(No Model.)

2 Sheets—Sheet 1.

W. HAINSWORTH.

FORGING PLANT.

No. 317,767. Patented May 12, 1885.

Fig. 1.

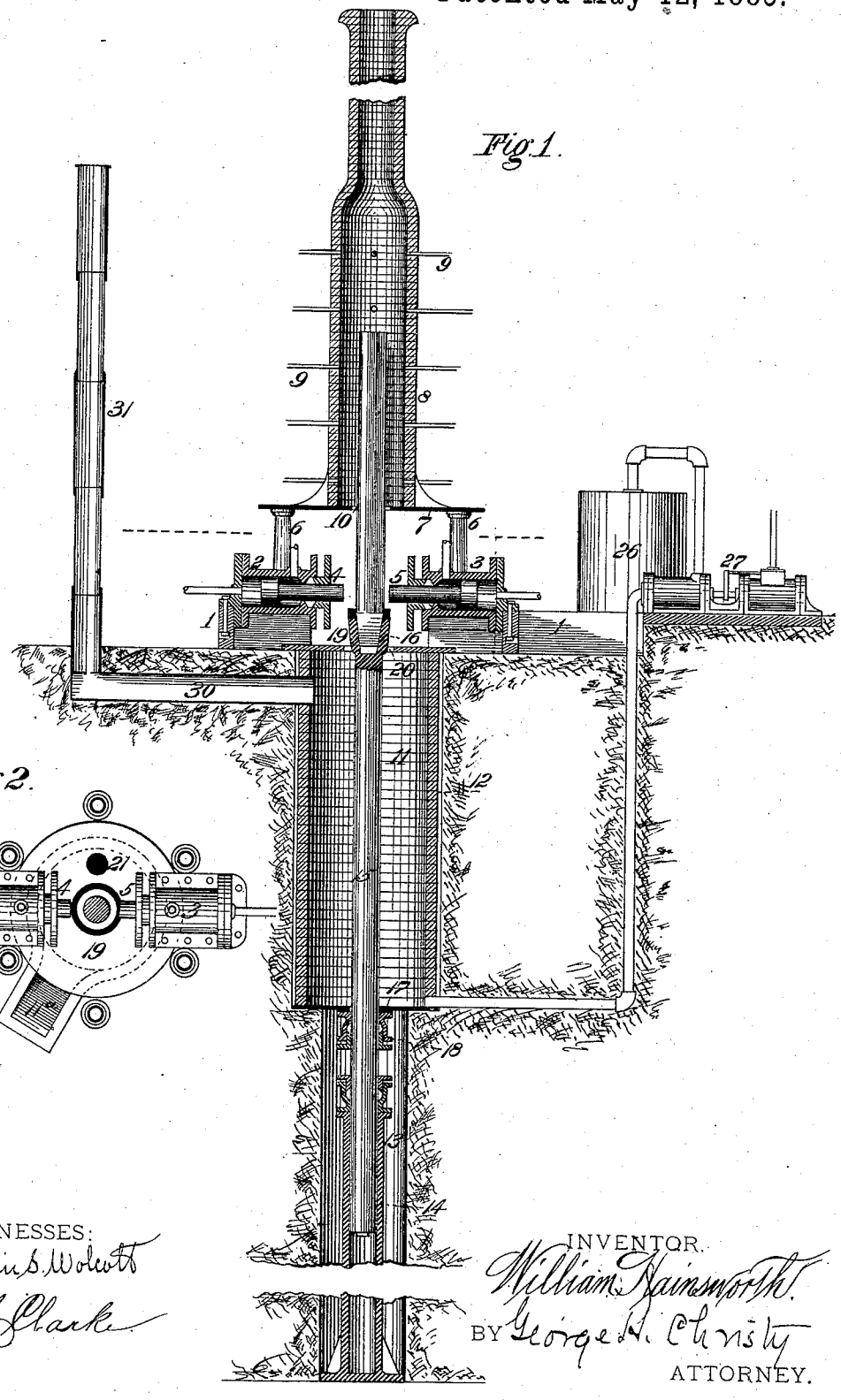
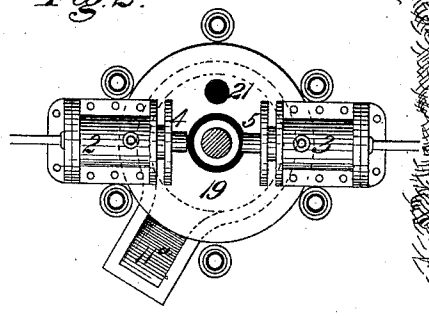


Fig. 2.



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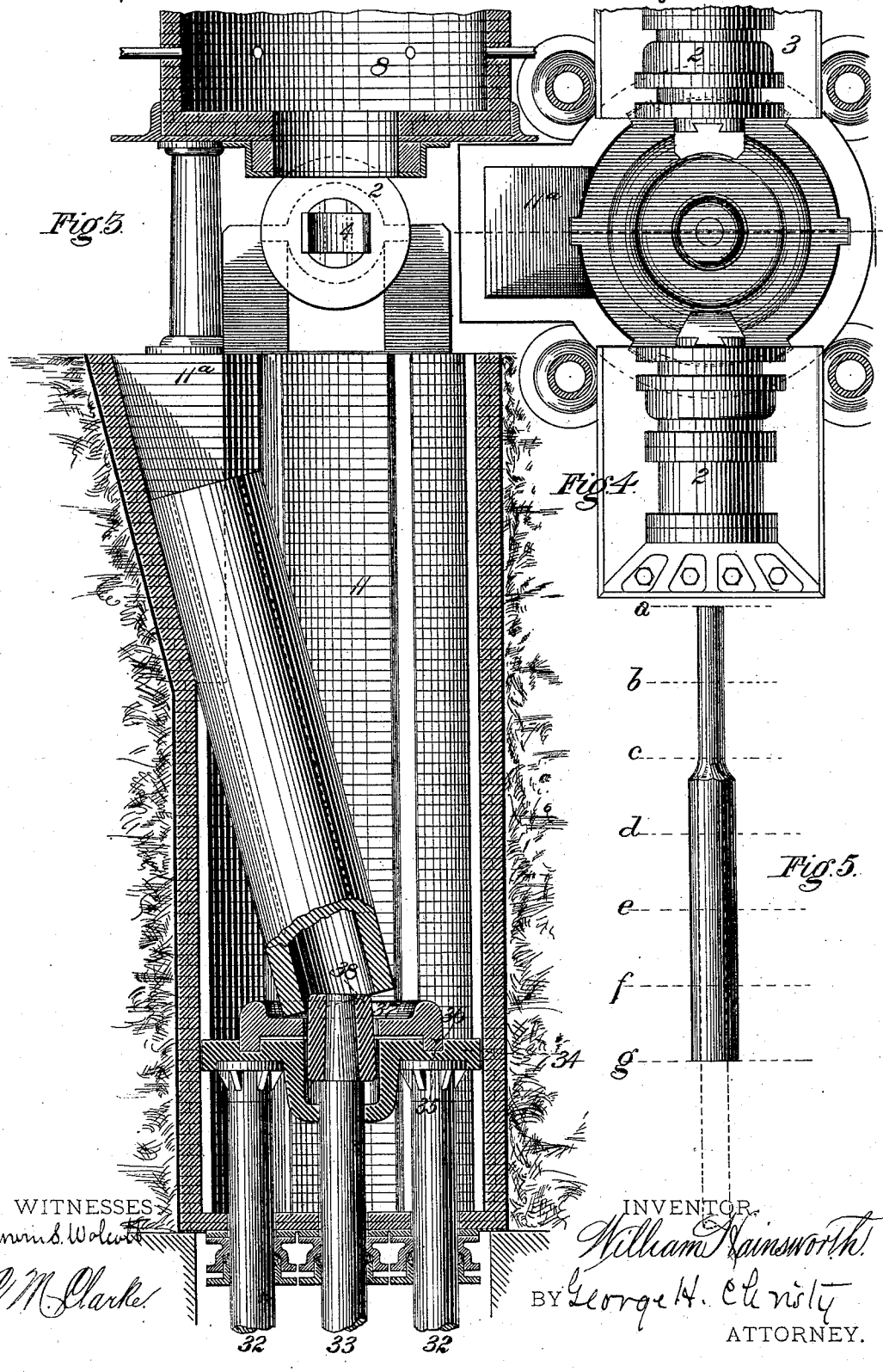

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UNITED STATES PATENT OFFICE.

WILLIAM HAINSWORTH, OF PITTSBURG, PENNSYLVANIA.

FORGING-PLANT.

SPECIFICATION forming part of Letters Patent No. 317,767, dated May 12, 1885.

Application filed December 6, 1884. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM HAINSWORTH, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered certain new and useful Improvements in Forging-Plants, of which improvements the following is a specification.

In the accompanying drawings, which make part of this specification, Figure 1 is a sectional elevation of my improved forging-plant. Fig. 2 is a top plan view, the furnace being removed. Fig. 3 is a sectional elevation of the plant, adapted to forging hollow articles. Fig. 4 is a top plan view of Fig. 3. Fig. 5 is a diagrammatic view of a partially-forged ingot.

My invention relates to certain improvements in the manufacture of steel shafts, cannons, and gun-tubes, and other articles which are produced by casting, condensing, and forging, or forging and condensing steel or Bessemer metal. These articles have heretofore been produced by casting the steel in large ingots and then condensing and forging such cast metal to shape by means of hydraulic presses or steam-hammers.

In conducting the condensing and forging operations, so much of the ingot, commencing at one end, as can be treated—*i. e.*, forged at one time—is placed in a suitable furnace, and there heated to the proper temperature for working. The ingot having the end thus heated is then taken to the press or hammer, and the heated portion is then condensed and shaped. After this part or section has been properly pressed or forged the ingot is again put in the heating-furnace, and the next succeeding part or section is heated and then forged. These heating and forging operations are continued in regular succession until the whole ingot has been forged to shape and properly condensed, such forging and condensing operations effecting a considerable elongation of the ingot. The heating and forging of one part or section of the ingot will produce a certain state or condition of the metal of that part, and when the ingot is again placed in the furnace for heating the next section to be treated a considerable portion of that part which was first treated will be highly reheated also. This reheating of a portion of the forged or shaped section will change the state or condition of the metal as produced by the previous forging, and after the second section has been reheated there will be three or more different states or conditions of metal in the ingot—as, for example, in Fig. 5 I have shown an ingot which has been partially treated, that part included between the lines *a* and *c* having been heated and pressed to shape, such forging effecting a considerable condensation and tension in the molecules of the metal. Now, if that section included between the lines *c* and *e* were put in a furnace and heated to the proper working temperature, at least a part of the section *a c* would be necessarily reheated, such reheated part being represented by *b c*. As this reheating will of necessity change the condition or state of the metal in the part *b c*, there will result from the heating of the part *c e* three varying states or tensions of metal in the ingot so far treated—to wit, the part from *a* to *b* will be hard and dense, the part *b c* will be dense but will have been annealed by the reheating, and the part *c e* will be soft and spongy. As the heating and forging by sections continues these varying tensions will be produced along the length—as, for example, the part *a b* will be hard and dense, *b c* dense but soft, *c d* dense and hard, the latter quality being somewhat modified by its position between two soft parts, *b c* and *d e*, and so on to the end last worked, which will be hard and dense. These different conditions in the finished product are modified to a certain extent by heating the whole forging simultaneously to a tempering-heat and then plunging it into an oil bath; but as the various parts of the forging are, as above stated, in different conditions when subjected to this tempering process, such process will effect only a partial restoration to homogeneity.

In addition to the above-described imperfections, the metal of these large forgings is subjected to dangerous strains by reason of the manner in which the forging is effected—*i. e.*, with the article lying in a horizontal plane and the press acting in a vertical or horizontal plane. As the forging proceeds from one end toward the opposite end there will be a portion overhanging on each side of the supporting-anvil, and as it is impossible to sup-

port both ends in the same plane with the top of the anvil, for the reason that the part under operation must rest firmly on the anvil, and to effect this firm support the ends of the article are supported a little lower than the part on the anvil, hence when the press is in operation the article being forged is subjected to shear-strains, such strains gradually increasing as the forging proceeds toward the center, where the strain will be greatest.

The object of my invention is to provide for the simultaneous and uniform heating of the whole of the ingot or article to be treated and for the maintenance of such a heat throughout such portions of the ingot as await the action of the press, and, further, to prevent the reheating of such parts as have been subjected to the condensing and forging operations; and it is a further object of my invention to so arrange the various parts of my apparatus that the ingot or article under treatment will not be subjected to any shearing or other strains during forging, and so that the compressive or condensing force of the press will be more effective, the elongation being resisted by the superincumbent mass of metal; and a further object of my invention is to provide for a uniform reheating of the whole forging preparatory to the tempering of the same in an oil bath; and to these ends my invention consists in the construction and combination of parts, all as more fully hereinafter described and claimed.

Upon a suitable bed or foundation, 1, are arranged the hydraulic cylinders 2 and 3, said cylinders being provided with suitable pistons, 4 and 5, the outer end of the piston 4 being suitably shaped to serve as the moving head or gear in the forging operation, and the outer end of the piston 5 being adapted to serve as an anvil, as clearly shown.

Upon posts or pillars 6, resting upon the bed or foundation 1, is supported the bed-plate 7, upon which is erected the vertical heating-furnace 8, said furnace being provided with a number of gas jets or burners, 9, having connections with suitable gas generator or supply. The opening 10 in the plate 7, for the admission of the ingot or article to be heated, is located directly above the meeting-point of the jaws or dies, and directly below said opening and meeting-point is formed a pit, 11, said pit having a diameter considerably in excess of the diameter of the forging to be produced, and in the side of the pit, near the top, is formed the inclined chute 11^a, to allow of the lowering of the ingot onto the piston in the pit. The walls of this pit are formed by bricks arranged inside of a shell, 12, of boiler-iron. Below this pit 11 is formed an additional pit, 13, in which is located the hydraulic ram 14, provided with a piston, 15, said piston being, if desired, provided with radial guide-arms (not shown) bearing against the sides of the pit, and with a socket, 16, for the reception of the end of the ingot or other article to be treated. This socket, 16 may be made removable from the piston 15, and sockets of various sizes and shapes may be made for use with the varying sizes and shapes of ingots to be forged. The pits 11 and 13 are separated by a plate, 17, having a central opening for the passage of the piston 15, said opening being provided with a stuffing-box, 18, the purpose of which will be hereinafter stated. Over the mouth of the pit 11 is arranged the plate 19, provided with a central opening, 20, for the passage of the piston 15 and any ingot or article resting thereon, and with an inspection or peep hole, 21.

In using the above-described apparatus the ingot to be forged is placed on the piston 15, the lower end of said ingot resting in the socket 16. This piston is then moved up, thus pushing the ingot up into the furnace 8, which has been previously heated, the portion of the opening 10 not closed by the ingot being closed by a ring of fire-clay resting on the rim of the socket 16. The ingot is retained within this furnace until it is heated uniformly throughout its entire length to the desired temperature, when it is lowered until that portion of it, next adjacent to the socket 16 lies in the operative plane of the jaws of the press. The moving jaw is then operated, the opposite side of the ingot being braced or supported by the anvil-die 5, said anvil being adjusted back and forth according as the ingot is reduced under the action of the moving jaw or head, and as new surfaces are presented as the ingot is turned, the latter operation being effected by a pair of tongs or other suitable tool applied to the ingot between the press and the bottom of the furnace. As soon as one section or part, which will be approximately equal to the width of the face of the jaws, has been properly forged, the ingot is lowered until another section is brought between the jaws or dies of the press. Care should be taken in constructing the apparatus that the distance between the bottom of the furnace and the press will not to be so great that the ingot, in moving from the furnace to the press, will be cooled below a forging-temperature.

In practice the ingot should be removed from its mold and transferred to the furnace as soon as its exterior is sufficiently hard to permit of handling and while its interior is in a fluid or semi-fluid condition. The chilled shell is then heated to such a point that it will not be cooled by its exposure during the movement from the furnace to the press below a good forging-temperature.

It is an important characteristic of this method of vertical forging that the elongative effect of the transverse compression is resisted to a great extent by the superincumbent mass, the lower end being supported by the hydraulic ram; and hence a portion of the force which produces an elongation in horizontal forging is utilized by my method in compacting the metal.

Another important feature of my invention

is that as soon as one part of the ingot is forged to shape it is lowered into a pit, where it is protected from cooling currents of air, and is allowed to cool slowly, thus avoiding all strains incident to unequal cooling. Nor is a part once forged to shape again heated, thereby avoiding the varying tensions or conditions incident, as above stated, to the usual method of heating and forging alternately and in sections.

It will be observed that as the ingot is entirely supported on one end, and as the anvil is adjusted to the varying irregularities of the surface, that it is not subjected to the shearing strains incident to balancing or supporting the ingot in a horizontal position over an anvil and then subjecting it to the squeezing action of the moving die. After the ingot has been forged to the desired shape it is lowered entirely into the pit and allowed to cool slowly therein, after which it is removed and turned to its final size and shape. Then the dressed forging is again lowered into the pit, its lower end being placed in the socket 16. It is then raised into the furnace, where it is heated to the proper heat for tempering. During this heating operation it can be lowered occasionally into the pit and there inspected through the peep-hole 21, to ascertain if it is properly and uniformly heated. If the heat is not sufficient or uniform, the forging is again raised into the furnace, and the burners are so regulated as to apply heat to such parts as are too cool and to cut off the heat from such portions as may be too hot. As soon as it is ascertained by the above method of inspection that the forging has been properly heated it is again raised in the furnace, and retained at that heat by regulating the supply of gas until the pit can be filled with oil or any other suitable tempering-fluid. The heated forging is then rapidly lowered into oil in the pit and allowed to cool therein. In lowering the heated forging into the oil its downward motion is momentarily arrested as soon as the socket has passed through the opening in the top plate, 19, and asbestus cloth is placed around the forging, completely covering the opening 20, and over the peep-hole 21. These coverings serve to protect the workmen around the pit from being burned by the flame from the oil, which flashes up as soon as the heated metal is brought into contact with the oil. As the flames cannot escape through the openings in the plate 19, they pass through the flue 30 into the stack 31, provided for the purpose. As soon as the forging has been sufficiently cooled the oil is transferred from the pit into the tank 26 by means of the pump 27. After the oil has been pumped out the forging is removed, when the apparatus is ready for operation on another ingot.

In lieu of the single ram shown in Fig. 1, three or four rams or elevators, 32, arranged around a central ram, 33, may be employed. Upon the pistons of these rams 32 is supported, within the pit 11, a cross-head, 34, provided with a central opening, whose function will be hereinafter stated.

In the periphery of the cross-head 34 is formed an annular groove or recess, 35, adapted for the reception of the annular rib or projection 36 formed on the under side of the socket 37. The groove 35 and rib 36 are so constructed that the rib will rest and be supported on a bed of oil or other liquid within the recess, thereby providing for the easy rotation of the socket. This socket 37 is constructed to hold an annular ingot, and is provided with a central opening corresponding to the opening in the cross-head 34.

On the end of the piston of the central ram, 33, is formed a shank for the reception of the mandrel 38. The peripheral or outside rams, 32, are so connected as to operate in unison, the central ram being operated independently.

In operating the above apparatus the cross-head is lowered to near the bottom of the pit 11, and the mandrel is lowered below the socket, then the annular ingot is placed in its socket and raised into the heating-furnace. After being properly heated the ingot is lowered until its lower end is in position to be operated on by the press. The mandrel is then raised into the ingot, and the forging operation is commenced. During this forging operation the mandrel is held in its place between the jaws of the press, and the ingot, as it is forged, is lowered down over the mandrel. If desired, water may be caused to circulate through the mandrel to keep it cool during the forging operation. In case a mandrel becomes too hot or in any way defective during the forging operation, the ingot may be raised from around said mandrel, the mandrel being simultaneously lowered. The jaws of the press are then caused to move inward and firmly clasp the ingot. The ingot being thus supported, the cross-head is lowered away from the ingot, and the mandrel can now be removed and another mandrel substituted therefor.

I propose in some cases to cast the ingot around a heavy core-bar thinly coated with some suitable refractory material, and so constructed as to permit of the circulation of a cooling medium therethrough. This heavy core-bar can be afterward utilized as a mandrel during the forging operations, being kept comparatively cool during or cooled after such operation by the circulation of a cooling medium.

By substituting a socket constructed to hold and support a solid ingot for the socket 37 the apparatus shown in Fig. 3 may be employed in forging solid ingots.

I claim herein as my invention—

1. The combination of horizontally-acting dies and a vertically-acting lift as an apparatus for the forging of heavy ingots, blooms, &c., while in a vertical position, substantially as set forth.

2. In a forging-plant, the combination of a horizontally-acting forging-press, a heating-furnace located over said press, and means for

lowering the ingot from the furnace to the press, substantially as set forth.

3. In a forging-plant, the combination of a horizontally-acting forging-press, a heating-furnace located in a vertical plane passing between the jaws of said press, and means for moving the ingot from the furnace to the press, substantially as set forth.

4. In a forging-plant, the combination of a horizontally-acting forging-press, an elevated heating-furnace, and a receiving pit, said furnace and pit being located in a vertical plane passing between the jaws of the press, and means for moving the ingot from the furnace through between the jaws of the press and into the pit, substantially as set forth.

5. In a forging-plant, the combination of a horizontally-acting forging-press, an elevated heating-furnace, and a receiving-pit, said furnace and pit being located in a vertical plane passing between the jaws of the press, mechanism for raising and lowering the ingot, and mechanism for moving and holding the mandrel independent of the mechanism for moving the ingot, substantially as set forth.

6. The combination of a heating-furnace, a testing-pit located below the furnace and provided with a suitable cover having a peep-hole, and mechanism for moving an ingot or forging back and forth from the furnace to the pit, substantially as set forth.

7. The combination of a heating-furnace, a pit containing tempering-fluid located below said furnace, and means for lowering an ingot from the furnace to the pit, substantially as set forth.

In testimony whereof I have hereunto set my hand.

WILLIAM HAINSWORTH.

Witnesses:

DARWIN S. WOLCOTT,

R. H. WHITTLESEY.