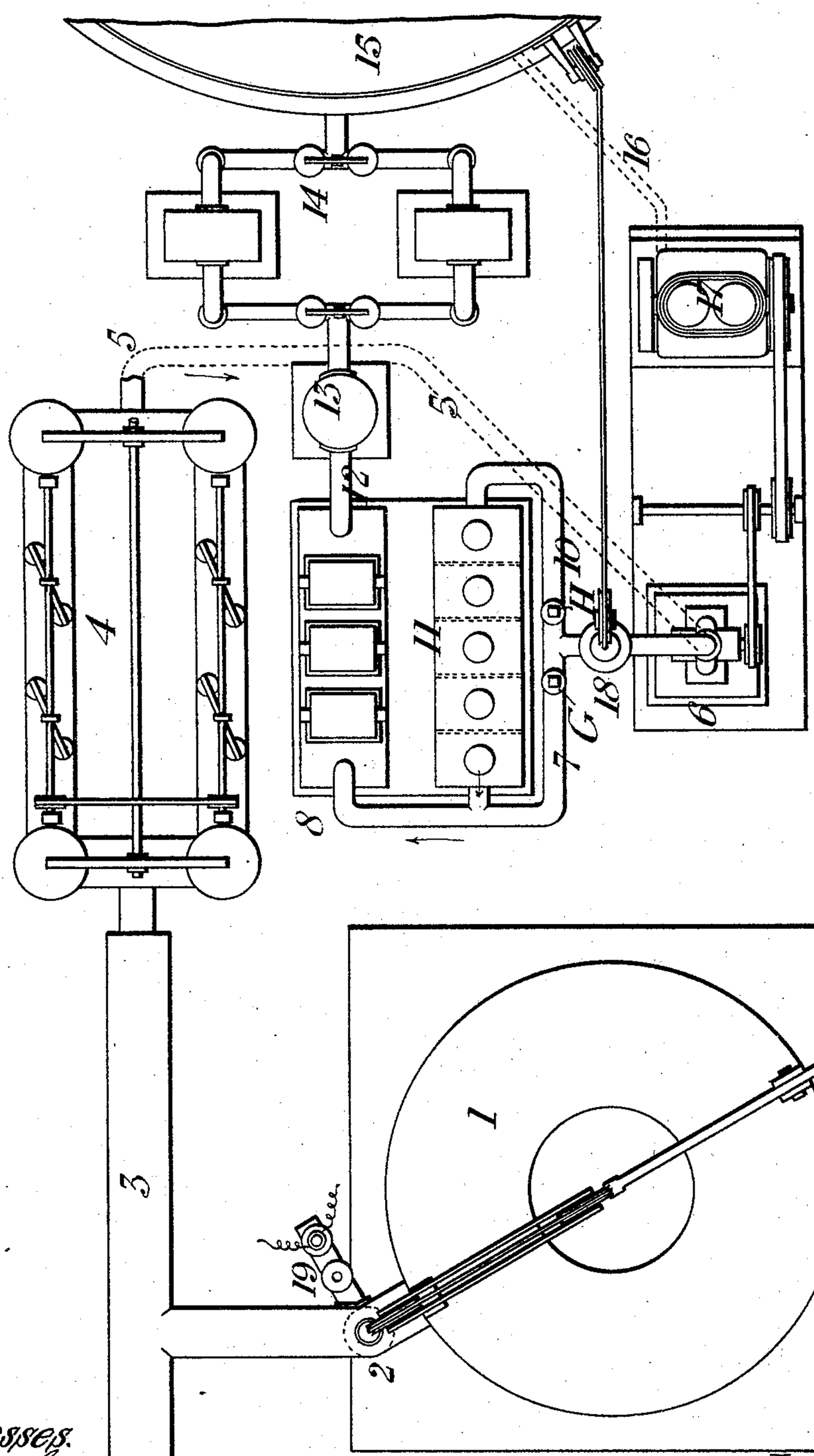
(No Model.) 6 Sheets—Sheet 1.

B. H. THWAITE.

APPARATUS FOR TREATING BLAST FURNACE GASES.

No. 576,005. Patented Jan. 26, 1897.

Fig. 1.



Witnesses.
Thos. A. Grim
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(No Model.) 6 Sheets—Sheet 2.

B. H. THWAITE.

APPARATUS FOR TREATING BLAST FURNACE GASES.

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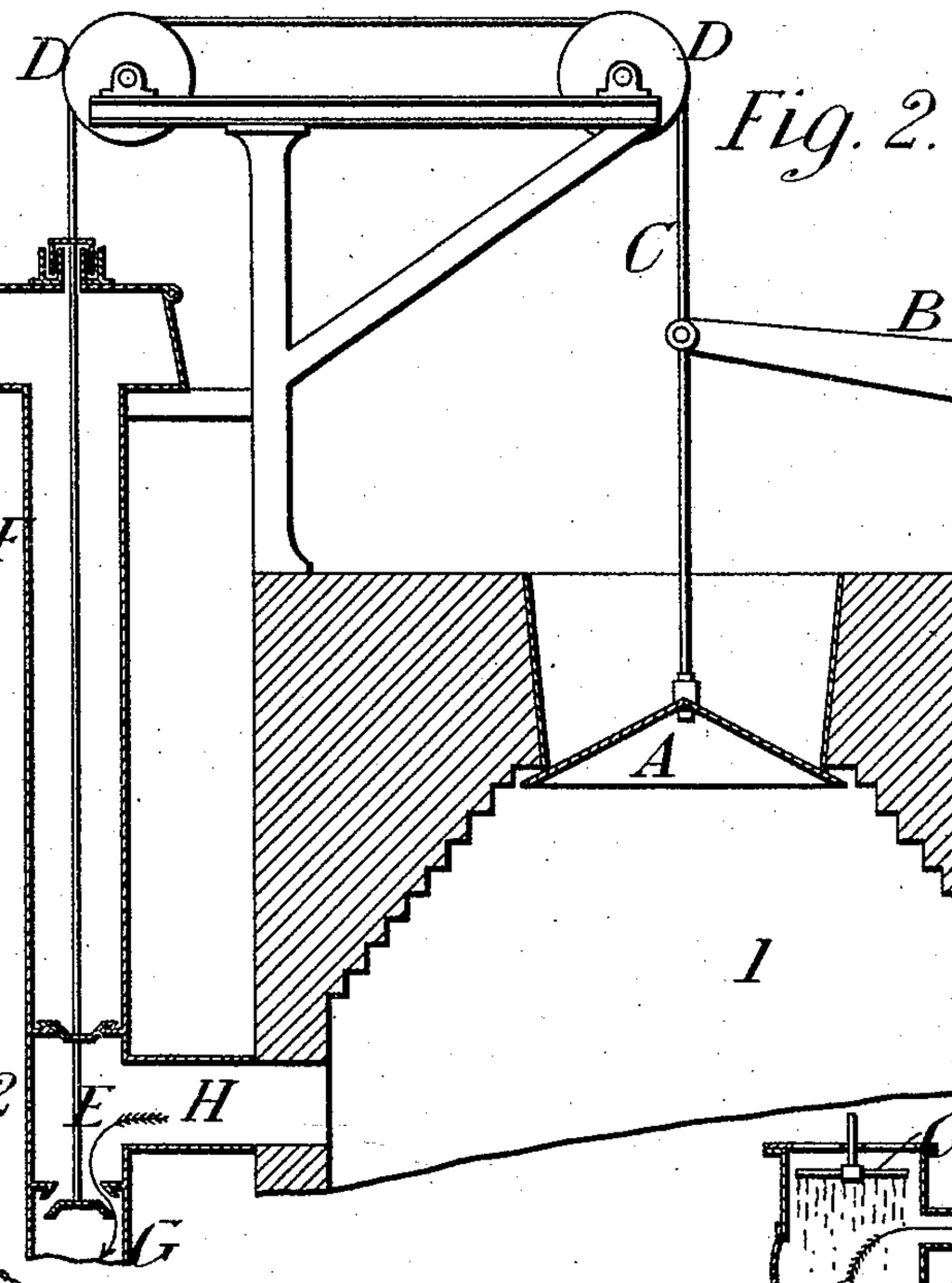

Fig. 2.

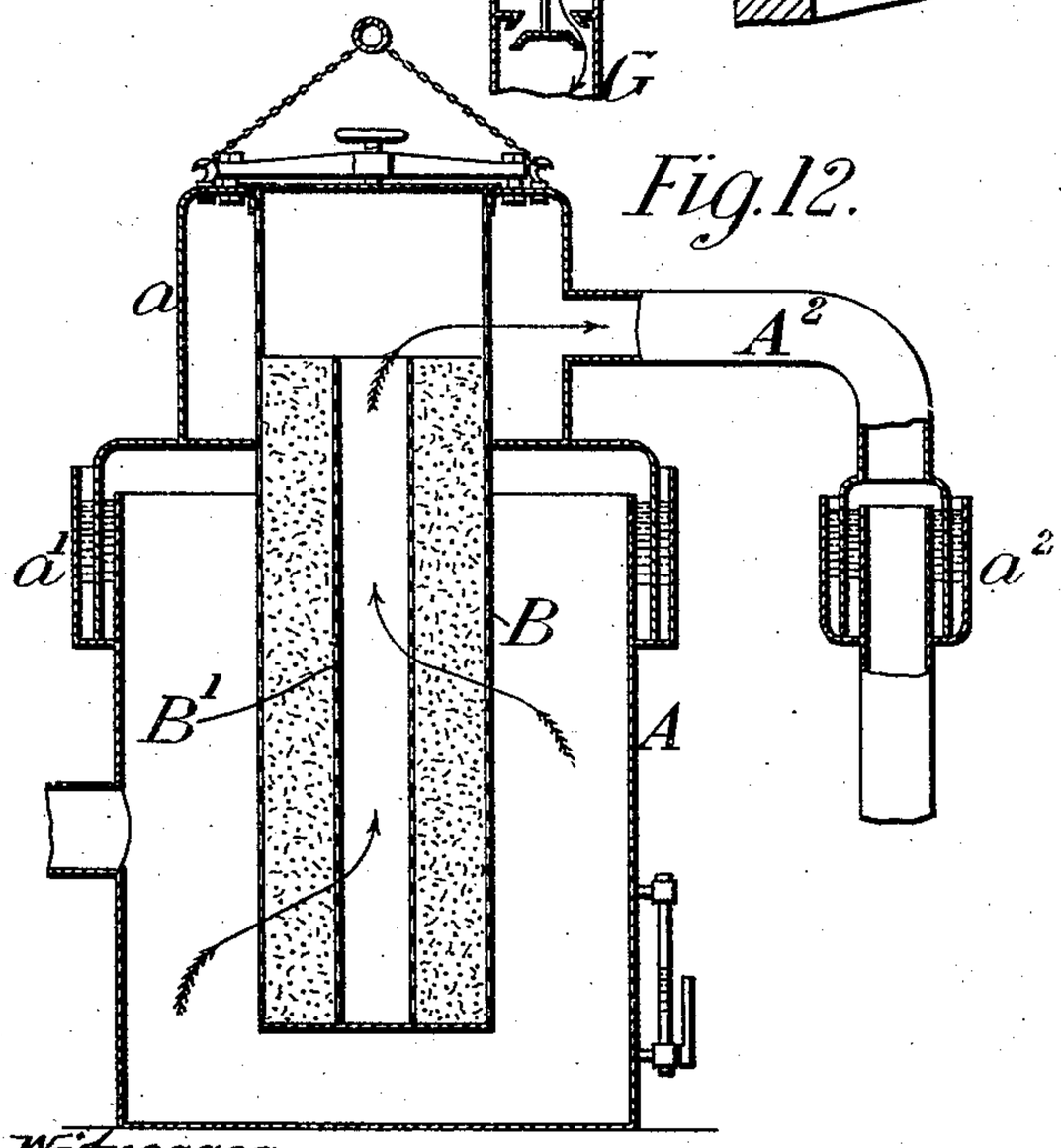

Fig. 12.

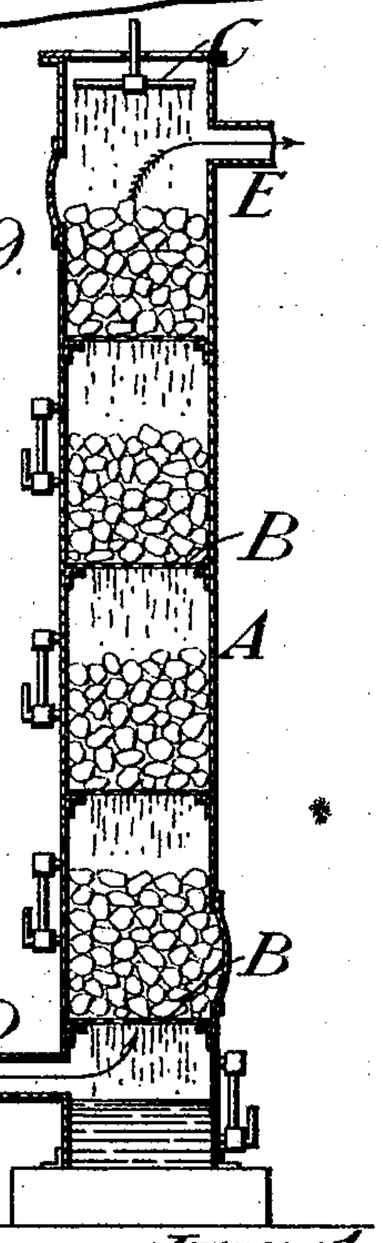

Fig. 9.

Witnesses,
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(No Model.) 6 Sheets—Sheet 3.

B. H. THWAITE.

APPARATUS FOR TREATING BLAST FURNACE GASES.

No. 576,005. Patented Jan. 26, 1897.

Fig. 4.

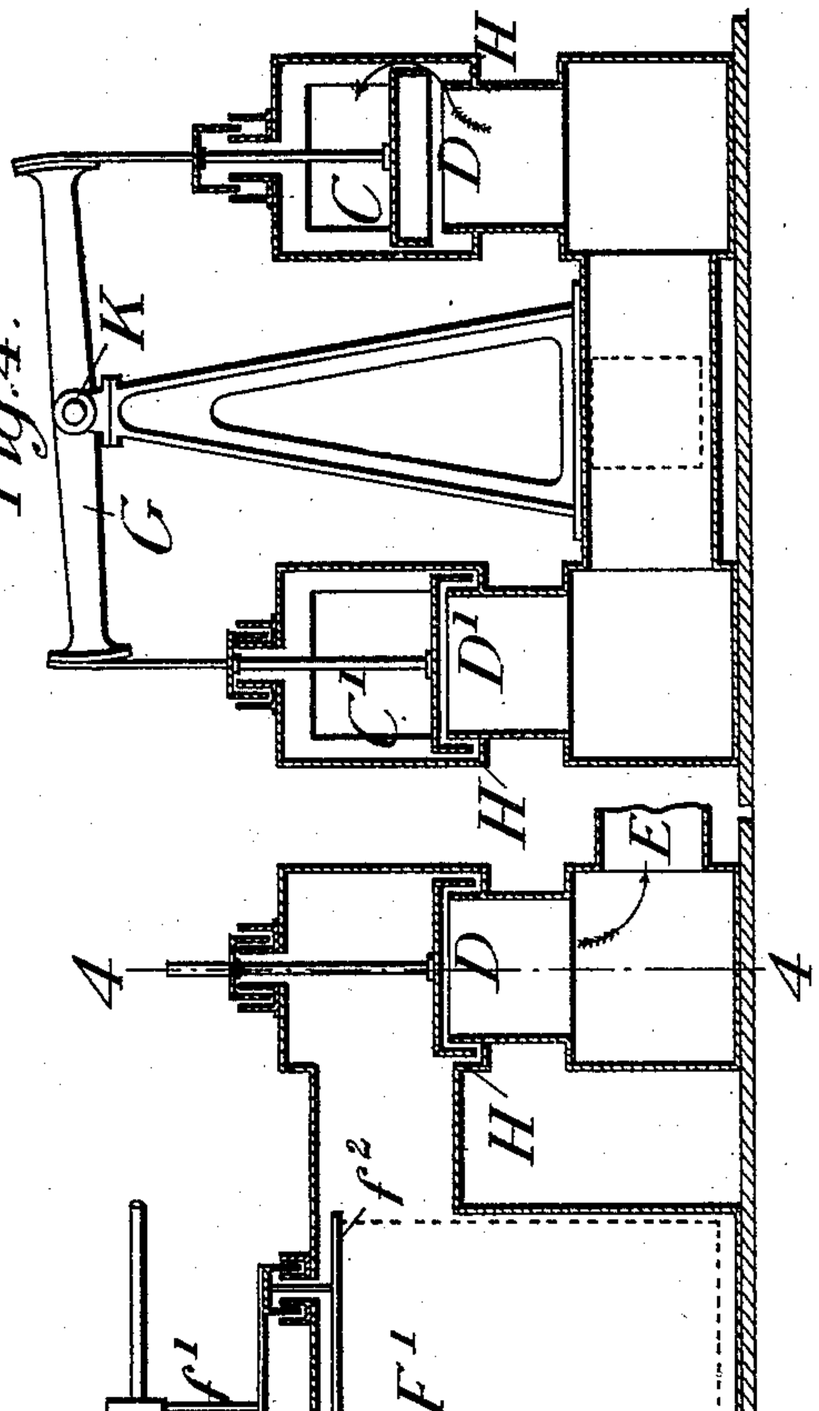
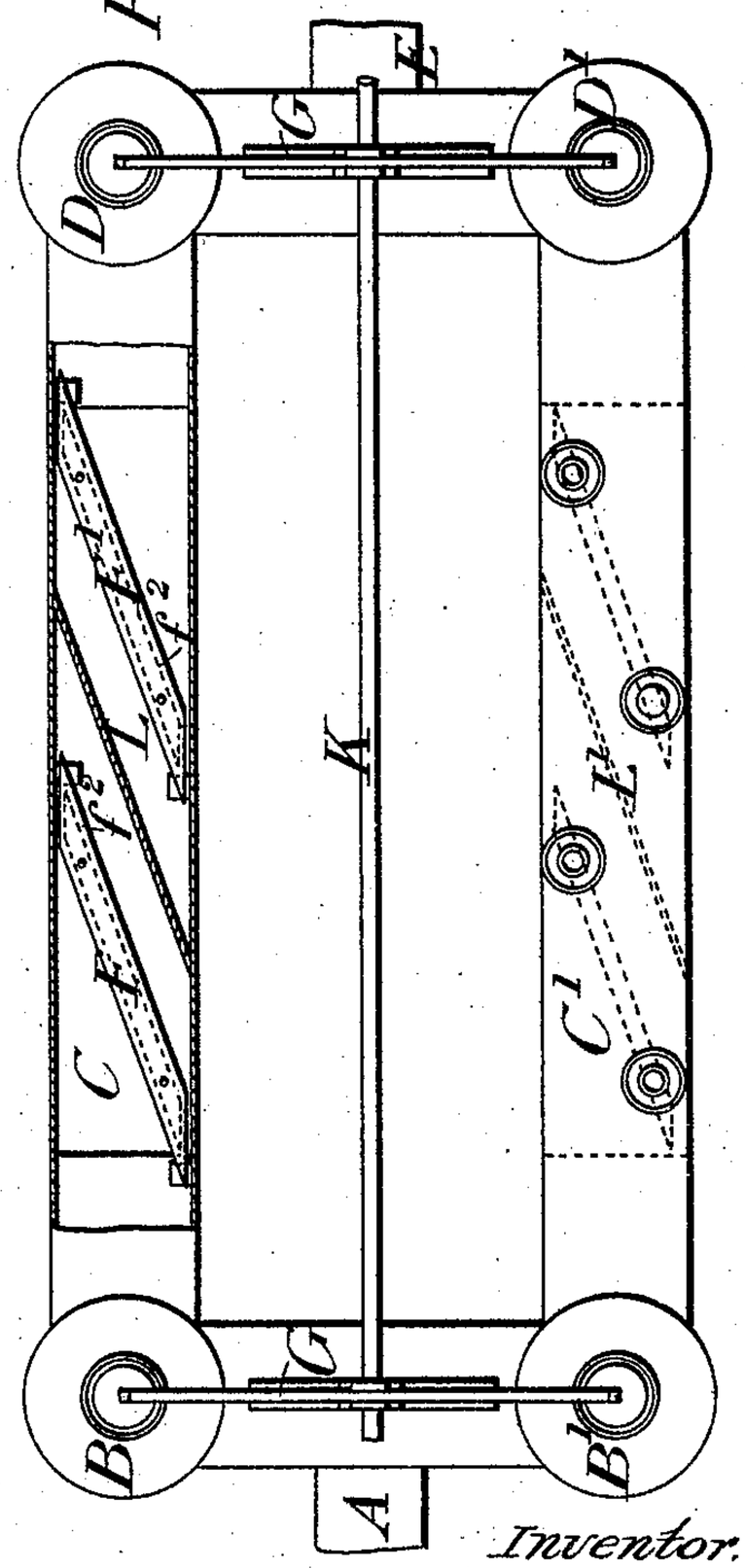


Fig. 3.

Fig. 5.



Witnesses
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(No Model.) 6 Sheets—Sheet 4.

B. H. THWAITE.

APPARATUS FOR TREATING BLAST FURNACE GASES.

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Fig. 7.

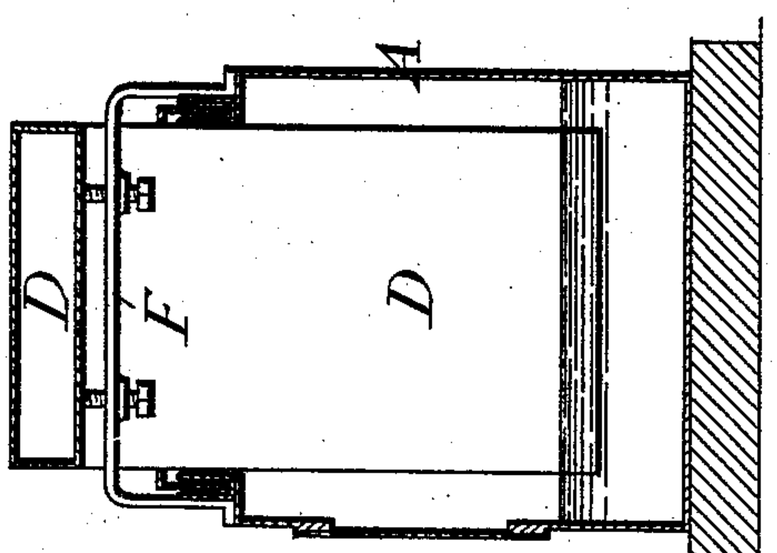


Fig. 6.

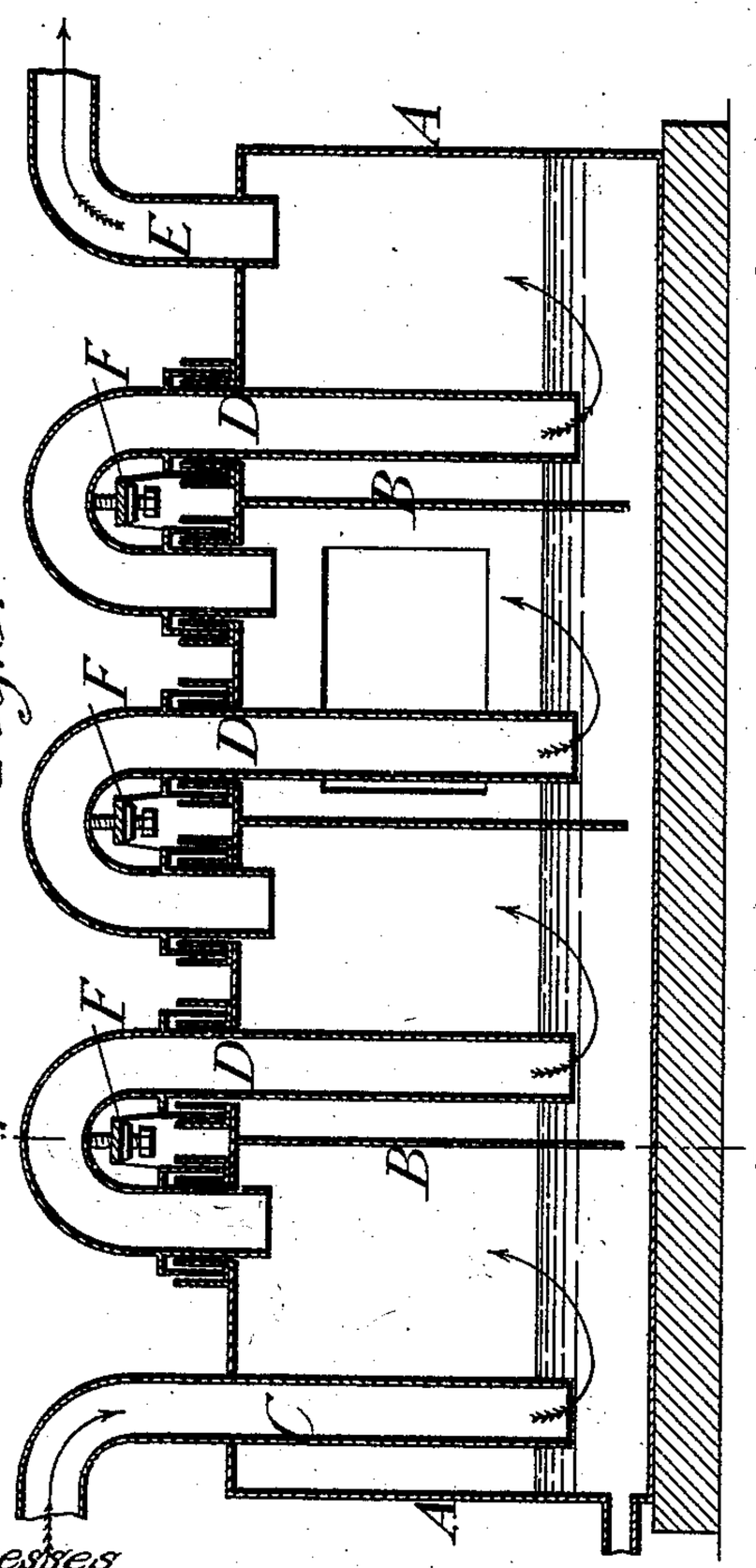
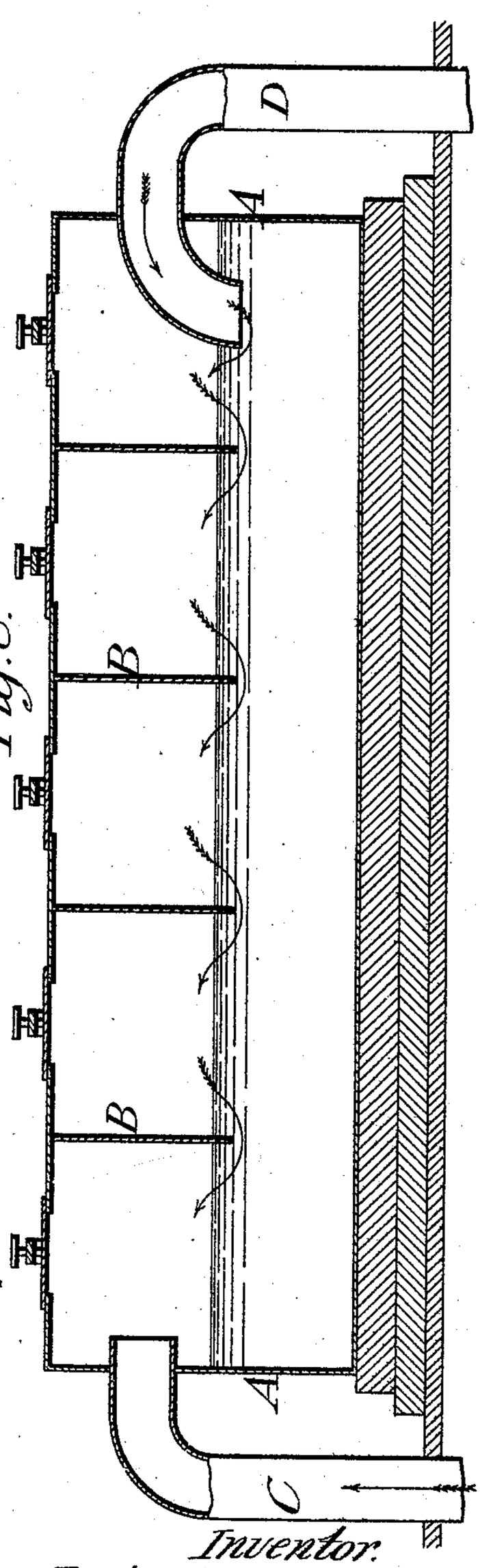


Fig. 8.



Witnesses.
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(No Model.) 6 Sheets—Sheet 5.

B. H. THWAITE.

APPARATUS FOR TREATING BLAST FURNACE GASES.

No. 576,005. Patented Jan. 26, 1897.

Fig. 12.

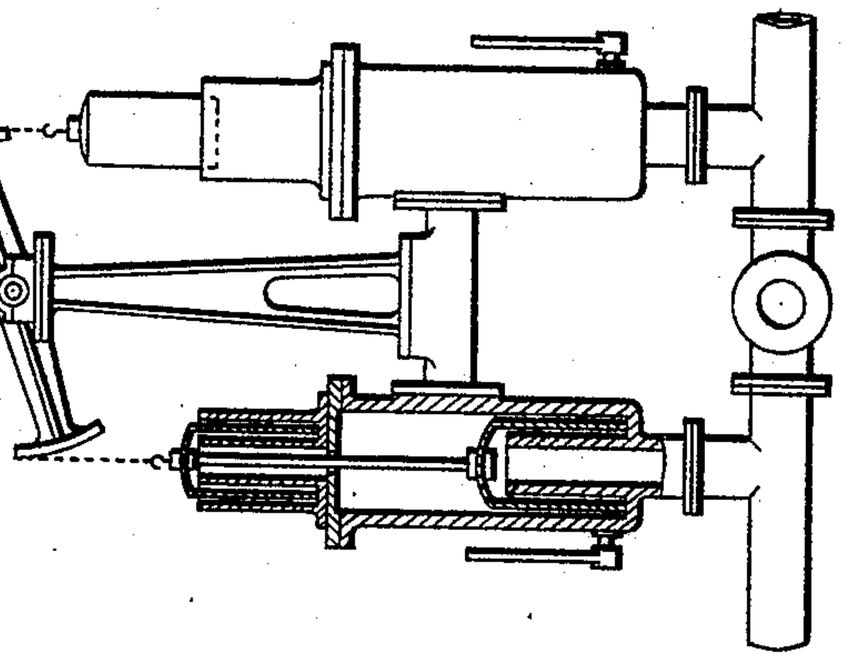


Fig. 10.

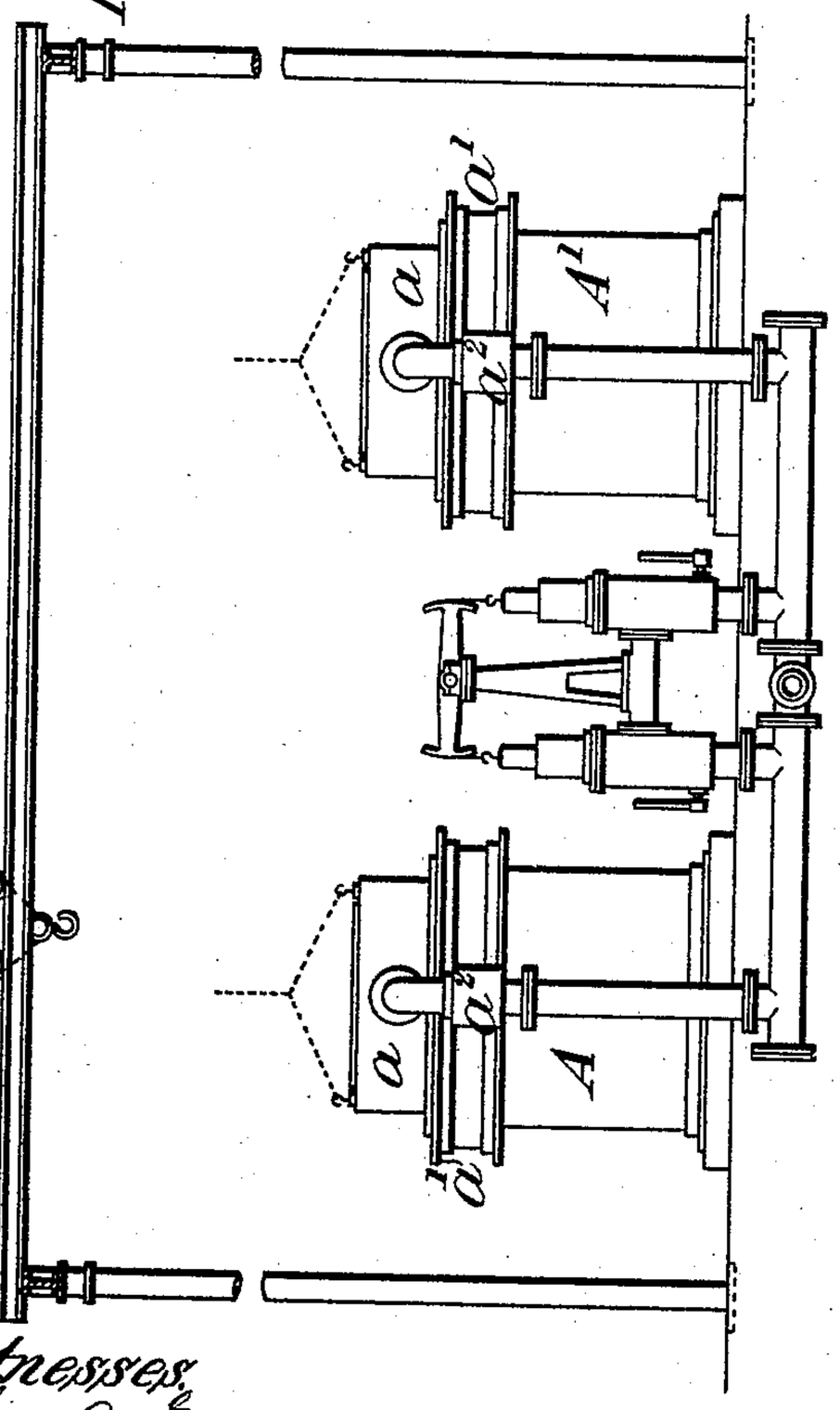
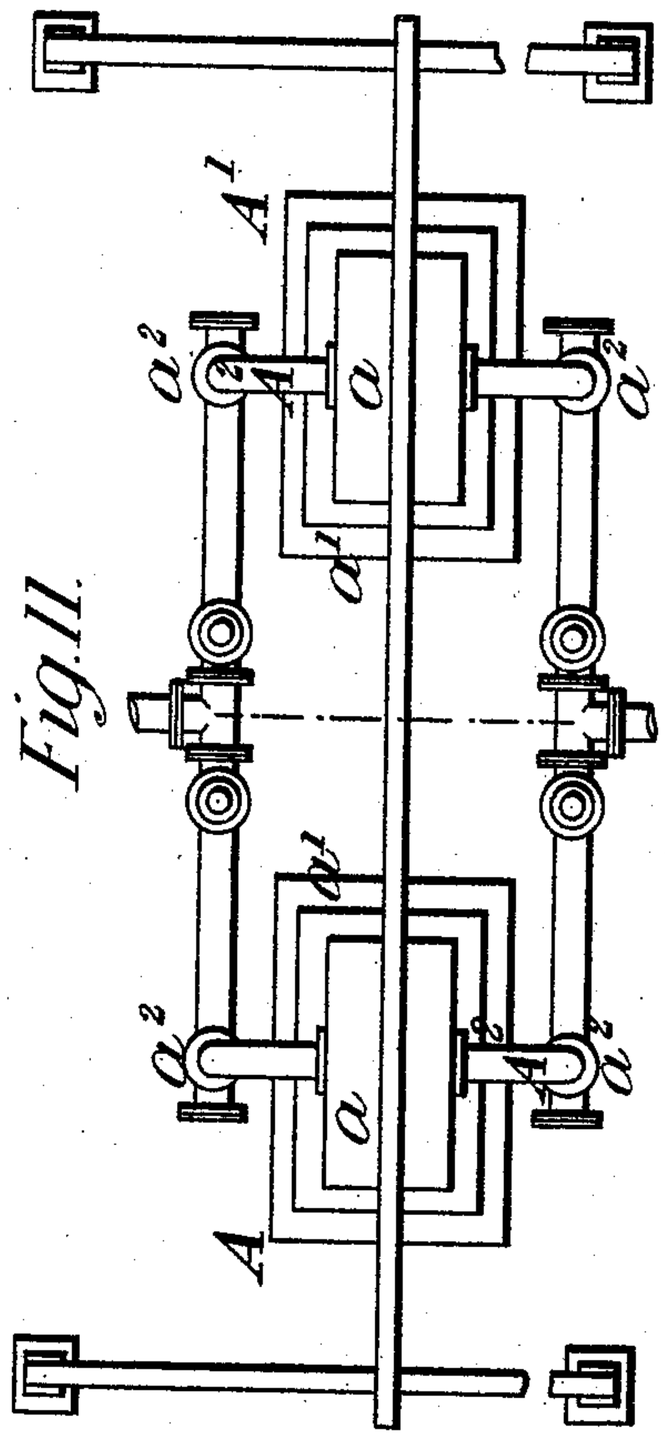


Fig. 11.



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(No Model.) 6 Sheets—Sheet 6.

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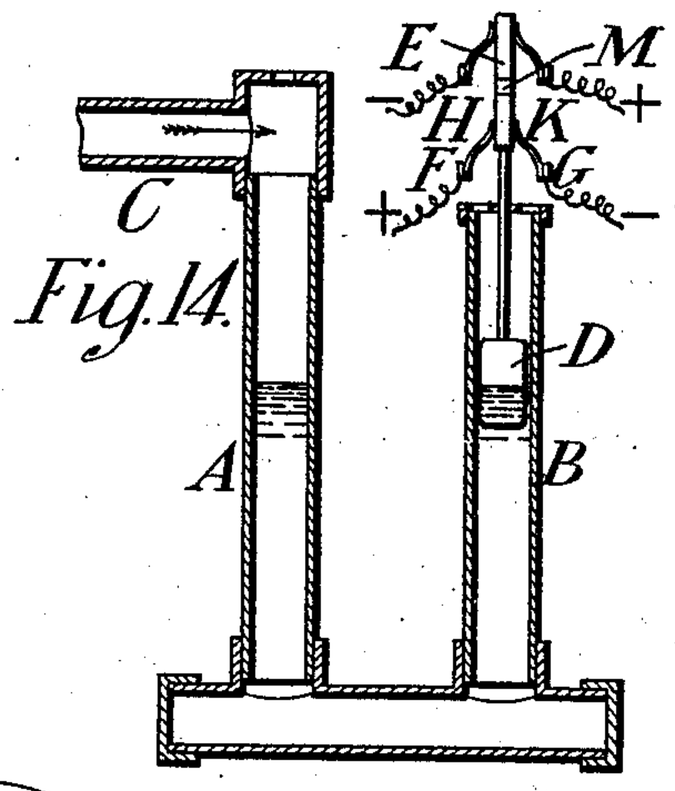


Fig. 14.

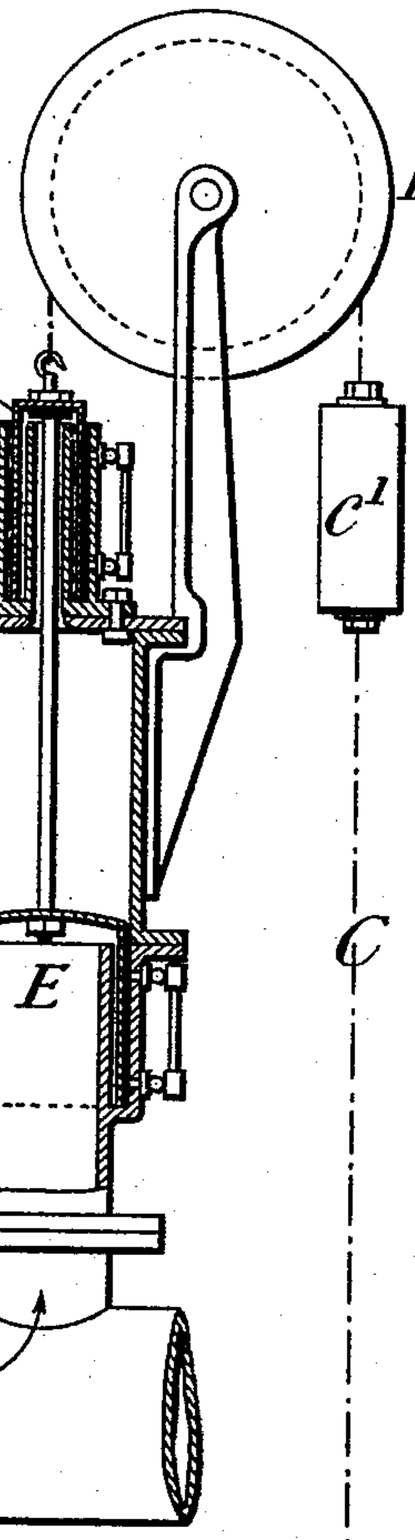
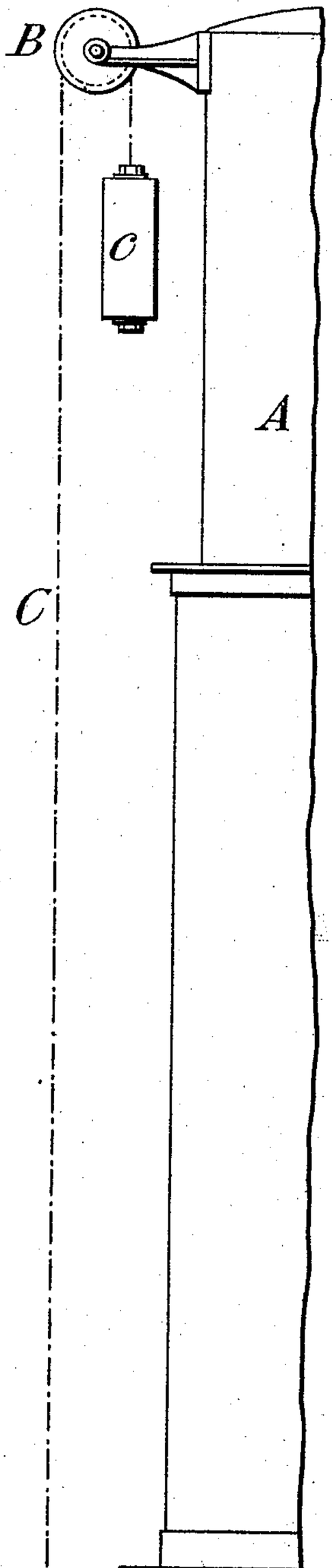


Fig. 13.



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UNITED STATES PATENT OFFICE.

BENJAMIN HOWARTH THWAITE, OF LONDON, ENGLAND, ASSIGNOR OF ONE-HALF TO FRANK LACROIX GARDNER, OF SAME PLACE.

APPARATUS FOR TREATING BLAST-FURNACE GASES.

SPECIFICATION forming part of Letters Patent No. 576,005, dated January 26, 1897.

Application filed July 20, 1896. Serial No. 599,907. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN HOWARTH THWAITE, a citizen of England, residing at 29 Great George Street, Westminster, London, England, have invented new and useful Improvements in Apparatus for Rendering Iron Blast-Furnace Gases Available for Working Gas-Motor Engines, of which the following is a specification.

In order to render blast-furnace gases available for production of motive power by acting in an internal-combustion or gas-motor engine, they have to be thoroughly cleared from matters suspended in them and regulated in pressure and volume to suit the demand.

This invention relates to apparatus for this purpose, consisting of dust-depositing, cooling, washing, scrubbing, and filtering apparatus, some of them preferably arranged in duplicate with valves for alternating their action, so that the blast-furnace gases can be passed through the one set of apparatus while the other set is being cleared of the deposited matters. The gases being drawn from the furnace and propelled by a fan through the cleansing apparatus into a gas-holder from which they pass to the engine, a valve is provided to close the suction-pipe of the fan when the top of the furnace is opened for charging, and a self-acting relief-valve is arranged to come into operation when the gas-holder is fully charged to allow escape of the surplus volume of gases. A water-column and float are also provided, which makes an electric contact to signal the reduction of pressure in the furnace when a twyer happens to give way, so that the suction of the fan may be at once reduced or entirely stopped in order to avoid the generation of an explosive mixture in the conduits. Such being the general character of the apparatus, the arrangement and construction of the several parts thereof will be described, referring to the accompanying drawings.

Figure 1 is a general plan of the whole apparatus. Fig. 2 is a part section of the top of the furnace, suction-pipe, and valve. Fig. 3 is a longitudinal section. Fig. 4 is a transverse section on the line 4 4 of Fig. 3; and Fig. 5 is a plan, partly in section, of duplicate dust-depositing chambers. Fig. 6 is a longitudinal section, and Fig. 7 is a transverse section on the line 7 7 of Fig. 6 of the gas-washing apparatus. Fig. 8 is a longitudinal section of the cooler. Fig. 9 is a vertical section of the scrubber. Fig. 10 is an elevation, and Fig. 11 is a plan, of the duplicate gas-filtering apparatus, of which Fig. 12 is a transverse section drawn to an enlarged scale. Fig. 12ª is an elevation, partly in section, of the valves for alternating the flow of the gases. Fig. 13 is an elevation, partly in section, of the relief-valve 18 for the gas-holder. Fig. 14 is a vertical section of the water-column and float for electrically signaling.

As shown in Fig. 1, 1 is the iron blast-furnace, 2 the valve through which the gases pass to a receiver 3, from which they pass to the dusting apparatus 4. Thence they are led by pipe 5 to the fan 6. From the fan they are propelled either directly by pipe 7 to the washing apparatus 8 or by a by-pass pipe 10, first through a cooler 11, to the washer 8. From the washer 8 the gases pass by pipe 12 to the scrubber 13 and thence through the duplicate filtering apparatus 14 to the gas-holder 15, from which a pipe 16 leads to the engine 17, which is indicated as being a double-cylinder or compound engine. 18 is the relief-valve, which allows escape of gas when the holder 15 is quite charged. 19 is the water-column and float for signaling when a twyer happens to give way.

Referring to Fig. 2, to the stem of the bell-hopper A, which is worked by lever B, a chain C is attached, passing over pulleys D to the stem of a double-valve 2, consisting of the two valves on one stem E in a pipe F G, which communicates by a lateral branch H with the upper part of the smelting-furnace 1. When the bell-hopper A is closed, as shown, the valve 2 is in such a position that the gases coming from the furnace through the branch H pass down the pipe G, which leads to the receiver 3. When the bell-hopper A is lowered for the purpose of feeding the furnace, the valve 2 is raised so as to close the pipe G and allow the gases to escape up the pipe F, the closing of the pipe G preventing the entrance of air which, mixing with the

furnace-gases, might produce an explosive mixture.

Referring now to Figs. 3, 4, and 5, showing the dust-depositing chambers 4, the gases from 3, entering by the conduit A, pass either of the two valves B B′ into either of the two chambers C C′ and thence by the corresponding valve D or D′ and the outlet E to the conduit 5. In the chambers C C′ are suspended oblique screens F F′, which are rapidly moved up and down by eccentrics or cranks on an overhead shaft, moving their rods *f f′*. Each of the screens F or F′ consists of two parallel webs of wire-gauze, the upper edges of which are attached to a bar f^2. The ends of the bars as the screens rapidly descend strike stops projecting from each side of the chamber C or C′, thus causing the dust collected in the meshes of the screens to be shaken off. Each of the valves B B′ D D′ is formed as a bell the edge of which dips into an annular trough H, containing mercury, forming a liquid seal when the valve is closed; also, the rods *f f′* of the screens have fixed on them bells which dip into annular troughs containing mercury of sufficient depth to allow for the vertical rociprocation of the screens. The valves B B′ and D D′ have their rods also provided with bells dipping in annular mercury-troughs, and the rods of each pair are attached to the ends of a sway-beam G, the two sway-beams being fixed on one longitudinal shaft K. When either of the pair of valves B B′ is raised, the other being at the same time lowered, movement is communicated through the shaft K, so that the corresponding valve of the pair D or D′ is opened and the other closed. When the gases have for a time passed through one of the chambers C or C′, depositing dust therein, the valves are moved so as to direct the gases into the other chamber while the former is being cleared of the deposited matter, which is withdrawn through side doors. (Not shown.) Between the screens there are in the chambers partitions L L′, extending about half-way down, so as to direct the gases obliquely through the screens.

Mercury is described as the liquid seal for the valves and their stems, and also for the stems of the screens. Obviously other liquid, such as water, may be used instead of mercury, the depth of immersion being sufficiently increased, so as to sustain the pressure of the gases, which practically is equivalent to a few inches of water column.

In order to insure more rapid and complete deposit of dust, it is preferred to provide to and along the screens insulated conductors with points by which electrical sparks may be passed through the dust-laden gases, these sparks having the known characteristic of causing rapid deposit of suspended particles. In order to connect these conductors to suitable electric generators, I make the stems *f f′* of the screens tubular and lead down them a number of insulated wires, leading to points distributed over each of the two webs of which each screen consists. Each of the wires that is connected to the one terminal of the electric generator having its point projecting from the one web of the screen has directly opposite to it a point of wire connected to the other terminal, so that whenever suitable contacts are made externally a number of sparks pass from the one set of points to the other set.

The fan 6, to which the gases after deposit of dust pass by the conduit 5, is of any known construction, and is driven at such speed as to give the gases a pressure of several inches of water column.

The gas-washing apparatus 8 (shown in Figs. 6 and 7) consists of a vessel A, having partitions B extending nearly to the bottom and dividing the vessel into several chambers. The furnace-gases enter from the conduit 7 by the inlet C, which dips into water occupying the lower part of the vessel. After bubbling through the water they issue from the upper part of the first chamber and pass by a bent conduit D to the next chamber, where they bubble again through the water, and so on from chamber to chamber until they issue by the outlet E to the conduit 12. The bends of the conduits D rest on setting-screws carried by cross-beams F, so that they can be adjusted in height, and in order to allow for this adjustment each limb of the conduits is provided with a bell dipping into a trough of liquid forming a seal. The washing apparatus may be made in duplicate and provided with valves like those described for the dust-depositing apparatus, so that one set may be cleaned while the other continues in operation.

The cooler 11, as shown in Fig. 8, is a vessel A, having partitions B extending down from the top to water, which occupies the bottom of the vessel and into which the lower edges of the partitions dip, so that gases coming from the fan 6 by the conduit 10 and entering by the inlet C, after passing the partition, issue by the outlet D to the conduit 7, leading to the cooling apparatus 8. By opening a valve G in the conduit 7 and closing a valve H on the by-pass 10 the gases are made to pass directly to the cooling apparatus 8. By closing G and opening H they are made to pass through the washer 11 on their way to the cooling apparatus 8. The washed gases pass from 8 to the scrubber 13. (Shown in Fig. 9.) It consists of a tower A, divided into compartments by gratings or perforated plates B, on which is piled coke, kept moistened by a shower of water from a perforated pipe C at the top of the tower. The gases, entering by the inlet D, rise through the interstices of the wetted coke and issue at the top by the outlet E, passing on to the filter 14.

The filter shown in Figs. 10, 11, 12, and 12ª is made in duplicate, with alternating valves arranged as described with reference to the dust-collecting apparatus 4. Each of the two

filtering-chambers A A′ is constructed as shown in Fig. 12. It is made with a removable cap *a*, which has its margin dipping into liquid in a trough *a′*, the pipe A^2, leading from the cap, having a bell dipping into liquid in a trough a^2. From the cap *a* descends a filter having its outer walls B of perforated metal and having inner walls B′ also of perforated metal, or it might be wire-gauze, and between the outer and inner walls filtering material, such as sawdust. In order to give access for cleaning or changing the filtering material, the cap *a* is raised by overhead tackle, raising the filter with it. In the automatic gas-regulating apparatus shown in Fig. 13 A is the bell of the gas-holder, from which gas is taken to the engine. Around a pulley B, carried by a bracket projecting from the bell A, passes a chain C, tightened by a weight *c*. This chain passing over suitable guide-pulleys and a pulley D is connected to the stem of a valve E, which is counterbalanced by a weight *c′*. The valve E is formed as a bell dipping into liquid in an annular trough *e;* also, on the valve-stem is a bell F, dipping into liquid in an annular trough *f*. When the bell A attains a certain height, it raises the valve E, allowing gas to escape from the conduit leading from the fan; but so long as no more gas is supplied to the holder than is consumed by the engine the bell A occupies a lower position, the valve E remaining closed.

The apparatus, Fig. 14, for electrically signaling to the engineer or attendant on the engine and fan when the pressure in the furnace varies beyond certain predetermined limits consists of a pair of pipes A B, connected together at the bottom and charged with a quantity of water, the pipe A communicating at C with the pipe which conducts the gases from the furnace, and the pipe B having in it a float D, the stem of which passes through a guide at the top of the pipe B and is connected to a rod E of insulating material, which as the float D ascends and descends slides between two pairs of contact-springs F G and H K. Through the insulating material passes a piece of metal M, which, when it comes between either pair of the springs, closes the circuit of which they form part, this circuit including a battery and any known visible or audible electrical signaling instrument, both signals being preferable. When the circuit of F and G is closed, the current takes the one direction. When the circuit of H and K is closed, the current is reversed. Thus if owing to the reduction of pressure in the gas-duct and furnace the float D descends so far as to bring the metal M down to the springs F G a circuit is closed, which causes an audible signal, such as a bell, to sound and an index to be deflected to one side, indicating too great reduction of pressure. If, on the other hand, the pressure in the gas-duct and furnace is so far increased that the float rises enough to bring the metal M between the springs H K, then the audible alarm is sounded and the index is deflected in the opposite direction, indicating excess of pressure.

Having thus described the nature of my invention and the best means I know for carrying the same into practical effect, I claim—

1. The combination with a blast-furnace, of a dust-collecting apparatus connected therewith, a washing and cooling apparatus connected with the dust-collecting apparatus, a scrubber connected with the washing apparatus, a filter connected with the scrubber, a gas-holder for collecting the gas as it leaves the filter, a gas-engine and a duct leading from the gas-holder to the engine, substantially as described.

2. The combination with a blast-furnace, of a dust-collecting apparatus connected therewith, a washing and cooling apparatus connected with the dust-collecting apparatus, a scrubber connected with the washing apparatus, a filter connected with the scrubber, a gas-holder for collecting the gas as it leaves the filter, a gas-engine, a duct leading from the gas-holder to the engine, a relief-valve interposed between the blast-furnace and the holder, and means for automatically opening said relief-valve when the gas-holder is full, substantially as described.

3. The combination with a blast-furnace having a valved feed-hopper, of gas-purifying apparatus, a duct leading from said furnace to the gas-purifying apparatus a double-acting valve normally operating to lead the gas from the furnace to said purifying apparatus, and means operating when the feed-hopper valve is opened to actuate said double-acting valve to close the communication between the furnace and purifying apparatus and lead the furnace-gases to an escape-pipe, substantially as described.

4. The combination with a blast-furnace, of a duplex dust collecting-apparatus connected therewith and consisting of two chambers having a gas inlet and outlet, screens arranged in each of said chambers, valves controlling said inlets and outlets, and means for simultaneously operating the valves of both said chambers to permit the passage of the gas through one of the chambers and prevent its passage through the other chamber, substantially as described.

5. The combination with a blast-furnace, of a duplex dust-collecting apparatus connected therewith and consisting of two chambers, vibrating screens arranged in said chambers, and means for alternately causing the gas from the furnace to pass through first one and then the other of said chambers, substantially as described.

6. The combination with a blast-furnace, of a duplex dust-collecting apparatus connected therewith and consisting of two chambers, vibrating screens arranged in said chambers, depending partitions disposed between said screens, and means for alternately causing

the gas from the furnace to pass through first one and then the other of said chambers, substantially as described.

7. The combination with a blast-furnace, gas-purifying apparatus and gas-holder, of a cylinder adapted to contain a liquid subjected to the pressure of the gas passing from the furnace to the purifying apparatus, two normally broken electric signaling-circuits, a float arranged in said cylinder and a circuit-closing device carried by said float and operating to close one or the other of said circuits as the float rises and falls, substantially as described and for the purpose specified.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of July, A. D. 1896.

BENJAMIN HOWARTH THWAITE.

Witnesses:

OLIVER IMRAY,

GERALD LAYTON SMITH.