

C. B. MOORE.
LOCOMOTIVE BOILER FURNACE.
APPLICATION FILED SEPT. 23, 1908.

990,375.

Patented Apr. 25, 1911.

4 SHEETS—SHEET 1.

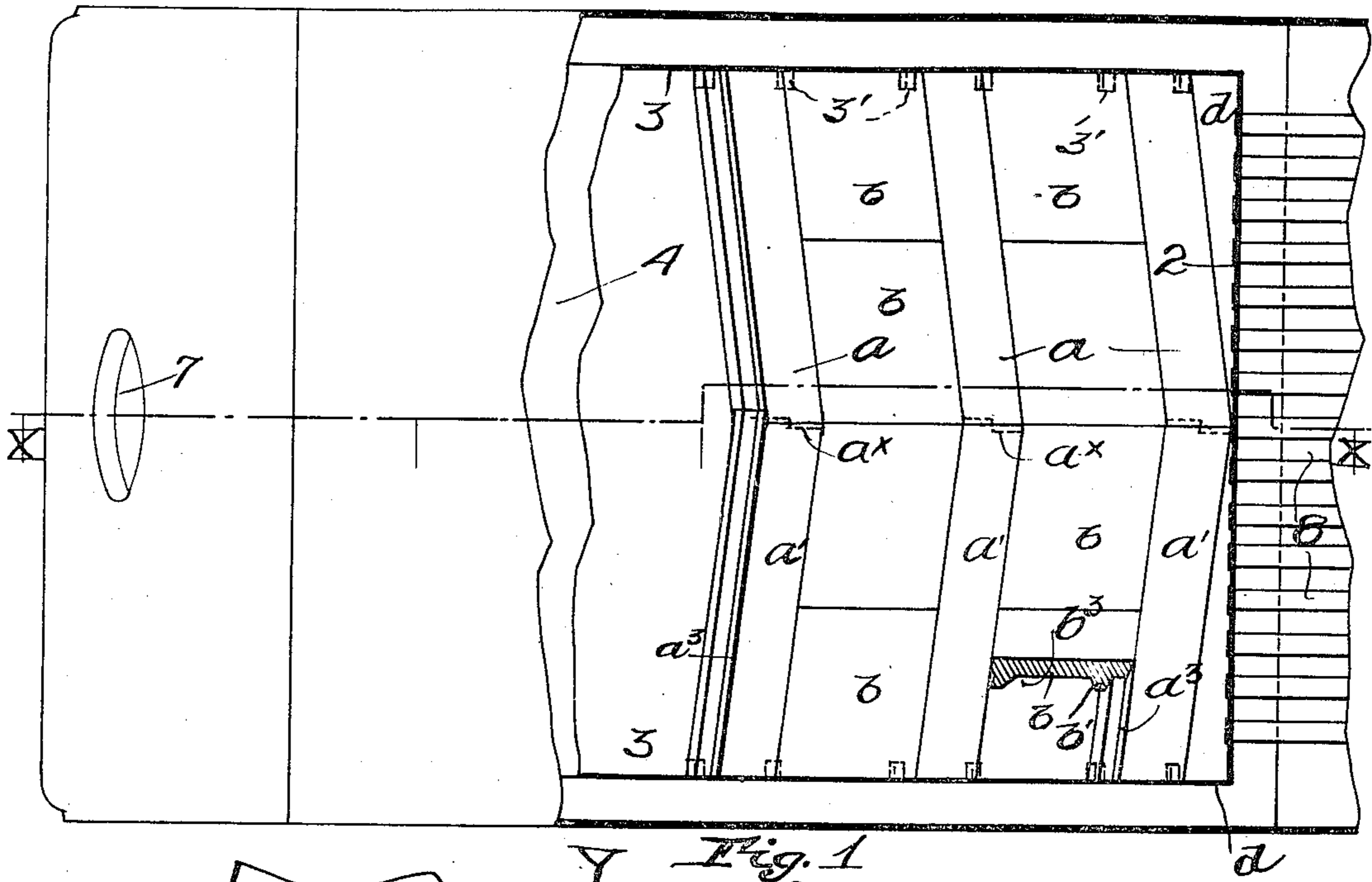


Fig. 1

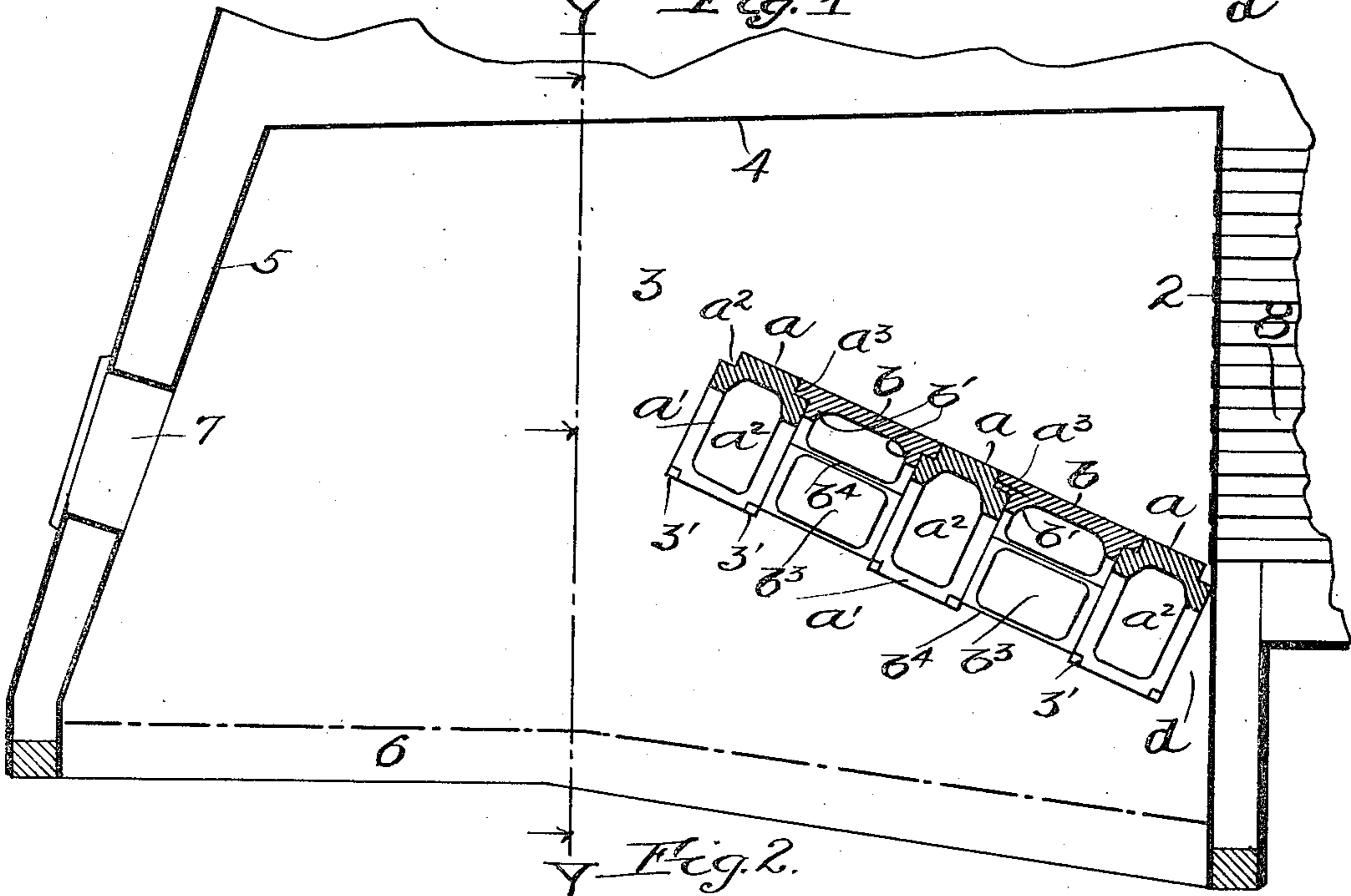


Fig. 2.

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Inventor:
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By *Charles Brearley Moore*
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4 SHEETS—SHEET 2.

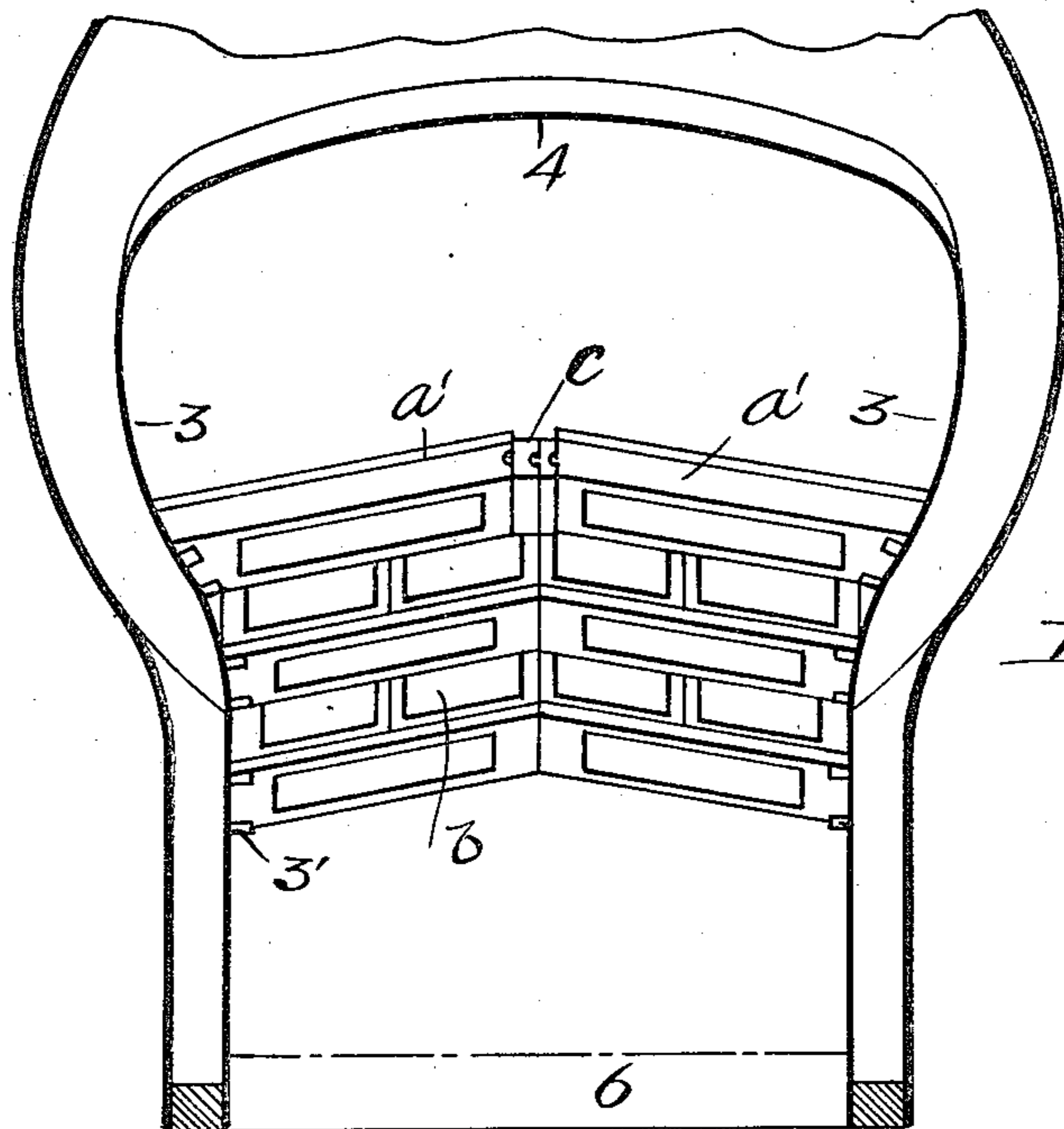


Fig. 4.

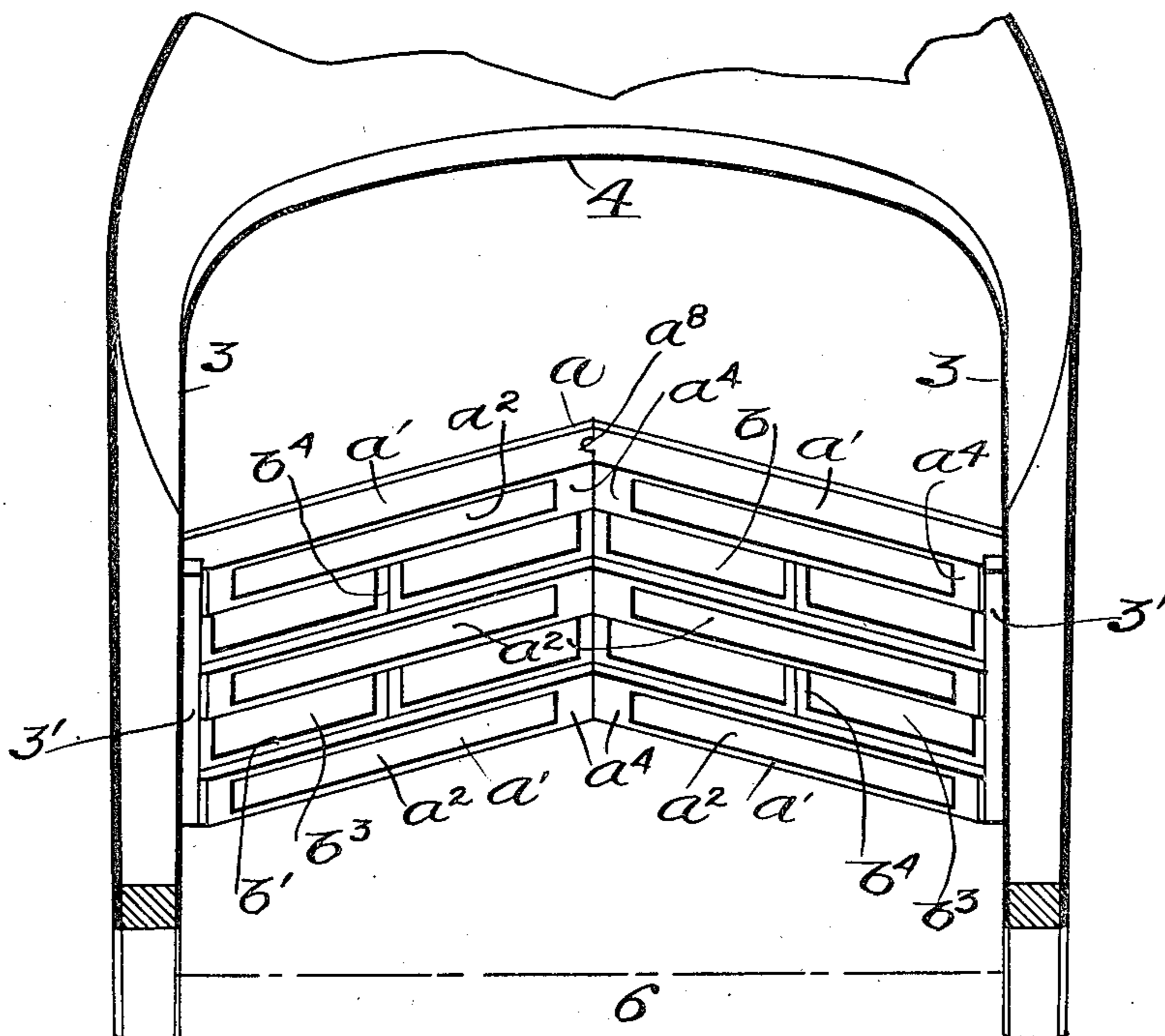


Fig. 5.

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4 SHEETS—SHEET 3.

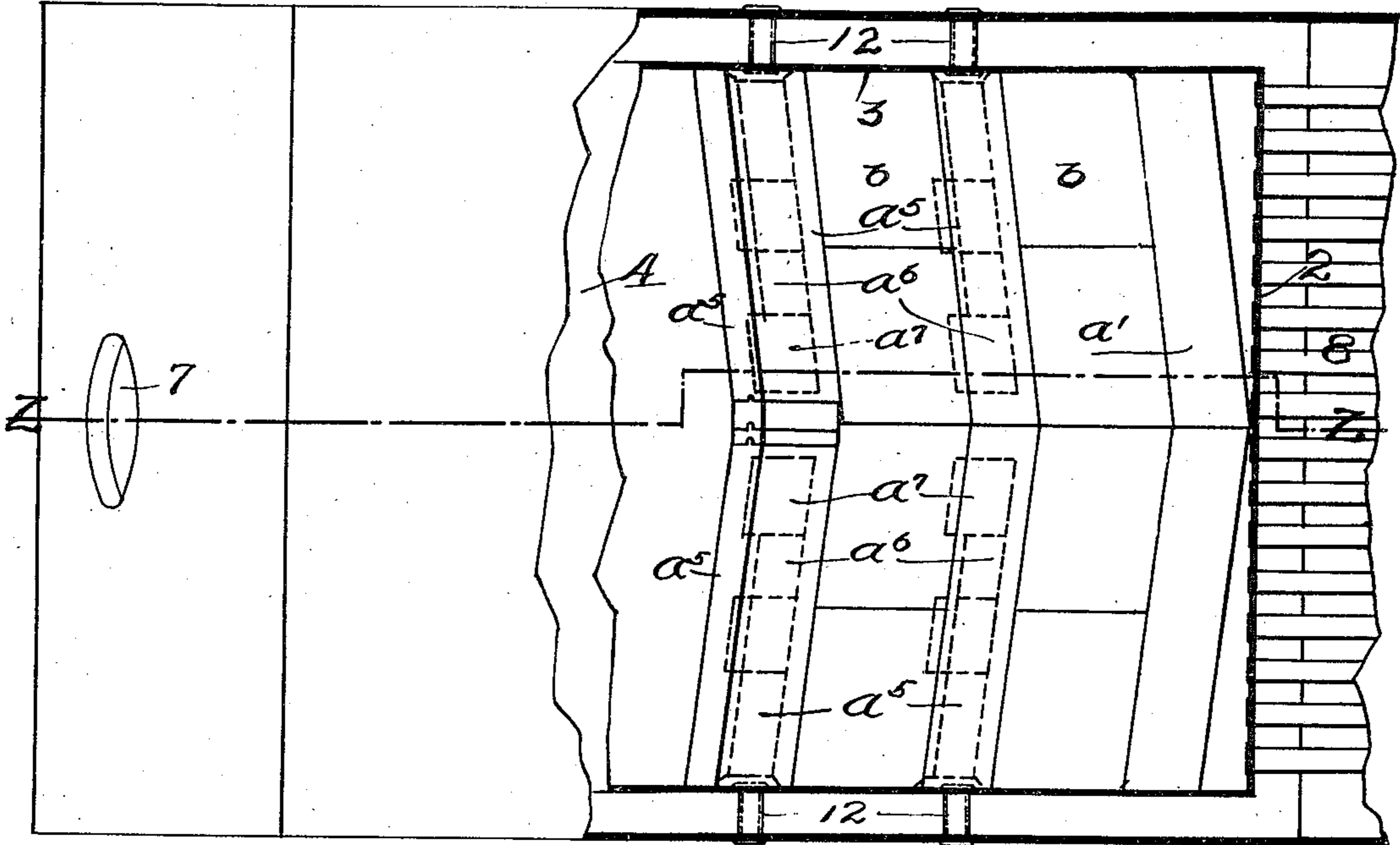


Fig. 5.

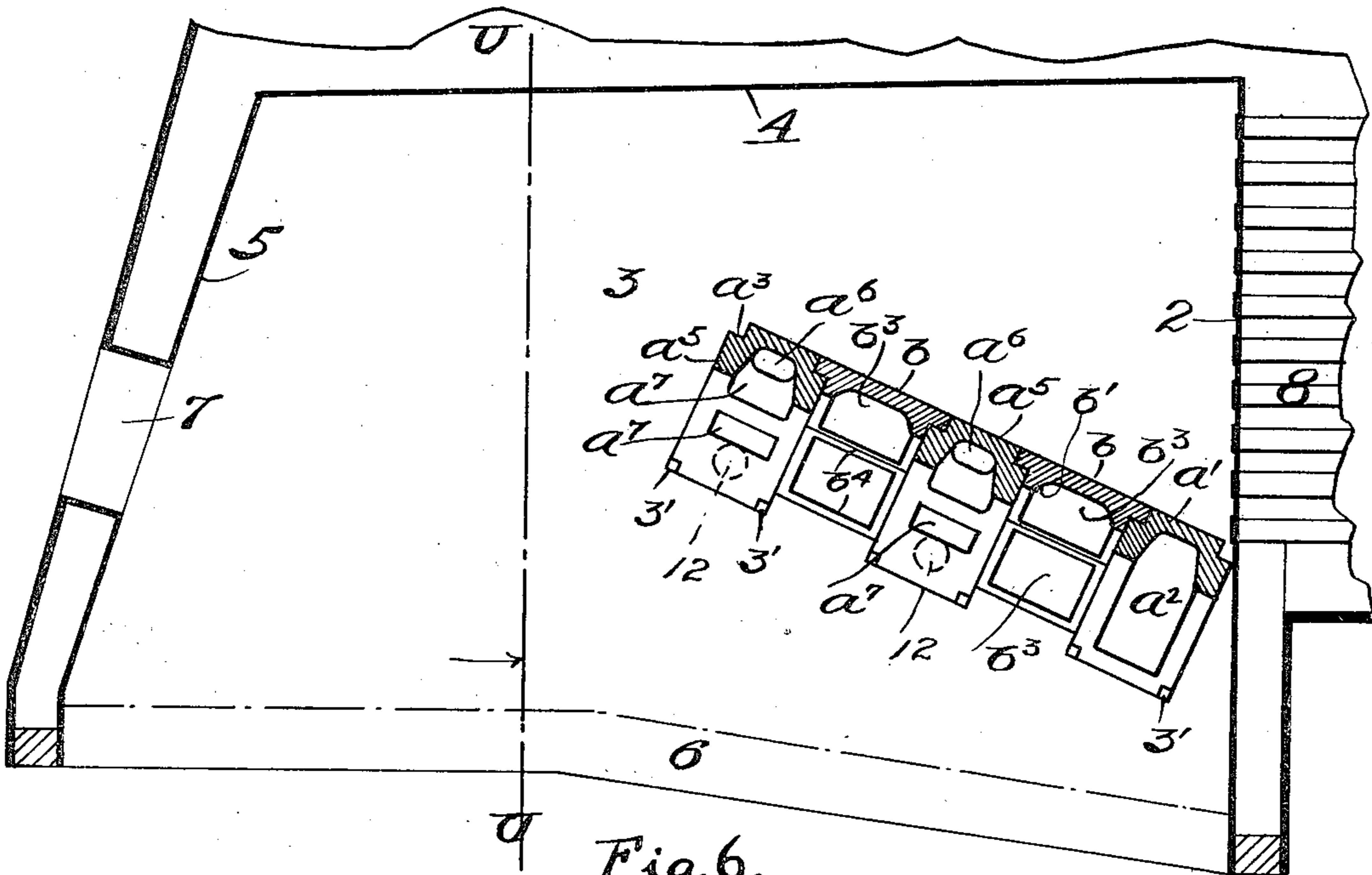


Fig. 6.

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 John P. Lefevre,
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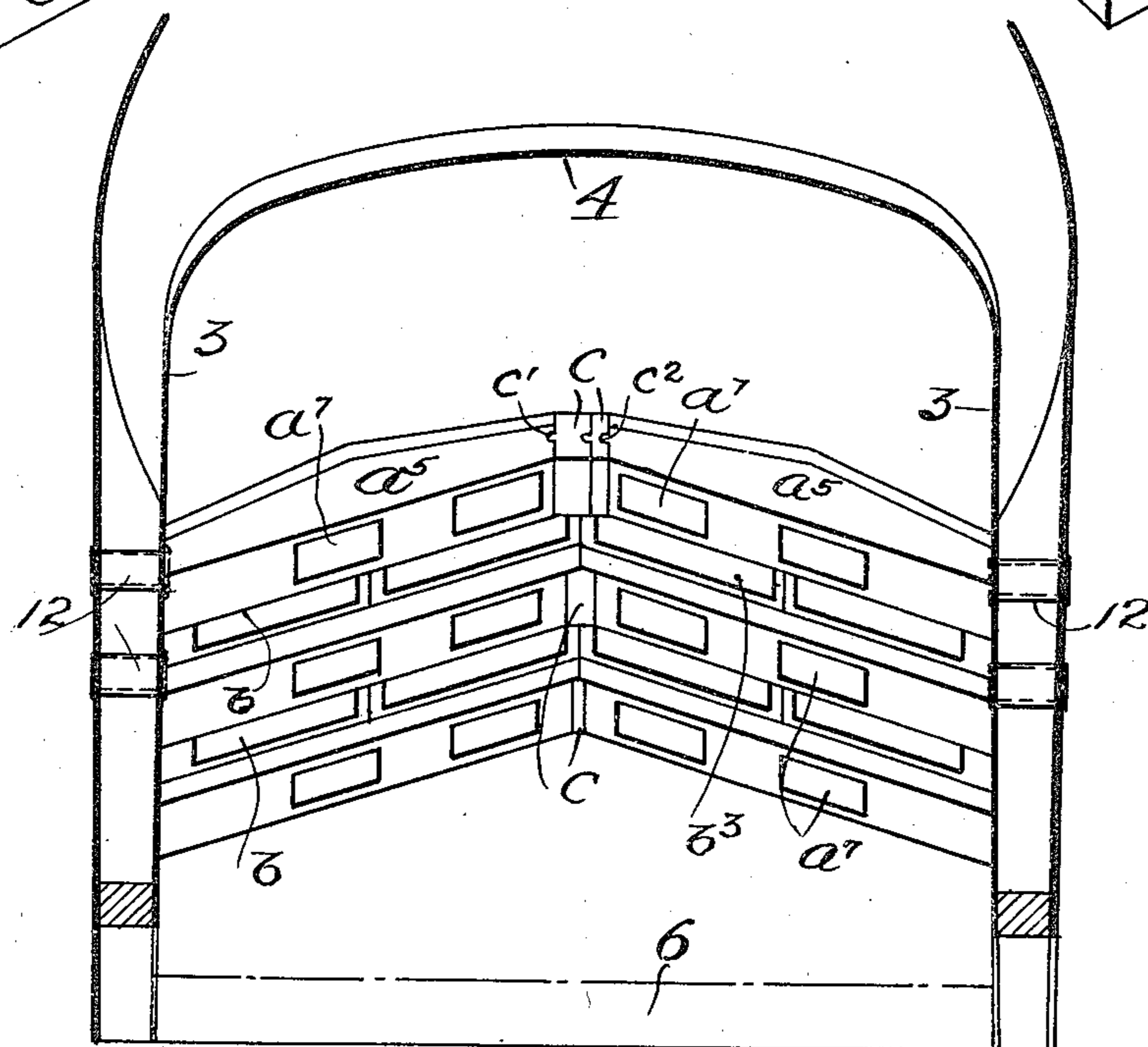
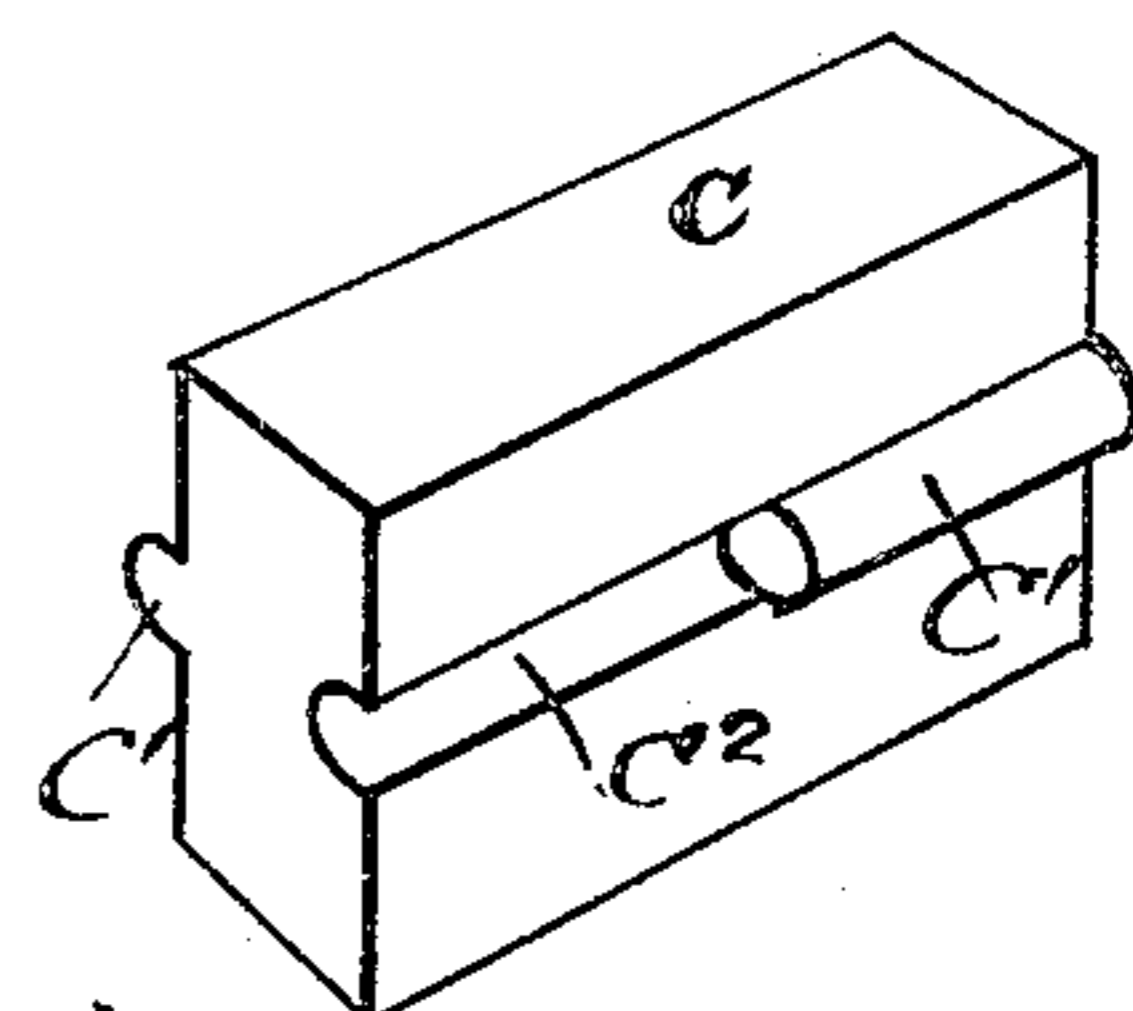
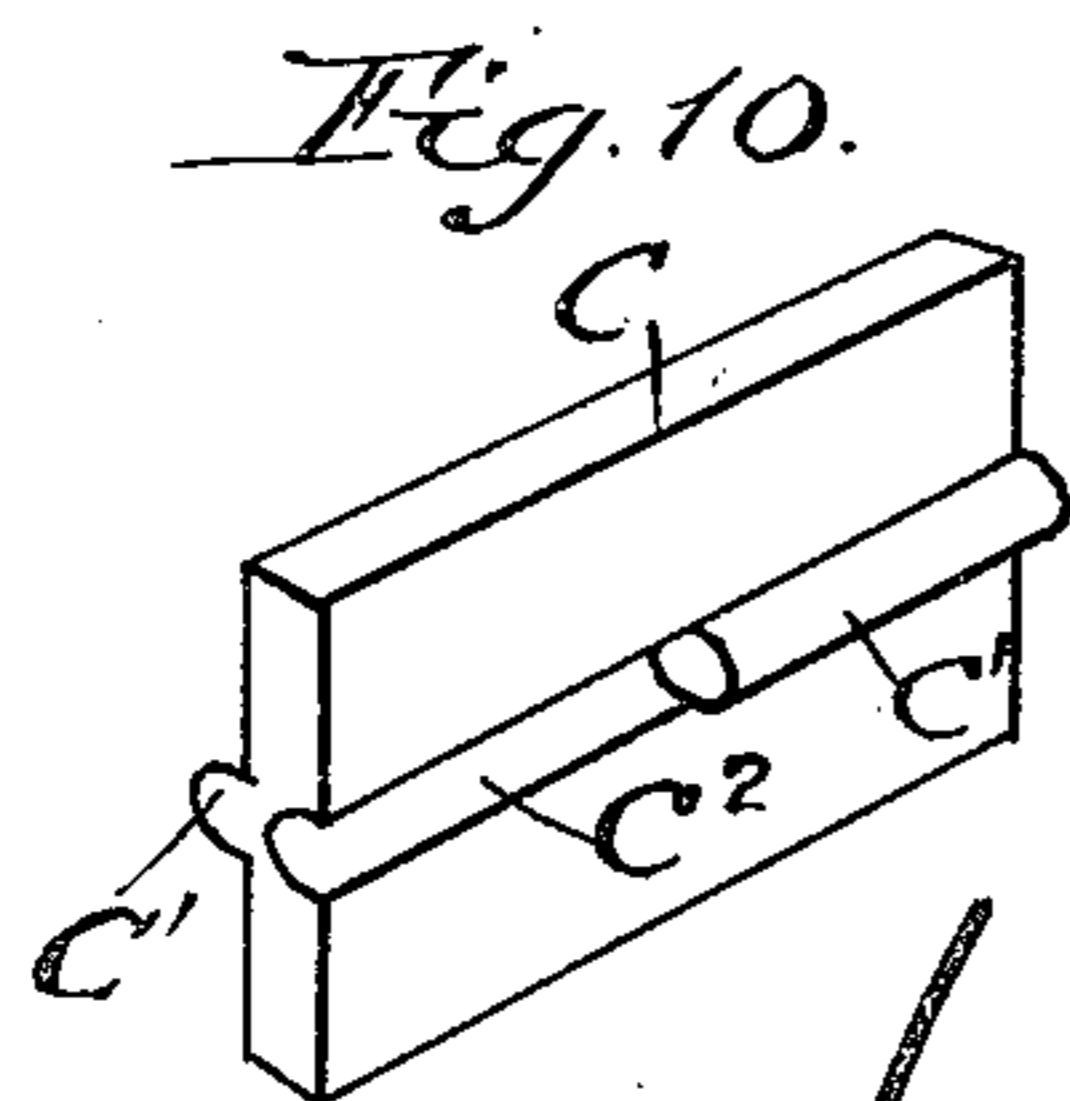
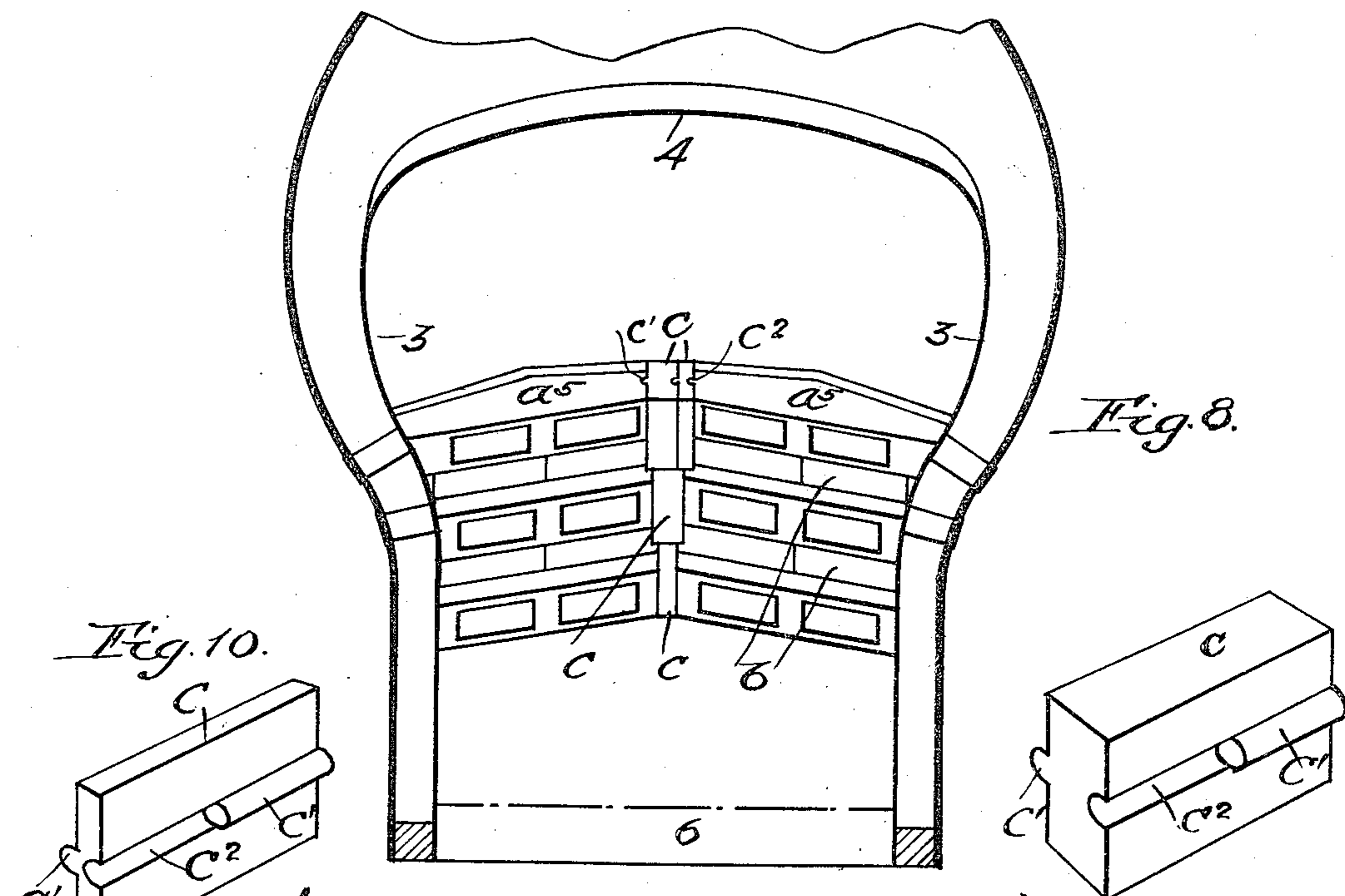
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4 SHEETS—SHEET 4.



Witnesses:
John R. Lefevre
John O. Hagitt

Fig. 7.

Inventor:
Charles Brearley Moore
By *[Signature]*
Atty.

UNITED STATES PATENT OFFICE.

CHARLES BREARLEY MOORE, OF EVANSTON, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

LOCOMOTIVE-BOILER FURNACE.

990,375.

Specification of Letters Patent.

Patented Apr. 25, 1911.

Application filed September 23, 1908. Serial No. 454,348.

To all whom it may concern:

Be it known that I, CHARLES BREARLEY MOORE, a citizen of the United States, and a resident of Evanston, Cook county, Illinois, have invented certain new and useful Improvements in Locomotive-Boiler Furnaces, of which the following is a full, clear, and exact description.

My invention relates to improvements in locomotive boiler furnaces and has special reference to improvements in refractory baffles or deflecting walls, commonly called arches, for the fire boxes of locomotive boilers.

The object of my invention is to provide an improved refractory arch which may be easily and quickly installed in locomotive fire boxes, which shall be of comparatively light weight and low cost, which shall be adapted for easy repair, parts of which may be removed to afford easy access to the sides or to the flue sheet of the fire box, and which shall be formed in such manner that it will materially assist in admixing the fire box gases.

A subordinate object of my invention is to provide an improved arch which shall be self supporting, *i. e.*, shall be adapted for use in locomotive fire boxes which are not equipped with arch supporting tubes; and, a further object of the invention is to provide an arch of the character here outlined which may be readily modified to adapt it for the introduction of heated air to the fire box.

Still further objects of my invention will appear hereinafter.

My invention consists in the several improvements, the various constructions, and the combinations of parts, hereinafter set forth and particularly pointed out in the appended claims; and will be readily understood upon reference to the accompanying drawings in which I have illustrated a structure which in a preferred form embodies the several features of my invention.

In these drawings, which form a part of this specification: Figure 1 is a plan view of a fire box containing a refractory arch embodying one form of my invention, the crown sheet of the fire box being broken away to disclose the arch; Fig. 2 is a sectional view on the line X—X of Fig. 1;

Fig. 3 is a sectional view on the line Y—Y of Fig. 2, viewed in the direction of the arrows; Fig. 4 is a similar section of a narrow fire box equipped with my novel arch; Fig. 5 is a plan view of a modified form of my arch; Fig. 6 is a sectional view thereof on the line Z—Z of Fig. 5; Fig. 7 is a vertical section on the line U—U of Fig. 6; Fig. 8 illustrates the adaptation to a narrow fire box of that form of my invention which is depicted in Fig. 5; Figs. 9 and 10 are perspective views of interlocking and spacing blocks or bricks, by which I adapt the main refractory members, carriers or supports of the arch to fire boxes of different widths.

My invention may be embodied in arches of various forms and in various locations in the fire box. I have herein confined the illustration of the invention to so-called self-supporting front arches which extend from side sheet to side sheet of the fire box, but desire that it shall be understood that my invention is not confined or limited thereto.

A locomotive boiler fire box, as shown in the drawings is made up of a flue sheet 2, the side sheets 3, 3, a crown sheet 4, and a rear sheet 5. The rear sheet contains the fuel door 7. The flues 8 lead forward from the flue sheet.

6 represents the fire box grate.

A so-called front arch usually occupies an inclined position in the front part of the fire box, its lower end closely approaching or being in substantial abutment with the lower part of the flue sheet. Its office is to prevent the direct flow of the gases and combustible particles from the grate to the flues and to force them toward the rear end and side sheets of the fire box and thus cause active combustion to take place throughout the length of the fire box, the object being to insure the uniform distribution of the heat to the walls and crown sheet of the fire box. An arch or baffle which is composed of refractory material attains the maximum temperature of the fire box and performs the further office of igniting gases and particles which might otherwise escape unconsumed.

A particular object of my invention is so to improve the arrangement and construction of refractory arches that the same shall better perform the function of diverting and

admixing the gases and combustibles within the fire box and the function of igniting them before they pass into the flues. To this end I build my arches of a number of refractory parts so disposed or arranged as to present a very large superficial area or ignition surface and also to enhance both the retarding and admixing effects of the arch upon the gases and combustibles.

The qualifying term "refractory" used throughout this specification and the appended claims is in all places intended to define non-metallic structures, and parts, *i. e.*, such as are made of fire clay or the like.

In carrying out my invention I employ a considerable number of independent refractory bricks, generally of several different shapes, and assemble them in a way to secure these advantages and others herein mentioned.

A special feature of my invention resides in a refractory arch which occupies an inclined position in the fire box, and is made up of two principal kinds of bricks, the one kind being supporting bricks that are separated by considerable spaces, and the other kind being cover or panel bricks that rest on the supporting bricks and close or substantially close the spaces between them. Irrespective of the form of the top of an arch of this construction, its under side obviously presents a plurality of surfaces which occupy different planes and positions and form deflecting walls and mixing cavities which are of such extent and capacity that they materially enhance combustion within the fire box. I make the supporting bricks, members, or spans, of sufficient strength to support their own weight and the weight of the superposed cover bricks. The size of the spans or supporting bricks and the disposition thereof in the fire box are determined by the positions of and the distances between their points of support in the fire box. In all cases the several supporting and cover bricks are small enough to be handled easily and passed through the furnace door. As the cover or panel bricks have no weight to support and are subjected to little, if any, strain they may be both thin and light. Another reason for this is that the cover bricks are farther removed from the direct heat and action of the fire and are in a measure protected by the cavities beneath them. The cinders and pieces of coal which by the action of the draft on the fire are violently thrown against the under side of the arch are impeded and broken by impact against the heavier supporting bricks, and the cover or panel bricks, which are in a great measure relieved from the scouring action of these particles, are practically as long-lived as the supporting bricks. In consequence of the employment of alternate light and heavy bricks, the total weight of

an arch embodying my invention is considerably less than that of an ordinary arch of the same over-all dimensions. Being made up of small units or members my arches may be put up and taken down more easily than others. Another advantage pertaining thereto is that the small, light, marginal bricks may be easily removed when work is to be done upon the side sheets or the flue sheet or the stay bolts of the fire box. Two other advantages are inherent to the structure described, namely; to a considerable degree, the arch is flexible, that is, being composed of parts which have no large areas of opposing contact one with another, it readily adjusts itself to the walls of the fire box and to any movement thereof which is occasioned by variations of temperature; and, second, the joints formed by the overlapping supporting and cover bricks do not fuse to the extent which causes an ordinary arch soon to become a substantially rigid mass or structure. These features and advantages are preserved in that form of my invention which is illustrated in the several figures of the accompanying drawings. The bricks *a'*, *a'* are the refractory sustaining spans or members which are first positioned in the fire box, and the refractory bricks *b* are the covers or panels which are later placed upon the supporting members. In the particular form of arch here shown the supporting members or carriers rest upon abutments or lugs provided therefor on the side sheets of the fire box. At each place I make use of two supporting bracks *a'*, *a'*, which together form a span, *a*, that reaches from one side sheet to the other. In this case each span *a'* has the side sheet as one support and the abutting brick *a'* as its other support. In short arches only two of the supporting spans are necessary; in longer arches three and sometimes more are used. Thus the arches herein shown have three of the self-supporting spans or arch sections. One manner of furnishing supports therefor will be explained hereinafter. In building this arch I first place a refractory support against or substantially against the flue sheet and then position the next support or span parallel to it and at a considerable distance from it. I then place the thin bricks, slabs or panels upon these two supports to secure the second support in its proper relation to the flue sheet and close the space between the two supports. Afterward the next span and the next set of panels are put in place in like manner. It will be noted that in that form of the invention shown in the drawings, cinder discharge openings *d* are left at the lower corners of the arch, due to the inclination of the lowest span bricks.

Referring now to Figs. 1 to 4, it will be seen that the particular arch there shown is made up of three of the self-supporting full

spans or arch sections, a , a , a , and two transverse rows or courses of thin bricks, slabs or fillers, b . Each span, a , is preferably composed of two long refractory bricks a' , a' , which constitute the supporting members. The ends of these bricks are here shaped to abut respective side sheets 3 of the fire box, and lugs 3', arranged in corresponding groups on said side sheets, take the weight of the arch and prevent vertical displacement of the supporting members or bricks. This construction in which few parts are directly supported by the side sheets, and in which the studs are arranged in groups, possesses the advantage that the usual number of studs is reduced, with consequent reduction in the number that need be maintained. The supporting bricks a' , a' , as shown in Figs. 3 and 4, are arranged at opposite inclinations and arch against one another, their ends meeting in the middle of the fire box. These bricks a' are of a width preferably exceeding their depth, for, as hereinafter described, I desire that these particular bricks shall form parts of the top as well as the bottom of the arch. Each supporting brick is provided with a deep recess, pit, or pocket a^2 in its under side, for the purposes above mentioned and hereinafter set forth. It will be noted that the ends of the bricks a' , a' , are of full cross section, the pockets or pits being of less length. In some cases I employ bricks or members a' which are of channel section throughout, but, for various reasons, including added strength and convenience in manufacture, I prefer the forms herein shown. A further advantage of such form will be explained hereinafter. The spans or arch sections, a , may occupy vertical positions in the fire box if desired, but the arch lends itself to simpler design when the spans are inclined with respect to a vertical plane and toward the flue sheet. Preferably, as shown in Figs. 1 and 2, the inclination is such that the upright planes of the supporting bricks are perpendicular to the pitch line of the arch, meaning the top plane of the arch as a whole. The bricks, b , are thin slabs of fire clay and are laid upon the tops of the spans, a , a , closing the spaces between them, and hence constituting panels or cover members between the supporting bricks. Inasmuch as the arch as a whole is pitched or inclined toward the flue sheet, it is desirable that the panel bricks be not simply laid on the supporting bricks, but that one or both bricks shall be provided with shoulders that will prevent the sliding or displacement of the panels and also positively hold the spans apart. In the present example, a^3 , a^3 , represent the shoulders on the supporting members, a' ; and b' , b' represent the shoulders on the panel bricks b . An advantage of shouldering the panels b

into or upon the supporting members in this manner is that the tops of the supporting members are not completely covered by the panels and the supporting members in themselves add to the total length of the arch. I prefer that the top of an arch of the kind here shown shall be flat or smooth and therefore provide the sections or members a' with comparatively deep shoulders for the ends of the panel bricks so that the tops thereof are made flush with the tops of the members a' . I prefer also that the bricks b shall have ribs or shoulders b' for engagement with the sides of the members a' , as clearly shown in Fig. 2. Each brick b is preferably provided with a pit or recess b^3 . These pits or recesses b^3 add to the depth of the recesses between the spans a ; and the end flanges b^4 of the bricks b serve to divide each main recess between the spans into several sections. An arch of this construction, as clearly shown in Figs. 2 and 3, contains in its bottom or under side five distinct transverse channels or recesses, each divided into several parts, as by the end portions a^4 of the members a' and the portions b^4 of the members b . As hereinbefore stated, the supporting members are also recessed or pitted. The substitution of plain bricks or slabs for the shouldered and recessed or pitted bricks is within the scope of my invention; but I prefer that the supporting members or carriers a' shall always be grooved or pitted, as herein indicated, particularly as such form lends itself to the construction of supporting members of minimum weight and maximum strength, considering the bulk of material used. In either construction, the arch is formed or provided with many deflecting surfaces and recesses of different depths, in which the currents of gases impinging upon the arch are effectually broken up and admixed, stratification of the gases being effectually prevented; and, obviously, the superficial area or ignition surface of the arch is much increased, as compared with an arch of the ordinary form.

Although I have herein shown supporting members or spans of a kind adapted to the peculiar supports furnished by the side sheets of a fire box and of a kind to reach from side to side of the fire box, it is obvious that my invention admits of other arrangements of spaced supporting bricks which span between supporting devices of other kinds and other arrangements in the fire box.

The arch illustrated in Figs. 1 to 4 is a solid arch, that is, it is substantially imperforate and no means are provided for heating and introducing air therethrough. When such an air feeding arch is required I modify the structure by substituting for the bricks a' the hollow or channeled bricks a^5 ,

as shown in Figs. 5 to 8. One or more spans may be substituted in this manner, as shown in Fig. 6. The upper and the middle spans are formed of the hollow bricks, and the lower span remains as in Fig. 2. The external form or configuration of the bricks a^5 is substantially identical with the form and configuration of the bricks a' , but in lieu of the pocket or recess above described, each brick a^5 is provided with a channel, passage, or duct, a^6 , and one or more downwardly leading openings or passages a^7 . By means of tubes or thimbles 12 in the sides of the fire box, air is supplied to the ducts a^6 . It is heated therein and, expanding, attains a high velocity, which results in its forcible expulsion through the ports or openings in the bottoms of the members a^5 . Thus the heated air is projected downwardly into the fire box where it combines with the combustibles therein. It is obvious that by means of such hollow arch sections or spans, heated air may be supplied to any desired part of the fire box.

As a means of interlocking the abutting ends of the bricks or members a' , I tongue-and-groove the ends thereof, as shown in Fig. 3, wherein a^8 represents the tongue on one brick accommodated in a groove of corresponding shape in the other, and, in order that the bricks may be interchangeable, I provide the end of each with what may be termed half-a-tongue and half-a-groove (see dotted line a^x in Fig. 1). In other words, I make the ends of the brick identical in form, each being the complement of the other. An advantage of this form of interlocking device is that it serves to prevent either vertical or lateral displacement of the abutting ends. One of the chief advantages of my invention is that an arch thus constructed will fit fire boxes of various widths and it is unnecessary to make the component bricks in many sizes. Considerable variation in fire box width may be compensated by increasing or decreasing the pitch or inclination of the members a' , and where the width of the fire box precludes adjustment in this manner I employ one or more small key blocks c between the ends of the members a' , a' . I make these key blocks (shown in detail in Figs. 9 and 10) of various thicknesses, and if one block is not sufficient I use two or more, fitting the same to the space between the ends of the arch members, as shown in Figs. 4, 7 and 8. The sides of the key blocks c are provided with half-tongues and half-grooves c' and c'' which correspond with the tongues and grooves in the bricks a' . They therefore interlock with one another. Such adjusting or spacing blocks c are of particular advantage in the narrow fire box wherein the width of the upper end of the arch considerably exceeds the width of its lower end.

The special half-tongue and half-groove arch brick interlocking devices above described are not claimed in this application, but are specifically described in a divisional application filed September 26th, 1910, Serial No. 583,763.

Other forms of the invention herein claimed are shown and described in my companion applications Serial No. 454,349 and Serial No. 454,351, filed simultaneously with this application, to wit, September 23, 1908. Thus in the modification shown in application Serial No. 454,349 the supporting members or spans are much like those herein shown, whereas in the modification shown in application Serial No. 454,351 the arch supporting devices in the fire box are arch tubes instead of lugs on the side sheets, and the supporting members, spans, or bricks, which carry the panels, each spans between and is supported by two arch tubes or between a tube and the side sheet instead of being wholly dependent on the side sheets of the box.

As various other modifications of my invention will readily suggest themselves to one skilled in the art, I do not confine the invention to the specific structures shown and described.

Having thus described my invention I claim as new and desire to secure by Letters Patent:

1. A locomotive boiler fire box in combination with two or more self supporting spans of refractory material spaced apart in the fire box and abutting the sides thereof, and a plurality of slabs or bricks in the spaces between and supported by said spans, substantially as described.

2. A locomotive boiler fire box in combination with two or more self supporting spans of refractory material abutting the sides of the fire box and spaced apart therein and a plurality of slabs or bricks filling the spaces between the spans and each supported by two said spans, substantially as described.

3. A locomotive boiler fire box in combination with two or more self supporting spans of refractory material abutting the sides of the fire box and spaced apart therein, and a plurality of slabs or bricks supported at the ends by adjacent spans and closing the spaces between the spans, substantially as described.

4. A locomotive boiler fire box in combination with two or more self supporting refractory spans arranged transversely and spaced apart therein, in combination with thin bricks or slabs resting upon and connecting said spans, forming therewith one or more transverse recesses or pockets, substantially as described.

5. A locomotive fire box arch composed of a plurality of spaced apart refractory spans, each comprising members arched

against one another, in combination with a plurality of thin bricks or slabs each resting upon two adjacent spans and said thin bricks closing the spaces between said spans, substantially as described.

6. A locomotive boiler fire box arch comprising a plurality of spaced apart parallel arch spans composed of refractory material in combination with a plurality of bricks or slabs each supported at the ends by adjacent spans and having its top flush with the tops of said spans, substantially as described.

7. A locomotive fire box arch comprising a plurality of refractory arch spans adapted to abut the side sheets of the fire box and spaced apart in parallel relation, in combination with a plurality of bricks or slabs having recesses or pits in their under surfaces and supported at the ends by said spans, and therewith completing the arch, substantially as described.

8. A locomotive fire box in combination with an arch comprising a plurality of refractory spans having their ends in abutment with the sides of the fire box and each provided with one or more pits or pockets in its under side, and thin bricks or slabs separating said spans, each brick extending between two spans and being supported at its ends thereby, substantially as described.

9. A locomotive fire box arch composed of refractory bricks, comprising a plurality of spaced, parallel arch spans each made up of two oppositely inclined bricks and a refractory arch top closing the spaces between said spans, substantially as described.

10. A locomotive boiler fire box in combination with an arch comprising a plurality of refractory spans having their ends engaged with the side sheets of the fire box, each said span being composed of several bricks, said spans being spaced apart, and refractory material in thin sheet or slab form resting upon said spans and closing the spaces between them, substantially as described.

11. A locomotive boiler fire box in combination with an arch comprising a plurality of refractory spans each composed of several members arched against one another and having their ends in abutment with and supported by the side sheets of said fire box, said spans being spaced apart in parallel relation and refractory material in thin slab form resting upon said spans and closing the spaces between them, forming therewith deep gas mixing pocket or pockets, closed at the top and open at the bottom, substantially as described.

12. A locomotive boiler fire box in combination with an arch comprising a plurality of refractory spans having their ends in abutment with the sides of the fire box each composed of oppositely inclined bricks having their abutting ends interlocked, and a

refractory covering or arch top resting upon said spans and therewith completing the arch, substantially as described.

13. A locomotive boiler fire box arch comprising a plurality of spaced apart refractory spans each composed of two oppositely inclined bricks and one or more spacing or adjusting blocks, said bricks and blocks being interchangeably interlocked, and an arch top or cover of refractory material supported by said spaced apart spans, substantially as described.

14. A locomotive boiler fire box in combination with a refractory arch comprising a plurality of spaced apart arch spans abutting the sides of the fire box and occupying inclined positions in the fire box, and transverse rows of fire bricks arranged between and supported by respective pairs of spans, said bricks also serving to maintain the spans in said inclined positions, substantially as described.

15. A locomotive boiler fire box in combination with a refractory arch therein, comprising a plurality of arch spans spaced apart in said fire box, abutting and supported by the sides thereof, members covering or closing the spaces between said spans, one of said spans being hollow and provided with ports or discharge openings and means for supplying air to the hollow span through the side or sides of the fire box, substantially as described.

16. A locomotive boiler fire box having air tubes in its sides in combination with a plurality of refractory arch spans spaced apart in said fire box, abutting and supported by the sides thereof, arch top or cover bricks resting upon said spans and each extending between two thereof, therewith forming gas pockets in the arch, and one or more of said spans being provided with air ducts and ports which communicate with said tubes, substantially as described.

17. A locomotive boiler fire box in combination with an arch comprising a plurality of spaced apart refractory spans abutting and supported by the sides of said fire box, and a plurality of filler bricks each extending between and supported by two of said spans, each of said bricks having a pit or pocket in its under side, substantially as described.

18. A locomotive boiler fire box, in combination with a plurality of refractory spans, spaced apart in said fire box and each having its ends in abutment with the sides thereof, and a plurality of thin refractory bricks or slabs having their front and rear ends supported by adjacent spans throughout, said bricks and spans together forming an imperforate arch having a plurality of gas mixing recesses or pockets in its under side, substantially as described.

19. A locomotive boiler fire box, in com-

ination with a plurality of refractory spans, spaced apart in said fire box and each abutting and supported by the sides thereof, a plurality of thin refractory bricks or slabs having their front and rear ends supported by adjacent spans throughout, said bricks and spans together forming an imperforate arch having a plurality of gas mixing recesses or pockets in its under side, certain of said spans constituting air feeding ducts and means for supplying air thereto, substantially as described.

20. A locomotive fire box having studs or lugs on its sides in combination with two or more transverse arch spans of refractory material resting upon said lugs and against the sides of the fire box, said spans being spaced apart in the fire box and being of greater width than depth and a plurality of slabs or bricks resting upon the tops of said spans and connecting them.

21. A locomotive fire box having air inlet tubes in its sides, in combination with hollow refractory arch spans spaced apart in, and abutting the sides of, said fire box, at least one of said arch spans abutting said air inlet tubes and having air discharge openings or ports in its under side and communicating with said tubes, and arch members substantially closing the spaces between said spans and between the sides of the fire box, substantially as described.

22. A locomotive boiler fire box, in combination with an arch therein, said arch consisting of a plurality of transverse refractory arch spans spaced apart in the fire box, supporting means at the sides of the fire box for said spans and a plurality of thin refractory slabs resting upon and closing the spaces between said transverse spans.

23. A locomotive boiler fire box, in combination with a plurality of spans of refractory material transversely positioned and supported therein and a refractory covering resting on said spans and therewith forming an arch structure within said fire box.

24. An arch for locomotive boiler fire boxes, comprising a plurality of refractory spans and a plurality of refractory slabs, the ends of said slabs being formed to fit the upper parts of said spans and space them apart.

25. An arch for locomotive boiler fire boxes, comprising a plurality of peaked refractory spans adapted for transverse arrangement in a fire box and a plurality of thin slabs or bricks formed to rest upon said spans and hold them apart.

26. An arch for locomotive boiler fire boxes, comprising a plurality of spaced apart peaked refractory spans adapted for transverse arrangement in a fire box and a plurality of thin slabs or bricks formed to rest upon and interlock with said spans.

27. An arch for locomotive boiler fire

boxes, comprising a plurality of spans each composed of a plurality of refractory bricks in combination with a plurality of thin slabs or bricks, resting upon and substantially closing the spaces between respective spans.

28. An arch for locomotive boiler fire boxes, comprising a plurality of spaced apart spans each composed of a plurality of refractory bricks and a plurality of refractory spacing slabs or bricks having their ends interfitting with respective spans, substantially as set forth.

29. An arch for locomotive boiler fire boxes, comprising a plurality of spaced apart spans each composed of a plurality of complementary interlocking bricks, in combination with a plurality of refractory slabs or bricks having their ends interlocked with respective spans, said spans and slabs together forming a refractory arch having an indented or grooved under surface.

30. A locomotive boiler fire box, in combination with a plurality of refractory spans spaced apart in the fire box, means upon the sides of the fire box supporting the ends of the spans and a refractory roof laid upon said spans and composed of a plurality of relatively small bricks or slabs.

31. A locomotive boiler fire box having a grate and provided with a door at one end and a flue sheet at the other end, in combination with an inclined front arch substantially abutting the lower part of said flue sheet and supported by the sides of the fire box, said arch comprising a plurality of refractory spans each composed of several members and a plurality of refractory slabs resting on said spans, the ends of said spans and certain of said slabs engaging the sides of the fire box.

32. A locomotive fire box having a flue sheet at one end and a fuel door at the other, in combination with a refractory arch substantially abutting the lower part of the flue sheet but at points spaced away therefrom to provide for the passage of cinders, said arch comprising a plurality of oppositely inclined bricks forming a plurality of spans supported by the sides of the furnace and inclined with respect to said flue sheet and a plurality of slabs or bricks resting upon, and closing the spaces between, said spans.

33. A locomotive boiler fire box, in combination with a plurality of parallel spans of refractory material spaced apart and sustained in said fire box, and a covering of refractory material resting on and supported by said spans, said spans and covering forming an arch having a cavities bottom presenting variously positioned deflecting surfaces.

34. A locomotive boiler fire box, in combination with a plurality of parallel spans each composed of several refractory bricks,

said spans being spaced apart in said fire box and a covering of refractory material resting on and supported by said spans, said spans and covering forming an arch having a cavi-
 5 tied bottom presenting variously positioned deflecting surfaces.

35. A locomotive boiler fire box, in combination with a plurality of parallel refractory spans transversely positioned, spaced
 10 apart and suitably sustained therein, and a covering of refractory material resting on and extending from span to span, said spans and covering forming an arch having a cavi-
 15 tied bottom presenting variously positioned deflecting surfaces.

36. A locomotive boiler fire box, in combination with a plurality of parallel refractory spans transversely positioned, spaced
 20 apart and suitably sustained therein, each said span comprising several refractory bricks, and a covering of refractory bricks supported by said spans.

37. A locomotive boiler fire box, in combination with a plurality of parallel refrac-
 25 tory span bricks spaced apart and sustained in said fire box and a refractory covering resting upon and interlocked with the tops of said span bricks, said bricks and coverings forming a substantially imperforate arch
 30 having a caviated bottom presenting variously positioned deflecting surfaces.

38. A locomotive boiler fire box, in combination with spans of refractory material spaced apart in said fire box and therein sus-
 35 tained in parallel relation, cover bricks resting upon and extending between said spans, said cover bricks having recesses in their sides, and said spans and cover bricks forming a substantially imperforate arch having
 40 a caviated bottom presenting variously positioned deflecting surfaces.

39. A locomotive boiler fire box in combination with spans each formed of several refractory bricks containing gas mixing re-
 45 cesses, said spans being spaced apart and suitably sustained in said fire box, and a plurality of refractory cover bricks resting upon and forming other gas mixing recesses between said spans.

40. An arch for locomotive boiler fire boxes, comprising a plurality of transversely disposed and spaced apart supporting bricks containing gas mixing recesses and a plu-
 50 rality of relatively longitudinal cover bricks formed to rest upon and extend between said supporting bricks and close the spaces be-
 55 tween them, substantially as and for the purpose herein specified.

41. An arch for locomotive boiler fire
 60 boxes, comprising a plurality of refractory panel-supporting bricks spaced apart in parallel relation and containing gas mixing recesses, in combination with a plurality of refractory panels having similar recesses,
 65 said panels extending between and resting

upon said supporting bricks and therewith presenting a substantially imperforate struc-
 70 ture having variously positioned recesses and deflecting surfaces, substantially as de-
 scribed.

42. An arch for locomotive fire boxes comprising a plurality of refractory span bricks containing gas mixing recesses and spaced
 75 apart and individually supported, in combination with a plurality of refractory cover bricks having similar recesses, said cover
 80 bricks extending between and having their individual ends supported by said span bricks and therewith forming a substan-
 tially imperforate structure having vari-
 ously positioned recesses and deflecting sur-
 faces.

43. The improvements herein described comprising an arch for locomotive boiler fire
 85 boxes, composed of a plurality of refractory span bricks, spaced apart and suitably sus-
 tained, in combination with a plurality of panel bricks resting upon and extending be-
 90 tween said span bricks, and said span bricks having stop portions for holding said panel
 bricks thereon.

44. The improvements herein described comprising an arch for locomotive boiler fire
 95 boxes, composed of a plurality of refractory supporting spans, spaced apart and suitably
 sustained, in combination with a plurality
 100 of panel bricks resting upon and extending between said supporting spans, and said panel bricks having stop portions engaged
 with the sides of said spans, as and for the
 purpose specified.

45. The improvements herein described, comprising an arch for locomotive boiler fire
 105 boxes, composed of a plurality of refractory supporting spans spaced apart and sup-
 ported in substantially parallel relation, in combination with a plurality of refractory
 110 panel bricks resting upon and extending between said spans and said spans and bricks having interlocking shoulders or stops, sub-
 stantially as and for the purpose specified.

46. A locomotive boiler fire box having projections spaced apart upon its sides, in
 115 combination with two or more self-supporting spans of refractory material sustained
 by said respective projections and also spaced apart in said fire box, and a plurality
 of refractory panel bricks supported at the
 120 ends by adjacent spans and covering the spaces between the spans, substantially as
 described.

47. A locomotive boiler fire box having arch-supporting lugs arranged in groups
 125 upon its side sheets, in combination with several elongated bricks of refractory ma-
 terial, spaced apart with their ends sup-
 ported by respective groups of lugs, and re-
 130 fractory cover bricks resting on and extend-
 ing from one to the other of said elongated bricks, therewith completing an arch.

48. A locomotive boiler fire box containing symmetrically disposed arch-supporting devices, in combination with refractory supporting bricks extending between and resting on opposite devices and spaced apart in the fire box, and a refractory covering laid upon said supporting bricks and closing the openings between them.

49. A locomotive boiler fire box containing symmetrically disposed arch-supporting devices, in combination with refractory supporting members extending between and resting on opposite devices and spaced apart in the fire box, and a plurality of refractory panel bricks closing the spaces between said supporting members and therewith forming a refractory arch having open-bottomed cavities in its under side.

50. A locomotive boiler fire box containing arch supporting devices in combination with refractory supporting members spaced apart and each supported by and bridging the space between two such supporting devices, and a plurality of refractory panel bricks in turn resting upon and in each case bridging the space between adjacent supporting members, forming therewith an arch having a caved bottom presenting a plurality of variously disposed and positioned deflecting surfaces.

51. A locomotive boiler fire box containing symmetrically disposed arch-supporting devices, in combination with an arch comprising refractory supporting spans which rest on said devices and are spaced apart within the fire box and a plurality of relatively thin refractory bricks constituting panels between said supporting spans.

52. A locomotive boiler fire box containing symmetrically disposed arch-supporting devices, in combination with a substantially imperforate arch comprising refractory supporting spans which rest on said devices and are spaced apart within the fire box and a plurality of refractory bricks arranged upon and constituting panels between the top portions of respective adjacent supporting spans.

53. A locomotive boiler fire box containing arch supporting devices, in combination with an arch comprising a plurality of refractory span members resting upon said devices and spaced apart in parallel relation and a plurality of refractory panel members in each case extending from one said member to another, and providing a closed top cavity therebetween.

54. A locomotive boiler fire box containing arch-supporting devices, in combination with an arch comprising a plurality of refractory span members resting upon said devices and spaced apart in parallel relation and a plurality of other refractory members in each case extending from one

span member to the next, said other members having recesses in their under sides.

55. A locomotive boiler fire box containing devices for supporting an arch in inclined position therein, in combination with parallel refractory supporting spans resting on said devices, refractory members adapted to and serving to hold said supporting spans apart at different elevations, said members extending between the tops of said supporting spans and closing the cavities or spaces between them.

56. A locomotive boiler fire box containing devices for supporting an arch in inclined position therein, in combination with substantially parallel refractory supporting spans arranged upon said devices and at different elevations in said box, and refractory panel bricks closing the space between said spans, said bricks having ends which lap upon respective spans and being also provided with shoulders that abut the sides thereof, substantially as described.

57. An arch for locomotive boiler fire boxes, comprising a plurality of parallel refractory supports each composed of several longitudinally interlocked refractory bricks, in combination with a plurality of refractory panels closing the spaces therebetween and resting upon the tops thereof, substantially as described.

58. A locomotive boiler fire box, in combination with a plurality of spans suitably supported and spaced apart therein, each said span being composed of two refractory bricks formed to interlock at their upper ends, and relatively thin bricks extending between, supported by and interlocked with said spans, as and for the purpose specified.

59. The improvement herein described comprising a locomotive boiler fire box, in combination with three refractory span members spaced apart, and sustained in substantially parallel relation, within said fire box, and a plurality of refractory panel bricks in turn sustained by said span members and closing the spaces between them.

60. A locomotive boiler fire box, in combination with a plurality of relatively heavy recessed refractory supporting members extending across said box and spaced apart therein at different elevations and rows of relatively light recessed panel bricks arranged between and supported by said members.

61. An improvement in arches for locomotive boiler fire boxes comprising two refractory span members spaced apart at different elevations, and a refractory panel brick extending from one to the other of said span members and sustained thereby.

62. The improvement herein described comprising a refractory arch for locomotive boiler fire boxes, comprising two kinds of

bricks, the one kind being supporting bricks that are separated by considerable spaces, and the other kind being thin cover or panel bricks that rest on the supporting bricks and substantially close the spaces between them, cavities being formed beneath the cover bricks and between the supporting bricks.

63. The herein described supporting brick or member for refractory arches comprising a supporting brick of greater length than width, having one end formed to fit a suitable abutment, and provided with an interlocking device at its other end, and said brick having a recess in its under side, in combination with panel bricks having their ends resting upon said supporting brick.

64. The herein described supporting brick or member for refractory arches, comprising a brick of greater length than width, having one end formed to fit a suitable abutment, provided with an interlocking device at its other end, and having a panel brick shoulder along its upper edge, in combination with a panel brick engaged with said shoulder.

65. The herein described panel brick for refractory arches comprising a brick containing a recess in its under side and provided with shouldered ends adapted for engagement with complementary supporting bricks, in combination with supporting bricks engaged with the shouldered ends of said panel brick.

66. A locomotive boiler fire box in combination with a plurality of refractory spans composed of elongated bricks extending upwardly from the sides of the fire box and inwardly and forwardly inclined, means interlocking the abutting ends of each pair of bricks and each said brick containing an elongated recess in its under side.

67. A locomotive boiler fire box containing devices for supporting an arch in inclined position therein and a refractory arch resting upon said devices and composed of alternate heavy and light refractory bricks, said heavy bricks serving to protect said light brick from wear, substantially as described.

68. A locomotive boiler fire box containing devices for supporting an arch in inclined position therein and a refractory arch resting upon said devices and composed of alternate heavy and light refractory bricks, said light bricks being sustained by said heavy bricks.

69. A locomotive boiler fire box containing devices for supporting an arch in inclined position therein, in combination with a substantially imperforate refractory arch comprising a plurality of refractory span members supported by said devices and widely spaced apart in said fire box, and a plurality of thin refractory panels each

resting upon and extending between two of said span members, said members and said panels containing individual gas mixing recesses, substantially as described.

70. A locomotive boiler fire box, in combination with a plurality of relatively heavy refractory supporting bricks extending across said box and spaced apart therein at different elevations and a transverse row of relatively light panel bricks arranged between, lapping upon and supported by said supporting bricks.

71. A locomotive boiler fire box, in combination with a plurality of deeply recessed refractory span bricks spaced apart and so supported in said box and a plurality of refractory panel bricks containing relatively shallow recesses and extending between, lapping upon and supported by said span bricks, substantially as described.

72. The herein described supporting member for refractory arches comprising an elongated refractory brick of greater length than width, having one end formed to interlock with a complementary member and having a panel receiving shoulder along its upper edge, in combination with a panel brick engaged with said shoulder, substantially as described.

73. A locomotive boiler fire box, in combination with an arch frame or skeleton composed of a plurality of refractory spans supported in spaced apart relation in the fire box and a plurality of refractory cover bricks resting upon and closing the openings in said frame.

74. A locomotive boiler fire box containing arch supporting devices, in combination with an arch therein, comprising supporting bricks spaced apart in the box and sustained by, and extending cross-wise with respect to, said devices, and cover bricks resting upon and closing the openings between said supporting bricks.

75. A locomotive boiler fire box in combination with two refractory panel-supporting bricks both extending from one wall of the fire box toward the opposite wall thereof, adjacent top edges of said bricks lying substantially in one inclined plane and a refractory panel brick which spaces the supporting bricks apart and rests on said edges thereof.

76. A locomotive boiler fire box, in combination with two arch-forming panel-supporting bricks at each side of said fire box, said bricks being spaced apart longitudinally of the fire box and extending from respective sides thereof toward the opposite side in each case, and a series of panels supported by said supporting bricks, closing the top of the space between them and together extending from side to side of the fire box.

77. A refractory arch for locomotive fire

boxes comprising a plurality of spaced apart bricks extending across the space occupied by the arch, in combination with a plurality of panel bricks supported by said spaced apart bricks and closing the openings between them, substantially as described.

78. A locomotive boiler fire box in combination with a refractory arch occupying and suitably supported in an inclined position in said box, said arch comprising a plurality of spaced apart bricks extending across the space occupied by the arch and a

plurality of panel bricks interlocked with and supported by said spaced apart bricks and closing the openings between them, substantially as described. 15

In testimony whereof, I have hereunto set my hand, this 19th day of September, 1908, in the presence of two subscribing witnesses.

CHARLES BREARLEY MOORE.

Witnesses:

CHARLES GILBERT HAWLEY,
JOHN R. LEFEVRE.