May 17, 1927. 1,629,184

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FOUNDRY LADLE CRANE

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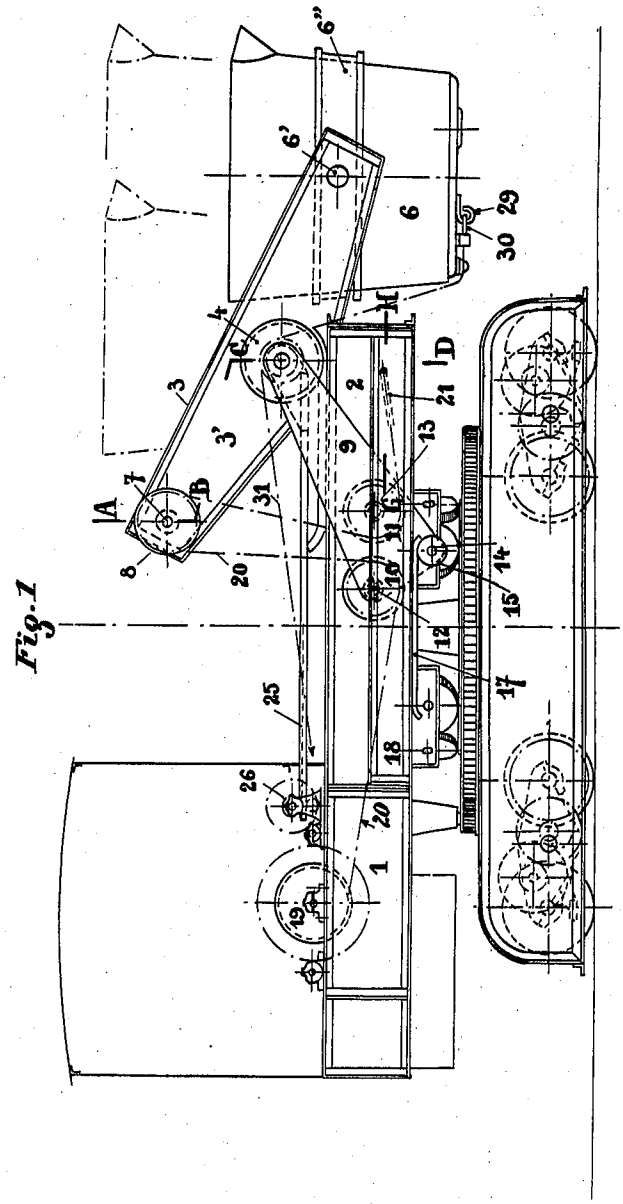


Fig. 1

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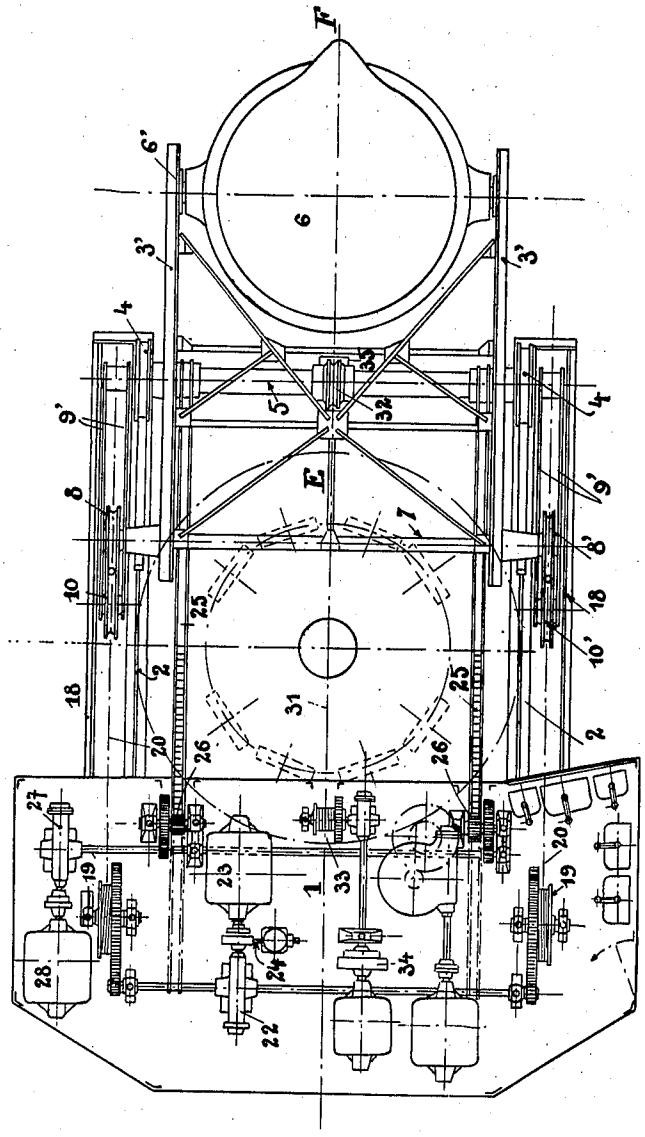
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Fig. 2



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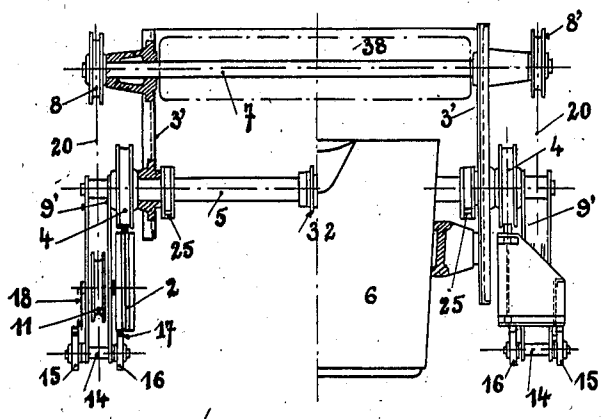


Fig. 3

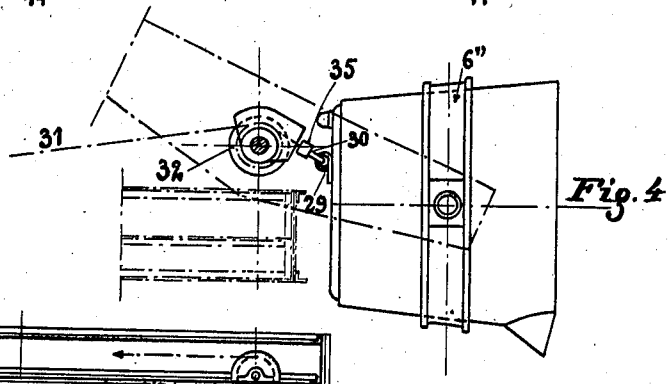


Fig. 4

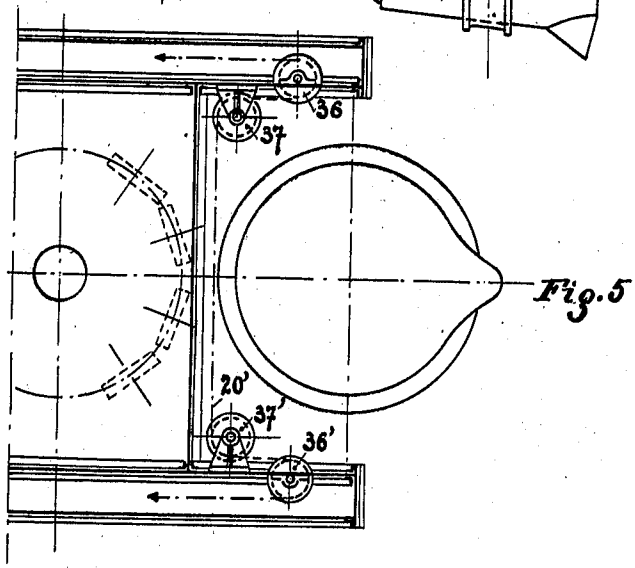


Fig. 5

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FOUNDRY LADLE CRANE

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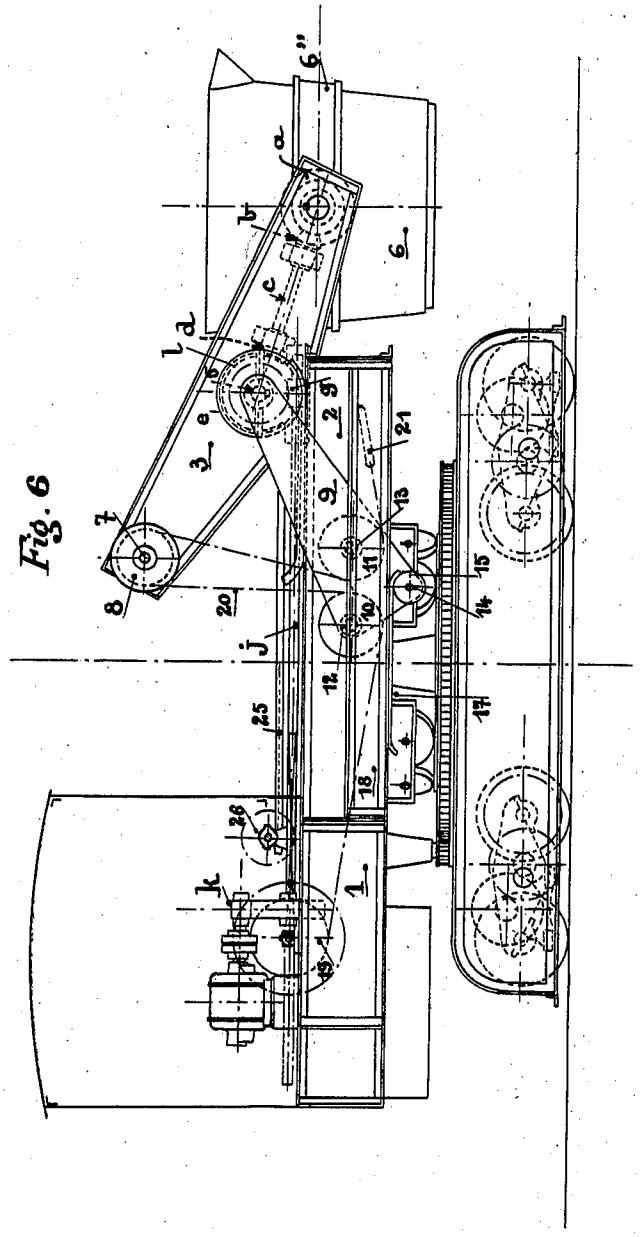


Fig. 6

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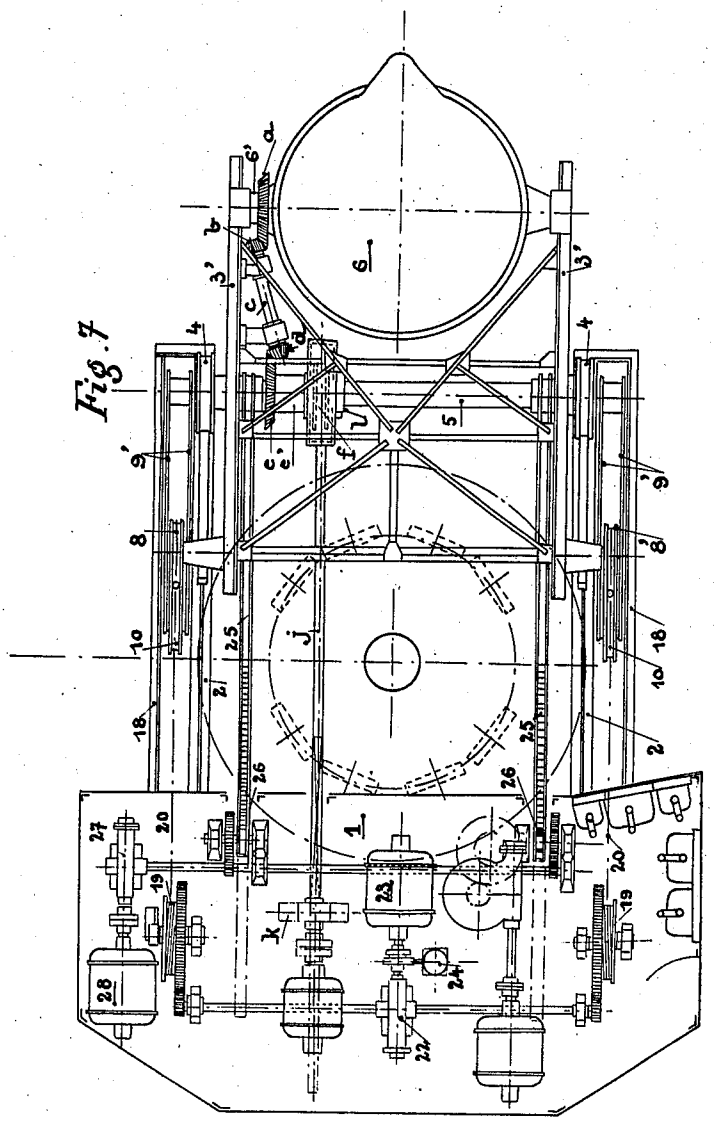
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FOUNDRY LADLE CRANE

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Fig. 7



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Fig. 8.

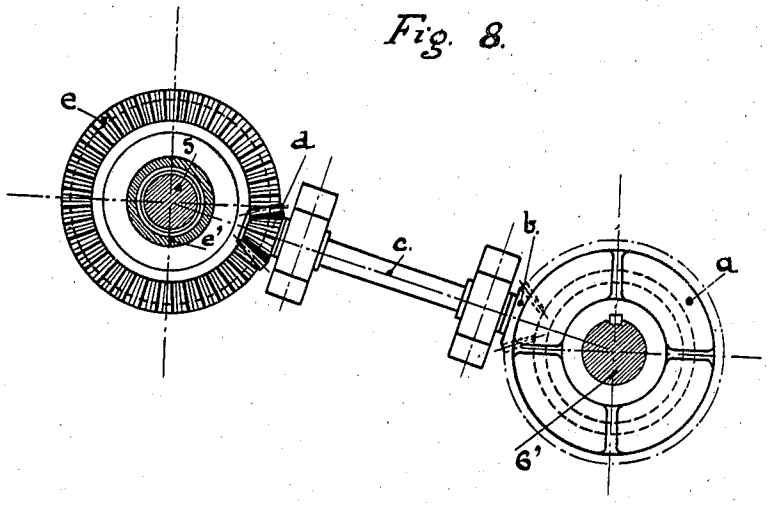
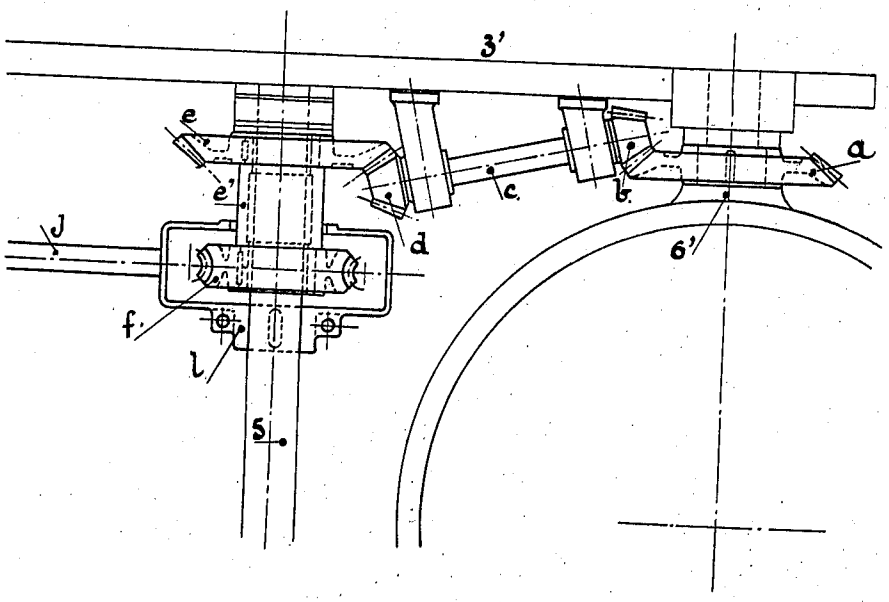


Fig. 9.



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UNITED STATES PATENT OFFICE.

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FOUNDRY LADLE CRANE.

Application filed March 19, 1926, Serial No. 95,865, and in Belgium March 25, 1925.

In foundry ladle cranes as employed in modern steel foundries and the like, the various movements of the pouring ladle required for the operations of filling from the converter or steel furnace, and of pouring into the ingot moulds, viz, hoisting, advancing, slewing and tilting, are effected by a combination of electrical energy with hydraulic power; the latter is generated by a high pressure force pump arranged beneath the crane itself and driven by an electric motor. The whole of the pivoting part, secured to a cylinder similar to a hydraulic accumulator, is lifted by hydraulic pressure acting upon the ram or piston mounted in the truck or rolling part of the apparatus.

Consequently the greater part of the crane, viz, the mechanisms and motors for slewing, advancing and tilting the ladle, the hydraulic pump with its motor and reducing gear, tank-frame, under-frame, cab, counterweight, longitudinal bearers, and electrical equipment, must be hoisted up together with the ladle containing the molten steel. At each slewing movement, the whole of this group pivots upon the water or else upon the roller tracks in the lowest position of the ladle. This load to be displaced at each operation represents for example for an eight-ton ladle containing twenty tons of steel, a dead weight of eighty tons, or 280 per cent of the useful load to be hoisted.

The present invention has for its object a form of construction of foundry ladle cranes which allows of suppressing completely the hoisting of this dead weight and of obviating the use of hydraulic energy, all the movements being carried out by electrical means.

Upon the annexed drawings, to which reference is made in the subsequent description, the same reference letters and numerals designate the same parts or elements.

Figure 1 represents by way of example an elevation of a complete crane, arranged according to the improved construction forming the present invention; the jib carrying the ladle is assumed to be slewed in line with the roller tracks, and the cab to be cut away along a vertical plane so as to disclose a portion of the mechanisms for hoisting and for advancing the ladle.

Figure 2 is a plan view of the pivoting part of the same crane, the cab which encloses the mechanisms and the electrical equipment being represented in section along a horizontal plane, so as to show the details of the mechanisms for hoisting, slewing, advancing and tilting the ladle.

Figure 3 represents on the left half, a sectional view of the ladle-supporting jib and its runway, this half being a transverse section upon the broken line A—B—C—D of Figure 1; the right half of the figure is an elevation of this detail.

Figure 4 is a part horizontal section on the line G—H of Figure 1, showing a modified arrangement of the hoisting cables.

Figure 5 shows in detail the arrangement for tilting the pouring ladle shown by way of example in Figures 1 and 2.

Figure 6 represents, by way of example, an elevation of a foundry ladle crane embodying an improved arrangement for tilting the pouring ladle, the jib carrying the pouring ladle being slewed parallel with the runways. The cab is assumed to be cut along a vertical plane in such a way as to disclose the tilting mechanism. The parts shown in the previous figures and not directly interested have not been reproduced.

Figure 7 is a corresponding plan view, the cabin being represented in section along a horizontal plane.

Figure 8 represents in elevation a detail of the tilting mechanism shown in Figures 6 and 7.

Figure 9 is a plan view corresponding to Figure 8.

Upon a frame 1, arranged to slew around a vertical axis but not to rise and fall, and extended by overhanging girders 2 forming a runway, there is movable in a horizontal direction a rocking beam or jib 3 carrying the ladle 6; see Figures 1 and 2.

This jib 3 consists of two similar side plates 3′ rigidly braced together. At its centre it rests upon the runway by means of two rollers 4 mounted upon the fixed axle 5, externally of the said side plates 3′.

The front ends of the side plates 3′ receive the pivots 6′ supporting the ladle 6, these pivots being secured to a belt 6″ in the case of a detachable ladle; the other ends of the said side plates 3′ carry a fixed horizontal axle 7 receiving two grooved pulleys

8 on its projecting extremities, i. e. externally of the side plates, the object of these pulleys being explained hereafter.

The axles 5 and 7, being fixed, serve to reinforce the bracing of the two side plates 3′ effected by means of angle irons or bars as seen in Figure 2.

The axle 5 is extended on each side beyond the rollers 4 in order to receive the respective halves of an auxiliary reaction jib 9. The auxiliary jib members are each formed by two interspaced plates 9′ of approximately triangular shape; at the ends opposite to their pivotal connection to the axle 5, they each carry internally two grooved pulleys 10, 11, similar to the pulleys 8 and rotating upon fixed axes 12, 13 forming distance pieces between the plates. The function of these pulleys will be referred to later. The bottom corners of each pair of plates 9′ are spaced apart by shouldered pins 14, the projecting ends of which receive the reaction rollers 15, 16, as seen in Figure 3.

The rollers 16 exert an upward pressure against rails 17 arranged beneath the runway girders 2, while the rollers 15 exert a pressure in the same direction beneath small supplementary track rails 18 parallel to the girders 2.

It will be seen that the main jib 3 and the auxiliary jibs 9 can roll along the girders 2, guided by the above-mentioned rollers, but whereas the jibs 9 have only a movement of translation, the main jib 3 can in addition rock about the axle 5.

This oscillatory movement of the jib 3 around the axle 5 is produced by the rotation of two drums 19 driven as in an ordinary hoist or winch by a speed reducing gear 22 and a motor 23, provided with an electromagnet brake 24 for stopping purposes.

Upon each of the drums 19 there is fastened the end of a cable 20 which can be wound thereon. The said cable engages successively in the grooved pulleys 10, 8 and 11, its other end being attached to a cable tension device 21 secured to the extremity of the corresponding girder 2.

It will be understood that the rotation of the drums 19, in one direction or the other, causes the rise or fall of the pulleys 8 mounted upon the main jib 3, and communicates to this jib 3, rocking on the axle 5, a movement of oscillation in a vertical plane; consequently, the pouring ladle 6 will be raised when the pulley 8 falls, and vice versa. The oscillatory movement of the jib 3 is produced even if the said jib is given a movement of translation at the same time.

The upward forces exerted upon the pulleys 10 and 11 are supported by the auxiliary jib members already described.

The small height of the lift necessitates only a limited winding capacity and allows the use of narrow drums 19 as well as cables 20 of large diameter, offering as a result a large factor of safety.

As a modification, the cable tension devices 21 may be omitted and a single cable 20′ provided (as illustrated in Figure 5), its ends being attached to the drums 19 and the cable passing successively over the pulleys 10, 8, 11, 36, 37, 37′, 36′, 11′, 8′ and 10′, every length of cable being subjected to equal tension in this case. The cable may be protected against splashes of molten steel by detachable sheet metal guards (not shown).

Another modification consists in reducing the load upon the cables by balancing the weight of the belt 6″ alone or else the combined weight of the belt and the empty ladle 6, by means of a counterweight 38 arranged upon or near the axle 7 (Figure 3).

The movement of translation or travel of the jib is effected as in ordinary ladle cranes. For this purpose two rack bars 25, connected to the axle 5, are meshed each with a pinion 26 driven by the motor 28 through a reducing gear 27. Neglecting friction, the power required for travel is in no way affected by the hoisting cables, the tension in their operating lengths being always balanced. This movement of translation can be carried out in both directions without any vertical oscillation of the ladle 6, from the moment when the drums 19 are brought to rest.

Naturally the two motions can be synchronized for oblique lifting of the ladle.

The up-tilting of the ladle for the removal of scoria and scale may be effected for example simply as in a foundry gantry, as represented in Figures 1, 2, 3 and 5. A cable 31, terminating in a ring 30 attached to the hook 29 secured to the bottom of the ladle 6, passes over a groove jockey pulley 32 loose upon the axle 5, and is then wound upon a drum 33 operated in the same way as the drums 19 but independently thereof and without requiring an electromagnetic brake. A brake operated by hand or foot may however be provided, the brake being normally "off" and being fitted with a pawl or sector for holding it applied. In order to obviate false movements and to prevent the operation of the drum 33 interfering with the travel of the main jib, the motor-coupling is fitted with a torque-limiting device 34 and the ring 30 has a suitable stop 35 which arrests the cable 31 and causes the operation of the said torque-limiting device.

The main jib 3 can draw out the cable 31 in its forward travel; during its backward movement, the height of the axle 5 is sufficient to keep the cable 31 from dragging on the ground owing to the drum 33 being stationary.

The cable 31 may, of course, be replaced by a chain or by a length of chain connected to a cable, the latter forming the part to be wound upon the drum 33.

Other auxiliary devices, such as clutches, automatic return of the drum 33, or co-ordination with the travel of the ladle, may be provided without departing from the scope of the invention.

By way of modification, the uptilting movement may be produced by a worm and worm wheel or the like, this device being operated by hand or by electric motor. The device in question may be:

Either fitted directly to the jib 3 as in known forms of sling or carriage for iron or steel foundry ladles.

Or controlled from the driver's cab, which is the position recognized as the most advantageous.

Figures 6 to 9 represent, by way of example, an arrangement of this last kind, operated by electric motor and suitable for cranes of the type previously described.

Upon one of the pivots or trunnions 6′ of the pouring ladle 6 (or of the belt 6″ in the case of a detachable ladle) there is keyed a gear wheel *a* (see particularly Figures 8 and 9) meshing with a pinion *b* fixed to the extremity of a shaft *c*; this shaft revolves in bearings fixed upon one of the side plates 3′ of the jib 3 and carries likewise at its other extremity a pinion *d*, which meshes with a toothed wheel *e* loose upon the axle 5.

It may be recalled that it is around this fixed axle 5 that the jib 3 oscillates and that moreover the said axle is subject to a movement of translation or horizontal travel.

The wheels *a* and *e* and the pinions *b* and *d* are conical or bevel gears and similar each to each or else the ratio of reduction between the wheel *a* and the pinion *b* is identical with the ratio between the wheel *e* and the pinion *d*.

The toothed wheel *e* being mounted loose upon the axle 5, as stated above, the movement of oscillation of the jib 3 has no effect upon the mechanism; as regards the longitudinal travel, it will be explained hereafter how this is compatible with the said mechanism.

The wheel *e* is extended by a boss *e′* upon which is keyed a worm wheel *f* actuated by a worm *g* (see Figure 6) mounted at the extremity of a shaft *j* driven indirectly by the motor.

This group constitutes the worm reduction gear, but between this mechanism and the motor there is interposed another reduction gear *k* either of the type previously described or of any suitable kind.

This reduction may be for example by gear wheels as represented at *k* in Figures 6 and 7. It completes the reduction necessary for the speeds usually adopted for the tilting of the pouring ladle.

The shaft *j* has a portion of its length of polygonal or square section for example, in such a way that it can slide in the hub of the toothed wheel of the reduction gear *k* while remaining fast therewith as regards the movement of rotation of the said wheel.

The bearings which support the worm *g* mounted upon the shaft *j* are combined with an oil bath casing *l* for the worm wheel *f*, this casing being fixed permanently upon the axle 5.

Thus any horizontal travel of the said axle 5 is transmitted by the worm wheel *f* to the worm *g* and therefore to the shaft *j* upon which it is keyed, the shaft *j* remaining however in sliding engagement with the toothed wheel of the reduction gear *k*.

From the foregoing explanation it will be understood that it is always possible to control the tilting movement of the pouring ladle 6 whatever be the position occupied by the said ladle.

The arrangement represented in Figures 6 to 9 presents the advantages, that firstly, the tilting movement of the pouring ladle is quite independent of the hoisting, travelling and slewing movements of the jib, and is controlled exclusively from the driver's position; secondly that the attachment of a cable or any other auxiliary operation necessary in the usual arrangements is suppressed; lastly, that the untimely or undesirable rotation of the pouring ladle 6 is obviated during upward and downward movements of the said ladle, produced by the oscillation of the jib 3 around the axle 5, for example, during the filling from the converter or the pouring into ingots.

In operation, the tilting mechanism will be stopped when the pouring ladle 6 has reached a given position, either vertical or inclined at a certain angle; by reason of the stoppage, the worm *g* holds fast the toothed wheel *f* and therefore the toothed wheel *e*.

If at this moment the jib 3 is made to oscillate for the purpose of producing the rise and fall of the pouring ladle 6, the vertical position or the initial inclination of the said ladle cannot thereby be modified, for the toothed wheels *e* and *a* being planetary gears the pinions *b* and *d* will then act as satellites.

The tilting mechanism previously described with reference to Figures 6 to 9 is only one example of construction; it is naturally permissible to adopt any other arrangement of parts allowing of attaining the same end without departing from the scope of the invention.

The other mechanisms of the improved ladle crane do not differ materially from the known arrangements; the pivoting part rests upon four rollers running upon a circular rail for cranes of low tonnage, and upon eight rollers connected in pairs or eight rollers mounted upon equalizers for cranes of high tonnage. In the case of eight connected rollers there are two circular rails.

A short central pivot, upon which is placed as usual the central current feeder, maintains accurate circular travel of the rollers.

There might likewise be employed a central pivot on which the whole pivoting part would rest by means of ball bearings or conical rollers.

The mechanism for the travel of the roller truck is similar to that of ordinary cranes.

The example of construction hereinbefore described comprises a cable hoisting system. Naturally there may be employed without departing from the scope of the invention, other means for the same purpose to effect the rocking movement of the jib 3, such as links, rods, cranks, worm and wheel, screw and nut, bevel wheels, shafts, etc., the operation of these devices can likewise be effected electrically in accordance with the present invention.

The improved construction of foundry ladle cranes presents the following advantages:—

(1) Complete suppression of all hydraulic apparatus and the drawbacks due to the use of water under pressure: water hammer, leakages from joints and glands, high cost of upkeep and repairs, complete lifting of the whole pivoting part with a view to the replacement of the cup leather in the lower gland, losses in the transformation of energy, etc.

(2) Reduction by about 63 per cent of the weight to be raised, and direct utilization of the electric current, giving great economy in power: by way of example, for a crane of 20 tons useful load, the power necessary to effect the lift at a speed of one metre per minute is reduced to approximately ten H. P. instead of twenty-eight H. P. required to operate the pressure pump in the electro-hydraulic crane.

It is therefore feasible to increase the hoisting speed, while using a motor of lower power than previously; thus a speed of two metres per minute can be obtained with a motor of twenty H. P. in the example given.

(3) Suppression of the heavy frame and tank for the pump suction.

(4) Small dimensions of the cab enclosing the mechanisms and operating means.

(5) Suppression of flexible cables or vertical current leads required by the upward movement of the pivoting part.

(6) Simpler and lighter mechanism as a whole, and therefore lower cost of the apparatus. Less over-all height.

(7) Operating means moved further back, consequently less exposure of the operator to the heat of the molten material, and increased field of vision.

What I claim is:—

1. A foundry ladle crane, comprising a structure adapted to pivot around a vertical axis, a ladle-support mounted on said structure, means for slewing said structure with said ladle support around said axis, means for operating said ladle support to move the ladle towards and away from said axis, and independent means for operating said ladle-support to raise and lower the ladle without lifting said pivotal structure.

2. A foundry ladle crane, comprising a structure adapted to pivot around a vertical axis, a ladle-support mounted on said structure, said ladle-support consisting of a rocking beam, an axle to said beam intermediate of its ends, means for controlling the rocking movement of said beam upon its axle, and means for guiding said axle and beam in horizontal travel towards and away from said axis.

3. A foundry ladle crane, comprising a structure adapted to pivot around a vertical axis, a rocking beam, an axle to said rocking beam intermediate of its ends, rollers rotatably mounted upon said axle, runways for said rollers upon said structure, means for supporting a ladle at one end of said rocking beam, means for pulling down upon the other end of said rocking beam, and means for traversing said axle along said runways, the inclination of said rocking beam remaining unaffected by the operation of said traversing means.

4. A foundry ladle crane, comprising in operative combination a truck adapted to run upon rails, a structure mounted upon said truck and adapted to pivot thereon upon a vertical axis, and a rocking beam mounted on said structure, said rocking beam arranged to oscillate in a vertical plane upon said structure and to receive an independent horizontal travel in said plane, the foundry ladle being carried by one end of said rocking beam.

5. In a foundry ladle crane, the combination of a horizontal turn-table, a structure rotatably mounted upon said turn-table, horizontal runways upon said structure, a pivoted jib adapted to travel upon said runways, one end of said jib supporting the foundry ladle, means for exerting a downward pull upon the other end of said jib, and means for sustaining the reaction of said downward pull, said reaction means including rollers adapted to travel beneath said runways.

6. A foundry ladle crane, comprising a turn-table, a structure rotatably mounted upon said turn-table, means for slewing said structure thereon, a rocking beam upon said structure, said beam carrying at one end the foundry ladle, a horizontal axle upon which said beam is mounted, means for guiding said axle to travel in a horizontal plane upon said structure, a pair of auxiliary jibs

connected at one end to the opposite extremities of said axle, guide sheaves mounted upon said auxiliary jibs, a pulley mounted upon said rocking beam at the end opposite to said ladle, flexible tension members passing over said guide sheaves and pulley, means for sustaining the reaction of said tension members upon said auxiliary jibs, said sustaining means allowing the travel of said jibs in unison with said rocking beam, and means for adjusting said tension members to raise and lower said ladle without lifting said structure in relation to said turn-table.

7. A foundry ladle crane, comprising a structure adapted to pivot about a vertical axis, a rocking beam, an axle for said rocking beam, means for guiding said axle for horizontal travel in a direction perpendicular to its axis, a foundry ladle attached at one end of said rocking beam, and means for controlling the inclination of said beam to raise and lower said ladle independently of the horizontal travel of said axis.

8. A foundry ladle crane, comprising a structure adapted to pivot about a vertical axis, a rocking beam adapted to travel upon said structure, a ladle pivotally carried by said rocking beam, and independent mechanisms for slewing said structure about its vertical axis, for rocking said beam to raise and lower said ladle, for causing said beam to advance and retire said ladle, and for tilting said ladle about its pivot on said rocking beam, all said mechanisms being operated directly by electric power, and means for controlling said independent mechanisms.

9. A foundry ladle crane, comprising a structure adapted to pivot around a vertical axis, a ladle-support mounted on said structure, means for oscillating said ladle-support in order to raise and lower the ladle without lifting said pivotal structure, and means for tilting the ladle in the plane of oscillation of its support.

10. A foundry ladle crane, comprising a structure adapted to pivot around a vertical axis, a ladle-support mounted on said structure, means for raising and lowering the ladle without lifting said pivotal structure, means for guiding said ladle-support in horizontal travel upon said structure, and means for tilting the ladle upon a horizontal axis.

11. A foundry ladle crane, comprising a structure adapted to pivot around a vertical axis, a ladle-support mounted on said structure, said ladle-support consisting of a rocking beam, an axle for said beam, means for controlling the rocking movement of said beam upon its axle, ladle-pivots upon said ladle-support, said pivots having a common axis parallel to said axle, a bevel gear mounted co-axially of said pivots and controlling the inclination of the ladle, a second bevel gear mounted rotatably upon said axle, planetary pinions connecting said bevel gears, and means for rotating said second bevel gear in relation to said axle.

12. A foundry ladle crane, comprising a structure adapted to pivot around a vertical axis, a ladle-support mounted on said structure, said ladle-support consisting of a rocking beam, an axle for said beam, means for controlling the rocking movement of said beam upon its axle, the ladle upon said ladle-support being tiltable upon an axis parallel to said axle, a worm gear rotatably mounted upon said axle, a worm meshing with said worm, means for operating said worm, said operating means including an electric motor and a telescopic shaft, and means for transmitting to the ladle the rotary motion of said worm gear, said transmitting means being unaffected by the rocking movement of said beam upon said axle.

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