H. BESSEMER.

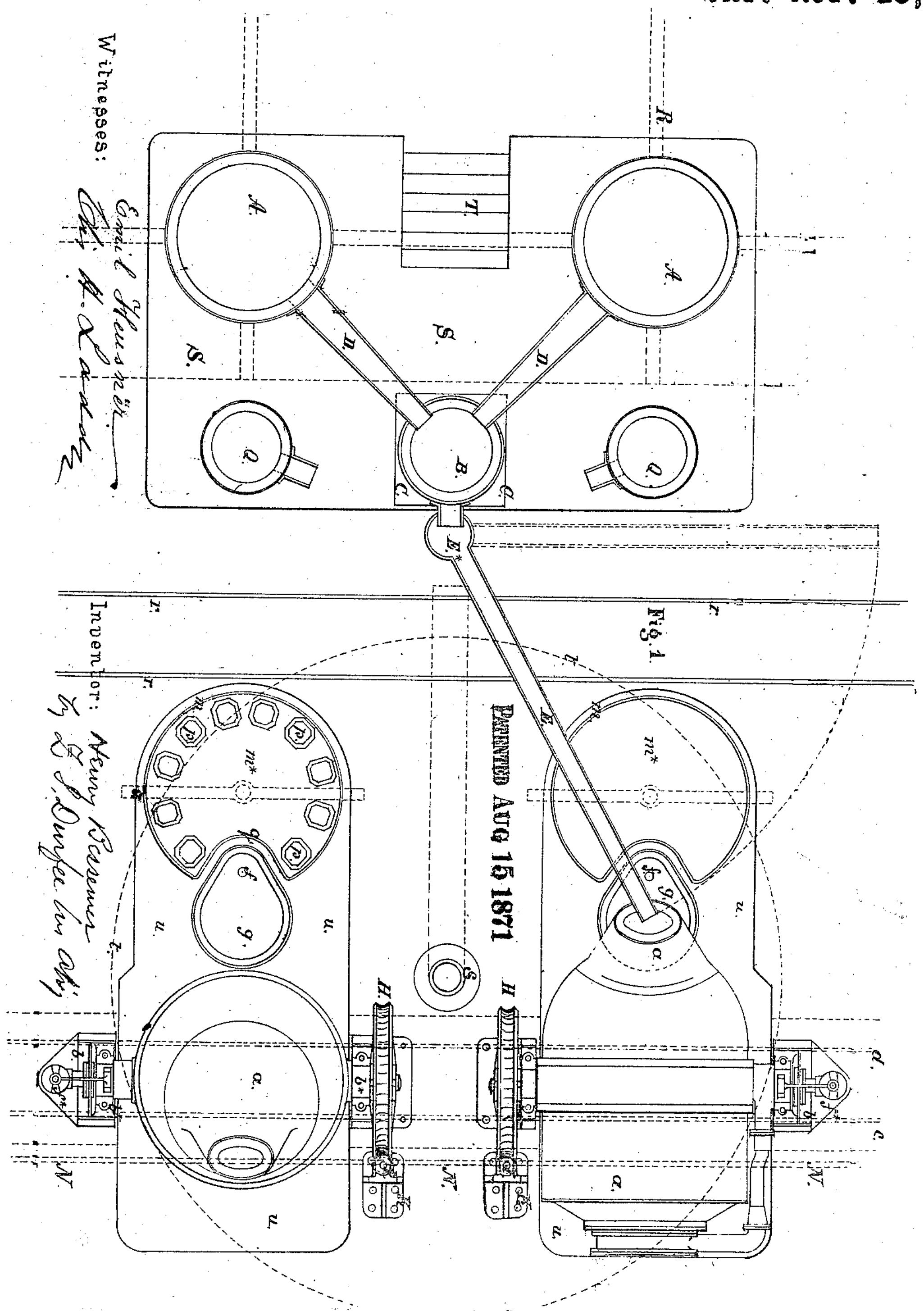
Sheet 1.- 2 sheets

IMPROVEMENTS IN THE CONSTRUCTION AND ARRANGEMENT OF MACHINERY ETC. EMPLOYED IN THE MANUFACTURE OF CAST STEEL AND MALLEABLE IRON.

INVENTOR: HENRY BESSEMER

NO. 117,968

PAT. AUG. 15, 1871.



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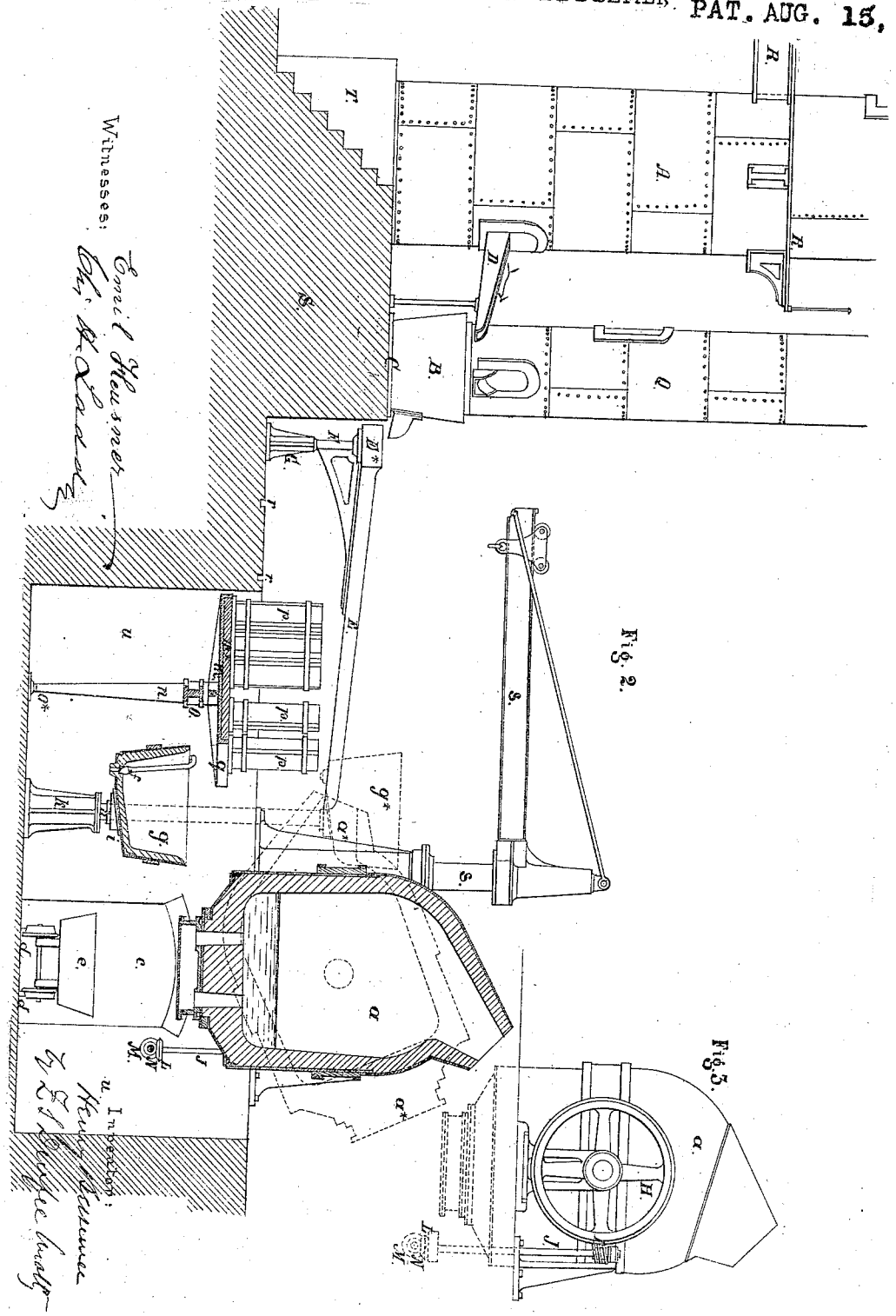

Witnesses:

Fig. 2.

Fig. 3.

UNITED STATES PATENT OFFICE.

HENRY BESSEMER, OF LONDON, ENGLAND.

IMPROVEMENT IN MACHINERY AND BUILDINGS FOR MANUFACTURE OF IRON AND STEEL.

Specification forming part of Letters Patent No. 117,968, dated August 15, 1871.

To all whom it may concern:

Be it known that I, HENRY BESSEMER, of Queen-Street Place, Cannon street, in the city of London, England, a subject of the Queen of Great Britain, have invented or discovered new and useful improvements in the construction and arrangement of machinery, apparatus, and buildings employed in or for the manufacture or production of cast-steel and malleable iron from pig or other carburet of iron; and I, the said HENRY BESSEMER, do hereby declare the nature of the said invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement thereof—that is to say:

The production of ingots or other masses of cast-steel or malleable iron from pig or other carburet of iron by the forcing of atmospheric air upward through the molten metal, and now generally known as the Bessemer process, consists of several distinct operations carried on in succession. The most important of these operations consists in melting the pig metal, transferring it in the molten state to the converting-vessel, blowing air through it, and converting it into a malleable metal, mixing the metal so converted with a certain quantity of fluid manganesian pig iron, pouring the mixed metals into a casting-ladle and running it from thence through a suitable valve into ingot or other molds, and the removal therefrom of the ingots or other cast masses when solidified. Now, it is essential to economic performance of these successive operations that the several kinds of apparatus employed should occupy such positions in reference to each other that no unnecessary time should be employed in passing the metal from one to the other, that the metal in its fluid state should not be unnecessarily cooled by exposing it to radiation in open gutters of great length, and that the motion of the several parts of the apparatus should be capable of being effected with ease and certainty with a view to economize time, save labor, retain heat, and conduct the process with safety. These objects are sought to be accomplished by the several arrangements or combinations of apparatus hereinafter described, and, at the same time, the first cost of the combined apparatus will be much reduced as compared with the cost of the apparatus now generally employed in the manufacture of Bessemer steel and iron, while the size and cost of the necessary building will also be much reduced.

In carrying into practical operation the objects set forth, I prefer to place two or more converting-vessels in such a position with reference to each other that their respective axes are in a straight line, the axes being at a distance of three to four feet above the general floor level. Beneath each vessel a small pit is formed, and an arched passage passes from one pit to the other in the line of the vessel's axes, and terminating beyond the building, so that by means of a line of rails laid in this passage the ashes or other débris of the operation may be readily removed on trucks moving on these rails. An incline or a lift may be employed to raise the trucks up to the general ground level.

And in order that the arrangement and construction of the converting apparatus may be fully understood I have hereunto annexed a drawing on which the same is represented in plan at Figure 1, and in vertical section at Fig. 2. A side elevation of the converting vessel, showing the gearing for giving it rotation, is shown at Fig. 3.

The same letters of reference in the drawing indicate a repetition of the parts so marked.

a a represent two converting-vessels, so placed that their respective axes are in a straight line, in which position any required number may be placed along one side of the converting-house. The axes of the vessels are supported on massive castings *b*, the upper parts of which are formed into plumber-blocks *b** for the axes to turn in. Each of the converters *a* stands over a separate pit, *u*, through which an arched passage, *c*, leads to the outer sides of the building. In this passage are fixed the rails *d*, on which an iron truck, *e*, may be moved beneath any number of vessels placed in a line, and receive from them the slags, cinders, or other débris, and convey it out of the converting-house. The pipe and usual valve arrangement for the supply of air to the converters are shown at *f*. In front of each vessel I mount a casting-ladle, *g*, on the top of vertical slide or ram *h*, the upper part of the slide or ram having a table, *i*, for the ladle to stand upon, as shown, or having two supports for the axes of the ladle, should it be desired to made the ladle movable, so as to discharge the slag by turning it over without removing it from the table. The ram or

slide *h* has a vertical movement given it by means of hydrostatic pressure acting in the cylinder *k*, in which the ram works; or it may be moved up and down by a screw and worm-wheel, similar to Healey's patent screw-jack; or it may be moved by forming a rack upon the ram or slide actuated by a pinion on a revolving shaft. The casting-ladle so mounted will be lowered as the metal from the converter is poured into it, after which it will be raised again so high that its under side will rise above the top of the molds, as shown by dots at *g**. The molds are to be brought successively under it by turning the plate *m* and be filled by means of the valve arrangement *f*, now generally employed in casting Bessemer steel. In front of the casting-ladle I mount a circular bed or table, *m*, on a vertical spindle, *n*, moving in a bearing, *o*, and foot-step *o**. The upper surface of the table I protect with brick fire-tiles or sand *m**. On this table the molds *p* are placed in a concentric circle. A hollow or indented part, *q*, is formed or cut out on one side of the table to allow the casting-ladle *g* to rise up past it. The table may be rotated by gearing or simply by a hand-spike or lever, and thus each mold will be quickly and with little force brought under the ladle to be filled. Against or near to the side walls I fix small cranes to lift off the ingot-molds and ingots from the revolving tables, and transfer them to trucks moving on the rails *r*, laid in a line parallel to the line of converting-vessels; or in lieu of the wall-cranes I use a hydraulic crane, such as is generally known as an ingot-crane, and represented at *s*, Figs. 1 and 2, and placed between each pair of converting-vessels, the range of the gib, shown by dots 1, being such that the top of the converter or the tuyere-box may be removed by it onto a truck moving on the rails *r* and be carried out of the converting-house.

By another arrangement the turn-tables may be replaced by a line of rails, on which a series of low trucks is moved, and on which the molds are placed, so that the trucks and molds may be moved beneath the casting-ladle in a line parallel to the axes of the converting-vessels, and be filled in succession; or in lieu of using trucks, wheels may be fitted to and axes attached to the bed of the molds, and capable of easy adjustment to new beds as the beds become worn out. The trucks, or molds on wheels, may be moved by hand, but I prefer to employ an endless-wire rope or chain passing beneath them and over suitable pulleys, so that by taking a gripe on the rope with a suitable lever attached to the trucks or molds they may be moved or allowed to remain at rest, as desired. By mounting each mold-bed on three or four wheels, great facility is afforded for their general movement from place to place. Both when using the line of rails or the circular table to move the molds I prefer to place the cupola melting-furnaces A A before the converting-vessels, or nearly so, as shown in the annexed drawing, so that when the vessels are turned down, as shown by dots at *a**, Fig. 2, to receive a charge of molten iron, the mouth of the vessel shall approach nearer to the cupola A. When two converting-vessels are used I prefer to employ two large cupolas, as shown at *a a* in the annexed drawing; but when a greater number than two converting-vessels are used in a line the arrangement and number of cupola-furnaces may be varied to suit the requirements of the manufacturer and the hours of working; but in all cases I prefer to have one casting-ladle and one turn-table for each converter, if turn-tables be employed. The cupola-furnaces may be of the ordinary kind used by founders, but I prefer to employ the description of cupola known as "Ireland's upper tuyere-furnace," or "Woodward's steam-jet cupola." In either case, in a line between the cupolas, but preferably nearer to the converting-vessels, I mount a ladle or receiver, B, on a weighing-machine, C, with a short spout, D, from each cupola leading into it, so that the charge of iron to be converted is first run into the receiver B and weighed. Beneath the tap-hole of the receiver is placed the enlarged end E* of a swinging gutter, E, by which the iron may be run (above the level of the turn-table or line of molds and trucks) into the mouth of the converter. The movable gutter or spout D is supported on a vertical spindle, F, which is retained in position by a pedestal, G, bolted to the foundation. The spout D is capable of supplying both converting-vessels, and when not in use may be moved out of the way by turning it in a direction parallel to the rails *r*. By this arrangement each of the cupolas may be employed to supply either of the converters, the exact quantity of metal employed being ascertained by weighing it in the receiver B before running it into the converter. The turning of the vessels on their axes may be effected by a small steam or air-engine, having reversing-gear similar to that generally employed in steam-cranes or winding-engines used in mines. A large spur-wheel or wheels may be employed in connection with the axes of the vessels, and a reversing-clutch so arranged that either vessel may be moved separately. A large worm-wheel, however, is to be preferred to spur-gearing, either as a first or second motion, as it has no tendency to run back or reverse the engine. In the accompanying drawing, at Fig. 3, a large worm-wheel, H, is shown at the axes of the converting-vessel. A worm, I, on the vertical shaft J gears into the worm-wheel, and is supported by the frame K bolted to the foundation. A beveled wheel, L, is keyed onto the lower end of the shaft J, and is geared into another beveled wheel, M, on the horizontal shaft, N. This shaft extends entirely across the building, and is provided with any of the usual means of connection with a steam or air-engine having a reversing valve-gear, so that the shaft N may be put in motion, reversed, or stopped, when required, by a workman so placed that he can see the pouring out of the molten metal into the ladle and be enabled to regulate the motion of the converter, as found desirable. A clutch is also provided for the purpose of disengaging the beveled wheel M when the vessel to which it gives motion is required to be at rest. Or, in lieu of this arrangement, a separate engine may

be employed to each axis of the converters at their outside end, in which case the air will be admitted at the axes that come near each other between the vessels. The winding-engines and the cranes employed to move the ingots may be actuated by steam; or the compressed air or blast may be used in lieu thereof, if desired. The winding-engine, instead of being placed between or at the outer ends of a pair of converting-vessels, may be placed at any convenient part of the converting-house, and transmit its power to the vessels by means of shafting, and may in such case, by similar means, be employed to work the cranes for removing the ingots and molds and for actuating the lifts for raising the pig metal to the upper floor and raising the débris from the casting-pits.

When the winding-engine is used between the vessels I prefer to build a wall on each side thereof, and to spring a brick arch over it; and in like manner I carry an arch above the mouth of the converters, so that the flame and heated gases may not rise to the roof of the building, but escape through suitable openings made in the brick wall for this purpose.

When two converting-vessels are grouped as described, I also employ two small cupola-furnaces, Q Q, for melting manganesian carburet of iron or speigeleisen. These may be placed near the weighing-ladle, as shown, and the iron from them be run into the vessel or casting-ladle along the gutters before named; but I prefer to tap these small furnaces into a swing or traveling ladle, where the iron may be weighed and be thus transferred to the converter or casting-ladle without being cooled or wasted by passing along a gutter.

I prefer to form an upper floor on girders, as shown at R, Fig. 2, or on arches, at that part of the converting-house where the cupola-furnaces are situated, onto which floor the metal and fuel may be hoisted by a suitable lift. The cupola-furnaces may form a support for the iron floor-beams at the central part, the outer walls of buildings supporting the other end of them. The cupola-furnaces A and Q are erected on a raised bed of masonry, S, in order that the workman may have a platform or floor to stand on. When tapping the furnaces the steps T give access to the raised platform.

The trunnion-bands generally employed in converting-vessels are of forged iron, and, from the difficulty of making them, are very expensive. I therefore replace them, in some cases, by employing a hoop of cast-iron, with the trunnions and air-passages formed therein. In this case I use rolled angle-irons to embrace the cast-iron hoop, and, by passing bolts entirely through the cast-iron and rolled angles, the several parts of the cast-iron hoop would be supported in case of accidental fracture. Or, in lieu of this mode, I make the central band of plate iron or steel, which forms part of the vessel thicker than the other parts of it, and secure to it the trunnions by a flange, using, by preference, for the trunnion, steel castings or iron or steel forgings. The central part of the vessel may be further stiffened by angle-rings riveted around it above and below the trunnion-flanges.

Having described my invention and the manner in which the same is to be carried into practical operation, I desire it to be understood that I do not confine myself to the precise details herein specified, so long as the peculiar character of my invention is retained; but

What I do claim is—

1. Placing two or more converting-vessels with their respective axes in a line, when used in combination with melting-furnaces to which the mouths of the converters approach when turned down to receive the molten iron.

2. Raising and lowering the casting-ladle vertically in front of the converting-vessel by the direct action of a hydraulic plunger, or by a screw or rack, as described.

3. Employing, in combination with such raising-and-lowering apparatus, a turn-table mounted on a vertical axis, for bringing the molds in succession under the casting-ladle, as herein described.

4. The movement of converting-vessels on their axes by means of a worm and worm-wheel and beveled gearing, as herein described.

5. The employment of a ladle or receiver for weighing molten cast-iron, so placed as to receive a charge of metal from two or more melting-furnaces, and provided with a movable gutter for the conveyance of the metal therefrom into two or more converting-vessels.

6. The mode herein described of receiving in a truck on rails and conveying away the waste fuel and slags or other matters from the converting-vessels.

7. The general arrangement and grouping together of the several implements or apparatus employed in the manufacture of Bessemer steel, as shown in the drawing hereunto annexed.

HENRY BESSEMER.

Witnesses:
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JOHN DEAN,
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