CHAPTER XXVIII.

HANDLING MATERIAL AT THE ROLLS.

Tongs.—If the piece to be rolled is small enough for a man to lift it with a pair of tongs, there is no need for any other handling appliances; the roller simply enters the piece on the front side of the mill, and when it has passed through, the catcher seizes it with his tongs, and, lifting it up, passes it back again over the top roll of a pull-over mill, or into the return pass of a three-high mill, the roll on which the piece rests in either case running in the direction required to take it back again to the roller.

Hand Levers.—When the piece is much over ¼ cwt., it is too heavy for the catcher to be able to lift it over the roll, and he is assisted by a lever-man, provided with a lever of the first order having a curved shorter end, the lever lying parallel to the axis of the rolls, and its fulcrum attached to a chain or long link hung from the roof of the mill. The man, placing the short arm of his lever under the piece, and bearing down on the longer arm, can support any requisite proportion of the weight; when the end of the bar next the mill is sufficiently high, the catcher, who has seized the other end, pushes it forward over the roll or into the pass, the lever swinging on the link towards the mill as the piece is pushed forward. The point of suspension of the link is situated very nearly over the centre of the rolls, to assist the men in swinging the piece towards them, and it is made as long as possible by securing it to the highest practicable point in the roof, so that it shall not have to swing at a greater angle from the perpendicular than can be avoided; the angle is not usually too great for convenience when the link serves for only one stand of rolls, but where the rolling has to be done in several stands in succession, all coupled up in line, the inclination of the link is too great, and in that case the upper end of the link is attached, not to the roof direct, but to a small grooved sheave which can run to and fro on a rail, a rolled joist, or a bar of some kind, carried from the roof nearly over the rolls, and parallel with them.

If the piece to be handled weighs more than 3 or 4 cwts., it is too heavy to be lifted by one lever-man, and a second, who stands facing him on the other side of the piece to be lifted, must be employed to assist him with a similar lever, both men bearing down on the longer ends of their levers simultaneously. Provided the mill is a small one, so that the piece has not to be lifted very far to get it over the top of the roll, they can handle thus weights up to 6 or 9 cwts. The distance through which it is possible to lift the piece is limited by the fact that, when the shorter end of the levers are made sufficiently long to give the height of lift required, there is too little purchase to enable the men to lift the weight; while stationing more than one man at a lever is unsatisfactory, as the men are in each other's way, even if standing room can be found for them, so that additional men cannot do work at all proportionate to their increase in numbers, and, if practicable at all, the cost of wages rises much faster than the weight handled.

Power Levers.—To get over the difficulty of there being insufficient purchase to serve a large mill, the sheaves carrying the levers run on a bar, which is not fixed at one height above the floor, but is slung at each end from chains or wire ropes which are carried over pulleys in the roof to a steam or hydraulic cylinder, by which the bar can be lifted bodily, thus lifting the fulcrum on which the levers turn, so that the workman has no lifting to do, but when he puts the short end of his lever under the piece, the lever is lifted for him. In that case the short end of the lever may be so much reduced in length, that weights up to half a ton can be handled with comparative ease, and with enough men double this weight can be handled at a low speed. The men get wonderfully expert in the use of such appliances, and transfer moderate weights from stand to stand with surprising ease. Fig. 403 shows a pair of power raised levers.

Before the use of these mechanical lifting appliances, weights up to 25 or 30 cwts. were occasionally rolled, but this was done by avoiding altogether the lifting required to pass the piece back. As the piece left the rolls it was

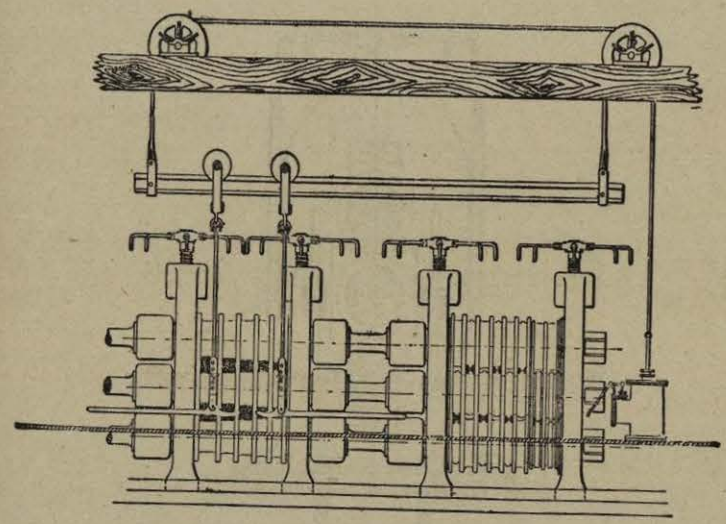


Fig. 403.—Rolling Mill fitted with Power Levers.

received on to a small bogie truck, which was dragged round the end of the mill by a number of men, and brought back again to the front, where the bar was put through the mill again, and the process repeated until the rolling was completed; such a method took much time and was very expensive as regards the labour, so that large rolled bars, when produced thus, were as costly as those forged under the hammer. Bright turned shafting, made from large rolled bars, can be sold to-day for less than the unturned bars cost thirty years ago.

The difficulty in lifting a given weight at the rolls is greatest when the weight is contained in a short length, because there is so little space in which to do the lifting; but if the same total is made up by a long length of small weight per running foot, there is room in its length for several sets of men to lift the bar with levers, which may be carried by sheaves running on bars placed at right angles to the axis of the rolls, and so capable of travelling in the direction which the piece takes when passing through the mill, the speed

being limited to that at which the men can "follow up," say 200 to 300 feet per minute at most; if the bar is of sufficiently small section to be flexible while hot, only the end next the rolls absolutely requires lifting, the rest lying along the mill floor; to avoid the friction which would be caused by dragging this length, it can be supported at intervals on loose rollers, consisting usually of pieces of flanged pipe, the bar resting on the body of the pipe, which rolls to and fro along the floor on its flanges; by this simple method considerable lengths and weights may be handled with comparatively few men, and the speed of the bar be double that given above. In some cases small trucks, which can travel backwards and forwards with the bar, are used instead.

Lifts.—When ingots of more than 7 to 10 cwts. each became common, it was found desirable to provide some form of lifting appliance, which in its simplest form consisted of a small roll on the catcher's side of the mill, parallel and close to the main rolls, upon which the end of the ingot next the rolls

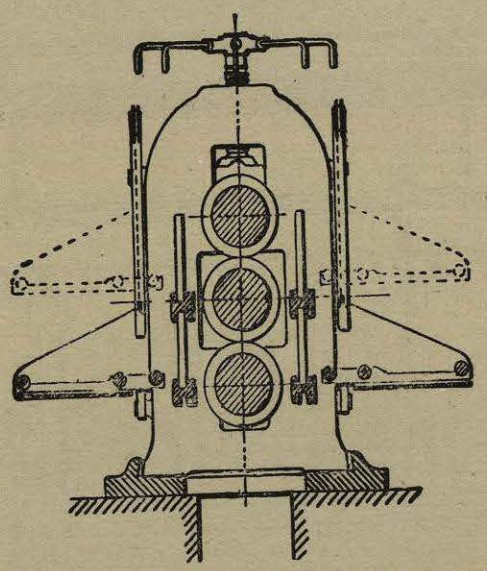


Fig. 404.—Lift used in Cogging Ingots of Moderate Weight.

rested, when it had passed through the mill. The roller was raised by some convenient appliance, and the catcher, assisted by one or more levermen to raise the end furthest from the mill, pushed the ingot back again. To the single roller were subsequently added others to carry the other end of the ingot and dispense with the levermen, thus forming a platform whose top was made of rollers, which lifted the ingot in a horizontal position; to facilitate the entry of the piece on the "roller's" side of the mill, he was provided with a similar platform to the catcher's, the platforms on each side of the mill being raised and lowered together by methods very similar to those used for the lifting bar previously described, or by direct-acting steam or hydraulic cylinders carried from the top of the housings and standing directly over the rolls, or placed below the floor and lifting by direct thrust. Fig. 404 shows the lifting platforms originally fitted to the 26-inch three-high rail mill at Crewe in 1875 to handle the 10½-inch square ingots from which the rails were then rolled. The platforms were raised and lowered by

means of chains which passed over multiplying sheaves actuated by a hydraulic cylinder which stood horizontally on the top of the pinion housings. The dotted lines show the position of the platform when raised. When the platform was fitted on the catcher's side of the mill only, the piece being rolled, when returned to the roller, fell from the top of the roll to the floor. If short and light there was no particular objection to this, but as the weight of the ingot increased, and likewise the length rolled, other methods had to be devised.

To push a ton ingot into the mill and turn it over on a platform of this kind, requires four men on each side of the mill, and is then very hard work. With appliances such as this, when dealing with ingots of 15 to 20 cwts., 250 to 300 tons of ingots can be cogged per day, and reduced until they are of sufficiently small section to be handled with the levers in the following roughing or finishing stands. When the ingots are much heavier than this, or greater outputs are required, regular power-actuated tables, which will be described later on, should be employed.

Roller-beds.—So far we have been treating of appliances for use in non-reversing mills, in which the necessity for lifting the piece to return it to the roller's side of the mill, has been the special difficulty, but with a reversible mill, which was expressly devised to avoid this necessity, no lifting is required, and the appliances for handling the piece at the rolls may be much simpler. By placing a small roller between the housings in between the mill floor and the rolls, in the position occupied by the fore-plate in a small mill, the small roller standing a trifle above the surface of the mill floor, and the axle carrying it revolving in sockets cast on the inner sides of the housings expressly to receive it (see fig. 346), the roller and catcher can push forward the ingot with crow-bars, when one end of it is resting on this roller, and can thus enter a considerable weight between the rolls with the expenditure of a moderate amount of labour. As there is no lifting to be done at the reversing mill, it will be understood why it takes less men to work it than the three-high mill, if both are served entirely by manual power.

As the convenience of the small roller close to the front of the mill was appreciated, other rollers were added further back, their upper sides just projecting through the floor plates, so that the ingot was supported on such rollers for its whole length on each side of the train, and thus was much more easily pushed in by the workmen. To further assist the men, these rollers were frequently arranged to form an inclined plane, sloping slightly downwards towards the mill on each side, so that the slightest exertion on the workmen's part sufficed to start the piece towards the rolls, which delivered it up the slight slope on the other side.

Live-roller Gears.—The first step in the direction for handling the ingot by power at reversing mills, consisted in running the axle on which the roller between the housings revolved, through the housing to the outside of the stand (see figs. 346, 353, and 489), and keying the roller tightly on the axle, so that the two revolved together; on the outer end of the axle was keyed a toothed wheel, round which passed a pitch chain driven by a corresponding wheel on the wobbler of the roll (see figs. 405 and 507), so that the roller was driven by it in the same direction as the main rolls, and the ingot resting on it was carried into the mill without any exertion on the part of the workmen. Subsequently the other rollers were coupled up in the same way, and long lengths could be thus automatically drawn in by the mill. In these cases all the rollers were kept on one level, forming a horizontal bed.

Experience has shown, however, that it is much more convenient to drive these rollers by some source of power other than that which drives the mill itself, and they are now accordingly worked by a separated pair of small reversing engines (figs. 447; 471, Plate xlii.; 473, Plate xliii.; and 490, Plate xliv.) or an electric motor (fig. 465, Plate xl.) which drives a long horizontal shaft 5 or 6 inches diameter, having a series of mitre wheels keyed on it, each wheel gearing with a similar one on the axle of the roller; and as these rollers can be run quite independently of the mill, they serve both as a means of transporting the ingot to the mill, handling it when there, and removing it when finished.

With live roller gear the speed of rolling may be much increased, and long heavy pieces passed through the rolls at speeds up to 800 or 1,000 feet per minute, which, of course, greatly increases the output of the mill. The increased speed of rolling has enabled material to be finished in such lengths that the roller beds rendered necessary to accommodate the work have encroached on the gangways originally left for the passage of men and materials

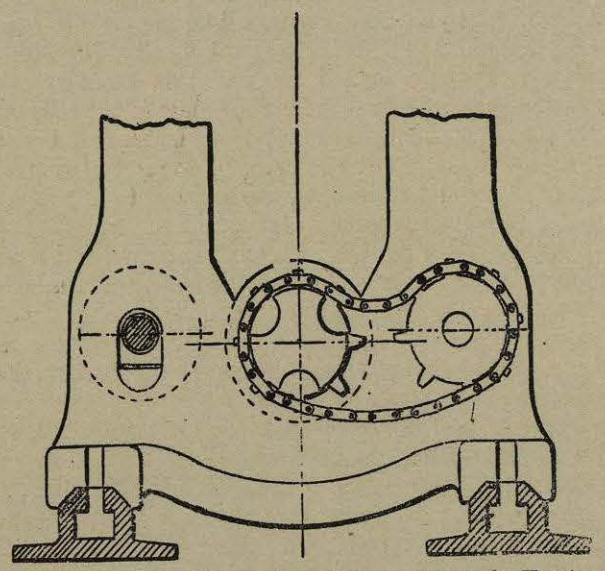


Fig. 405.—Method of Driving Live Rollers between the Housings.

across the ends of the mill, and to enable work to be carried on, roller troughs in many cases have had to be raised so high above the floor that men can pass below. In some works, to avoid moving plant which was in the way, the ends have actually been taken out above the roof. In such cases only some of the rollers next the mill are driven, the rest being allowed to run free.

As mechanical appliances are now used to turn over the ingot, and transport it across the front of the rolls from pass to pass, there is no longer any need for workmen to stand facing the cogging mill, and often no floor-plates whatever are provided between the rollers, but open spaces are left between them through which scale can drop, and where air may circulate freely to keep the rollers and their attachments cool.

When foot plates are provided between the rollers, flush with the general mill floor, for the men to stand on, the tops of the rollers must project above the floor, the bearings and the shafting and gearing driving them must all be situated below the floor plates (where they are difficult to get at to

oil or repair), and the mitre wheels, being entirely below the floor plates, must be considerably smaller in diameter than the rollers they drive. To avoid this the whole roller bed is now usually raised 2 or 3 feet above the general level of the floor of the mill. The mitre wheels may then be larger, instead of smaller, than the rollers they drive, shafts and bearings much stronger, and all parts are far more accessible for oiling and repairs. Strong guards, formed of flat bars, are fixed on each side of the bed, to prevent the piece being rolled from running over the side of the bed on to the floor, and light readily removable guards, of sheet iron or wire netting, protect the gearing. The ingots cannot be tipped from a hand bogie on to a bed of this height, but such methods of handling them are now obsolete, and if a bar does run over the edge during rolling, it cannot be pushed into position again with hand spikes, as may be done when the table is flush with the general floor level; but most mills now possess overhead cranes, hy which it can be easily replaced or removed.

When first introduced, the live rollers, the gearing driving them, and in fact all the appliances for handling the ingot at the rolls, were far too light; the rollers were only 6 or 8 inches diameter, with spindles 2 or 3 inches diameter, driven by wheels smaller than the rollers, with the result that much trouble was caused by breakages, and the wear and tear was excessive. To-day rollers are scarcely ever less than 14 inches in diameter, sometimes twice this size, and those next the mill are of wrought iron or cast steel fitted on shafts 6 or 8 inches diameter, while the other rollers further from the mill are of cast iron, and have 5-inch spindles. All are driven by cast-steel mitre wheels 18 to 24 inches in diameter, and breakages are far less frequent. The arrangement of live rollers is clearly shown in figs. 465, Plate xl.; 473 Plate xliii.; and 490, Plate xliv.

One German firm gets rid of gearing altogether by connecting the shafts of the rollers with cranks and coupling rods, in the same way as the driving wheels of a locomotive are coupled together.

The rollers are also used to bring the piece to and from the mill, and to carry it about the works. Rollers were in use at Dowlais for transporting iron rails from the mill to the straightening press as early as the year 1868.* Live rollers are also employed to take slabs to and from the shears (see figs. 468, 470, 471, and 472, Plate xlii.) and for various purposes of transport in and about the works.

Combined Travelling and Lifting Tables.—In some works travelling tables are provided, which not only move from one stand to another, like the tables shown in figs. 416 (Plate xxx.) and 490 (Plate xliv.), but are also provided with a top composed of live rollers, which rise and fall as required. The driving of the rollers is accomplished by electro-motors carried on the table, which revolve in either direction or stop as desired, when the switch controlling them reverses or cuts off the current, while the lifting of the top is performed by hydraulic cylinders carried in the lower carriage, controlled by water conveyed to them by telescopic supply pipes, or by electric power. Fig. 406 shows a table of this kind made by the Benrather Machine Works near Dusseldorf. The lifting is done by electricity, the weight of the table being balanced by water subjected to the pressure of compressed air.

Lifting Tables.—Live rollers on the floor are all that are required for a reversing mill, but for a three-high mill, where the piece must be lifted to pass over the top of the middle roll, lifts such as fig. 404 are insufficient, unless the piece is very short, and regular lifting tables are necessary. A lifting table in its simplest form consists of a series of flat bars, placed in

* *Iron and Steel Inst. Journ.*, 1869, p. 169.

pairs a short distance apart, with small rollers a little larger in diameter than the width of the bars, running loose on pins, which serve also to hold the bars at the right distance apart from each other, the whole forming a grating with the rollers standing a little above the surface, so that the piece

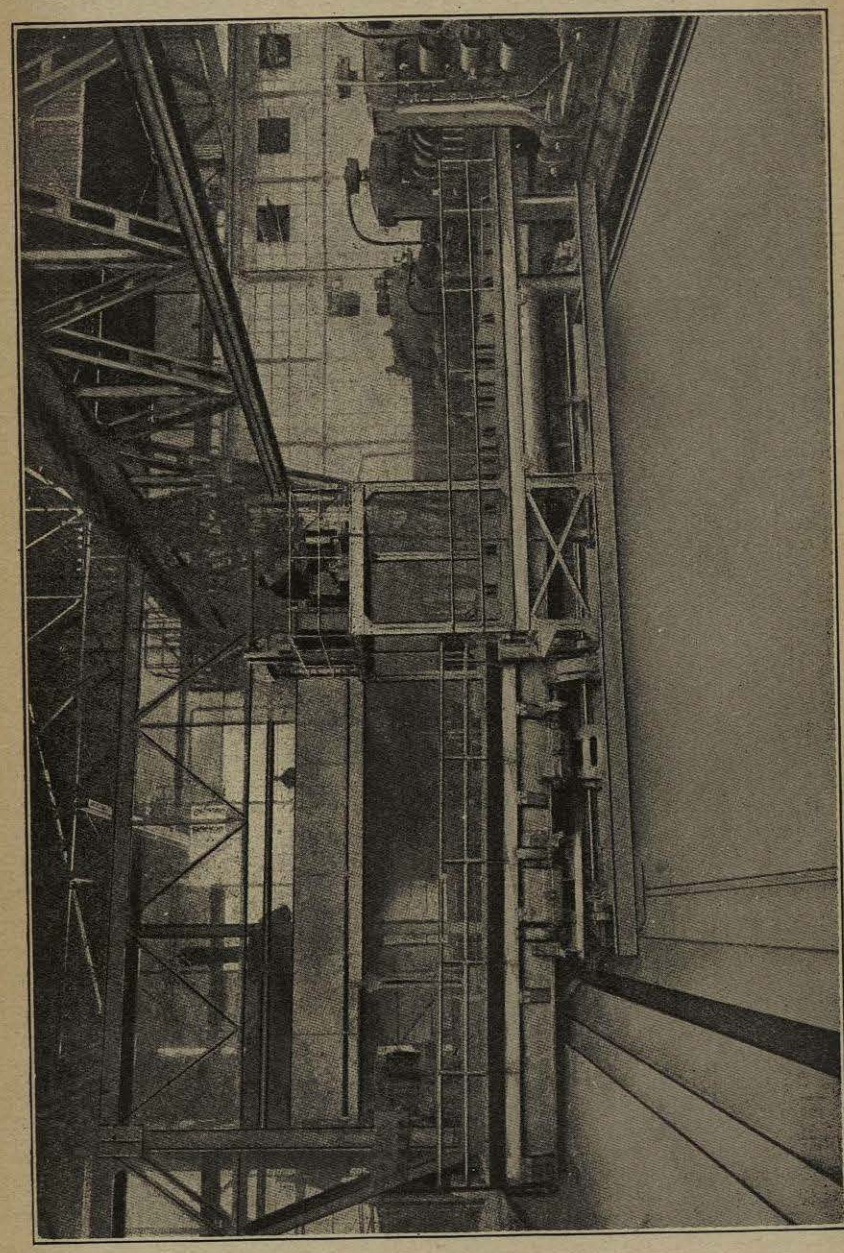


Fig. 406

runs on them instead of rubbing on the bars. The gratings are pivotted at their ends farthest from the mill, so that the opposite ends next the rolls may be raised or lowered. The pivot on the roller's side of the mill is usually situated at the level of the centre of the middle roll, and that at the catcher's

side at the level of the upper side of the middle roll. By thus placing the pivots, the piece to be rolled runs down a gently sloping surface to make its first pass below the middle roll, the rolls, as they pass it through the mill, delivering it up the inclined surface of the table on the catcher's side. Both tables are then raised, until that on the catcher's side is horizontal, so that he may not have to push the piece uphill to enter it between the top and middle rolls, which take it back to the roller, running it down his gently sloping table. Both tables are then lowered, and the piece is ready to make its third pass, at the same level as that at which it made its first.

If the piece to be rolled is always long enough, the pivot on which the table turns may be fixed, but where short pieces have sometimes to be rolled, the ends of the tables nearest to the mill must fit so close up to the rolls, as to leave no space between the rolls and the tables through which the piece being rolled could slip down. To permit of this, the pivot on which the table turns is carried on a swinging support, so that the other end of the table, when being moved from one position to the other, may withdraw as far as is needed to clear the middle roll, the end of the table next the mill being guided in an inclined or curved slot, so as to follow closely the contour of the roll.

When the rollers are not driven by power, the piece to be rolled can often be got in between the rolls without any hand labour, by moving the rising table towards the mill, and bumping it smartly against the housings, so that the momentum imparted to the piece jerks it forward into the pass.

Tables of this kind are useful for rolling light plates, and if balanced, may, for small work, be raised or lowered by hand. A 26-inch three-high plate mill on the Continent, with two stands of rolls, served by tables of this kind, raised and lowered by power, has turned out 50 tons of tank plates of $\frac{5}{16}$ inch and under in thickness per twelve-hour shift, starting with ingots of 1 ton in weight. Their capabilities are soon reached, however, as weights increase, and to deal with heavy pieces the loose rollers must be replaced by power-driven rollers, similar to those just described for use with reversing mills, the whole bed of live rollers being raised or lowered bodily at each pass.

If the piece to be rolled is sufficiently flexible, the roller bed may be hinged, as in the case of the lifting table just described, but instead of hinging it at the end, the pivot on which it turns is generally situated somewhat out of the centre of the length, so that the table shall be partially balanced, and yet retain a sufficient preponderance of the end next the rolls, to prevent it tipping up when the piece is at the end farthest from the rolls; the shaft driving the live rollers passes through the centre of the pivot. The arrangement is clearly shown in fig. 493, Plate xlv. The two tables are raised or lowered simultaneously by lifting rods connected to bell-crank levers coupled together, and actuated by the horizontal cylinder below one of the tables.

In the finishing stand, when the piece is flexible, and has been drawn out to such a length that the larger portion is resting on the mill floor before the last end has left the rolls, live rollers in the floor will suffice to carry the piece back again through the bottom pass, and a lifting table on only one side of the mill will suffice. In any case, when the piece to be rolled is very long, additional rollers are fixed in the floor to support the ends of the bar beyond the lifting tables at each side of the mill. For short stiff pieces which are not flexible, such as ingots, the tables rise parallel with the floor (see fig. 466, Plate xli.). The power to actuate the rollers is conveyed to the shaft running alongside the table, by the spur-wheels shown, which are held in gear at all times by swinging links joining the shafts, and maintaining the connection between the wheels in all positions. In other

cases pinions are provided sliding on short lengths of square shafting placed vertically. The tables are steadied, while rising and falling, by guide brackets provided for the purpose.

Manipulators or Tilters.—The least laborious part of the work at the mill is the turning over of the piece which is being rolled, between one pass and another, so that it may enter the rolls with the requisite side upwards. This can be done with hand levers, even when the piece is so heavy as to need lifting and pushing forward by power, but for very heavy ingots it is necessary to provide some mechanical tilting gear worked by power.

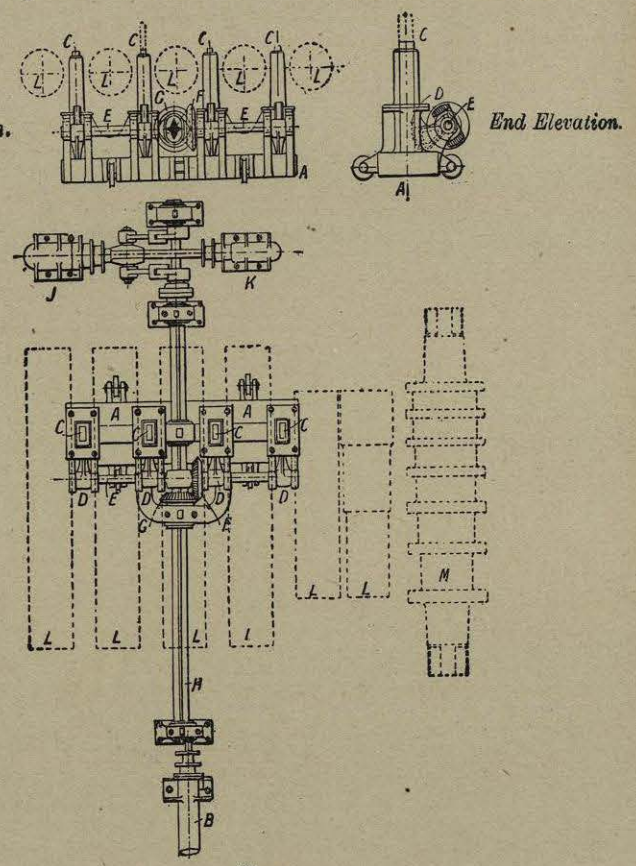
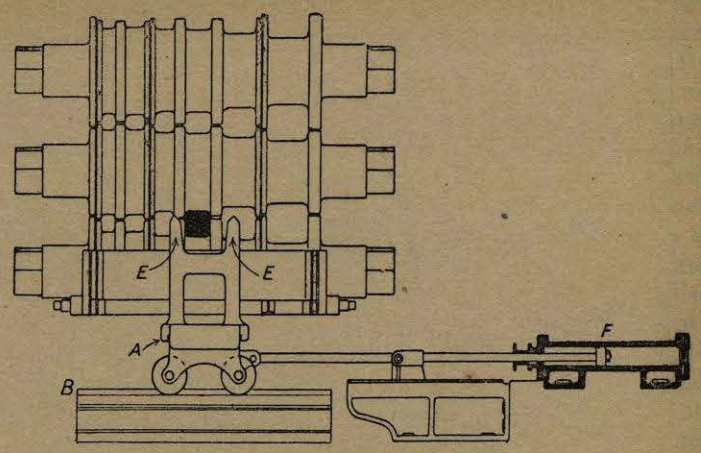


Fig. 408.—Manipulator for Reversing Mill.

When lifting tables for ingots of moderate weight were introduced, the workmen soon found out that if they placed something on the mill floor, which could pass between the rollers and project a sufficient distance above them when in their lowest position, the table could be lowered with the ingot upon it in such a way that the projection would arrest the descent of one edge of the ingot, which would roll over on its opposite edge, and so be turned over; the mechanical ingot tilter to-day, used with lifting tables, is merely an elaboration of this crude contrivance. Fig. 407 (Plate xxix.) shows one of these tilters or "manipulators," which consists of a small trolley, A, travelling on rails, B, B, laid on the bed plate of the mill, below and parallel to the axis of the rollers, C, C, carried in the lifting table, D. This trolley

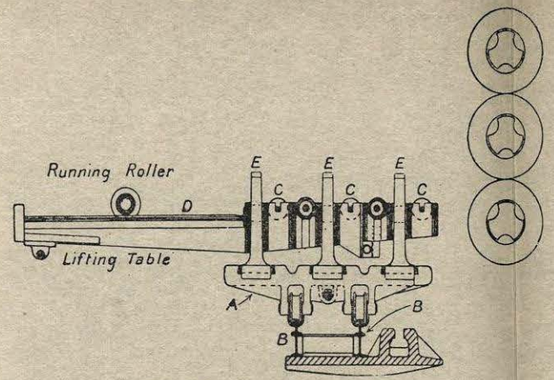
: Ingot Tilter for Three-high Mill. [*To face p.* 644.



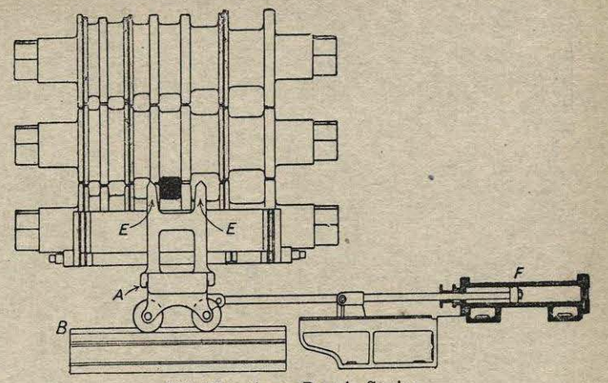
Side Elevation.—Part in Section.

Fig. 407.

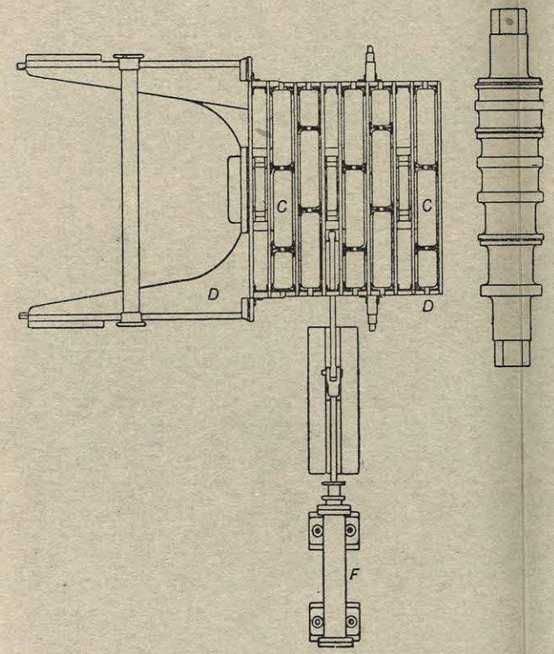
PLATE XXIX.—Hydraulic Ingot Tilter for Three-high Mill. [*To face p.* 644.



End Elevation.—Part in Section.



Side Elevation.—Part in Section.



Plan.

Fig. 407.

carries on its upper surface a series of projections or tappets, E, E, six in number, which can project between the rollers in two lines at right angles to their axes to such a height as to stand well above the top of the table when in its lowest position. The trolley can be moved to and fro across the face of the rolls by a small steam or hydraulic cylinder, F, and by placing the row of tappets below one edge of the ingot and lowering the table, the tappets arrest the edge in its descent, while the ingot, falling with the table, is turned over on its opposite edge round its longitudinal axis, at right angles to its former position. By again lifting the table the ingot can be turned around its own axis a quarter of a revolution as often as is necessary, one turn for each pass being, however, as many at is usually required. The tilter used at the mill (fig. 466) is of this kind. By providing the trolley with two lines of tappets, placed a short distance apart, and turning the ingot over so that it will be between the two rows, the trolley can transfer the ingot parallel to the axis of the rolls to right or left, and present it opposite to any pass in their length which it is desired that the piece shall enter. The tilters (figs. 409 and 466) have to carry the ingot if it has not been tilted in the direction required.

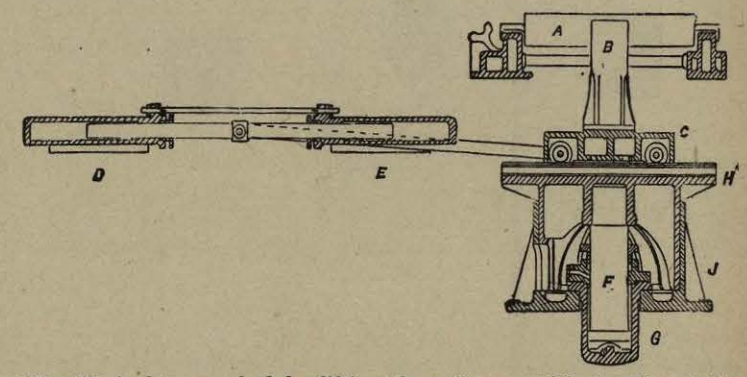


Fig. 409.—Manipulator worked by lifting the rails on which the Tappet Carriage Travels.—A is one of the live rollers in front of the mill, B one of the tappets bolted on the trolley C, which is moved to and fro, parallel with the axes of the rolls, by the hydraulic cylinders, D and E. In a pit, below the bed of live rollers, is a ram, F, working up and down in the hydraulic cylinder, G. This ram carries on its upper end the table, H, for the trolley to run on. The table is steadied by the deep ring cast on its lower side, which moves up and down in the socket, J; a hole is provided in the side of both ring and socket, to afford access to the packing round the ram, F.

For reversing mills whose roller beds do not rise and fall, the tappets must themselves be capable of being raised vertically, so that when passed beneath the ingot lying on the roll bed, they may, by their rise, turn the ingot over. This may be accomplished either by lifting the rails on which the trolley runs, or by keeping the rails fixed and lifting the tappets only. Fig. 408 is an example of this latter arrangement, which, as well as the preceding example, is taken from a paper read by M. Lantz, at Dusseldorf, in 1898.* A is the trolley, which can be moved backwards and forwards across the face of the rolls by the hydraulic cylinder, B. The trolley contains four movable tappets, C C C C, which rise and fall in sockets formed in the trolley, and are provided at their lower ends with toothed racks, into which gear four toothed quadrants, D D D D, all secured on a shaft, E, on which is fastened the mitre wheel, F, into which gears a similar mitre wheel, G. This is carried

* *Stahl und Eisen*, November, 1898.