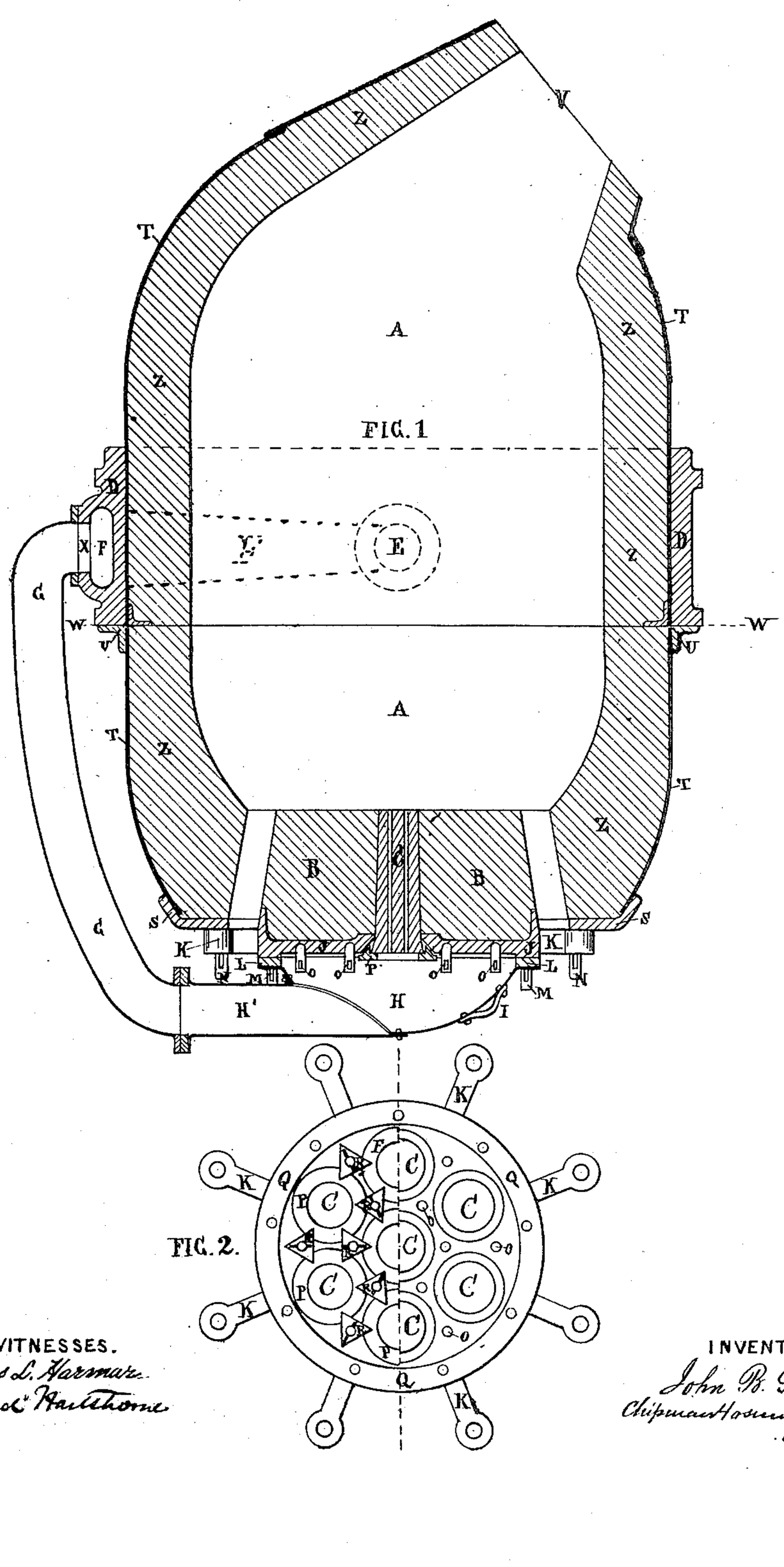
5 Sheets--Sheet 1.

J. B. PEARSE.

Apparatus for Manufacturing Iron and Steel.

No. 164,029. Patented June 1, 1875.



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5 Sheets--Sheet 2.

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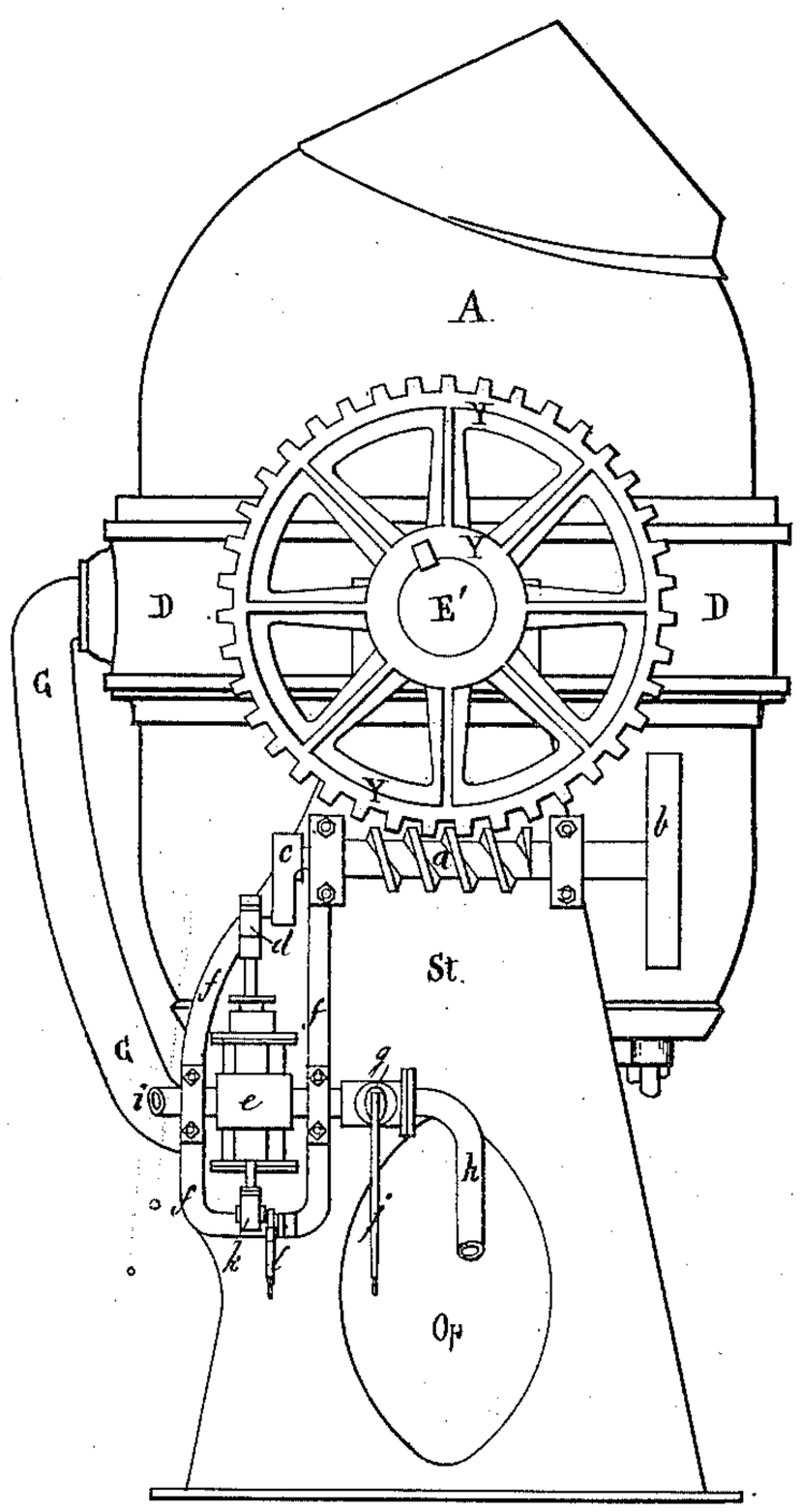

FIG. 3.

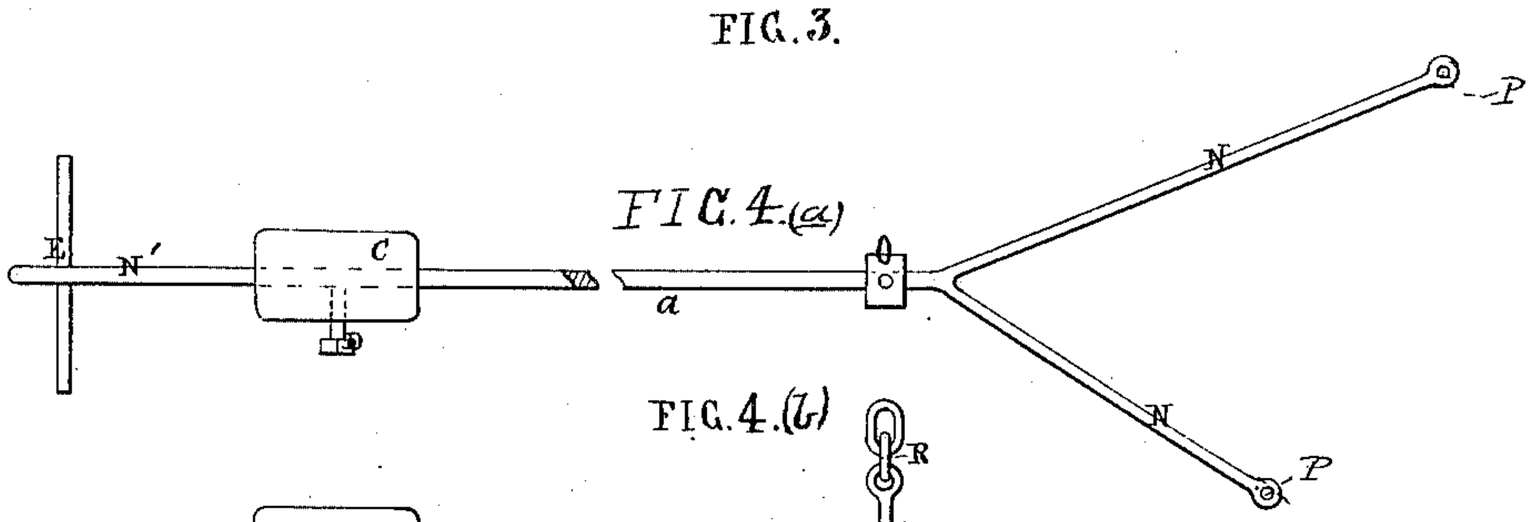

FIG. 4. (a)

FIG. 4. (b)

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5 Sheets--Sheet 3.

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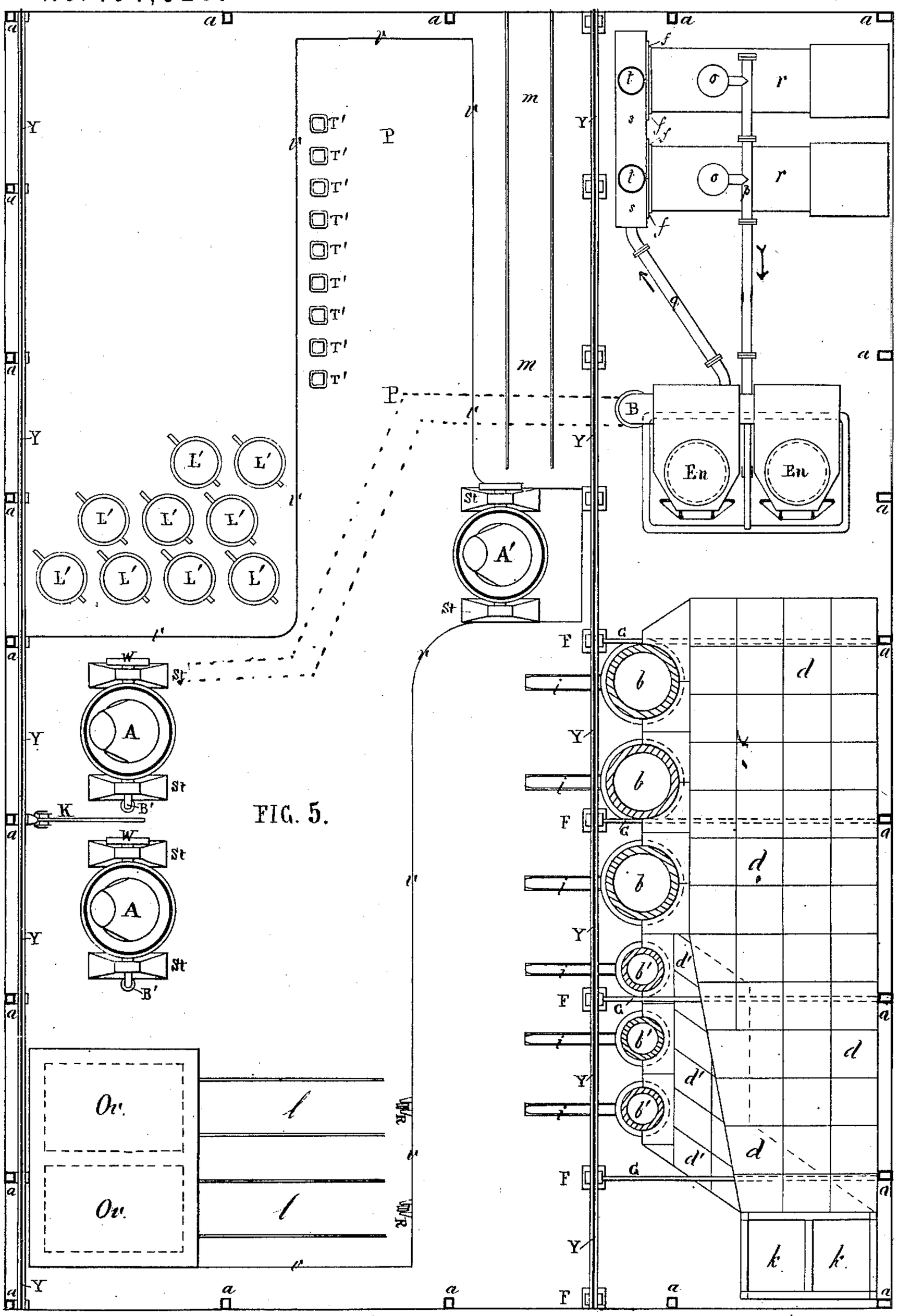

FIG. 5.

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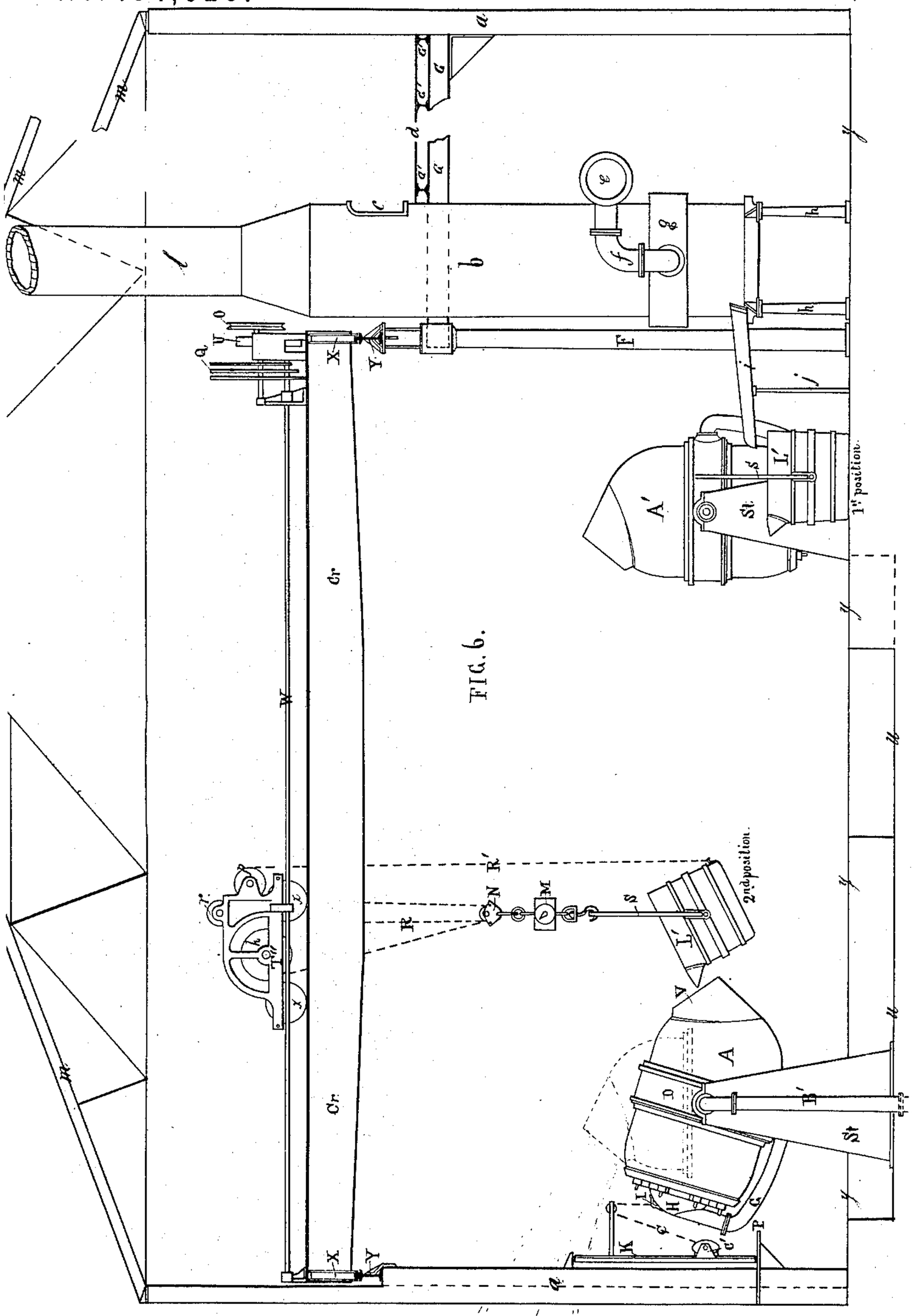

FIG. 6.

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5 Sheets--Sheet 5.

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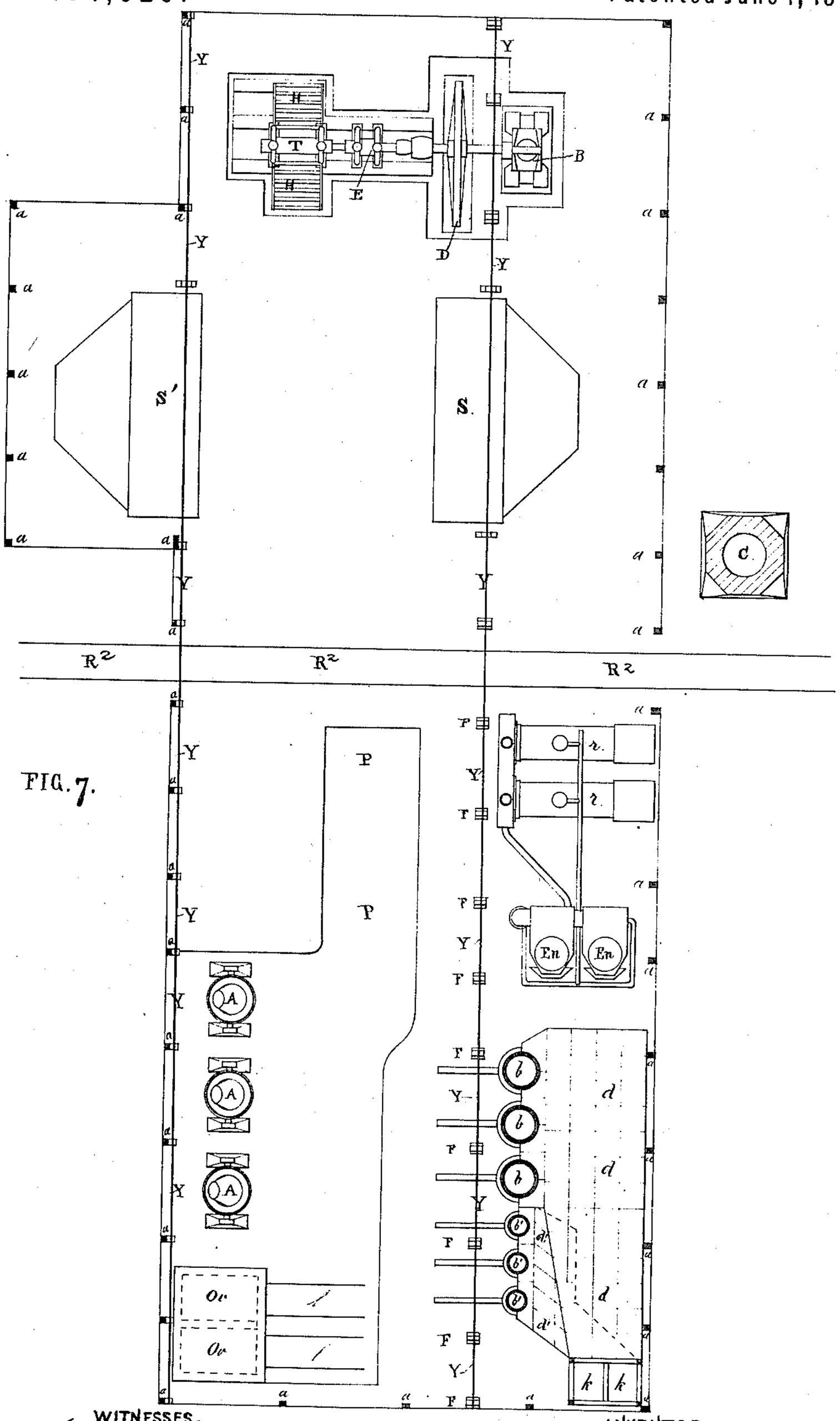
FIG. 7.



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UNITED STATES PATENT OFFICE.

JOHN B. PEARSE, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN APPARATUS FOR MANUFACTURING IRON AND STEEL.

Specification forming part of Letters Patent No. **164,029**, dated June 1, 1875; application filed December 26, 1874.

To all whom it may concern:

Be it known that I, JOHN B. PEARSE, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and valuable Improvement in Apparatus for Manufacturing Iron and Steel; and I do hereby declare that the following is a full, clear, and exact description of the construction and operation of the same, reference being had to the annexed drawings, making a part of this specification, and to the letters and figures of reference marked thereon.

This invention has relation to the manufacture of steel by what is known as the Bessemer or pneumatic process. The apparatus heretofore used in carrying out this process has been constructed as follows: The whole works or plant has been divided into three parts, viz.: first, the division in which the crude metals for conversion are melted, called the cupola department; second, the division in which the crude metals are converted into steel and cast into ingots, called the converting department; third, the engine and boiler department, which supplies the hydraulic power required to move the machinery, and which furnishes the blast used for converting the crude metals into steel. These several departments have been so constructed as to be separate from each other, and so as to be practically separate buildings, separated by partition-walls extending to the roof.

Though the capacity of the steel-making plant described above is great, yet the expense of erection is exceedingly large. The cupola department must be of great height, so that the cupola and ladles may be sufficiently far above the converting-vessel trunnions to secure a steep inclination of the runners through which the molten crude metal and recarbonizers run into the vessels. All the metal and fuel for melting must be lifted to a great height, thus necessitating heavy hoisting arrangements and large expenditure of power.

The object of my improvement is chiefly to diminish the relative cost of plant per ton of steel, as well as the original total cost of erection; also, to facilitate the manufacture of steel and reduce the cost of repairs; also, to arrange each part of an improved Bessemer plant, and the whole design of the combination of the several individual parts, so that each division of the operations necessary to conversion shall be performed in an entirely separate place, and so that each separate division of the work may be reached from the outside of the building. For these purposes I so arrange my improved converting-plant, including blowing-engine, pumps, boilers, and all other necessary parts, that the whole of the plant lies under one single roof of moderate span, allowing space to increase capacity by increasing the length of the building. The building is only one story, and open on all sides, made fire-proof, if required. I arrange in this building an overhead traveling crane, that commands all the machinery in the building except the cupolas, the blowing-engines, and the boilers. This traveling crane lifts the ladles containing the molten pig-iron and spiegeleisen, and automatically pours the contents of said ladles into the converting-vessels. The detachable cupola-ladle and contents are weighed on the crane, and the diminution of their weight, as the pouring goes on, is indicated, so that by watching the index of the weighing apparatus combined with the crane the required quantity may be poured out. Ladles are then employed to receive the steel from the converters, and these ladles are handled by the traveling crane and crab in a manner similar to that above described, when the varying inclination of the mouth of the converter is compensated by the adjustment of the crab. The steel ladles are then conveyed by the crane in a straight line over the molds, which are filled, after which the steel ladles are carried by the crane directly to the repair room. I also arrange a worm-wheel, worm, and oscillating engine directly on one standard or pedestal of a converting-vessel, that the vessel may be rotated by the motion of the engine, which is so constructed as to be easily reversed.

To enable others to construct and use my invention, I shall describe the same by reference to the annexed drawings, forming a part of this specification.

Figure 1 of the drawings is a vertical sectional view of a converting-vessel at right angles to the axis of the trunnions. Fig. 2 is

a plan view of the tuyere-plate as it appears from below, looking up at it, showing the tuyere-holes and the method of packing the tuyeres air-tight. Fig. 3 is an elevated view of a converting-vessel mounted on a pedestal, having a worm-wheel, worm, and an oscillating steam-engine, by means of which the vessel is rotated on its trunnions. Figs. 4ª 4ᵇ show the plan and side elevation of the "peel." Fig. 5 is a ground plan, representing my improved plant and the machinery. Fig. 6 is a sectional view of the improved plant. Fig. 7 is a ground-plan view of my improved plant for steel-making by pneumatic process in connection with a rolling-mill.

In the annexed drawings, *a a* represent the posts of the building, and the line connecting the posts represents the walls or side of the building. *b b* are the large cupolas, in which the pig-iron is melted; and *b′ b′*, the small cupolas, in which the spiegeleisen is melted. These cupolas have runners *i i*, to convey the molten metal into ladles. Directly in front of, and close to, the cupolas runs one of the girders and rails of the track Y, supported on cast-iron pillars F. The other rests on the posts *a a* of the building. On this track a traveling crane moves at a height sufficient to pass over any of the machinery in the building. In the pit are placed the ovens O *v* O *v*, for drying the removable refractory vessel-bottoms, and also the converting-vessels A A and A′ and the ingot-molds T′. A A represent the converting-vessels, mounted on the standards or pedestals S *t* S *t*, which are so placed with reference to the side of the building that the flame, smoke, and matter thrown out go directly outside the building, a suitable large opening being made for that purpose between the posts *a a* in the side of the building. Upon a post between the converting-vessels the hand-crane K is placed to handle the tuyere-plate covers. L′ L′ are the detachable cupola-ladles, which receive the molten matter from the cupola. The vessel A′ is called a spare vessel, used for the purpose of quick repair, facilitating relining, &c. For supplying the blast required by the vessels during the process of conversion, small quick-running engines E *n* E *n* are employed, and the blast passes through the pipe B, which is carried under ground to supply the pipes B′ B′, through which it passes into the vessel-trunnion and through the tuyeres. These engines are supplied with steam by boilers *r r*, placed in a corner of the building.

In order to generate steam quickly, I connect the exhaust steam of the engines with the chimneys *t t* of the boilers by means of the pipe *q*.

That part of the pit marked P P is used for casting ingots. The ingot-molds T′ may be arranged on either side of the pit, or on both sides, according to the amount of steel made. For conveying the ingots away to be rolled or hammered a narrow-gage railroad-track, *m m*, may be used; but if the rolling-mill or hammers are located near I prefer to extend the elevated girders and tracks Y Y into the mill or forge, and entirely through the same, so that the traveling crane running on these tracks may carry the ingots wherever desired.

The converting-vessel consists of the iron shell T, held in place by the cast-iron trunnion-band D. The trunnion through which the blast passes into the trunnion-band is marked E, the other trunnion being directly opposite. Instead of taking the pipe G, connecting the trunnion with the tuyere-box, directly out of the trunnion E, or out of the trunnion-band close to the trunnion, I make a passage, F, in the trunnion-band, extending from the trunnion E to the center of the vessel—that is, to the point where the vertical section at right angles to the trunnion-axis cuts the trunnion-band at the back. At this point the opening *x* is made for the pipe G, which goes thence vertically direct down to the tuyere-box H, being bolted at each end through suitable flanges. V represents the mouth of the vessel, and Z the refractory lining of quartz and fire-clay, which covers the whole interior of the shell of the vessel except the bottom, which is open for the reception of the removable refractory bottom B, in which are tuyeres. S represents the cast-iron ring around the bottom of the vessel, in which the studs N are fastened, and K are the arms of the tuyere-plate, ending in a circular plate, in which a hole admits the studs N until the arms come up against the ring S, where they are keyed fast by means of wedges driven through the slots in the studs. J represents the body of the tuyere-plate, on which the refractory bottom B rests, and in which the studs O are fastened for the purposes of packing in the tuyeres air-tight by means of the glands P, and in which are also fastened the studs M, which serve to hold the flange L of the nearly hemispherical sheet-iron plate H, which is made with a pipe, H′, projecting outwardly to meet the pipe G. The arms K and the body of the plate J form the tuyere-plate. When the nearly hemispherical sheet in chamber H is off, the whole of the glands and the ends of the tuyeres are exposed to be reached from every side. The converting-vessel is divided into two sections at the point W, the angle-iron U being riveted on the lower section of the shell T, and holding it to the trunnion-band D. The glands P fit closely around the base of the tuyeres, and are wedge-shaped in their projecting ring, as shown in Fig. 1, to consolidate the packing firmly around the tuyere. The glands are pressed firmly in by means of the studs O, and the triangular pieces of sheet metal R driven up by keys in the studs. S *t* designate the pedestals on which the converting-vessels are mounted, and on the pedestals is cast a suitable frame, *f*, on which an oscillating steam-cylinder, *e*, is fitted. *h* is the steam-

pipe; *i*, the exhaust-pipe, and *g* the valve. The piston-rod *d* connects through the crank *c* with the worm *a*.

In Figs. 4[a] and 4[b] is fully shown the counterbalanced peel used in handling the removable tuyere-plates and worn-out refractory vessel-bottoms, for repairing the vessels and for preparing and drying the bottoms. N′ is the long forked lever suspended by means of a stirrup, and having at one end a cross-handle, E. The other end is split into two arms placed at an angle, whereby the tuyere-plate and bottom can be placed on the vessel in its particular position. The outer ends of the arms have perforated bosses, receiving loose-fitting pins P, to steady the plate and refractory bottom while being handled. A movable counterbalance-weight, C, is used to balance the weight of the tuyere-plate and refractory bottom, and the counter-balance is held in position by a set-screw, D.

It will be noticed that the vessels A A A′ have their respective gear or worm wheels on the same side, and their blast-trunnions on the same side, for the purpose of an easy interchange of all parts of all vessels, and so that each or either may, as required, be used for converting crude iron into steel.

The line *y y* is the general level of the floor of the building. On this floor stand the cupolas, engines, boilers, and the posts of the building, and all other apparatus, except the drying-ovens, converting-vessels, and ingot-molds, which are placed in the pit.

To handle the ladles containing molten pig-iron, spiegeleisen, and steel, and to perform all the work usually done by the heavy hydraulic lifting-cranes and ladle-crane, I place on the tracks Y Y a traveling crane, C *r*, running on four wheels. This traveling crane is provided with a crab, T″, running also on four wheels, *x x*, and having two chain-drums, *k p*. From the large drum *k* the chain-tackle R suspends the block N, the chain passing over the block *r* on the crab, and from the small drum *p* the chain R[1] depends.

The traveling crane C *r* is driven by an endless rope, and the hoisting and lowering motion is given by the endless rope transmitted through the gearing U to the shafts, with which the levers Q are connected. One of these levers moves the crane; a second gives motion to the crab through the shaft W, connected with the crab; the third gives the hoisting and lowering motions by means of a similar shaft to W, but on the other side of the crab. All of these motions are given and regulated by a man standing in front of the levers Q.

Below the block N the hydrostatic or other weighing apparatus is suspended, and from this depends the usual swiveling crane-hook.

The ladle L′, when taken up by its sling S, is moved over to the converting-vessel A, previously placed in such position that its mouth V may receive the molten iron. The ladle is then tilted, as shown in the second position (see Fig. 6) by means of the chain R[1] and the drum *p* on the crab, and as the ladle is tilted the molten metal flows over its spout into the mouth of the vessel. As the iron flows out the weight on the weighing apparatus diminishes, and by noting the indication the required quantity may be poured out.

Whenever the products of the converting or Bessemer plant are to be worked up on the spot and put into shape for rolling or forging, I make the combination of apparatus described, and shown in Fig. 7, which exhibits a plan view of the plant illustrated in Fig. 5.

On one side of the cross-tracks R[2] R[2] a plan view is shown of a rolling-mill with two or more Siemens or regenerative heating-furnaces and a blooming-mill. The cross-track R[2] R[2] is carried through the building, and connected with a track running to all the shops and mills of the establishment. The track Y Y extends from one end of the united rolling-mill and converting-plant building to the other end, so that a traveling crane on said track can command the whole working part of both departments. S S′ are the heating-furnaces for the ingots; B, the engine; D, its fly-wheel; E, the gearing, and H T the blooming table and rolls.

If it is desired to forge the ingots under hammers, the hammers can be placed where the blooming-mill stands.

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

1. The process of feeding converters, which consists in carrying the molten metal from the cupola to the converting-vessel in detachable cupola-ladles by means of a crane, whereby the usual runners are dispensed with, substantially as described.

2. The combination, with the traveling crane and crab, of the second chain-drum *r* on said crab, the tilting-chain R[1], and the conveying-ladle L′, substantially as and for the purpose specified.

3. In a Bessemer plant, the combination, with a counterbalanced peel for handling the tuyere-plate, of the elevated tracks extending the length of works, and arranged in relation to the cupola-ladles, converters, and molds, the transverse traveling crane, and the crab or hoisting-carriage, substantially as described.

4. The trunnion-band section of a converting-vessel, interchangeable with every converting-vessel in the plant, substantially as specified.

5. The combination of a tuyere-plate, having no depending flanges and a nearly hemispherical sheet-metal chamber, with a projecting extension or pipe, for easy handling and free access to the interior of the tuyere-box, substantially as described.

6. In a Bessemer plant, the elevated parallel tracks extending the length of the works, the transverse traveling truck or crane, and crab, combined and arranged to command the

cupola-ladles, converters, steel ladles, and ingot-molds, substantially as described.

7. The combination, with the cupola-ladles, converting-vessels, steel ladles, and ingot-molds, of a single crane and its tracks, arranged to command all said articles in a Bessemer plant, substantially as specified.

In testimony that I claim the above I have hereunto subscribed my name in the presence of two witnesses.

JOHN B. PEARSE.

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JAMES L. PENNIMAN.