

No. 628,790.

Patented July 11, 1899.

A. P. GAINES & C. J. GUSTAFSON.
COOLING DEVICE FOR FURNACE WALLS.

(Application filed Dec. 28, 1898.)

(No Model.)

4 Sheets—Sheet 1.

Fig. 1

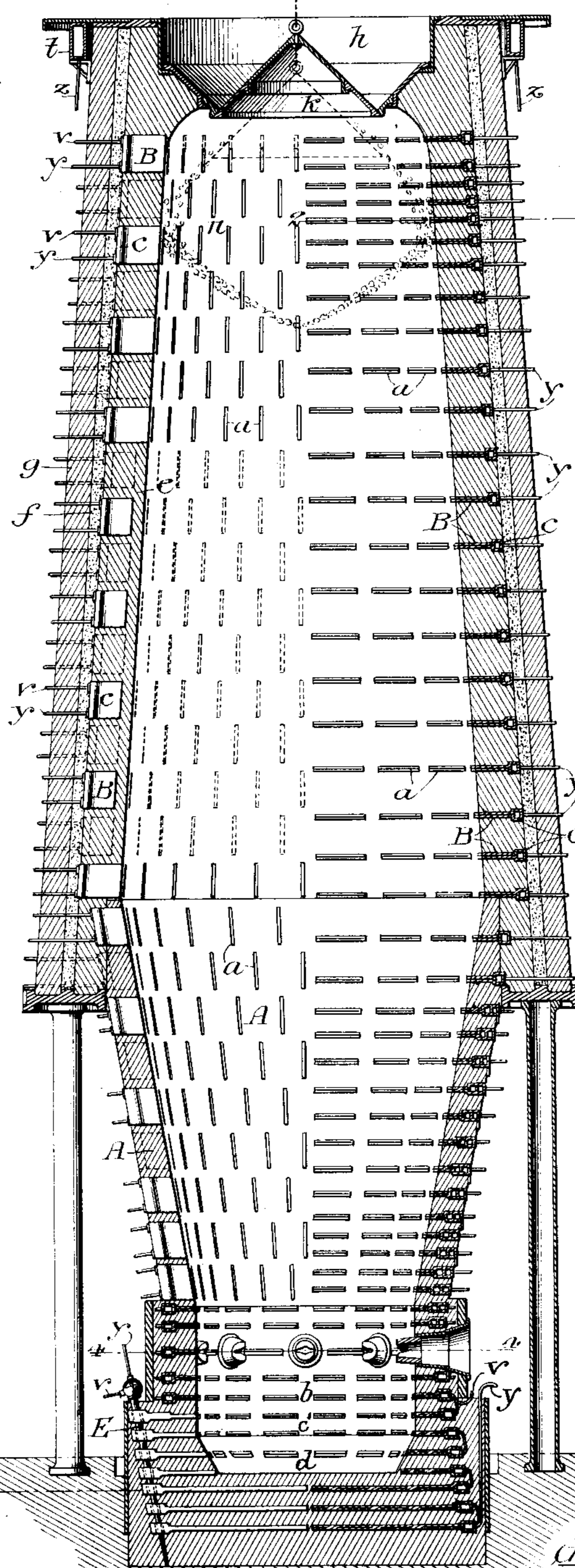


Fig. 2

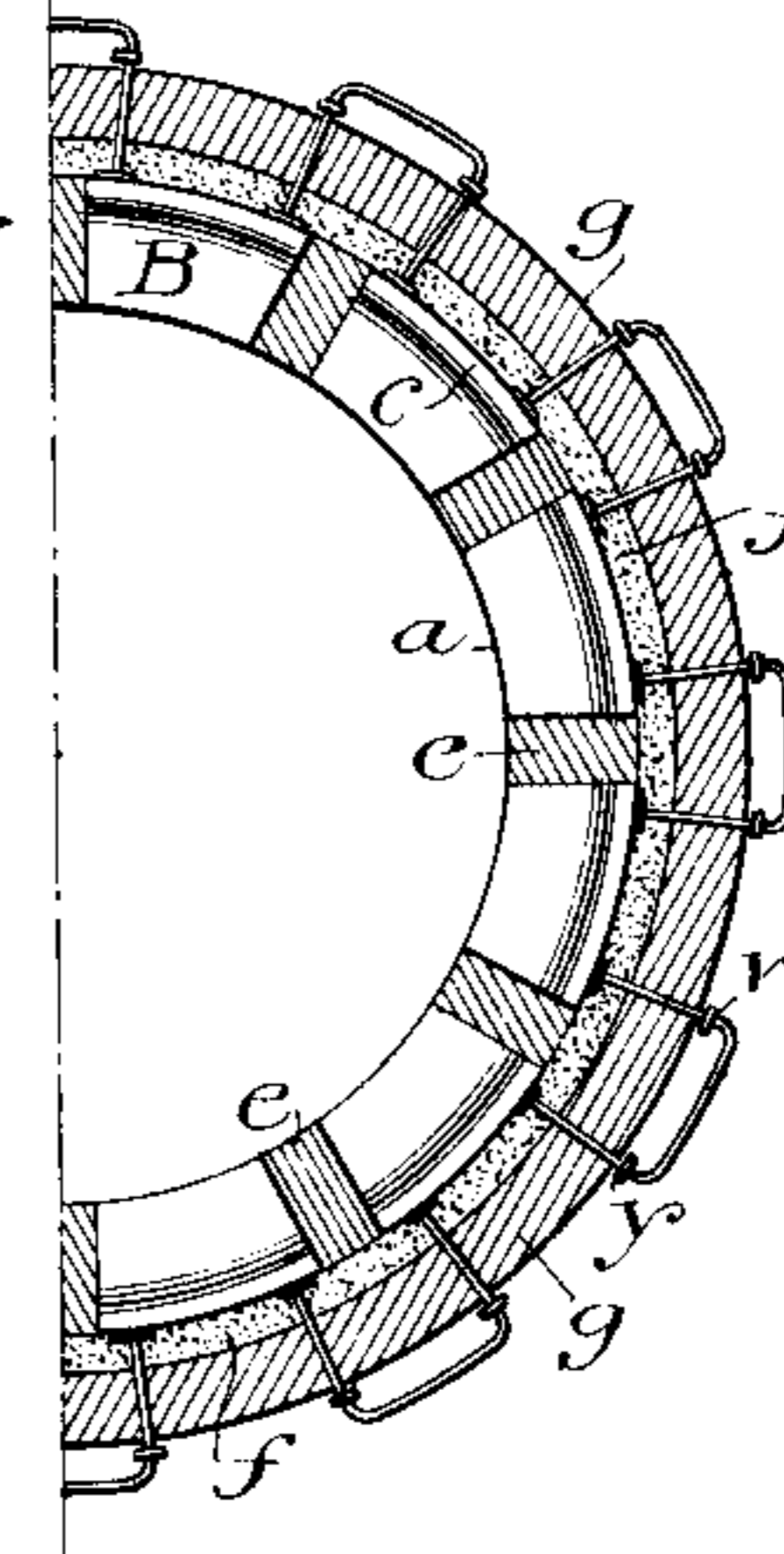


Fig. 3

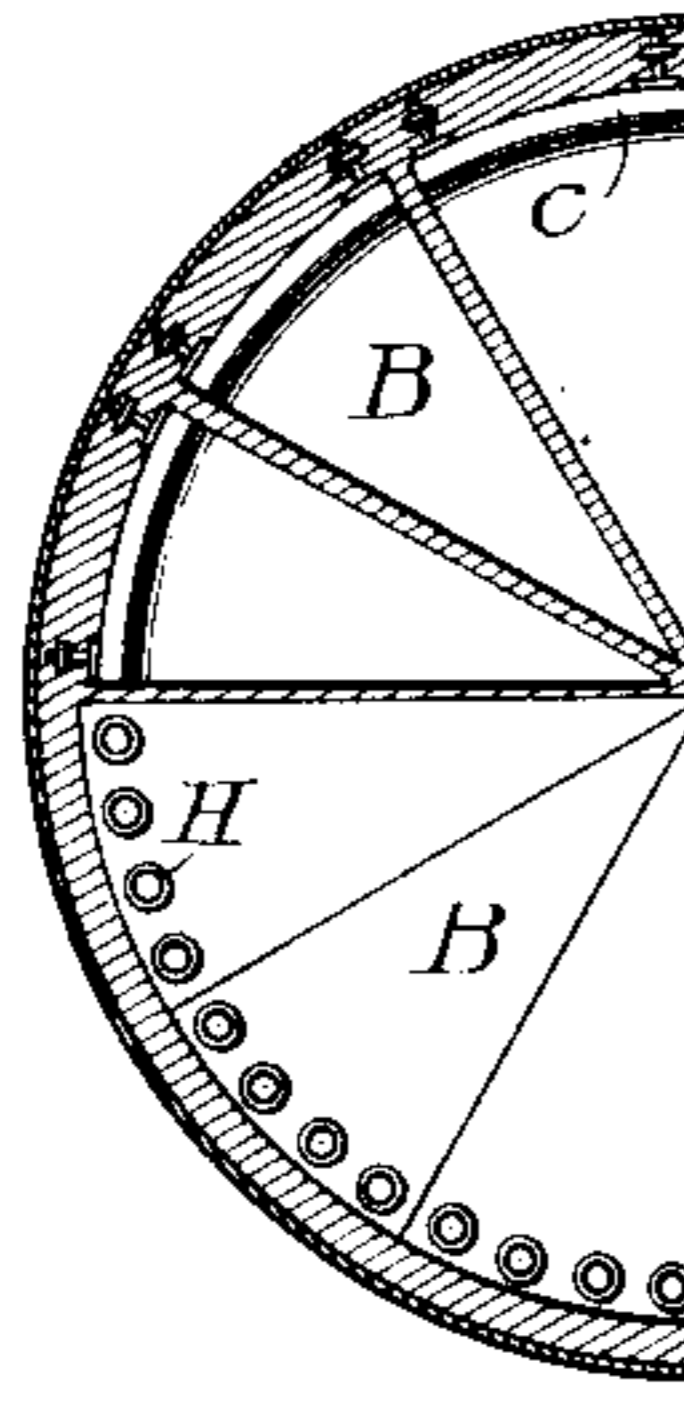
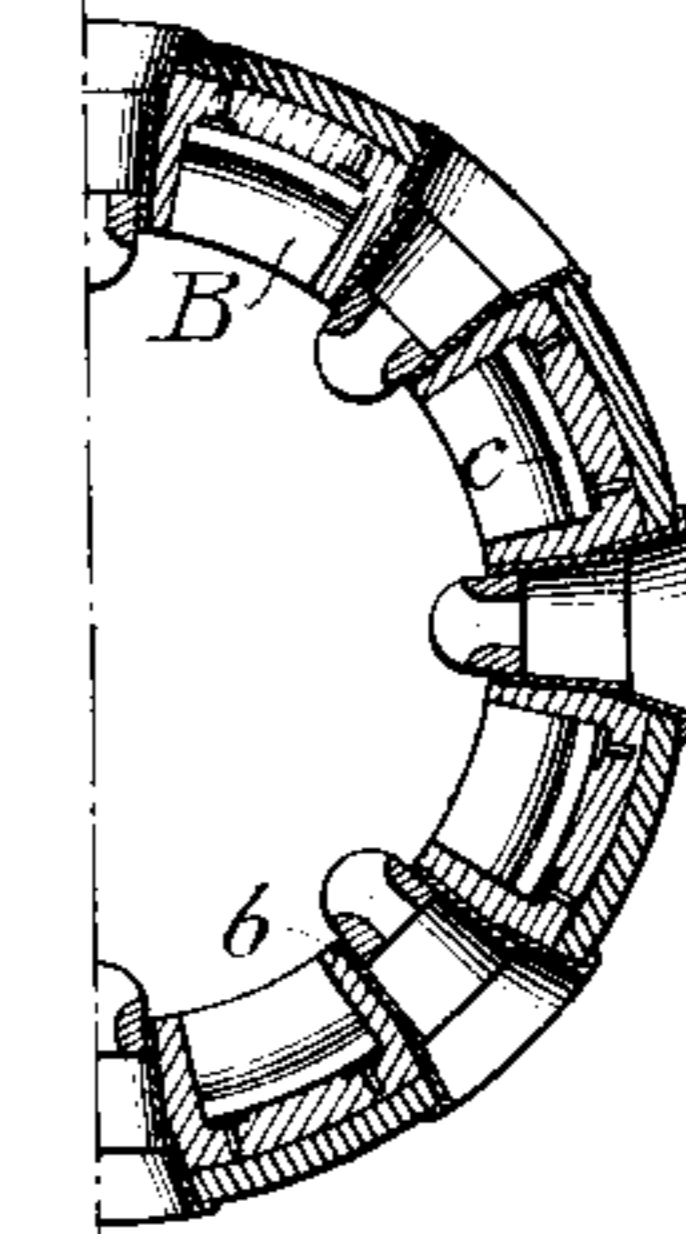


Fig. 4



Witnesses: 3

Louis H. Whitehead.
Hamilton D. Turner

Inventors:

Ambrose Porter Gaines
Charles J. Gustafson.
by Their Attorneys
Hanson & Hanson

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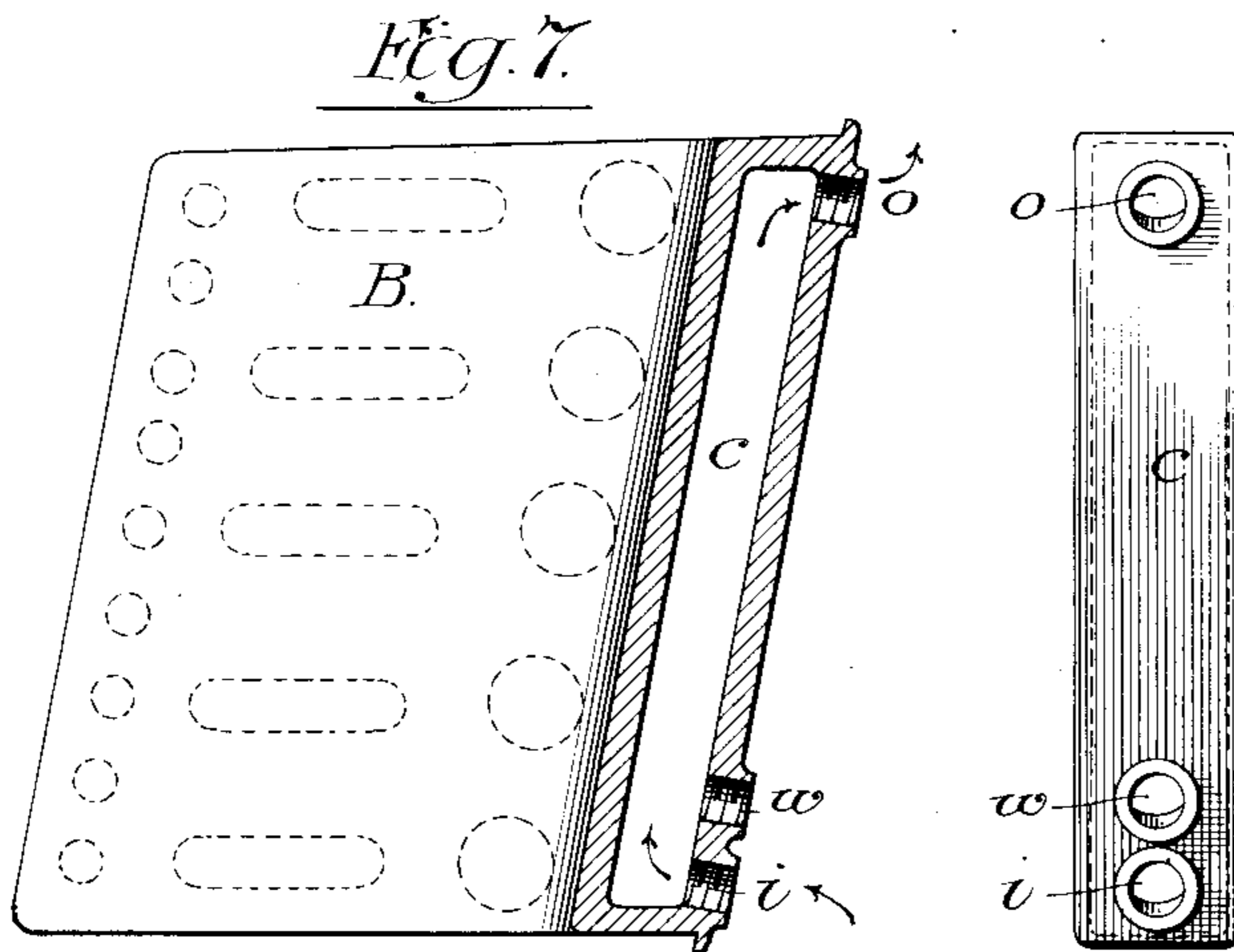
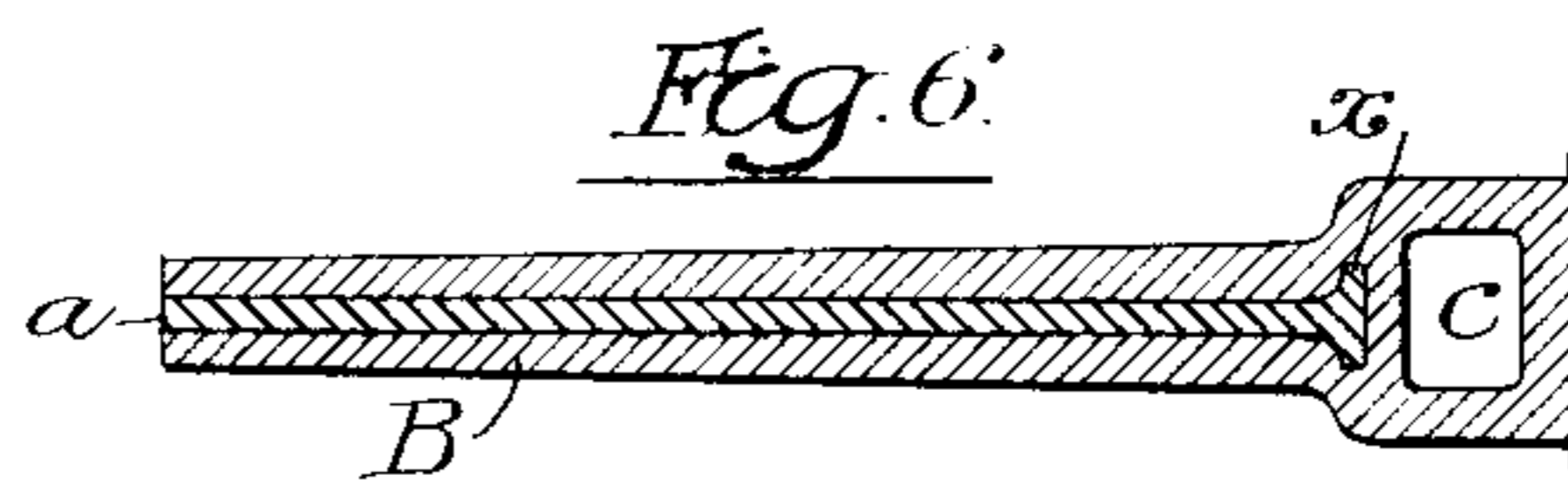


Fig. 8.

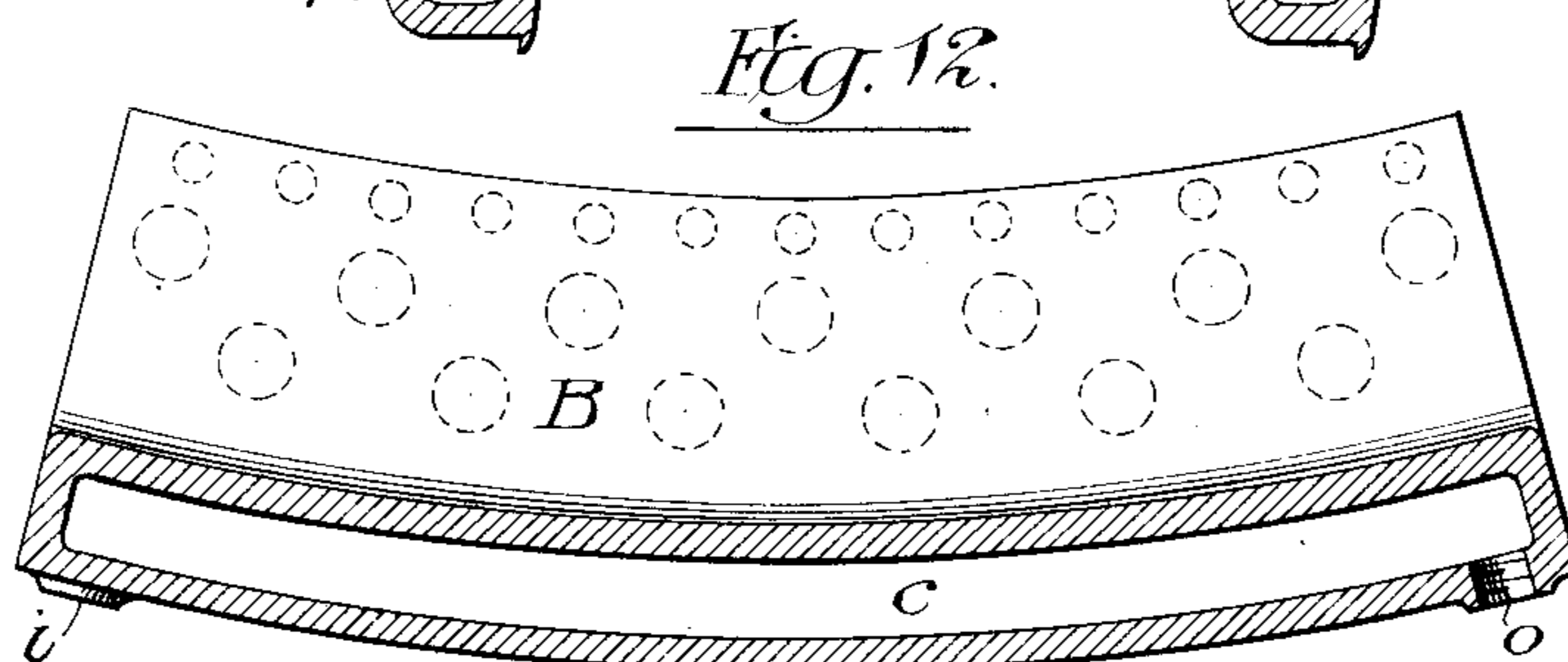
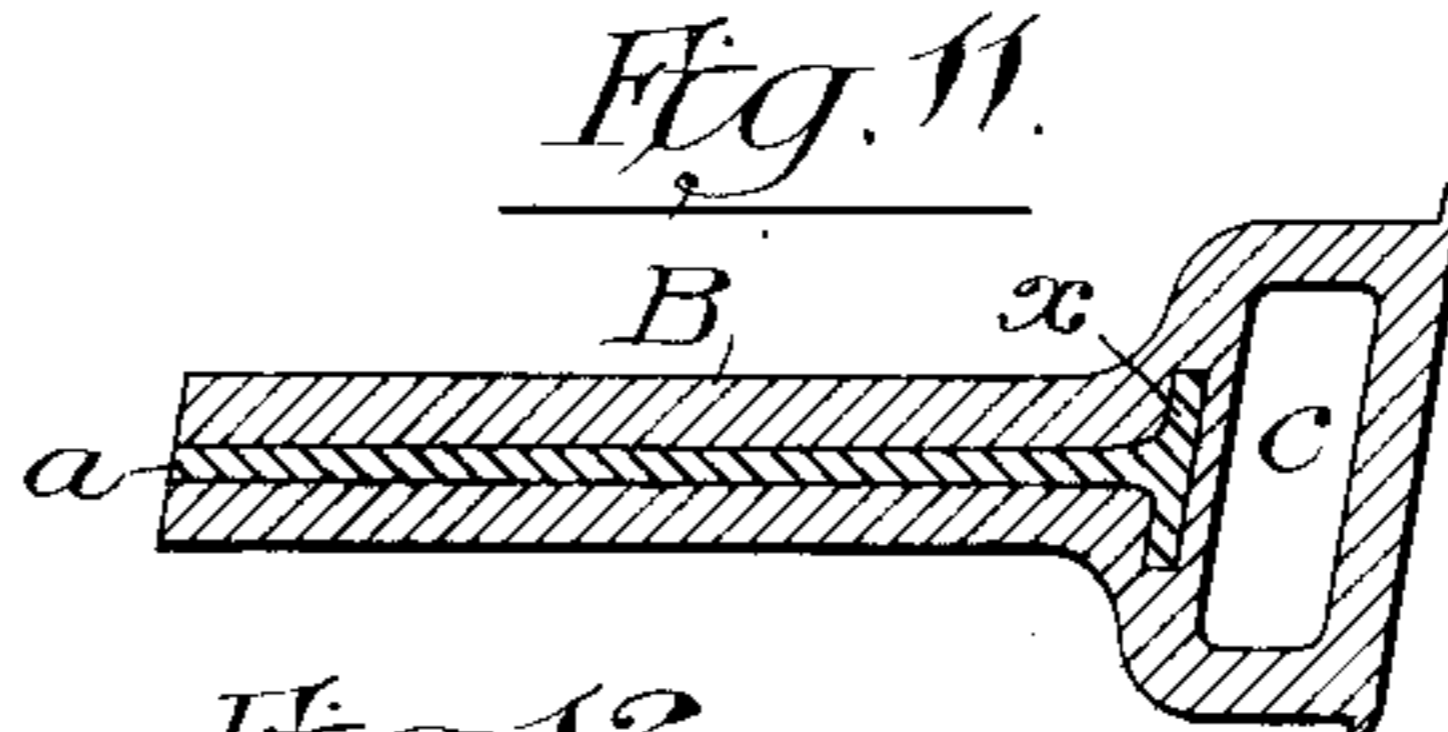
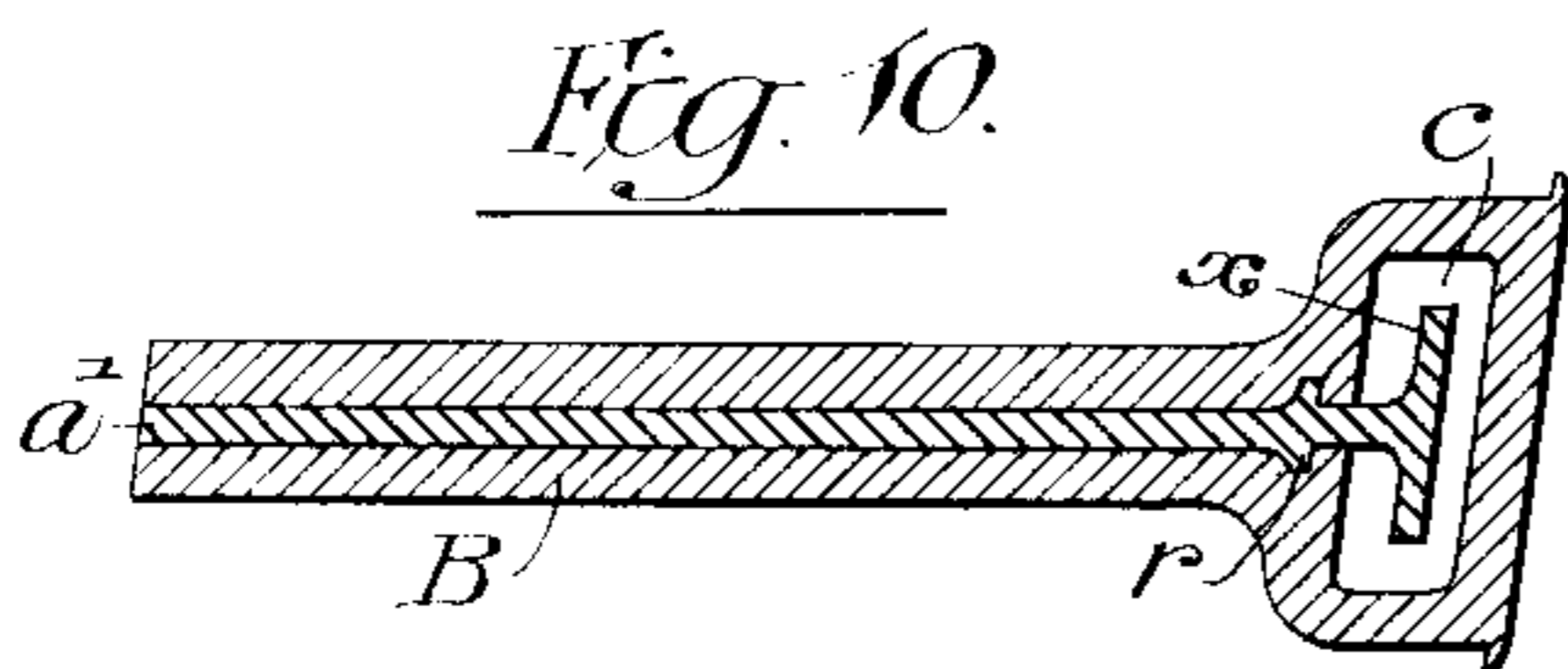
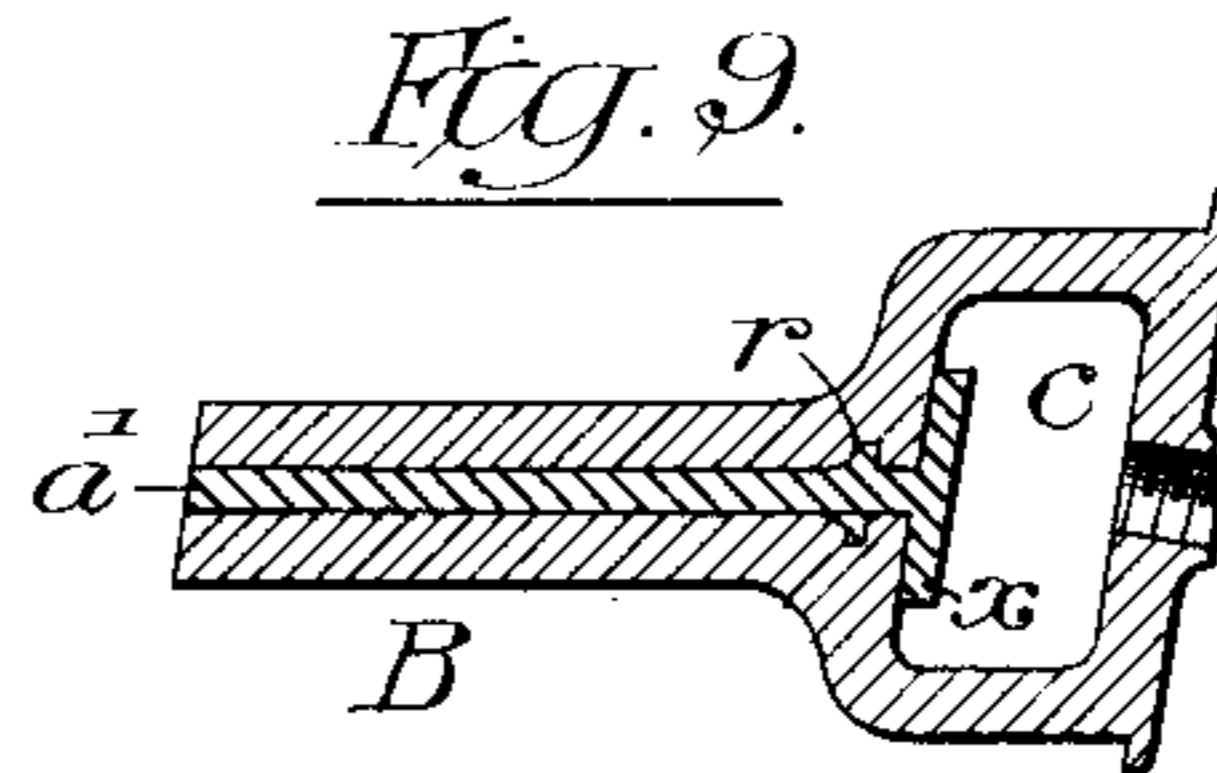
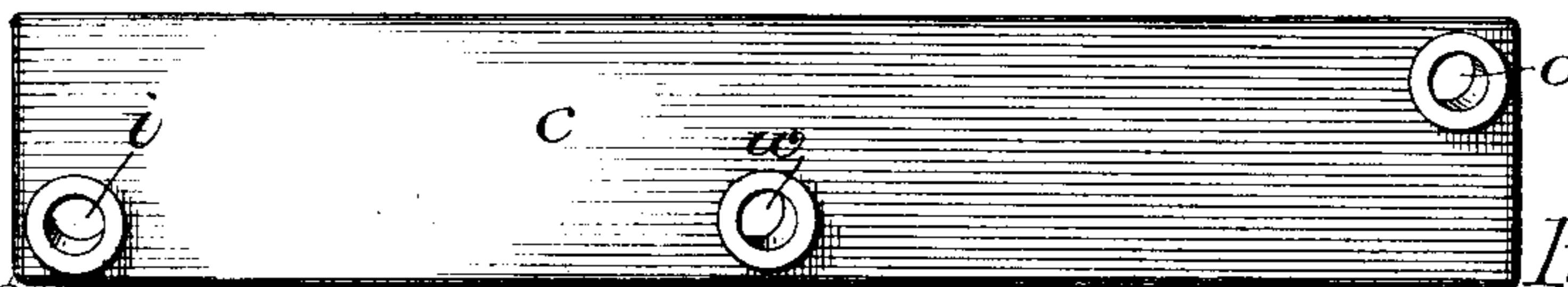


Fig. 13.



Witnesses:-

Wm. S. Blake.
Louis H. Whitelaw.

Inventors.

Ambrose Porter Gaines.
Charles J. Gustafson.
by their Attorneys.

Howard Hanson.

No. 628,790.

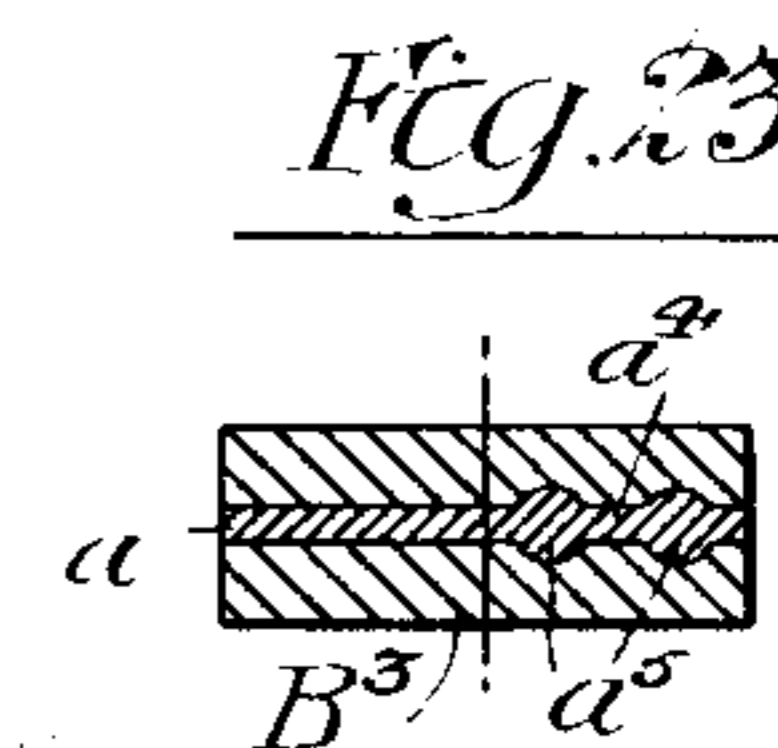
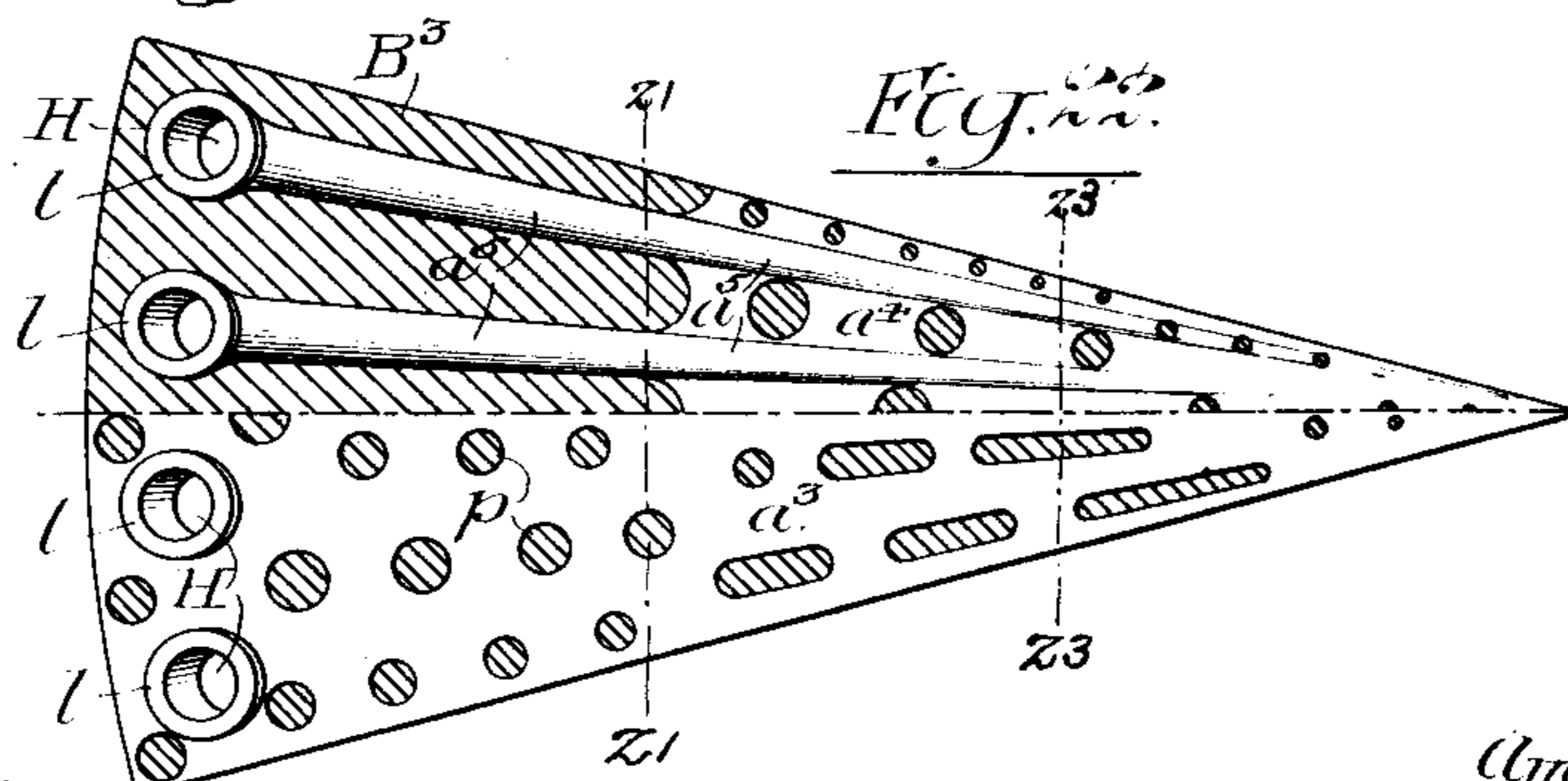
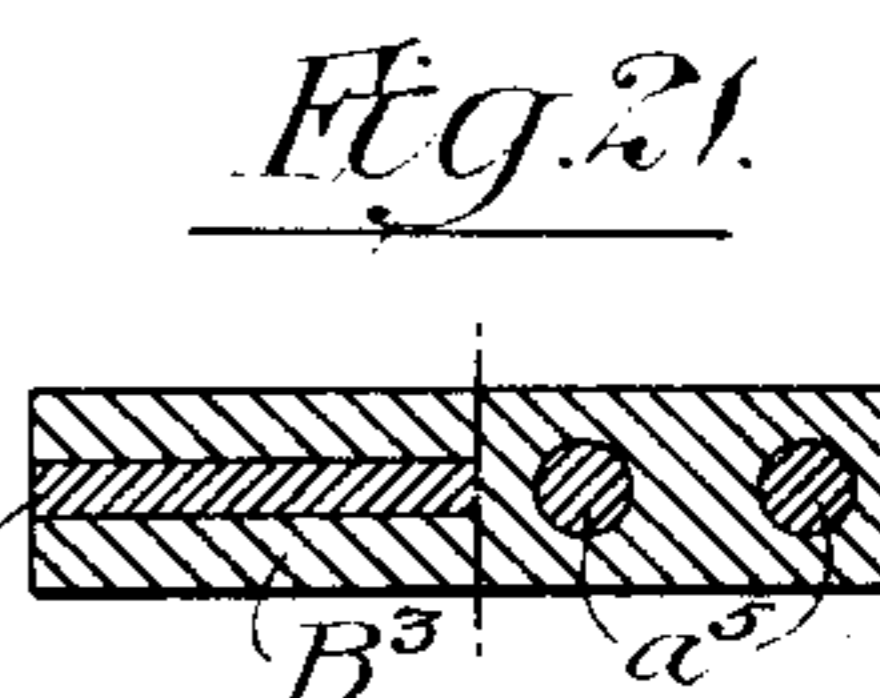
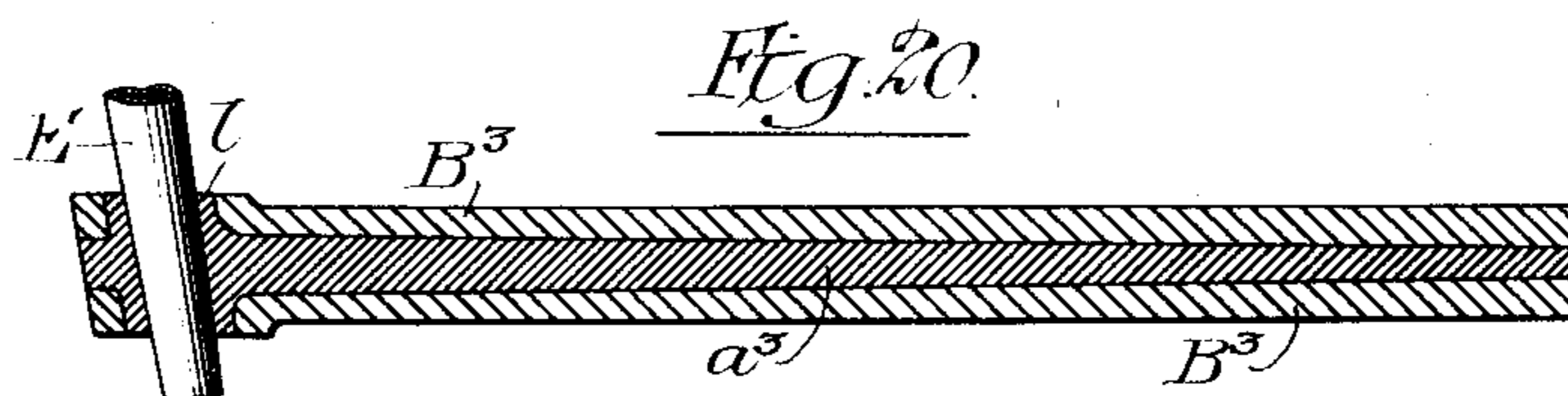
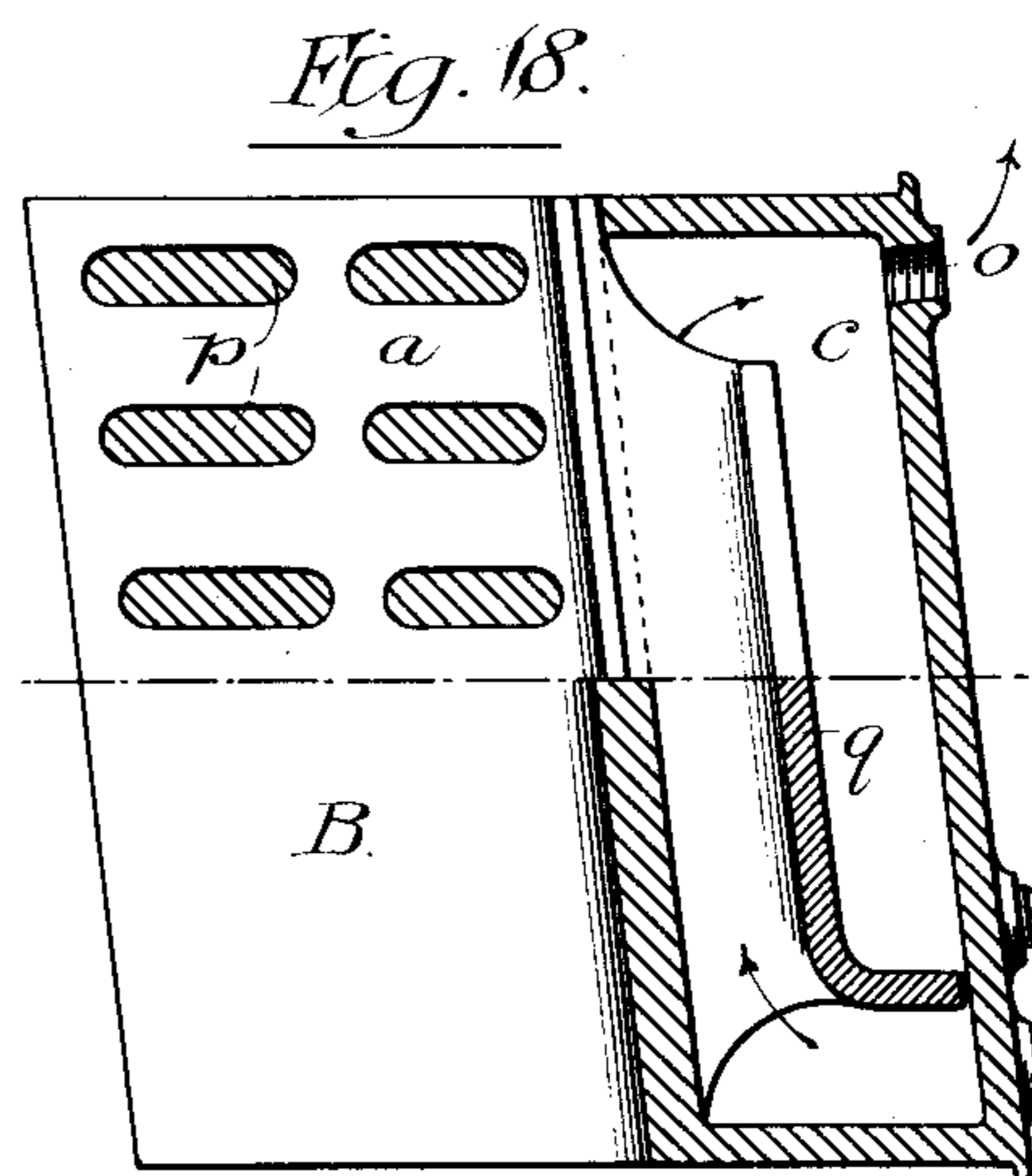
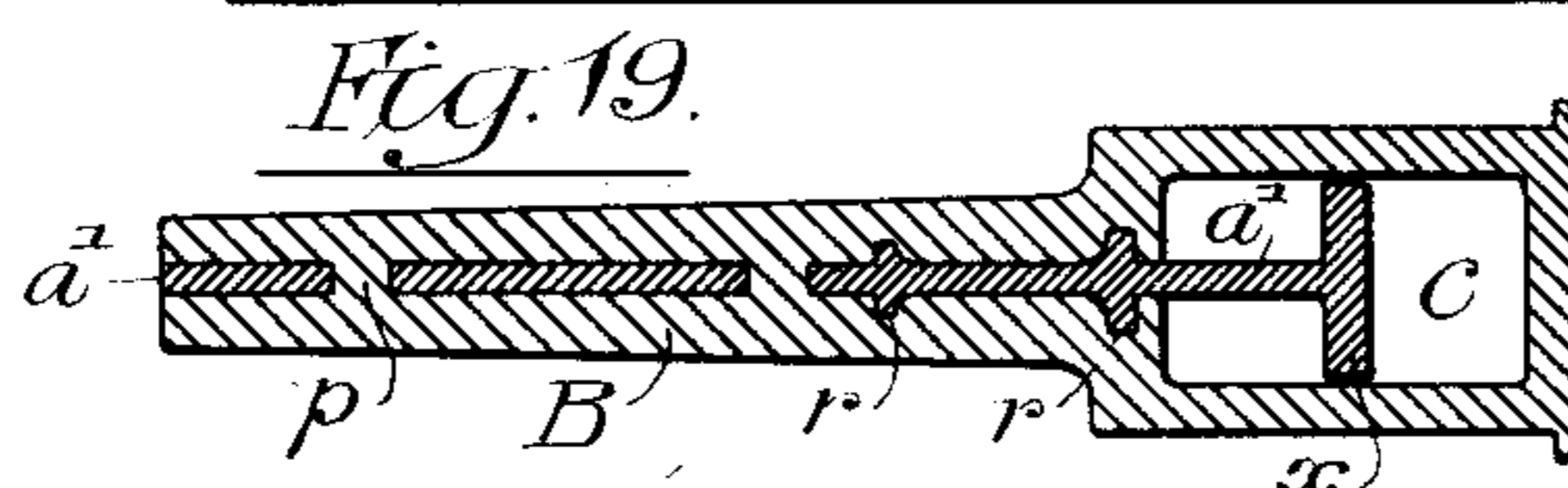
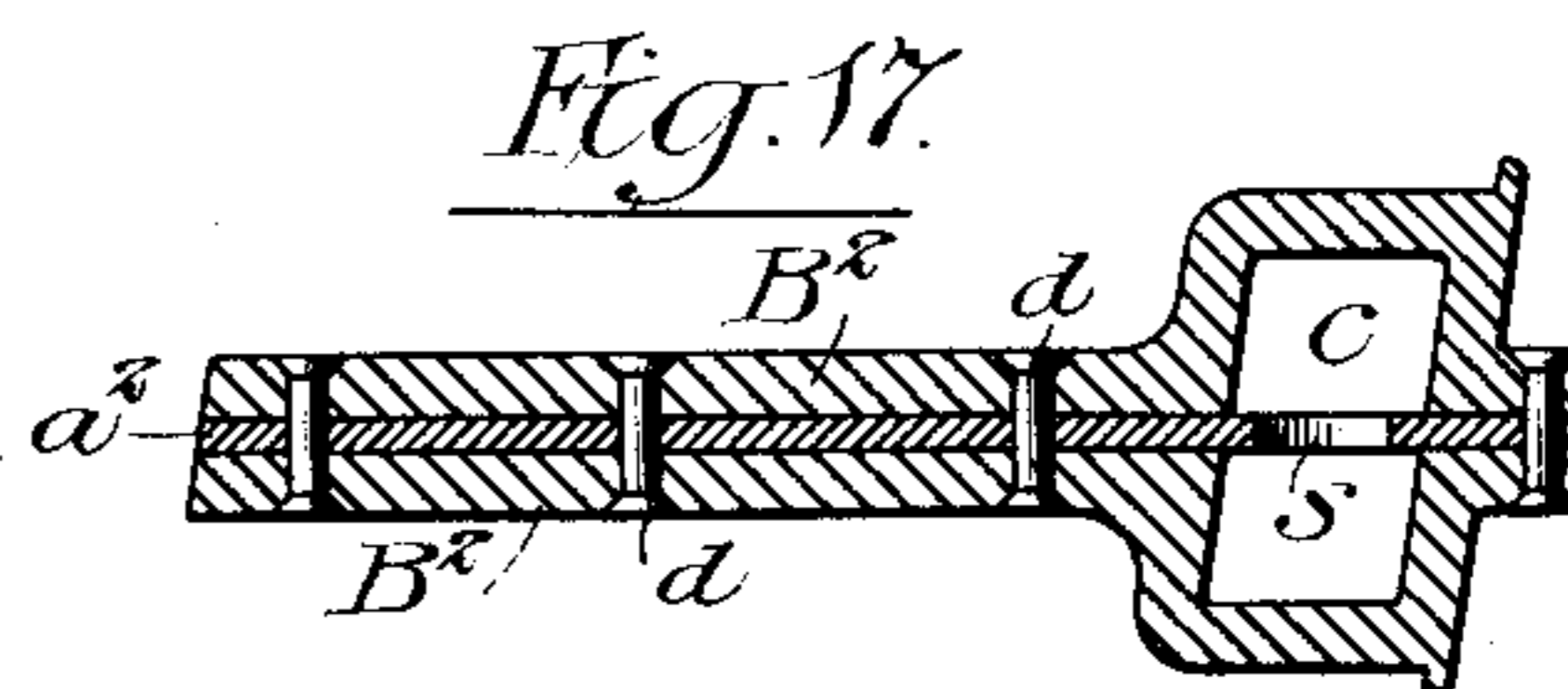
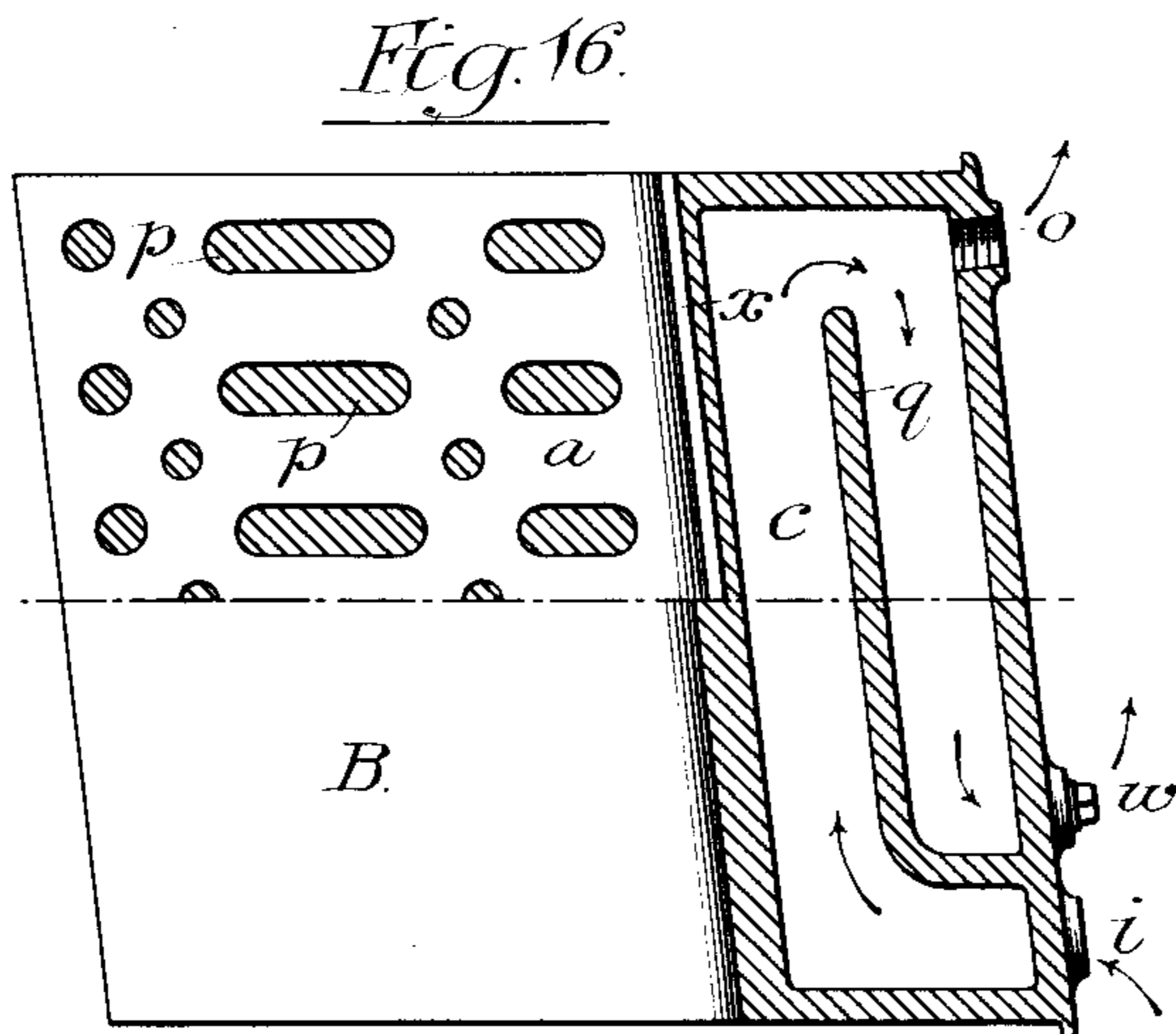
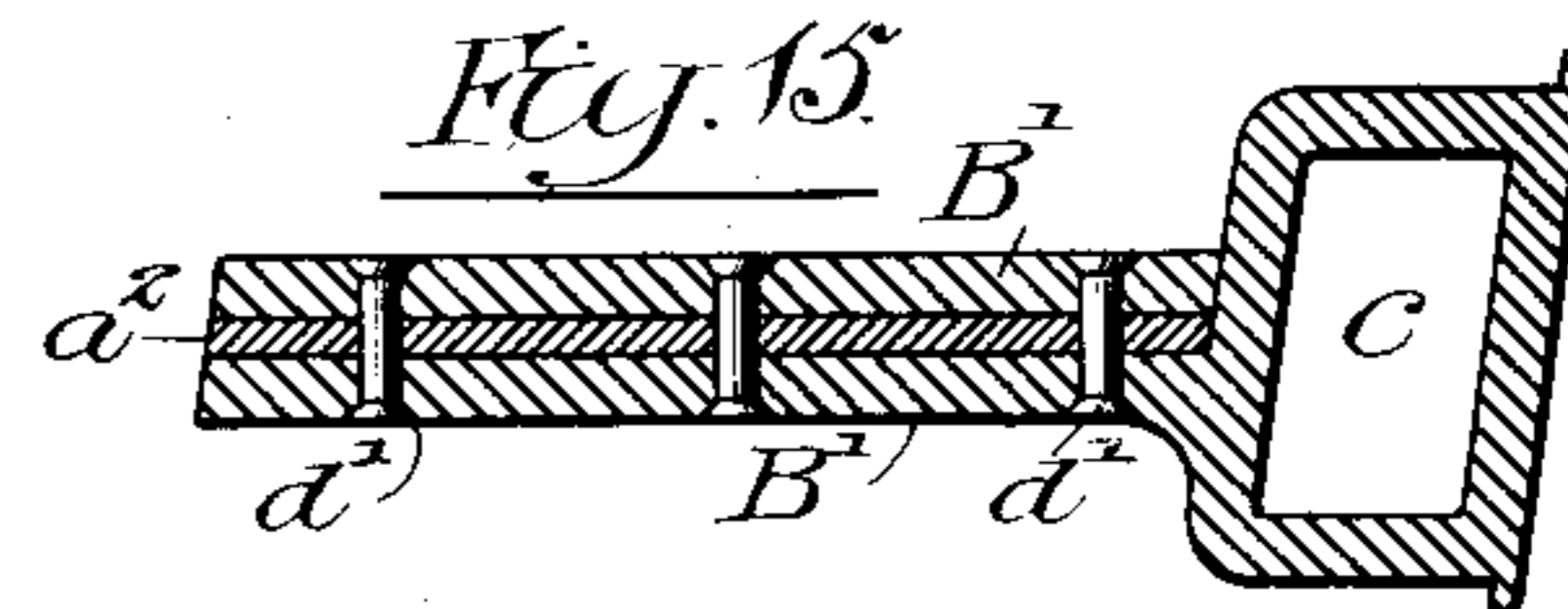
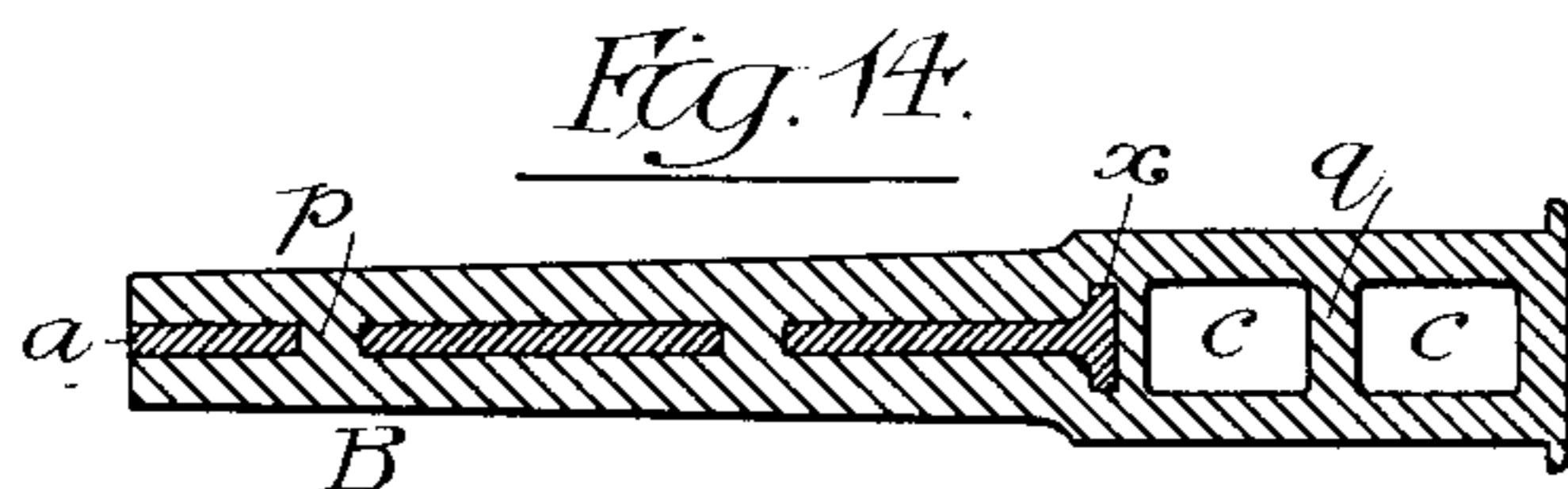
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Witnesses:
Hamilton D. Turner
and M. F. Whithead.

Inventors:
Ambrose Porter Gaines
Charles J. Gustafson
by their Attorneys
Johnson & Johnson

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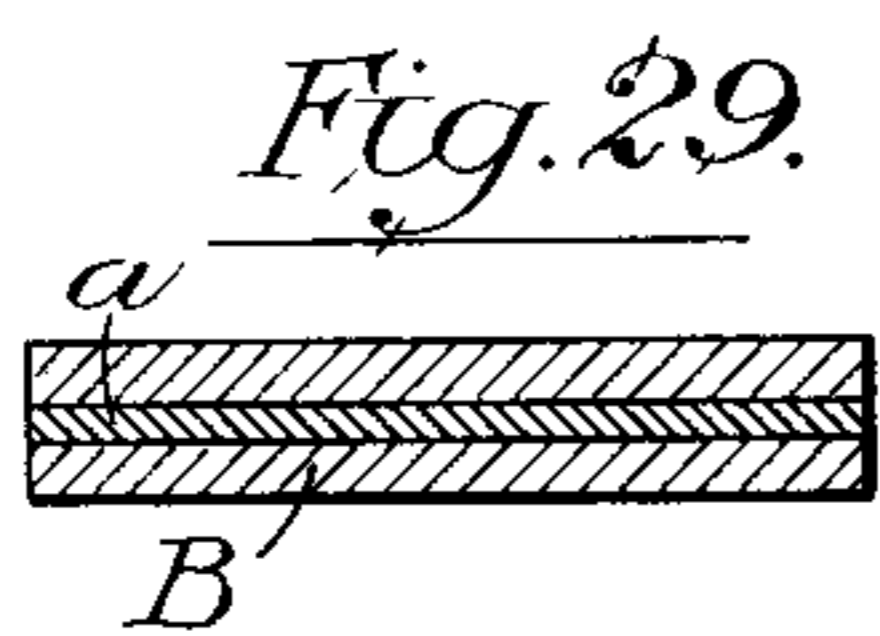
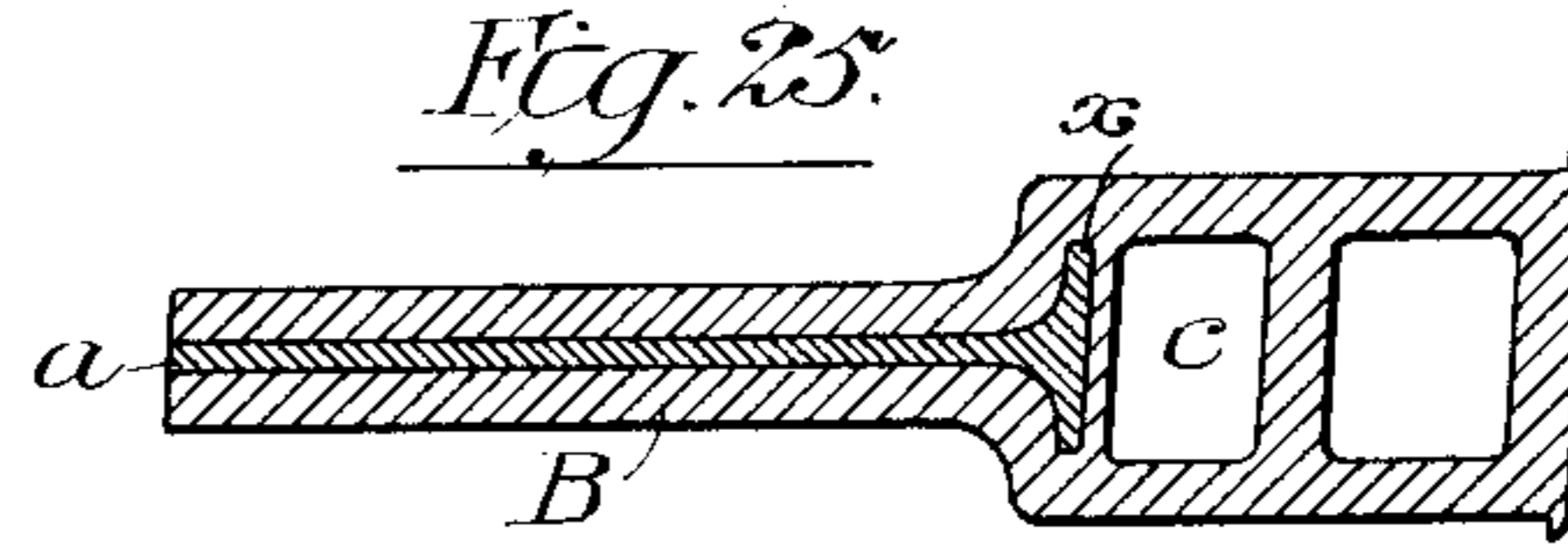
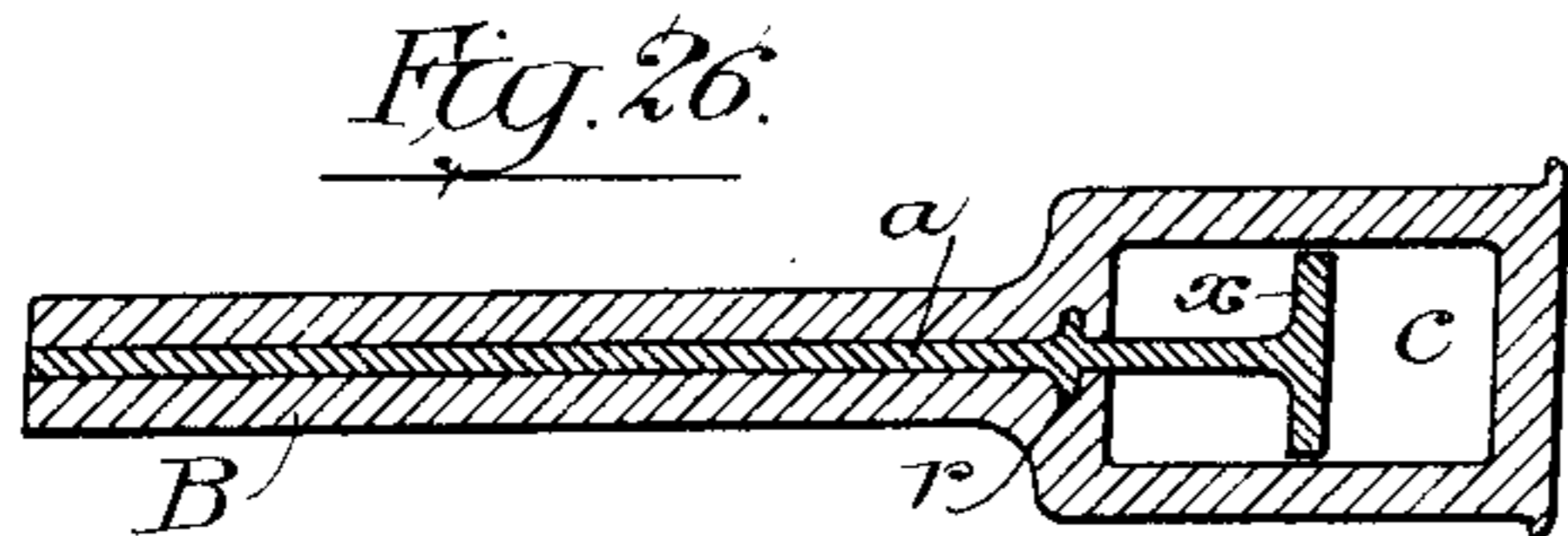
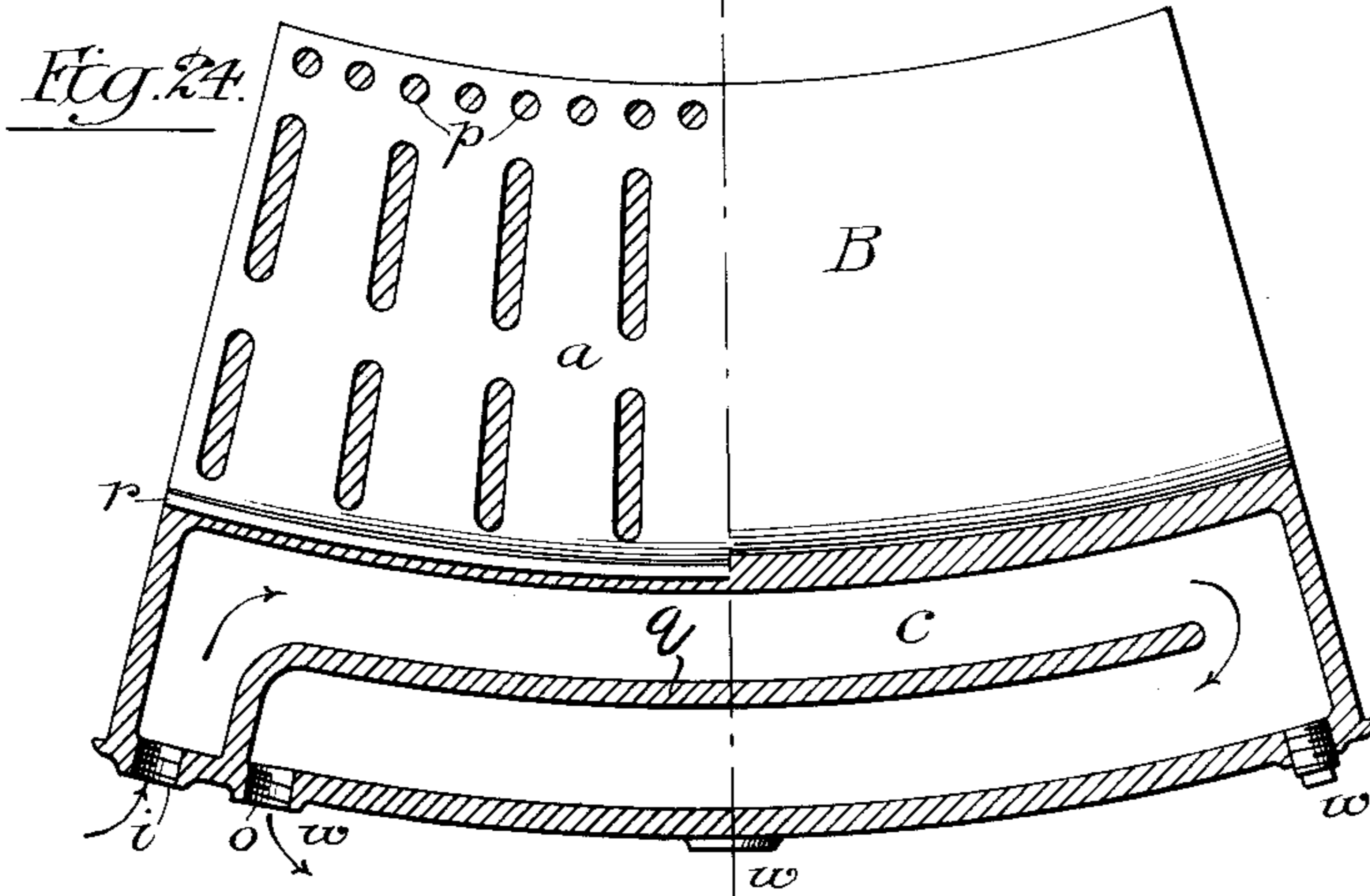


Fig. 27.

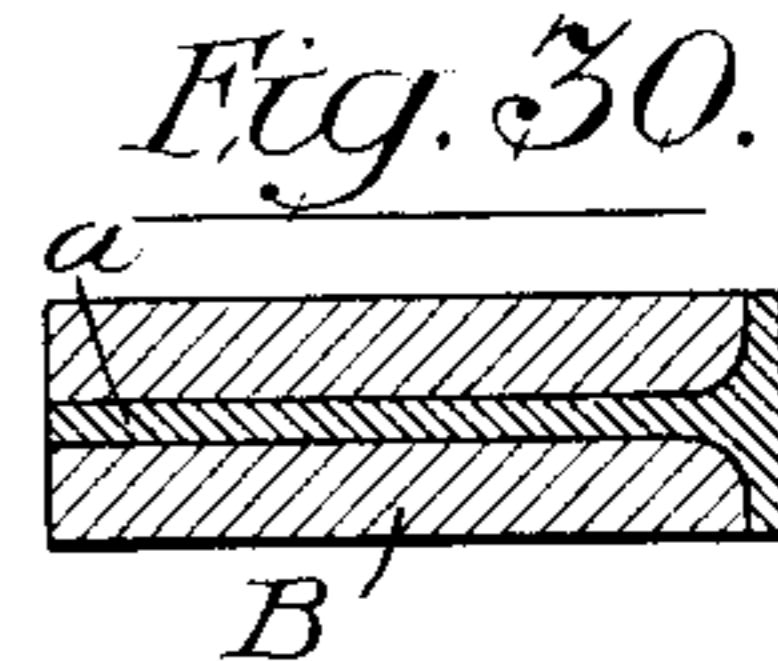
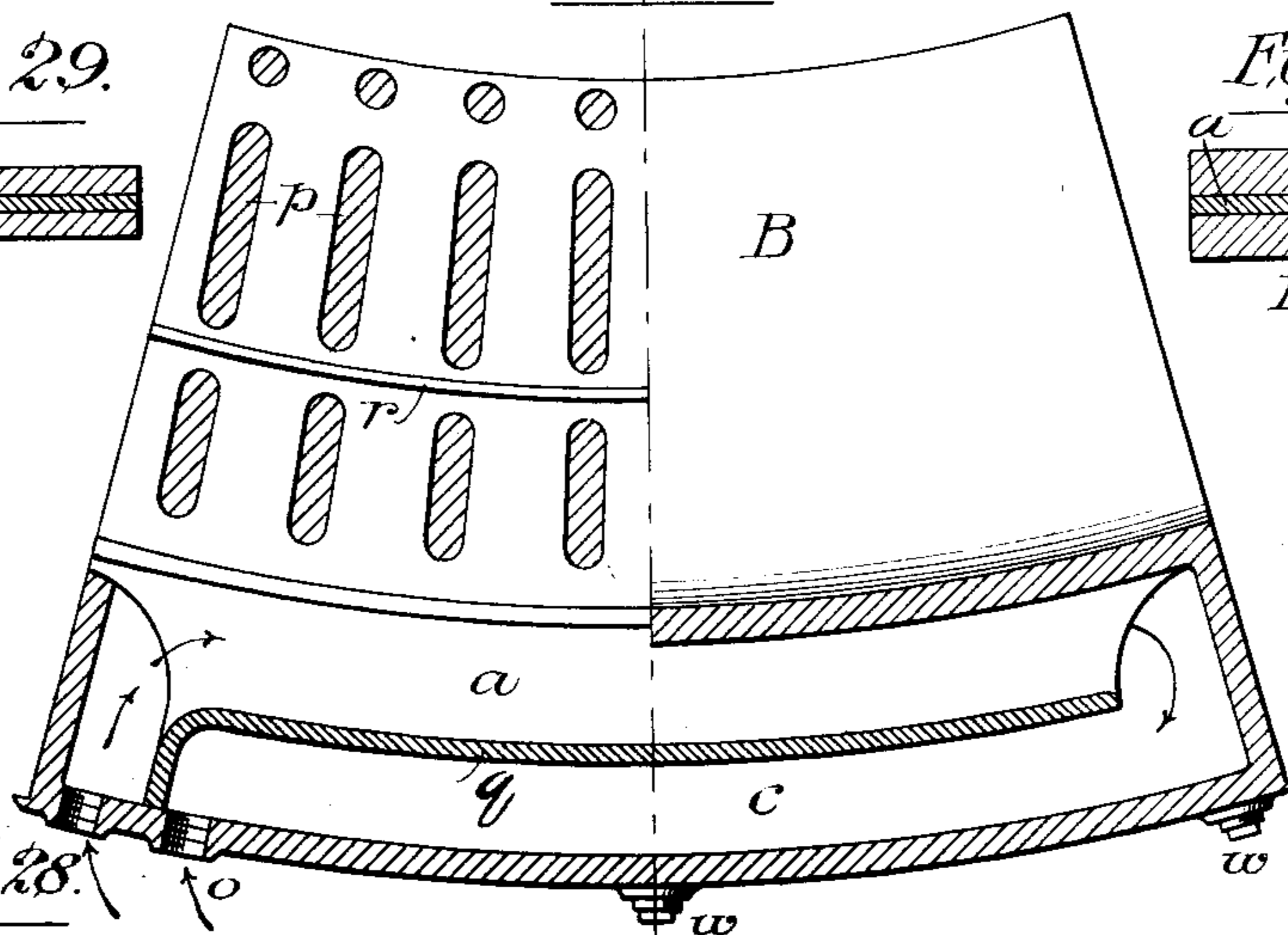
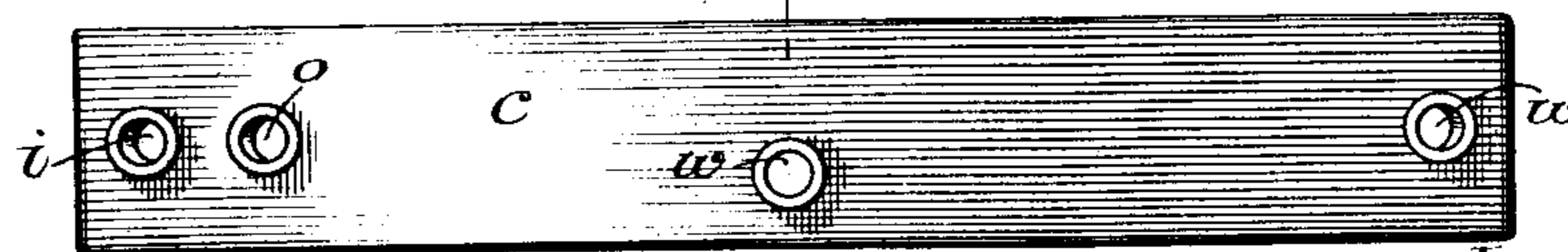
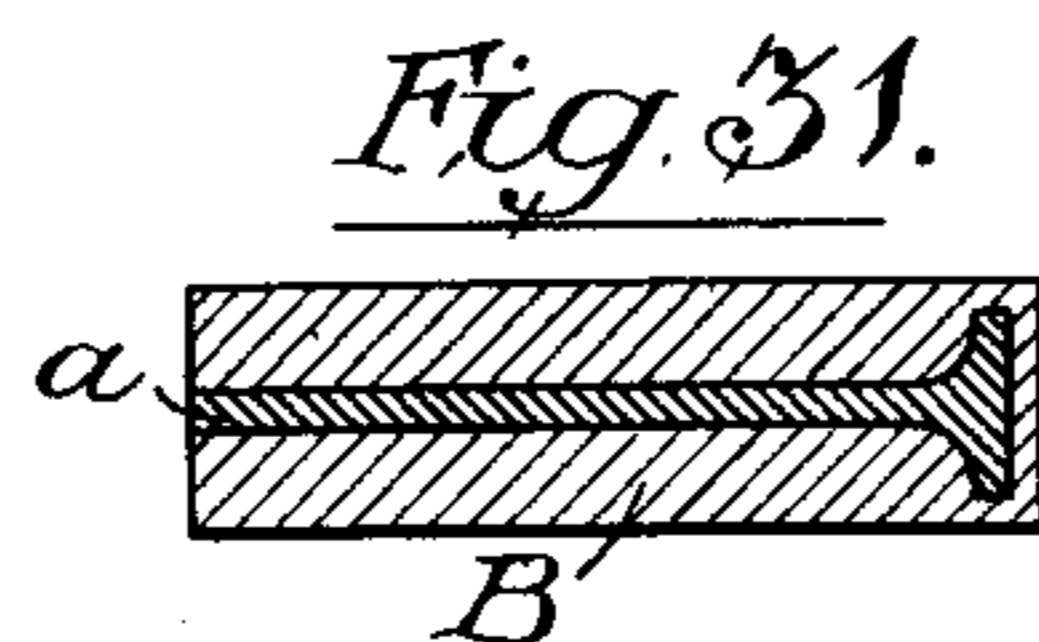


Fig. 28.



Witnesses:
James C. Krager
Charles H. Whithead



Inventors:
Ambrose Porter Gaines
Charles J. Gustafson
by their Attorneys:
Horton & Horton

UNITED STATES PATENT OFFICE.

AMBROSE PORTER GAINES, OF SOUTH PITTSBURG, AND CHARLES J. GUSTAFSON, OF SEQUACHEE, TENNESSEE.

COOLING DEVICE FOR FURNACE-WALLS.

SPECIFICATION forming part of Letters Patent No. 628,790, dated July 11, 1899.

Application filed December 28, 1898. Serial No. 700,524. (No model.)

To all whom it may concern:

Be it known that we, AMBROSE PORTER GAINES, residing at South Pittsburg, and CHARLES J. GUSTAFSON, residing at Sequachee, Marion county, State of Tennessee, citizens of the United States, have invented certain new and useful Improvements in Cooling Devices for Furnace-Walls, of which the following is a specification.

Our invention relates to cooling devices for blast or other furnaces, and more particularly to a device of the character specified, in which are combined two or more parts, one of which incloses or surrounds, partially or wholly, another, forming what we may term a "composite plate," by the use of which term it is to be distinctly understood that we do not intend that the shape of any of the parts or the whole device is limited to a plate form, as any part or the whole may be of flat, round, square, circular or semicircular, irregular, or any shape suited to the requirements of the particular furnace or the particular position of the furnace wherein the device is to be used, and consequently whenever we use the term "plate" in the specification and claims it is to be understood that we employ that term in the broadest sense, as above indicated.

A better comprehension of the objects and advantages of our invention may be derived from a brief consideration of the serious objections commonly encountered in the operation of blast-furnaces, and these objections we will now briefly enumerate.

It has been found that the walls of a blast-furnace in operation are worn unequally at certain points relative to the main stack, as the bosh-wall, crucible, and hearth-bottom are found to wear or burn out two or more times as rapidly as the main stack, necessitating renewals. Again, the hearth and crucible in many instances burn and cut away proportionately faster than the bosh-wall, and it frequently happens that melted iron breaks out through the hearth and under the furnace as a result of fusion and erosion caused by the high pressure and heat of the melted iron constantly contained thereon, often resulting disastrously to life and property. It is the general practice to have the

bell of such size as to throw the stock against the wall at the point at which it is desired to keep the furnace full, so that the larger lumps, having the greater momentum in the rebound from furnace-wall, will be thrown toward the center and the smaller material along the wall, thus keeping the draft open through the center of the stack, and hence another weak point of the furnace is near the top of the stack—that is, at the stock-line, which is the area just below the "bell," where the stock (ore, coke, and limestone) strikes the side of the furnace-wall. At this point the destructive action is almost wholly physical, as it is due to friction or abrasion caused by the impact of the stock striking against the walls. It very often happens, therefore, that this part of the furnace weakens and wears out even before the bosh-wall, crucible, and hearth. Although the annular recess thus worn can be repaired without "blowing out," as is necessary when the bosh-wall, crucible, or hearth is worn out and fused away, at the same time it necessarily involves considerable expense and a great risk of life, as those employed on the repair have to go inside the stack in order to renew the masonry or otherwise repair the weakened and worn-out walls, because this not only subjects the workmen directly to the suffocating and poisonous gases given off from the burning coke and roasted ores and limestone, but also to the still more dangerous liability of slipping or settling of the stock, thus sending up a volume of gas and heat while the workmen are inside, in which case there is almost no possibility of escape, and they are burned to death.

To promote the safety of human life around furnaces, to keep the furnace at its maximum capacity, and to lengthen the life of the furnace itself by keeping the lines of wall intact and to reduce the cost of construction and maintenance by correcting the above-mentioned weak parts of the furnace-wall, so as to increase the life thereof, are the general objects of our invention.

Our further object is to prevent unnecessary loss of heat from the burning and highly-heated stock, which results from the application of too-intense cooling devices located too

close to or in actual contact with the stock. These intense cooling devices, largely presenting their most efficient cooling area at the points where directly exposed or too close to the stock, carry off the heat not so much from the walls as from the stock direct, thus increasing the fuel consumption and reducing the melting capacity. They are also placed at too great a distance apart, thus allowing the intermediate portions of the wall to be destroyed. By our invention we secure a more uniform distribution of heat throughout the furnace-walls, thus permitting of thicker and heavier walls, which will necessarily give a larger wearing area, and thereby also reduce the loss of heat by radiation.

Another object of our invention is to provide a plate which when once in position shall not by any possibility of breakage, wear, or other cause have to be removed from the wall until the latter is worn out uniformly too thin to be safe for further use and one which, with slight modification, is specifically applicable to any furnace and to any part of said furnace.

We accomplish these objects by the use of a composite plate comprising a plurality of parts, one inclosing or surrounding, partially or wholly, another and preferably consisting of a cooling or heat-conducting plate or body and a wear-resisting plate or body protecting the said conducting-plate. The said wear-resisting plate is preferably placed around the heat-conducting plate or body, so as to fully protect the same, and the heat-conducting plate or body is preferably of higher conducting quality than the wear-resisting plate or body.

In the drawings we have shown various forms of our invention applied to the different parts of the furnace, in which drawings—

Figure 1 is a vertical section of a blast-furnace equipped with different modifications of our composite plates. Fig. 2 is a cross-section of furnace-wall on line 2, Fig. 1. Fig. 3 is a cross-section of furnace-wall on line 3, Fig. 1. Fig. 4 is a cross-section of furnace-wall on line 4, Fig. 1. Fig. 5 is a cross-section of composite plate having the heat-conductor extending into the circulating-chamber. Fig. 6 is a cross-section of composite plate having the heat-conductor cut off from the circulating-chamber. Fig. 7 is a sectional side elevation of a composite plate having a circulating-chamber for use in a vertical position. Fig. 8 is a rear elevation of the same. Fig. 9 is a cross-section of composite plate having the heat-conductor in contact with a wall of the circulating-chamber. Fig. 10 is a cross-section of another form of composite plate having the heat-conductor extending into the circulating-chamber. Fig. 11 is another form of composite plate having the heat-conductor cut off from the circulating-chamber. Fig. 12 is a sectional plan view of composite plate having a circulating-chamber for use in a horizontal position. Fig. 13 is a rear elevation of the same. Fig. 14 is a

cross-section of another form of composite plate having double or tortuous circulating-chamber. Fig. 15 is a cross-section of composite plate in which the plates or parts are secured together by rivets. Fig. 16 is a broken sectional elevation of the composite plate shown in Fig. 14 for use in a vertical position. Fig. 17 is a cross-section of another form of composite plate in which the plates are secured together by rivets. Fig. 18 is a broken sectional elevation of a modification of the composite plate shown in Figs. 14 and 16. Fig. 19 is a cross-section of the same. Fig. 20 is a longitudinal section of composite plate having two heat-conducting parts. Fig. 21 is a cross-section of composite plate on lines 21 21, Fig. 22, showing different forms of heat-conductors. Fig. 22 is a broken plan section of composite plate for use in the bottom of the furnace, showing different forms of heat-conductors therein. Fig. 23 is a cross-section of composite plate on line 23 23, Fig. 22. Fig. 24 is a sectional plan view of composite plate with double circulating-chamber for use in a horizontal position. Fig. 25 is a cross-section of the same. Fig. 26 is a cross-section of a modified form thereof in which the conductor extends into the circulating-chamber. Fig. 27 is a part sectional plan of the same, showing heat-conductor extending into the circulating-chamber. Fig. 28 is a rear elevation of the same, and Figs. 29 to 31 are details of further modifications.

Referring now to the drawings, in which the same reference characters designate the same or corresponding parts in all the views, A designates the bosh-wall; *b*, the twyer-wall; *c*, the hearth-wall; *d*, the bottom. The stack-wall has the usual inner lining *e* and outer lining *g*, between which linings is an expansion-space *f*, with suitable filling. The furnace is provided with a hopper *h*, having a bell *k*.

The letters *n n* designate the stock-line or the line of the stack-wall where the stock strikes.

Our plate, which is shown in Fig. 1 applied to different positions of the furnace, consists, preferably, of one or more solid heat-conducting plates protected by a wear-resisting plate. These two may be combined with or without the use of a cooling-chamber, such as C, formed in the wear-resisting plate B, or such as the opening H, provided with an external cooling device E, Figs. 1, 20, and 22, and the chamber C may be unobstructed, as in Figs. 5, 6, 9, 11, and 15, or it may have a partition or diaphragm *q*, as in Figs. 14, 16, and 18. The conducting-plate *a* is preferably made of copper with perforations *p*, through which perforations some of the metal of the plate B passes when the latter is cast thereon, thus serving to hold firmly and in perfect contact the wear-resisting plates B, the latter of which are preferably chilled iron cast over the copper plate *a*. The plates B are preferably provided with a circulating-chamber C, Figs. 5

to 19 and 24 to 28; but in some cases this chamber may be omitted or holes *H* provided, through which a cooling device *E*, receiving a cooling medium therein, may be used, as shown in Figs. 20 to 23. The inner and outer ends of the plate *a* are preferably exposed, so that when the device is inserted in the furnace-wall heat may be readily conducted through said plate *a* to the outside.

Instead of casting the plates or bodies *B* around the plate or body *a* these parts may be connected together by rivets or other suitable mechanical means, in which case the parts are made separate, as shown in Figs. 15 and 17, where *a*² is the conducting-plate, extending to the wall of the cooling-chamber *C* and held upon the lower part of the plate *B*¹ by a separable member *b*¹ of the plate *B*¹, with rivets *d*¹ passing through all the parts; or, if desired, the wear-resisting plate may be made in two symmetrical parts *B*², Fig. 17, with the conducting-plate *a*² passing through the chamber *C* and clamped by rivets between said parts, a perforation *s* being formed in the cooling-chamber, through which the cooling fluid may pass.

In some parts of the furnace-wall it may be advisable to place the plates in a vertical position, in which case they may be formed as shown in Figs. 7, 16, and 18, and when designed for horizontal positions they may be formed as shown in Figs. 12, 24, and 27.

As the introduction of water at the bottom of the furnace, according to the arrangement adopted in other parts of the furnace, is dangerous, the cooling of the plates located in the bottom may be effected by air circulated through the chamber *C*, and the plates may be extended to the center from all sides, such plates being in the shape of a sector of a circle, as shown in Fig. 22, all meeting at a common point. In this form the plate *B*³ is preferably cast over the plate *a*³, the latter of which is provided with an opening *H*, around which extend in both directions annular flanges *l* and through which opening may be inserted a cooling device *E*, such as that disclosed and claimed in United States Letters Patent granted to A. P. Gaines November 15, 1898, No. 614,381. This cooling device preferably passes through several of the plates, arranged one above another, as shown in Fig. 1, so that a sufficient amount of metal is concentrated upon said cooling device to radiate or conduct heat into the conducting or cooling device *E*; or, if desired, the cooling at the bottom may be effected by independent means, such as shown at the upper part of Fig. 3 and in Fig. 1, where plates, with the chambers *C*, are used, or both of these plans may be adopted.

In order to more securely fasten the plates *a* and *B* together, as shown in Figs. 9 and 19, the plate *a*¹ may be provided with one or more ribs *r* in addition to the perforations *p*, by which means the said plate *a*¹ is more firmly secured or anchored to the cast plate *B*. This

form of plate is especially effective in preventing leakage when the form used is that in which the plate extends into the water-chamber *C*, the ribs being clenched by the cast-iron of the plate *B* as it contracts in cooling and forms an effective break-joint. To further contribute to this result the plate *a*¹ may be hammered or calked on its external edges. Where it is possible, however, without too great a sacrifice of conductivity of the plate *a*, it is preferable to have this plate entirely separated or cut off from the chamber *C*, as shown in Figs. 6, 11, 14, 15, and 25, where it will be seen that the said conducting-plate terminates outside of wall or partition on the inner side of the chamber, by which construction all possibility of leakage is avoided.

In Figs. 21, 22, and 23 we have shown a modified form of the conducting-plate, in which the latter is in the form of ribs *a*⁴, rods or bars *a*⁵, or the combination of these two with a flat plate, such ribs or rods extending, in the form shown, to the inner ends of the plates. The rods, ribs, or bars may of course be of any suitable shape, and they may be formed separate or cast with the plate *B* thereupon, preferably the latter. The chambers *C* for the cooling fluid are provided with suitable inlets *i*, outlets *o*, and washout-openings having closing-plugs *w* fitted thereto.

In all the forms employing the chamber *C* it will be noted that the outer end of the plate *a* is laterally extended in a T head or flange *x*, which is either inclosed by the walls of said chamber or is in contact with the inner wall thereof, by which an increased conducting-surface is obtained.

While we do not limit ourselves to any special kind of metal or material for the manufacture of our plates, we may say that we prefer to make the conducting or inner plate of copper, as that has a high conducting power for heat, while the wear-resisting or protecting plate is preferably made of chilled cast-iron. Whatever material that will be durable enough to resist the action of the heat of the highly-heated stock will suffice for the protecting-plate, and the inner or conducting plate may be made of any suitable conducting material, though preferably of a metal that has a higher conducting power than the outer plate or plates. In the application of water or any other cooling fluid as the cooling medium to these plates, where the general reservoir does not give pressure sufficient to force the cooling medium to the required height of the stack, a force-pump can be used, or any number of circulating reservoirs, troughs, or pipes *t*, filled with the fluid, located at any desired height, as shown in Fig. 1, where it is seen that said reservoir is in the form of a casing supported at the top of the furnace upon suitable brackets, from the bottom of which trough lead supply-pipes *z*, which are connected to the plates below, preferably to the inlets *y* of the lower series of

plates, so as to secure a vertical circulation of the cooling fluid, the said plates having outlets *v*, forming connection with the inlet-openings of the adjacent plates.

5 It has been found that in parts of the furnace where the heat is not so intense it is not essential that any circulating medium or chamber C be used, as a sufficient amount of heat will be removed from the inner edges of
10 the wall and plates by conduction and diffusion toward the outside, in which case the plates may be made as shown in Figs. 29 to 31, the heat being abstracted from the conducting-plate by the outside air acting in
15 such case as a cooling medium.

From the foregoing description it will appear that by the use of our invention the lines of the furnace are preserved by a partial and not too active conduction of heat
20 from the walls through these plates, which being cheaper than the all-copper or bronze plates may be placed very much closer, thus giving a more uniform temperature to the wall, enabling it to resist the effects of heat
25 and friction, and also reinforcing the masonry by presenting a practically indestructible surface of considerable extent for actual contact with the moving stock at all parts of the furnace.

30 In our drawings, while we have shown the plates in position, Fig. 1, practically immovable, as our plates will not require removal until the walls of the furnace are worn so thin that safety necessitates blowing out for
35 relining for the reason that the said plates may be worn back to the line of the inner walls of the circulating or cooling chambers without leaking or materially weakening the walls; nevertheless it may be found advisable
40 that in some parts of the walls—for example, the bosh—a removable plate be used, and hence we wish it understood that our invention may be embodied in a removable as well as an immovable plate. Again, we have shown
45 no other support for the plates in the wall than the masonry, but at the top of the furnace where the plates will be subject to such frequent abrasion, due to the striking of the charge against the wall at the stock-line, it
50 may be desirable to fasten or bind the plates in position in any suitable way, and around the bosh-wall they may be bound together and linked by any of the well-known means for securing bosh-plates.

55 Without limiting ourselves to the specific forms of plate shown in the drawings, as we believe we are the first to provide a composite cooling device for furnaces,

What we claim, and desire to secure by Letters Patent, is—

60 1. The herein-described cooling device for blast or other furnaces, consisting of a solid conducting plate or body of high heat-conducting power and a protecting plate or body
65 of other metal capable of resisting wear in contact with said conducting-plate, the inner end of said conducting-plate being exposed

so as to conduct heat from the furnace-chamber, and its outer end extending to a point where heat may be abstracted by a cooling
70 medium, substantially as described.

2. The herein-described cooling device for blast or other furnaces, consisting of an inner solid plate of high heat-conducting power and an outer protecting-plate of other metal ca-
75 pable of resisting wear partially inclosing the same, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted
80 by a cooling medium, substantially as described.

3. The herein-described cooling device for blast or other furnaces, consisting of a plurality of plates, arranged one within another,
85 the inner plate being a solid conducting-plate and of higher specific heat-conducting power than the inclosing plate, and the latter possessing wear-resisting qualities to resist heat
90 or abrasion, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber and the outer end extending to a point where heat may be abstracted by a cooling medium, substantially
95 as described.

4. The herein-described cooling device for blast or other furnaces, consisting of a composite plate formed of an inner solid conducting metal plate of high heat-conducting power
100 partially surrounded by a plate of other metal capable of resisting wear, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber and the outer end extending to a point where heat
105 may be abstracted by a cooling medium, substantially as described.

5. The herein-described cooling device for furnace-walls, consisting of a solid metal plate of high heat-conducting power, and a protecting-plate of other metal capable of resisting
110 wear cast upon said conducting-plate, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling
115 medium, substantially as described.

6. The herein-described cooling device for furnace-walls, consisting of a metal plate of high heat-conducting power and a protecting-plate of other metal capable of resisting wear
120 cast around said conducting-plate, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling me-
125 dium, substantially as described.

7. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of a solid metal plate of high heat-conducting power and a protecting-plate of
130 other metal capable of resisting wear cast upon said conducting-plate, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, said

composite plate being provided at its outer end with a cooling-chamber for circulation of a cooling medium to abstract heat from the outer end of said conducting-plate, substantially as described.

8. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of a solid metal plate of high heat-conducting power and a protecting-plate of other metal capable of resisting wear cast thereon, with means for anchoring the two plates together, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling medium, substantially as described.

9. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of an inner solid plate of high heat-conducting power, with a protecting-plate of other metal capable of resisting wear cast thereon and devices on the inner plate for rigidly binding the cast metal to the said inner plate, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling medium, substantially as described.

10. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of an inner solid plate of high heat-conducting power, having a lateral extension at one end, and a protecting-plate of other metal capable of resisting wear in contact with said inner plate, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling medium, substantially as described.

11. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of an inner plate having a lateral extension at one end, a protecting-plate surrounding and in contact with said inner plate, said protecting-plate having a cooling-chamber formed therein, and the lateral extension of the inner plate being disposed in proximity to said cooling-chamber, substantially as described.

12. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of an inner solid plate of high heat-conducting power, having a lateral extension at one end, and a protecting-plate of other metal capable of resisting wear in contact with both sides of said inner plate, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling medium, substantially as described.

13. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of an inner solid metal plate of high heat-conducting power, having a lateral extension at one end and a protecting-plate of other metal capable of resisting wear cast upon said conducting-plate, with ribs or projections for binding the two plates together, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling medium, substantially as described.

14. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of a solid metal plate of high heat-conducting power surrounded by a protecting-plate of other metal capable of resisting wear, said composite plate having openings for the admission of a cooling medium from an external source, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling medium, substantially as described.

15. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of an inner conducting-plate having a lateral extension at one end, and a wear-resisting plate cast upon said conducting-plate, said outer plate having a chamber therein for a cooling medium and the lateral extension of the inner plate being disposed adjacent to the wall of said chamber, substantially as described.

16. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of an inner solid plate of copper and a chilled iron plate cast thereon, the inner end of said conducting-plate being exposed so as to conduct heat from the furnace-chamber, and the outer end extending to a point where heat may be abstracted by a cooling medium, substantially as described.

17. The herein-described cooling device for furnace-walls, consisting of a composite plate formed of an inner conducting-plate, and an outer protecting-plate provided with a chamber for a cooling medium, with ribs on one of the plates located outside of the inner wall of the cooling-chamber and serving to hold the two plates together and to form a break-joint to prevent leakage from said chamber, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

AMBROSE PORTER GAINES.
CHARLES J. GUSTAFSON.

Witnesses:

A. A. COOK,
T. G. GARRETT.