



No. 700,320.

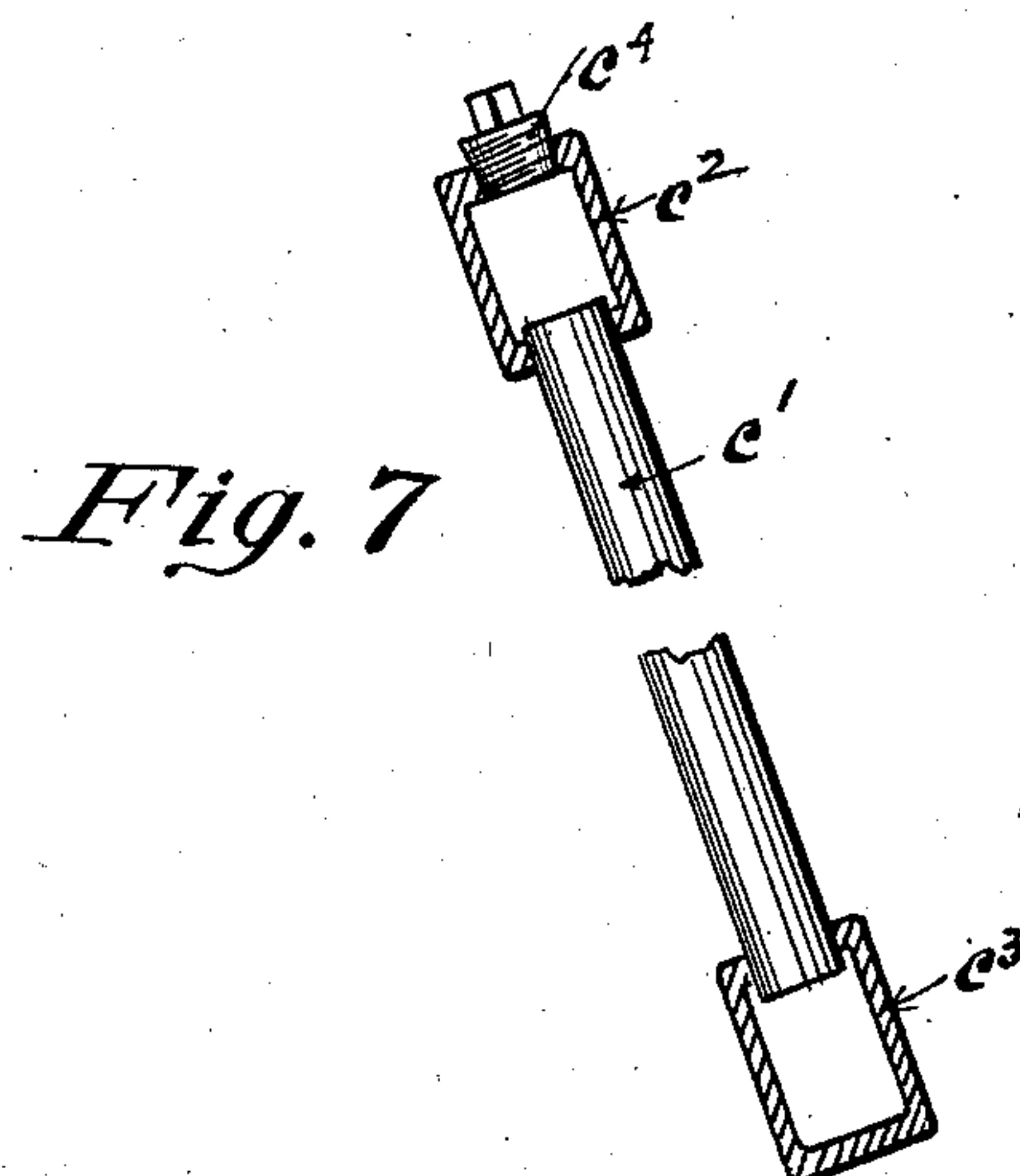
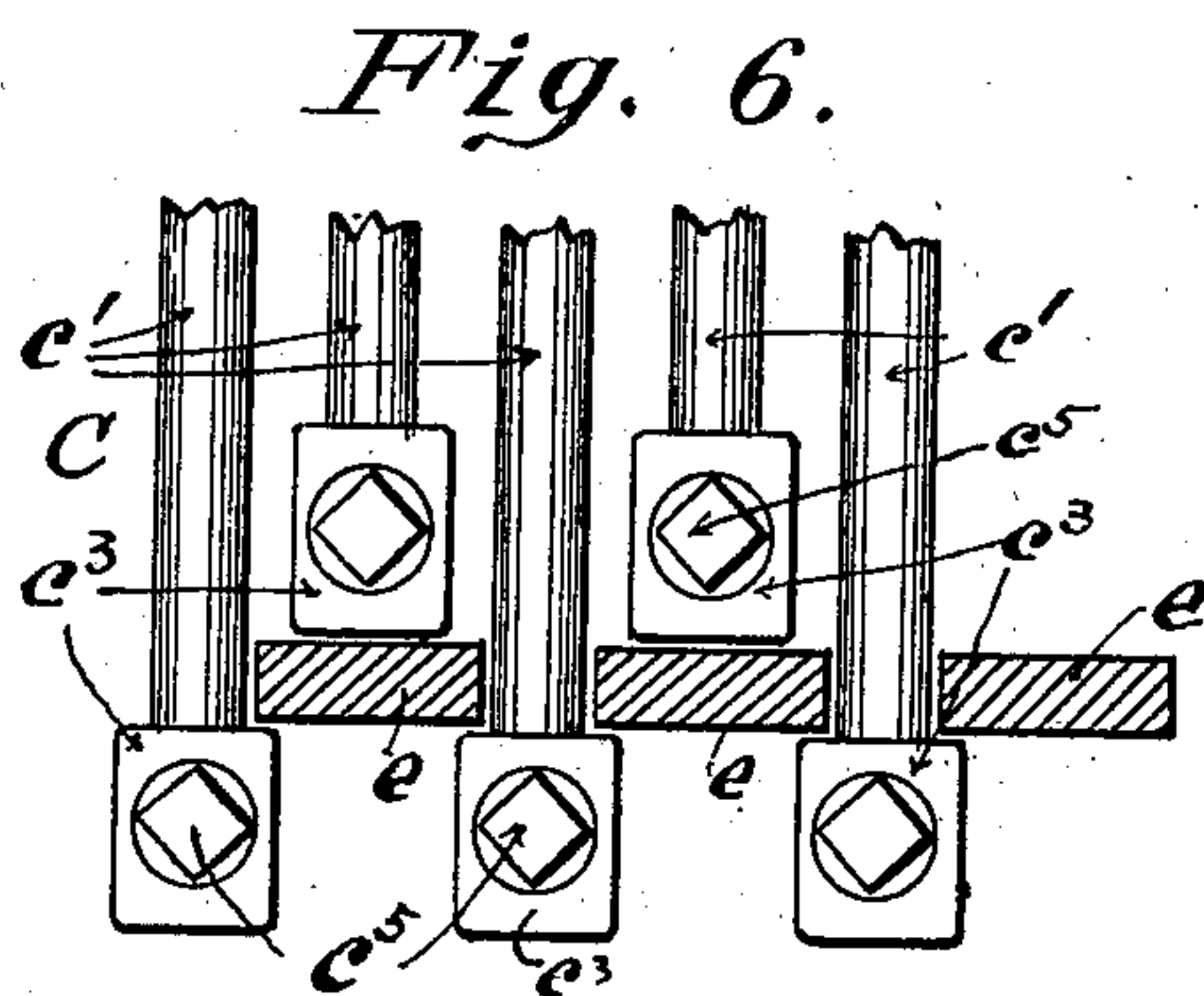
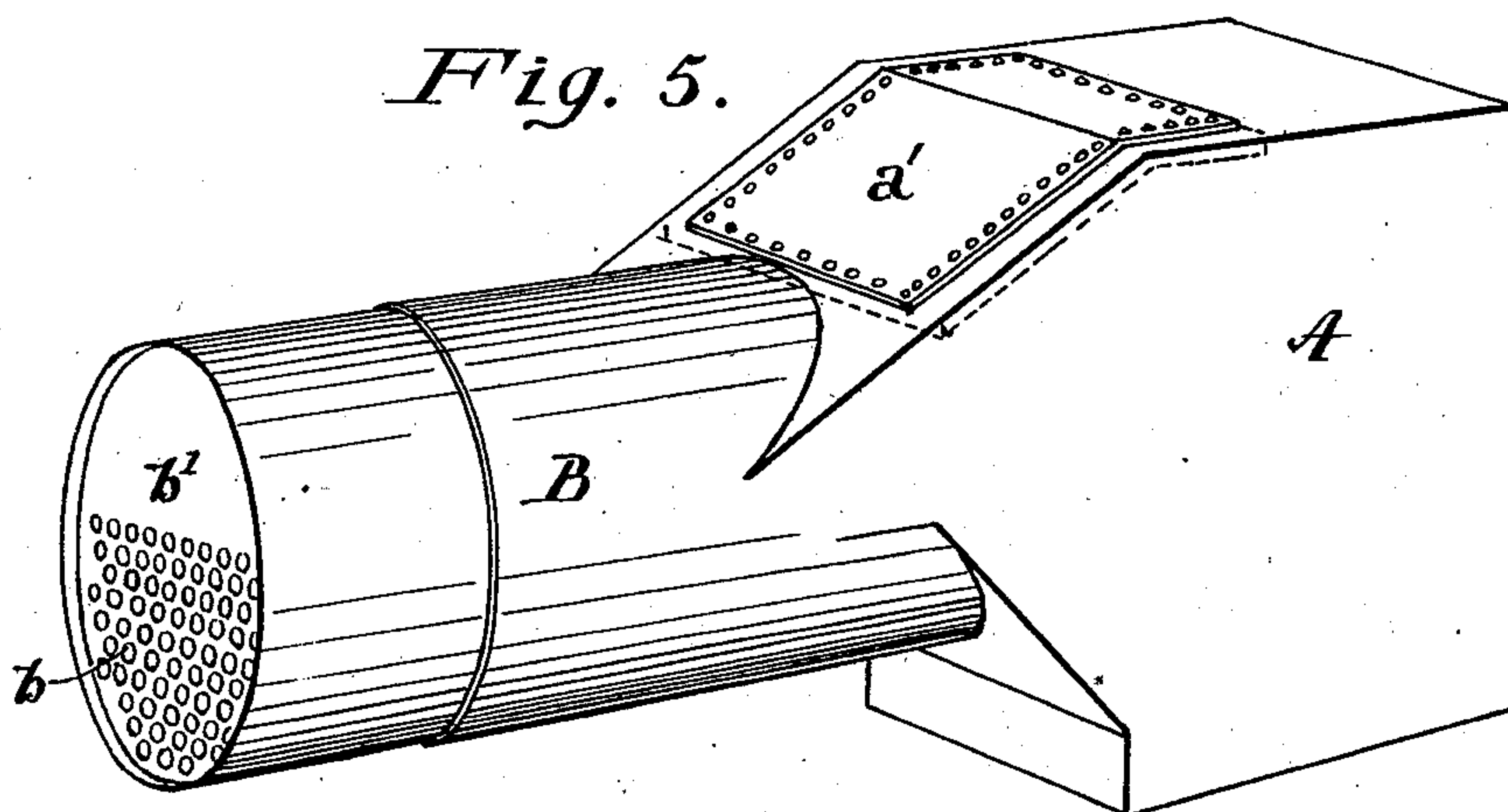
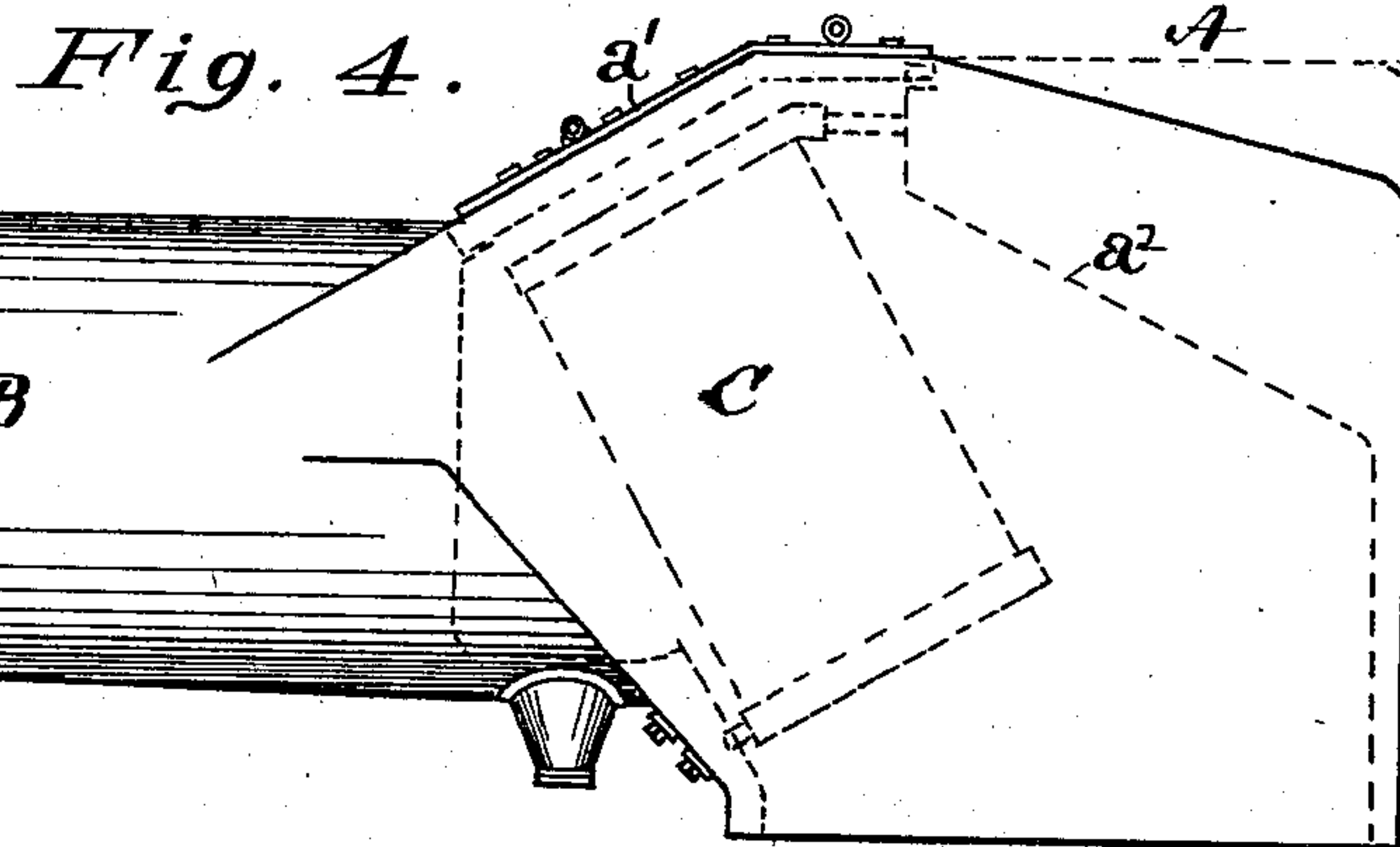
Patented May 20, 1902.

C. H. FOX.  
STEAM GENERATOR FOR LOCOMOTIVE SERVICE.

(Application filed July 18, 1901.)

(No Model.)

3 Sheets—Sheet 2.



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Fig. 8.

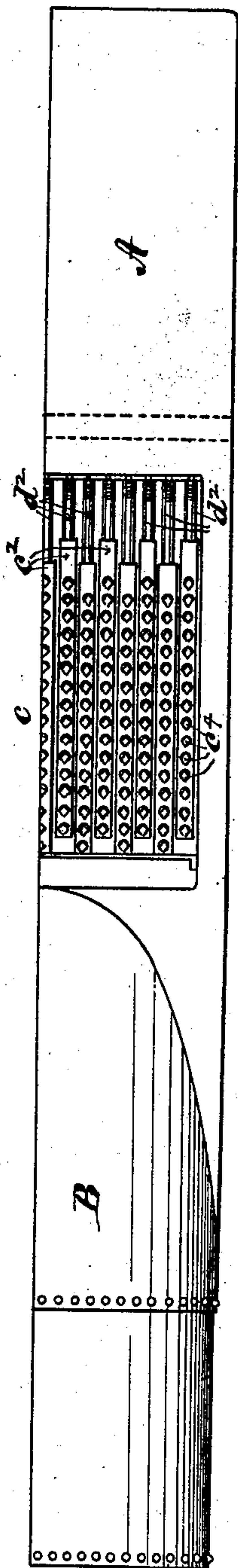
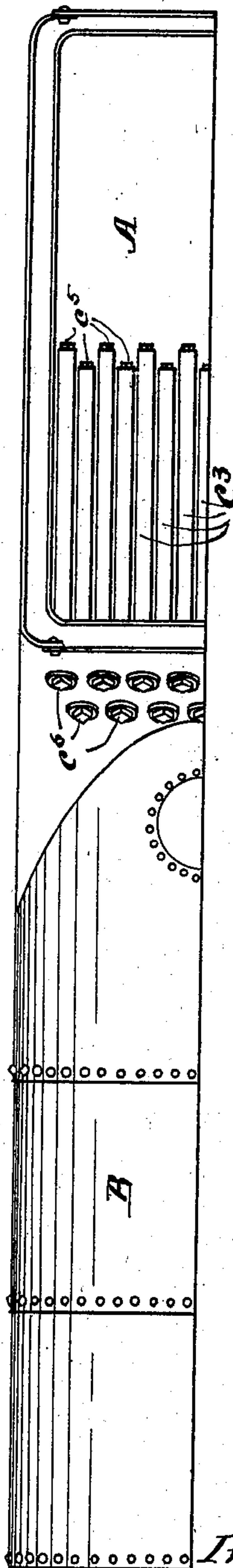


Fig. 9.



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# UNITED STATES PATENT OFFICE.

CHARLES H. FOX, OF CINCINNATI, OHIO.

## STEAM-GENERATOR FOR LOCOMOTIVE SERVICE.

SPECIFICATION forming part of Letters Patent No. 700,320, dated May 20, 1902.

Application filed July 18, 1901. Serial No. 68,787. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES H. FOX, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented new and useful Improvements in Steam-Generators for Locomotive Service, of which the following is a specification.

My invention relates to steam-generators of the class used in locomotive service, its object being to produce a generator adapted to the present arrangement of cylinders, underframing, wheels, and machinery and which shall embody and combine with the fire-box discharging through submerged horizontal flues into the smoke-arch a system of water-circulating tubes whereby the heating-surface is largely increased and the general circulation of water from end to end of the boiler directly stimulated. These being the main objects of my invention, the construction in which they are attained embodies certain further advantages which add materially to the efficiency of the generator as a whole, both in respect to its steaming capacity and its better adaptation to the conditions of railway service. The fire-box is relatively increased in capacity (insuring more complete initial combustion) and the smoke-tubes correspondingly shortened, an arrangement which adds to the efficiency of both and permits the insertion of a system of independently-removable water-tube units in and as part of the fire-box heating-surface, which in no way detracts from or interferes with the ordinary functions of the fire-box. These tube units are suspended in the fire-box area in an inclined position, approximately vertical, and connect for circulation with the forward and lower part of the boiler in front and at rear at the upper part of the fire-box jacket, discharging upon and over the crown-sheet an advantageous arrangement in respect to the circulation and also facilitating repairs, &c., all as will be more fully explained.

My invention is illustrated in the accompanying drawings, forming part of this specification, in which—

Figure 1, Sheet 1, is an axial fore and aft vertical section of the generator complete, omitting all extraneous features, such as steam-dome, pipes, &c., common to such struc-

tures. Fig. 2 is a one-half front or end view showing the position and relation of the usual smoke-flues. Fig. 3 is a detail of the construction and joining of the rear flue-sheet of the cylinder end of the boiler with the ring bounding the upper opening of the fire-box. Figs. 4, and 5 Sheet 2, are side elevations and perspective elevations, respectively, of the boiler designed to show more particularly the general constructive features of the entire external shell. Figs. 6 and 7 are details illustrating the tube units construction; and Figs. 8 and 9 are longitudinal half upper and lower plan views, respectively, of the generator complete.

Referring now to the drawings forming part of this specification, and premising that the internal bracing, &c., usual in such constructions is omitted in these illustrations to avoid confusion, the generator shown is a "boiler" of the locomotive type, differing but little from the ordinary forms, excepting in the "fore and aft" enlargement and structural features of the fire-box A, the shortening of the cylindrical portion B, and the mode of junction between the two.

The forward cylindrical portion B of the boiler is of the usual construction, having a series of parallel smoke-flues *b* occupying the space below the water-line *x*, extending to and through a front partition *b'* and a rear partition *b''*, which latter constitutes the front inner wall of the fire-box A.

The fire-box A is somewhat higher than usual and is elongated fore and aft, its outer shell being joined to the cylindrical shell of the part B by inclined converging sheets above and below, forming an inclosing shell of irregular shape, (indicated in Figs. 1, 4, and 5,) having the usual grate-opening *y* below and a large rectangular opening above fitted with a cover *a'*. The latter opening has a riveting-ring *r* of rectangular form and bent out of a right plane to accommodate the incline of the top of the fire-box forward. The inner and outer sheets of the fire-box are riveted together through the intervening ring in the usual manner. The inner shell of the fire-box bounds an inclosed area of substantially the same form as that bounded by the outer shell, the two walls constituting a "water-jacket" surrounding the combustion-



chamber, the "crown-sheet"  $a^2$  of which is preferably arched crosswise and inclined downward toward the rear, while the corresponding outer sheet at the top of the fire-box 5 may be continued backward from the ring  $r$  in a horizontal plane or at a slight declivity.

The front inner wall of the fire-box, as already intimated, constitutes the rear tube-sheet  $b^2$  of the cylindrical part of the boiler, 10 but is not connected with the cylindrical part of the boiler except by the smoke-flues  $b$ . It consists of a flange-sheet  $b^2$ , (shown in Fig. 3,) attached above to the ring  $r$  at the sides to the inner side sheet of the fire-box and at 15 the bottom to a rear extension-sheet  $b^3$ , which is ultimately connected to the ring  $r'$  of the grate-opening. In the interior space of the fire-box is mounted a series  $c$  of "tube units," (so called,) each consisting of parallel tubes 20  $c'$  of uniform length arranged in a common plane and opening at their ends into "headers"  $c^2$   $c^3$  at top and bottom. Each tube unit consists of two parallel headers  $c^2$  at the top and  $c^3$  at the bottom, united by a plurality of tubes  $c'$ , arranged parallel to each 25 other and perpendicular to the headers in the common axial plane of the headers. The headers are enlarged tubes, preferably of rectangular cross-section, into which the connecting-tubes enter, as indicated in the detail section Fig. 7. In the upper header  $c^2$  30 opposite each connecting-tube is a corresponding aperture normally closed by removable screw-plugs  $c^4$ , the removal of which gives access to each connecting-tube for the 35 insertion of a cleaning-rod when necessary. The forward end of each lower header  $c^3$  is likewise provided with an aperture and a screw-plug  $c^5$  for a similar purpose.

40 The tube units are arranged side by side in parallel series across the fire-box space, the upper headers having a resting support in front against a strong cross brace or beam  $f$ , bolted at each end to the inner side sheets of 45 the fire-box A, the units being set sufficiently high to leave space below for the fuel upon the grate covering the opening  $y$ , the tubes  $c'$  themselves being inclined forward above and the headers upward from front to rear, so that 50 the fire-space beneath the tube units is deeper in rear than in front. Each tube unit communicates at the forward end of its lower header by a pipe connection  $d'$  with the front leg of the water-jacket of the fire-box just in 55 rear of the cylindrical end B of the boiler, while the upper headers are similarly provided at rear by a pipe connection  $d^2$  with the water-jacket at the upper rear portion of the fire-box just over the forward and upper 60 end of the inclined crown-sheet  $a^2$ . All the pipe connections are so constructed as to allow the insertion and removal of any one of the tube units independently of the others at any time. I prefer to connect the pipe con- 65 nections  $d'$  with the inner shell of the boiler by the usual method of radial expansion by suitable expansion-tools inserted through

plugged openings  $c^6$  in the outer shell, which openings also permit the application of a 70 cleaning-rod to the lower headers when necessary. The upper connections  $d^2$  are preferably made by cutting a long thread on the pipes  $d^2$ , whereby they may be screwed through the boiler-shell beyond the normal position, 75 and then the pipes are screwed forward into their seats in the header, and a loose jam-nut  $c^7$  on the pipe connection is screwed against the side of the shell.

The tube units are set alternately at different elevations, principally, in this instance, 80 to allow them to be brought very close together in series, yet not crowd the apertures in the boiler-shell. The inclination of the headers upwardly at rear is taken advantage of to place refractory tiles  $e$  between the ad- 85 jacent units of the lower series and resting upon the ledges formed by the headers, as shown in Fig. 6, thus closing the open space of the bottom to a large extent and converting the bottom of the entire system of units 90 into a "baffle-plate," which deflects the gases of combustion in the first instance rearward and upward around the bottom headers, whence they pass forward between and at 95 right angles to the water-tubes into the smoke-flues  $b$ . The water-tube units may be introduced from above through the rectangular opening at the top of the fire-box or from below through the grate-opening. Access to 100 the screw-plugs of the upper headers may be had by removing the cover plate or plates  $a'$ .

The inclined front of the system of water-tube units also produces an angular free space 105 widest below at the interior front lower part of the fire-box. The outer and inner sheets of the water-jacket at this point are joined to a circular manhole-frame sufficiently large to permit access to the rear partition or tube-sheet  $b^2$  of the cylindrical part of the boiler 110 for inspection or repairs. The manhole thus formed may be fitted with a funnel-shaped extension  $g$  to serve as a catch-basin for cinders and provided with a suitable gate or discharge-register.

In operation the boiler is governed by the 115 conditions usual in locomotive service, excepting only as modified by the water-tube portion, which action is as follows: Water enters freely at the lower connection of the tube units and is carried upward by the cir- 120 culation-currents induced by the action of heat on the outer surface of the tubes. The currents thus set up carry the water above the normal water-line  $x$  and discharge at the highest point of the tube units at the rear 125 pipe connections  $d^2$  of the upper headers over and upon the crown-sheet  $a^2$ , where the discharge of steam and entrained water is directed against a deflecting-plate  $a^3$ , so placed and formed as to carry water downward and 130 distribute the same uniformly over the crown-sheet over which it flows down to the normal water-line.

In order to keep the inclined crown-sheet



constantly flooded, and thereby protect it from injury from overheating, the flow is partially guided and obstructed by side dams *h* and one or more cross-dams *h'*, arranged in any suitable manner to retain water constantly on the crown-sheet.

I claim as my invention and desire to secure by Letters Patent of the United States—

1. In combination with a steam-boiler, a plurality of vertical or inclined tube units placed within the combustion-chamber and each including two parallel headers at the top and two parallel headers at the bottom, said headers united by a plurality of tubes, and the upper portions of said tubes and the upper headers being above the normal water-level, and the lower headers communicating with the water-space and the upper headers communicating with the steam-space of the boiler.

2. In a steam-boiler of ordinary locomotive type; the combination, with the fire-box of an inclined crown-sheet extending above the normal water-line, and a series of vertical or inclined water-tubes placed within the fire-box the lower ends of the tubes in communication with the water-jacket of the fire-box and the upper terminals of same arranged to discharge upon and down the crown-sheet for the purpose of protecting same from the action of heat, substantially as set forth.

3. In a steam-boiler of the ordinary locomotive type; the combination of an inclined crown-sheet extending above the normal water-level with transverse and longitudinal dam-plates erected thereon and preferably forming a part of the bracing thereof, for the purpose of entrapping thereon a portion of the water discharged upon the upper end of the crown-sheet and flowing down over the same, substantially as set forth.

4. In a steam-boiler of the locomotive type; the combination of a fire-box; a series of vertical or inclined water-tubes housed therein; a manhole between the said series of water-tubes and the rear tube-sheet, and a pocket or funnel-shaped receptacle forming a pendent extension of the manhole for receiving cinders or unburned particles of the fuel, and a suitable gate or cut-off arrangement for discharging the contents thereof at pleasure, substantially as set forth.

5. In a steam-boiler of the ordinary locomotive type; a fire-box including converging sheets above and below, forming an inclosing shell of irregular shape, said fire-box having its upper side pierced for the purpose of inserting and removing a system of vertical or

inclined water-tubes attached as part of the steam-generating apparatus, substantially as set forth.

6. In a steam-boiler of the modified type hereinbefore described, the combination of a water and steam jacketed fire-box; a series of inclined water-tubes accessible at the top, through an opening piercing the boiler; a removable cover-plate over said opening; a system of water-tubes extending above and below the normal water-line and communicating with the steam and water spaces of the boiler respectively; a baffle-plate for deflecting the entrained water carried thereby upward into the steam-space; a cylindrical forward extension containing the usual smoke-flues and joined to the front leg of the fire-box; a manhole provided at the lower part of the shell near its juncture with the fire-box; smaller openings or hand-holes in the leg of the boiler for giving access to the interior of the tube-sections constructed and arranged as and for the purpose hereinbefore set forth.

7. In a fire-box boiler of the type indicated; a fire-box provided with a system of independent laterally-adjacent tube units each consisting of upper and lower "headers" connected by a series of parallel tubes in the common axial plane of the headers, each upper header connected at one end with the steam-space and each lower header being connected at the relatively opposite end with the water-space, in combination with a forward extension of the boiler provided with submerged flues communicating with the combustion-chamber of the fire-box, substantially as set forth.

8. In a fire-box boiler of the type indicated, a fire-box provided with a system of laterally-adjacent tube units inclined forward and connecting above and below to the steam and water spaces of the fire-box, and a series of refractory plates or tiles carried between and upon the lower headers of the tube units, constituting with said headers a baffle-plate to carry the initial products of combustion backward and thence upward around the rear ends of the headers, and thence forward across and between the tubes to the smoke-flues of the forward cylindrical extension of the boiler, substantially as set forth.

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

CHARLES H. FOX.

Witnesses:

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LLOYD T. BRUNSON.