3 Sheets—Sheet 1.

A. L. HOLLEY.

MANUFACTURE OF IRON AND STEEL BY THE BESSEMER OR PNEUMATIC PROCESS.

No. 86,303. Patented Jan. 26, 1869.

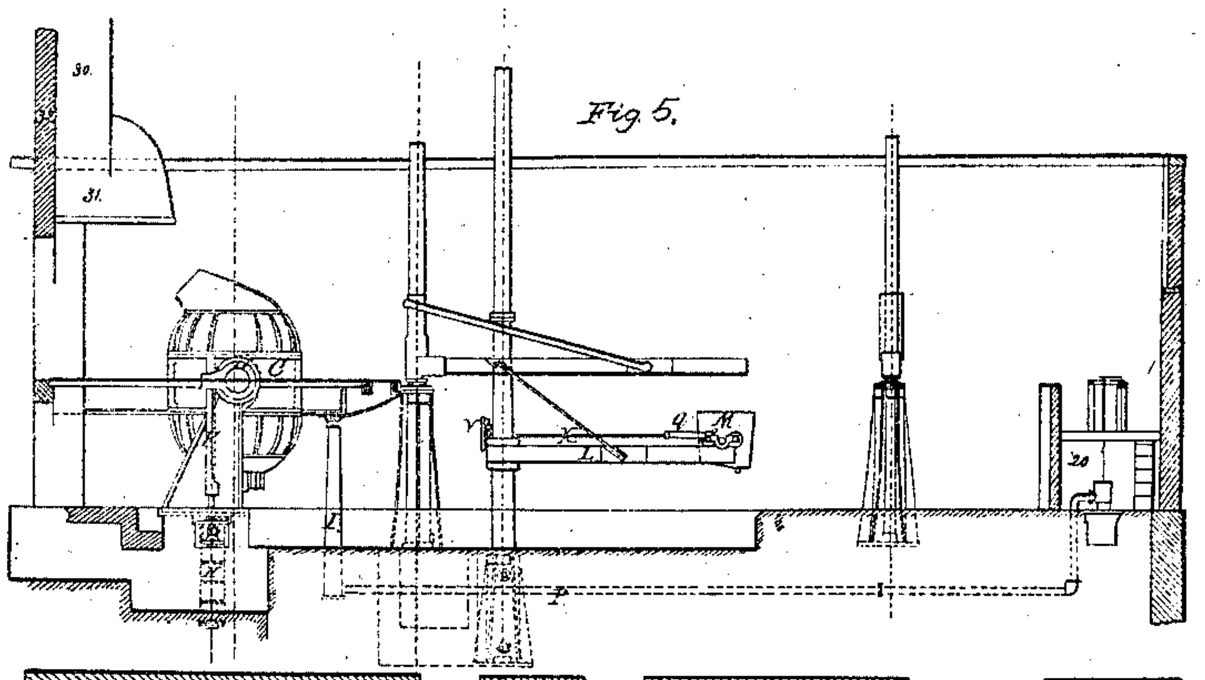

Fig. 5.

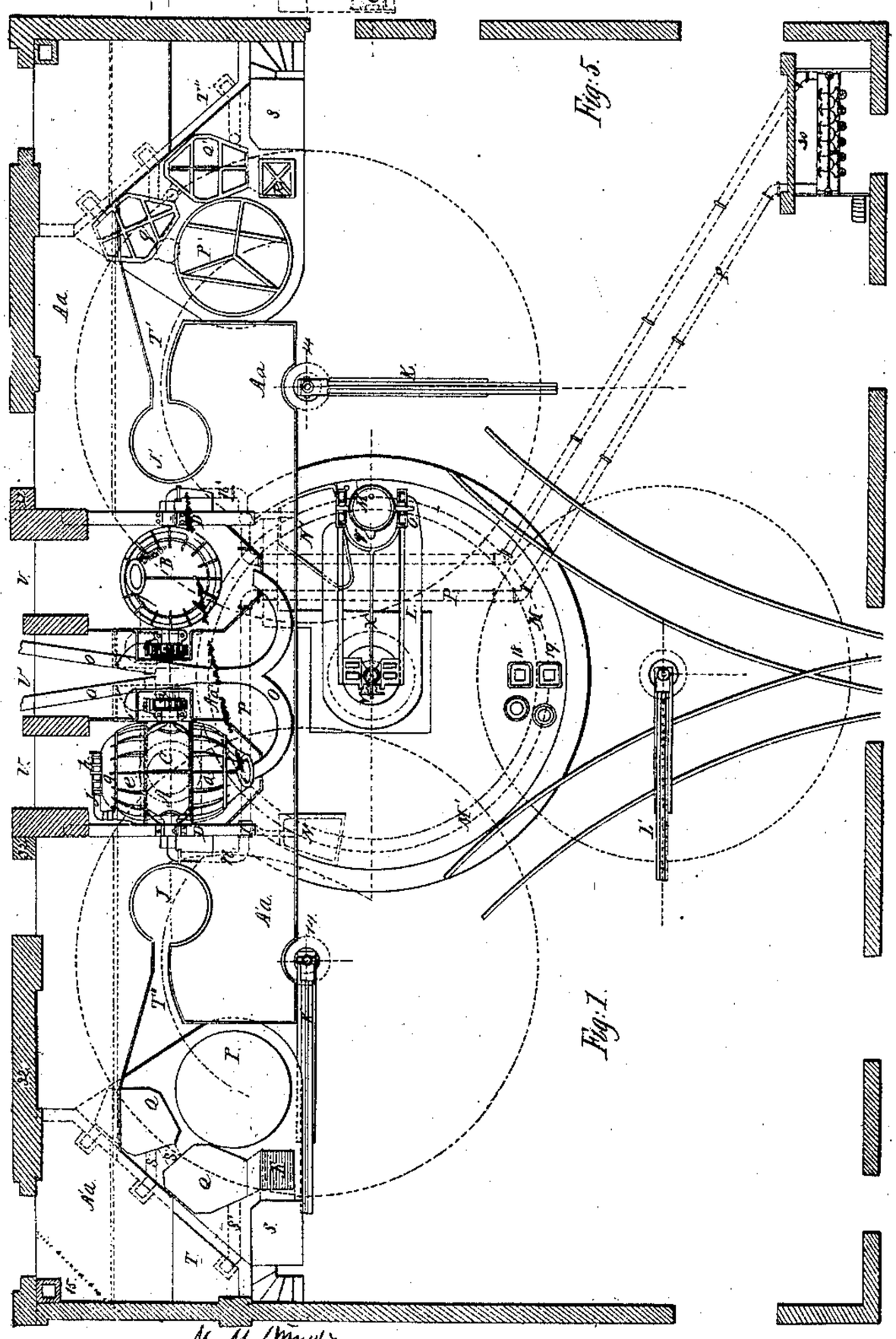

Fig. 3.

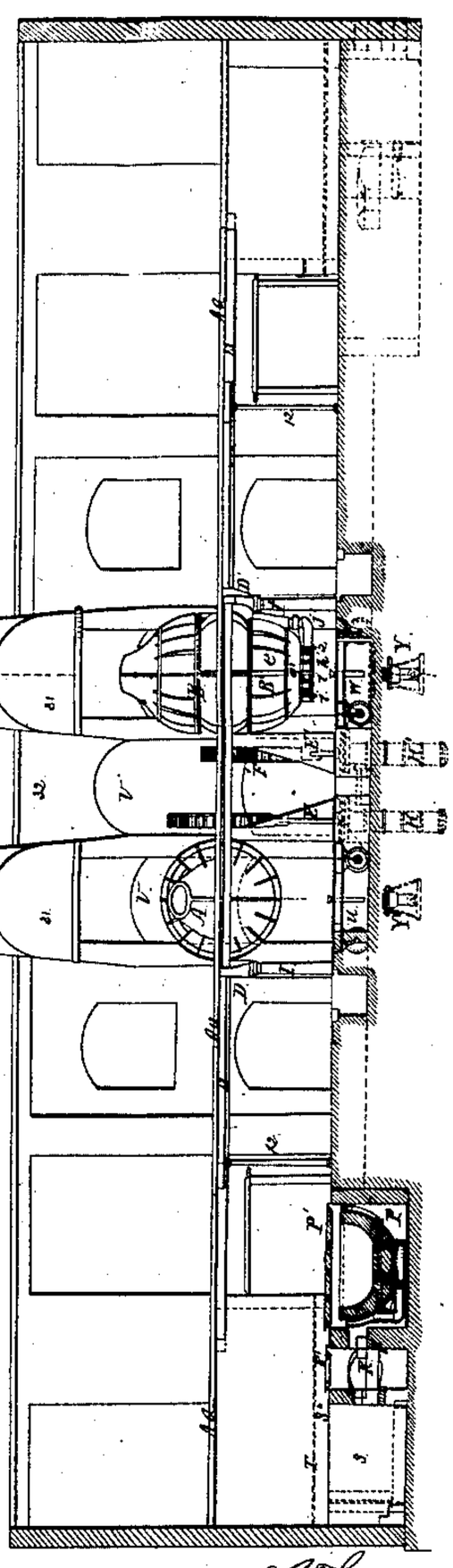

Fig. 2.

Witnesses: H. M. Whyte
Benj. Cooper

Inventor: A. L. Holley

3 Sheets—Sheet 2.

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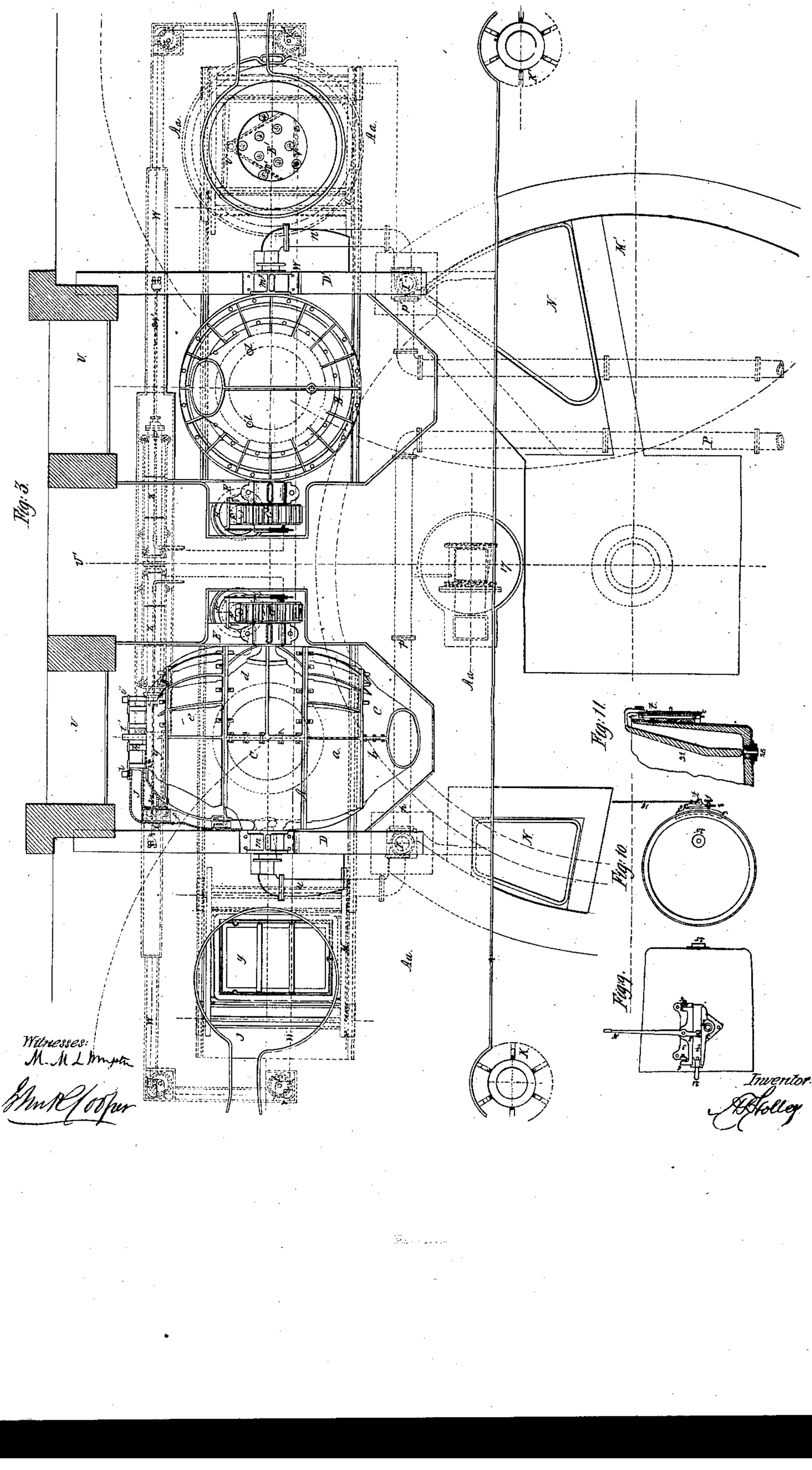

3 Sheets—Sheet 3.

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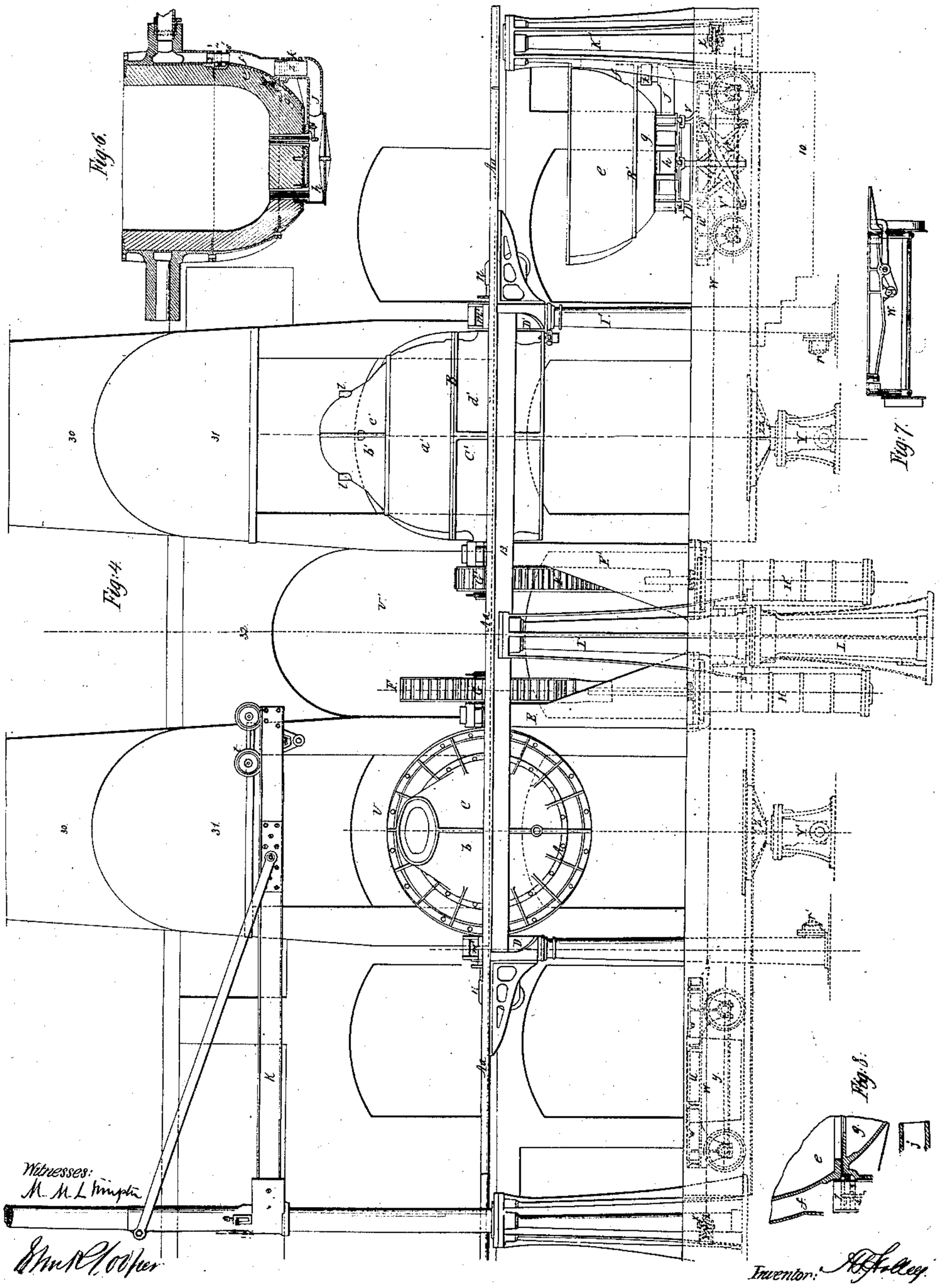

United States Patent Office.

ALEXANDER LYMAN HOLLEY, OF SWATARA TOWNSHIP, PENNSYLVANIA.

Letters Patent No. 86,303, *dated January* 26, 1869.

IMPROVEMENT IN THE MANUFACTURE OF IRON AND STEEL BY THE BESSEMER OR PNEUMATIC PROCESS

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, ALEXANDER LYMAN HOLLEY, of Swatara township, in the county of Dauphin, and State of Pennsylvania, have invented certain new and useful Improvements in Plant and Machinery for the Manufacture of Iron and Steel; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings.

These improvements relate to the manufacture of iron and steel by what is known as the Bessemer or pneumatic process, which may be generally described as the forcing of air, or other material capable of supplying oxygen, into and among the particles of fluid crude iron, in such a manner that the iron thus treated becomes purified, and is "converted" into malleable iron or steel while retaining the fluid state.

The apparatus generally heretofore employed in carrying out this process has been constructed substantially as follows:

Two converters, movable on their axes by means of hydraulic cylinders, are placed on the opposite sides of a casting-pit. The hood of a detached chimney behind each converter receives the gaseous products issuing from the converter. A hydraulic crane, in the centre of the casting-pit, carries a ladle, into which the metal from either converter may be poured by turning down the mouth of the converter, and from which ladle the metal is run out, by means of a suitable valve, into ingot-moulds ranged around one side of the ingot-pit in the orbit of the ladle-crane.

Two hydraulic cranes standing outside of the ingot-pit, and capable of swinging over the whole space occupied by the moulds, are used to put the moulds into the pit and lift the ingots out. Water, under pressure, is admitted to these cranes, and to the cylinders that turn the converters, by a workman standing on a raised platform, from which all the operations can be overlooked.

Melted iron is run into the converters from melting-furnaces, by means of movable iron spouts lined with loam.

The converter is shaped substantially like those shown in the drawing attached to this specification, but it is not made in several movable sections. The shell is made of boiler-plate, and the trunnions are formed on a wrought-iron hoop that encircles the converter, or are made of cast-iron and riveted to the converter. The converter is lined with fire-stone and clay mixed with water into a plastic mass and rammed into an annular space between a mould and the inside of the walls of the converter. The mould is then withdrawn and the lining glazed.

Air is admitted to the converter through a hollow trunnion and a pipe leading into a compartment at the bottom of the converter, opposite the mouth, called a tuyere-box, whence it is conducted up through the fire-stone lining into the liquid metal by means of perforated blocks of fire-brick called tuyeres. When, after six or eight charges or conversions, the tuyeres become burnt or worn too short for further use, they are knocked out by means of a long rod or battering-ram put into the mouth of the converter. New tuyeres are then inserted from the tuyere-box, and the annular spaces between the lining and the tuyeres, and also any cavities in the lining of the bottom, are filled by means of pulverized refractory material so mixed with water as to be semi-fluid, and poured through the mouth into the bottom part of the converter. As the water dries out, the refractory material sets more or less solidly around the tuyeres.

The chief defect of the said arrangement of machinery heretofore used, and especially of the above-described method of setting new tuyeres, is that only three or four charges are made in both converters in day, or six or eight in a day and night.

The object of my improvement is chiefly to increase the production of iron and steel in the same number of converters, and to reduce the cost of production.

For this purpose, I construct the converter with a joint at any suitable place below the trunnions, and I arrange a lift and a car, both operated (by preference) by water under pressure, so that the lower portion of the converter (which, for the purposes of this specification, I call a movable bottom) can be moved out from under the body of the converter, where the workman can get directly at the tuyeres, and can set them quickly and strongly by ramming ground refractory material solidly around them, instead of pouring it around them in a semi-fluid state. The movable bottom is then rapidly replaced by the same car and lift.

To still more facilitate repairs and production, I prefer to have two or more duplicate movable bottoms fitted to be attached to one or to either of the converters, so that while one movable bottom is being repaired, another can be in use. By these means, properly worked, I can make ten to fifteen charges or more, in twenty-four hours, with two converters.

In order to provide pit-accommodation for this increased production, I prefer to place the converters near each other on one side of the ingot-pit, and I arrange three ingot-cranes, instead of two, to swing over the pit. The chimneys behind the converters are built into the walls of the building, and do not, as in the previously-described arrangement, stand out in the way of the ingot-cranes. Two of the ingot-cranes are arranged to swing over the converters, respectively, for conveniently taking the converters apart, or placing solid or other materials in them.

For the purpose of conveniently placing coal or other materials in the mouths of the converters, and of keep-

ing in order the spouts that conduct liquid metal to them, and of economically making two stories of valuable room around the converters, and also in order to conveniently repair the movable bottoms, I construct, at about the level of the trunnions, a platform around the converters, and extending some distance on either side of them. In this platform I make two openings large enough for the converters to turn over in, and two other openings over the movable bottoms when they are run out on the cars before mentioned. Workmen standing on this platform can, with suitable bars and rammers, work through the last-named openings upon the tuyeres and lining of the movable bottoms below, while said bottoms are still hot.

In order to raise the bottom of the ingot-pit near to the general level of the building, so that ingots and moulds can be more quickly handled, and in order to make head-room under the aforesaid platform around the converters, and in order to have a clear space around the lower parts of the converters, on the general level or floor, I place the trunnions of the converters at a height suitable for these purposes, by preference, about eight or nine feet above the general level.

The two ingot-cranes that swing over the converters respectively, also swing over ovens made upon or under the floor of the converting-house. I prefer to divide the ovens into several compartments, and to heat them by means of a fire-place common to all. The heat in the different compartments may be regulated by dampers in the passages between them, or separate fire-places may be connected with or situated in the compartments.

In order to keep the loam, or other fire-materials used for linings, moulds, and other purposes, from freezing in cold weather, I sometimes store them in bins, under which one or more flues pass from the ovens to suitable chimneys.

These ovens are used chiefly to dry or heat and thus prepare for use the loam, or clay, or other refractory linings of ladles and movable bottoms, also moulds for castings.

Access is usually made to ovens in foundries and for other similar purposes by doors in the sides of said ovens, and the ladles, moulds, and other things to be heated are run in and out upon cars.

These cars take up much room when run out of the ovens, and the track for the cars must be kept clear, and all heavy things must be lifted on or off the cars by cranes. On account of the heat in the ovens, the cars cannot be well lubricated, and hence run very hard.

I prefer to make my ovens with holes in the top sufficiently large to let in the ladles, moulds, &c., to be dried. These holes are covered with suitable lids, which may be quickly lifted off or on by the cranes swinging over them. The ladles, &c., may be quickly lowered into or lifted out of the ovens by the same cranes, and set down anywhere within the orbits of the cranes. Thus, a ladle may, by the same ingot-crane above mentioned, be taken out of the ladle-crane, set on the floor to be lined, placed in the oven to be heated, and then lifted out of the oven and set in the ladle-crane again.

I prefer the hydraulic crane, which consists of a plunger, the lower part of which works up and down in a hydraulic cylinder. The jib is fastened to and rises and falls with the upper part of the plunger. A carriage, made to roll easily from end to end of the jib, carries the weight.

It will thus be seen that, in my arrangement of oven and crane, the crane takes the place of the car ordinarily used to carry the weight into the oven, and the operations of placing the weight on the car by a crane, and running the car into and out of the oven, are dispensed with.

The cars under the converters, arranged to carry the movable bottoms, may be also arranged to carry tanks, which catch the coal and slag that are poured out of the converters.

When a tank requires to be emptied, the car may be run out under the crane, and the tank may be lifted out and emptied, or set upon another car, which takes it out of doors to be emptied. Thus, the pit may be kept clear of slag and coal from the converters.

In order to construct a converter, with one or more movable bottoms, at a comparatively small cost, and in order to cheapen the cost of the converter throughout, as compared with the wrought-iron converter heretofore made, I prefer to make it of cast-iron sections, fastened together by bolts, by preference, cotter-bolts.

In order that the pieces may be small enough to be easily moulded and cast, and in order to save making a pattern for each part, I make some of the parts, as far as possible, duplicates of other parts.

The central part of the converter, that has the trunnions, I prefer to divide, perpendicularly to the axis of the trunnions, into two sections, which are just alike, except that the trunnion on one section is hollow, and arranged to conduct air into an air-pipe formed in the next section below, whence it is conducted into the tuyere-box. Thus, one pattern with different core-boxes, for the different trunnions, will answer to mould both halves of the centre section.

These sections are then bolted together by means of suitable flanges

The sections, above and below the centre section thus formed, I prefer to mould from the same pattern, except that I cast an air-pipe on the side of the lower section.

These four castings form the body of the converter, and are joined together by suitable flanges and bolts, and strengthened by suitable ribs.

Upon the top of the body of the converter is a mouth-piece, which I prefer, for convenience of moulding, to make in two sections, divided vertically.

Underneath the body of the converter, I place the tuyere-box, or, I bolt on a bottom section, which is arranged to receive the tuyere-box.

The different sections of air-pipe, thus formed on the side of the converter, are connected by suitable joints.

When the iron or steel has been let out of the ladle into the ingot-moulds, there remains in the ladle a considerable amount of slag. This slag, and the lining of the ladle, when a new lining is to be put in, have heretofore been emptied on the floor of the pit, or of the converting-house. To avoid this litter, and the inconvenience of removing it, I place a tank in the ingot-pit, within range of the ladle-crane, into which the slag and lining may be emptied. When the tank is full, it may be hoisted out by one of the ingot-cranes, set on a car, and run out of doors to be emptied.

It sometimes happens that, from the failing of the tuyeres or some other cause, it is impossible to carry the converting-process to completion. If, in such a case, the cast-iron or partially-converted metal is run into ingots, the moulds are likely to be injured, and the ingots, thus formed, have to be broken up, at considerable cost, in order to be remelted.

For the purpose of cheaply putting such metal into a convenient form for remelting, without using the ingot-moulds, and also for the purpose of making shotted metal for crucible-steel, and also for the purpose of preventing a heavy scull in case the nozzle of the ladle should become stopped, I sometimes place, in the ingot-pit, another tank, so situated that the ladle may be either teemed or tipped into it. This tank is arranged to be rapidly filled with water, and quickly emptied. The liquid metal, falling from the ladle into the water, is reduced to shot, or small pieces, which may be easily removed and remelted without breaking up.

The table *z z* is then raised until the tripod is lifted off the car into contact with the legs *i* of the tuyere-box *h*, fig. 2.

The cotters that fasten the movable bottom B′ to the body of the converter B, are then knocked out; the lift, and, with it, the tripod and the movable bottom, are lowered; and the car, tripod, and movable bottom are run out together, into the position shown at B′, fig. 4.

Workmen, standing on the platform A *a*, then knock out the old tuyeres, which fall into the pit 10.

New tuyeres are inserted by a workman standing in the pit 10, and ganister, or other refractory material, may be rammed around them, and the bottom be made good by the workmen standing on the platform A *a* while the interior of the converter is still red hot.

The car is then run under the body B of the converter, and the movable bottom B′ is lifted and fastened into place, when the car is again run back out of the way.

The new bottom is rapidly dried by the heated lining of the converter.

A new set of tuyeres may be set, and rammed, and the converter made ready for use, by these means, in a very short time.

To insure a good joint between the movable bottom and the body of the converter, I prefer to cover the fracture of the lining with a paste, of fire-clay or other refractory material, in the manner usually practised for making such joints.

The upper part *a′ b′ c′* of the converter may be turned straight down, and removed by the tripod, the lugs *l*, and the lift, as already described, if it is preferred to line or repair the converter in this way.

Instead of removing the whole lower part of the converter B′, fig. 4, to set new tuyeres, I sometimes prefer to remove only the lower section of it, *g′*, which is cottered to B′, just as B′ is cottered to the upper part of the converter B.

This section *g′*, I let down, move out, repair, and replace, in the same manner and by the same means as in case of the section B′, as above described.

The joint of the lining, between the section *g′* and the body of the converter, may be made good in the manner before described, or in any suitable manner.

When the production is large, I prefer to use duplicate movable bottoms.

The old bottom *g′* or B′, fig. 4, is, in this case, lifted from the car by the crane K′, fig. 1, and set out upon the floor for repairs. A repaired bottom, hot from the oven P′, is then lifted upon the car by the same crane, and attached to the converter, in the manner already described. A bottom (drawn in section) is standing in the oven P, fig. 2.

The use of duplicate bottoms enables me to dry the lining more slowly and uniformly, and thus to insure its greater soundness and durability.

The bottoms may be dried and heated by a fire placed within or upon them. This may be done while they are standing on the floor; but to avoid the nuisance of excessive smoke, the bottom should stand in a chamber having a chimney. The oven is not only such a chamber, but its heated atmosphere promotes the uniformity of drying.

The arrangement of the plant, before referred to, is shown in figs. 1 and 2.

The converters A and B are placed side by side. The converter-chimneys 30, provided with hoods 31, are built in the wall, 32, of the converting-building, and so situated that the cranes K and K′ can swing clear of them.

I make openings, U, in the walls, under the chimneys, leading to a floor or platform in the melting-building, upon which workmen can stand to get at the tuyere-boxes.

The ingot-cranes K K′ and L′ are so placed that each one will swing over about one-third of the available part of the ingot-pit M′, and so that K and K′ will swing over the ovens P Q, P′ Q′, and over the holes J and J′, in the platform A *a*, and over the centres of the converters.

The platform A *a* extends around the converters, and I prefer to extend it laterally to the walls of the building. It is, by preference, made of cast-iron plates, with a low flange around the outer edge, and is supported by the beams D and D′, the crane-cylinders 14, and by suitable posts, 12, and beams 13.

It will be observed that by setting the converters high enough to leave head-room under the platform A *a*, situated at their centres, a clear space, on the general level or floor of the building, is left around the converters, so that workmen can see and get at all the lower parts of the converters, without getting into the pit beneath them.

The openings J and J′ are made in the platform A *a* to allow working at the movable bottoms, as already described, and the passages T and T′ are made in the platform for the crane-chain, when it swings over the openings J J′, to lift a movable bottom, or any weight.

I prefer to place the centre of the oven P′ as far from the centre of the crane K′ as the movable bottom B′ is, when the car is run out, so that a bottom can be transferred from an oven to a car, without moving the carriage on the jib of the crane.

The construction of oven I prefer, for reasons previously mentioned, is shown in plan by fig. 1, where P is the compartment for converter-bottoms; Q Q are compartments for ladles, (which may be further heated over the furnace 17, fig. 3, in the ordinary manner;) R is the fire-place; S is the firing-pit; S′ are flues for hot gases to pass from the fire-place to the compartments, and thence into the space S″, fig. 2, (the top of which forms the bottom of the bin T,) and thence into the chimney 15, fig. 1. The heat in the various compartments may be regulated by dampers in the flues S′. The lids or covers for the compartments are shown in plan at P′ Q′, and the ovens and lids are shown in vertical section at fig. 2.

These ovens may be built upon the floor of the converting-room, and extend up to the platform A *a*; but to increase the working-space on the floor, I prefer to place them as shown in the drawing. The tops of the lids may be paved with brick, or left bare, when they form a convenient heater for drying fire-clay or other materials. The lids are lifted by the cranes K K′ by means of suitable chains and eye bolts.

When the tripod *v′*, figs. 3 and 4, is not in use, it may be removed from the car by a crane, and a tank, 7, (shown in the car *u*, fig. 4,) set in its place. When the converter is turned down to empty, the car may be moved under it, and the tank will then catch the coal or slag that runs out. The tank may be lifted out, when filled, by the same crane, thus keeping the casting-pit clear of debris.

I place the water-tank N, figs. 1 and 3, in the ingot-pit, within the orbit of one of the ingot-cranes, and in such a position that the contents of the ladle may be either teemed or tipped into it, and thus "shotted." Suitable supply and drainage-water pipes are connected with the tank. When the tank is drained, the shotted metal may be shovelled into buckets, and hoisted out by the crane. The uses of the tanks *y* N and N′ have been further referred to above.

The means I prefer for moving the ladle radially on the ladle-crane, are shown at figs. 1 and 5. The trunnions of the ladle M rest upon the carriages O O, which run upon the jibs L of the ladle-crane, and are moved by means of the rod X, which is attached, at one end, to the cross-head *q*, which is attached to the carriages O O, and at the other end is screwed and passes through

It sometimes happens that a charge of ingots cannot be removed from the casting-pit, and the moulds replaced, before another charge is ready to be blown. This is especially likely to occur in melting the iron to be converted in a cupola-furnace. To prevent delay from this cause, I leave room in the casting-pit for two concentric lines of ingot-moulds, and, in order to fill these moulds, I set the ladle in a carriage that may be run in and out on the ladle-crane by means of a screw, or a rack, or other suitable device.

This moving in or out of the ladle is also useful for placing the ladle to catch the iron or steel as it pours from the converter, and for placing the nozzle of the ladle over the centres of the ingot-moulds, where the moulds are not set in the pit at equal distances from the centre of the ladle-crane.

The nozzle or hole by which iron or steel is let out of the bottom of the ladle into the moulds, is usually opened and closed by a fire-clay stopper, fitted to the end of a rod that passes up through the iron or steel, and over the side of the ladle, where it is moved up and down by means of a slide and hand-lever.

It frequently happens that the stopper-rod gets bent, or, from some other cause, does not stand over the centre of the nozzle, and hence cannot be tightly closed upon it. In order to quickly regulate the position of the stopper, when it is put into the ladle, or while it is in use, I arrange the aforesaid slide so that it can be moved toward or away from the ladle, by a screw within reach of the workman who raises and lowers the stopper.

To enable others to construct and use my inventions, I will describe the same by reference to the annexed drawings, which form a part of this specification, and in which the same letters refer to the same parts.

Figure 1 is a horizontal section of the converting-building, and a plan of the principal plant and machinery therein.

Figure 2 is a vertical section of the converting-building, and of one of the ovens, and an elevation of the converters, converting-chimneys, and a part of the other apparatus.

Figure 3 is a plan of the converters, and of the parts immediately surrounding them.

Figure 4 is an elevation of the parts shown in fig. 3.

Figure 5 is a vertical section made through the centre of the converting-building, at a right angle with the section shown at fig. 2.

Figure 6 is a longitudinal section of the centre and lower parts of the converter, showing the joints in the air-pipe leading from the trunnion to the tuyere-box.

Figure 7 is a longitudinal section, on a larger scale, of two of the air-joints shown in fig. 6.

Figure 8 is a cross-section of one of the cars used for removing the bottoms of the converters.

Figure 9 is an elevation of a ladle and ladle-stopper arrangement.

Figure 10, a plan, and

Figure 11, a vertical section of the same.

The inner trunnion of the converter A rests in a pillow-block, forming the top of the stand E.

The converter is rotated by the hydraulic cylinder and piston H, and the rack F, and pinion G, which is keyed to the trunnion.

The outer trunnion of the converter rests in the pillow-block *m'*, formed in the beam D, which rests in the wall at one end, and on the column I at the other end. The beam and column are employed under this side of the converter, to allow the car and movable bottom to pass out to one side, as shown on the right of fig. 4.

Air is conducted from the blowing-engine, through the regulator 20, figs. 1 and 5, the pipe *p*, the column I, the pipe *n* leading into the trunnion, and thence through the pipes *f* and *j* (see also figs. 3 and 6) formed in the side of the converter, to the tuyere-box *h*.

The iron to be converted is melted in a suitable furnace in another building, in the rear of the converters, and conducted, by the spouts *o*, fig. 1, through the opening U' in the wall of the building, to the converters, and the converted metal is poured into the ladle M on the ladle-crane L, and thence cast into ingots in the usual manner.

The centre section of the converter A is cast in two pieces, C and *d*, fig. 3, which are shown bolted together, but they may be cast in one piece if preferred.

The section *a* is secured to the centre section by cotter-bolts.

The nose may be cast in one piece, or may be made in two pieces, *b* and *c*, bolted together. It is fastened to the section *a* by cotter-bolts.

Section *e* is like section *a*, except that it has the air-pipe *f* cast upon its side.

Section *g* may be cast upon section *e*, if preferred, or may be cottered to it.

The tuyere-box *h* has a pipe, *j*, (which is a continuation of the pipe *f*,) cast upon it, and is secured to section *g* by bolts and nuts, or in any suitable manner, and the tuyere-box cover is put on in the usual manner.

The manner of making the joints in the air-pipe leading from the trunnion to the tuyere-box is shown by fig. 6.

The lower joint is shown, on a larger scale, by fig. 7.

The pipe 2, by preference made of copper, a quarter of an inch thick, is riveted within the flange *k*, cast upon the section *g*, so that one end of it projects into, but is not attached to the pipe *f* on section *e*, and the other end into the pipe *j*, cast upon the tuyere-box.

The sections and tuyere-box may thus be separated without disturbing the position or attachments of the copper pipe.

In order to prevent the air from blowing out around said pipe, where it fits loosely into pipes *f* or *j*, an India-rubber ring, 5, fig. 7, is placed around the copper pipe, and pressed into the joint by tightening the iron ring or gland 4, by means of the nuts 9 on the stud-bolt 7.

I find that a hollow rubber gasket will adapt itself very well to irregularities in the joint, but any suitable gasket may be used.

I prefer to remove the lower part of the converter, to line it, as shown at B', figs. 3 and 4, and to turn the remaining part of the converter straight down, to line it.

The lining may be rammed in around a mould, in the usual manner.

The upper part is then turned straight up, as shown at B, fig. 4, and the bottom part, or movable bottom, run under, and attached, by means of the car *u'* and lip Y.

The car *u'*, shown in cross-section at fig. 8, may be run under the converter, as shown in fig. 2, or into the position shown at B', fig. 4, by hand; but I prefer to move it by means of a hydraulic cylinder Z, fig. 3, lying under the floor, behind the converters, or in in any suitable position.

The piston of the cylinder Z has a stroke equal to the entire travel of a car, and the two piston-rods, 24 and 24', running out of each end of the cylinder, are attached to the two ends of the chain W, which runs around the sheaves 22, 23, *x* and *x'*, so that, by starting the piston, and treading upon the clutch-lever, shown at fig. 8, and thus clamping the chain to the car, either car may be moved in either direction.

To repair a movable bottom, after the tuyeres are worn out, the tripod *v'*, fig. 4, is set into the car, and held up by means of the lugs *v*, resting on the car-frame.

The car is then run under the converter, the legs of the tripod just clearing the table *s s* of the hydraulic lift Y.

the nut V, which is prevented from moving radially by the hook *r*.

By turning the hand-wheel, of which the nut V is the hub, the rod X will thus be made to move the ladle radially, so as to swing the nozzle over either one of the double row of ingot-moulds 18, 19, or in any required position.

I have shown, in figs. 9, 10, and 11, one form of apparatus for adjusting the ladle-stopper. The stopper-rod 21 is moved up and down, over the nozzle 25, in the usual manner, by means of the sliding bar *t*, working in the guide 8, and the hand-lever 16. But instead of making the guide 8 stationary upon the ladle, I attach it to the casting 3, which is bolted upon the ladle, by means of a hinge, 6, on one side, and by means of a hand-screw, 1, on the other side, so that by turning the hand-screw, the stopper-rod may be moved and adjusted over the nozzle.

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

1. The arrangement of a crane, converter, and chimney, relatively to each other, so that the crane can swing entirely around its orbit over the converter, without coming in contact with the chimney, substantially as described.

2. Supporting one side of a converter upon a beam, in such manner as to permit a car, or its equivalent, to run under the converter, from the side thereof, substantially as and for the purposes set forth.

3. The combination of a car, tripod, and lift, substantially as and for the purposes described.

4. The relative arrangement of an oven and crane, and a car and lift, for removing the movable bottom of the converter, substantially as and for the purposes set forth.

5. The combination, with a converter, of a hollow column for supporting the beam D, and adapted to convey the blast to the converter, substantially as described.

6. The arrangement of converter and platform A *a*, so as to enable the latter to be employed, without depressing the floor or floors beneath or around the converter, substantially as and for the purposes described.

7. The construction of the air-joint, substantially as described.

8. The combination, with a crane, of a ladle, capable of being moved in and out thereon, substantially as described.

9. The combination of the guide and hand-screw, or its equivalent, for the purpose of adjusting the ladle-stopper, substantially as described.

Witnesses: A. L. HOLLEY.

M. M. LIVINGSTON,

JOHN R. COOPER.