

No. 753,057.

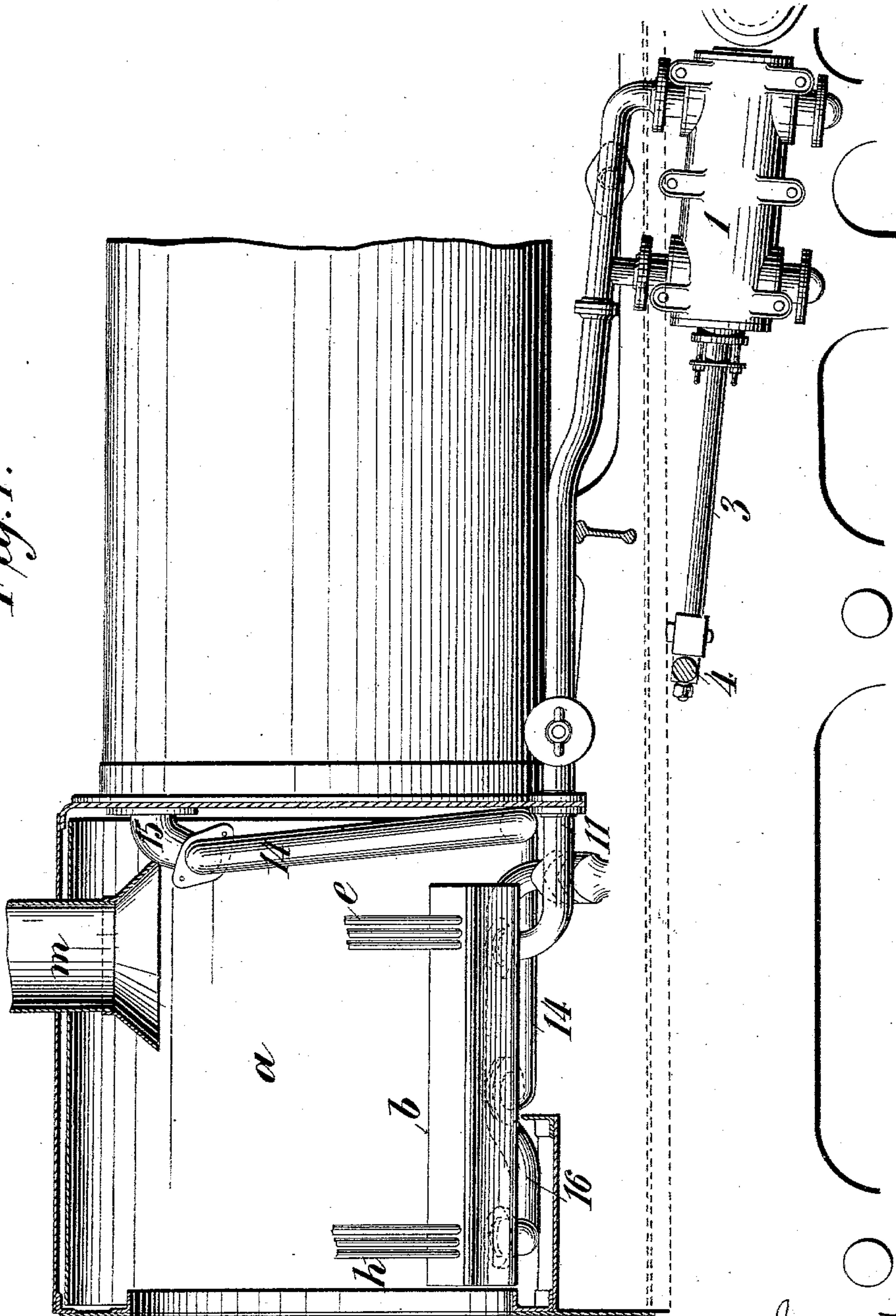
PATENTED FEB. 23, 1904.

E. FIELD.
LOCOMOTIVE ENGINE.
APPLICATION FILED APR. 23, 1903.

NO MODEL.

6 SHEETS—SHEET 1.

Fig. 1.



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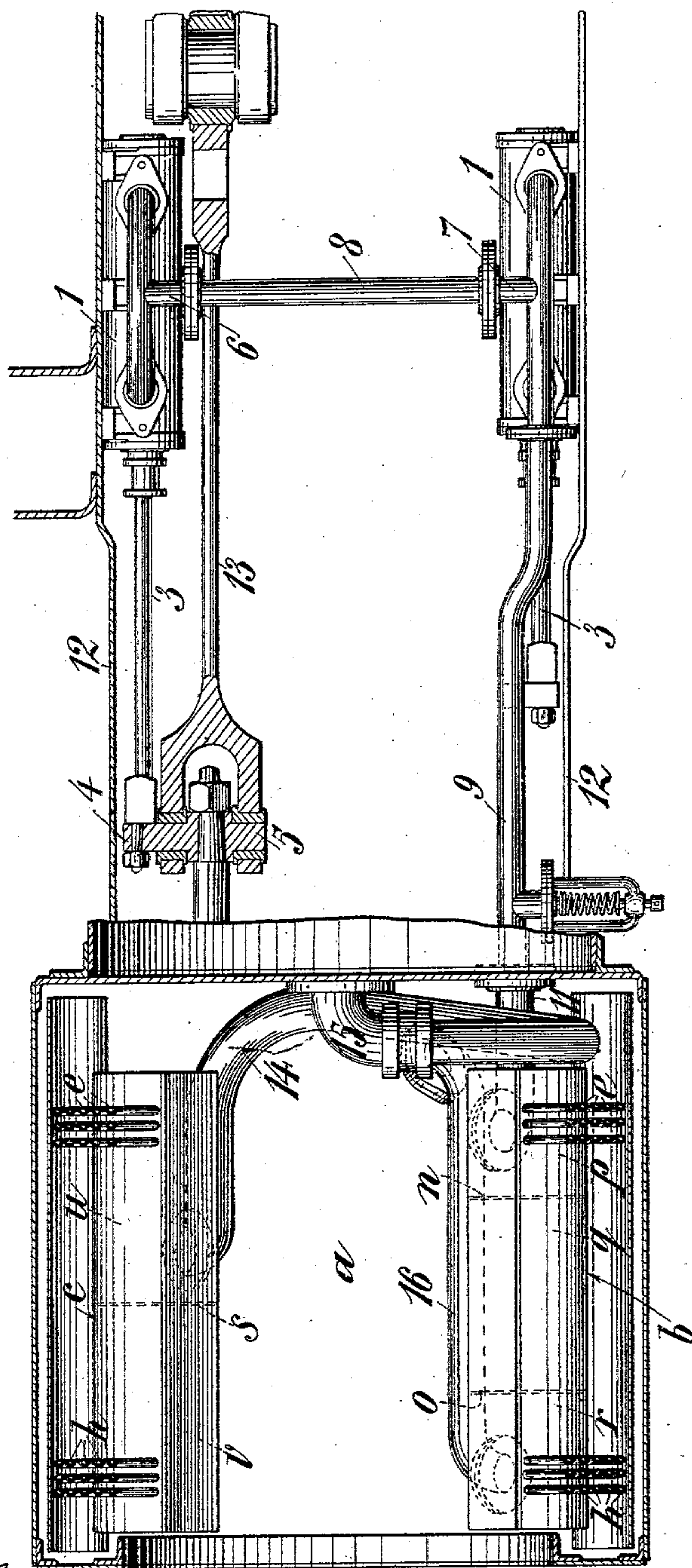
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6 SHEETS—SHEET 2.

Fig. 2.



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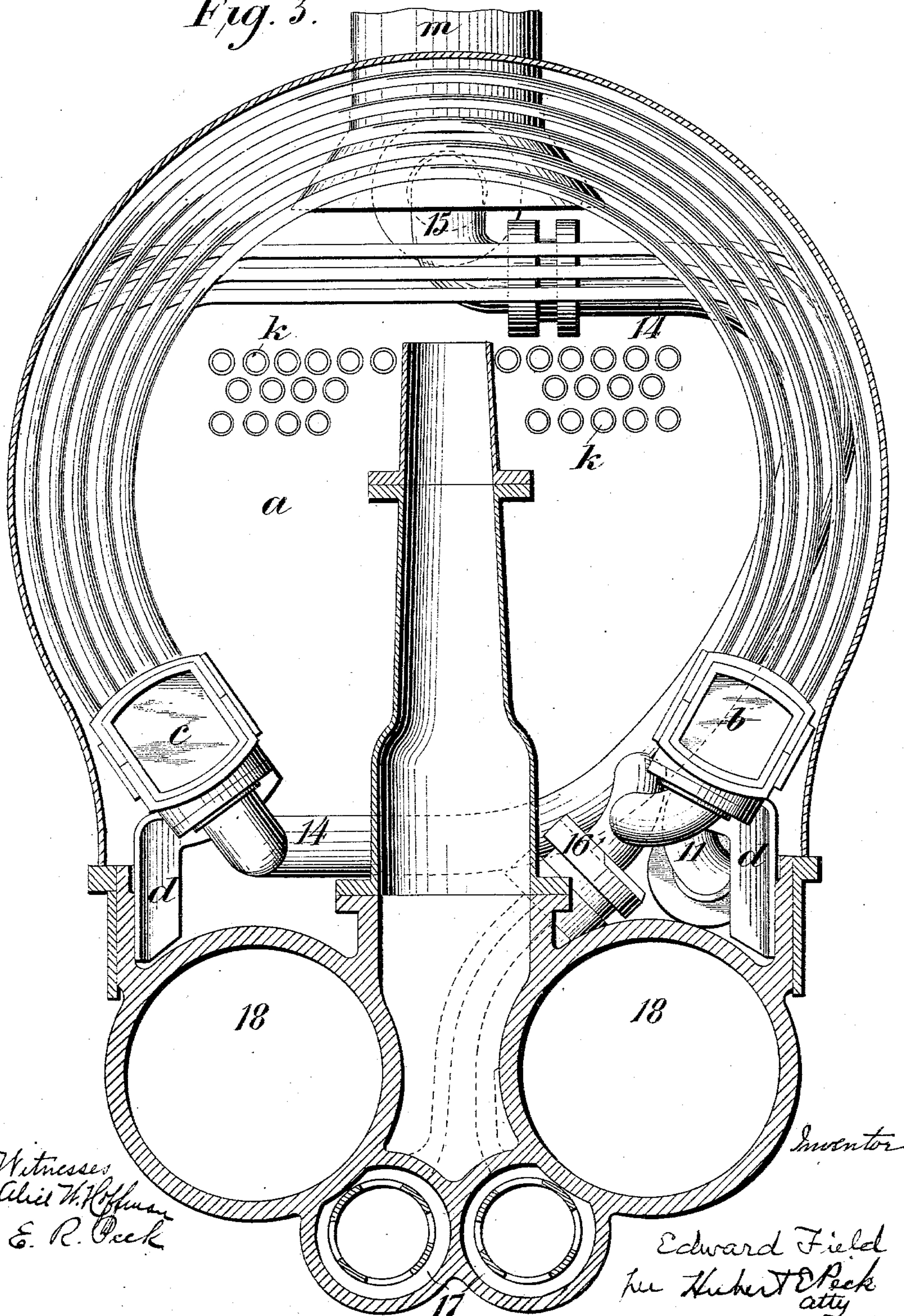
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6 SHEETS—SHEET 3.

Fig. 3.



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6 SHEETS—SHEET 4.

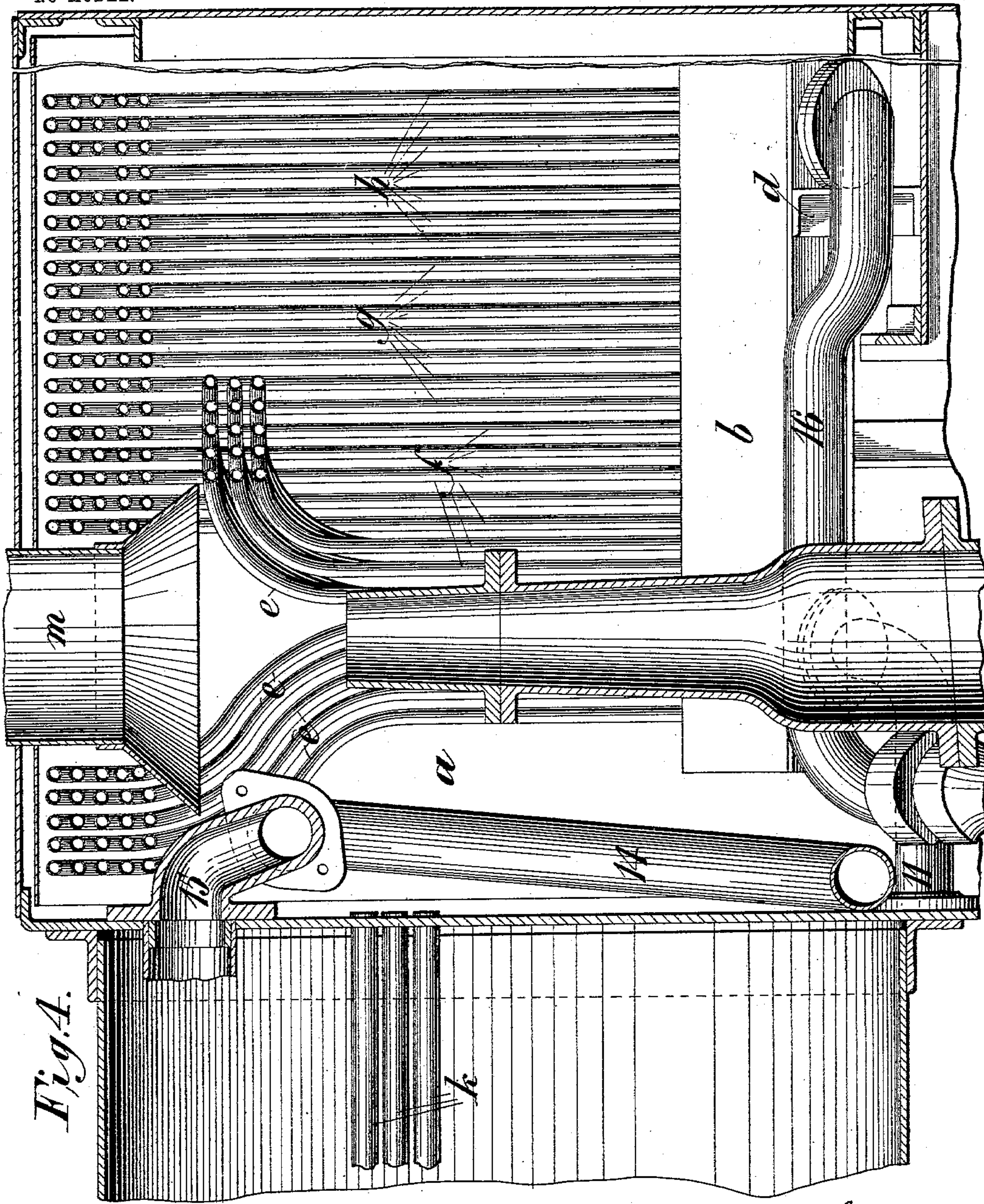


Fig. 4.

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6 SHEETS—SHEET 5.

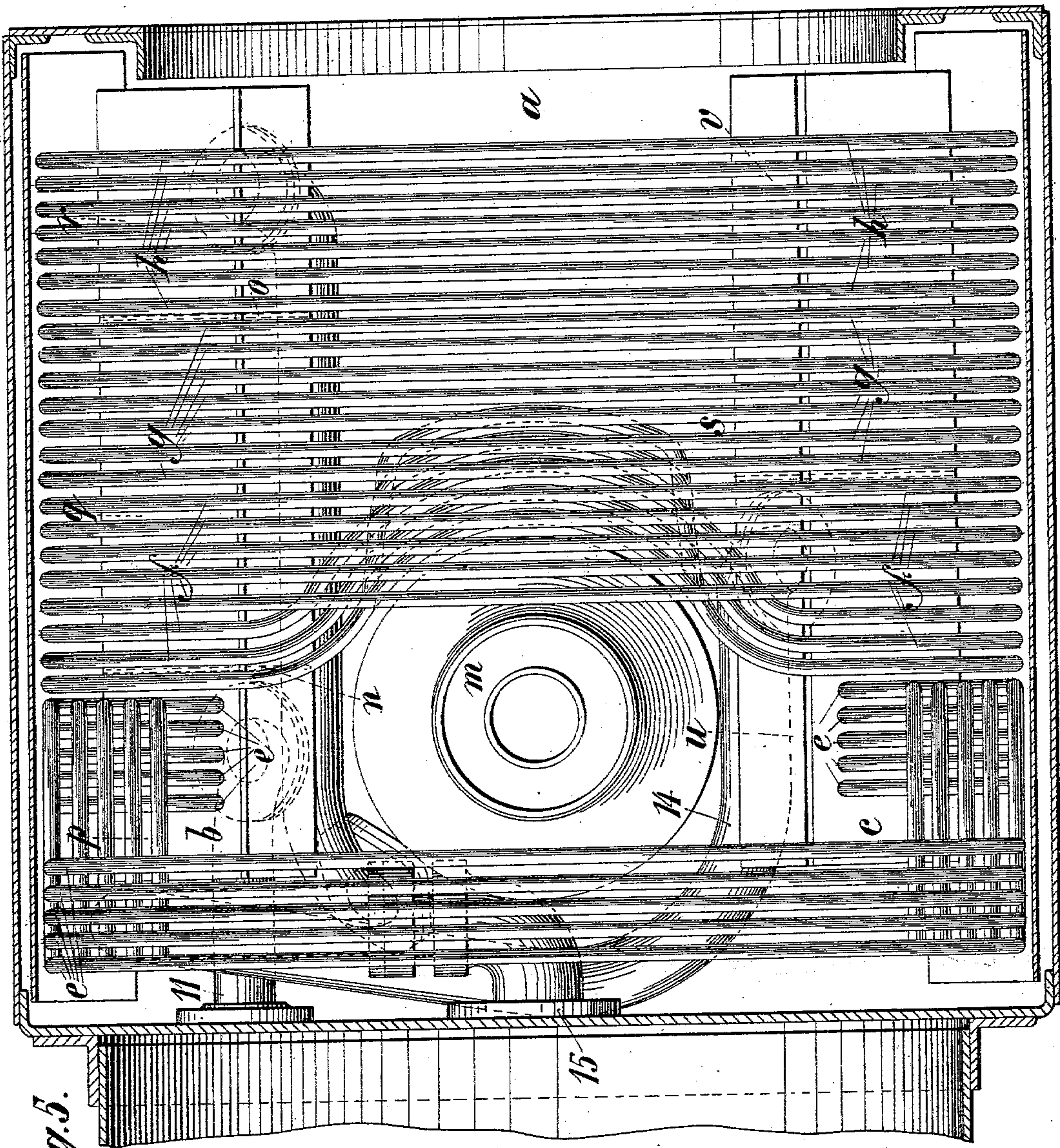


Fig. 5.

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6 SHEETS—SHEET 6.

Fig. 7.

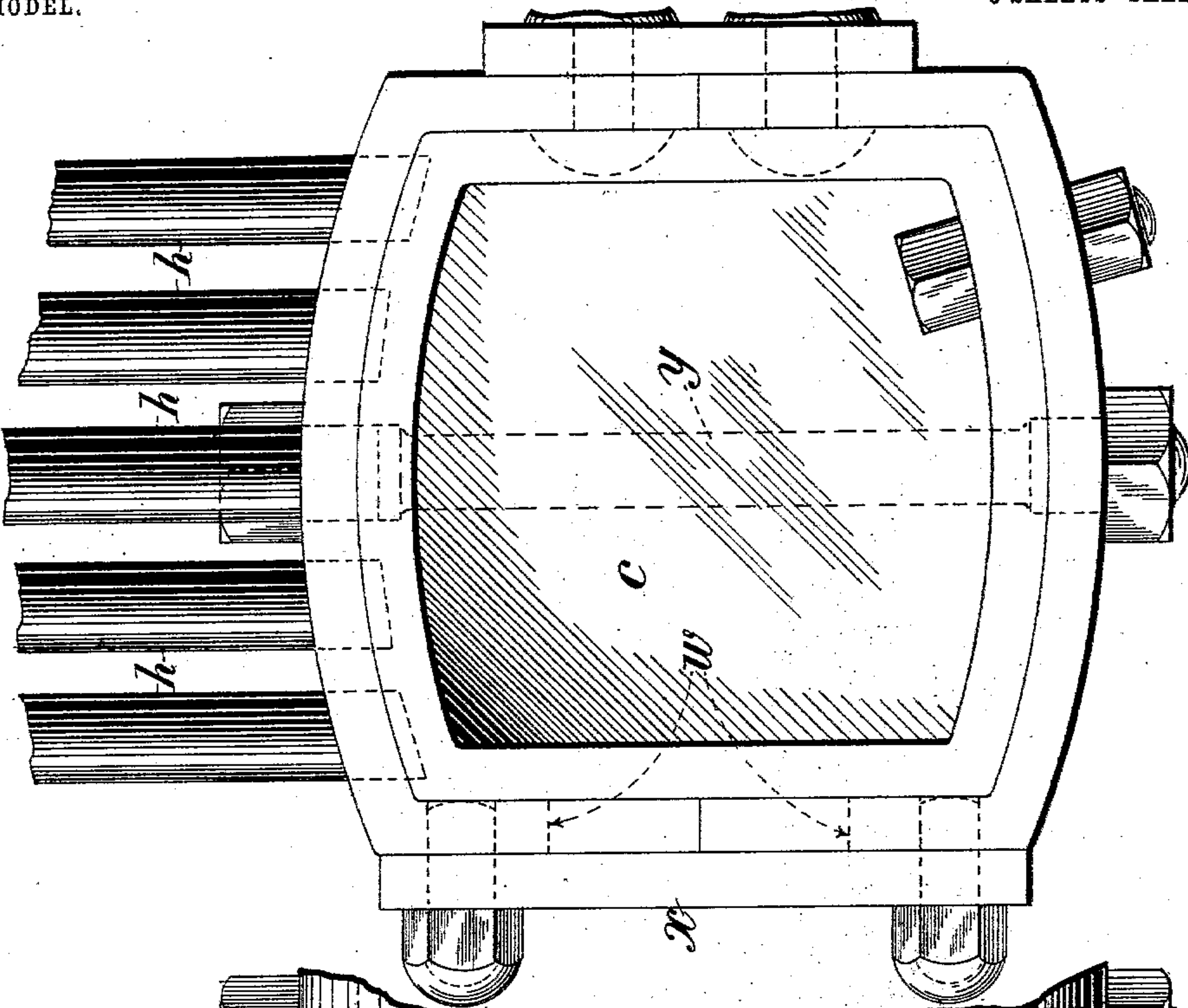
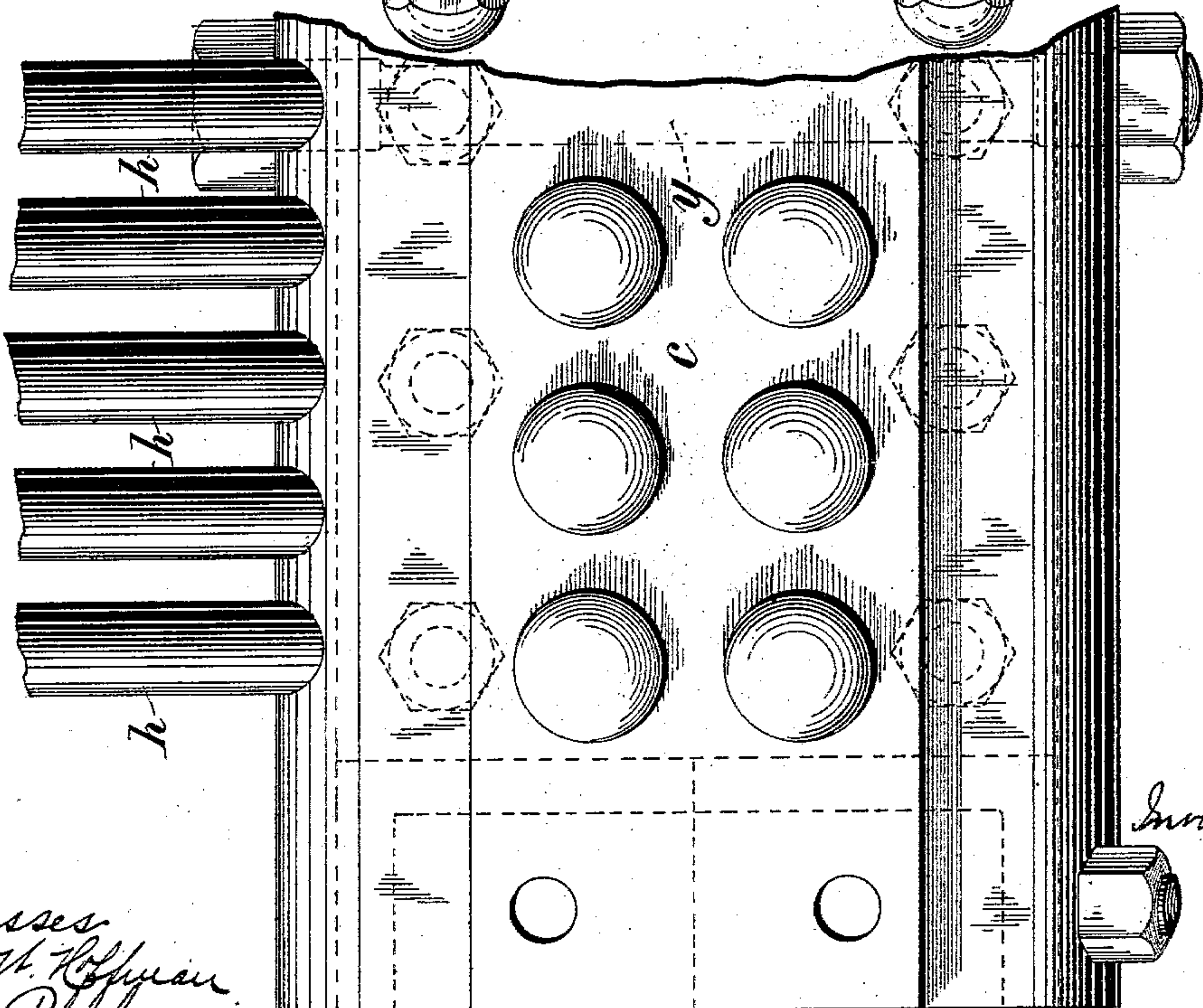


Fig. 6.



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UNITED STATES PATENT OFFICE.

EDWARD FIELD, OF LONDON, ENGLAND.

LOCOMOTIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 753,057, dated February 23, 1904.

Application filed April 23, 1903. Serial No. 154,022. (No model.)

To all whom it may concern:

Be it known that I, EDWARD FIELD, a subject of the King of Great Britain and Ireland, residing in London, England, have invented
 5 Improvements in or Relating to Locomotive-Engines, of which the following is a specification.

As is well known, fuel represents a very considerable item in the cost of working railways
 10 with locomotive steam-engines.

Now this invention has for its object to reduce the consumption of steam, and consequently of fuel, in locomotives without reducing their power, and thus to enable railways
 15 to be worked in a more economical manner than heretofore usual.

To this end the invention consists in improvements in the construction and mode of working locomotive steam-engines whereby
 20 heat from the hot gases passing from the boiler-tubes to the chimney instead of being allowed to escape as waste heat is utilized to increase the temperature and volume of a mixture of air and steam under pressure,
 25 which is then used as motive fluid to propel the locomotive. For this purpose the smoke-box of a locomotive steam-engine is provided with a heating device which is adapted to present a large heating-surface to the hot gases
 30 on their way to the chimney without interfering with the draft requisite for efficient combustion of fuel in the furnace. Also there are provided means for supplying to the said heating device air and steam (which are mixed
 35 therein) and means for conducting the heated mixture of air and steam from the heating device to the valve-chests of the engine-cylinders. Thus during working air and steam at
 40 a suitable pressure and temperature will be admitted to the heating device, the mixture will have its temperature raised and its volume considerably increased by heat from the escaping hot gases, and the mixture of air and steam so heated will be admitted at
 45 high pressure to and be utilized in the engine-cylinders.

The construction and arrangement of parts are such that the invention can be readily applied to existing locomotives, which can thus
 50 be rendered at comparatively small cost much more economical than they are at present.

In the accompanying illustrative drawings, Figure 1 shows in longitudinal section, and Fig. 2 in plan, part of a locomotive-engine constructed according to this invention, a portion
 55 of the heating device being omitted. Fig. 3 is a cross-section, Fig. 4 a longitudinal section, and Fig. 5 a horizontal section, through the smoke-box portion of the locomotive, the said figures showing the complete heating device
 60 respectively in end elevation, longitudinal section, and plan. Figs. 6 and 7 show a portion of the heating device respectively in side and end elevation to a larger scale than the remaining figures.

The heating device within the smoke-box *a* of the locomotive comprises in the example shown two longitudinal vessel *b* and *c*, carried by supports *d*, and four groups *e*, *f*, *g*, and *h* of bent metal tubes that are connected at their
 65 ends to the said vessels and are arranged to be heated by the hot gases passing from the boiler-tubes *k* to the chimney *m*. The end portions of the tubes in the group *e* are arranged in six transverse rows with five tubes
 70 in each row, the tubes in the five rows nearest the boiler extending first upward and then toward the boiler and afterward in a curved direction around and within the upper portion of the smoke-box at a part thereof to the
 75 rear of the chimney *m*. The tubes in the outermost transverse row of tubes in the group *e* and those in the two innermost transverse rows of tubes in the group *f* extend upward at the ends and are then curved in a
 80 forward and horizontal direction, so as to leave a clear opening below the bottom of the chimney *m* for the passage of hot gases thereto, the curved central portions of the tubes belonging to the three rows being arranged
 85 in three superimposed horizontal planes. The remaining tubes in group *f* and also those in groups *g* and *h* are bent in a circular direction, so as to conform approximately to the curvature of the sides and top of the smoke-
 90 box in which they are placed.

Vessel *b* is divided by transverse divisions *n* and *o* into compartments *p*, *q*, and *r*; and vessel *c* is divided by a transverse partition *s* into compartments *u* and *v*. The tubes in
 95 group *e* communicate at one end with compartment *p* and at the other end with com-
 100

partment *u*. The tubes in group *f* communicate at one end with compartment *u* and at the other end with compartment *q*. The tubes in group *g* communicate at one end with compartment *q* and at the other end with compartment *v*, and the tubes in group *h* communicate at one end with compartment *v* and at the other end with compartment *r*, so that the tubes in each group are in parallel with one another and in series with the tubes in the other groups.

Each vessel *b* and *c* is formed at its inner side with an opening *w*, that is closed by a cover-plate *x* and through which access can be gained to the tube ends for fixing and other purposes.

y represents stay-bolts for strengthening the vessels *b* and *c*.

1 represents double-acting air-pumps each having its piston reciprocated through a rod 3 from a projection 4 of the corresponding cross-head 5 of the engine. The delivery-pipes 6 and 7 of the two pumps are connected by a cross-pipe 8 and discharge into an air-supply pipe 9, that is provided with a pressure-relief valve at 10 and is connected to a pipe 11 in communication with the compartment *p* of vessel *b*. The pumps are arranged between the side frames 12 of the locomotive and the adjacent connecting-rods 13. Where this cannot be done, they may be arranged in any other convenient position and be driven from any suitable part of the engine. In some cases a single pump may be used; but the arrangement shown is preferred.

14 is a bent pipe for supplying steam from the boiler steam-pipe 15 to the compartment *q* of vessel *c*.

16 is a pipe for supplying the mixture of air and steam from compartment *r* to the valve-chests 17 of the engine-cylinders 18.

The steam-pipe 15 is controlled, as usual, by a regulator-valve, and the air-and-steam supply pipes 9 and 14, respectively, may be provided with non-return valves.

The air-pumps are adapted to compress air to a pressure slightly above that of the steam in the boiler. The heating device is made of such dimensions that the compressed air while flowing through the group *e* of tubes into which it is delivered, and which may constitute about one-fourth of the length of the heating device, will be raised in temperature to or it may be above that of the steam in the boiler, the air so heated being mixed in compartment *u* with steam supplied by pipe 14, and that the mixture of air and steam on passing through the remaining groups *f*, *g*, and *h* of tubes will be further heated—say to a temperature of about 250° to 350° centigrade, according to the initial temperature of the steam—whereby such mixture will be considerably increased in volume while maintained at an approximately uniform pressure.

When the locomotive is first started, steam

will occupy the whole of the interior of the heating device, and the engine will make its first few revolutions under the action of steam alone. As the engine continues working the steam will be gradually and partially displaced from the heating device by the air delivered to the group *e* of tubes by the air-pumps 1 at or about the same pressure as the steam, the air and steam flowing on together from the compartment *u* through the groups *f*, *g*, *h* of tubes and the compartments *q*, *v*, *r* to the pipe 16 and thence to the engine, which will then be driven by the mixture of air and steam. Air will be admitted in an intermittent manner to the heating device while the air-pumps are at work and steam will be admitted from the boiler to the heating device when the pressure in the latter falls below the normal pressure due to consumption of the mixture by the engine. Thus the supply of air and steam to the heating device is self-regulating, the supply of compressed air depending upon the working of the air-pumps and the supply of steam upon the rate of consumption of the mixture in the engine, both supplies automatically stopping when the engine and consequently the pumps are stopped and automatically recommencing when the engine is restarted.

As will be obvious, a heating device for the purpose herein described can be constructed in various forms and the tubes be arranged in various ways to obtain the object in view.

What I claim is—

1. In a locomotive steam-engine, the combination with the locomotive-boiler, the engine-cylinders, and the smoke-box, of a heating device located in said smoke-box so as to be heated by hot gases admitted thereto and formed with a plurality of passages for air and steam, means for supplying air and steam under pressure to one end portion of said heating device, and means for conducting the superheated mixture of air and steam, constituting motive fluid, from the opposite end portion of said heating device to said engine-cylinders.

2. In a locomotive steam-engine, the combination with the locomotive-boiler, the engine-cylinders, and the smoke-box, of a heating device located in said smoke-box and adapted to present a large heating-surface to hot gases flowing therethrough, means for supplying air and steam under pressure to one portion of said heating device, and means for conducting the superheated mixture of air and steam from the delivery end of said heating device to said engine-cylinders, said heating device having long tortuous heating-passages through which said air and steam are constrained to flow and become highly heated as set forth.

3. In a locomotive steam-engine, the combination with the locomotive-boiler, the engine-cylinders, and the smoke-box, of a heating device arranged within said smoke-box so as to be heated externally by hot gases and to per-

mit said hot gases to pass to the chimney at a point located to the rear of the forward end of the heating device, means for supplying air and steam under pressure to one portion of said heating device, and means for conducting the superheated mixture of air and steam from the delivery end of said heating device to said engine-cylinders.

4. In a locomotive steam-engine, the combination with the locomotive-boiler, the engine-cylinders, and the smoke-box, of a tubulous heating device located in said smoke-box and extending partly around the interior thereof, said device having an opening through its upper part to permit hot gases entering the smoke-box to pass upward to and through the chimney, means for supplying air and steam under pressure to one portion of said heating device, and means for conducting the superheated mixture of air and steam from the delivery end of said heating device to said engine-cylinders.

5. In a locomotive-engine, the combination with the locomotive-boiler, the engine-cylinders, the smoke-box, and a chimney the lower end of which extends into said smoke-box, of a heating device located in said smoke-box, adapted to present a large heating-surface to hot gases, and arranged to extend partly around the interior of said smoke-box and to surround the lower projecting end of said chimney, means for supplying air and steam under pressure to one portion of said heating device, and means for conducting the superheated mixture of air and steam from the delivery end of said heating device to said engine-cylinders.

6. In a locomotive steam-engine, the combination with the boiler, the engine-cylinders, the smoke-box, and a main steam-pipe terminating in said smoke-box, of a heating device located in said smoke-box, means for supplying air under pressure to said heating device, a steam-pipe located within said smoke-box, connected to the end of the main steam-pipe therein and arranged to supply steam under pressure to said heating device, and means for conducting the superheated mixture of air and steam, after traversing said heating device, to said engine-cylinders.

7. In a locomotive steam-engine, the combination with the main steam-pipe, the engine-cylinders, and the smoke-box, of a heating device comprising a number of tubes arranged to extend around the sides and top of said smoke-box and adapted to present a large heating-surface to hot gases flowing therethrough to the chimney, means located in said smoke-box for supplying steam from said main steam-pipe to one end portion of the heating device, means for supplying air at a pressure equal at least to that of the steam to the same end portion of said heating device, and means for supplying the heated mixture of air and steam from the other end portion

of the heating device to said engine-cylinders.

8. In a locomotive steam-engine, the combination with the main steam-pipe, the engine-cylinders, and the smoke-box, of a heating device located in said smoke-box and adapted to present a large heating-surface to hot gases flowing therethrough to the chimney, means for compressing and supplying air at a pressure about equal to that of the steam in the boiler to one end portion of the heating device, means for supplying steam from said steam-pipe to the heating device at a point thereof between its ends, and means for supplying the heated mixture of air and steam to the engine-cylinders.

9. In a locomotive steam-engine, the combination with the main steam-pipe, the engine-cylinders, and the smoke-box, of a heating device located in said smoke-box and adapted to present a large heating-surface to hot gases flowing therethrough to the chimney, an air-compressor arranged to be driven from the locomotive-engine and an air-supply pipe adapted to deliver the air from said compressor to one end of such heating device, a pressure-relief valve for said air-delivery pipe, a steam-supply pipe connecting said main steam-pipe to the heating device at a point thereof between its ends but nearer to the air-inlet end of the said device than to the opposite end thereof, and a pipe for conducting the heated mixture of air and steam to the engine-cylinders.

10. In a locomotive steam-engine, the combination with the main steam-pipe, the engine-cylinders, the engine cross-heads, and the smoke-box, of a heating device arranged in said smoke-box so as to be heated by hot gases admitted thereto, air-compressors each located between a side frame of the locomotive and the adjacent connecting-rod of the engine and adapted to be worked from the corresponding cross-head, an air-supply pipe connected to the air-delivery pipes of said pumps and to one end of said heating device, a pressure-relief valve in connection with said air-supply pipe, a steam-supply pipe connecting said main steam-pipe to said heating device at a point thereof between its ends, and a pipe connecting the other end of said heating device to the valve-chests of said engine-cylinders.

11. In a locomotive steam-engine, the combination with a main steam-pipe, the engine-cylinders, and the smoke-box, of a tubular heating device located in said smoke-box and comprising two lower longitudinal vessels divided into compartments, and groups of tubes connected at their ends to said vessels and arranged in said smoke-box so as to be acted upon by hot gases therein, said tubes being connected to the compartments of said vessels so that the tubes in each group are in parallel with each other and in series with the tubes in the other groups, means for supplying air and steam under pressure to said heat-

ing device, and means for conveying the heated mixture of air and steam to said cylinders.

12. In a locomotive steam-engine, the combination with the main steam-pipe, the engine-cylinders, and the smoke-box with chimney, of a tubular heating device located in said smoke-box and comprising groups of tubes connected together in series and some of which have their upper curved portions located to the rear of said chimney and some to the front of said chimney, means for supplying steam from said main steam-pipe to one end portion of said heating device, means for supplying air under pressure from the external atmosphere to said heating device, and means for conducting the heated mixture of air and steam to said cylinders.

13. In a locomotive steam-engine, the combination with the main steam-pipe, the engine-cylinders, and the smoke-box with chimney, of a tubular heating device located in said smoke-box and comprising two longitudinal vessels each divided into compartments by transverse divisions and a number of groups of bent tubes connected to said vessels so as to be in series with each other through the compartments in said vessels, means for supplying air and steam under pressure to one end portion of said heating device, and means for conveying the heated mixture of air and steam from the other end portion of said heating device to said engine-cylinders.

14. In a locomotive steam-engine, the combination with the main steam-pipe, the engine-cylinders, and the smoke-box with chimney, of a tubular heating device located in said smoke-box and comprising two longitudinal vessels each divided into compartments by transverse divisions and a number of groups of bent tubes connected to said vessels so as to be in series with each other through the compartments in said vessels, means for supplying compressed air to one end of said heating device, a bent pipe located in the smoke-box and connecting said main steam-supply pipe to one of said vessels so as to supply steam to the heating device at about a quarter

of its length from the air-inlet end, and a pipe connecting the last compartment of said heating device to said cylinders.

15. In a locomotive steam-engine, the combination with the main steam-pipe, the engine-cylinders, and the smoke-box with chimney, of a tubular heating device comprising groups of bent tubes located within and extending around the sides and top of said smoke-box, an air-compressor worked from said engine, an air-supply pipe connecting the delivery of said air-compressor to one end of said heating device, a pressure-relief valve located on said air-supply pipe, a bent steam-supply pipe located in said smoke-box and connecting said main steam-pipe to said heating device at a point between two of the groups of tubes thereof, and a pipe connecting the outlet end of said heating device to said engine-cylinders.

16. In a locomotive steam-engine, the combination with a main steam-pipe, the engine-cylinders, and a smoke-box, of a tubular heating device located in said smoke-box and comprising a pair of longitudinal vessels divided into compartments, and groups of bent tubes connected to said vessels and extending around the sides and top of said smoke-box, air-compressors having their air-delivery pipes connected together and each located between one of the side frames of the engine and the adjacent engine connecting-rod, a compressed-air-supply pipe connected to the air-delivery pipes of said compressors and to one end of said heating device, a pressure-relief valve in communication with said air-supply pipe, a steam-supply pipe connecting said main steam-pipe to said heating device at a point between the ends thereof, and a pipe connecting the outlet end of said heating device to said engine-cylinders.

Signed at 75-77 Cornhill, London, England, this 31st day of March, 1903.

EDWARD FIELD.

Witnesses:

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