No. 701,921. Patented June 10, 1902.

C. & A. MUSKER & W. G. HAY.

CONTROLLING THE GENERATION OF STEAM.

(Application filed Oct. 25, 1900.)

(No Model.) 3 Sheets—Sheet 1.

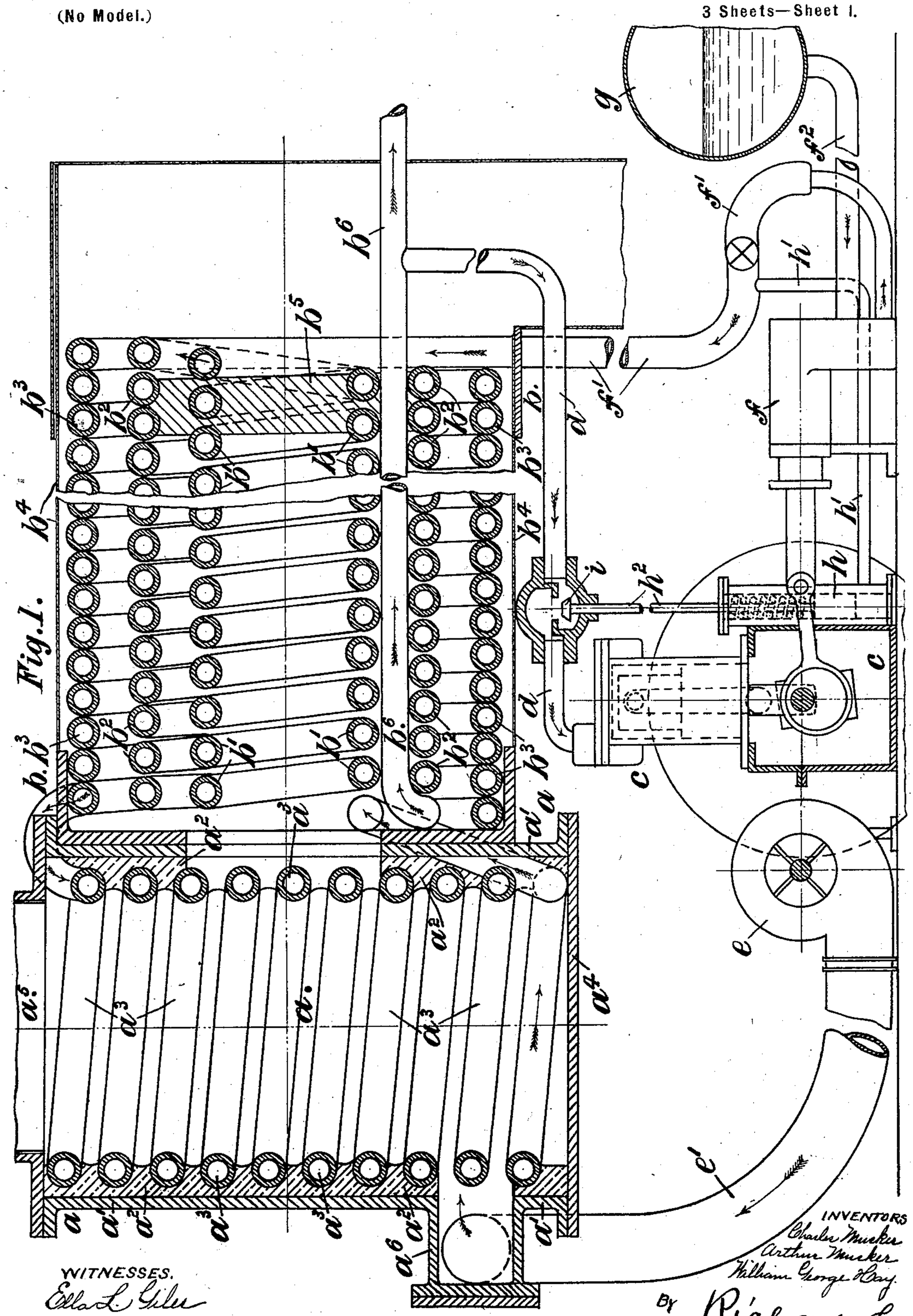

Fig. 1.

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Fig. 2.

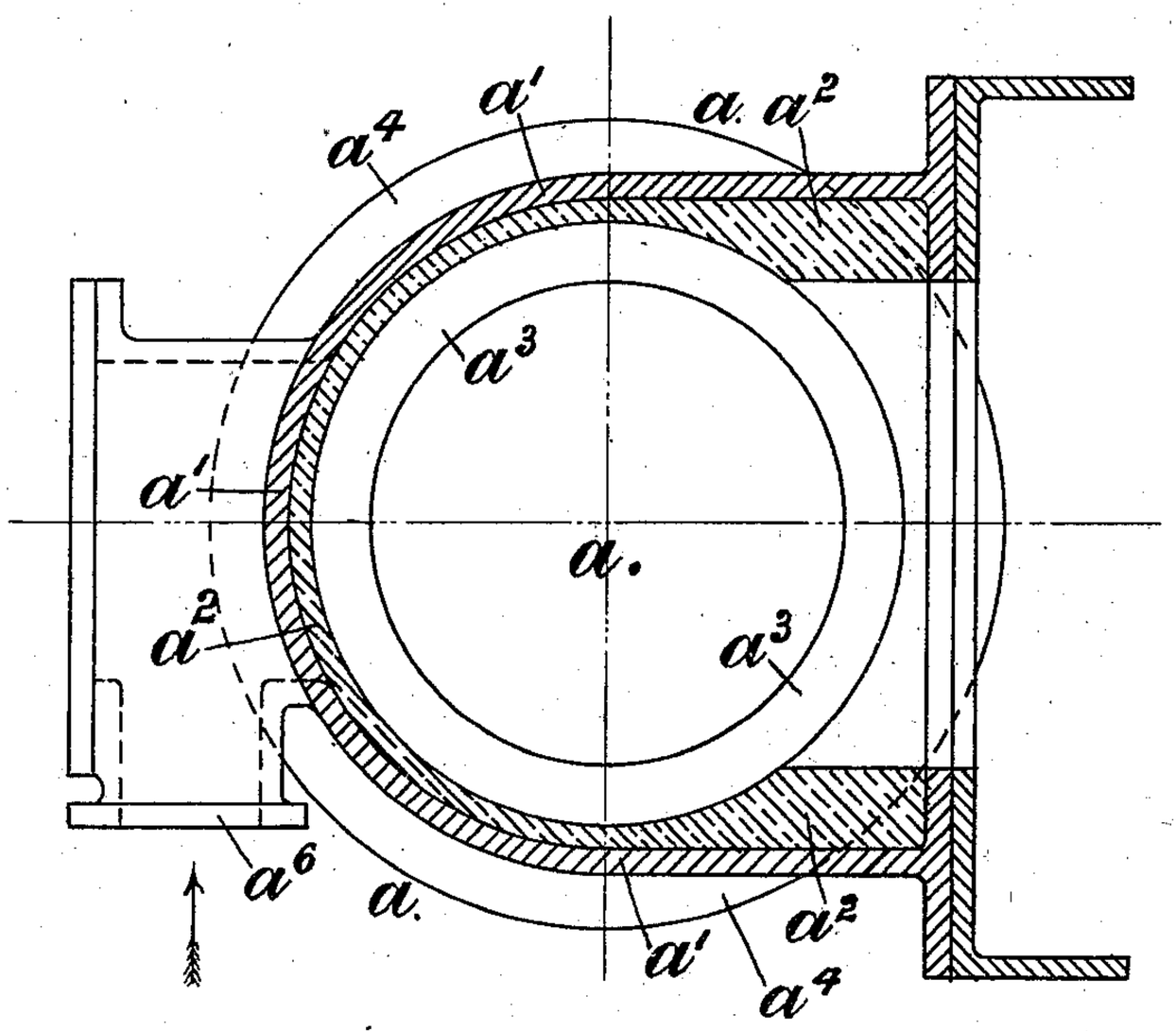

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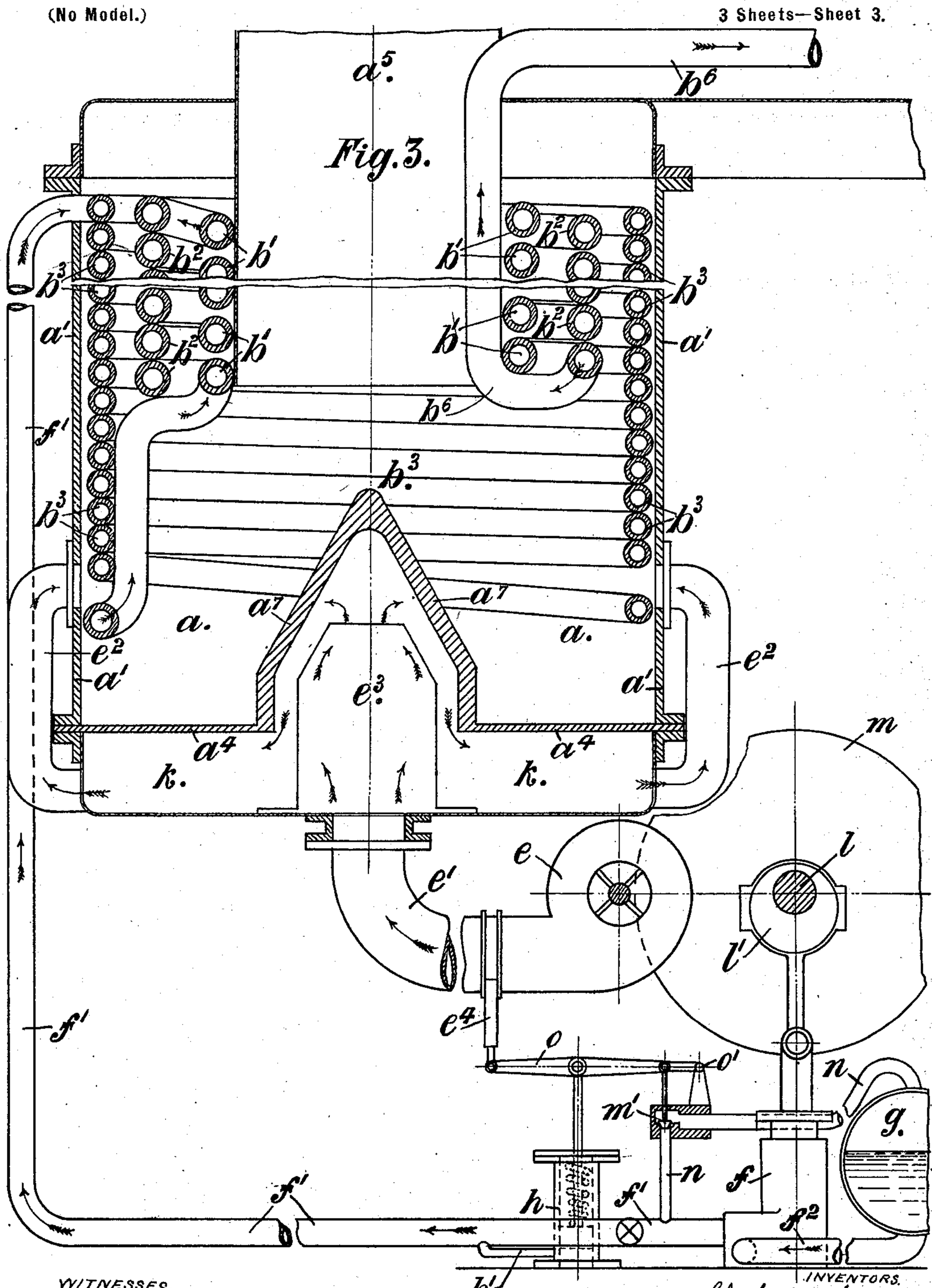
Fig. 3.



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UNITED STATES PATENT OFFICE.

CHARLES MUSKER, ARTHUR MUSKER, AND WILLIAM GEORGE HAY, OF LIVERPOOL, ENGLAND.

CONTROLLING THE GENERATION OF STEAM.

SPECIFICATION forming part of Letters Patent No. 701,921, dated June 10, 1902.

Application filed October 25, 1900. Serial No. 34,262. (No model.)

To all whom it may concern:

Be it known that we, CHARLES MUSKER, ARTHUR MUSKER, and WILLIAM GEORGE HAY, subjects of the Queen of England, and residents of Tue Brook, Liverpool, in the county of Lancaster, England, have invented certain new and useful Improvements in Controlling the Generation of Steam, of which the following is a specification.

This invention has reference mainly to the generation of steam by solid fuel, such as coal or coke, for employment in the propulsion of vehicles on common roads and streets; but it is also applicable for use in propelling navigable vessels and other purposes in which it can be advantageously employed.

It has more particularly for its object to provide improvements in connection with same whereby the generation of such steam is regulated or controlled automatically according to the requirements at all times and under varying conditions and also in some cases its temperature.

According to this invention varying quantities of steam required at different moments are generated by automatically supplying different quantities of air to the fuel of the generator by mechanical means—viz., by air-forcing apparatus—and also variable quantities of water to the generator, and, further, the superheating of the steam is regulated or governed automatically, these variable quantities, or quantities and temperatures, being governed or controlled by the pressure of steam in the generator through a suitable governor, which acts directly or indirectly on such air-supply and feed-water-supply means. The furnace portion, including the ash-pit or hearth, will be a closed one, and the air will be forced directly from the fan or other blower into it.

This invention is illustrated in the annexed drawings, in which—

Figure 1 is a longitudinal sectional elevation of the improved system and combination, and Fig. 2 is a plan in cross-section of the furnace portion of the steam-generator. Fig. 3 shows a modified arrangement of the apparatus.

Referring to the drawings, and in the first instance to Figs. 1 and 2, *a* is the portion of the steam-generator in which the solid fuel is disposed and burned, forming the "fireplace" or furnace proper of the generator, while *b* is a different portion, into which gaseous products of combustion given off from the fuel burned in the portion *a* are passed, and these gases give up their heat to the water-containing tubes therein.

The fireplace portion *a* is comprised of an iron casing a', having an internal lining a^2 of fire-brick or fire-resisting material, and a coil of pipe a^3, through which all the water contained in the generator is forced to circulate. The fireplace is a closed one, having a closed bottom a^4 and closed storage feed-hopper a^5.

The portion *b* of the generator is a series of concentric coils, there being three in the case shown, b' being the inner coil, b^2 the intermediate coil, and b^3 the outer coil, and these coils are contained within a casing b^4, and the space within the inner and intermediary coils at the outer end is closed or blocked by a plug b^5.

c is a small or auxiliary motor for supplying air for burning the fuel in the fireplace *a* and for forcing the water through the coils of the steam-generator. This engine is supplied with steam through a pipe *d*, connected with the main steam-supply pipe b^6, which conveys steam from the steam-generator to the main steam propelling-engine of the autovehicle or vessel, as the case may be.

e is an air-fan driven by the auxiliary engine *c* and connected with the bottom of the fireplace *a* through the air-pipe e' and an air-inlet branch a^6 on the casing a'.

f is the water-supply pump for supplying the generator-coils with water, f' being the delivery-pipe for conveying the feed-water to the pipe-coils of the generator, and f^2 is the intake-pipe, connecting the pump with the supply water tank or reservoir *g*.

h is a pressure-governor consisting, say, of a piston working in a cylinder, one side of the piston of which is in communication with the pressure of the generator or pipe connected with same, and the other is pressed down by a spring. In the case shown this communication is effected by a pipe h', connecting the bottom of the cylinder of the governor *h* with the steam-generator water-feed pipe f', while the

piston of this governor is connected by a rod h^2 with a governor-valve i on the steam-supply pipe d of the auxiliary motor c.

In action the fireplace a would be kept charged with coke or fuel, and air would be supplied to it by the fan e in regulated quantities through the instrumentality of the auxiliary engine c, which will be kept constantly running, its rate of speed only being varied when the pressure in the steam-generator pipe system becomes greater than that required. When this happens, this pressure acting on the piston in the governor h presses it up and moves the valve i toward its seat in the valve-case, with the result that the supply of steam passing to the engine c through the pipe d is diminished, and consequently the rate of speed of the engine is reduced. This reduction, of course, causes less air to be delivered by the fan e into the fireplace a, in which the fuel is burned, and consequently less heat is generated and steam made. Concomitantly with this the rate of movement of the water-pump f, feeding the boiler with water, is reduced in velocity and less water is supplied to it. When the pressure of steam again falls to the normal, the valve i is opened by the spring acting on the piston of the govenor h, overcoming the pressure acting against it, whereupon the engine c is given more steam, and the volume of air and water supplied to the furnace or fireplace a and generator is again increased. Thus the greater the quantity of steam used by the motor-engine supplied through the pipe b^6 the higher would be the velocity of the air-fan e and pump f and the greater volume of air and water delivered—that is, these quantities synchronize with the rate of consumption of steam taken from the steam-generator.

In the modification shown in Fig. 3 the steam-generator pipes, as well as the furnace portion, are disposed within a single vertical casing a', and the air supplied by the blower e is discharged into a chamber k beneath the bottom plate a^4, and from this chamber it passes by the pipes e^2 into the furnace a, in which the solid fuel would be disposed and burned. The bottom plate a^4 in this case is provided with an upwardly-projecting cone a^7, and the air from the pipe e' is led by a conduit e^3 into the upper part of this cone, from whence it passes downward to the lower part of the chamber k. By this construction the cone a^7 would be very hot, and the air passing over it will become heated, so that it will be supplied in this hot state to the fuel.

A further modification illustrated in Fig. 3 is connected with the driving of the fan e and the water-pump f for supplying water to the steam-generator coils. This modification consists in driving the fan and pump by the main propelling-engine itself, of which l represents the crank-shaft, and m the wheel on this shaft for driving the fan e, the plunger of the pump f being driven by an eccentric l' on the shaft l. In this case the governing of the air is regulated by a slide shutter-valve e^4 on the air-supply conduit e' and actuated by the governor h, while the quantity of water is regulated by a valve m' on a conduit n, communicating between the supply water-tank g and the delivery-pipe f' of the pump f. The action of these parts is that when the pressure in the boiler, and consequently the pipe f', becomes above the normal this pressure acts through the pipe h' on the piston of the pressure-governor h and through the lever o, fulcrumed at o', moves the slide of the valve e^4 in and partially closes the air-conduit e' and at the same time opens the valve m' and allows the return of water from the delivery-pipe f' of the pump to the water-tank g to take place. When the steam-pressure is normal or under normal, the spring of the governor h acting on its piston presses it down and opens the air-shutter of the valve e^4 and closes the return-water-controlling valve m'.

What is claimed in respect of the herein-described invention is—

In steam-power machinery, wherein the rate of generation of steam is automatically governed, the combination of a steam-generator, comprising a plurality of annular coils b' b^2 b^3; a closed furnace a adapted to receive and have solid fuel burned within it, in direct connection with the heating-space about said coils; an auxiliary steam-motor c; a pipe d connected with the steam-supply pipe of the generator, for supplying steam to the motor c; controlling-valve i on said pipe d; a pressure-governor h actuated by the pressure within the steam-generator, connected with and adapted to operate the valve i; a pipe h' connecting said pressure-governor with a suitable pipe connected with the steam-generator and subject to the pressure thereof; an air-supplying fan e and feed-water pump f, both driven by the auxiliary motor c; and conduits e' and f' connecting the fan with the closed furnace a, and the pump with the steam-coils of the steam-generator respectively; substantially as herein set forth.

In witness whereof we have hereunto set our hands in presence of two witnesses.

CHARLES MUSKER.
ARTHUR MUSKER.
WILLIAM GEORGE HAY.

Witnesses:
JNO. W. BROWN,
FRANK E. FLEETWOOD.