

(No Model.)

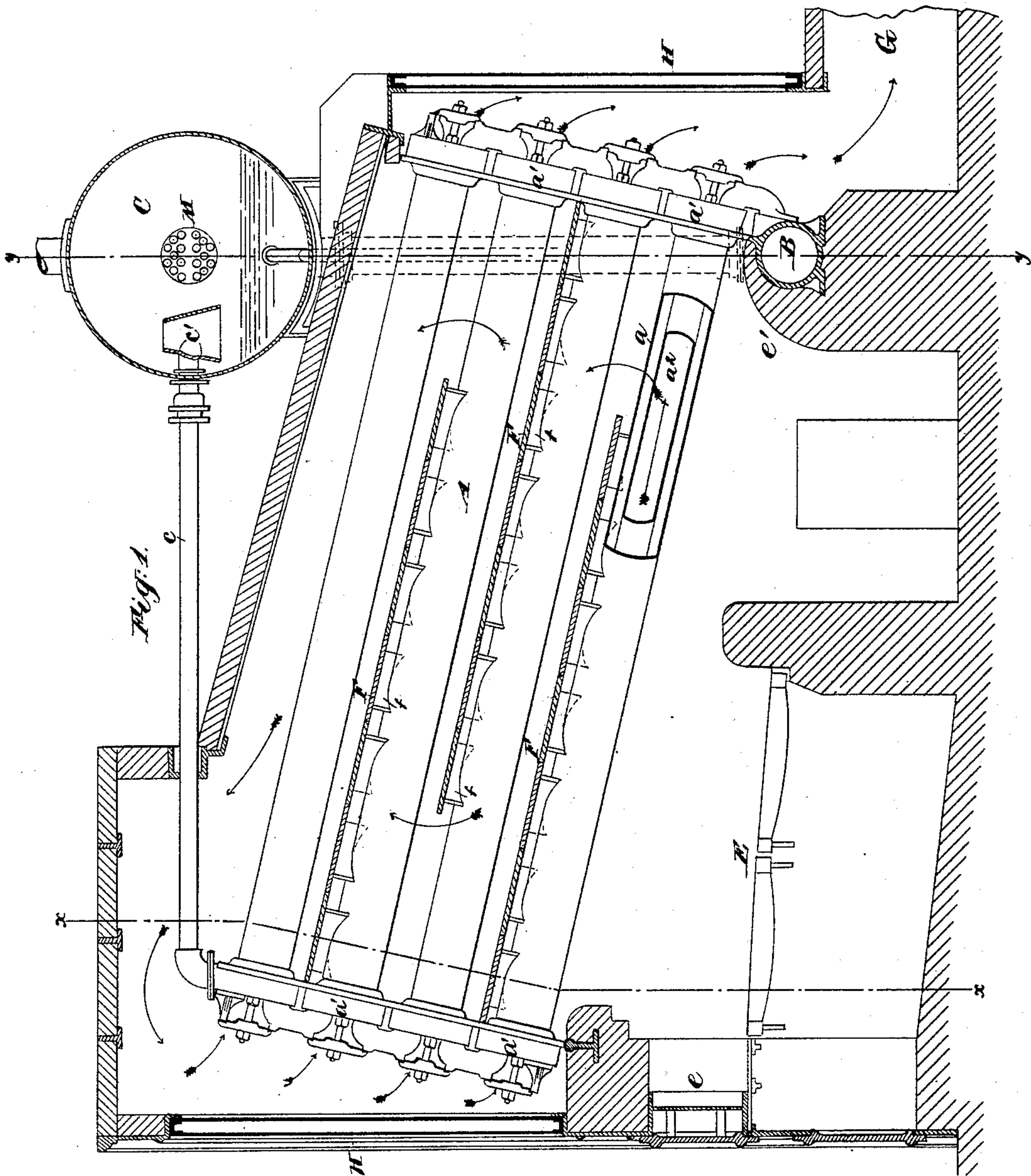
3 Sheets—Sheet 1.

G. G. M. HARDINGHAM.

STEAM GENERATOR.

No. 348,672.

Patented Sept. 7, 1886.



Witnesses:
Landon P. Smith,
Charles R. Seale,

Inventor:
G. G. M. Hardingham
by his attorney
Thomas Dewar

(No Model.)

3 Sheets—Sheet 2.

G. G. M. HARDINGHAM.

STEAM GENERATOR.

No. 348,672.

Patented Sept. 7, 1886.

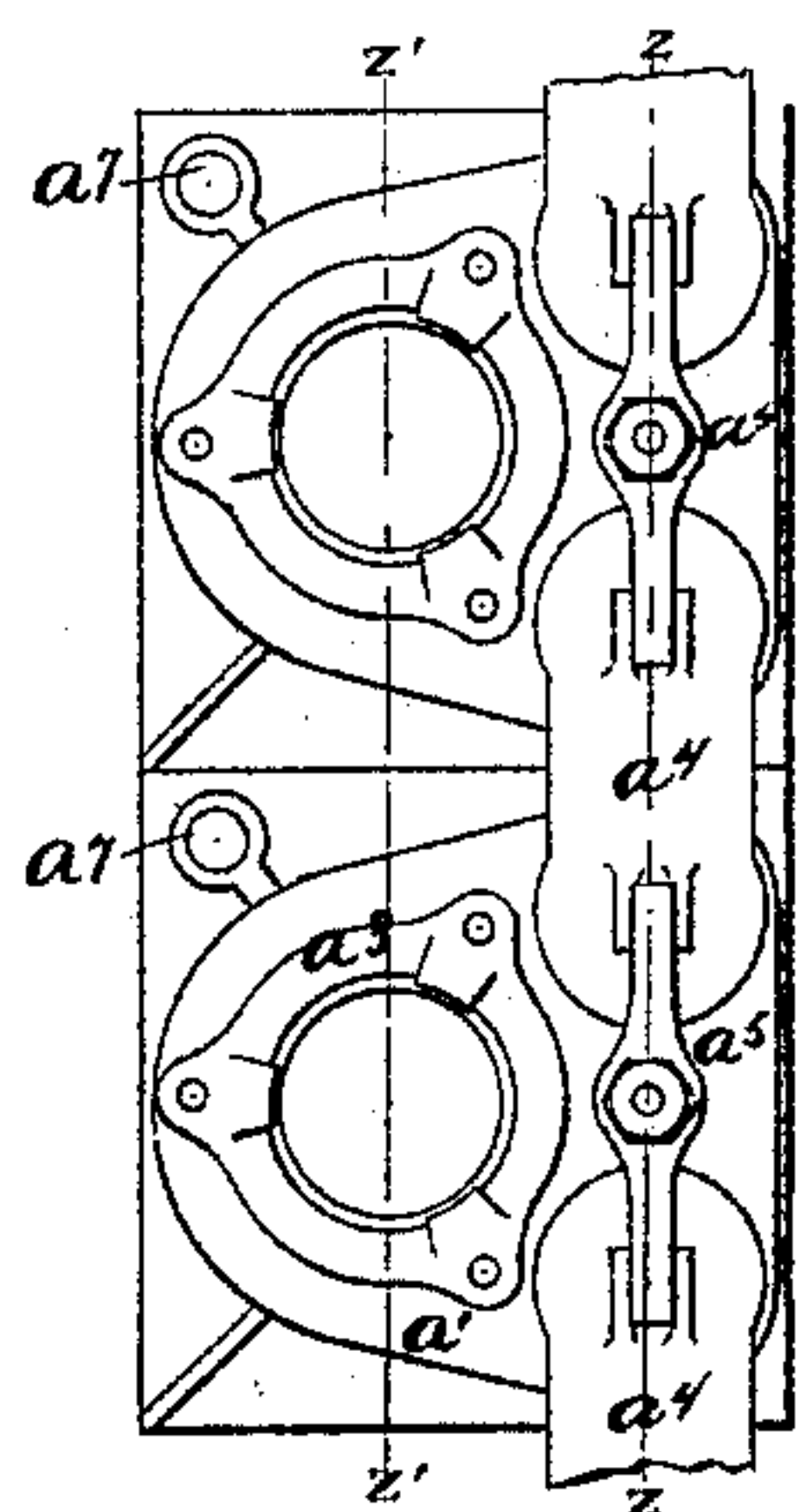
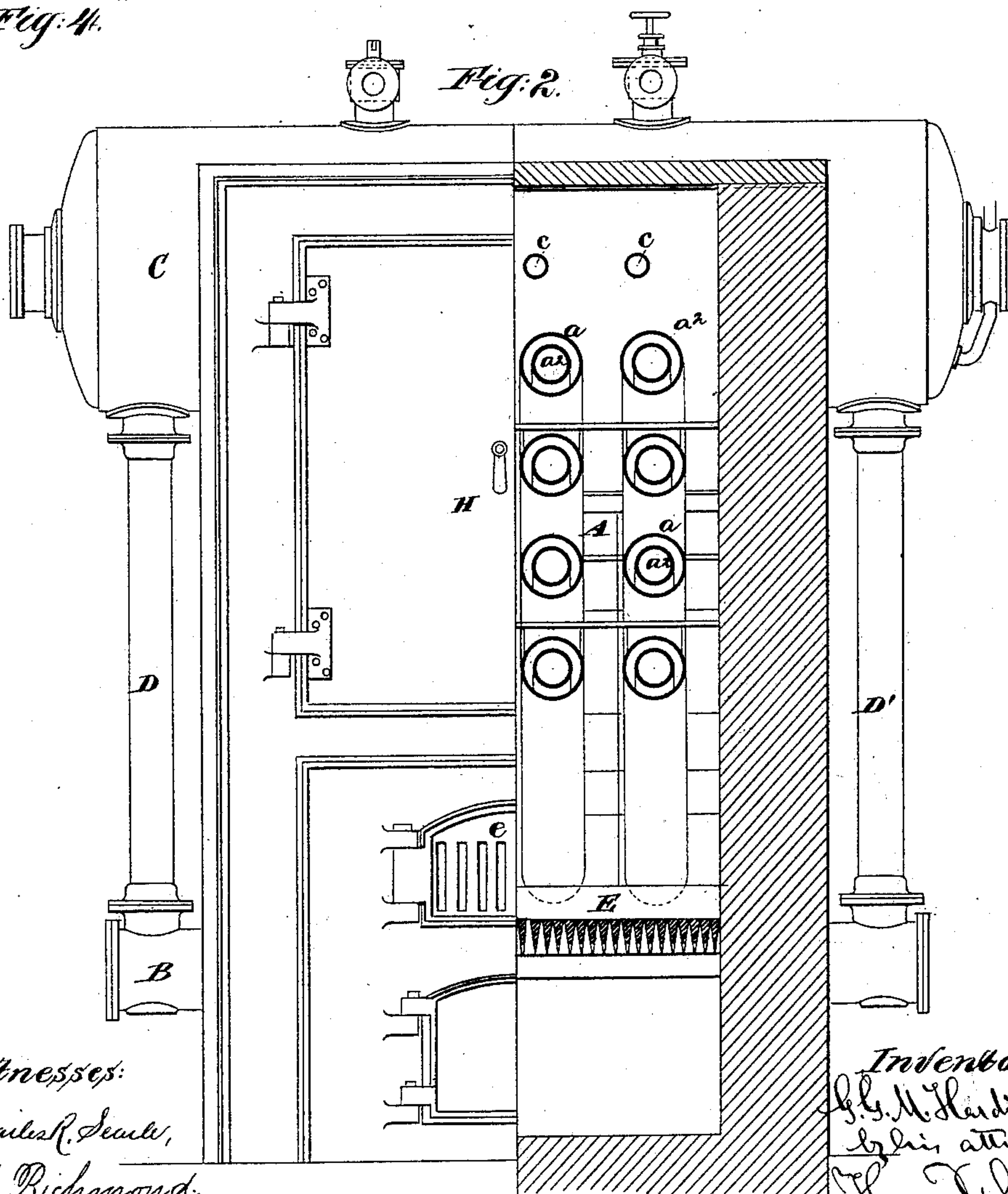
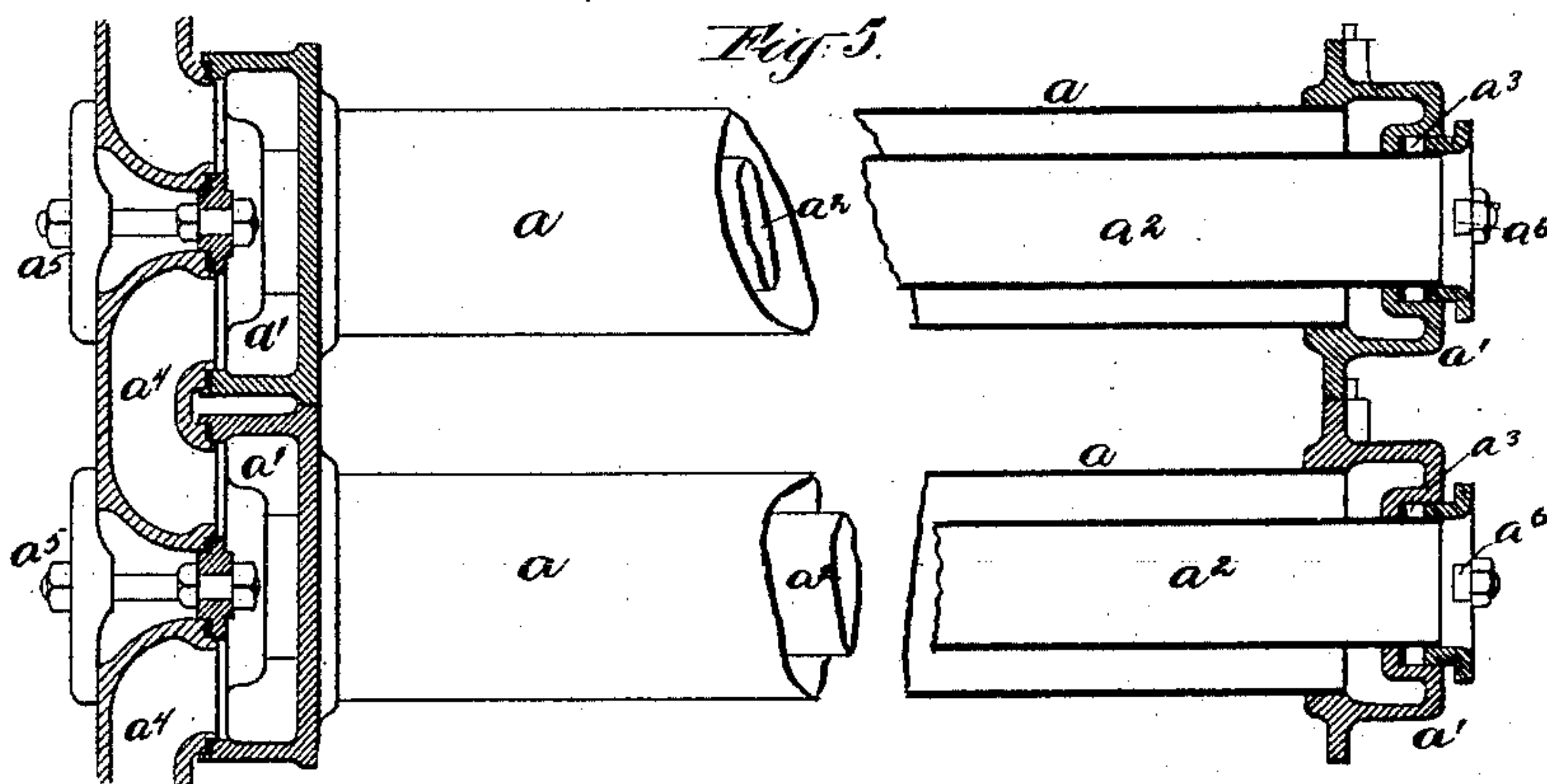


Fig: 44.



Witnesses:
Charles R. Seale,
T. A. Richmond.

Inventor:
G. H. M. Hardingham
by his attorney
Thomas J. Stetson

(No Model.)

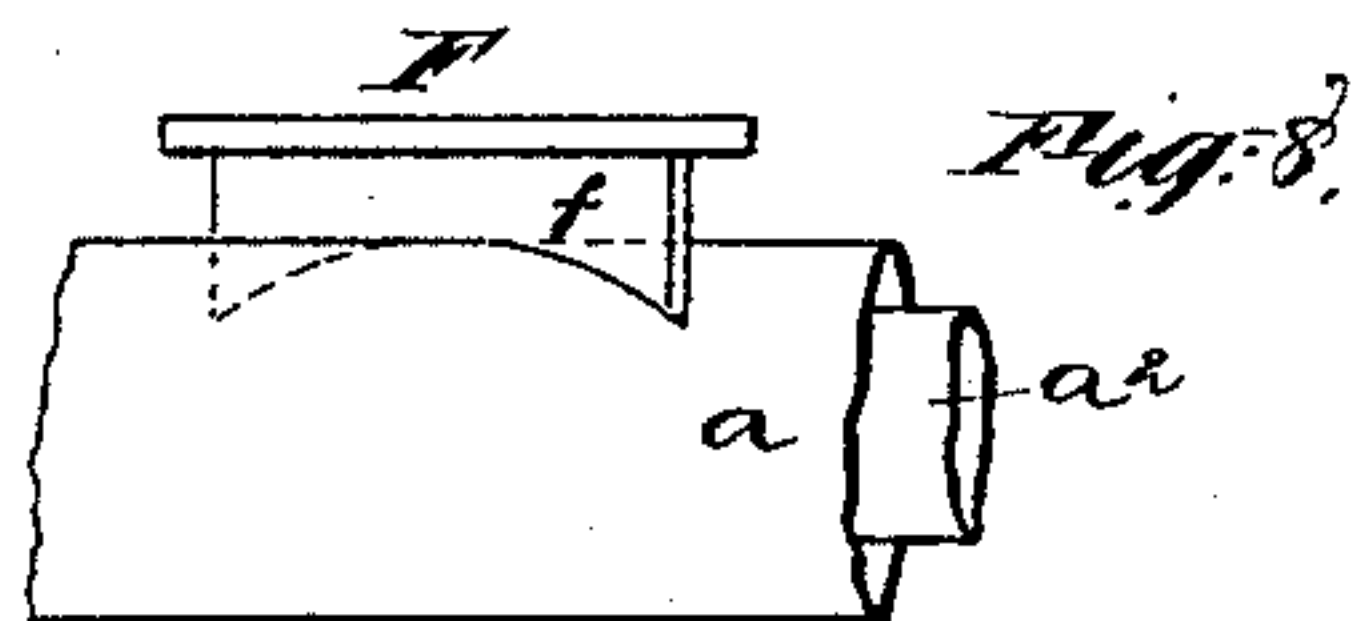
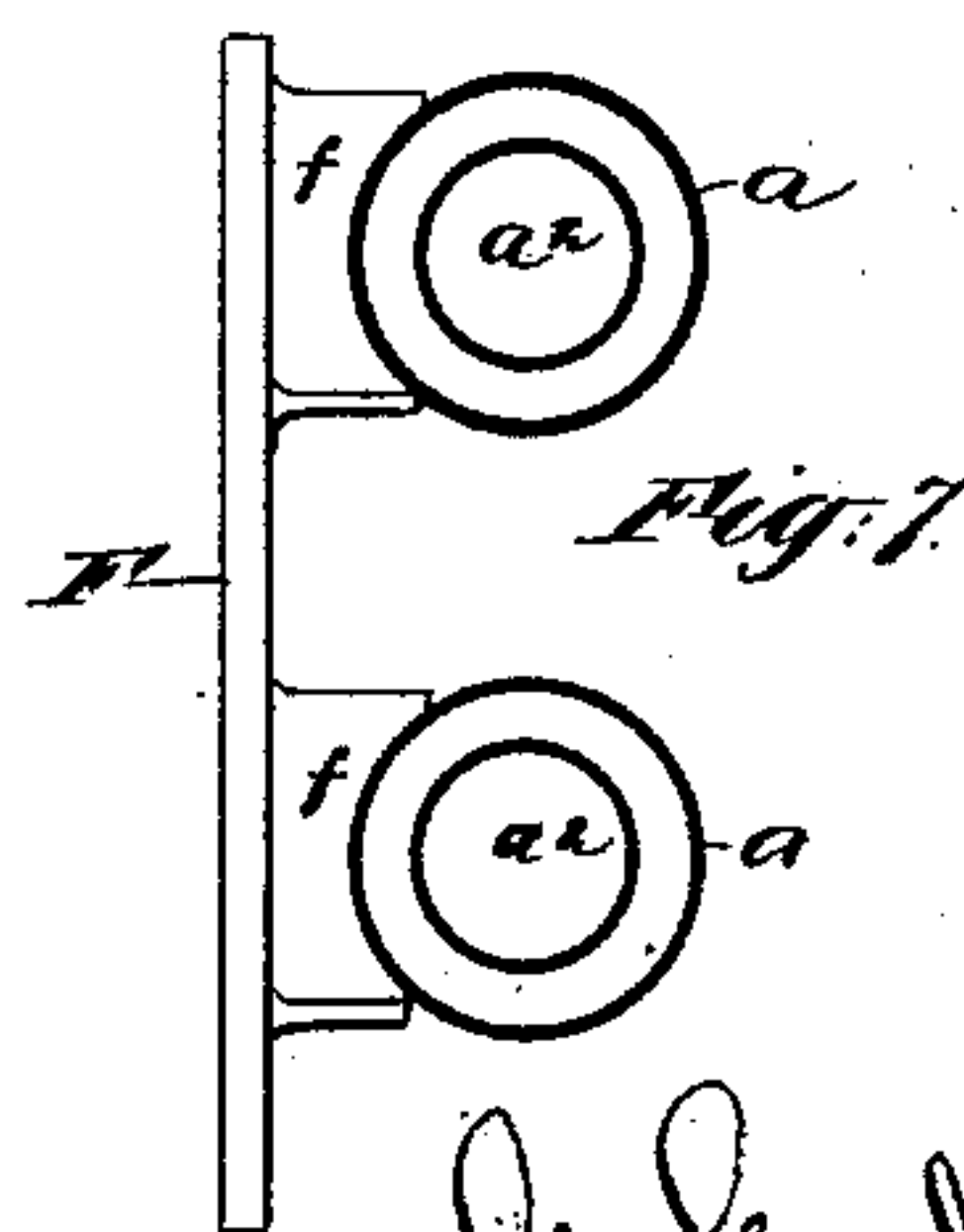
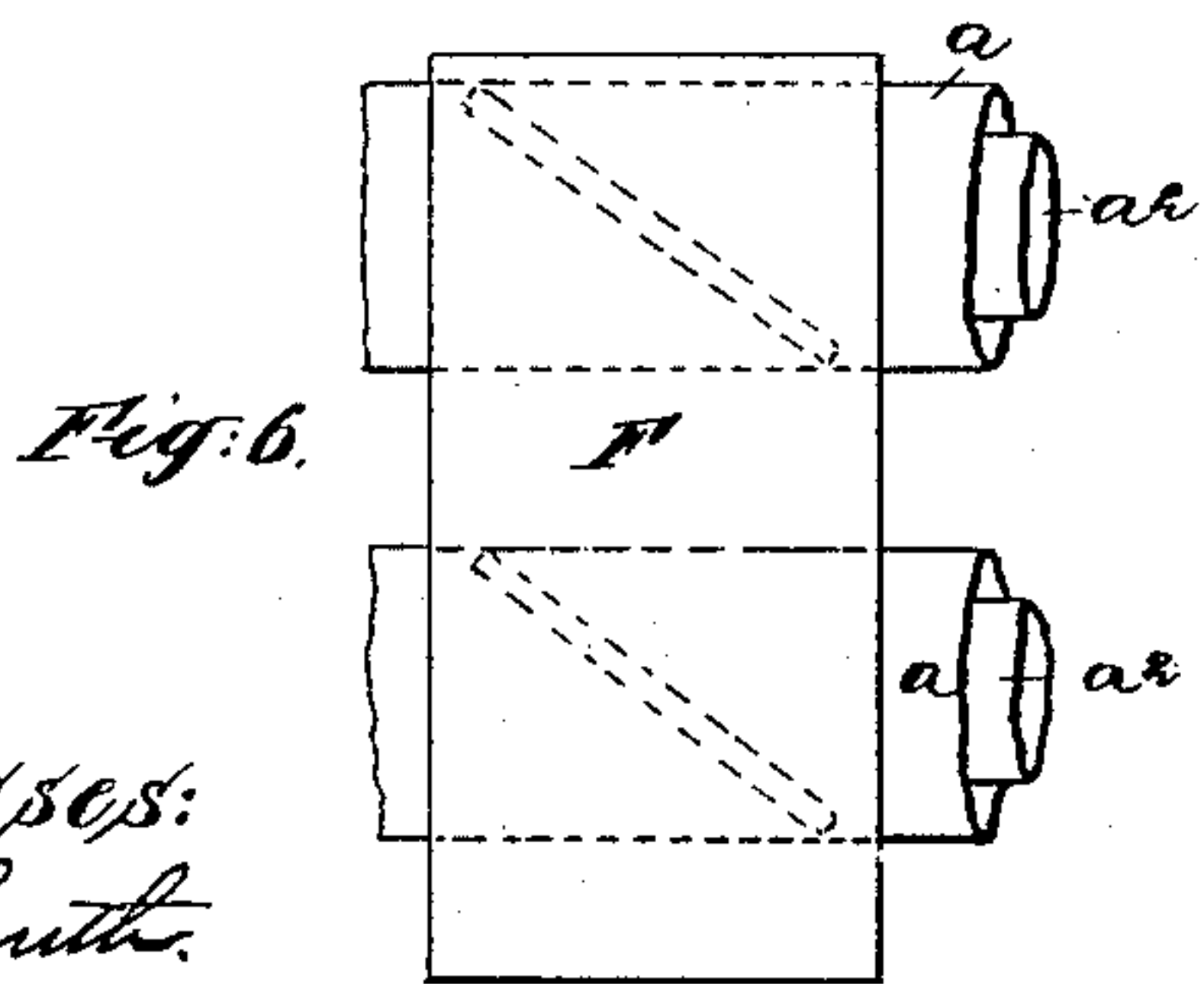
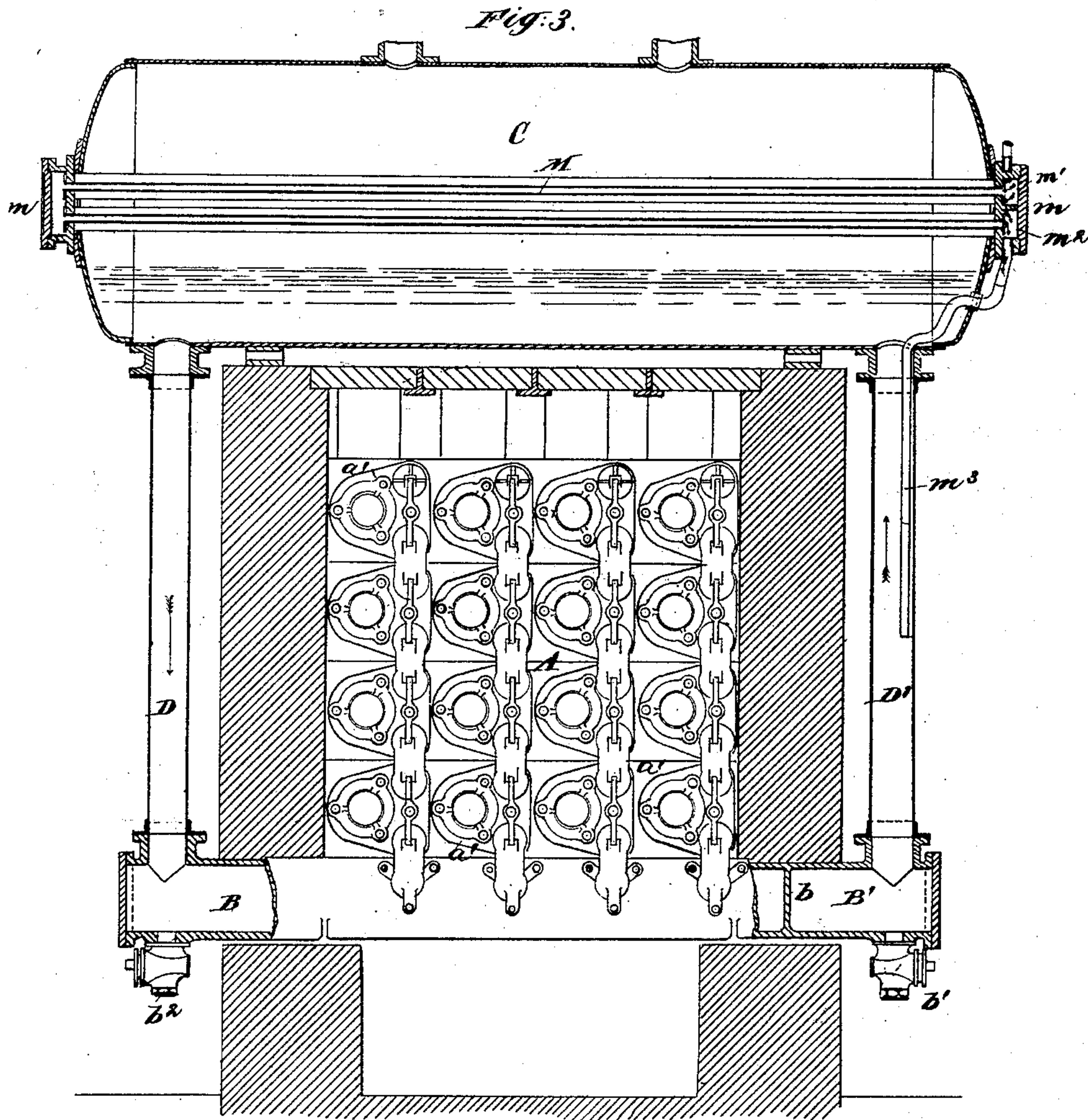
3 Sheets—Sheet 3.

G. G. M. HARDINGHAM.

STEAM-GENERATOR.

No. 348,672.

Patented Sept. 7, 1886.



Witnesses:
Lyndon Smith,
Charles R. Seale,

Inventor:

G. G. M. Hardingham
by his attorney
Thomas Drew Stetson

UNITED STATES PATENT OFFICE.

GEORGE G. M. HARDINGHAM, OF LONDON, COUNTY OF MIDDLESEX,
ENGLAND.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 348,672, dated September 7, 1886.

Application filed March 20, 1886. Serial No. 195,952. (No model.) Patented in England January 3, 1884, No. 565.

To all whom it may concern:

Be it known that I, GEORGE GATTON MEL-
HUSH HARDINGHAM, a subject of the Queen
of Great Britain and Ireland, and a resident
5 of London, in the county of Middlesex, Eng-
land, civil engineer, have invented certain
new and useful Improvements in Steam-Gen-
erators, (for which I have obtained a British
Patent dated January 3, 1884, No. 565,) of
10 which the following is a specification.

This invention relates to sectional steam-
generators of the compound water and fire
tube type; and it consists in so constructing
and working such generators that the gases
15 during their passage through the inner or fire
tubes are caused to flow downward and in a
direction opposed to that pursued by the wa-
ter in course of circulation through the sur-
rounding water-tubes. By these means the
20 heating effect on the water is improved, while
the liability for dust to become deposited in
the inner or fire tubes is diminished.

In sectional steam-generators of the kind
above referred to, and wherein the water-ways
25 are comparatively narrow, it is desirable with
certain kinds of feed-water to adopt special
measures for preventing incrustation of the
heating-surfaces. For this purpose I employ
means whereby certain of the impurities com-
30 monly contained in feed-water are separated
therefrom before the water passes into circula-
tion, fouling of the water-ways being thereby
prevented or greatly modified, and interfer-
ence with the effectiveness of the heating-sur-
35 face being correspondingly avoided.

In my improved construction of sectional
steam-generator communication is effected be-
tween the various sections constituting the
generator according to an improved method
40 as compared with that described in the speci-
fication to my United States Patent of April
21, 1885, No. 316,032, the connecting-pieces
employed for the purpose being capable of re-
moval independently of one another and with-
45 out disturbing the inner or fire tubes. At the
same time differential expansion between the
outer and inner tubes is more perfectly pro-
vided for. The baffle-plates employed for di-
recting the flow of the gases while bathing the
50 outer tubes are also of an improved kind as

compared with those shown in my aforesaid
specification or hitherto employed.

In order that my invention and the mode of
carrying the same into effect may be fully un-
derstood, I will, with the aid of the accompa- 55
nying drawings, proceed to describe a steam-
generator embodying the features of novelty
hereinbefore enumerated.

The design of the generator adopted as con-
venient for the purpose of the present illus- 60
tration resembles in some respects that de-
scribed in the specification of United States
Letters Patent issued to me April 21, 1885, No.
316,032—that is to say, it represents a sectional
boiler, whereof each section consists of an outer 65
or water tube communicating at each end with
the section next in order and traversed longi-
tudinally by an inner or fire tube. It will,
nevertheless, be understood that the essential
features of my present invention are not ex- 70
clusively applicable to sectional boilers of the
compound water and fire tube type.

Figure 1 is a vertical longitudinal section of
a sectional boiler constructed according to my
invention. Fig. 2 is a part front elevation 75
and part vertical transverse section on the
line *x x*, Fig. 1. Fig. 3 is a vertical transverse
section on the line *y y*, Fig. 1, the back end of
the generator being, however, shown in ele-
vation. Figs. 4 and 5 show in front elevation 80
and vertical section, respectively, and to an
enlarged scale the detailed construction of the
heating-sections. Fig. 6 shows in plan, and
Figs. 7 and 8 in side view, and to an enlarged
scale, the improved type of baffle-plate as ap- 85
plied to the outer tubes for directing the gases
while bathing same.

Similar letters of reference indicate corre-
sponding parts in all the figures.

The steam-generative portion of the boiler 90
is constituted by a group of sections which I
will designate A. Each section consists of an
outer tube, *a*, furnished at each end with a
head, *a'*, and traversed by an inner tube, *a''*,
the water being inclosed between the two tubes. 95
The sections are arranged and connected to-
gether in vertical series and communicate with
a water-drum, B, below and with a steam-
drum, C, above. The drums B and C are also
connected together by a pipe or pipes, D D'. 100

Beneath the generator is arranged a fire-grate, E, *e* being the fire-door, and *e'* a fire-brick shield for the protection of the drum B.

Between horizontal rows of the heating-tubes are arranged directing-plates F for the purpose of causing the heated gases to circulate among and externally to the sections before passing over the front part of the generator, as indicated by the arrows, and gaining access to the inner or fire tubes, *a'*, with which the sections are furnished, and through which the gases have to pass before reaching the flue G.

H H' are doors provided, respectively, at the front and rear of the inclosing-chamber, and by means of which access is had for cleaning and other purposes. The water, while exposed to the heat arising from the furnace, is inclosed between the several pairs of tubes *a* *a'*, and these being placed at an inclination the steam rises toward the higher ends of the sections and passes by way of the connecting-pieces at those ends to the pipe *c*, and thence to the reservoir or drum C, each vertical series of sections communicating independently with the receiver C. The extremity of each of the pipes *c* is furnished within the receiver C with a separator, *c'*, consisting of a hollow conical body open above and below and having a tangential inlet. The steam and any water carried over therewith are subjected on arrival in the separator *c'* to centrifugal action, the water or heavier fluid assuming the outer path of rotation, while the steam or lighter fluid becomes separated therefrom and escapes upward in a comparatively dry state from the center of the separator. The separated water is discharged from below, and mingling with the water in the drum C passes by the pipes D D', or one of them, to the drum B, and thence to the heating-sections, the circuit for the purpose of circulation being thus complete.

From the foregoing general description it will be perceived that the heated gases, after circulating among the sections and bathing the external tubes, *a*, pass over or around the front end of the generator and enter the inner tubes, *a'*, at their upper ends, escaping therefrom at their lower ends. The back or lower ends of the fire-tubes *a'* are open to the flue G, the draft whereof causes the heated gases to follow the downward course described. By thus causing the fluids—that is, the heated gases and circulating water—on the respective sides of the medium to flow in opposite directions, a larger proportion of the heat is absorbed by the water from the gases, while the latter, passing in a downward direction through the inner tubes, act in conjunction with gravity to sweep out dust tending to become deposited therein. Where, on the other hand, the flow of the gases is in an upward direction, and therefore is opposed to gravity, as proposed in my aforesaid previous patent specification, the tendency is for dust to accumulate more rapidly, the result being that the conductivity

of the heating-surface is impaired and the draft interfered with in consequence of the effective tube area becoming contracted.

For diminishing or preventing incrustation of the heating-surface by impurities contained in the feed-water, I employ means of the character represented in Figs. 1 and 3. This apparatus consists of a heater, M, composed of a number of tubes mounted in the steam-space in the drum C and terminating at each end in a chamber, *m*. One of these chambers is partitioned into two compartments, *m'* *m''*. The feed-water is introduced, preferably at a high temperature, by the pipe communicating with the compartment *m'*, and passes to the tubes of the heater connected with that compartment. After traversing these it reaches the chamber *m* at the opposite end of the drum C, and returning by way of the remaining tubes arrives in the compartment *m''*, whence it passes by the discharge-pipe *m''* and escapes some distance down the leg D', as indicated in Fig. 3. The object of this treatment is to expose the feed-water to the full heating effect of the steam contained in the receiver, it being well known that at a temperature approximating to that of boiling water certain of the impurities commonly occurring in feed-water becomesolidified. Various other means might, however, be substituted for effecting the necessary exposure of the feed-water to the heating effect of the steam. The impurities contained in the feed-water having become solidified during their passage through the heater M, are thus discharged at a point whence they readily subside to the mud-chamber B', while the purified water slowly rises to the receiver C and ultimately finds its way by the leg D and water-drum B to the heating-sections. The diaphragm *b* separates the lower or water drum, B, from the mud-chamber B'. The impurities are periodically discharged in the form of mud by the blow-off cock *b'*, the drum B being furnished with a drain-cock, *b''*. Where the feed-water is sufficiently pure to render unnecessary the use of apparatus of the kind above described, the diaphragm *b* may be omitted, and both the legs D and D' employed for circulating water from the drum C to the drum B.

It will be obvious that the means above described for purifying feed-water within the generator itself, but before the said water passes into circulation, are applicable to generators other than those having annular water tubes.

For connecting together the sections of my improved generator I employ means such as represented in Figs. 1 and 3; but which may, however, be more fully explained with the aid of the supplementary views, Figs. 4 and 5, the left and right hand portions of Fig. 5 being respectively vertical sections on the lines *z z* and *z' z'*, Fig. 1. Each section consists of an outer tube, *a*, screwed or otherwise fastened at each end in the back wall of a terminal chamber or head, *a'*. The front wall of this

chamber is formed with a gland stuffing-box, a^3 , for the reception of the inner or fire tube, a^2 , and has two orifices for the reception of the hollow connecting-pieces a^1 a^4 , communicating upward and downward, respectively. The connecting-pieces a^1 are secured and tightened by means of the stud and cross-bar a^5 . The heads a' are subtended by the edges of a rectangular plate, whereby the sections are supported upon one another at proper distances. Loose plates or distance-pieces may, however, be substituted, if preferred. To prevent the inner tubes, a^2 , working out of position in a longitudinal direction, the glands may be provided with inwardly-projecting snugs a^6 , as shown.

a' is a plugged hole, through which a steam-jet may be applied for the removal of any soot or dust which may have become deposited upon the outer tubes, a .

By means of this improved method of connecting the sections of compound water and fire tube boilers any one of the connecting-pieces—such as a^1 —may be readily removed and replaced without disturbing the inner tubes or their packings, and without necessitating the removal of either of the adjacent connecting-pieces. These facilities are not secured when using connecting-pieces, which serve to carry the inner tubes, or which overlap one another.

The method of construction described secures the further advantage, that the inner or fire tube being free to slide longitudinally in its packings provision is made whereby any differential expansion between the inner and outer tubes takes place without unduly straining either of the tubes or terminal chambers or distressing the packings. Excessive longitudinal movement of the tube in either direction is, however, checked by the inwardly projecting lip or lips with which the glands are furnished.

The manner in which I prefer to construct the baffle-plates F is indicated in Figs. 6, 7, and 8. Instead of allowing such plates to rest in contact with the heating-tubes, I support them at a moderate distance therefrom by means of two or more oblique ribs, f , which rest upon a corresponding number of the heating-tubes. Such ribs permit the heated gases to reach and to properly bathe the upper as well as the lower and lateral portions of the heating-tubes, while they present but little obstruction to the longitudinal flow of the gases.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The sectional steam-generator having upwardly-inclined water-tubes a , traversed by downwardly-inclined fire-tubes a^2 , the intervening water-ways being in communication with a water-drum, B , below and with a steam-receiver, C , above, these being connected by a down pipe or pipes, such as D , the said generator being provided with self-contained means for the elimination of impurities from

the feed-water before the latter arrives in the contracted water-ways, and being so arranged that the gases, after leaving the furnace E , bathe the water-tubes a , and subsequently pass to the flue G in a downward direction through the fire-tubes a^2 , the whole constructed and operating substantially as described.

2. In a sectional steam-generator of the compound water and fire tube type, the combination, with the upwardly-inclined water-tube a , of the downwardly-inclined fire-tube a^2 , traversing the water-tube and its terminal chambers and serving to conduct the gases in their course to the flue in the direction of gravity and in the opposite direction to that pursued by the water in course of circulation, substantially as and for the purposes set forth.

3. In a sectional steam-generator having narrow water-ways, as herein described, the self-contained means for eliminating impurities from the feed-water before the latter passes into circulation, such means consisting of the feed-water-heating coil M , exposed to the live steam in the receiver C , and having an outlet to a subsiding chamber, D' , the purified water flowing thence through the receiver C and pipe D to the water-drum B , whence the several sections of the generator are supplied, combined and operating substantially as described.

4. In a sectional steam-generator of the compound water and fire tube type, the combination, with the feed-water-heating coil M , mounted in the steam-receiver C , of the receiver C , the water-drum divided by a diaphragm, b , into two compartments, B B' , pipes D D' , connecting the respective compartments with the upper drum, C , one compartment serving, in conjunction with the pipe D' , for the reception of impurities precipitated from the feed-water, while the other compartment, in conjunction with the pipe D , conducts the purified water to the generative portion of the boiler, operating substantially as and for the purposes set forth.

5. In a sectional steam-generator of the compound water and fire tube type, the improved means for connecting each section with the sections next above and below, such means consisting of two hollow connecting-pieces communicating with the section and also with the adjacent sections, respectively, each of such connecting-pieces being independently movable without disturbing the inner tubes or their packings, as set forth.

6. In a sectional steam-generator of the compound water and fire tube type, the provisions for differential expansion between the outer and inner tubes, substantially as described, the same consisting in mounting the inner tube in packed stuffing-boxes formed in the head a , in which the tube is free to slide longitudinally, such motion being limited by a stop or stops formed by the gland of the stuffing-box, as set forth.

7. For use in steam-generators of the water-

5 tube type, the improved construction of baffle-plate, substantially as described, the same being furnished as to its under side with two or more oblique ribs, which, with a minimum reduction of flue area, serve to support the plate at such a distance from the heating-tubes as to permit access of the gases to the upper sides of the latter.

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

G. G. M. HARDINGHAM.

Witnesses:

E. W. THURGAR,
C. W. LEES.