(No Model.)

3 Sheets—Sheet 1.

W. CLARK.

STEAM BOILER.

No. 315,243.

Patented Apr. 7, 1885.

Fig 1

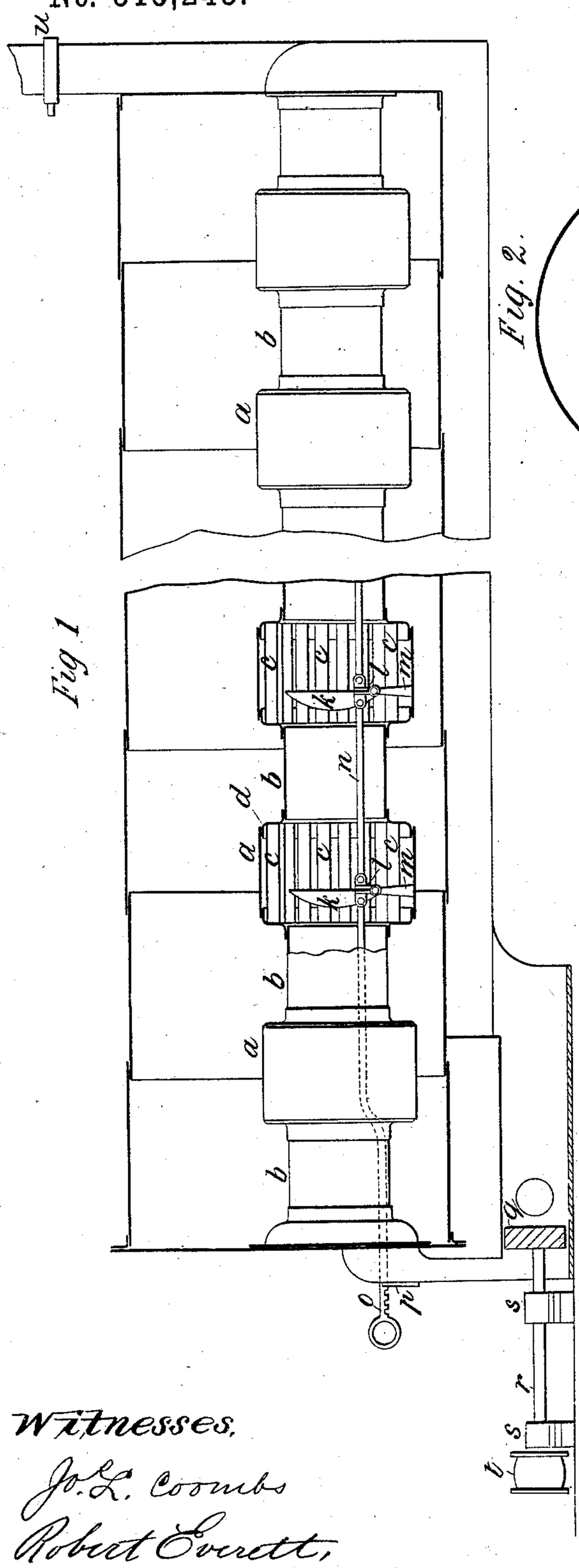


Fig. 2.

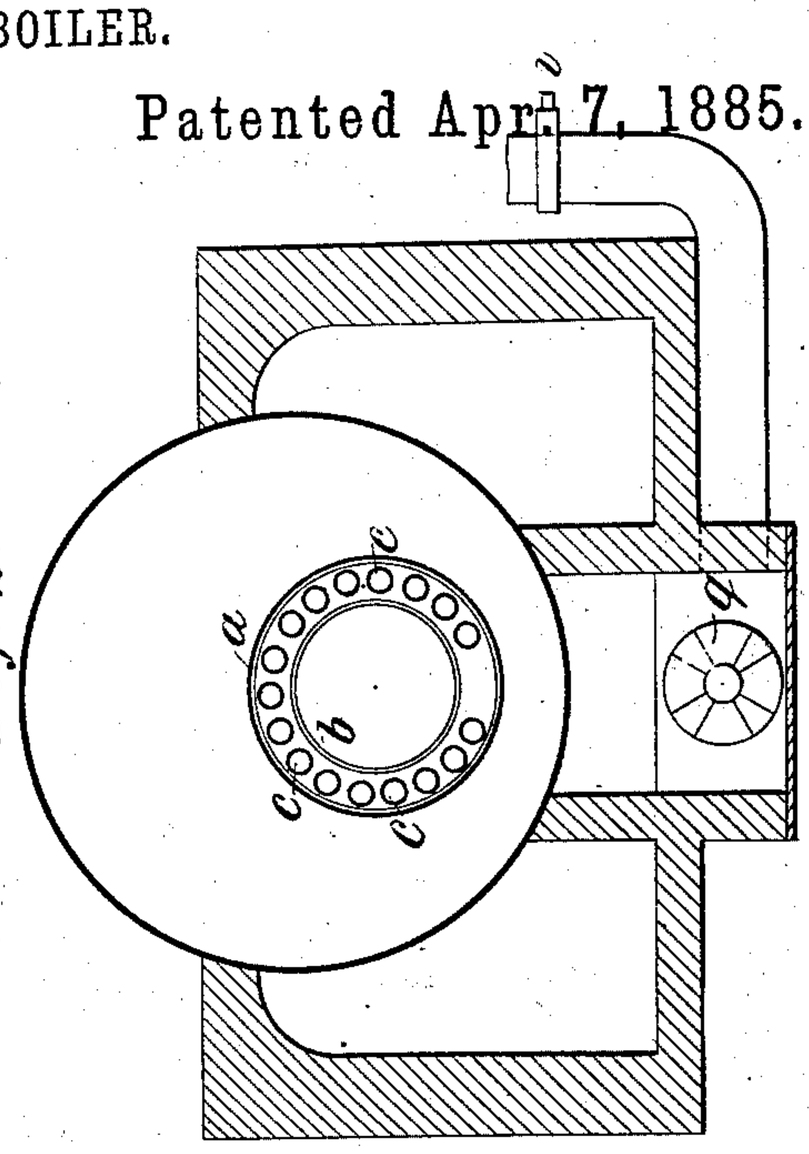
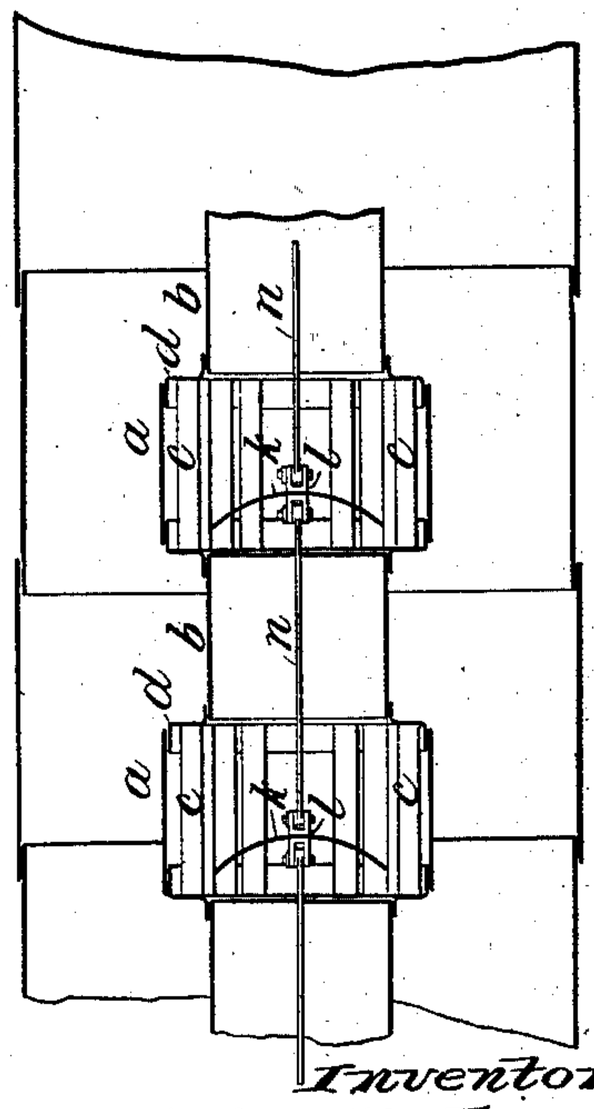


Fig. 3.



Witnesses.

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Robert Everett,

Inventor.

William Clark.

By James L. Norris

Atty.

(No Model.)

3 Sheets—Sheet 2.

W. CLARK.

STEAM BOILER.

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Fig. 4.

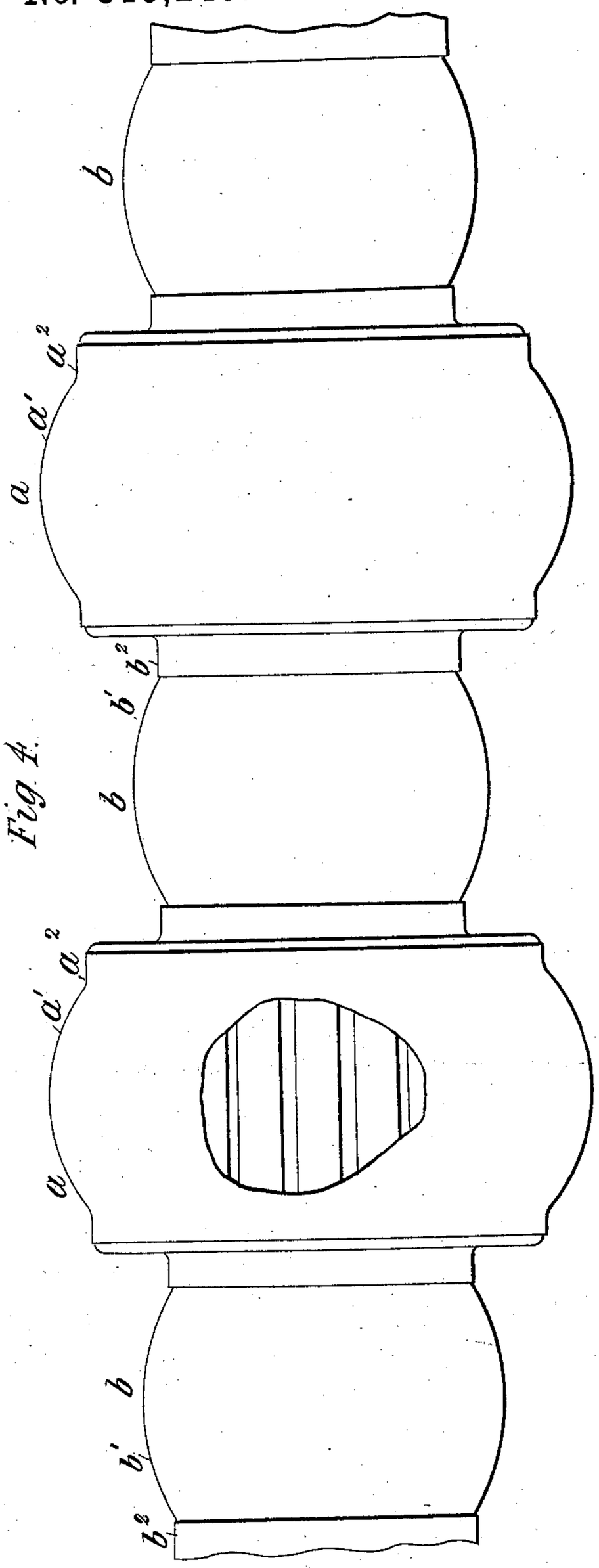


Fig. 6.

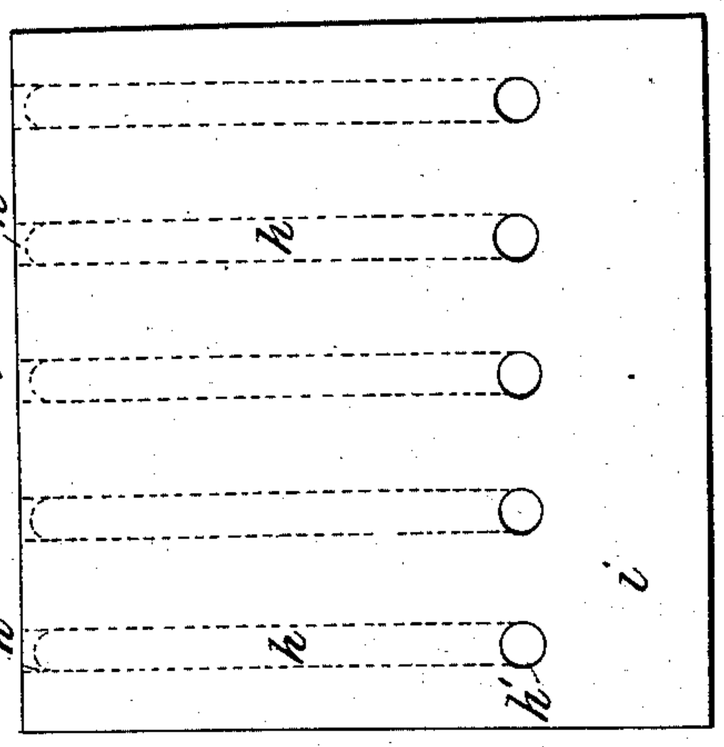


Fig. 3ª.

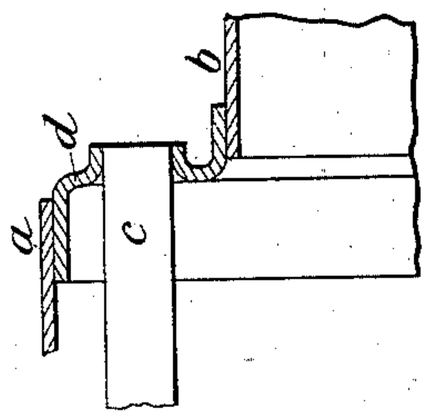
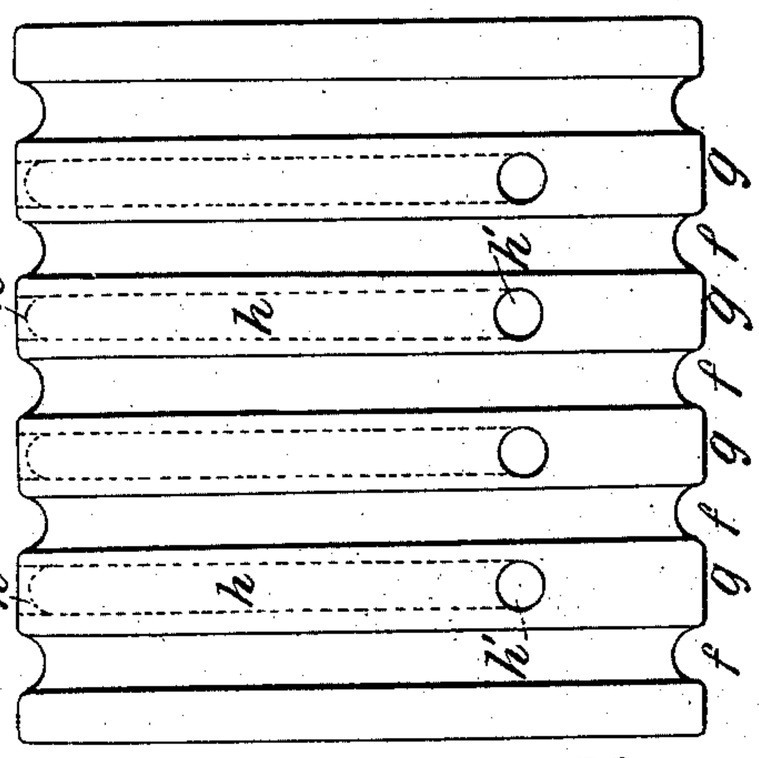


Fig. 5.



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

W. CLARK.

STEAM BOILER.

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Fig. 8.

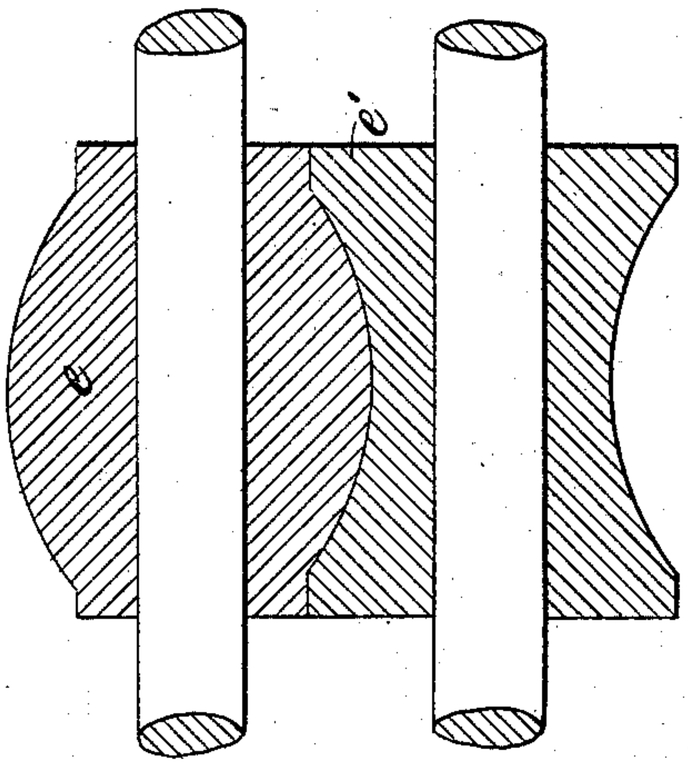


Fig. 9.

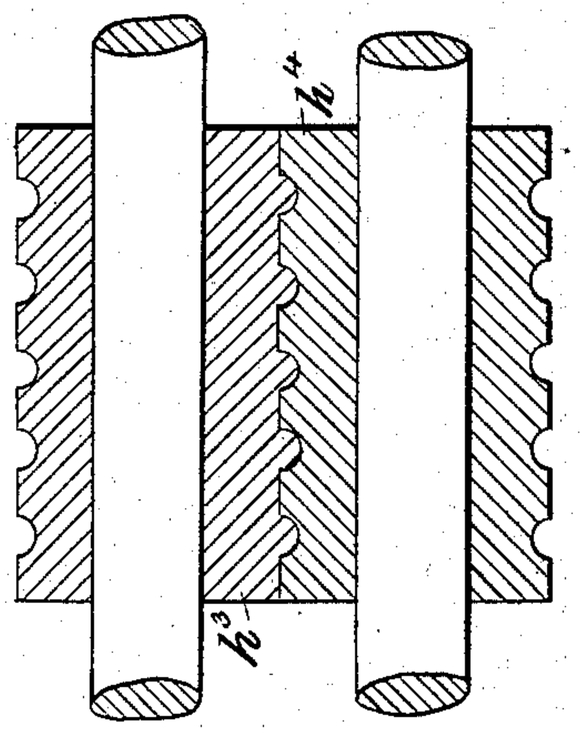
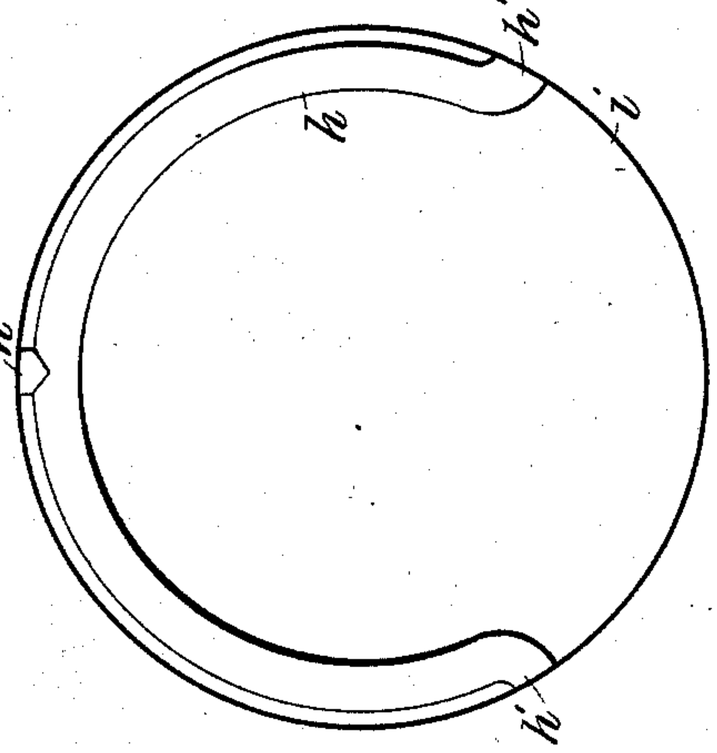


Fig. 7.



Witnesses.

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William Clark.

By James L. Norris.

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UNITED STATES PATENT OFFICE.

WILLIAM CLARK, OF PLUMSTEAD, ENGLAND.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 315,243, dated April 7, 1885.

Application filed June 24, 1884. (No model.) Patented in England March 31, 1884, No. 5,714, and in Belgium March 31, 1884, No. 64,686[B].

To all whom it may concern:

Be it known that I, WILLIAM CLARK, engineer, a subject of the Queen of Great Britain, residing at Plumstead, England, have invented new and useful Improvements in and Relating to the Construction and Heating of Steam-Boilers, (for which I have applied for provisional protection in Great Britain on the 31st day of March, 1884, No. 5,714, and for which I have obtained a patent in Belgium dated March 31, 1884, No. 64,686[B],) of which the following is a specification, reference being had to the accompanying drawings.

My invention has for its object to increase the heating-surface of flue-tubes for steam-boilers and to strengthen the same, to offer great resistance to compression, and also to retard the movement of currents of heated air and gas and compel them to remain longer in the flues and around the boiler, thereby the more fully to utilize the heat generated in the furnace.

My invention may be conveniently and advantageously carried into practice in the manner illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal central section of a boiler embodying my improvements. Fig. 2 is a transverse section of the same. Fig. 3 is a horizontal section of part of the said boiler. Fig. 3[a] is a section showing the manner in which the water-tubes and angle rings or plates are usually joined together. Fig. 4 is a side elevation, partly in section, drawn to an enlarged scale, showing a modified form of my improved flue-tube. Fig. 5 is a side elevation of a flue-tube provided with water-tubes, as hereinafter described. Fig. 6 is a side elevation, and Fig. 7 a transverse section, showing the application of the said water-tubes to existing plain cylindrical flue-tubes. Figs. 8 and 9 show different forms of rolls for manufacturing flue-tubes similar to those shown in Figs. 4 and 5.

Like letters indicate corresponding parts throughout the drawings.

In carrying my said invention into practice I arrange around or partially around the interior of a furnace or flue-tube a series of tubes, through which the water in the boiler will circulate, and upon the exterior of which the heated air and gases in the said furnace or flue-tube will act, so that the heating-surface of the boiler is greatly increased. The flue-tubes shown in Figs. 1, 2, and 3 are made in sections; but instead of being of the same diameter throughout the alternate sections are made of different diameters—that is to say, there is a large section, *a*, between two small sections, *b*, and each large section has extending longitudinally through it a series of water-tubes, *c*, opening at their ends just outside of the adjacent small sections and fixed in double angle-iron rings or plates *d*. The said water-tubes *c*, therefore, are in connection with and filled by the water in the boiler, and the heat-currents in the flue act not only upon the surface of the flue-plates *a* and *b*, but also all around the water-tubes *c*. By constructing the flue tube or tubes of a boiler in this manner I greatly augment the heating-surface thereof and obtain an increased evaporation of the water in the boiler with less consumption of fuel. The plates *d* are usually swaged or bent outward around the holes, as shown in Fig. 3[a], so that the tubes can be easily fitted therein and made water-tight. In some instances I make the flues in both the large and small sections plain; but for flues of large diameter I form the various sections of the flue-tubes with undulations or corrugations; or I form the flue-sections into bulbous or barrel-shaped figures, as shown in Fig. 4—that is to say, I first form the sections of plain plates with welded joints. I then place them in a furnace until the required heat is obtained and pass them through a set of rolls, which are so constructed as to impart to the plain circular plates the required bulbous, corrugated, or other shape, leaving a plain or parallel part at each end to form a lap-riveted or other joint; or, if desired, the flue-sections may be formed from a bloom or solid piece of iron or other metal forged and rolled into the required form.

In Fig. 8 I have shown a pair of rolls, *e e'*, such as I employ for manufacturing the sections of the flue-tube shown in Fig. 4, in which

a' b' are the bulbous or barrel-shaped portions, and a^2 b^2 the plain or parallel parts for the joints. By this form of construction I increase the resistance of the said sections to external pressure, and I am thus enabled to make them of thinner plates than would otherwise be the case.

According to another modification of my invention, instead of arranging the water-tubes longitudinally, as above described, I make the said tubes bent or curved to correspond with the circumference of the flue-tube and insert them therein. I sometimes form flue-tubes by rolling or otherwise into a series of regular or irregular corrugations with plain portions, into which curved water-tubes are inserted, as shown in Fig. 5, in which *f f* are the corrugations, *g g* the plain portions, and *h h* the curved water-tubes.

The flue-tube shown in Fig. 5 is formed by means of rolls, such as those shown at h^3 h^4 in Fig. 9. The whole length of the flue or any part of it may be provided with these curved water-tubes. The said tubes may be connected to the flue-tubes at two or more points; but I prefer to connect them at three points, as shown in Fig. 7—that is to say, the two ends of the said water-tubes are connected to the flue-tubes at a convenient distance from the bottom or lower part of the same, as shown at *h'*, and the intermediate portion of the water-tube is connected with the top or crown of the said flue-tube, as shown at h^2. Suitable holes are formed in the flue-plates for the reception of the said ends and intermediate portion of the water-tubes, the metal around them being swaged or bulged up to thicken and strengthen the plates at the parts that receive the said water-tubes, which may be expanded and fixed in the said holes, according to the well-known method of fixing tubes in boilers. The water enters the bent tubes at the two ends and escapes at the top aperture. I thus insure a continuous circulation from the lower to the higher parts of the boiler and a very rapid evaporation of the water. The aforesaid bent or curved water-tubes can be conveniently fixed to existing ordinary plain cylindrical flue-tubes without removing them from the boiler by simply pressing the ends of the tube toward each other, so that it can be inserted in the flue-tube and will then expand; and when properly arranged these water-tubes will insure a very efficient action of the heated currents in passing along the flue and a more rapid evaporation of the water in the boiler. This form of construction is shown in Figs. 6 and 7, in which *i* is the flue-tube, and *h h* are the water-tubes.

I sometimes provide the flue-tubes with a series of plates or shields to retard the passage of the heat and cause the heated currents to impinge more effectually upon the flue-plates and water-tubes. If desired, I may employ, in combination with the longitudinal water-tubes shown in Figs. 1 to 3, bent or curved water-tubes arranged around or partially around the interior of the small sections of the flue-tube, so as to still further increase the heating-surface.

In Figs. 1 and 2, *k k* are the said shields or plates, which are mounted on arms or levers *l*, hinged or jointed to eyes or eyebolts *m*, fixed in the flue. These arms or levers are connected by links *n*, and a rod or bar, *o*, is attached to the first of the said arms or levers and extends to the front of the boiler, where it is conveniently arranged to be moved to and fro for the purpose of raising and lowering the said plates or shields, and thus regulating or controlling the passage of the heated gases or products of combustion through the flue. The rod *o* may be notched, as shown, so that it can engage with a stud or projection, *p;* or other suitable means may be provided for securing the said rod in the desired position.

Instead of allowing the heated currents of the gases and smoke from the furnace to escape from the flues, I provide for keeping them in circulation through the flues by means of an air propeller or circulator, by which they are caused to return below the furnace and up through the fire-grate. The unconsumed gases thus having to pass up repeatedly through the fire-grate are quickly ignited and greatly increase the heat. This air propeller or circulator is shown at *q*, in Figs. 1 and 2, mounted on a shaft, *r*, which is carried in bearings *s*, and driven by means of the pulley *t*. A damper or air-valve, *u*, is placed at the uptake or any convenient part, and another damper or air-valve, *v*, is placed in front of the propeller or circulator, so as to regulate the admission or passage of air to assist combustion. With this arrangement I can maintain a slow combustion in the furnace with great advantage, and in some cases I can work with both dampers closed, the heated currents being kept in circulation by the propeller without being allowed to escape from the flues.

What I claim is—

1. A flue-tube having raised sections *a* and small sections *b*, arranged alternately, in combination with the angle-plates *d*, formed with flanges, as shown, and connecting the raised sections to the small sections, and tubes fitted within the raised sections, with their ends resting in said plates and opening outside of the small sections, substantially as described.

2. The combination, with a flue-tube, of an arched water-tube located within the same and provided with extensions connecting said tube at its ends and a point intermediate thereof to the flue-tube, and at such points communicating with the water-space outside of the flue-tube, substantially as described.

3. The combination, with a flue-tube consisting of large sections *a* and small sections *b*, as above described, of the plates or shields *k*, pivoted to the said large sections and ar-

ranged to be raised and lowered, substantially as and for the purpose set forth.

4. The combination of the flue-tube having raised or enlarged portions, the retarding-shields located therein, the water-circulating tubes located inside the tube within such enlarged portions, and the air-propeller for returning the unconsumed gases back to the fire-grate beneath the same, substantially as and for the purpose set forth.

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

WILLIAM CLARK.

Witnesses:
JOHN E. BOUSFIELD,
ALFRED WAUGH.