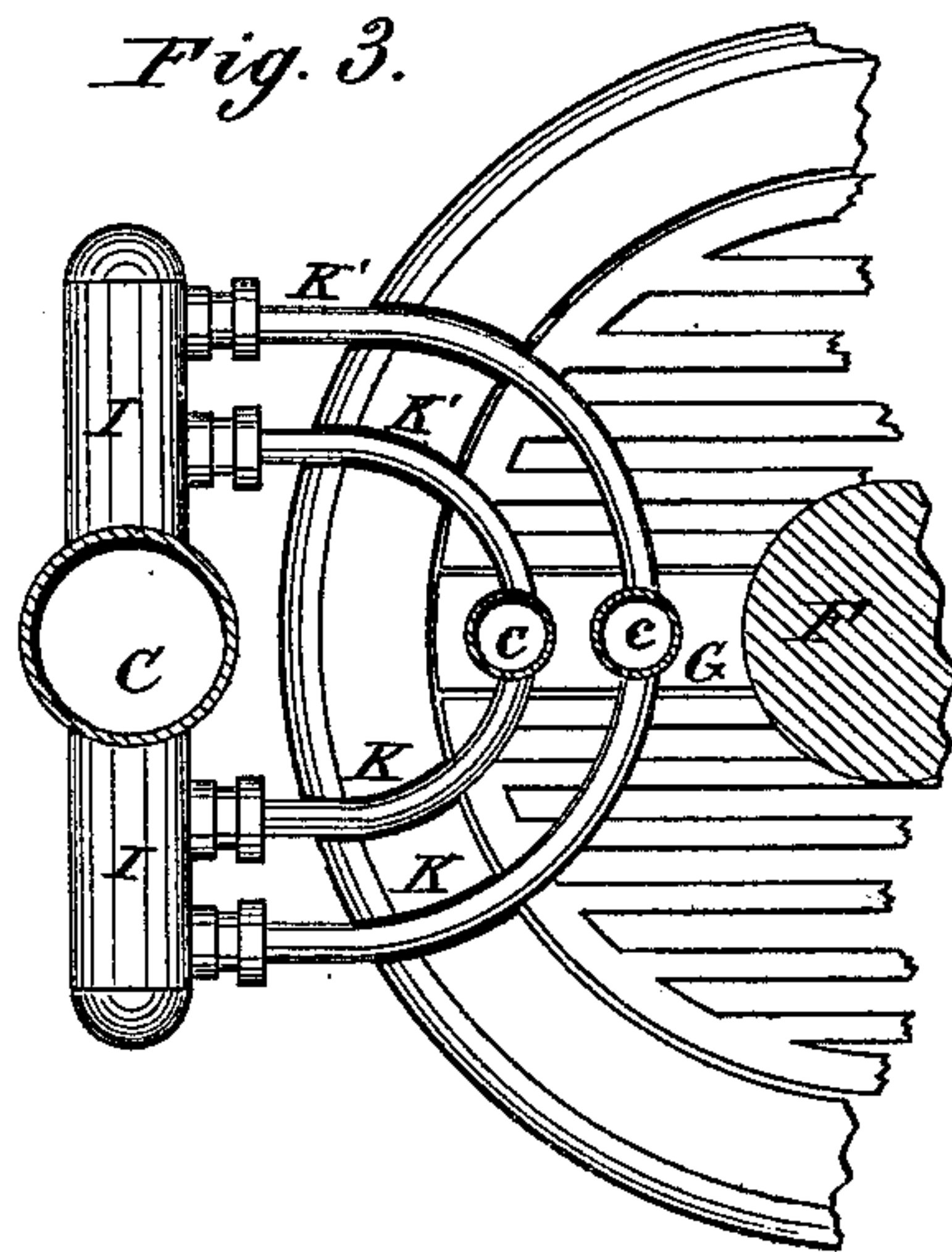
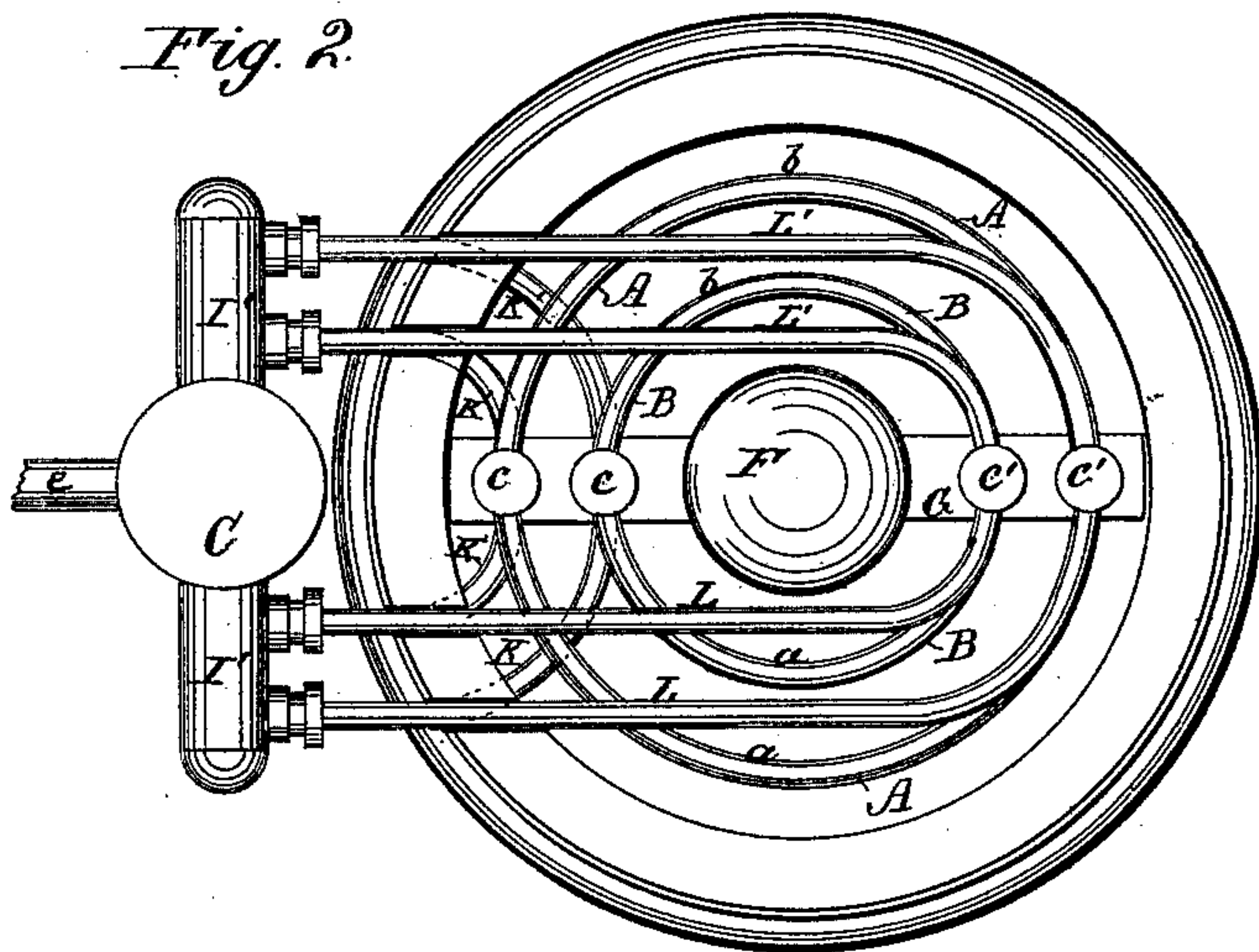
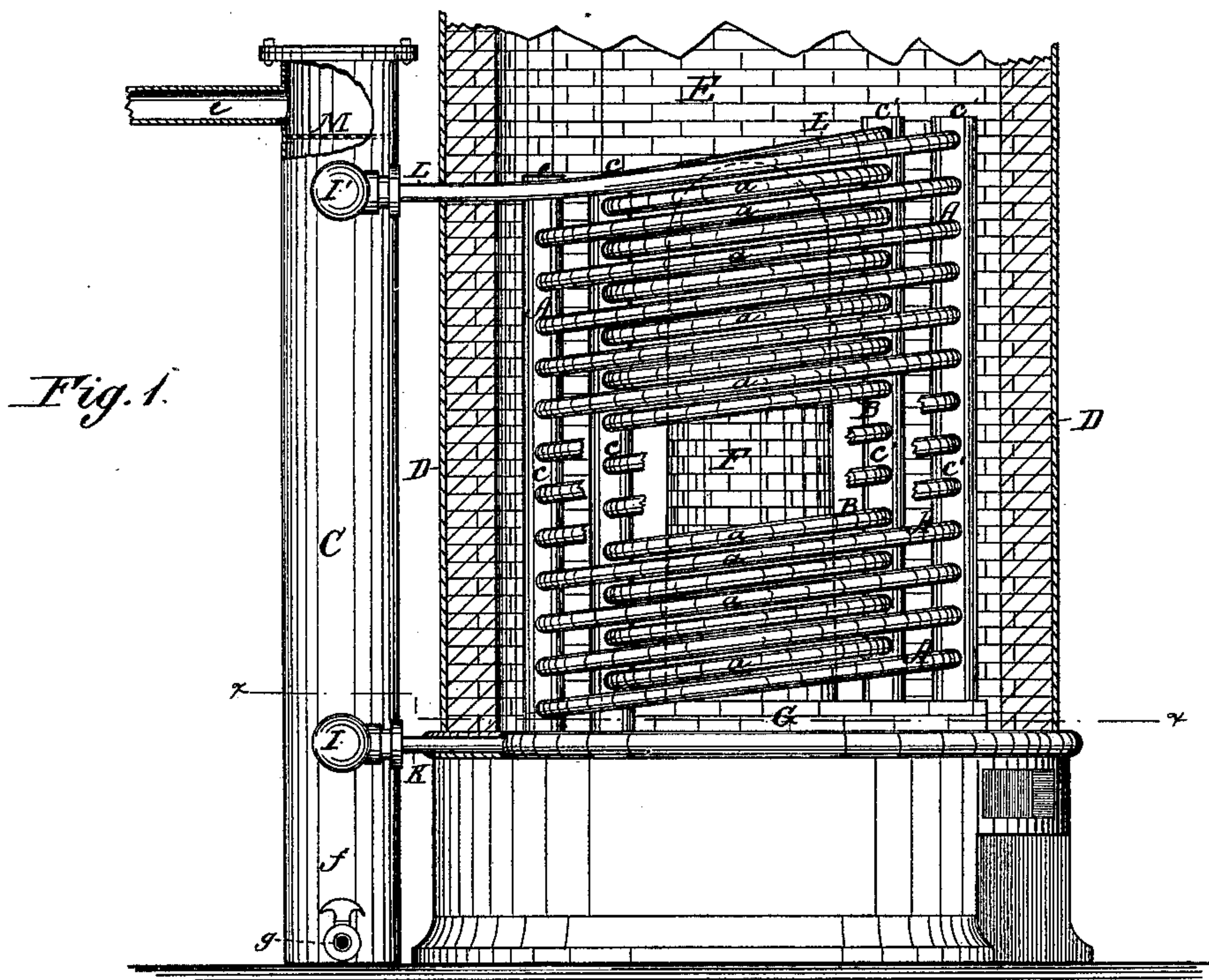


C. WARD.  
Water-Tube Steam-Generator.

No. 220,451.

Patented Oct. 7, 1879.



WITNESSES:  
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# UNITED STATES PATENT OFFICE.

CHARLES WARD, OF CHARLESTON, WEST VIRGINIA.

## IMPROVEMENT IN WATER-TUBE STEAM-GENERATORS.

Specification forming part of Letters Patent No. **220,451**, dated October 7, 1879; application filed June 19, 1879.

*To all whom it may concern:*

Be it known that I, CHARLES WARD, of Charleston, in the county of Kanawha and State of West Virginia, have invented a new and useful Improvement in Water-Tube Steam-Generators; and I do hereby declare that the following is a full, clear, and exact description of the same.

My invention is an improvement in the class of boilers or steam-generators formed of concentric or other coils of tubes, through which the water circulates in a continuous round.

My invention consists in the construction and arrangement of parts, as hereinafter described and claimed.

In the accompanying drawings, forming part of this specification, Figure 1 is mainly a sectional elevation of my improved generator. Fig. 2 is a plan view. Fig. 3 is a detail cross-section on line *x x* of Fig. 1.

The generator proper consists of a connected series of curved pipes, of which there may be two or more sets, A B, concentrically arranged, and the vertical separating drum or cylinder C. The two series of pipes A B stand vertical, and are concentrically arranged and inclosed by a concentric iron casing, D, having a fire-brick lining, E. The inner series, B, also surrounds a vertical cylinder, F, having a facing of fire-brick.

Each series A or B consists of curved parallel inclined tubes *a* and *b* and two vertical tubular connections or stand-pipes, *c c'*. The latter are placed on opposite sides of the series, and the tubes *a b* extend from one to the other, to both of which they are connected by suitable joints. The object of placing the pipes *a b* inclined is to assist and accelerate the flow of water and steam toward the upper end of stand-pipes *c'*. The stand-pipes *c c'* are set in the division-wall G of the fire-box, and thus serve to support the whole system of pipes.

The flame and gaseous products of combustion pass up from each portion of the fire-box in the several annular spaces between the fire-brick casing E and outer series, B, and fire-brick post or cylinder F. Thus the fire-brick surfaces E and F radiate heat on the outer and inner series of pipes, respectively, and the flame and heat act on them from the

space within, so that fuel is economized and steam generated rapidly.

The manner of connecting the series or systems of pipes A B with the drum or cylinder C is as follows: The drum C is provided with two pairs of horizontal tubular arms, I I', the two of each pair projecting on opposite sides near top and bottom. The two stand-pipes *c*, which are nearest the drum C, are connected at the bottom with the lower arms, I, of the drum by curved tubes K and K', respectively, while the stand-pipes *c'*, which are farthest from the drum, are similarly connected with the upper arms, I', by tubes L L'. Thus the lower portion of the separating-cylinder C is in communication with the lower ends of one pair of stand-pipes, and the upper end in communication with the upper ends of the outer stand-pipes. From this arrangement it results that when the proper degree of heat has been attained the water in the tubes *a b* becomes expanded, and in part converted into steam, so that a circulation sets upward in all the tubes *a b* of both systems or series A B from the stand-pipes *c* toward the stand-pipes *c'*, where the slow-moving currents mingle into one, which flows upward to the top of the stand-pipe *c'*, and there divides into currents that pass through tubes L L' to the arms I', and thus enter the upper portion of the cylinder C.

The water is separated from the steam immediately upon entering the cylinder C, since the water falls by its own gravity into the main body of cooler water in the lower part of the cylinder. The steam is taken from the upper portion of the cylinder by pipe *e*; but to prevent the water which discharges through pipes L L' from following the course of the steam, I interpose the perforated or wire-gauze screen M between such pipe and the arms I'. Said screen is arranged horizontally and attached to the sides of the cylinder.

As the heated water rises in tubes *a b*, its place is supplied by the cooler and heavier water flowing from the cylinder C through pipes K K', which, becoming heated, in turn ascends through stand-pipes *c'*, and is finally delivered into the cylinder by pipes L L' and arms I', and thus the circulation goes on in a continuous round, the action depending on the



difference in gravity between the hot water in the series of pipes A B and the cooler body of water in the cylinder.

When the hot water discharges from arms I' into the cylinder and mingles with the colder water therein, the slower motion of the current through the latter, owing to its increased diameter, favors the deposition of mud or sediment, which is collected in the bottom *f* of said cylinder, and may be removed therefrom by discharge-cock *g*.

Feed-water may be supplied to the cylinder C at any convenient point.

The connections of the pipes K K' and L L' with the cylinder C are such that they may be readily detached. Thus each system or series of pipes A or B may be removed, when necessary, for the purpose of repair or other cause, and the use of the other continued the same as before.

What I claim is—

1. In a water-tube steam-generator, the series of pipes or tubes consisting of curved parallel tubes *a b*, and the vertical stand-pipes

or connections *c c'*, and a vertical cylinder, with which such stand-pipes are connected at top and bottom, all arranged as shown and described, for the purpose specified.

2. The combination of the inner fire-brick cylinder, F, with the concentric series of curved pipes A B, vertical pipes *c c'*, and outer fire-brick casing, all arranged as shown and described, to operate as specified.

3. The combination of the bridge-wall or dividing-partition of the fire-box, and the coils A B, having stand-pipes *c c'*, which rest on such wall and support the coils, all as shown and described.

4. The combination of the screen or separator with the cylinder and coil discharge-pipes L L', arms I', and steam-exit pipe *e*, all as shown and described, for the purpose specified.

CHARLES WARD.

Witnesses:

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JAMES E. MIDDLETON.