(No Model.) 2 Sheets—Sheet 1.

T. KAYS.

STEAM BOILER.

No. 315,511. Patented Apr. 14, 1885.

Fig. 1.

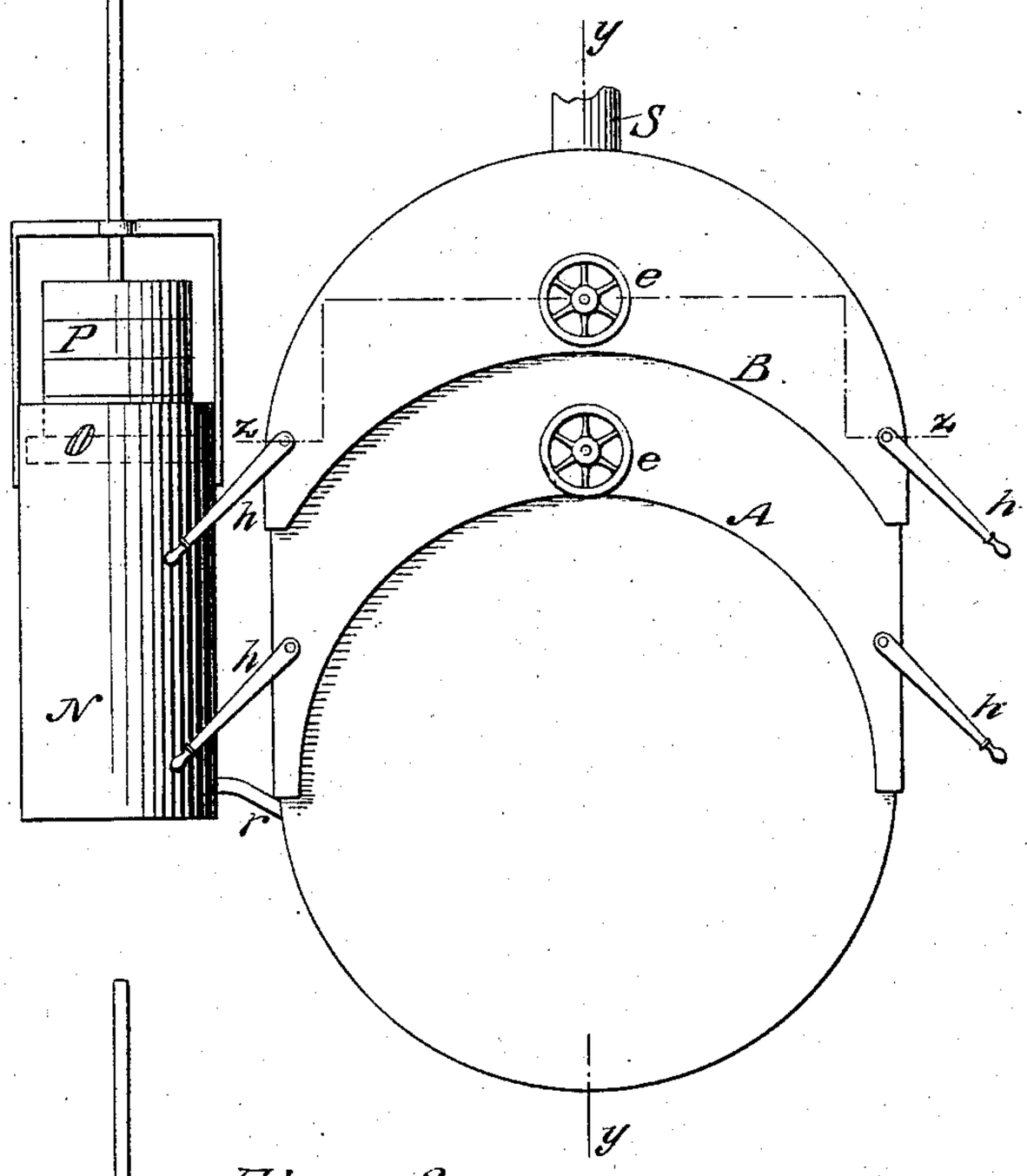
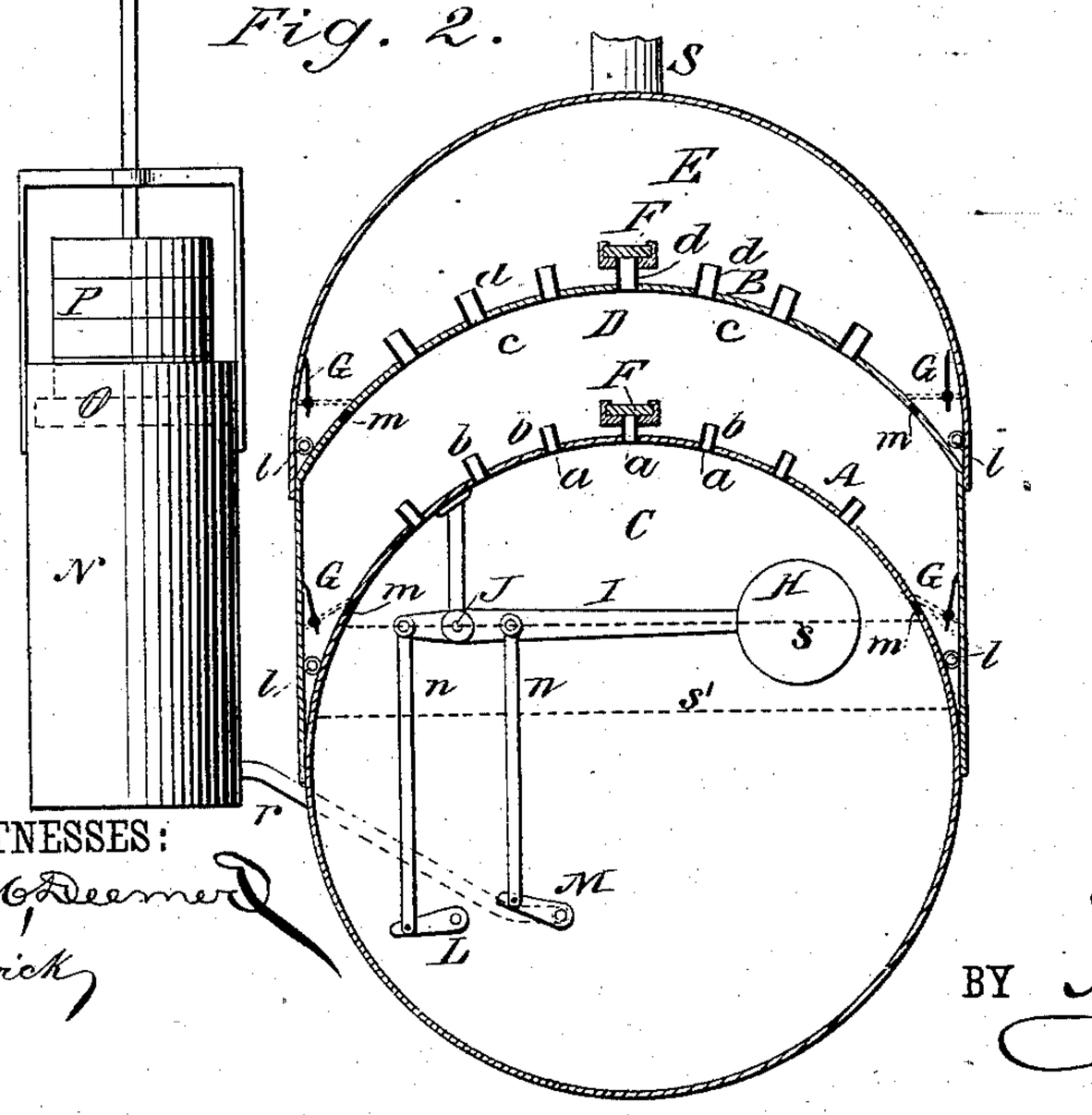


Fig. 2.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

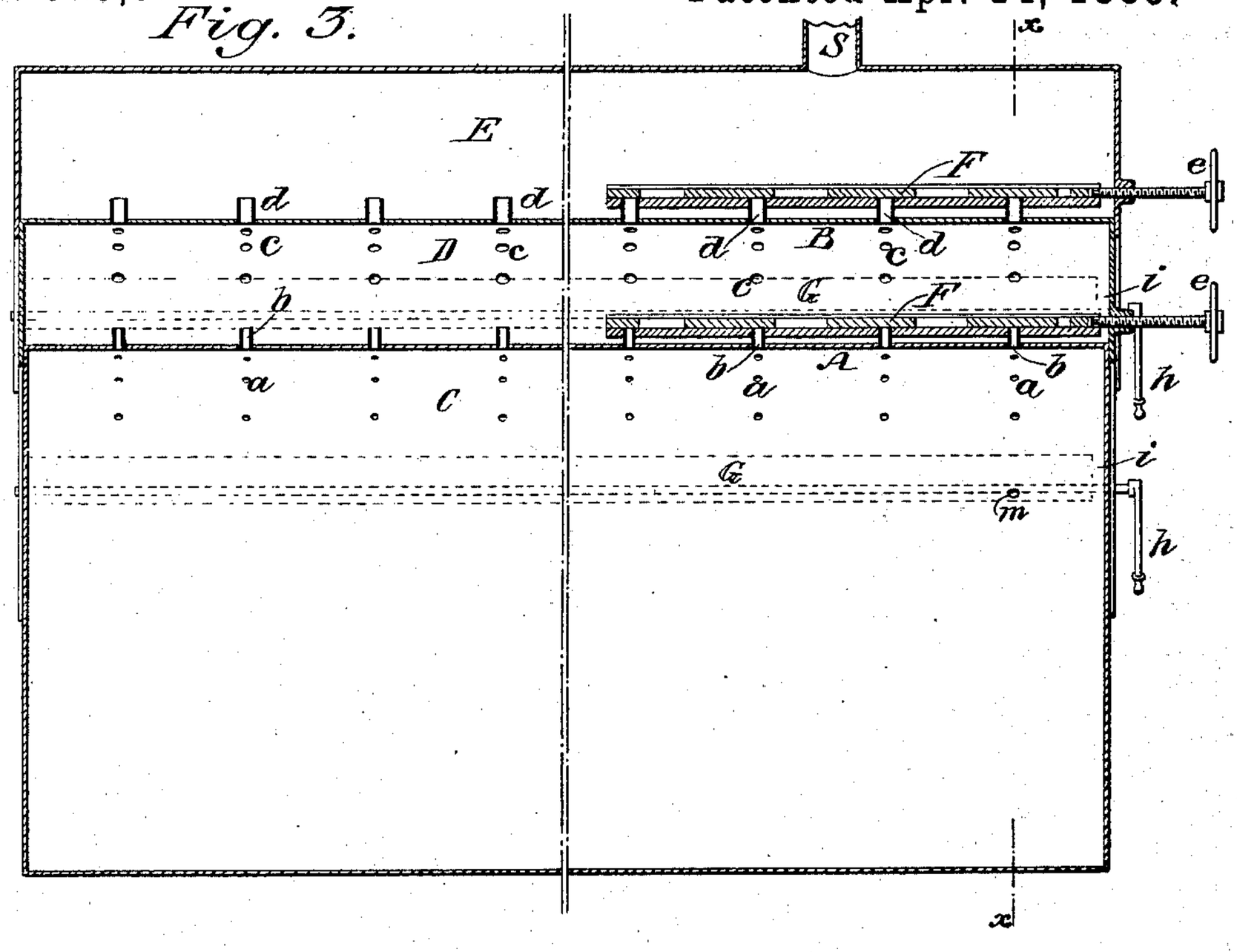
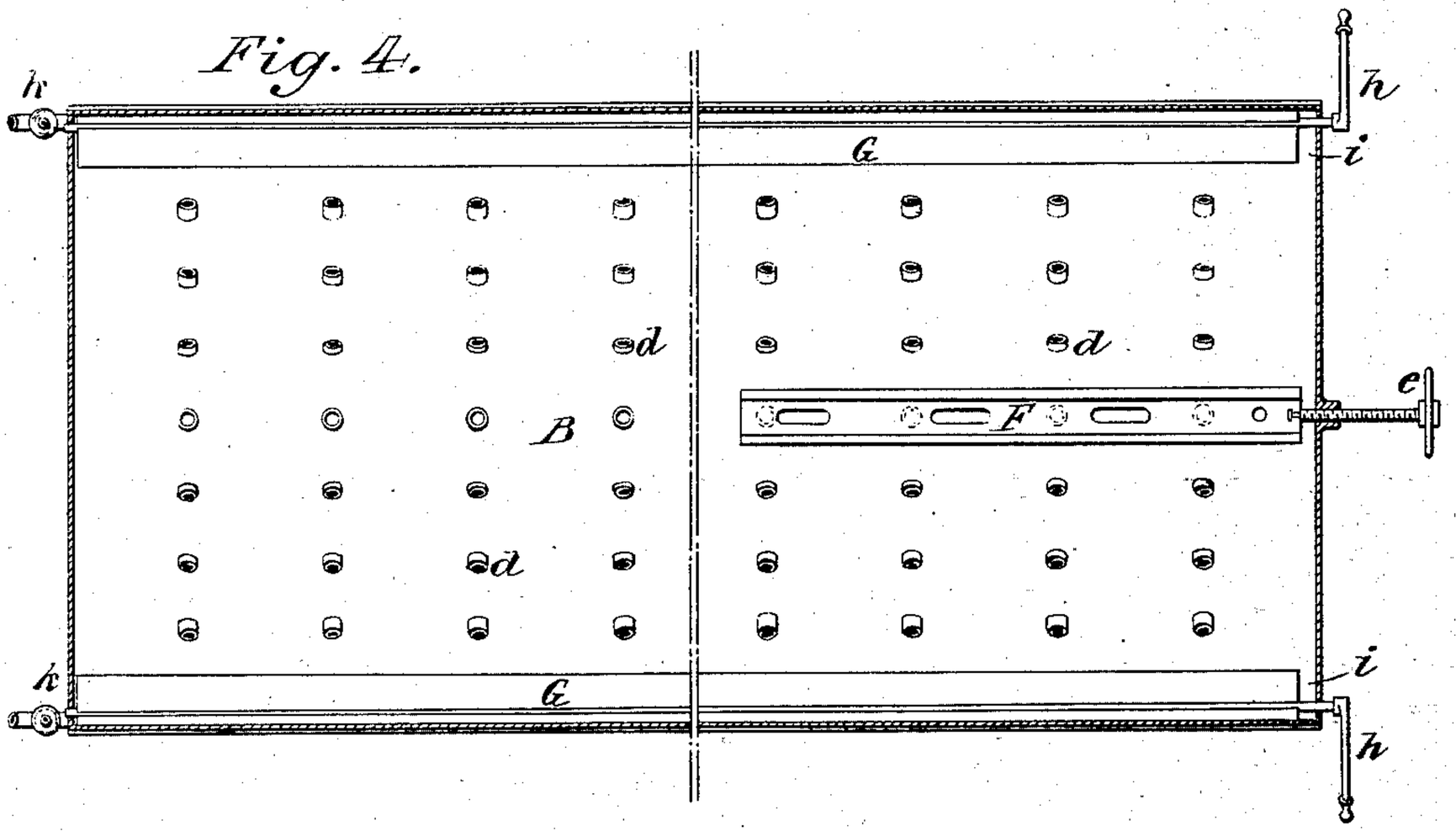


Fig. 4.



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UNITED STATES PATENT OFFICE.

THOMAS KAYS, OF NEWTON, NEW JERSEY, ASSIGNOR TO THE LAWSON NON-EXPLOSIVE BOILER COMPANY, OF NEW YORK, N. Y.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 315,511, dated April 14, 1885.

Application filed May 27, 1884. (No model.)

To all whom it may concern:

Be it known that I, THOMAS KAYS, of Newton, in the county of Sussex and State of New Jersey, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a full, clear, and exact description.

My invention has primarily for its object the prevention of explosions of steam boilers or generators used for working engines, and for other purposes. It also has for its objects, in connection with such steam boiler or generator, the prevention of foaming, priming, or entrainment, also of incrustation and corrosion; and it furthermore has for its many objects or uses, among others, securing the generation and delivery of dry steam direct from the boiler, and the safer use of steam at high pressures.

The invention generally is an improvement upon that described in Letters Patent No. 227,024, granted to Daniel T. Lawson, April 27, 1880, which invention was for a method of preventing concussive strains in boilers, due to the intermittent escape of steam into the cylinder of an engine, that consisted in retarding or prolonging the flow of the steam from the water to the steam-space through a greater length of time than is allowed for the escape of the same quantity of steam from the steam-space; and which invention furthermore consisted in a steam-boiler adapted to carry a permanent bulk of water, having a partition dividing the main steam-space from the water-space, with one or more openings in said partition controlled by a valve, if desired, of less aggregate area than that of the throttle-valve or opening through which the steam is led from the steam-space of the boiler to the cylinder of the engine.

The invention comprises an additional partition or diaphragm dividing the steam-space of the boiler arranged above or beyond the partition which divides the main steam-space from the water-space of a boiler, as above described, such additional partition having openings in it for the passage of the steam through it of a somewhat greater aggregrate area than that of the openings in the first partition, but still of less aggregate area than that of the opening through which the steam passes from the steam-space of the boiler to the cylinder of the engine, whereby the results sought to be obtained are more perfectly secured. The invention also includes the providing of said perforated diaphragm with short tubes in the perforations thereof, whereby the velocity of the steam is increased as it passes through the orifices in the diaphragms, and by means of which all sediment passing to the upper or outside of said diaphragms is prevented from returning to the water-space in the boiler or from being carried into the engine. Furthermore, the invention comprises certain valvular devices in connection with said diaphragms, whereby sediment settling in certain angular spaces formed by the junction of the diaphragms with the shell of the boiler may be readily blown off at the will of the engineer without any interference with or stopping the regular operation of the boiler.

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

Figure 1 is an end view of a boiler with my invention applied. Fig. 2 is a vertical transverse section of the same on the line *x x* in Fig. 3. Fig. 3 is a broken central longitudinal section on the line *y y* in Fig. 1, and Fig. 4 a broken horizontal section thereof on the irregular line *z z* in Fig. 1.

The boiler, as represented in the drawings, is a horizontal one, and presents an oblong figure in transverse section for its general contour, the same being divided internally by two arched diaphragms, A B, arranged one above the other, and extending the whole length of the boiler, and forming three separate steam spaces or chambers, C D E, from the upper one, E, of which the steam is passed by a pipe, S, to the engine. The lower interior diaphragm, A, may be a part of a cylindrical shell of which the body of the boiler is composed, as here shown, the same dividing the steam-space above it from the water-space of the boiler, also forming a steam-space below it immediately above the water, and the upper steam-chambers, D E, be supplementary ones separately built upon the main body; or the

boiler may be otherwise constructed to provide for substantially the same arrangement of water-space and steam chambers. The diaphragm A has a series of apertures, *a a*, in which are screwed or inserted small tubes *b b*, the length of which should be about one and three-quarter times their diameter, and the aggregate area of which is less than that of the induction port or opening through which the steam is passed to the cylinder of the engine and less than that of the throttle-valve. The second or upper interior diaphragm, B, has also orifices *c c*, fitted with tubes *d d*, the length of which may also be about one and three-quarter times their diameter, but the aggregate area of which is somewhat greater than that of the aggregate area of the tubes *b b*, though, like them, less than the area of the opening through which the steam is led from the boiler to the engine-cylinder. These tubes *b d*, or certain of them, may have perforated plates mounted on them, carrying slide-valves F F, provided with oblong slots, and capable of operation from the one end of the boiler by a lever or hand-wheels, *e e*, for partially or wholly closing the orifices which they control, one orifice at a time, to adjust the proper relative aggregate areas of the tubular steam-passages through the two perforated diaphragms to each other and to the throttle-valve or opening through which the steam is led to the engine-cylinder.

G G represent two valves, each of which is composed of a sheet-iron plate slightly spiral in direction of its length and extending the whole length of the boiler, or nearly so, within each angular space formed by the junction of the diaphragms A B with the sides of the boiler. These valves, which may be operated by levers *h*, and which are made slightly spiral to secure an easier and more effective closing of them (shown by dotted lines in Fig. 2) against the sides of the boiler and tops of the diaphragms A B, are constructed to leave an opening, *i*, between their one end and the end of the boiler for the passage of steam beneath them when closed to blow out, through stop-cocks *k* at the opposite end of the boiler, any sediment that may collect from time to time in the angular spaces formed by the junction of the diaphragms A B with the sides of the boiler, said valves remaining open, as shown by full lines in Fig. 2, excepting when it is required to blow off collecting sediment, as described. The orifices *l*, communicating with the stop-cocks *k*, are arranged as low down in said angular spaces as it is convenient to place them, and when the valves G are closed and stop-cocks *k* opened the steam admitted through the openings *i* at the opposite end of the boiler will pass freely into the space beneath the valves from that end, and flow as a current through the full length of the valve-closed spaces and out of the stop-cock *k*, carrying the collected sediment along with it.

Water collecting in the angular spaces beneath said valves G, above the sediment deposited in the angular spaces at the sides of the boiler, may be returned to the water-space of the boiler by orifices *m* in the diaphragms A B.

The arched configuration of the diaphragms A B not only serves to strengthen the boiler, but to facilitate the fall of water and sediment or foreign matter carried up by the steam into the angular spaces beneath the valves G at the sides of the boiler, thus depositing the same where they can easily be removed, and the tubes *b d* in the diaphragms A B act as barriers to prevent return of uplifted sediment through the apertures *a c* back into the lower water and steam chamber of the boiler.

H is a ball-float on a lever, I, having its fulcrum J within the lower water and steam space of the boiler, said float resting on the water therein. Connected with this lever I, on opposite sides of its fulcrum by rods *n n*, are two stop-cocks, L M, arranged within the water-space of the boiler, and the one, L, of which is a water-blow-off cock connected by pipe with the outside of the boiler, while the other one, M, is a water-supply cock, and is connected by a pipe, *r*, with an outside water-reservoir, N, of cylindrical form, and fitted with a piston, O, loaded with one or more weights, P, of suitable specific gravity to force water from the reservoir N into the boiler against the pressure of the steam therein when the cock M is open. This apparatus forms an automatic regulator of the water-level in the boiler and an auxiliary water-feeder to the boiler, distinct altogether from and operating in addition to the regular feed-pump. It serves to keep the water in the boiler at a uniform level, or nearly so. Thus supposing the dotted line *s* in Fig. 2 to be the extreme high level to which the water should be permitted to rise in the boiler, and the dotted line *s'* to indicate its lowest safe level, then as the float H rises or falls between and approaches either of these levels it will operate through its connections either the cock L or the cock M to regulate the amount of water in the boiler. For instance, if it rises, owing to a too free supply of water, it will open the cock L and discharge surplus water therethrough, while if it falls below a proper level it will open the cock M and admit water from the reservoir N till the proper level is again reached in the boiler. Such apparatus not only prevents an undue or destructive and dangerous exposure of the boiler to the action of the fire by the water falling too low in the boiler, but it preserves a regular or nearly fixed amount of water in the boiler, and, what is equally or more important in a boiler constructed to work upon the principle the boiler shown in the drawings does, it preserves a nearly uniform steam capacity and proper relative proportion of the lower steam chamber or space to the steam chambers or spaces above such lower one.

In this improved boiler the lower section or

chamber is filled with water up to the line *s* or *s'*, or to an intermediate level, and the space above such level or levels in said chamber with steam, which steam-space C is in communication by the tubes *b d* and valves F with the upper steam chambers or spaces, D E. The aggregate area of the openings thus established through the diaphragm A being less than the aggregate area of the openings through the diaphragm B, and the aggregate area of said steam-openings in the diaphragm B being less than the area of the throttle-valve or induction-port to the engine, any sudden reduction of pressure upon the surface of the superheated water in the boiler is prevented and the pressure thereon kept approximately uniform. There should be three steam-gages attached to the boiler, the same communicating, respectively, with the steam-chambers C, D, and E, and when the boiler is put in operation the slide-valves F F should be adjusted so as to make the aggregate area of the openings through the diaphragm A, say, about one-tenth less than the aggregate area of the openings through the diaphragm B, and to keep the last-named openings less than the opening by which the steam is passed from the boiler to the cylinder of the engine. These adjustments having been attained, there can be no sudden reduction of the pressure upon the surface of the water in the boiler, no rapid withdrawal and sudden check of steam from the compartment next to the water, no violent concussive actions or strains on the boiler due to the intermittent escape of steam into the cylinder of the engine, the effect of the draft or check being first and most sensibly felt in the compartment E, and being only gradually transmitted in succession to the other compartments, D C, below, and hence there can be little or no risk of explosion from this cause, and an approximate uniformity of pressure upon the water is much more perfectly secured than where a single perforated diaphragm is used. Such improved construction of boiler will also serve to deliver dry steam directly from the boiler to the engine, the steam passing from the lower steam-compartment to the second steam-compartment, and so on to the third steam-compartment, not at one point in each, but in small quantities at several points. Water passing by chance along with the steam from the first steam-compartment will be deposited in the second steam-compartment, and should any (which is not probable) be carried up into the third steam-compartment it cannot fail to be deposited there. There can be no rising and falling of cone-shaped columns or bodies of water, no churn-like motion or action take place, and no irregular and violent ebullition. In this way "foaming," "priming," or "entrainment" are avoided and dry steam may be taken directly from the boiler without the aid of domes, superheaters, or steam-drums. Incrustation, too, will be prevented, inasmuch as all foreign solid substances held in suspension or solution will be separated from the water and be deposited upon the upper sides of the diaphragms A B, where they will not interfere with the generation of steam, and from whence they may readily be removed, as hereinbefore described. All foreign matter, as it is separated from the water by crystallization or otherwise by the mere motion of the water, will be carried to the surface of the water, and by the motion of the steam be carried through the small orifices in the diaphragms A B, or lower one at least, and as the motion of the steam is quickened by its passage through the small tubes *b d*, said foreign substances, being of a greater specific gravity than the steam, will be dropped as they leave the tubes and fall upon and down either side of the diaphragms A B into the angular spaces formed to receive them. Should the lower diaphragm, A, fail to thus catch all the uplifted foreign matter, the second diaphragm, B, certainly will. By thus removing, too, certain foreign substances which have a corroding tendency, corrosion of the boiler will be largely prevented, and by keeping the boiler clean economy in fuel necessarily follows.

Notwithstanding the fact that superheated water is highly explosive, and that it bursts into steam from a sudden reduction of pressure, a boiler constructed as here described may be worked with perfect safety, and this under a very high and economical pressure of steam without any or very little danger from such cause.

The form of the boiler may be more or less changed, as may also the shape of the diaphragms, likewise the number and sizes of the openings of less aggregate area in each diaphragm than that of the induction-port; also, valves for regulating such area of escape through the diaphragms be used or not.

The feeder herein shown and described forms no part of the present application; but I reserve to myself the right to make a separate application therefor at some future time.

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

1. In a steam-boiler adapted to carry a permanent bulk of water and having a diaphragm or partition dividing the main or upper steam-space from a lower steam and water space, with apertures in said partition of less aggregate area than the opening through which the steam is led from the steam-space to the cylinder of an engine, the arrangement within the steam-space of the boiler, above or beyond said partition, of a second partition or diaphragm also having openings in it of less aggregate area than the steam-supply opening to the engine, and whereby three consecutive steam-spaces are formed in the boiler, substantially as specified.

2. A steam-boiler having its steam-space divided into a series of consecutive compartments in communication with each other by apertures in the partitions which separate said

compartments, the aggregate areas of said apertures increasing for each successive compartment, but the aggregate area of the apertures in each partition being less than that of the opening through which the steam is led from the steam-space to the engine-cylinder, essentially as and for the purposes herein set forth.

3. In a steam-boiler having its steam-space divided into two or more compartments, the separating diaphragm or diaphragms of said steam chambers or compartments studded with small bore tubes of greater length than diameter in or about in the proportions specified and of less aggregate area than the opening through which the steam is led from the steam-space of the boiler to the cylinder of the engine, substantially as and for the purposes specified.

4. The within-described boiler having three steam spaces or compartments, C, D E, separated from each other by arched diaphragms A B, fitted with upwardly-projecting tubes *b d* of different aggregrate areas and of less aggregate area in each partition than the opening through which the steam is led from the steam-space to the cylinder of the engine, essentially as specified.

5. The combination, with the outer shell of the boiler and the arched perforated diaphragms A B, dividing the steam-space of the boiler or either of them, of the valves G in the angular spaces formed by the junction of either diaphragm with the sides of the boiler, constructed to pass the steam from their one end when closed, and the blow-off cocks *k*, substantially as and for the purposes herein set forth.

6. The combination of the tubes *b* or *d* and either arched diaphragm A or B, separating the steam-space of the boiler, with the valves G G and blow-off cocks *k k*, essentially as described.

THOMAS KAYS.

Witnesses:
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C. SEDGWICK.