

(No Model.)

2 Sheets—Sheet 1.

C. HUSGAFVEL.

APPARATUS FOR PRODUCING MALLEABLE IRON OR STEEL DIRECT  
FROM THE ORE.

No. 369,525.

Patented Sept. 6, 1887.

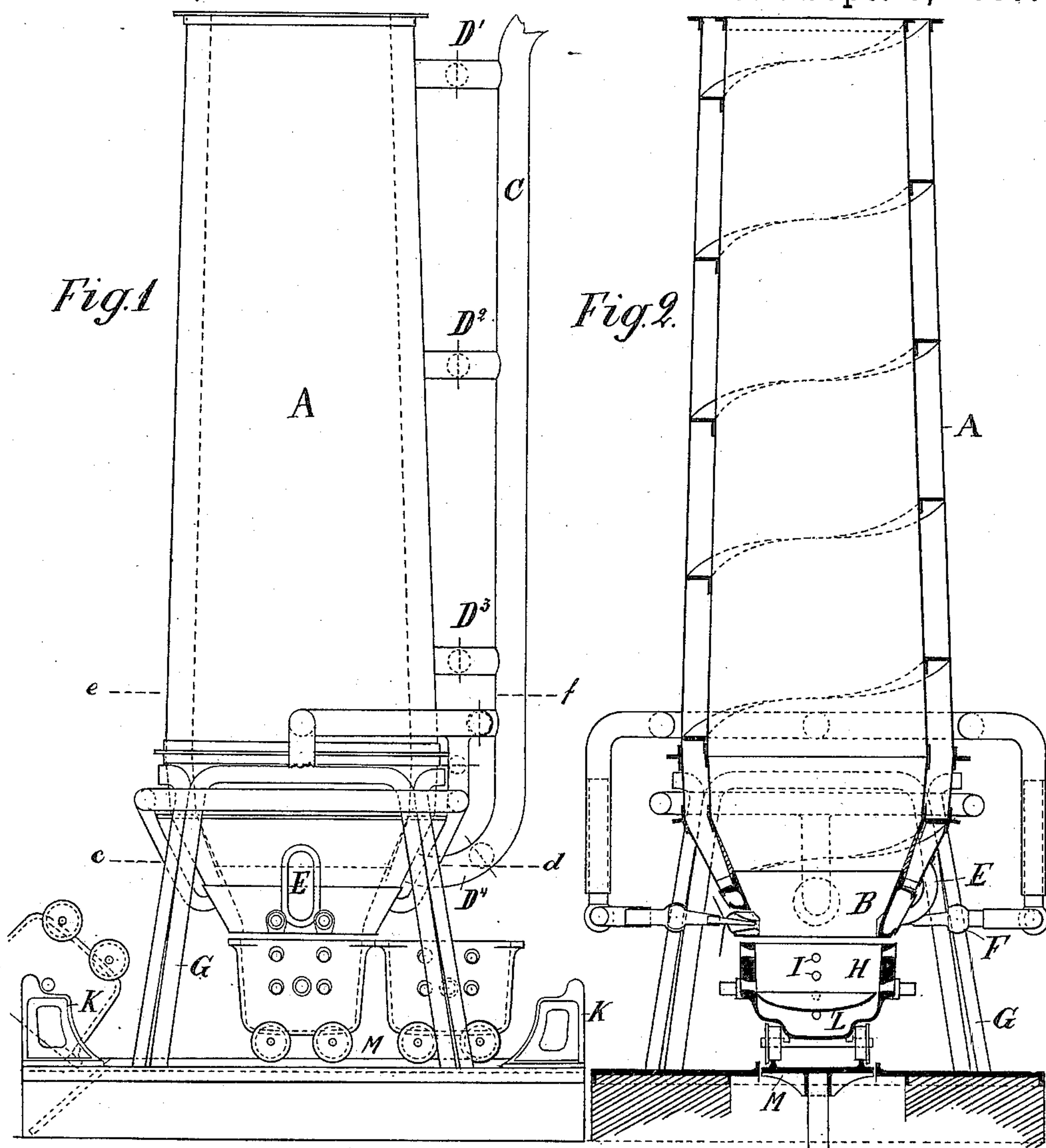


Fig. 3.

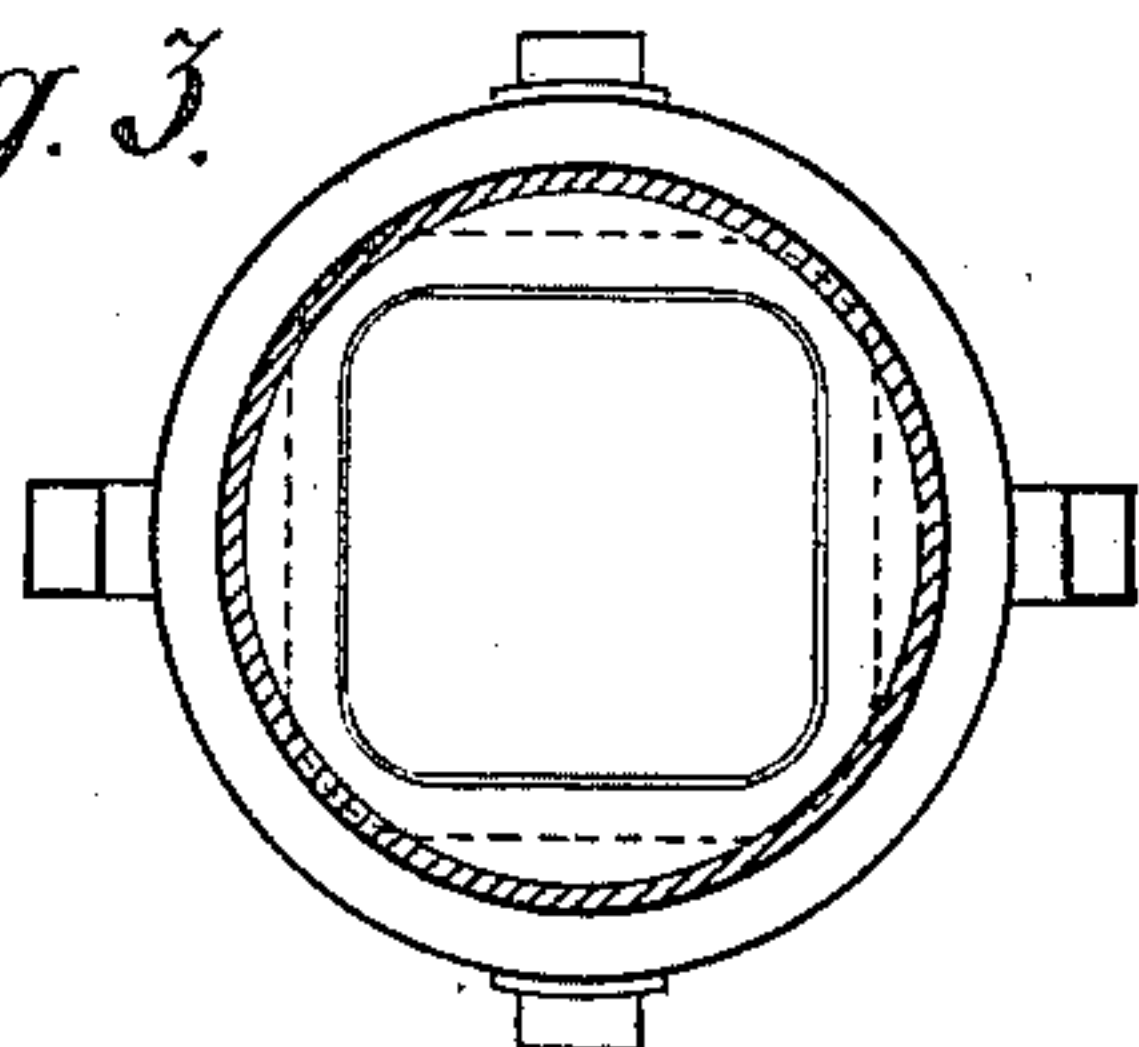
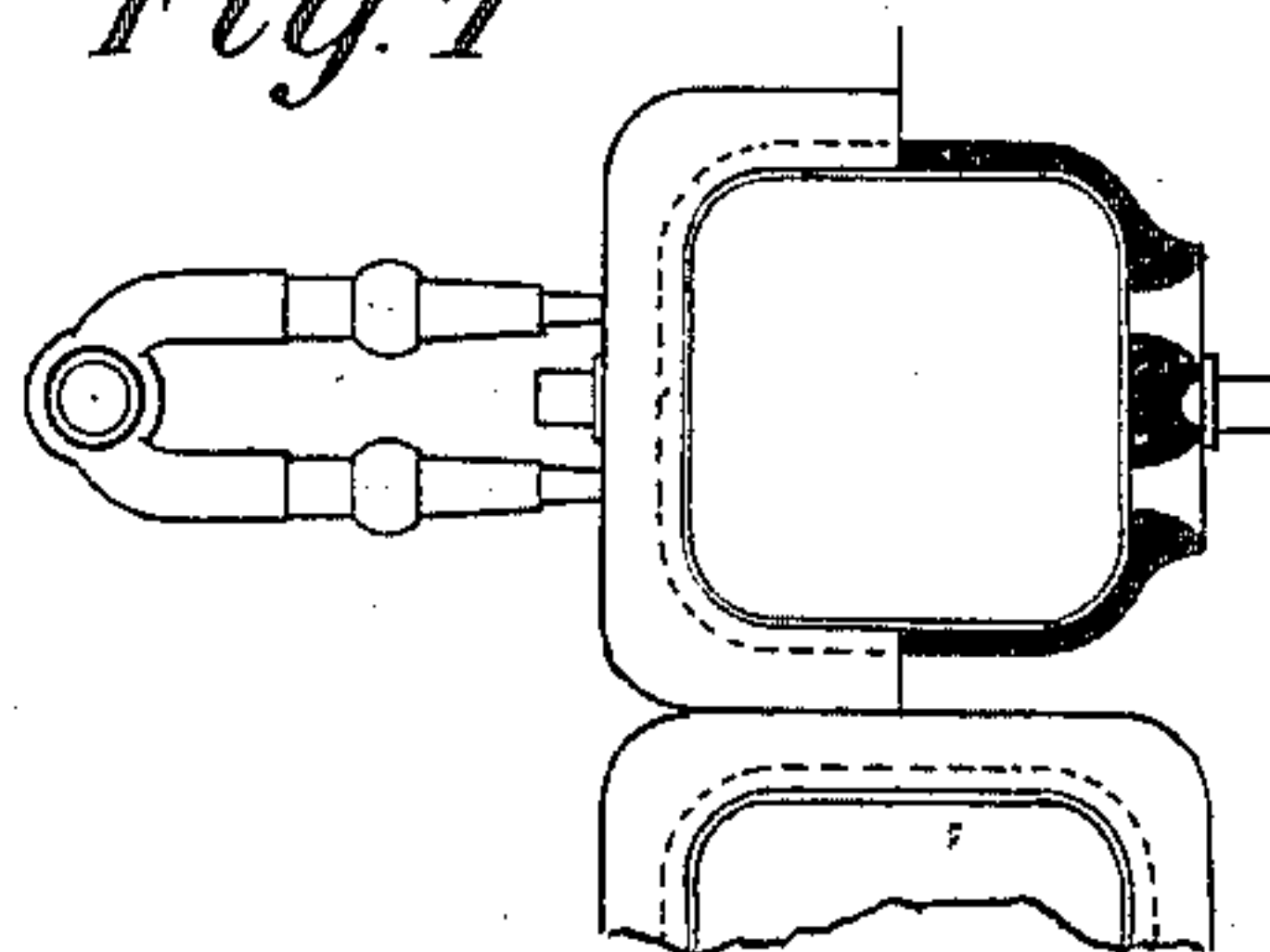


Fig. 4.



WITNESSES.

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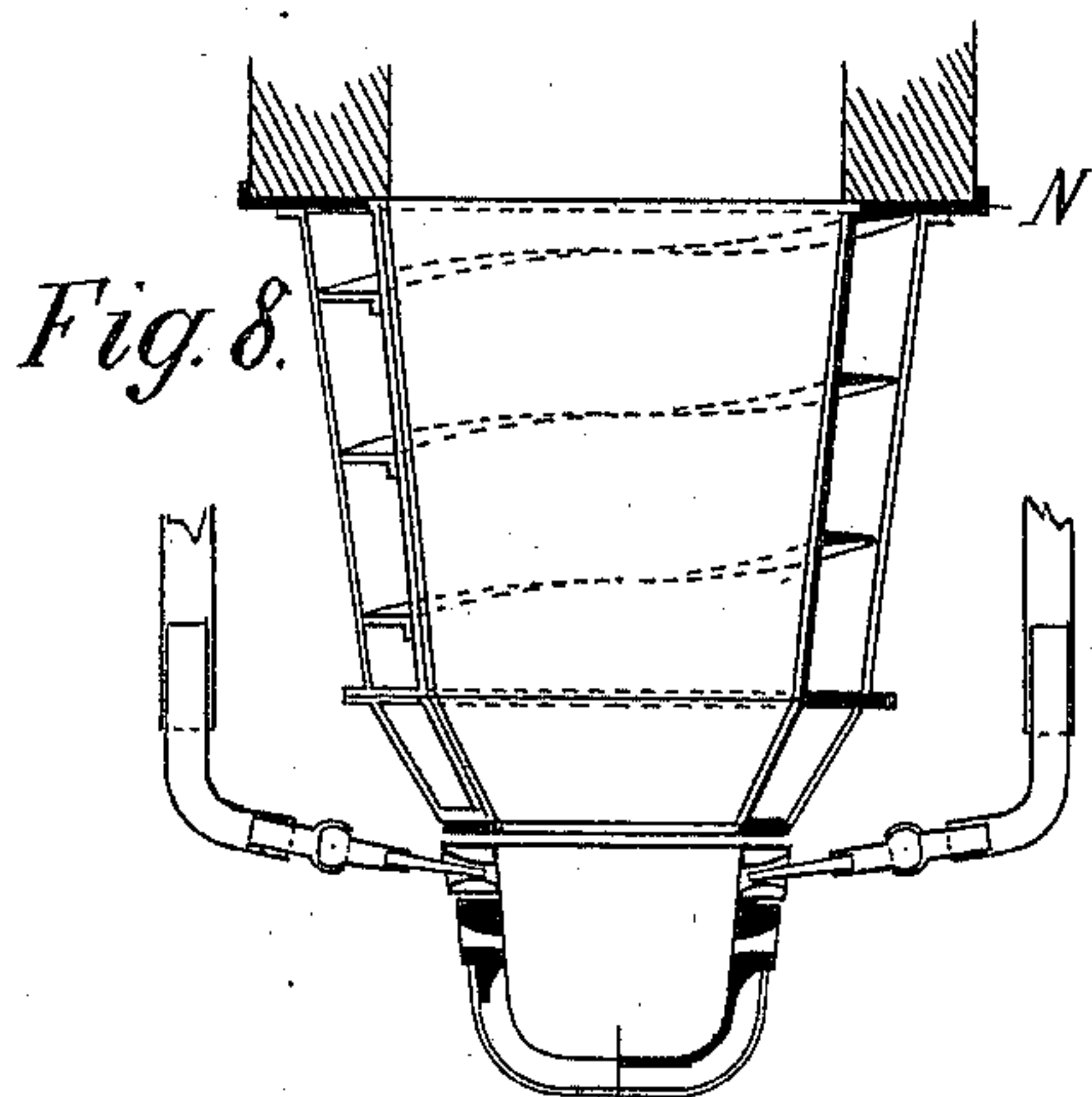


Fig. 8.

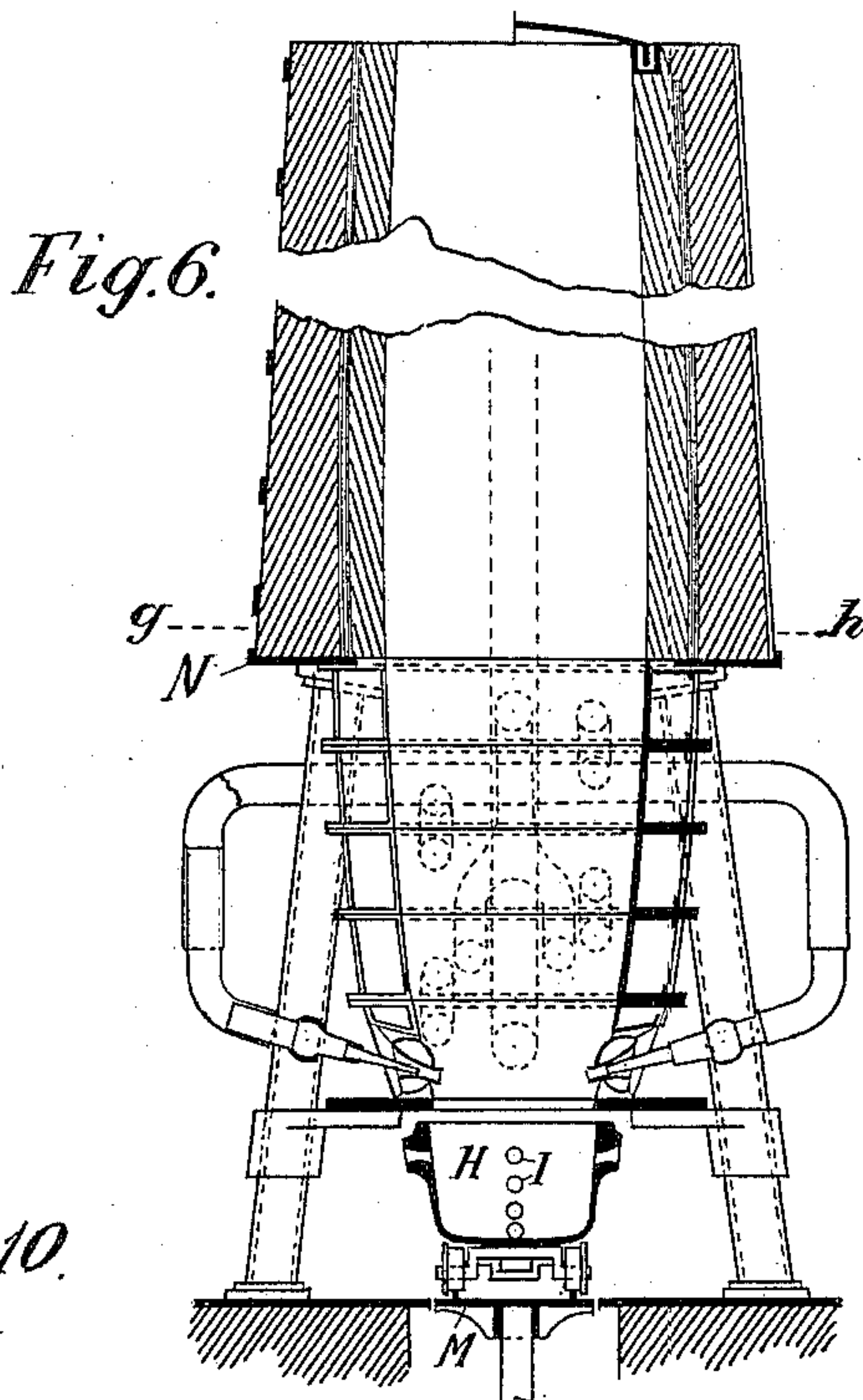


Fig. 6.

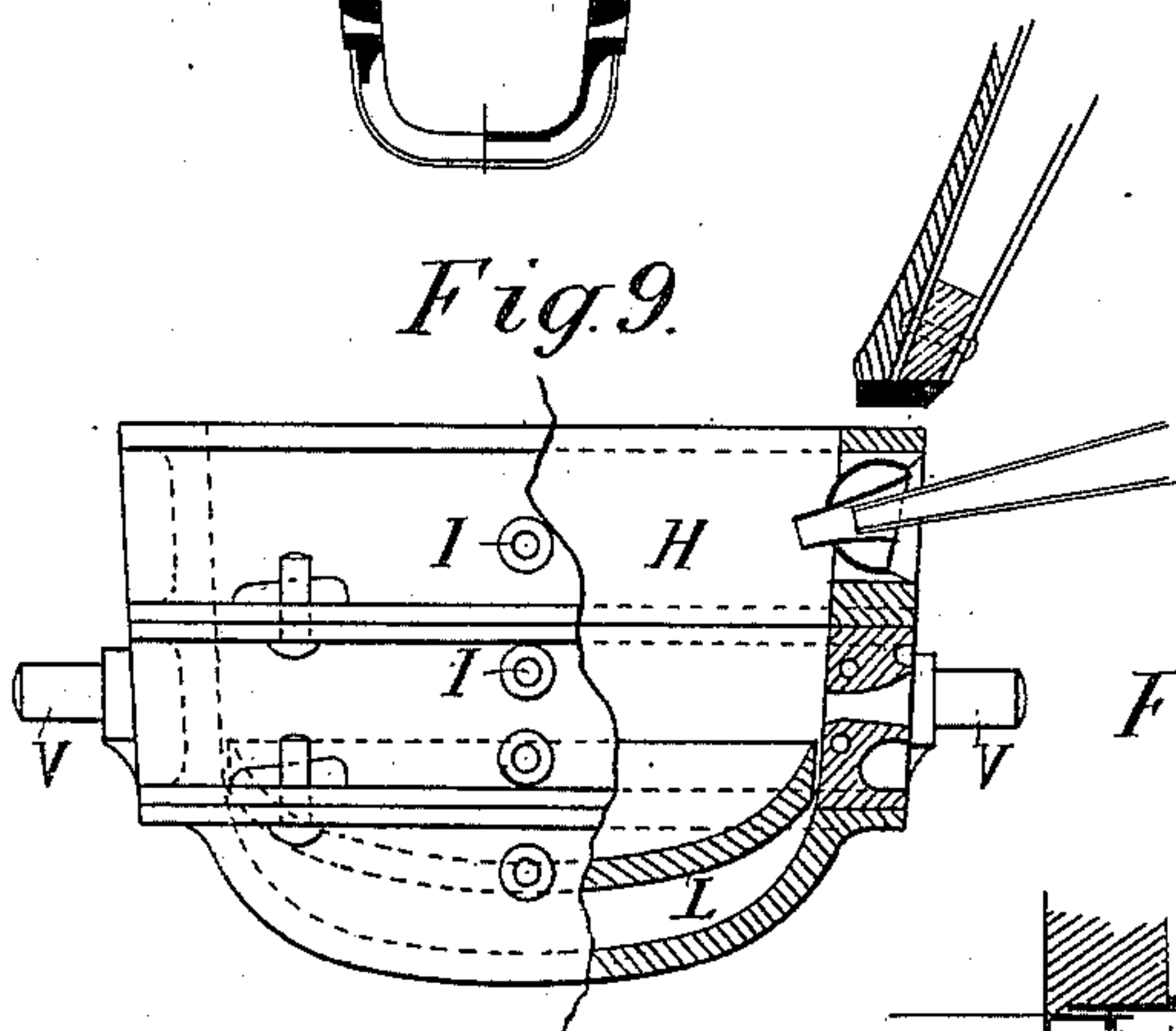


Fig. 9.

Fig. 10.

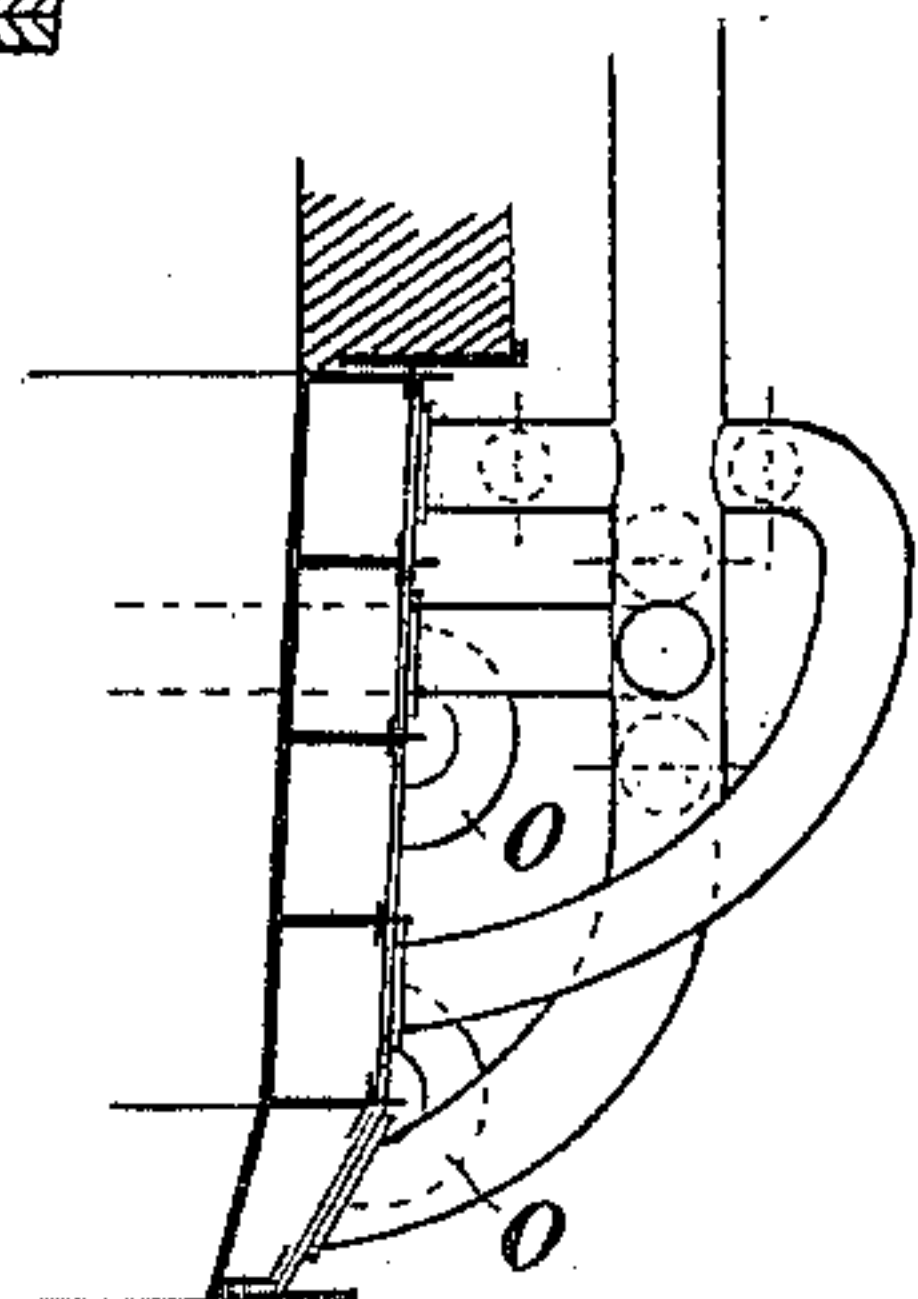


Fig. 5.

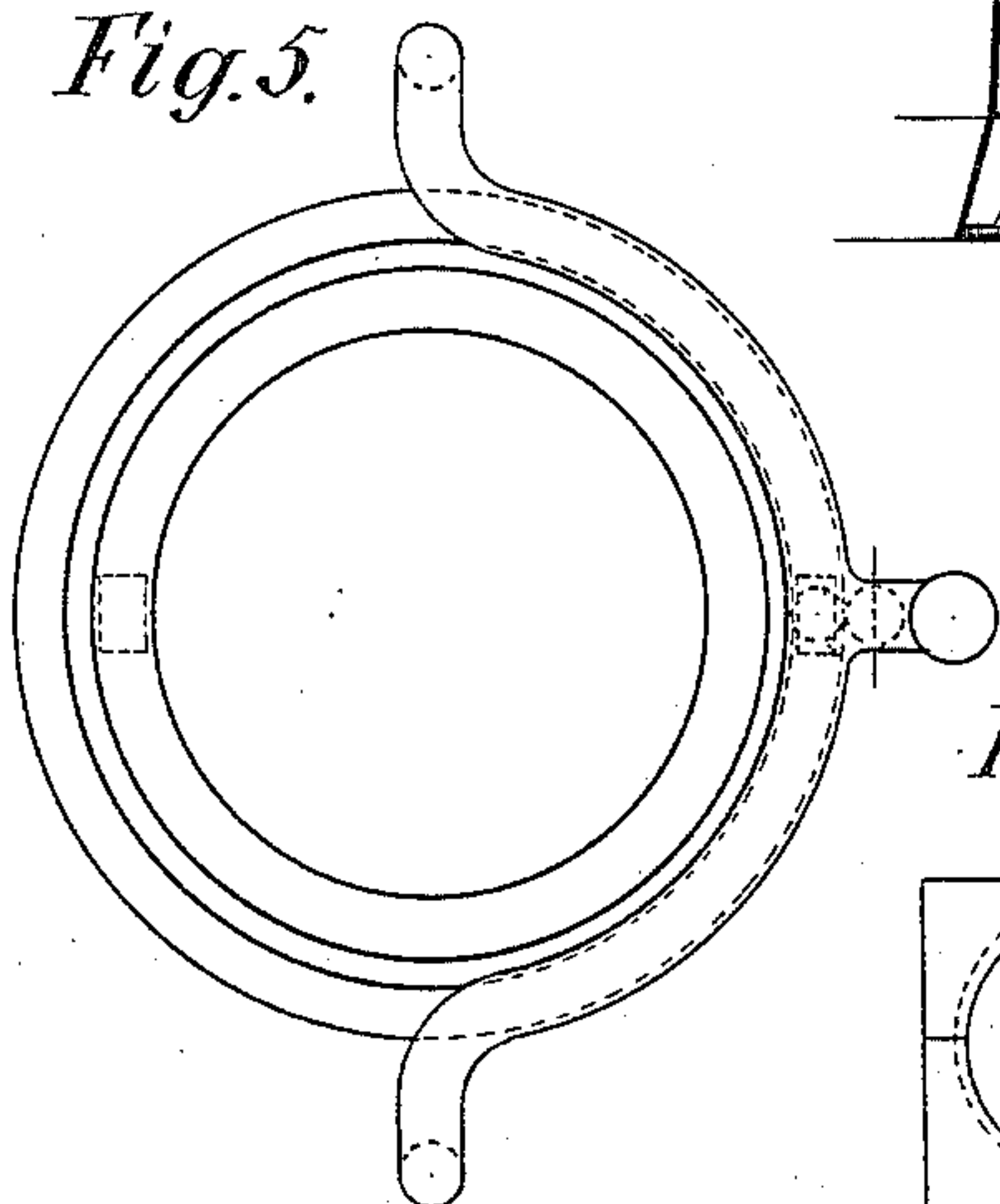


Fig. 7.

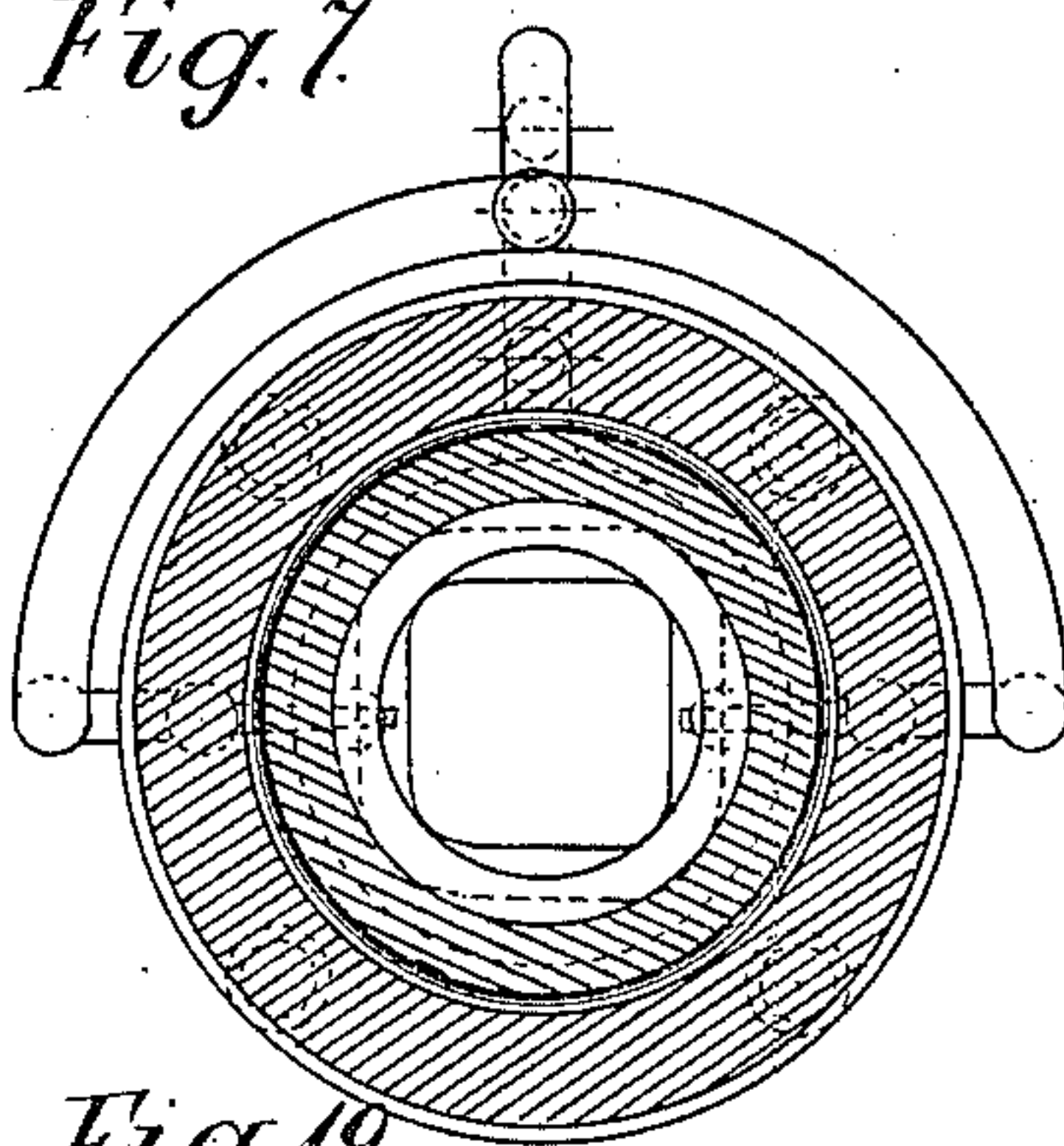
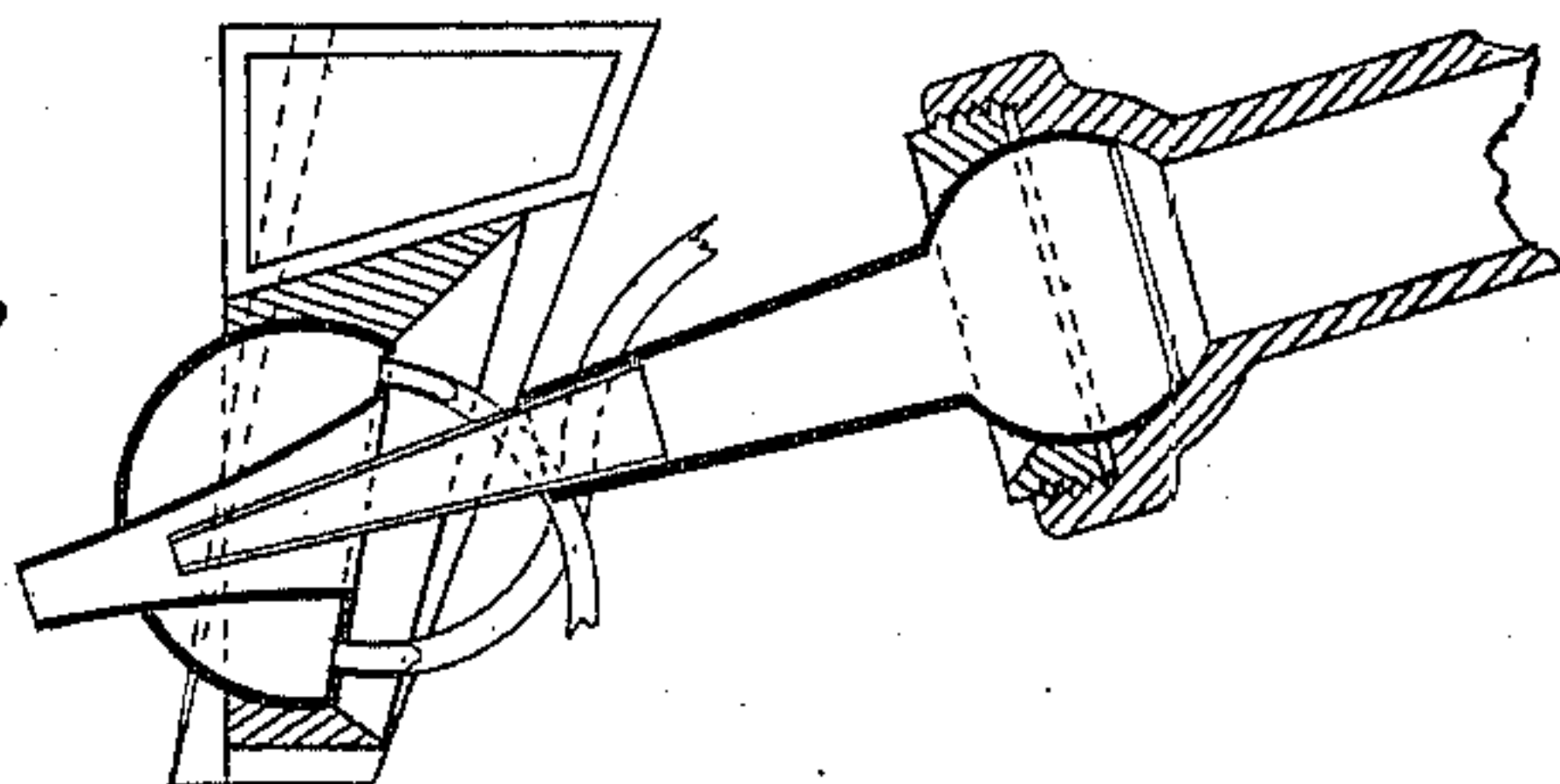
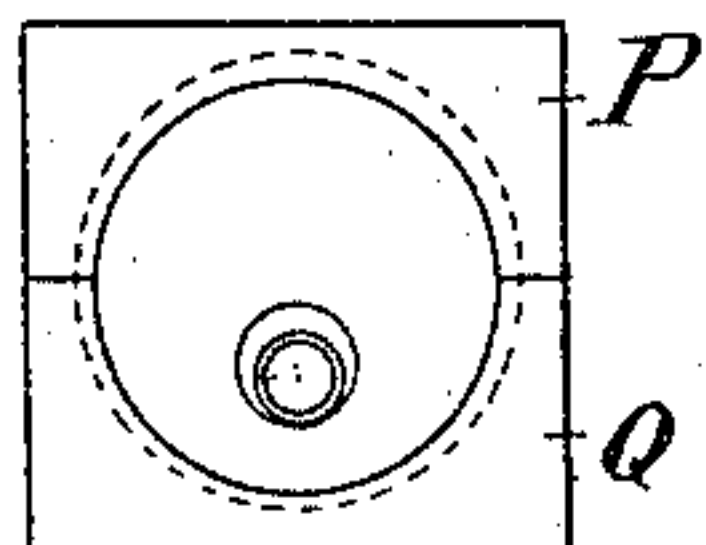


Fig. 12.

Fig. 11.



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# UNITED STATES PATENT OFFICE.

CHRISTIAN HUSGAFVEL, OF PICKSAMAKI, FINLAND.

APPARATUS FOR PRODUCING MALLEABLE IRON OR STEEL DIRECT FROM THE ORES.

SPECIFICATION forming part of Letters Patent No. 369,525, dated September 6, 1887.

Application filed December 26, 1885. Serial No. 186,744. (No model.) Patented in Sweden November 30, 1885, No. 431; in France December 4, 1885, No. 172,725; in England December 5, 1885, No. 14,924; in Germany December 8, 1885, No. 37,178; in Belgium December 31, 1885, No. 71,173, and in Russia June 11, 1886, No. 4,868.

*To all whom it may concern:*

Be it known that I, CHRISTIAN HUSGAFVEL, of Picksamaki, Finland, have invented a new and useful Improvement in Apparatus for Producing Malleable Iron or Steel Direct from the Ores, of which the following is a full, clear, and exact description, and which has received protection by Letters Patent, in England, December 5, 1885, No. 14,924; Germany, December 8, 1885, No. 37,178; Belgium, December 31, 1885, No. 71,173; France, December 4, 1885, No. 172,725; Russia, June 11, 1886, No. 4,868, and Sweden, November 30, 1885, No. 431.

The object of my invention is to produce malleable iron or steel direct from the ore, and thus avoid the intermediate process and the device required in carrying out the same.

The invention consists in charging the ore with less coal and reducing the working temperature of the furnace; and the invention also consists in the construction and combination of parts and details, as will be fully described hereinafter, and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a side view of my improved furnace. Fig. 2 is a vertical sectional view of the same. Fig. 3 is a sectional plan view of the same on the line *c d*, Fig. 1. Fig. 4 is a plan view of the removable hearth, parts being in section. Fig. 5 is a sectional plan view on the line *e f*, Fig. 1. Fig. 6 is a vertical sectional view of a modified construction of the furnace, parts being broken out. Fig. 7 is a sectional plan view of the same on the line *g h*, Fig. 6. Fig. 8 is a sectional view of another modification. Fig. 9 is a partial side and sectional view of the removable hearth. Fig. 10 is a cross-sectional view of the lower part of the furnace. Fig. 11 is a detail view of one of the tuyeres. Fig. 12 is a cross-sectional view of the same.

The main part of the furnace consists of the hollow metal plate-casing A, which may be divided into horizontal belts by horizontal partitions, or which may be provided with a

spiral partition, forming a spiral flue in the said casing.

The lower part of the furnace is provided with the hollow cast annular piece B, into which air is conducted from the large casing A above it. This annular piece B has a smaller inside diameter than the casing A, directly above it, whereby a shoulder is obtained for supporting a lining of the fire-clay with which the lower part of the casing A is provided. A pipe, C, is connected by the pipes D' D<sup>2</sup> D<sup>3</sup> D<sup>4</sup> with the spiral flue in the casing A at different elevations, thus permitting of conducting air into the casing A from the pipe C at different elevations, so that the furnace is cooled by said air more or less.

From the lowest thread of the spiral flue in the casing A the air is conducted through the pipes E into the ring B, and from the latter through suitable pipes to the nozzle or tuyeres F.

Tuyere-openings may be provided at different heights. For instance, in Fig. 2 I have shown them at three different heights—two in the hearth and one in the lower part of the furnace.

The plate-casing of the furnace is supported by the pillars G, of wrought or cast iron.

The hearth H is mounted on wheels running on suitable tracks, to permit the hearth being removed from below the furnace when the lump of iron is ready, another hearth containing glowing coal being immediately pushed under the furnace in place of the hearth removed. The hearth is provided with a series of slag-holes I, for withdrawing the slag at the proper height.

When the hearth containing the lump of iron arrives at one of the supports K, it can be turned on its pivots, as shown in Fig. 1, and the lump can then be removed easily.

The hearth is preferably provided with a loose bottom, L, as shown in Fig. 9, which can be raised or lowered by placing a greater or less quantity of a poor conductor of heat below the same, thus permitting of regulating the size of the lump.

The tracks for the hearths rest on an elevator below the furnace, to permit of raising or



lowering the hearth, and thus a close joint can be formed between the top of the hearth and the bottom of the ring B.

The modifications shown in Figs. 6, 7, and 8 differ mainly from the construction shown in Figs. 1 and 2, in that the hollow casing surrounds the lower part of the furnace, the upper parts being constructed of brick resting on the ring N, supported by the pillars, which also support the casing.

In Fig. 10 the manner of connecting the chambers of the casing by pipes O is shown, the furnace-casing being divided into horizontal compartments.

The hearth shown in Fig. 9 is composed of two rings and a separate bottom.

In Fig. 9, V are the pivots of the hearth, and in one ring a tuyere is shown, and the tuyere-opening in the other ring is surrounded by channels for conducting cooling-water.

The movable tuyeres are shown in Figs. 11 and 12. On the end of the tuyere a spherical or bulbous part is formed, which is passed into a corresponding recess or cavity in the said hearth. By means of this construction the inclination of the tuyere can be changed and the tuyere adjusted to deliver the current of air in any desired direction. The tuyere is also provided with pipes for the circulation of the cooling-water, and the said pipes may be used as handles in shifting and adjusting the tuyere.

The operation is as follows: In the ordinary blast-furnace from seventy-five to one hundred kilograms of charcoal are used for each one hundred kilograms of pig-iron produced, while in my apparatus for producing steel I charge the furnace with even a smaller or less quantity of charcoal, and for producing malleable iron a still less quantity of charcoal is used. Just how much less charcoal is used depends upon the quality of the coal and upon the quality (especially the yield of oxygen) of the ore. The furnace is kept comparatively cool by the circulation of the air around it. Flux is added, so that the slag becomes easily fusible and preferably basic, whereby the greater part of the phosphorus in the ore is taken up by the slag. In consequence of the cooling of the furnace the ore is not reduced until it is directly above the tuyeres. The reduced iron soon sinks below the slag in the hearth and forms a solid spongy semi-molten lump, and as the same increases in size the tuyeres are raised and the lower tuyere-openings are closed. The slag is drawn off at suitable intervals through the slag-holes.

When the lump is of sufficient size, the platform on which the hearth rests is lowered and the hearth is moved from under the furnace and a fresh hearth is pushed in place. Then the said platform on which the hearth rests is raised and the joint between the top of the hearth and the bottom of the furnace is closed by means of clay. The lump is then taken from the hearth that has been removed from below the furnace in the manner described.

In my apparatus the combustible substance (charcoal) serves to withdraw the oxygen from the ore, reducing the same to iron, and also to deliver a small quantity of carbon to the reduced iron, thus producing malleable iron or steel.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a furnace for producing malleable iron or steel direct from ore, the combination of an air chamber or casing forming the stack of the furnace, a blast-pipe with branches admitting air at different heights and to said chamber, a movable hearth disposed below the furnace-stack, provided with tuyere or tuyere-holes, and a pipe connecting said chamber and hearth, substantially as and for the purpose set forth.

2. A furnace for producing malleable iron or steel direct from the ore, provided with a movable hearth having tuyere or tuyere-holes, and in addition to its permanent bottom a vertically-movable bottom, substantially as shown and described.

3. In an iron or steel producing furnace, the combination, with the air-chamber forming the stack of the furnace, of the blast-pipe connecting at various intervals or points throughout its height with the air-chamber, substantially as and for the purposes specified.

4. In a furnace for producing iron or steel, the combination, with the air-chamber forming the stack of the furnace and its bottom and provided with an annular chamber, of the blast-pipe having pipe-connection at intervals throughout its height with the air-chamber, said air-chamber having pipe-connection with the said annular chamber, and the said annular chamber connecting with the tuyere-nozzles, substantially as and for the purpose set forth.

5. In an iron or steel producing furnace, the combination, with the air-chamber forming the stack of the shaft-furnace, of the vertically-movable hearth and the tuyere nozzles or pipes connecting with said air-chamber and with one or more tuyere-openings of the hearth, substantially as and for the purpose set forth.

6. In an iron or steel producing furnace, the air-chamber constituting the stack of the furnace, connected with an annular chamber in the bottom end of the furnace, and the vertically-movable hearth having a loose or vertically-movable bottom, and the tuyere nozzles or pipes connecting said annular chamber of the furnace with one or more tuyere-openings of the hearth, substantially as and for the purpose set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CHRISTIAN HUSGAFVEL.

Witnesses:

NERE A. ELFWING,  
H. ANDERSSON.