and 7, the front and back feet shown being done away with. The surface of these feet as used on a sliding track 2.50 meters wide is sufficient for supporting the weight of the apparatus on any ground without its being necessary to consolidate the ground by ramming it or in other ways preparing it. It must be pointed out here that the distance between the two girders on one and the same side of the sliding track can be reduced to such an extent as to form a closed hollow beam, these girders being connected by metal sheets a^4 and a^5, Fig. 4, one of which, a^4, serves besides as a surface bearing on the ground for the purpose of increasing the width of the central bearing-surface when the frame rests on the ground, while the base *a* is being caused to advance.

The feet *a'* and *a''* are secured to the frame in such manner that the latter can be raised by the action of the jacks *b'*, Fig. 4, resting on these feet. In that case it is no longer the front of the frame that effects the leveling of the surface along which the advance takes place, as at *i*, Fig. 1. Instead it is the front of the base *a* that is provided with the angle-iron *i*. The advance then takes place as follows: By the action of the jacks the frame and the support are lifted off their feet, owing to the engagement with the upper flanges of the girders of the base *a* and with the frame and the support. The base *a*, which no longer rests on the ground and does not offer any resistance to an advance, is also lighter. At that moment the weight of the frame and that of the parts it is carrying in addition to the weight of the base is taken by the feet. In this position the frame offers, therefore, a great resistance to a longitudinal movement. A horizontal jack acts then on a cross-bar of the base and pushes the latter forward. The angle-piece *i* has been placed in the position desired in order to level the surface along which the advance takes place. The base may then be advanced as far as the position of the bottom tool *n'* at its starting position will allow. Several successive advances of the frame of 0.20 to 0.25 meters can be effected before it becomes necessary to move the base. After the base *a* has been advanced the jacks cease to act, all the weight of the frame bears on the base, and the frame slides on the base under the influence of a jack resting on the said base or by means of a spur-wheel driven by worm-gearing on the frame, which engages with a rack on the base. In case of this gearing being used it may also be em-

ployed for causing the base to advance, and the jacks for effecting the movements of the frame and of the base are no longer necessary. At the moment when the base *a* is raised from the ground the parts which rise vertically at the right and at the left hand sides of the sliding track are arranged in such manner that the platforms 14 and 15, arranged at each end of these portions and on which is placed the ballast for increasing the stability of the apparatus do not follow the base; but, on the contrary, each of the platforms 14 and 15 remains on the ground, thus preventing any lowering of the frame secured to the base. This is effected either by means of a locking arrangement operated automatically or by hand or by hydraulic means—that is to say, by introducing water, which occupies the empty space left between the bottom of a cylinder secured to each of the frames and a piston secured to each of the platforms. Owing to its incompressibility, water insures stability of the whole of the apparatus during the raising of the base, and thus enables the platforms to play the same part as when the track rests on the ground.

The whole machine can be operated by steam-engines; but it is preferable to use electric motors, current being supplied from a generating-station installed in proximity to the place of working of the machine.

The material excavated is removed by means of trucks or wagons movable on two parallel tracks or lines laid from the point where the material is excavated to the beginning of the dumping-ground. One of the tracks serves for the loaded trucks and the other for the return of the empty trucks. Near the apparatus there are two crossover-lines *y*, Fig. 6, by which the trucks can pass from one line to the other.

At present trains of twenty or more trucks are formed and drawn by a steam-locomotive; but in certain cases it will be preferable to adopt the following arrangement: Of each five trucks one would be a motor-truck rendered self-propelling by the addition of an electric motor, but otherwise capable of being loaded in the same way as the others. These five trucks are placed at one side of the band conveyer, the length of which is such that they can all be arranged beyond the chute ready for being loaded. A similar set of five trucks is placed in the same way on the other track, Fig. 6. As soon as the first five wagons on either side have been filled, being drawn forward in order under the chute *r*, which discharges alternately to either side, they are taken away to be emptied, and a new series of empty wagons are placed in position, and so on. As many groups of five trucks as necessary can be used, according to the distance to which the material has to be transported. This method of working may be employed for depositing material to form embankments and earthworks, as it enables the discharge to be divided longitudinally into several sections, the loaded trucks being supplied from one line or track and discharged from the sides, and the empty ones removed via the other track. In the case of an embankment made by successive deposits of material this process may also be employed; but it will then be advisable to combine several groups of five trucks into longer trains, so that the navvies and workmen shall have time to trim the material and otherwise prepare for the next train of material in the intervals between trains. When the transport of excavated material is thus effected in trains of twenty to thirty trucks each, it may not always be necessary to install two continuous lines or tracks. In such case the lines *z* and 3, Fig. 6, would be left along the length on which the excavating-machine is working. Then these two lines join and form a single line until the point where the material is being discharged to form an embankment or the like. A locomotive brings its train of empty wagons on the line 3 and leaves them there. It then passès to the line *z* and backs onto a train of loaded wagons on that line and then takes this train to the discharge-point. Meanwhile the empty wagons have been taken alternately to the loading position on the line 3 and the line *z* by horses or by small locomotives of just sufficient power to draw four wagons and loaded up. One of these small locomotives is preferably used for each track and is kept at the place occupied by the fifth wagon, Fig. 6. The full wagons from each loading position are collected into trains on the line *z*.

A large proportion of the stones and blocks that occur in certain grounds can be moved or uprooted by one or the other of the tools. Nevertheless, as an additional precaution, as soon as the presence of a stone or block has been ascertained, it is advisable to undermine it and blast it by means of explosives. Furthermore, if the proportion of such blocks occurring on certain grounds should make it necessary a crane is placed at the top of the bucket-conveyer frame 4, Fig. 1, which crane has its axis in the continuation of the axis of the pivot *t* and which will lift blocks of a volume of 0^3m.600 to 0^3m.700 and lower them into the first wagon.

The arrangement of the different parts of the apparatus and the operations described refer to the working of the apparatus when making cuttings or trenches not exceeding ten meters in depth and seven meters in width with a slope of forty-five degrees.

The dimensions of the machine may be increased or reduced according as the final dimensions of the cutting or trench are larger or less than the above figures. When the final depth of the cutting or trench is more than fifteen meters, it is done in stages—for in-

stance, for a depth of twenty meters in two stages of ten meters each. In order to change from forward excavating to "widening "or side excavating, the machine is arranged as follows: It is assumed that the widening is on the right-hand side and that the apparatus has arrived at the end of the work that it can execute by advancing. The machine is moved on two girders 5, Fig. 12, which are parallel to each other and connected by transverse bars. These girders are placed in the ground, so that the tops of the said girders do not project beyond the surface of the ground which has been specially leveled to receive the machine. As soon as the transverse axis of the sliding track of the base is parallel to the longitudinal axis of the fixed girders the machine stops, the conveyer is lifted from its supports by means of crane-fittings arranged on the tops of the metal girders *m* and placed in a parallel direction outside the base. The machine can then be moved laterally by raising it and causing it to bear by means of vertical jacks 6, Fig. 12, on the rollers 7, which then rest and roll on the transverse fixed girders 5. This lateral movement having been obtained, the jacks 6 cease to act, the apparatus rests on the ground, the frame is placed at the back end of the sliding track of the base, the conveyer is raised in accordance with the new position of the frame and of the machine relatively to the line *z*, Fig. 6, and the supports replaced. The apparatus is then ready to perform widening work of about seven meters, as shown at 8 in Fig. 6.

Fig. 4 shows a modified construction of the sliding track of a machine cutting by "advance" excavation a trench 11 sixty meters wide. In that case the distance between the girders of the sliding track, as well as the length of the platform *c*, could be increased according to the requirements. When the machine works by widening excavation and when said widening is of sufficient size to necessitate several journeys of the machine, the necessity for moving the transport-track can be avoided by arranging the support *u* on a track arranged between the apparatus and the loading-track, Fig. 8. In that case the chute *r* being fixed to the support the conveyer can assume any position between the points 11, 12, and 13, according to the progressive moving away of the apparatus from the service-tracks. The support will be caused to follow the movement of the machine by the action of a motor which will communicate to it the necessary movement. This arrangement can also be used for leveling fortifications and earthworks which have been made by the use of material excavated from the trenches of the same fortifications. The machine in such a case deposits the material excavated in the trenches without the intermediary of service tracks or wagons. A sliding track similar to that of the machine and on which is placed the support of the conveyer enables the same result to be obtained. When the slope of the trench or the earthworks is curved, the machine follows its curvature, the straight girders at the ends of the sliding track of the base being replaced along the necessary length by curved ones.

In order to generalize the use of the machine, it is built so as to enable it to be transformed for the purpose of making cuttings of different widths—for instance, cuttings for narrow-gage (one meter) railways—and then to enable the same machine when certain parts have been added to it to execute cuttings for ordinary-gage railway with single track or with double track. For large works suitable machines can be constructed in accordance with the local or special conditions of such work.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In an excavating apparatus, the combination of parallel girders forming a base or track, a superposed frame bearing on said girders, excavating mechanism carried by said frame, means for raising said frame from said base, means for advancing the same relatively to said base, and means for likewise advancing said base after the seating of said frame.

2. In an excavating apparatus, a frame, a mast or shaft mounted thereon, a platform supported on said mast, a tool-carrying jib carried by said platform, mechanism on said platform for operating the tools on said jib, a bucket elevator carried by said jib adjacent said platform, and a conveyer supported at one end on said mast adjacent said elevator.

3. In an excavating apparatus, a frame, means for supporting the same, an upright mast swiveled on said frame, means for rotating said mast, a platform carried by said mast, a tool-carrying jib mounted on said platform, a bucket elevator carried by said jib adjacent said platform, and a conveyer supported on said mast and so disposed as to receive excavated material from said elevator.

4. The combination, with a base or track, of a frame, an excavating mechanism carried thereby and embodying an upright mast, a horizontally-disposed conveyer supported at one end on the upper end of said mast, and a support movable on said base or track at the rear of said frame and upon which the opposite end of said conveyer is mounted.

5. The combination, with the excavating mechanism, of a track for guiding the same, a support or standard mounted on said track and movable thereon, a conveyer extending between said excavating mechanism and said

standard, and means carried by the latter for deflecting the excavated material to either side of the same.

6. The combination, with a jib embodying parallel girders, of flanges carried by said girders, rollers movable on said flanges, a scraper carried by said rollers, a chain connected to said scraper, and means for driving said chain.

7. In an excavating apparatus, a jib constituted by parallel girders having inwardly and outwardly extending longitudinally-disposed flanges, a scraper guided on the inner flanges, a similar scraper guided on the outer flanges, and means for driving said scrapers.

8. In an excavating apparatus, the combination, with an upwardly-inclined jib, of a longitudinally-disposed track carried thereby at its under portion, a scraper mounted on said track at either end thereof, and means for driving said scrapers toward each other.

9. In an excavating apparatus, the combination of an upwardly-inclined jib having a horizontal base portion, tools movable longitudinally of said jib at the lower side thereof, means for operating said tools, a bucket elevator the frame of which is carried by said jib and which extends through the same, and means for raising and lowering said bucket elevator in its frame.

10. In an excavating apparatus, the combination of parallel girders countersunk in the earth, girders superposed on said first-named girders and constituting a base, a frame carried by said upper girders, excavating mechanism carried by said frame, and means for shifting the upper girders constituting the base transversely of said countersunk girders.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

ALFRED JULIEN DUCELLIER.

Witnesses:

EMILE LEDRET,

JOHN BAKER.