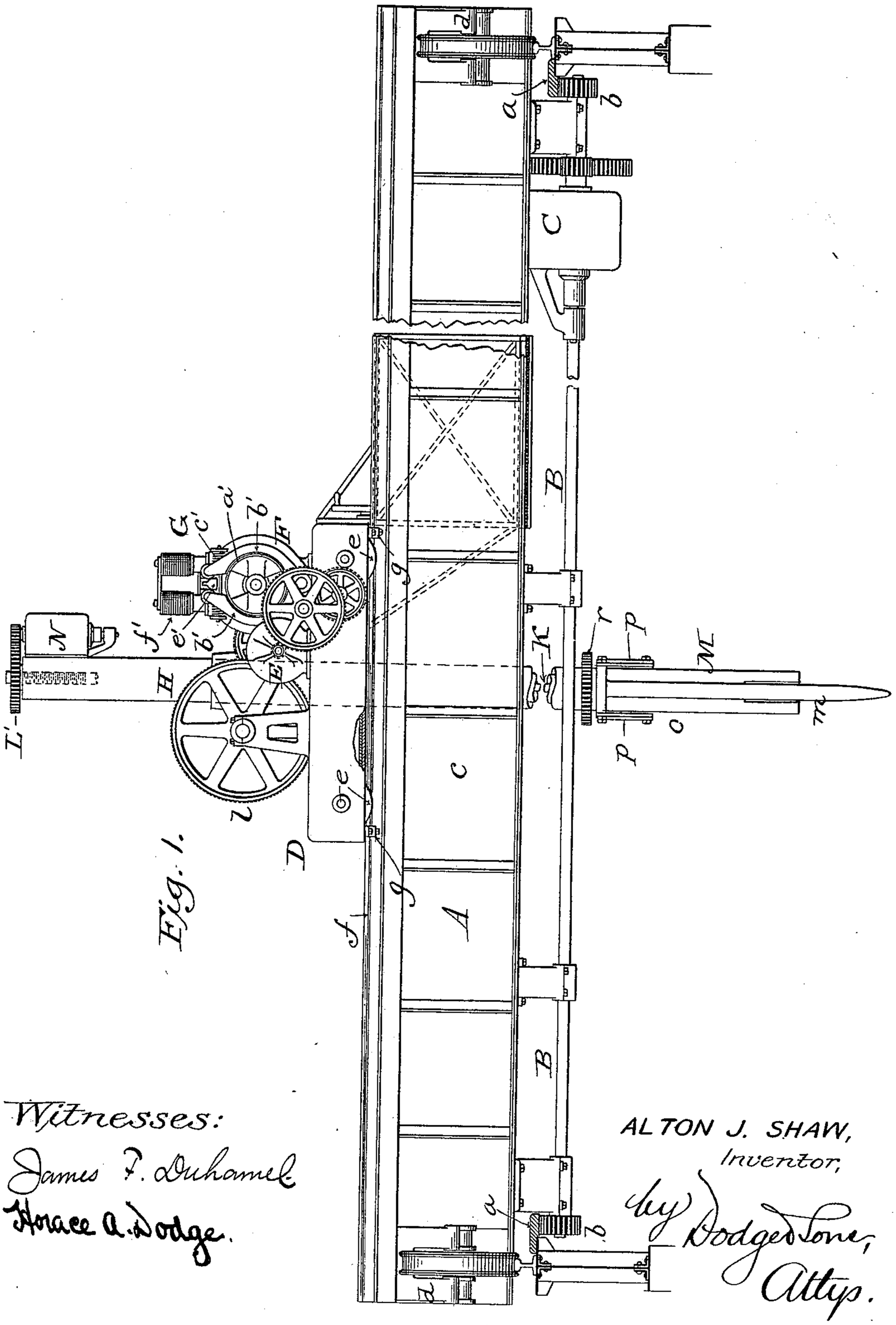
No. 622,280. Patented Apr. 4, 1899.

A. J. SHAW.

HOISTING MACHINERY.

(Application filed May 6, 1893.)

(No Model.) 7 Sheets—Sheet 1.



Witnesses:
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Horace A. Dodge.

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Attys.

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7 Sheets—Sheet 2.

Fig. 2.

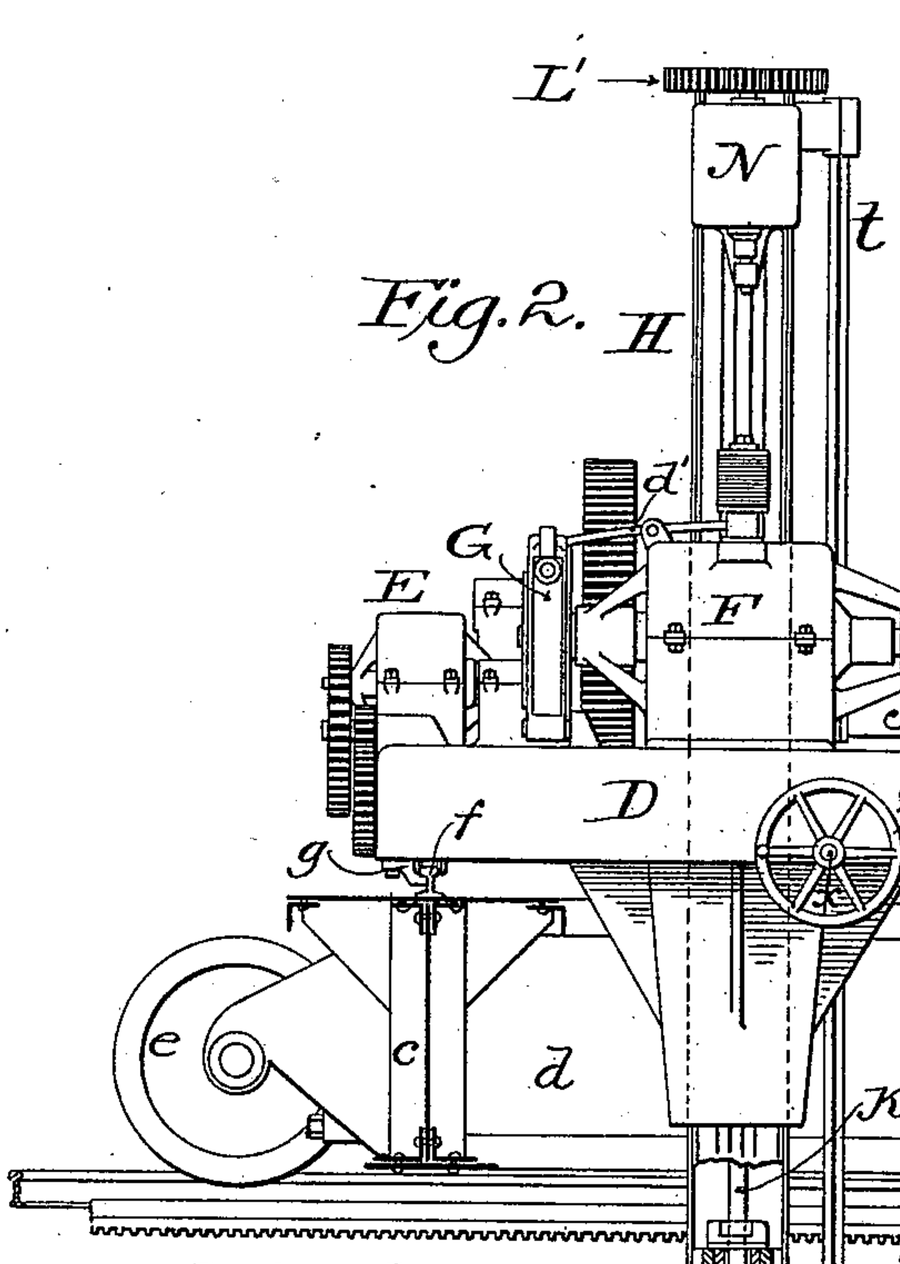


Fig. 6.

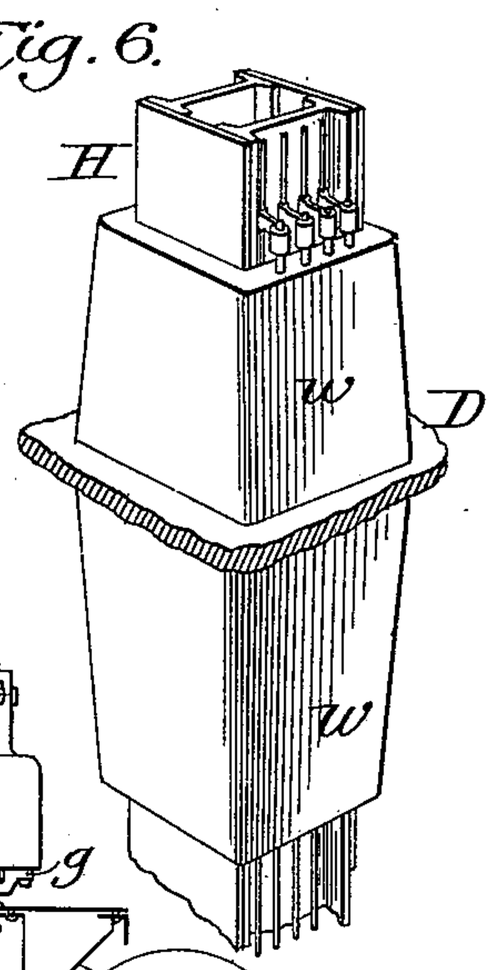


Fig. 3.

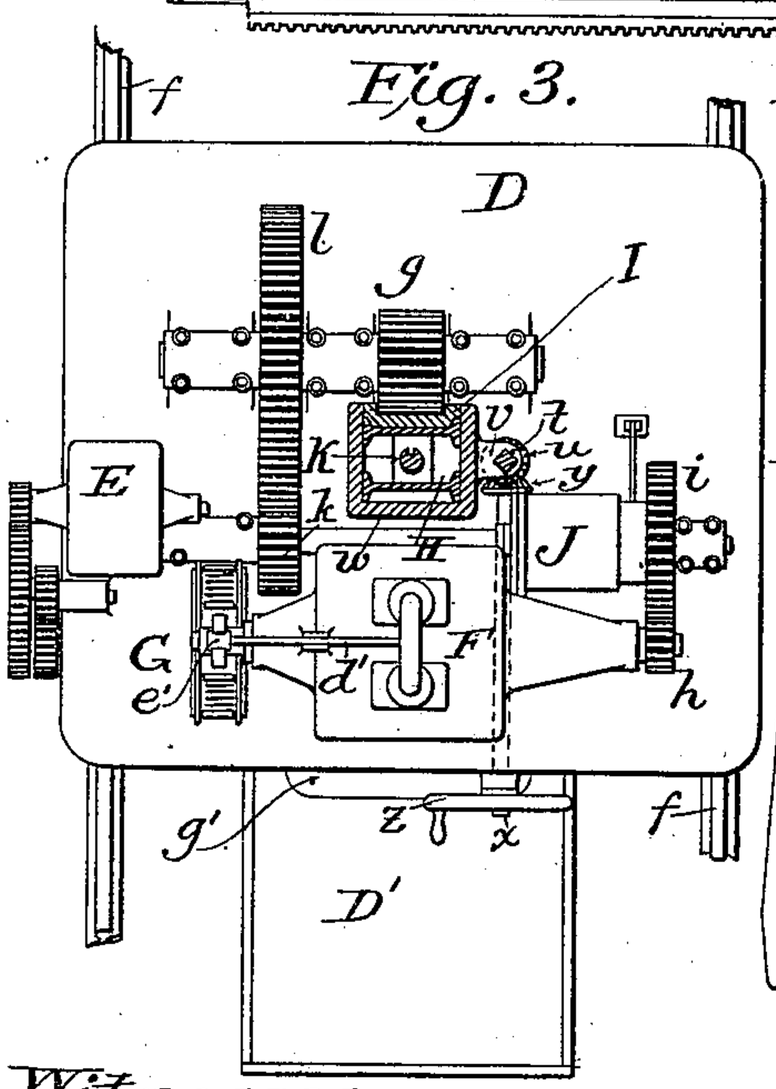


Fig. 4.

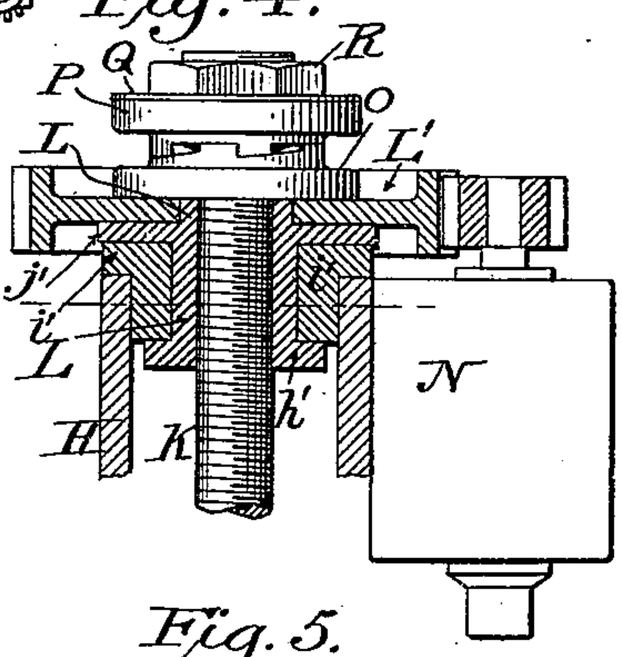
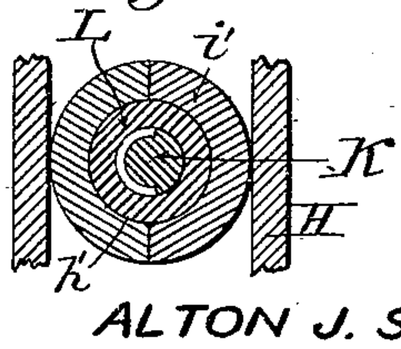


Fig. 5.



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(No Model.) 7 Sheets—Sheet 3.

Fig. 7.

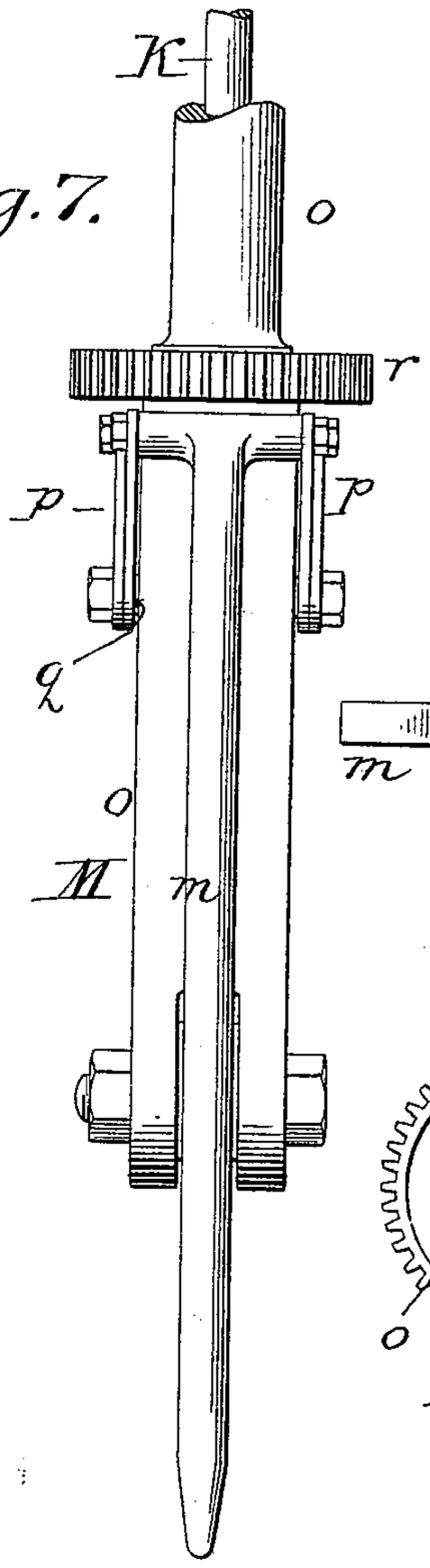

Fig. 8.

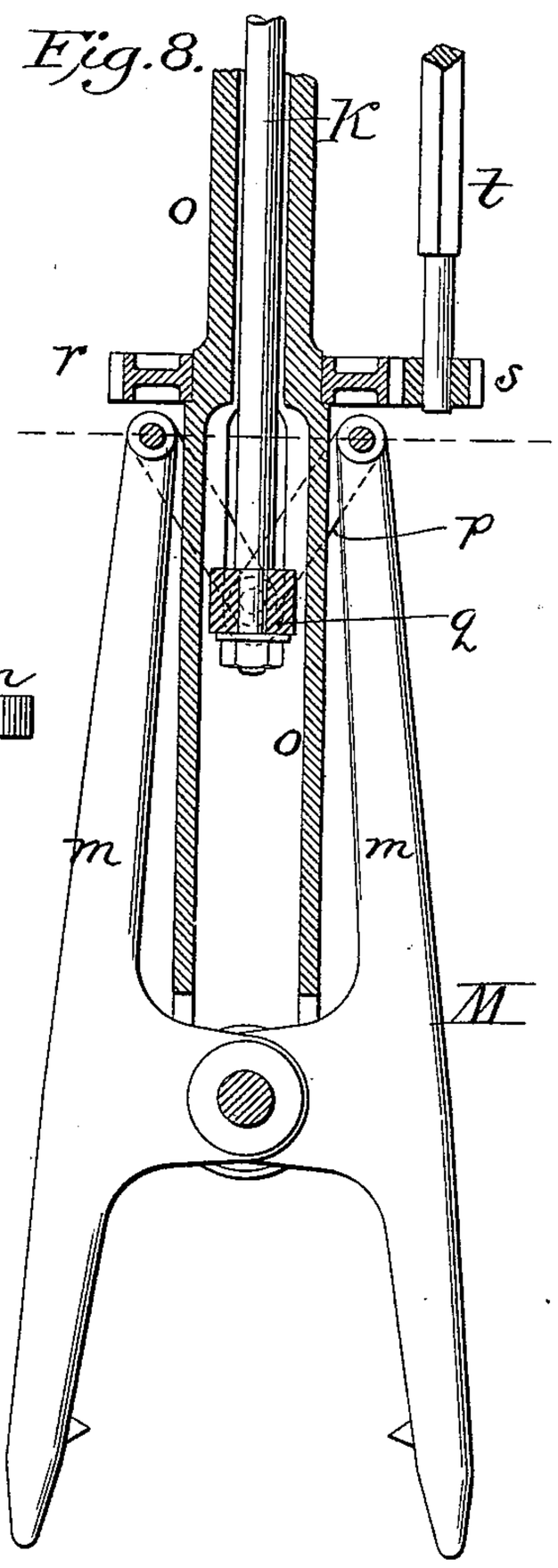

Fig. 9.

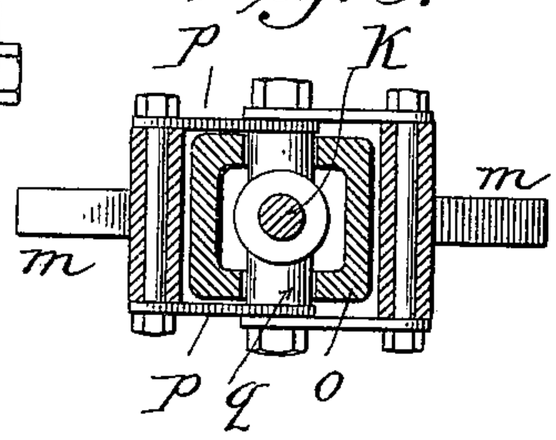

Fig. 10.

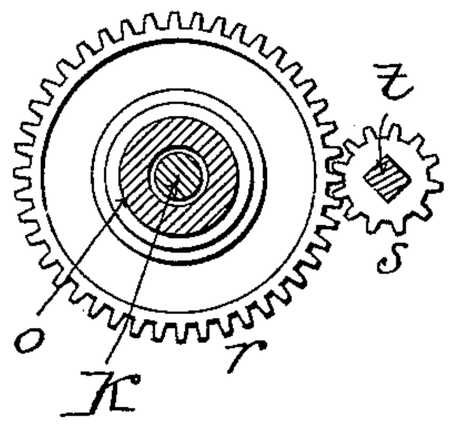

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Fig. 11.

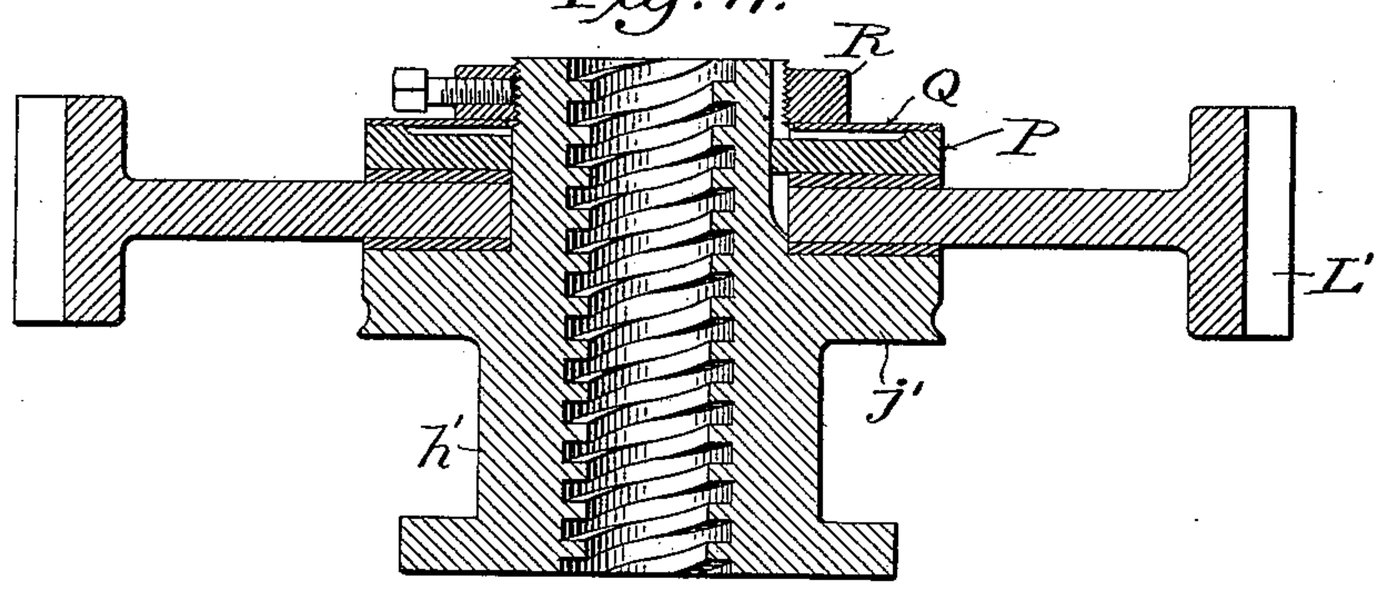

Fig. 12.

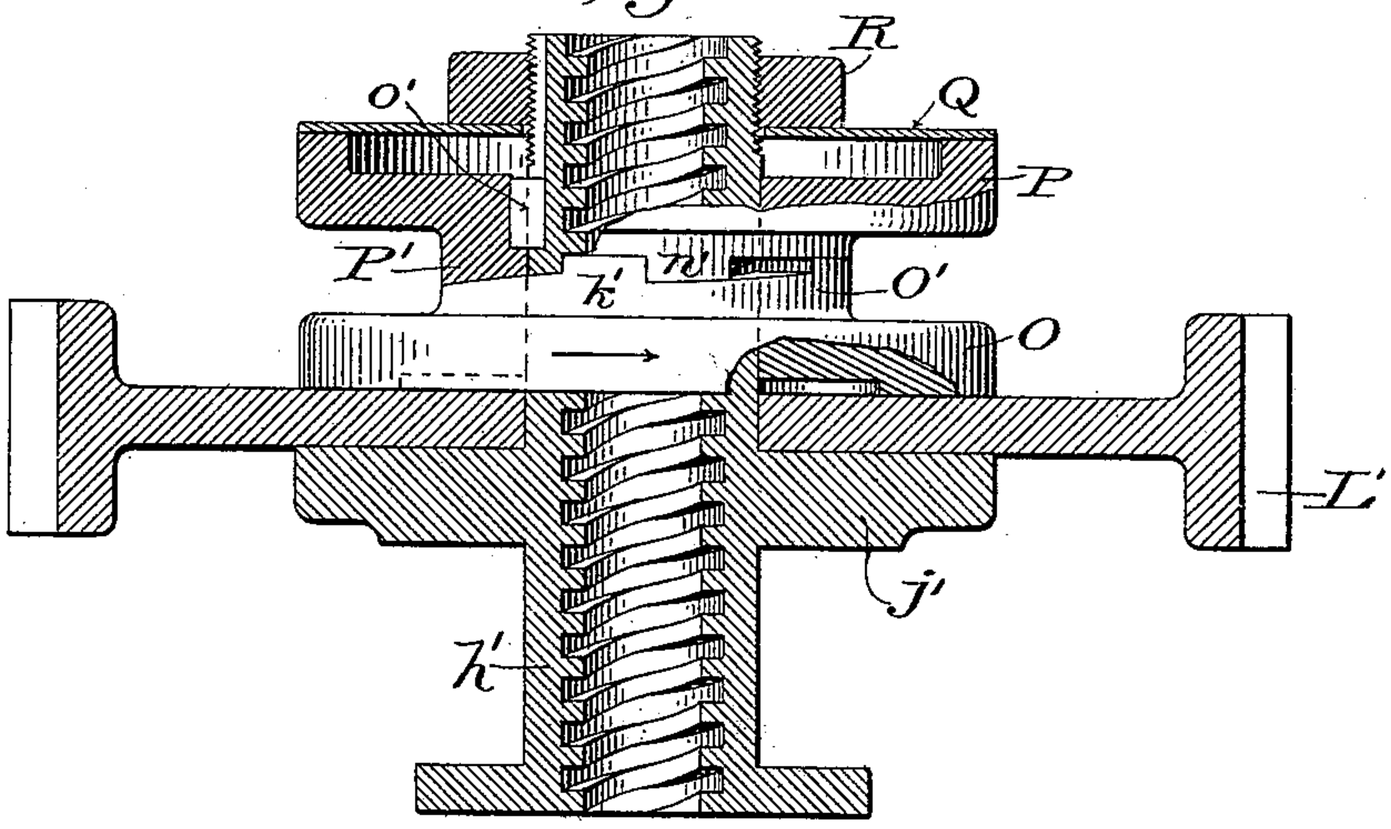

Fig. 13.

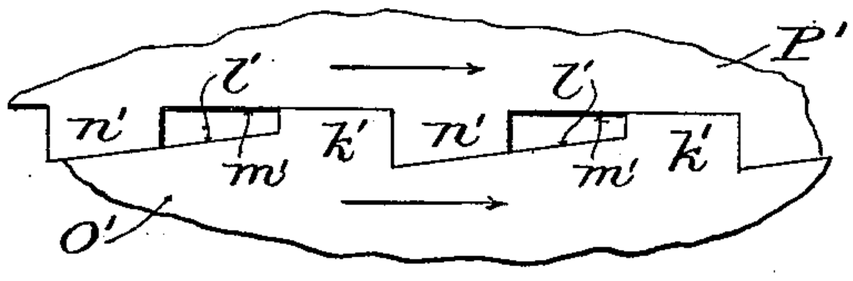

Fig. 14.

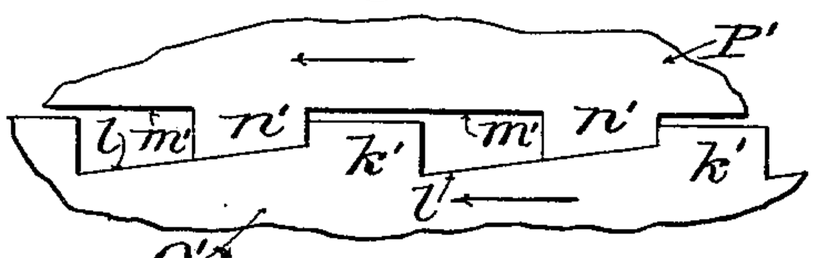

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Fig. 15.

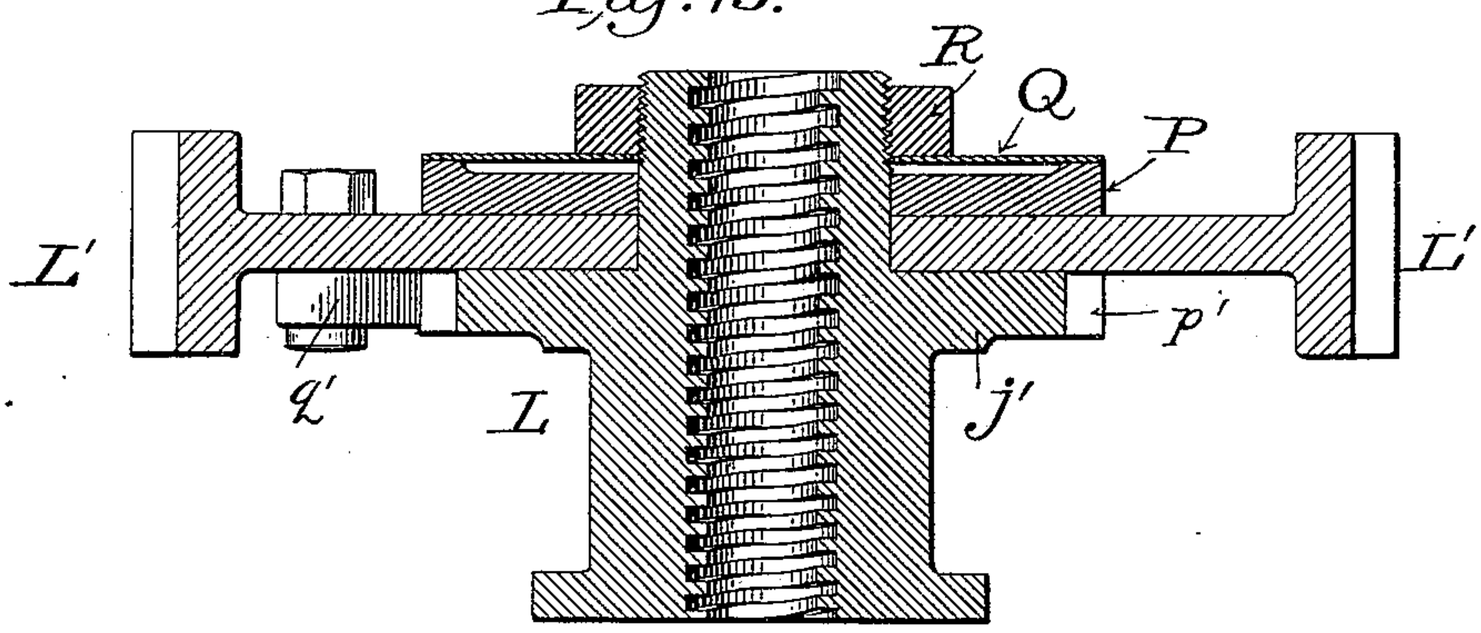
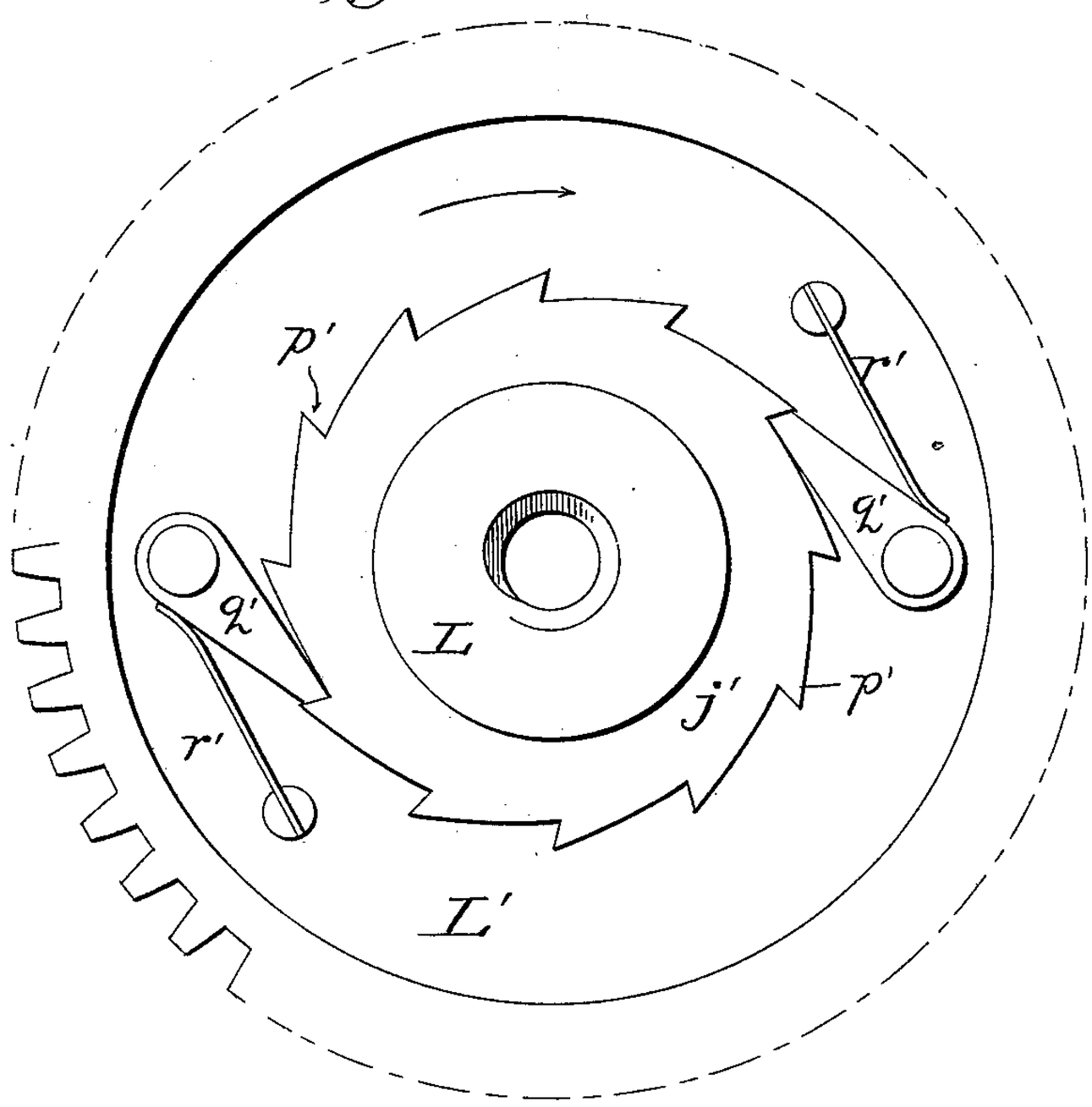


Fig. 16.



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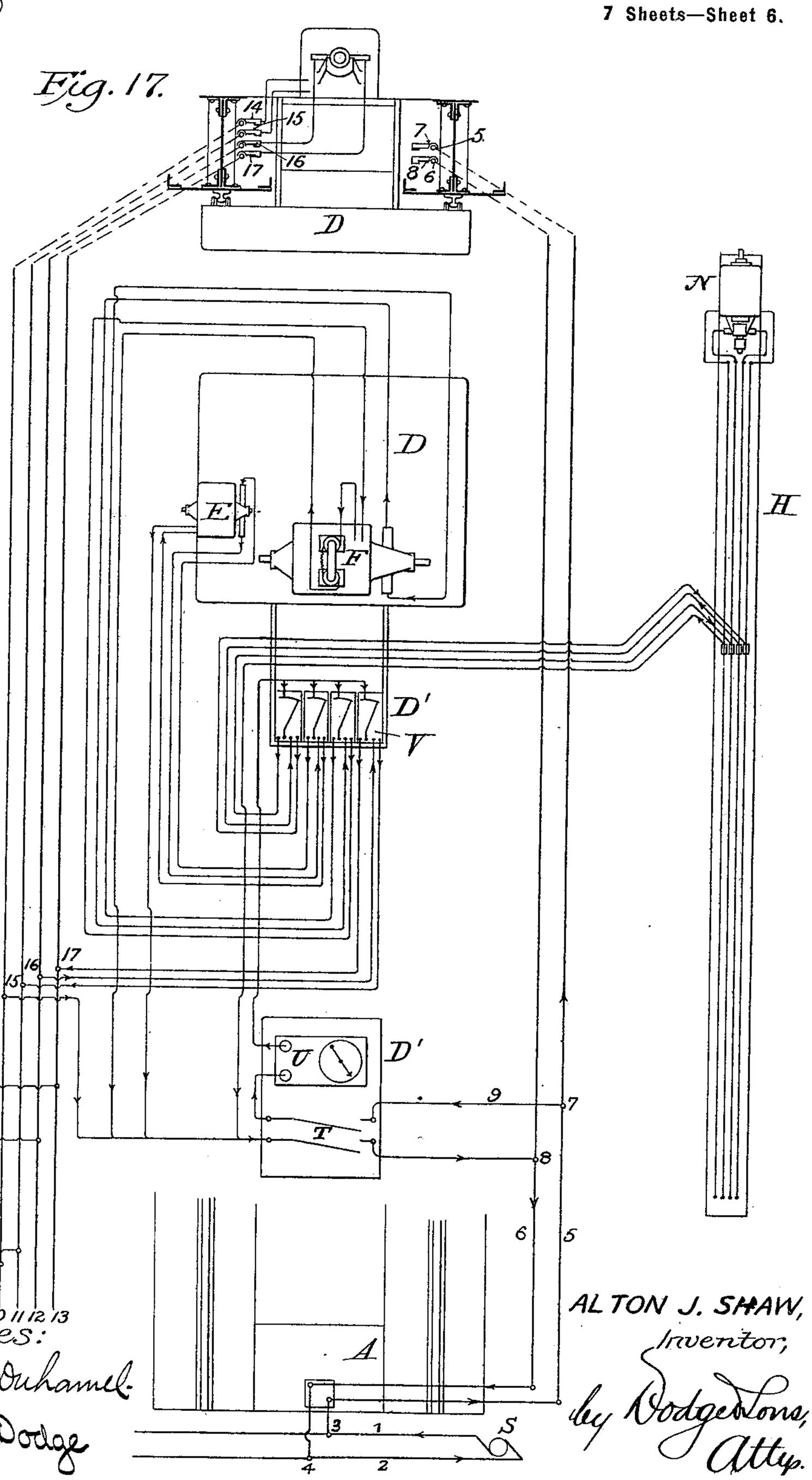
(No Model.) 7 Sheets—Sheet 6.

Fig. 17.



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HOISTING MACHINERY.

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(No Model.) 7 Sheets—Sheet 7.

Fig. 18.

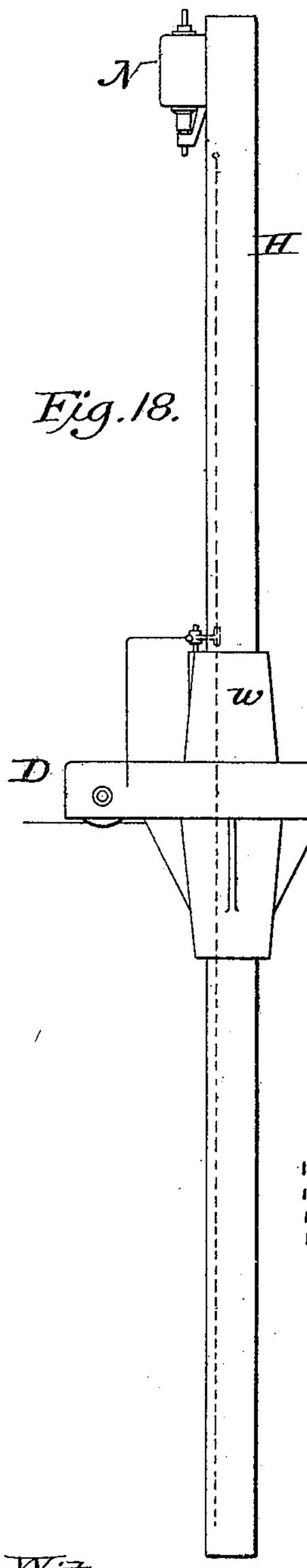


Fig. 19.

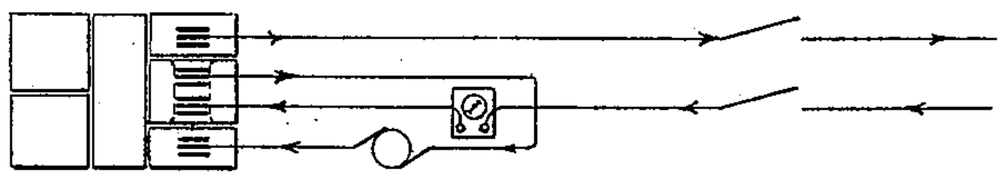


Fig. 20.

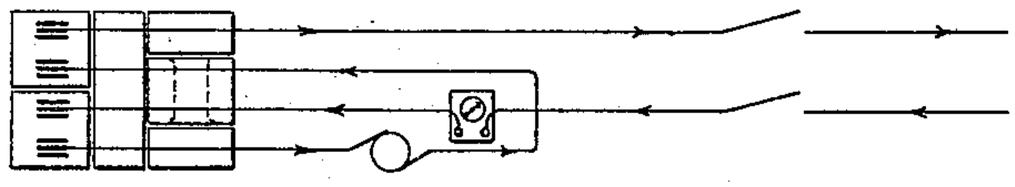
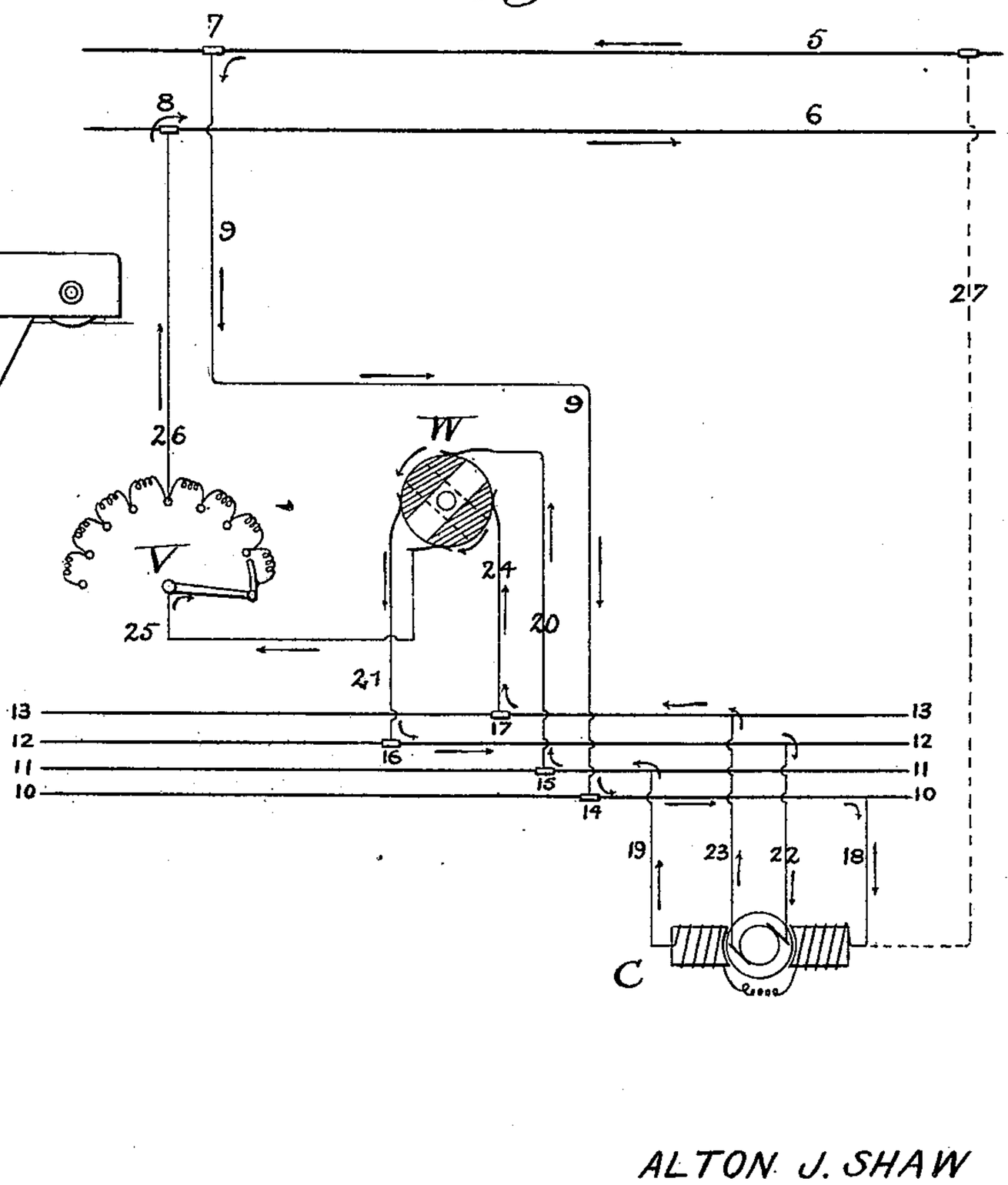


Fig. 21.



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UNITED STATES PATENT OFFICE.

ALTON J. SHAW, OF MUSKEGON, MICHIGAN, ASSIGNOR TO THE SHAW ELECTRIC CRANE COMPANY, OF SAME PLACE.

HOISTING MACHINERY.

SPECIFICATION forming part of Letters Patent No. 622,280, dated April 4, 1899.

Application filed May 6, 1893. Serial No. 473,287. (No model.)

To all whom it may concern:

Be it known that I, ALTON J. SHAW, a citizen of the United States, residing at Muskegon, in the county of Muskegon and State of Michigan, have invented certain new and useful Improvements in Hoisting Machinery, of which the following is a specification.

My invention relates to electrically-operated traveling-bridge cranes; and it consists in various novel features, combinations, and details hereinafter set forth, prominent among which may be mentioned a trolley provided with a cab or cage for the operator of the crane and containing all necessary controlling and reversing levers, switches, &c., for effecting the various movements of the bridge, the trolley, and the hoist.

In the accompanying drawings, Figure 1 is a side elevation of a portion of the bridge of my improved crane, with the trolley and attendant parts; Fig. 2, a transverse sectional view of the bridge, showing the trolley in end elevation and a portion of the hoisting-bar in section; Fig. 3, a top plan view of a portion of the bridge and the trolley thereon; Figs. 4 to 16, inclusive, detail views of parts hereinafter referred to; Fig. 17, a diagrammatic view illustrating the circuits or manner of running the electric conductors; Fig. 18, an elevation of the hoisting beam or bar; Figs. 19 and 20, views illustrating the path of the current under different adjustments of the reversing-switch; and Fig. 21, a diagram illustrating the construction and arrangement of the reversing-switch in connection with the conductors, contacts, and rheostat.

The present construction is more especially designed for the handling of ingots in steel-works, and many of the features are peculiarly suited to such use. Thus the location of the operator upon the trolley, so that he may be directly or nearly over the hoisting or carrying device at all times, is particularly advantageous in that he is thereby enabled readily to direct the tongs and properly to seize the ingot, which cannot be conveniently done from a fixed cab or cage at the end of the bridge, where it is ordinarily placed. So, too, it is important to be able to manipulate the tongs quickly and with necessary power and certainty of direction. These ends are also attained by the construction which I shall now describe.

Referring first to Figs. 1, 2, and 3, A indicates the traveling bridge, provided at each end with suitable trucks or flanged supporting-wheels, which run upon supporting-rails in the usual manner, said rails being commonly arranged lengthwise of the shop or building upon suitable supports.

To prevent the bridge wheels or trucks from leaving the rails or being lifted therefrom, I provide the girders, sills, or supports upon which the rails are laid with horizontally-projecting plates or flanges *a*, preferably of metal, and beneath these plates or flanges I locate wheels *b*, which may be mere retaining-wheels or, as is preferred, gear-wheels meshing with a toothed rack formed upon or secured to the under face of plates *a*. In the latter case the wheels *b* are keyed or otherwise secured upon a stiff shaft B, carried in suitable bearings or hangers made fast to the bridge, the shaft extending nearly the entire length of the bridge and receiving motion, either directly or through suitable intermediate connection, from an electric motor C, which I term the "bridge-traverse" motor. The manner of connecting motor and shaft will depend upon the character of the motor, whether high or low speed, and also upon the character of work to which the crane is to be applied.

The construction of the bridge may vary considerably as to details, but should comprise, ordinarily, two parallel beams or girders *c*, of suitable strength and stiffness, joined at their ends by the truck-frames *d*, but having no intermediate cross connections. This open construction is adopted in order that the lifting devices may descend between the beams and move freely from end to end of the bridge, and, further, that the attendant may have an unobstructed view of the work and space beneath the bridge.

D indicates a trolley provided with flanged wheels or trucks *e*, similar to those of the bridge, which wheels traverse rails *f*, running lengthwise of the beams or girders *c* of the bridge A.

To preclude the running or lifting of the wheels *e* from the rails *f*, I provide clips *g*, Figs. 1 and 2, which extend beneath the heads of the rails and travel close to the webs thereof.

The trolley, with its flanged wheels and clips, serves to prevent any spreading apart of the girders *c c* of the bridge, though this is purely incidental, and the construction will in all cases be so strong and rigid as to preclude such spreading, regardless of the contribution of the trolley.

Instead of locating the cage or platform for the attendant at one end of the bridge, as has hitherto been customary in this type of cranes, I attach said cage or platform to or make it a part of the trolley, so that the attendant may be always directly or nearly over the load, where he may best see and control the gripping or carrying devices. In order to render this arrangement feasible in connection with independent electric motors for effecting and controlling the several operations of traversing the bridge, traversing the trolley, actuating the hoist, and controlling or actuating and controlling the gripping devices, it is necessary to adopt a peculiar arrangement of electric conductors, with the switches, rheostats, levers, &c., necessary to the proper control of the several motors, and this I have devised and shall explain.

So far as I am aware no one has ever before proposed to control the several independent motors of an electric traveling-bridge crane from the movable trolley, nor has any one heretofore proposed to control an electric motor from a relatively-movable switch or station, so far as I am informed, and this I mean to claim, broadly, having after considerable study worked out a thoroughly practical arrangement of the kind.

In the present instance I employ, by preference, a rigid lifting bar or beam movable vertically and carrying at its lower end the gripping or load-lifting devices. Obviously if such a bar were caused to descend unduly and the power of the motor actuating it were sufficient the bar or beam bearing at its lower end upon the ground or other resisting body would tend to lift the trolley from the bridge or the bridge from its rails; hence the importance of the retaining devices above set forth.

E indicates an electric motor carried by the trolley, which I term the "trolley-traverse" motor and which is connected, preferably through gearing, with one of the axles thereof, serving to rotate the axle and the truck-wheels fast thereon, and thereby to propel the trolley. This motor, as is the case with all others used about the crane, is advisably reversible, being preferably series wound and reversed by reversing the armature-current, while the fields are excited by a current of constant direction. This arrangement is not essential, but is found most satisfactory in practical work.

F indicates a third electromotor, which I term the "hoist-motor," because it actuates the vertical lifting bar or beam. It is mounted upon the trolley D and is provided with a magnetic brake G, again referred to, such as shown and described in Letters Patent No. 461,052, granted to me October 13, 1891, or of any equivalent construction.

The magnetic brake G is shown in Figs. 1, 2, and 3, in which *a'* indicates the brake drum or disk secured upon the armature-shaft; *b' b'*, the brake-arms; *c' c'*, springs tending to press the arms against the periphery of the disk or drum; *d'*, a lever provided at one end with a wedge *e'* to enter between the brake-arms *b' b'* to throw off the brake, and *f'* the electromagnet or solenoid included in the hoisting-motor circuit and serving when energized to move the lever in the proper direction to carry the wedge between the brake-arms, and thus to free the motor.

H indicates the hoisting bar or beam, which is represented as composed of two iron **I**-beams or channel-bars facing each other and connected by iron plates riveted to the flanges after the manner of constructing wrought-metal columns. This construction is not essential, but is advantageous in that it is strong and comparatively cheap, and, further, because the recessed or channeled faces afford convenient spaces for the application of a rack-bar I and for electric conductors hereinafter referred to, and the hollow interior affords space for other parts.

The rack-bar I is firmly bolted or riveted to the face of one of the **I**-beams of bar or beam H in the position shown in Fig. 3 and is engaged and moved by a pinion *g*, secured upon a shaft which receives motion from the armature-shaft of motor F through intermediate gearing *h i k l*, Fig. 3, or any other suitable transmitting-gear.

When lowering the hoisting bar or beam H, the hoisting-motor is thrown into action, and the magnetic brake G is consequently withdrawn. Hence it is necessary to provide means for regulating the descent of the load, as otherwise it would fall at a dangerous speed, or if the fall were a long one the motor would be caused to run above the speed due to its actuating-current, in which case the counter electromotive force generated would cause it to act as a brake, and the rapidly-descending load would be abruptly stopped, thus subjecting the crane and all its machinery to very dangerous strain. To prevent these results, I provide a mechanical brake J of any approved construction, either to be controlled manually or automatically.

In practice I prefer to employ an automatic brake of the well-known spiral strap or band type, in which an elastic spiral band constitutes a connection between the driving and driven sections of a two-part shaft and checks the backward rotation of the driven section necessary to lowering except in unison with and as permitted and controlled by the driv-

ing-section. Inasmuch as any good mechanical brake may be employed for this purpose, as no claim is made thereon, and as the special form of spiral-band brake preferably employed will probably constitute the basis of another patent, it is not deemed necessary to do more than indicate conventionally a mechanical brake, which is represented at J.

Passing down through the hollow or tubular beam or bar H is a rod or shaft K, the upper end of which is screw-threaded and encircled by a nut L, suitably swiveled or journaled in the upper end of the bar or beam H, as best shown in Fig. 5. The rod or shaft K is capable of longitudinal movement relatively to and independent of the beam or bar H, which movement will be effected by rotation of the nut L; but rotation of the shaft is prevented, preferably, by means of a spline or feather projecting from the shaft into a seat or guideway within the bar or beam H, by means of a spline or feather extending into a groove in the shaft, or in any equivalent and usual way.

Swiveled in the lower end of bar or beam H is the stock or shank of tongs M, which may be of any approved construction, but which are preferably of the style shown in Figs. 1, 2, 7, and 8. As represented in said figures, the tongs consist of two levers *m m*, pivoted upon a common pin or bolt *n* in the stock or body *o*. The levers are not crossed, but each has an upwardly-extending arm reaching a suitable distance above the pivot, said arms being connected by links *p* with a cross-head or block *q*, swiveled upon the lower end of shaft or rod K. The links *p* constitute a toggle-lever connecting the arms or levers of the tongs, the point of attachment of the links to the cross-head being preferably below the points of attachment to the levers of the tongs, so that as the cross-head is elevated the toggle is straightened and the lower or gripping ends of the tongs-levers are thrown together. It will thus be seen that as the shaft or rod is lowered the tongs will be opened and as said rod is drawn upward they will be closed, the power of the closing movement increasing as the toggle straightens.

No claim is made to this construction of the tongs, as such are in extensive use at the present time.

The cross-head or block *q* extends transversely through the stock or body of the tongs, and by preference a pair of links *p* is used at each end of the block, as shown in Figs. 1, 7, and 9.

Fig. 2 illustrates the preferred manner of swiveling the tubular tongs-shank in the lower end of bar or beam H, though the details thereof are immaterial.

At a convenient point above the links *p* there is formed or secured upon the stock or body of the tongs M a gear or circular toothed rack *r*, with which meshes a pinion *s*, carried at the lower end of a shaft *t*, extending from end to end of the bar or beam H and journaled in bearings or boxes carried thereby, as shown in Fig. 2.

The shaft *t* is preferably polygonal, except for its journals; but it may be splined or grooved instead, so that it may freely slide through, but may not turn independently of, a bevel-pinion *u*, Fig. 3, which encircles the shaft and is held between two arms *v*, the upper one of which is seen in Fig. 3. The opening in the pinion will of course fit the polygonal splined or grooved shaft.

The arms *v* are carried by some fixed part of the trolley, preferably by the guide-box *w*, through which the bar or beam H moves and by which it is guided and maintained in vertical position.

A horizontal shaft *x* is carried in suitable bearings in the trolley D and is provided at opposite ends with a bevel-pinion *y*, to mesh with pinion *u*, and a hand-wheel *z*, by which to turn the shaft.

The hand-wheel *z* is located within easy reach of the attendant in the cage D′ of the trolley and enables said attendant, through the connecting-gear described, to rotate the gear or rack *r*, and consequently the stock or body of the tongs M, so as to present the tongs properly to the ingot or other object to be lifted, and this regardless of the elevation of the tongs and their carrying bar or beam H.

As shown in Fig. 3, an opening *g′* is formed between the trolley and its cage or through the latter, through which the attendant may readily observe the lifting-bar and tongs and all objects in proximity thereto, so that he may conveniently and accurately control the movements of the tongs according to the needs of the work to be done.

For the purpose of rotating the nut L, and thereby raising or lowering rod or shaft K to close or open the tongs, I provide a fourth electromotor N which being small and light may be most conveniently made fast to and carried by the upper end of the bar or beam H, as indicated in Figs. 1 and 2, a pinion on the armature-shaft gearing directly with the gear-wheel L′, forming part of or connected with nut L, affording a suitable means of transmission.

It is impracticable, or at least inconvenient, to provide an automatic cut-out to interrupt the motor-circuit when the tongs are properly closed, for the reason that the closing of the tongs, the movement of the rod or shaft K, and consequently the number of turns of the motor are variable according to the size of the object or portion of an object to be grasped. On the other hand, it is important to prevent undue rotation of the nut L because of undue strain that would be brought upon the all-connected parts. Again, if the screw-thread of rod K be of ordinarily slow pitch there is liability of jamming the threads of the nut and rod so tightly, in consequence of the speed and momentum of the armature, that the same

motor, when reversed and started from a standstill, will be incapable of turning the nut backward to lower the rod and open the tongs.

By employing a screw of steep or quick pitch the angle may be made so great that jamming will be impossible, in which case nut L and gear-wheel L′ will be made in one or firmly joined; but this involves other objectionable features, such as too sudden action, undue expenditure of power, increased weight of motor, &c.

To avoid the various objectionable results stated, I introduce between the motor and the nut L a friction coupling or connection which limits the application of force to said gear, and I preferably so construct the friction device that the friction shall be greater when turning backward or in a direction to open the tongs than when turning in a direction to close them, or that the connection shall be frictional when turning in one direction and positive when turning in the reverse direction.

Referring now to Figs. 4, 5, 11, 12, 13, and 14, the variable friction arrangement will first be explained.

As shown in Figs. 5, 11, and 12, the nut L is formed with a flanged tubular neck *h′*, which is seated or journaled in a two-part box *i′*, secured in the upper end of hoisting bar or beam H, so that the nut may be rotated freely, but may not move up or down except with the bar or beam H. The gear-wheel L′ encircles the cylindrical body of the nut, and its web or plate is held between a flange or collar *j′* of the nut and a friction-disk O, encircling the body of the nut, as best shown in Fig. 12. The under or bearing face of disk O is recessed or dished, so that it bears only at its outer portion upon the web of gear-wheel L′ some distance from the center or axis. The upper side of disk O is provided with a neck O′ of less diameter than the friction-face of the disk, which neck has upon and in its upper face a series of alternate projections and depressions *k′ l′*, the bottom faces of the depressions being inclined, as shown in Figs. 12, 13, and 14. P indicates a second disk, having a neck P′ similar to that of disk O, but having the bottoms of its depressions *m′* perpendicular to its axis and the outer faces of its projections *n′* inclined at the same angle as the bottom faces of the depressions *l′* of the disk O. The disk P is held against rotation upon or independently of nut L by means of a key, feather, or spline *o′*, Fig. 12, but is free to rise and fall a limited distance relatively to or independently of the nut. The upper face of the disk P is recessed to form an annular bearing-face, upon which rests a spring plate or disk Q, advisably of fine spring-steel, and above this disk or plate is a nut R, screwed upon the externally-threaded upper end of nut L. The nut R is turned down to bear upon the spring plate or disk with whatever force required to produce the necessary degree of friction between gear-wheel L′ and the collar *j′* and disk O, by which said wheel is held. The nut R is held firmly in its adjusted position by a set-screw or other suitable fastening, as shown in Figs. 11 and 12, in which first figure, however, the disk O is not shown. If, now, the gear-wheel L′ be rotated in the direction indicated by arrow in Figs. 12 and 13, (the direction for closing the tongs,) the projecting lugs of the two disks O P will stand in the relation indicated in said figure, the lugs of each being at the deeper ends of the depressions of the other, and consequently the upper disk P will be in its lowermost position relatively to disk O. In this position disk P will place spring plate or disk Q under less compression or flexure than if the disk P were slightly elevated, and the friction applied to gear-wheel L′ will be proportionately less than if said spring plate or disk were under such greater compression or flexure. The initial adjustment of the spring-plate being such as to give the necessary friction to insure proper closing of the tongs, but not enough to rotate the nut when the limit of safe resistance is reached, it will be seen that the nut and wheel will rotate as one until the resistance reaches the predetermined limit, whereupon the web of wheel L′ will slip between collar *j′* and disk O until the motor comes to rest. Upon reversing the motor, and consequently the direction of rotation of the wheel L′, the web of the wheel will slip upon collar *j′*; but as the bearing-face of the disk O upon the web of the wheel is of greater diameter than the contacting bearing-faces of the necks O′ P′ and the moving power is applied to the lower face of disk O at a greater distance from the center than is the friction of necks O′ P′ it follows that the disk O will rotate with wheel L′ in the direction indicated by arrow in Fig. 14, the slip occurring between the necks O′ P′ and the inclines of neck O′ riding beneath and lifting the projections of neck P′. This action results in a slight elevation of disk P, which, however, is sufficient to flex or compress the spring plate or disk Q to a greater degree than when turning forward or in the direction to close the tongs, and as a consequence by the time that, or it may be before, the lugs of the lower disk traverse the full space of the recesses or depressions of the upper disk the friction is so far augmented that the wheel L′ can no longer slip upon the collar *j′* of the nut, and hence the nut will turn backward with the wheel, thereby lowering the rod K and opening the tongs. The slight play or movement of wheel L′ independently of the nut thus occasioned and the proportionately greater movement of the motor-armature affords that limited initial movement of the armature with but partial load so desirable in bringing an electromotor into action from a state of rest. It is not to be understood, however, that such initial movement of the armature without its

full load is essential to operation in the present instance, for such is not the fact. The motor at the time the wheel L′ begins to rotate without the nut is developing surplus power, or power beyond that required to properly close the tongs, and through the increased friction applied when turning backward a greater percentage of the power of the motor is applied to the rotation of the nut than is done in closing. This increase, which may still leave a surplus of power, will be adequate to insure the turning of the nut even when the motor starts from a standstill. In Figs. 15 and 16 I have illustrated another way of securing the same ultimate end—that is to say, of permitting the wheel to turn independently of the nut when the tongs have been closed with due force, but insuring the backward rotation of the nut with the wheel when the motor is reversed. Under this construction the nut L is swiveled or journaled in the upper end of bar or beam H and is provided with collar j', as before; but the disk O and the interlocking necks O′ P′ are omitted, the lower face of disk P being a plane face and resting directly upon the web of the wheel L′, as plainly shown in Fig. 15. The spring plate or disk Q and nut R are arranged above the disk P, as before, and serve to give the requisite friction. The periphery of collar j' of the nut L is formed or furnished with ratchet-teeth p', and the wheel L′ carries a pawl or pawls q' to engage with said teeth when the wheel is turned backward to open the tongs. Each pawl is thrown toward the ratchet-teeth by means of a spring r', which yields to permit the ratchet-teeth to ride freely under the pawl or pawls when the resistance offered by the nut exceeds the friction between the nut and wheel. Under this arrangement the wheel L′ and the nut L will rotate together in the direction indicated by arrow in the lower face view, Fig. 16, in closing the tongs and until the tongs are closed so firmly that the nut L offers a resistance in excess of the friction by which the nut and wheel are held together. If now the motor continues to operate, the wheel will continue to turn in same direction, the pawls riding freely backward over the ratchet-teeth of the then stationary nut. The motor when reversed will rotate the wheel I in the opposite direction from that indicated in Fig. 16, whereupon the full power of the motor will be transmitted to the nut L by reason of the positive engagement of the pawls with the teeth of the ratchet.

As the trolley will often stand directly over a ladle while the latter receives and pours its supply of molten metal and over soaking-pits and other places from which a great amount of heat will arise it will be found expedient to face the lower side of the trolley and cage-floor with asbestos or other heat-resisting substance, and it will be well to make the floor double with an open-air space or with a filling of mineral wool or like pyro-insulator. Such provision will protect both the operator and the apparatus.

Referring now to Figs. 17 to 21, inclusive, the arrangement of circuits, connections, and switches or controlling devices by which the several motors are manipulated will be explained. For convenience and clearness of explanation Fig. 17 shows the trolley both in plan and in end elevation, the connections being shown in connection with both views, and the hoisting beam or bar is shown at one side in elevation in order that the connections may be more clearly illustrated. S indicates a source of electric energy, which may be a dynamo-electric generator, as shown, or a primary-battery accumulator or any equivalent source of supply. From the two terminals or electrodes of the source of energy two conductors 1 and 2 are carried along the runway or line of travel of the bridge, said conductors being of heavy wire, rods, or strips or of any convenient form and of suitable material. These conductors are supported in any convenient manner, and being bare are insulated from the supports to prevent loss of current. They are arranged in convenient position to be swept or rubbed by two sliding contacts 3 and 4, carried by the bridge A. From the contacts 3 and 4 two bare wires or conductors 5 and 6 are carried lengthwise of the bridge A, from which they are, however, carefully insulated, and these wires or conductors are swept or rubbed by two sliding contacts 7 and 8, carried by but insulated from the trolley D. Thus the current for the entire apparatus is carried to the operator's cage on the trolley, where it is divided up and delivered as required to the several motors, the positions of the crane and trolley being variable at will without interruption of or interference with the delivery of current to the controlling devices within the cage. T indicates a main switch mounted upon a suitable switchboard within the trolley-cage and serving to open or close the main working or supply circuit of the crane at the will of the operator, the current entering by a conductor 9, which passes from contact 7 to the switch T, thence to an ammeter U, and thence to a series of rheostats V, each of which contains a reversing-switch W, Fig. 21. There are as many rheostats V as there are motors, or four under the construction and arrangement set forth, and in each the reversing-switch is so constructed and arranged as to reverse only the armature-current of the motor which it controls, the field-magnet circuits all remaining constant as to direction. The conductors 5 and 6 are carried along one face of the bridge or girder A, which for convenience of explanation is designated as the "rear" face, and along the front face thereof are four bare wires or conductors 10, 11, 12, and 13, also extending the length of the bridge or girder, but carefully insulated therefrom. Four contacts 14, 15, 16, and 17, carried by but insu-

lated from the trolley, sweep or slide upon the conductors 10, 11, 12, and 13, as shown both in plan and in elevation in Fig. 17 and as better illustrated in connection with the rheostat and reversing-switch in Fig. 21.

Referring now to the last-mentioned figure, (21,) from which the main switch and ammeter are omitted, the current passes by contact 7 and conductor 9 to sliding contact 14 of the trolley, thence by conductor 10 on the front face of bridge or girder to conductor 18, by which it passes to the field-magnets of the fixed bridge-traverse motor C, whence it passes by conductor 19 to conductor 11 on the front face of the bridge or girder, thence by sliding contact 15 of the trolley and conductor 20 through one of the conducting-sections of rotary switch W, to conductor 21, to sliding contact 16 of the trolley, and by this to conductor 12 on the front face of the bridge or girder, thence by conductor 22 to one of the armature-brushes, through the armature-winding, and by the second armature-brush to the conductor 23, whence it passes to conductor 13 on the front face of the bridge or girder, thence by sliding contact 17 of the trolley to conductor 24, by this to a second conducting-section of switch W, thence by conductor 25 to the rheostat V, and finally by conductor 26 to the ground or return conductor 6, which connects through contact 4 and conductor 2 with the second terminal or electrode of the source of electric energy.

It will be seen from the foregoing explanation that the current enters the switch W only after traversing the fields of the motor. Hence the current may be reversed through said switch, and consequently through the armature of the motor, without affecting the direction of the field-current. So, too, the supply and reversal of the bridge-traverse motor is effected from the trolley-cage without interference or difficulty, whether the trolley be at one or another point on the bridge or moving thereon, because the contacts 14, 15, 16, and 17 are always bearing upon the conductors 10, 11, 12, and 13.

It is not essential that the conductor 9 be carried through the trolley, because the motor C being fixed in position upon the bridge said conductor may pass directly from the conductor 5 or sliding contact 3 to the field-coils of the motor, as indicated by dotted line 27 in Fig. 21. It is, however, preferred to carry the current through the trolley and the main switch T, as otherwise the field-coils of the bridge-traverse motor C would be always "alive" so long as the generator should continue operative.

Figs. 19 and 20 illustrate the directions of the current under the two different adjustments of switch W, it being obvious from an inspection of Fig. 21 that if the switch be turned to the position indicated by dotted lines conductor 20 will be connected with conductor 24 and conductor 21 will be connected with conductor 25, so that the armature-circuit will be reversed.

The construction and arrangement of rheostats and reversing switches being the same for each and all the motors, it is unnecessary to trace out the other circuits, but a brief explanation as to the hoist-motor connections is perhaps needed.

As indicated, the bridge-traverse motor is fixed relatively to the bridge and the trolley is movable relatively to said motor, whereas all the other motors are fixed in or upon and move with the trolley, hence the necessity of the sliding contacts 14, 15, 16, and 17. On the other hand, the lifting bar or beam II moves relatively to the motor, and hence it is necessary to provide means for supplying current to the trip-motor N, which, being mounted upon the bar or beam, moves therewith relatively to the trolley. This end may be attained by the use of flexible conductors of adequate length extending from the rheostat and switch apparatus of the trolley to the motor N, with suitable take-up devices; but as this would be likely to complicate matters needlessly I prefer to provide the beam or bar II with four bare conductors extending nearly or quite its whole length and carefully insulated therefrom, as indicated in Figs. 2, 17, and 18. The manner or order of coupling or connecting the motor will be precisely the same as that described above in connection with the bridge-traverse motor C, except that the four conductors connect directly with and slide up and down in electrical contact with four contacts fixed in or upon the trolley. The construction and arrangement of the rheostat and switch for this motor will be precisely the same as for all the other motors, the four being placed side by side in the trolley-cage D', as indicated in Fig. 17. In view of this identity in all respects except that the conductors slide relatively to the contacts instead of the contacts sliding relatively to the brushes, further description and lettering are deemed superfluous.

Recurring to the bridge-traverse motor C, it is to be kept in mind that it is fixed upon the bridge and is, so far as its relation to the trolley, and consequently to its controlling switch and rheostat, is concerned, a stationary motor. So far as I am aware the idea of controlling a relatively stationary motor from a relatively movable station or switch is broadly new, and as it enables me to place the operator or attendant of an electric bridge-crane upon the trolley without necessitating the employment of a polygonal shaft and other intermediaries and without adding the weight of the bridge-traverse motor to the trolley, it is of marked importance. I wish to be understood as claiming, broadly, the combination and arrangement.

Flexible cables could be employed in lieu of the conductors 10, 11, 12, and 13, but not to so good advantage.

It is obvious that the tongs actuating and controlling devices may be used with a vertically-moving beam carried in a stationary support as well as in a movable trolley, and hence in the claims I shall employ the word "support" as indicating any suitable body or guide in or through which the hoisting-beam may move. So, too, it is apparent that a straight lever may take the place of the hand-wheel *z*, that chain-gearing or equivalent transmitting or connecting gear may take the place of shaft *x*, and that other minor details may be varied without departing from the spirit of my invention.

I am aware that in traveling-bridge cranes employing hoisting-chains and chain barrels or drums the trolley-frame is necessarily made open to permit the proper fall of the chains; but I am not aware that any one has hitherto provided such trolley with an operator's cage containing the controlling mechanism of the crane, or that the floor of such a cage has been provided with a special opening through which the attendant in the cage might readily view the work below. I do not claim, broadly, a trolley with an open frame; but I do claim a trolley having an operator's cage other than the mere frame of the trolley, provided with controlling devices for effecting or determining the movements and operation of the crane and having in its floor an opening through which to observe the work beneath.

The electric circuits and controllers shown herein are to a certain extent embodied in and covered by claims of a divisional application, Serial No. 497,067, filed January 16, 1894, in compliance with a requirement of the Patent Office, which said divisional application eventuated in Patent No. 600,092, dated March 1, 1898.

Having thus described my invention, what I claim is—

1. In combination with a trolley, a hoisting-bar movable vertically in relation to said trolley, a motor for elevating said bar, carried by the trolley, tongs carried by said bar, mechanism for opening and closing the tongs, and a motor carried by the bar to actuate the said mechanism in both opening and closing.

2. In a hoisting apparatus, the combination with a suitable support, of a hoisting bar or beam vertically movable in said support, tongs carried by said bar or beam, mechanism for opening and closing the tongs, an electric motor carried by the bar or beam to operate said mechanism in both opening and closing the tongs, and a switch located in or upon the support, for controlling the motor.

3. In a hoisting apparatus, the combination with a suitable support, of a hoisting bar or beam vertically movable in said support; tongs carried by said bar or beam; mechanism for closing the tongs; and an electric motor carried by the bar or beam and serving to positively operate the mechanism for closing the tongs.

4. In combination with a trolley provided with an operator's cage or platform, a hoisting bar or beam carried by the trolley and provided at its lower end with tongs, an electric motor carried by the beam and serving to open or close the tongs, electric conductors extending from the motor to the operator's cage, and a switch located within easy reach of the operator and adapted to control the supply of current to said motor.

5. In a hoisting apparatus, the combination with a trolley or support, of a hoisting-beam movable vertically in said support, tongs M carried by said beam and provided with links *p* and cross-head *q*, rod K connected with cross-head *q*, and nut L applied to a threaded portion of rod K and serving when rotated, to move the rod longitudinally and thereby to open or close the tongs.

6. In combination with a trolley, a hoisting-beam vertically movable relatively to said trolley, and tongs swiveled in said beam substantially as set forth, whereby they are adapted to be turned to any required position.

7. In combination with a trolley, a hoisting-beam vertically movable in relation to said trolley; tongs swiveled in said beam and provided with a rack or gear concentric with the swivel; a pinion meshing with said rack; an operating-shaft for said pinion extending lengthwise of the beam and carried in bearings thereon; and a second pinion encircling the operating-shaft but held at a fixed elevation in supports upon the trolley, the shaft being free to rise and fall through said pinion but incapable of rotation independently thereof.

8. The combination in a hoisting apparatus, of a suitable support, as a trolley, a hoisting bar or beam vertically movable in said support, tongs swiveled in said beam and provided with a rack concentric with the swivel, a pinion meshing with said rack, a polygonal shaft carrying said pinion, extending lengthwise of the hoisting-beam, and journaled in bearings carried thereby; a wheel encircling said shaft and rotatable therewith, fixed supports for said wheel whereby it is prevented from rising or falling with the beam, and means substantially as described for rotating the wheel from the hoisting-beam support.

9. The combination of a trolley, a hoisting-beam vertically movable relatively to the trolley, tongs swiveled in said beam, a hand-wheel located in or upon the trolley, and connecting devices substantially such as shown and described, extending from the tongs to the hand-wheel; whereby the tongs may be raised or lowered relatively to the trolley, and may be turned by the operator in or upon the trolley.

10. In a hoisting apparatus, the combination of a hoisting-beam, tongs carried by said beam, a rod extending longitudinally through the interior of the beam for actuating the tongs, and a nut swiveled in the beam and encircling a threaded portion of the rod, for raising and lowering the rod to actuate the tongs.

11. In a hoisting apparatus, the combination of a hoisting-beam, tongs carried by said beam, a rod extending lengthwise of the beam and connected with the tongs, for opening and closing them, a nut swiveled in the beam, encircling a threaded portion of the rod, and serving to move the same longitudinally, a motor for rotating the nut, and a friction-coupling connecting the motor and the nut, whereby the motor is enabled to rotate the nut but is prevented from exerting an injurious strain upon the nut or parts controlled thereby.

12. In a hoisting apparatus, the combination of a hoisting-beam, tongs carried by said beam, a rod for actuating said tongs, a nut swiveled in the beam and serving to move the rod, a wheel for rotating said nut, and a friction-coupling interposed between the wheel and the nut and adapted to produce a greater degree of friction when turned in one direction than when turned in the reverse direction.

13. In combination with the tongs of a hoisting device, and with a screw-threaded actuating-rod therefor, a swivel-nut encircling and serving to move the rod, a wheel L′ for rotating said nut, and a friction-coupling connecting the wheel and the nut and comprising disks O, P, provided respectively with alternate elevations and depressions k', l', and n', m', spring-plate Q and nut R.

14. In a hoisting apparatus, a hoisting bar or beam composed of two I-beams joined together face to face, and provided with a rack-bar in one outer face, electric conductors in the other outer face, and a central longitudinal rod, tongs carried at one end of the beam, and an electric motor at the opposite end of the beam, the rack-bar serving as a means of applying power to raise and lower the beam, the rod and motor serving to actuate the tongs, and the conductors serving to supply the motor, substantially as set forth.

15. In combination with a traveling bridge provided with a propelling-motor, a trolley mounted and movable upon the bridge, a hoisting-bar mounted and movable in the trolley and provided with tongs, two motors carried by the trolley, one to propel the trolley and the other to actuate the hoisting-bar, a motor carried by the bar and serving to actuate the tongs, and controlling devices for the respective motors, said devices being located in or upon the trolley, whereby the attendant may control all movements from the trolley.

16. In a hoisting apparatus, the combination of a trolley, a hoisting bar or beam carried by said trolley and provided with tongs, two electric motors carried by the trolley, one to propel the trolley and the other to actuate the hoisting bar or beam, an electric motor carried by the bar or beam and serving to actuate the tongs, an external source of electric energy, conductors connecting the several motors with the source of energy, and a series of switches carried by the trolley and serving to independently control the supply of current to each of said motors.

In witness whereof I hereunto set my hand in the presence of two witnesses.

ALTON J. SHAW.

Witnesses:
THOMAS C. AKIN,
JOHN M. WING.