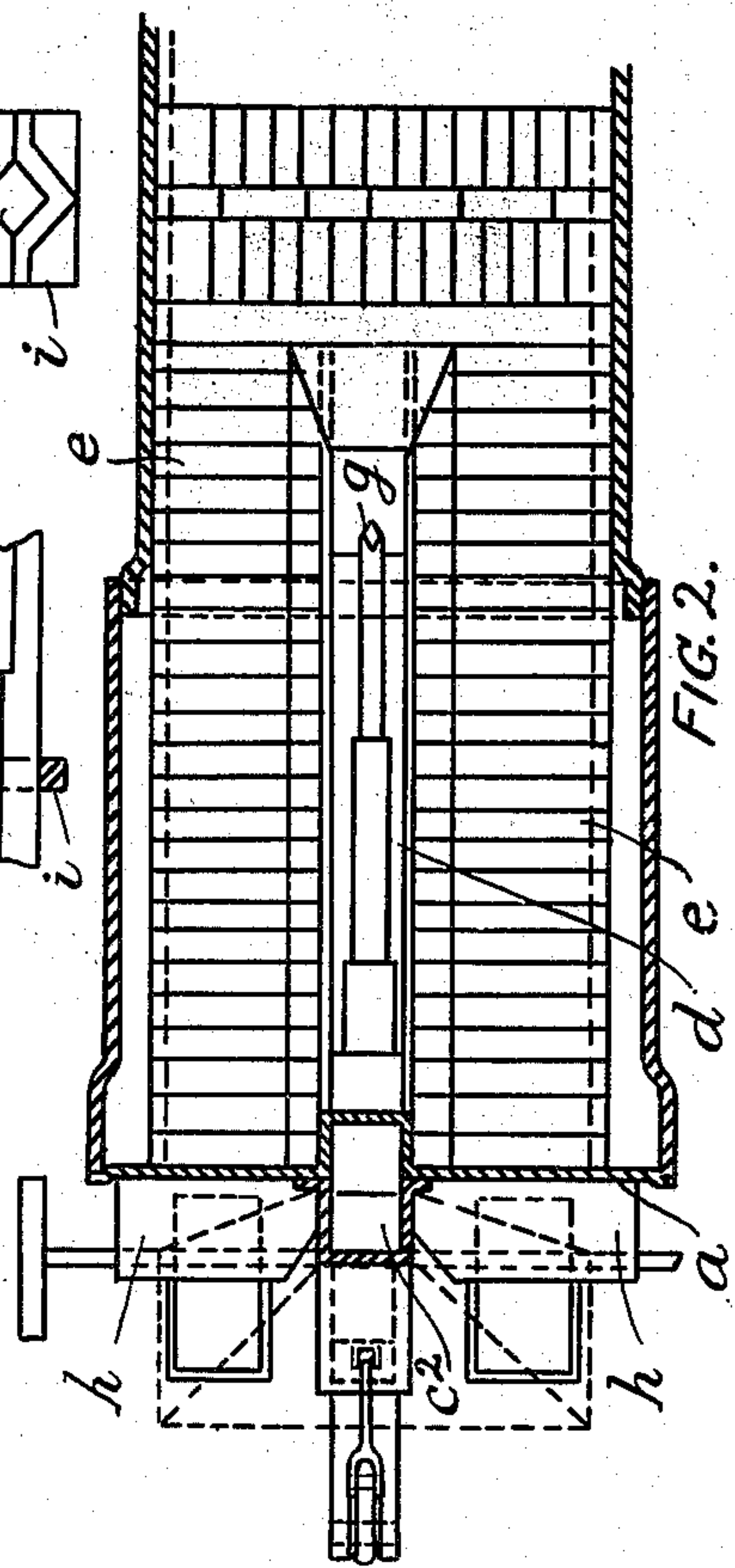
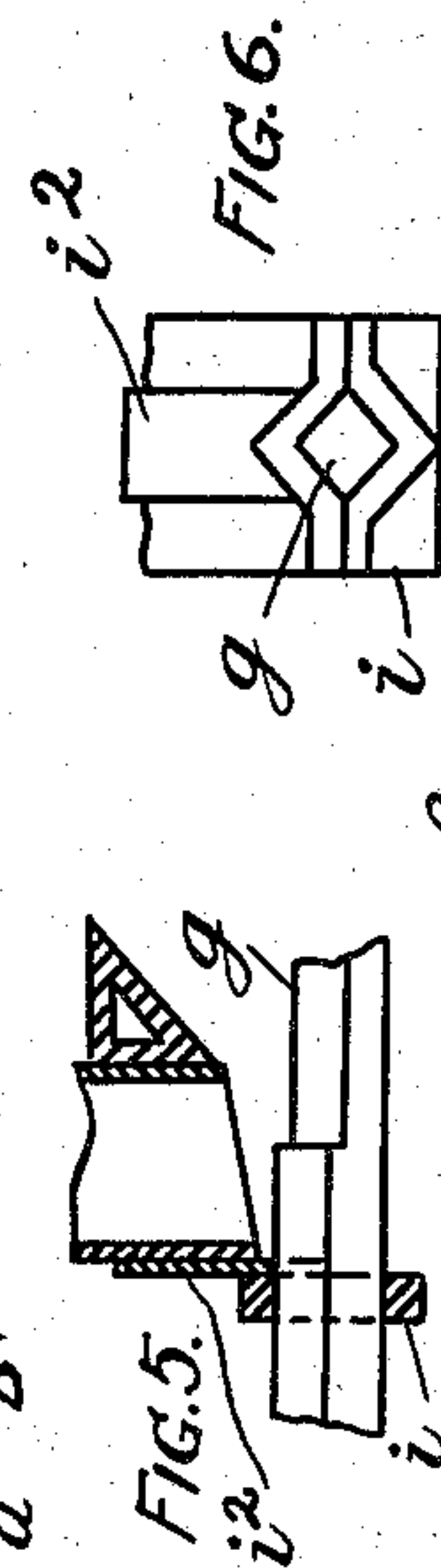
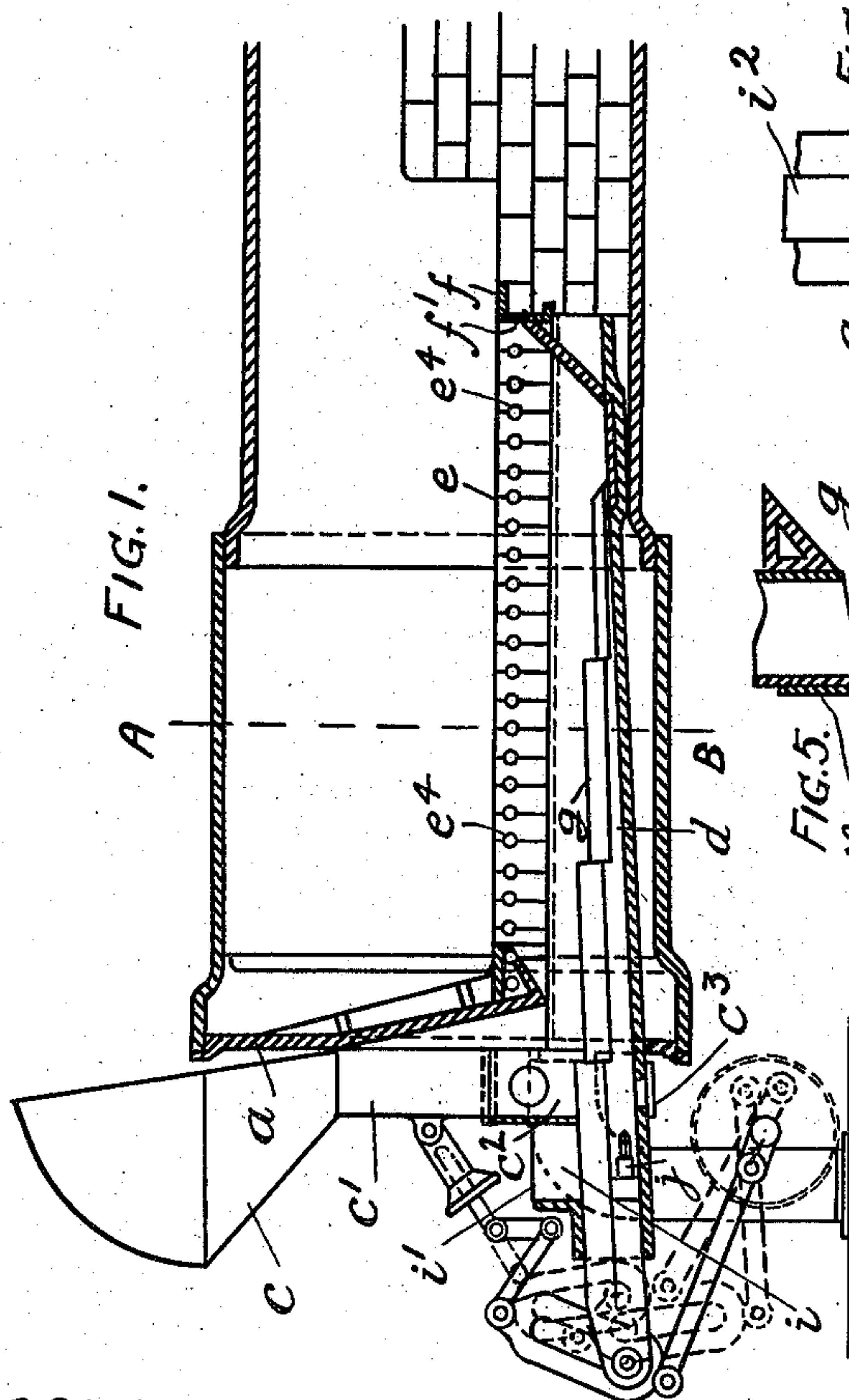
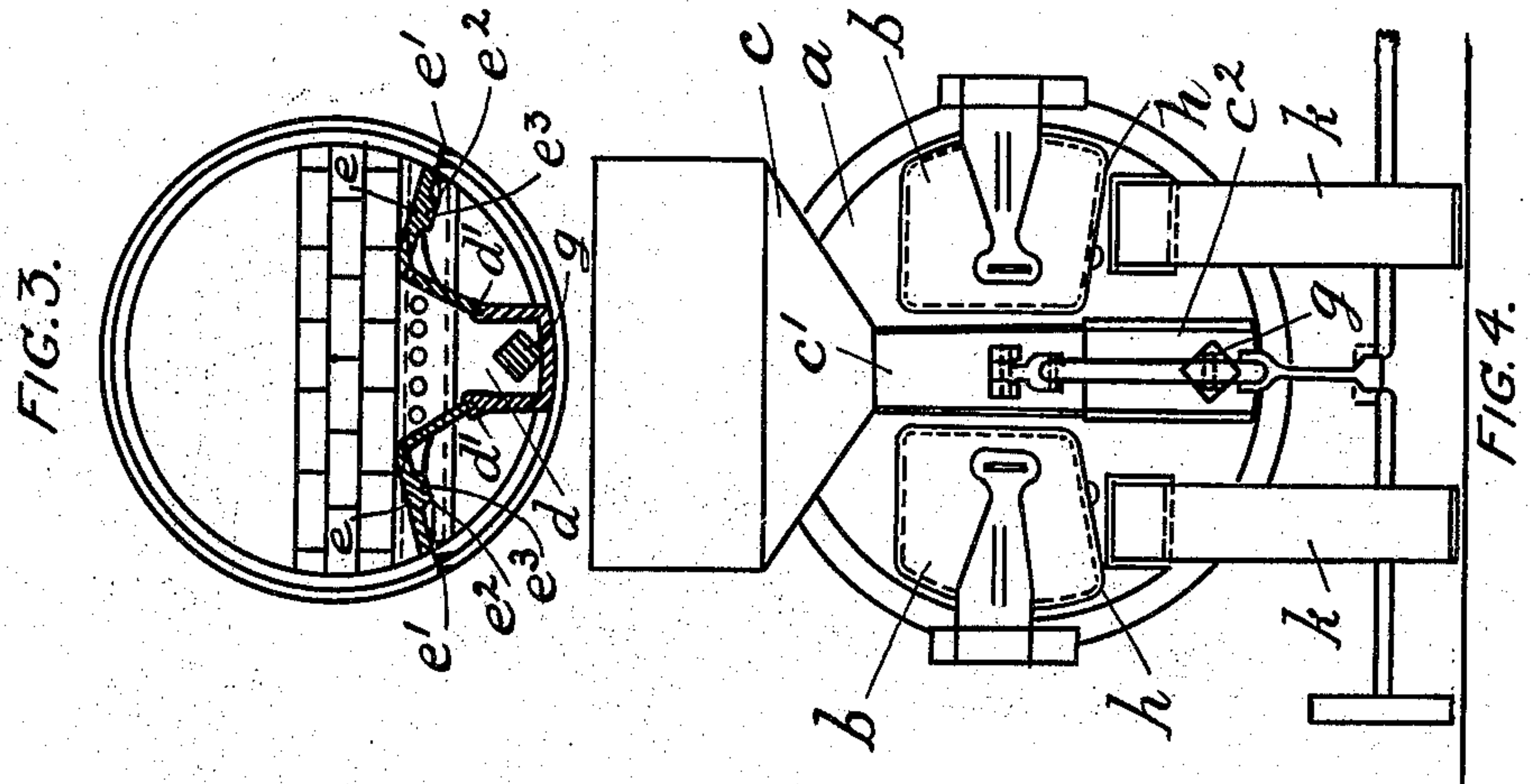


W. R. WILLS.
FURNACE.

APPLICATION FILED JULY 28, 1905.

3 SHEETS—SHEET 1.



WITNESSES
Alvin E. White
W. P. Burks

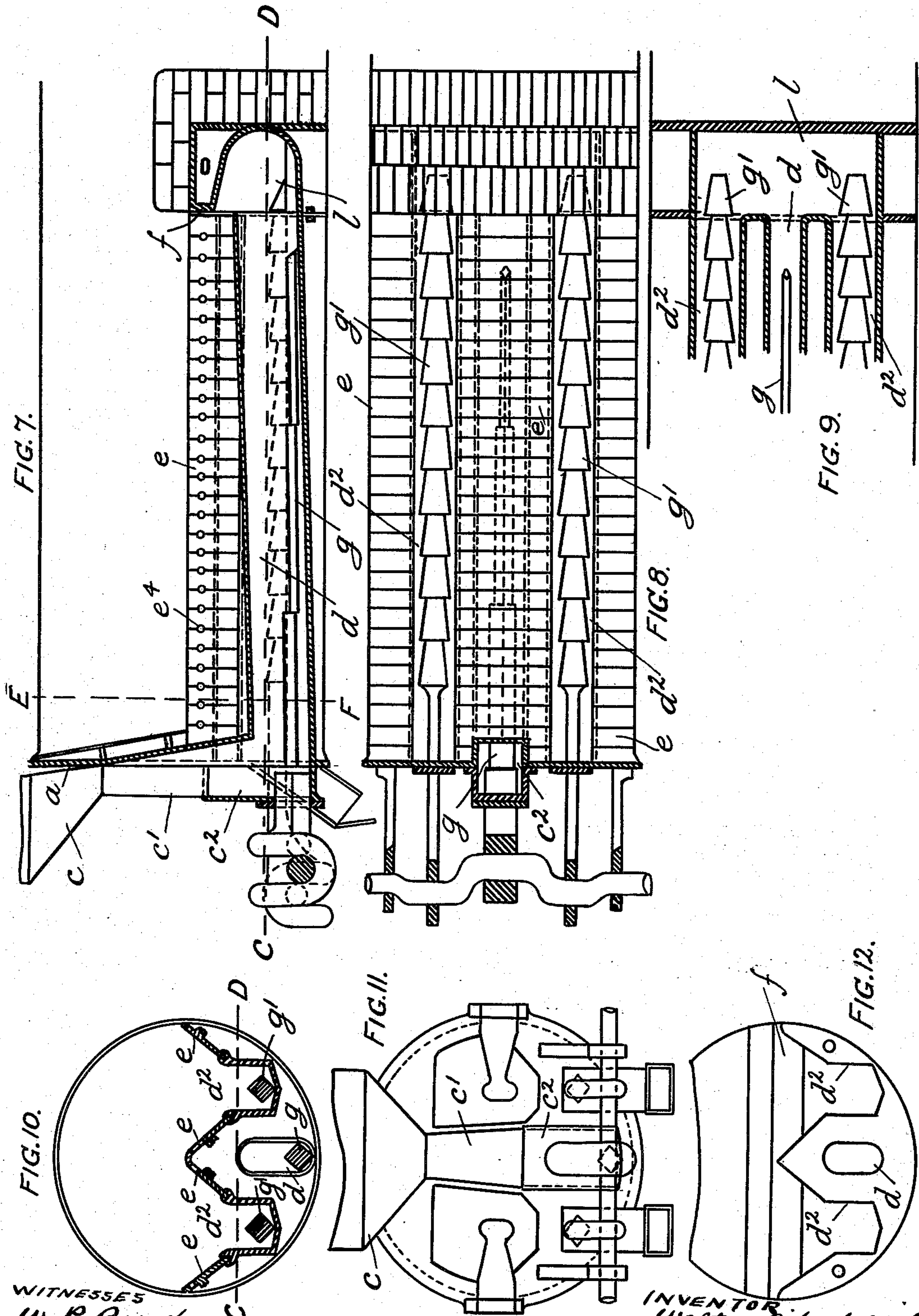
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APPLICATION FILED JULY 28, 1905.

3 SHEETS—SHEET 2.



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APPLICATION FILED JULY 28, 1905.

3 SHEETS—SHEET 3.

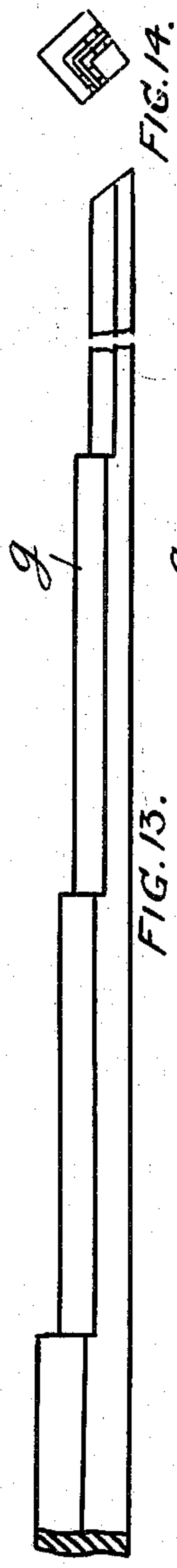


FIG. 13.

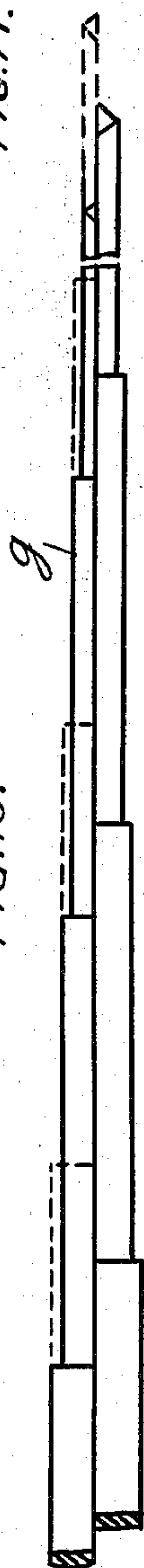


FIG. 14.

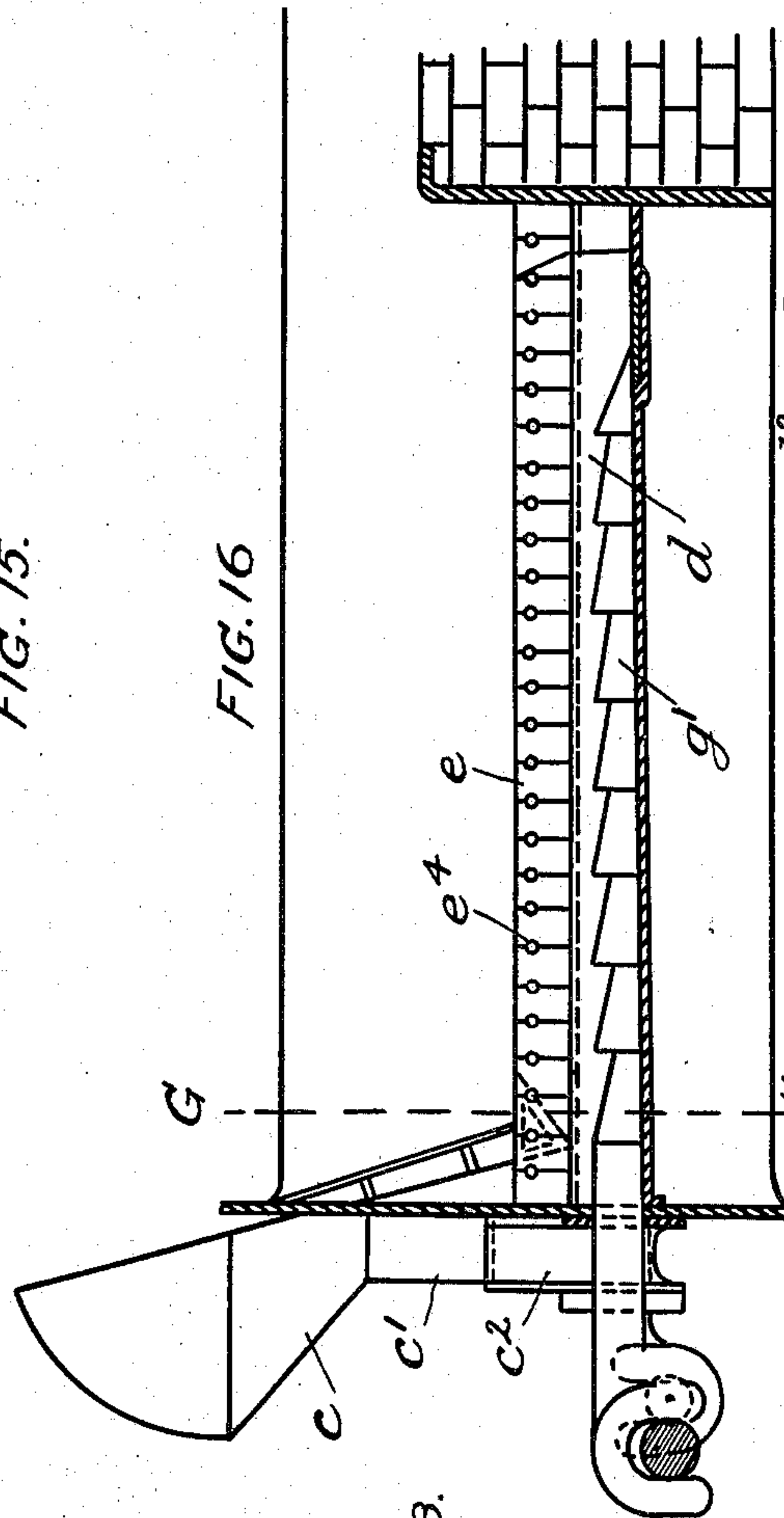


FIG. 15.

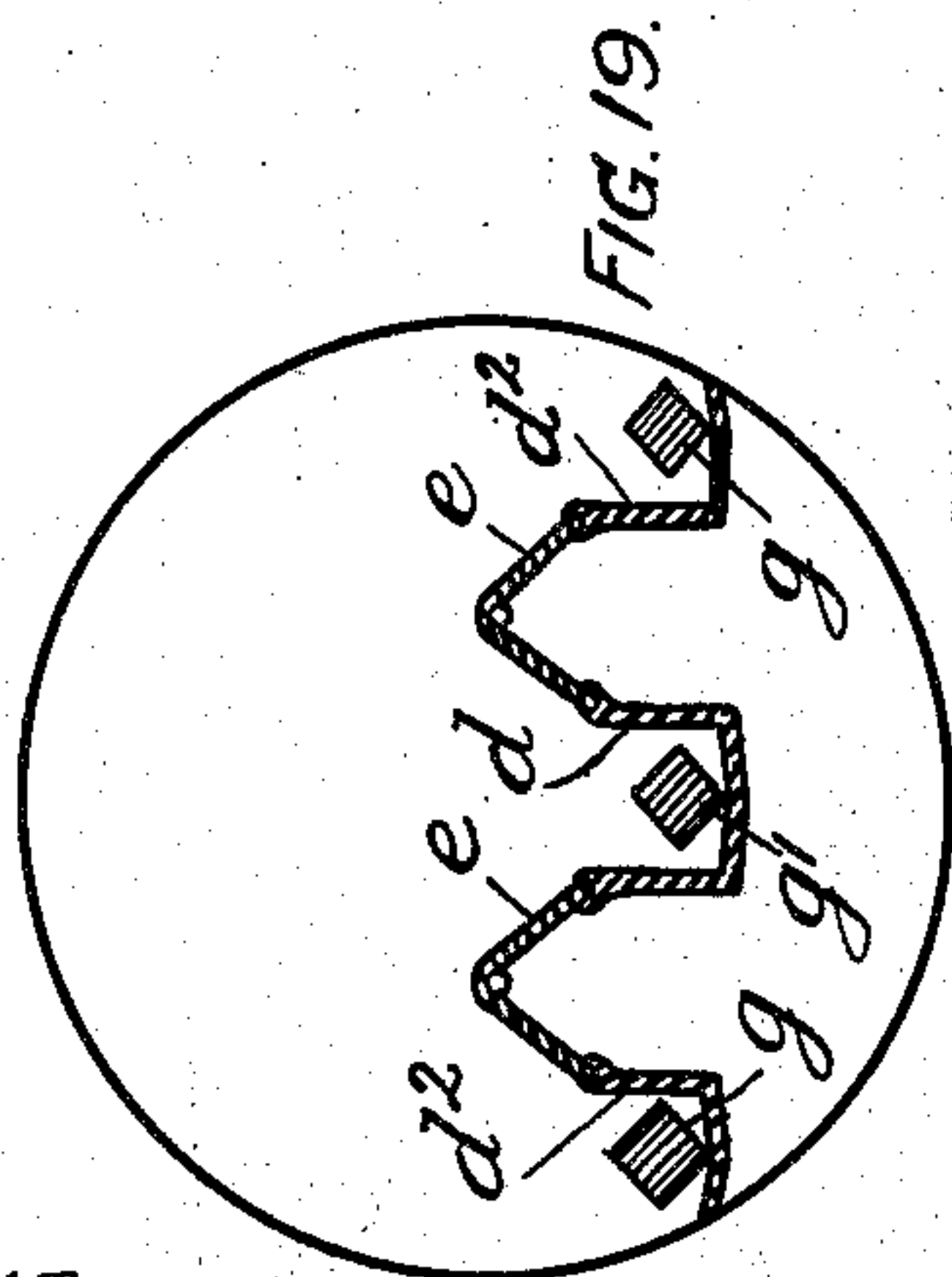


FIG. 16.

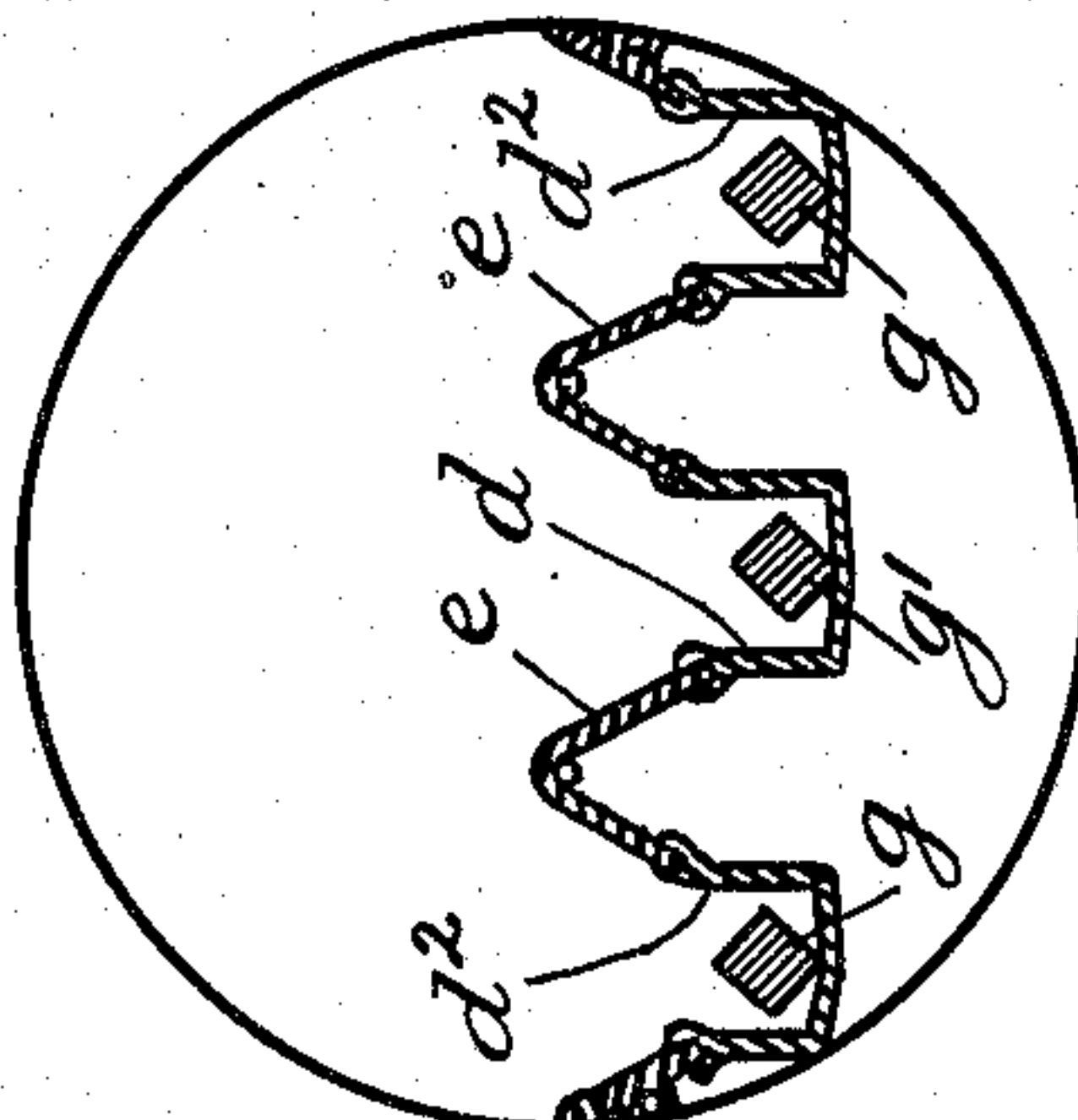


FIG. 17.

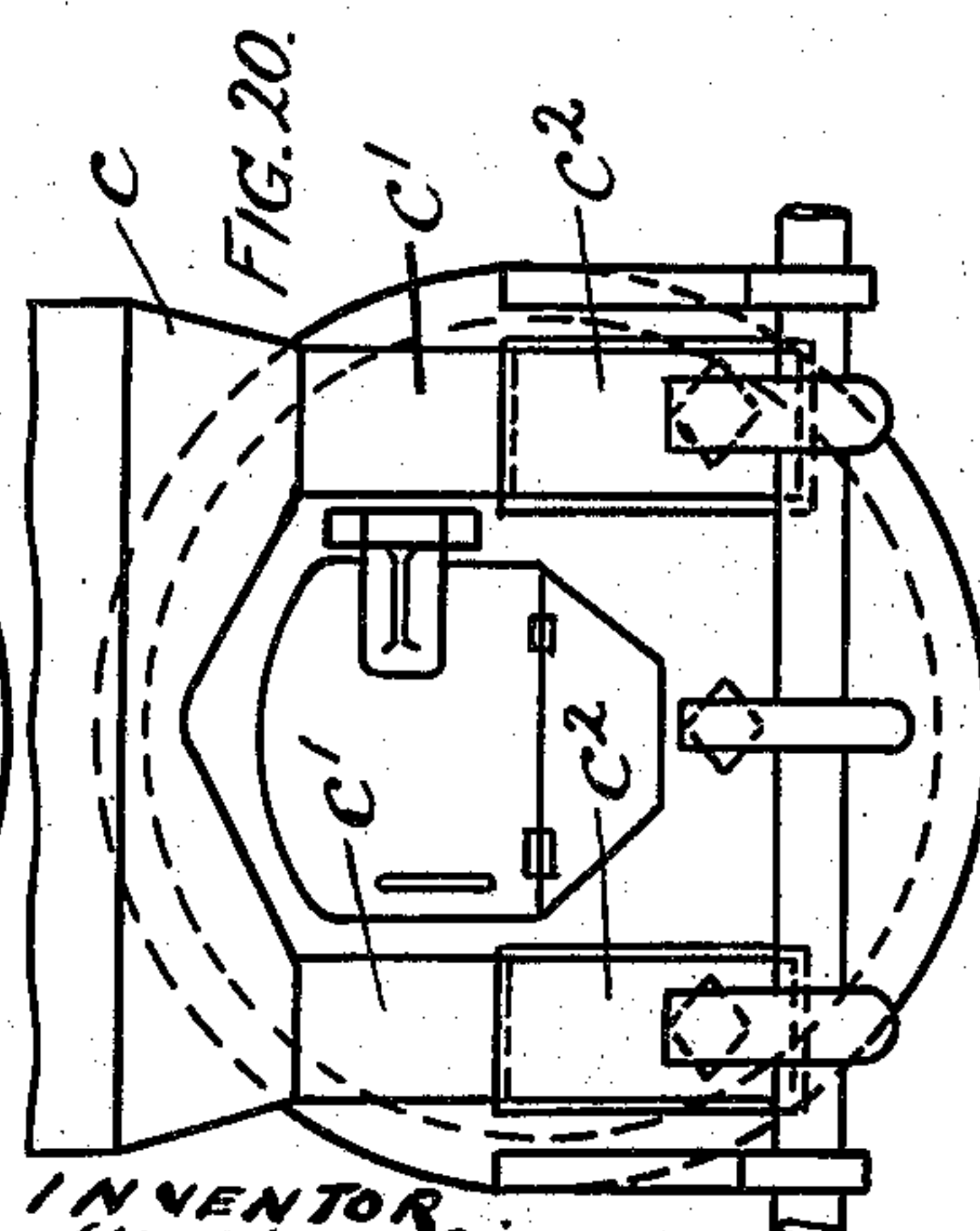


FIG. 18.

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UNITED STATES PATENT OFFICE.

WALTER RIDOUT WILLS, OF SHEFFIELD, ENGLAND.

FURNACE.

No. 840,542.

Specification of Letters Patent.

Patented Jan. 8, 1907.

Application filed July 28, 1905. Serial No. 271,657.

To all whom it may concern:

Be it known that I, WALTER RIDOUT WILLS, a subject of the King of Great Britain and Ireland, residing at 203 Abbeyfield road, Pitsmoor, Sheffield, in the county of York, England, have invented certain new and useful Improvements in Furnaces, (for which I have filed an application for a patent in Great Britain, No. 17,098, bearing date August 4, 1904,) of which the following is a specification.

This invention relates to furnaces of the underfed type, in which the fuel to be consumed is fed below the surface of that which is burning, its object being to provide improvements in the method of the feed and in the construction of the parts whereby greater simplicity is attained.

I carry out my invention in the following manner, and though applicable to a variety of furnaces a description of it as applied to the furnace of a Cornish steam-boiler will suffice.

My invention will be better understood on reference to the accompanying three sheets of drawings, in which—

Figure 1 is a longitudinal section of one of my improved furnaces. Fig. 2 is a plan of the same. Fig. 3 is a cross-section taken on the line A B, Fig. 1. Fig. 4 is a front elevation. Fig. 5 is a sectional elevation of one form of stuffing-box for the pusher, and Fig. 6 is a front elevation of the same. Fig. 7 is a longitudinal section of a modified arrangement of furnace, Fig. 8 being a plan of the same, Fig. 9 being a sectional plan of the back part of the furnace, taken on the line C D, Figs. 7 and 10. Fig. 10 is a cross-section taken on the line E F, Fig. 7. Fig. 11 is an elevation of the furnace-front. Fig. 12 is a front elevation of the bridge. Fig. 13 is an elevation of a laminated pusher, Fig. 14 being an end view of the same. Fig. 15 is an elevation of a divided pusher. Fig. 16 is a longitudinal section of a further modified arrangement of furnace, Fig. 17 being a plan of the same, and Fig. 18 a cross-section on the line G H, Fig. 16. Fig. 19 is a similar cross-section, but without the side pieces. Fig. 20 is an elevation of the furnace-front.

The same letters refer to similar parts throughout the several views.

An iron front-plate *a* is provided having two doors *b*, one on each side. Between these doors is situated a hopper *c*, which terminates by an expanding iron pipe *c'* below

and in front of the furnace-plate in an iron box *c'*, which may be called the "feed-box." Behind the furnace-front plate and lying on or close to the bottom of the flue is a cast-iron trough *d*, the bottom of which is inclined downward on either side toward the center and which communicates at one end with the feed-box *c'*. On each upper side of this trough, parallel with the flue and beyond the dead-plate, is a groove *d'*, into which engage cast-iron transverse grate-bars *e*, so shaped that they first pass upward and then in a partially-horizontal direction to the sides of the flue, where their outer ends rest on bearers *e'*, passing from the furnace-front plate to the bridge-casting *f*. These bars may be made interlocking and may be further secured by claws *e''*, which drop over rods *e'''*, passing underneath them. The bars are therefore securely held in place by these rods, which pass from the furnace-front to the bridge-casting, while by loosening the nuts which are provided at the ends of the said tie-rods any bar may be removed without disturbing the rest. These grate-bars are made either with air-spaces between them at any desired point or they may be perforated, as shown at *e''*, Fig. 1, or both.

A reciprocating plunger, ram, or pusher, hereinafter referred to as a "pusher" *g*, is situated within the trough and passes through a hole in front of the feed-box and through an opening in the furnace-front plate corresponding with the trough. In the construction shown this reciprocating pusher is approximately square in cross-section and is arranged with one of its diagonals in a vertical position. Its upper portion is stepped, as shown, thus providing a series of faces thereon, the sectional area of the pusher diminishing in steps from front to back of the furnace, whereby the fuel pushed is always moving into a larger space, as the cross-section of the trough when the area of the pusher is deducted from it is large at the back than the front. This pusher I make in various ways and also of various sections other than square, while retaining the same leading feature of a series of faces on its upper portion, with a stepped diminution toward the outer end. In some cases I construct it with laminations, so that the sizes of the squares may be readily increased or diminished at any point, either as to area or to length, as shown in Figs. 13 and 14, the object of these variations in the pusher being

that an even feed of coal upward along the length of the trough may be obtained. In some cases I cause one part of the pusher to move forward while the rest recedes, as shown in Fig. 15.

The motion of the pusher is reciprocating, and when the hopper *c* is filled with coal and the pusher *g* is withdrawn the coal falls in front of one of the faces formed by the steps on the upper portion of the pusher and on the next forward stroke of the pusher is carried forward with it toward the end of the trough *d*, and as the trough becomes filled the coal is forced upward as well as forward. By constructing the pusher in the manner described it will be appreciated that the fuel is fed into the furnace and then conveyed along it and distributed therein by the one pusher alone and that with this construction it is thus unnecessary to employ a separate feed-piston or other device, as has heretofore been the case in stokers of the reciprocating underfeed type.

By constructing the trough approximately rectangular in cross-section and arranging the approximately square plunger on one edge, as shown, not only will the latter be reciprocated with the least amount of friction, but there will be little tendency for any of the fuel to become wedged, owing to the space beneath the opening between the sides of the pusher and trough being of considerably greater width than that opening. I drive this pusher in various ways; but in the drawings it is driven by means of a link-motion similar to the reversing-gear of an engine by which the stroke can be varied in length, as shown in Figs. 1, 2, and 4. On either side of the hopper *c* and feed-box *c*² are external plates *h*, approximately corresponding to the width of the grate within the furnace, these plates being supported partly against the hopper and feed-box and partly on the bolts securing the bars.

Where the pusher passes through the front of the feed-box, I provide a stuffing-box *i* of such a nature as to intercept the passage of coal-dust. In one case this consists of a box *i* external to the feed-box having a removable cover *i*'. On the two lower sides of the feed-pusher at this point are two small subsidiary pushers *j*. Conveniently these subsidiary pushers may consist of suitable projections on the under sides of the main pusher *g*, and what coal-dust leaks through the opening between this stuffing-box and the feed-box falls below these two small subsidiary pushers *j* and is thereby pushed back into the main feed-box. In other cases I provide a stuffing-box *i* consisting of two halves, Figs. 5 and 6, bolted to each other and bolted to the front of the feed-box through which the pusher *g* moves. The pusher rests on the lower half of this stuffing-box; but the upper part of the stuffing-box is clear of the pusher.

Through the upper half is inserted a sliding shutter *i*², placed vertically, its lower end being so shaped as to fit the pusher *g*. The said shutter merely resting on the pusher therefore intercepts dust with the smallest amount of friction. Suitable doors *c*³ to the feed-box allow the feed-box and hopper to be readily emptied from below. In certain cases I provide the top of the hopper *c* with a lid which may be shut down when the furnace is standing to prevent a draft working up the hopper and igniting the coal therein.

The furnace-front plate on either side of the feed-box is provided with suitable steam-blowers *k* or with openings for a fan-draft. The bridge-piece *f*, to which the tie-rods are fixed, is provided with air-holes *f*', directed toward the trough. I also in certain cases make a modification in the arrangement of feed and construction of furnace, so as to render it self-cleaning, as illustrated in Figs. 7, 8, 9, 10, 11, and 12, in which I cover in the central trough *d* completely. On each side of this central coal-delivery trough or pipe in which the feed-pusher reciprocates I place two troughs *d*², reaching from the front plate to the bridge-casting, and from each of these on one side sectional diagonal grates *e* are taken up to the flue sides, and on the other two similar grates *e* are taken, meeting above the top of the coal-trough *d*, the whole grate being thus formed somewhat of a W shape. Within the troughs referred to works one or more moving graduated bars *g*', so arranged, if desired, at the bridge as to lift up when they move toward the furnace-door.

The fuel is delivered from the hopper or feed-box to the central feed-trough *d*, thence into a receptacle *l*, beneath or about the bridge, and out above the return moving bars *g*', but below the surface of the burning fuel on the grates *e*. There is thus provided a stream of fresh fuel delivered under the surface of that burning at the bridge end of the grate, and by means of the moving graduated bars *g*' in the side troughs *d*² the fuel as burned out is gradually carried toward the door. In this case I also provide for delivery of air at the bridge. If desired, the faces on the pushers in the central and side troughs may be arranged so as to feed along the side troughs *d*² and withdraw along the central one *d*, as shown in Figs. 16 to 20. In this case there is a cast-iron front-plate, with three troughs open at the top, lying between the said front-plate and the back casting, between which troughs are the section-castings and sometimes also the outside section-castings. Attached to the front-plate is a hopper *c*, dividing into two feeding-boxes *c*², two pushers *g*, situated in the two outside troughs for feeding coal toward the back of the furnace, and a reciprocating graduated bar *g*', which withdraws the fuel toward the door as burned out.

The stuffing-boxes, methods of driving, external plates, hoppers, and doors as used in the first-described arrangement are also common to the second.

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

1. In a furnace of the underfed type, the combination with a fuel-hopper, *c*, and feed-box, *c*², and a longitudinal trough, *d*, of a reciprocating pusher, *g*, therein, whose lower portion is approximately triangular in cross-section and arranged to travel on one edge, and whose upper portion is provided with a series of faces for feeding, conveying, and
15 distributing the fuel, in the manner and for the purposes substantially as herein described and illustrated on the accompanying drawings.

2. In a furnace of the underfed type, the
20 combination with a longitudinal trough, *d*, below the level of the fire-bars, an angular pusher, *g*, with a stepped diminution toward the outer end therein, traveling on one edge, and having a series of faces on its upper portion, of a fuel-hopper, *c*, and feed-box, *c*², communicating with the trough, *d*, at the front of the furnace and a stuffing-box, *i*, in the manner
25 and for the purposes substantially as herein described and illustrated on the accompanying drawings.

3. In a furnace of the underfed type, the modified arrangement comprising the combination with a fuel-hopper, *c*, a feed-box, *c*², a central covered trough, *d*, below the fire-bars

communicating with the hopper and feed-box at one end, and with a receptacle, *l*, under the bridge at the other end, a reciprocating pusher therein having a series of diminishing faces on its upper portion, so formed and arranged as to carry fuel from the hopper, *c*, to the receptacle, *l*, two longitudinal troughs, *d*³, one on each side of the said chamber below the average fire-level and a reciprocating gradated bar in each trough, so arranged as to carry fuel and ashes from the
35 back toward the front of the furnace, in the manner and for the purposes substantially as herein described and illustrated on the accompanying drawings.

4. In a furnace of the underfed type, the
50 modified arrangement comprising the combination with a fuel-hopper, and a feed box or boxes, a central trough below the fire-bars, two side troughs below the average fire-level, a receptacle below the bridge communicating with all three troughs and reciprocating
55 pushers in each trough, so formed and arranged that the fuel in the side troughs will always travel in a direction contrary to the fuel in the central trough, in the manner and
60 for the purposes substantially as herein described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

WALTER RIDOUT WILLS.

Witnesses:

W. H. BAIRSTO,
J. F. BIRD.