976,522.

G. L. WALL & V. J. SHEPARD.

STEAM STORAGE LOCOMOTIVE.

APPLICATION FILED NOV. 18, 1909.

Patented Nov. 22, 1910.

5 SHEETS—SHEET 1.

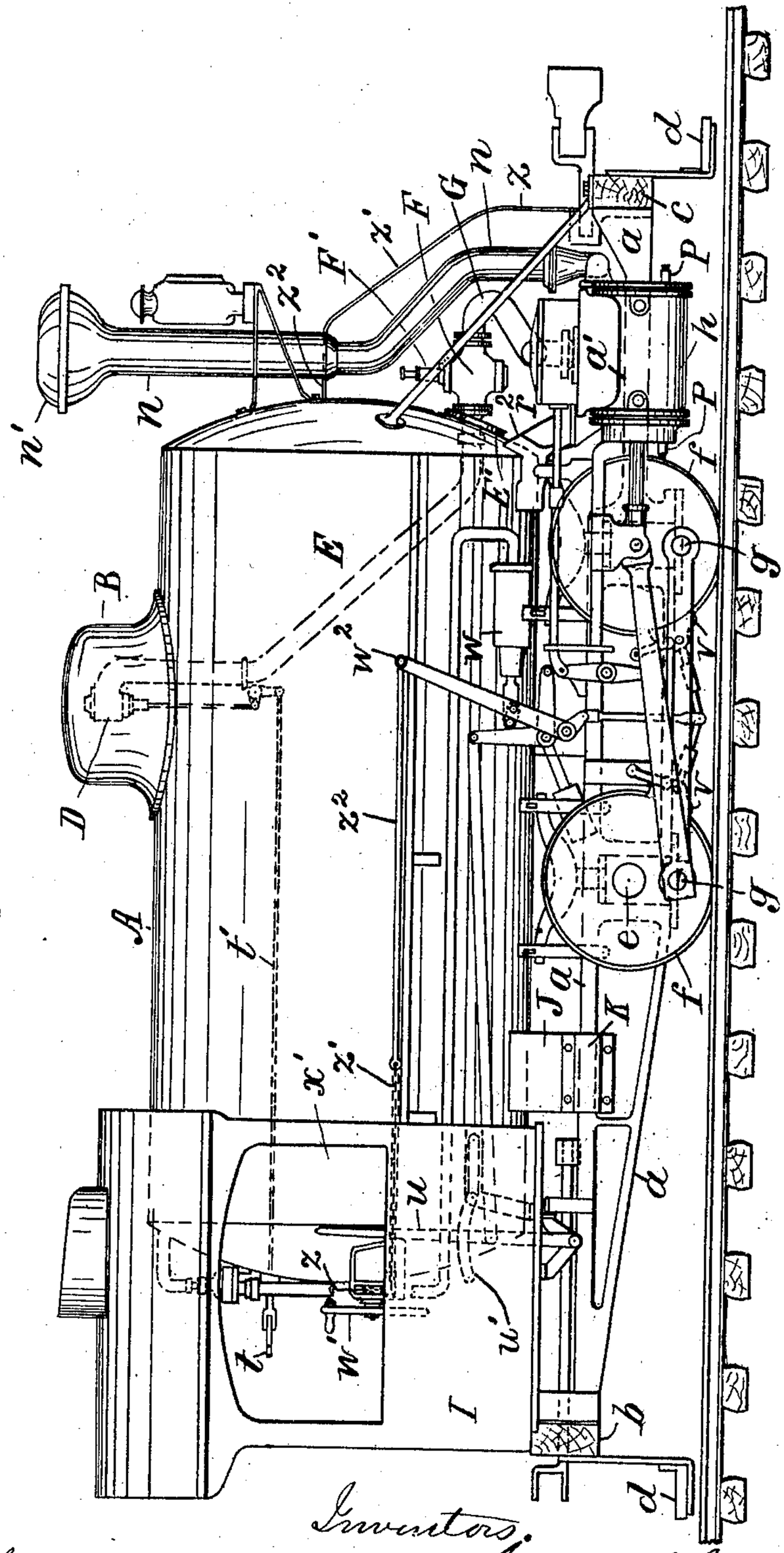



Fig. 1.

Witnesses.
L. Lee.
J. Walter Greenbaum.

Inventors.
George L. Wall,
Victor J. Shepard,
per Thomas S. Crane, Atty.

G. L. WALL & V. J. SHEPARD.

STEAM STORAGE LOCOMOTIVE.

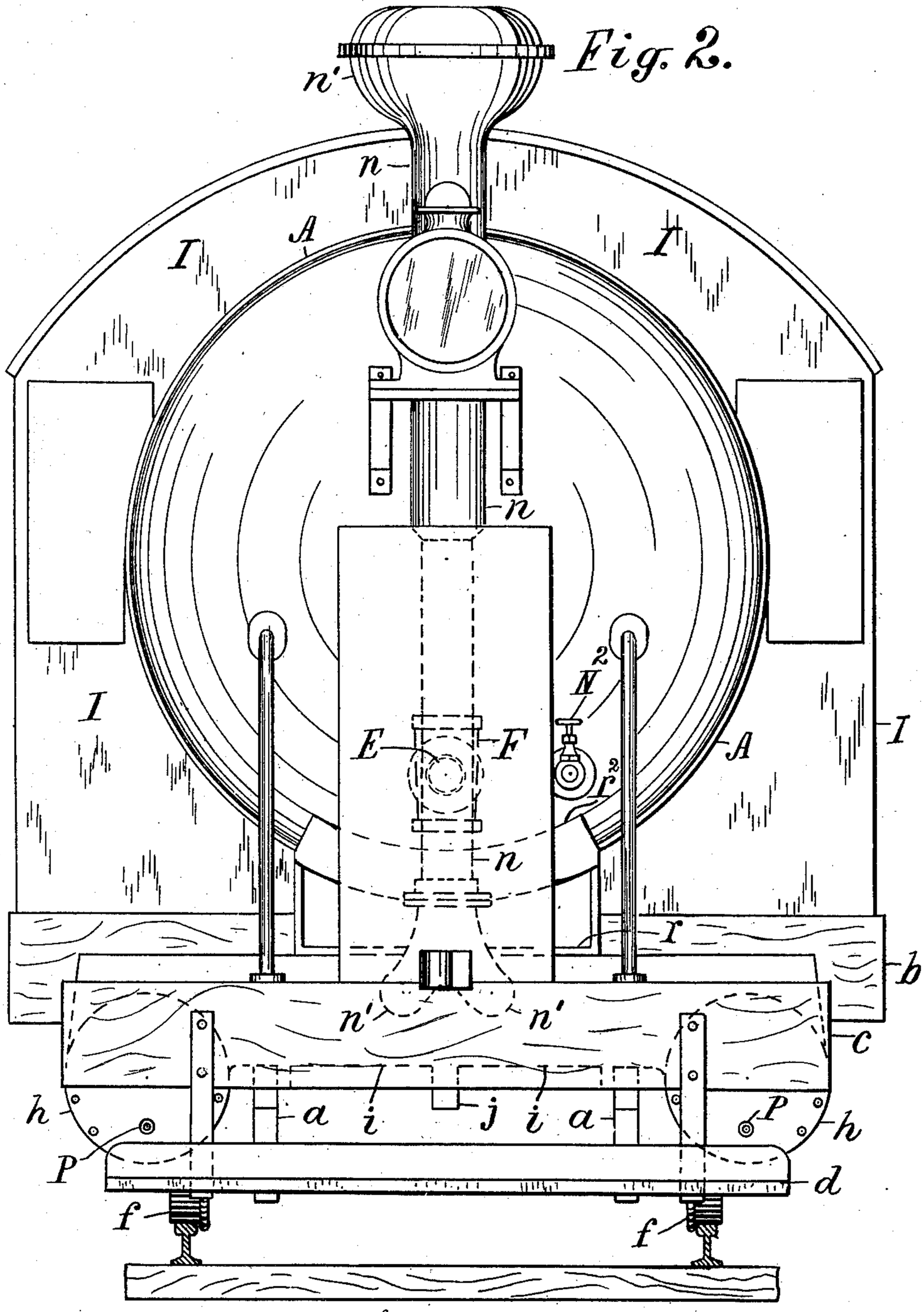
APPLICATION FILED NOV. 18, 1909.

976,522.

Patented Nov. 22, 1910.

5 SHEETS—SHEET 2.

*Fig. 2.*




Witnesses:
L. Lee.
J. Walter Greenbaum.

Inventors. George L. Wall,
Victor J. Shepard, by
Thomas S. Crane, Atty.

G. L. WALL & V. J. SHEPARD.

STEAM STORAGE LOCOMOTIVE.

APPLICATION FILED NOV. 18, 1909.

976,522.

Patented Nov. 22, 1910.

5 SHEETS—SHEET 3.

Fig. 5.

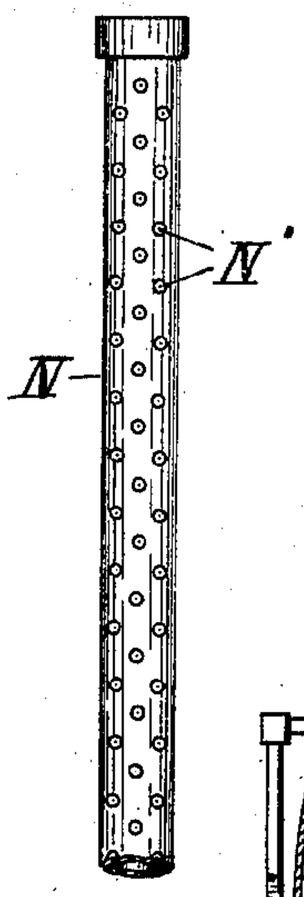



Fig. 3.

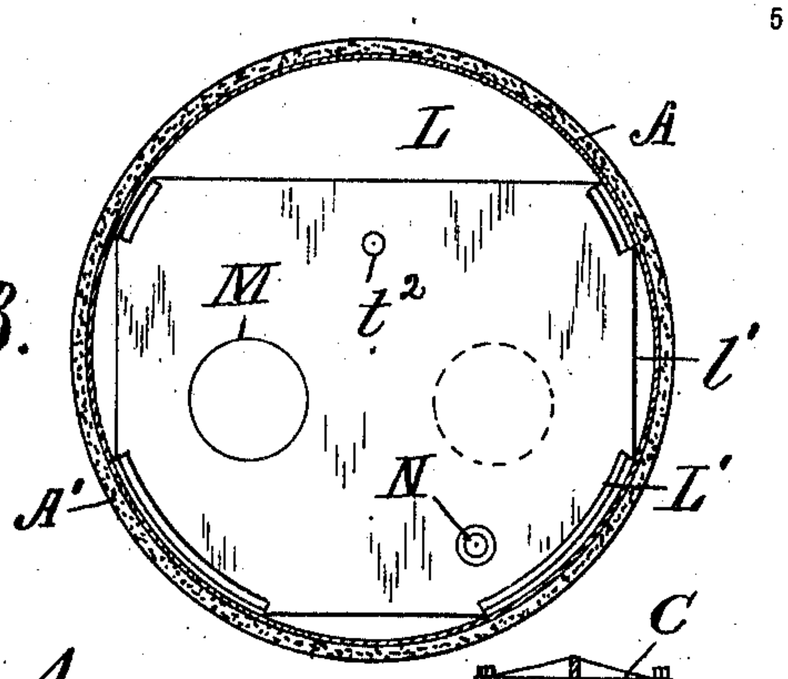
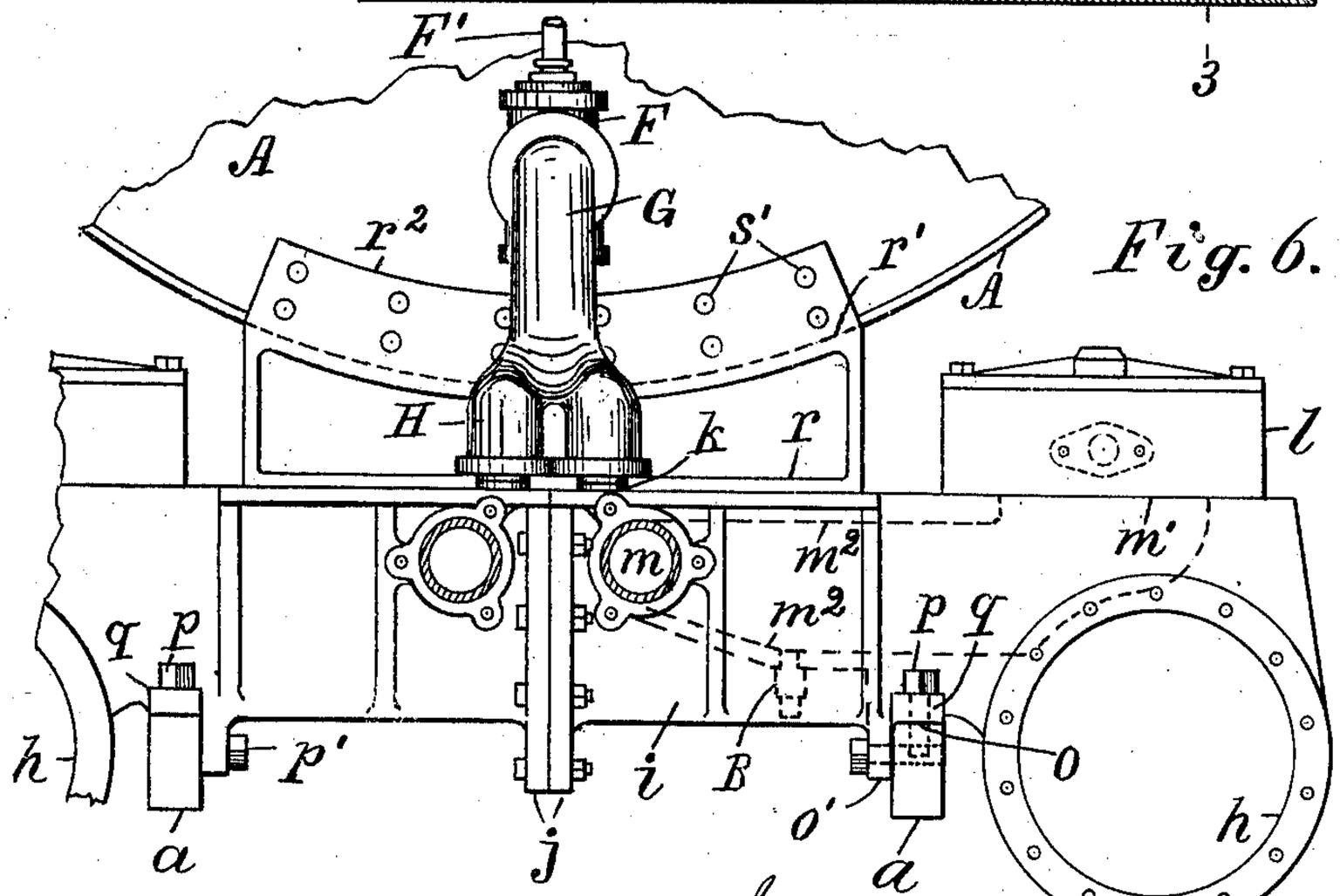



Fig. 4.




Fig. 6.




Witnesses:
L. Lee.
J. Walter Steinbrenner.

Inventors.
George L. Wall,
Victor J. Shepard, per
Thomas S. Crane, Atty.

G. L. WALL & V. J. SHEPARD.

STEAM STORAGE LOCOMOTIVE.

APPLICATION FILED NOV. 18, 1909.

976,522.

Patented Nov. 22, 1910.

5 SHEETS—SHEET 4.

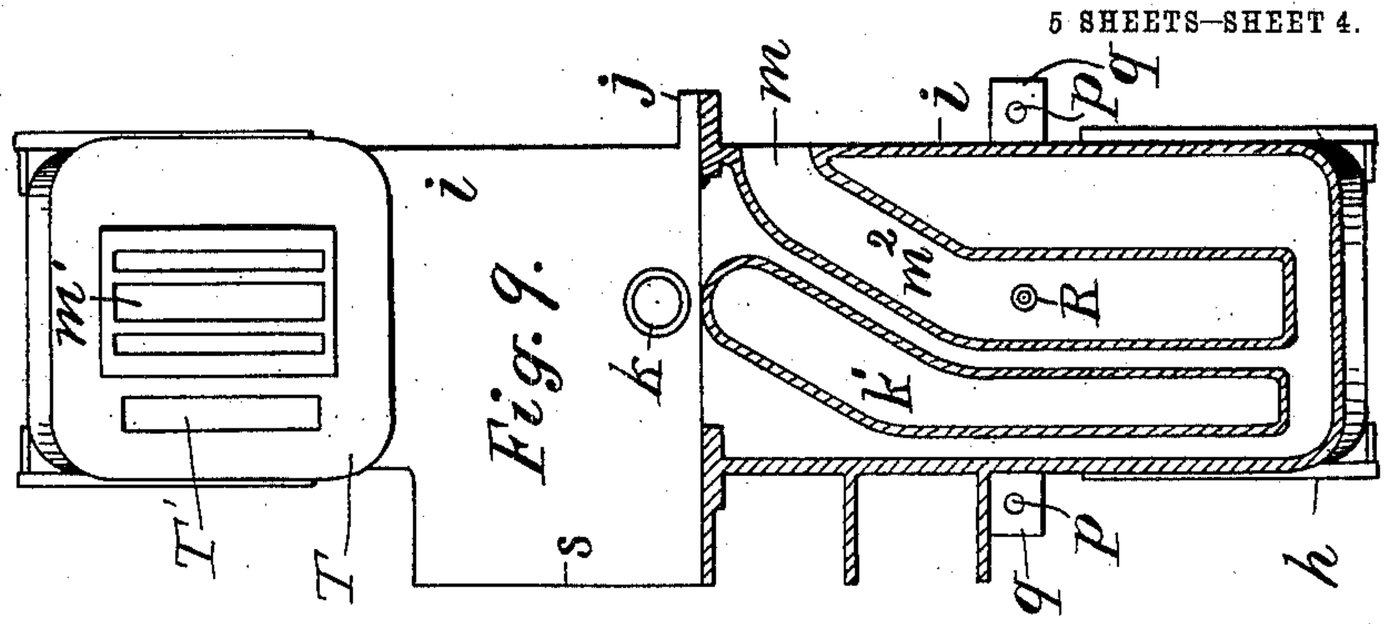



Fig. 9.

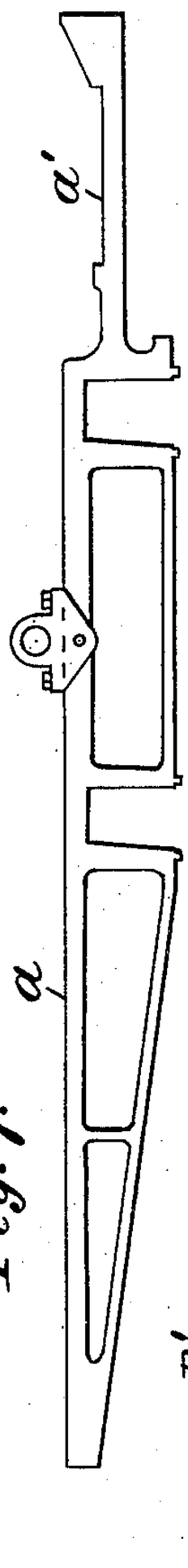



Fig. 7.

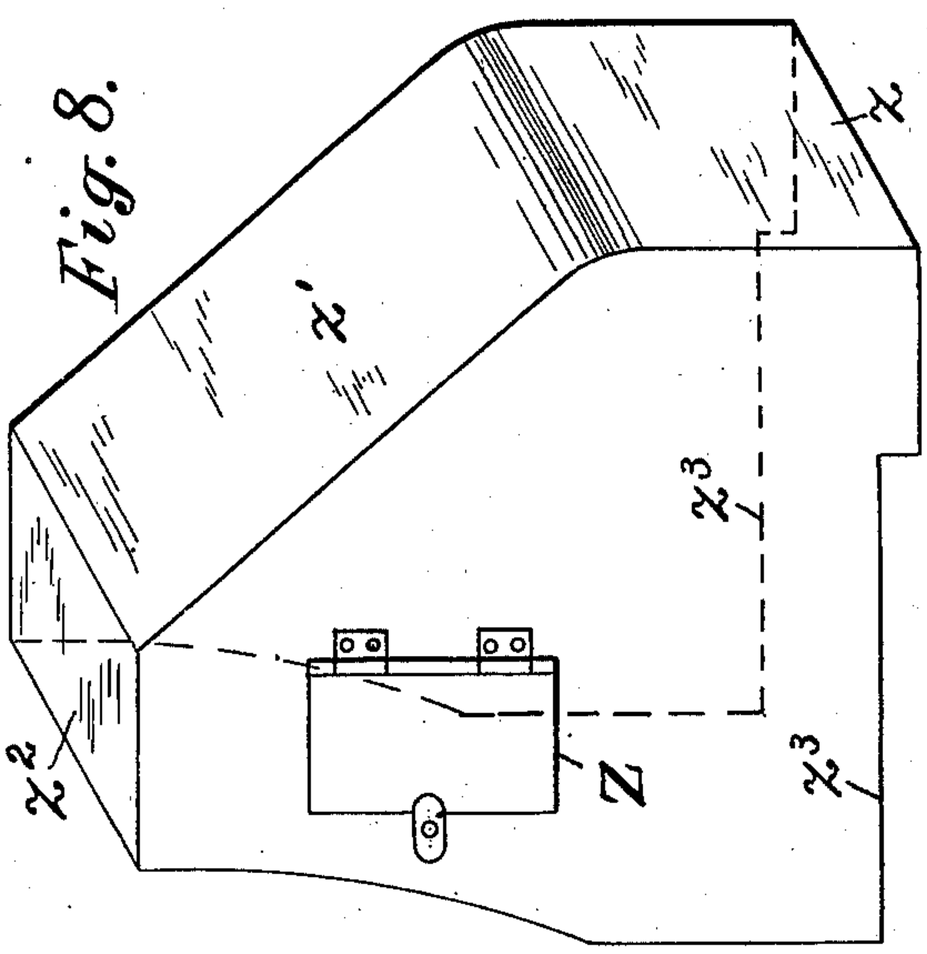



Fig. 8.

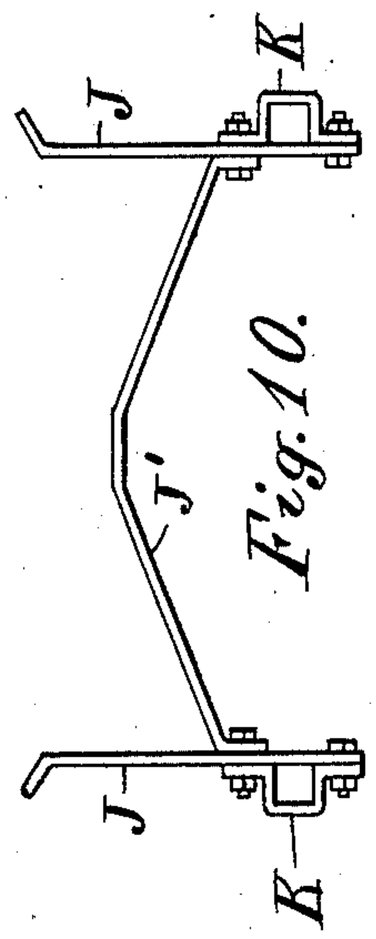



Fig. 10.

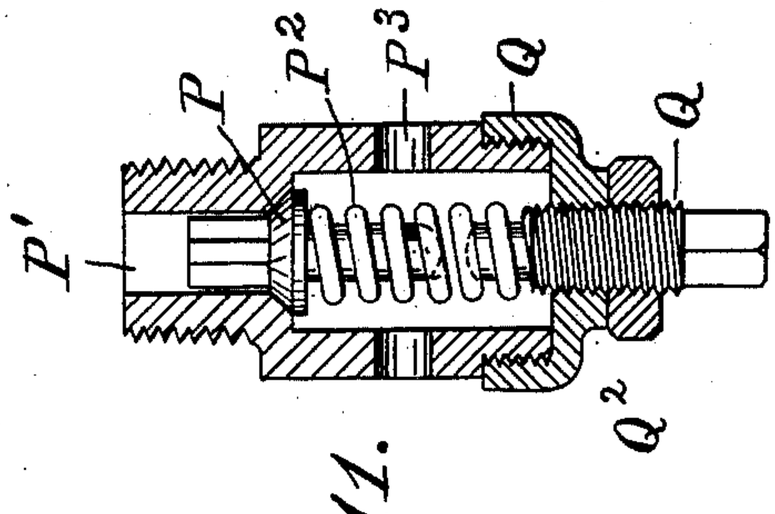



Fig. 11.

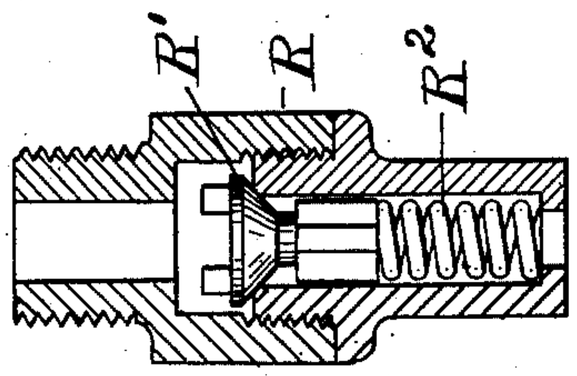



Fig. 12.

Witnesses:
L. Lee.
J. Walter Dienbaum

Inventors.
George L. Wall,
Victor J. Shepard, by
Thomas S. Crane, atty.

G. L. WALL & V. J. SHEPARD.

STEAM STORAGE LOCOMOTIVE.

APPLICATION FILED NOV. 18, 1909.

976,522.

Patented Nov. 22, 1910.

5 SHEETS—SHEET 5.

*Fig. 13.*

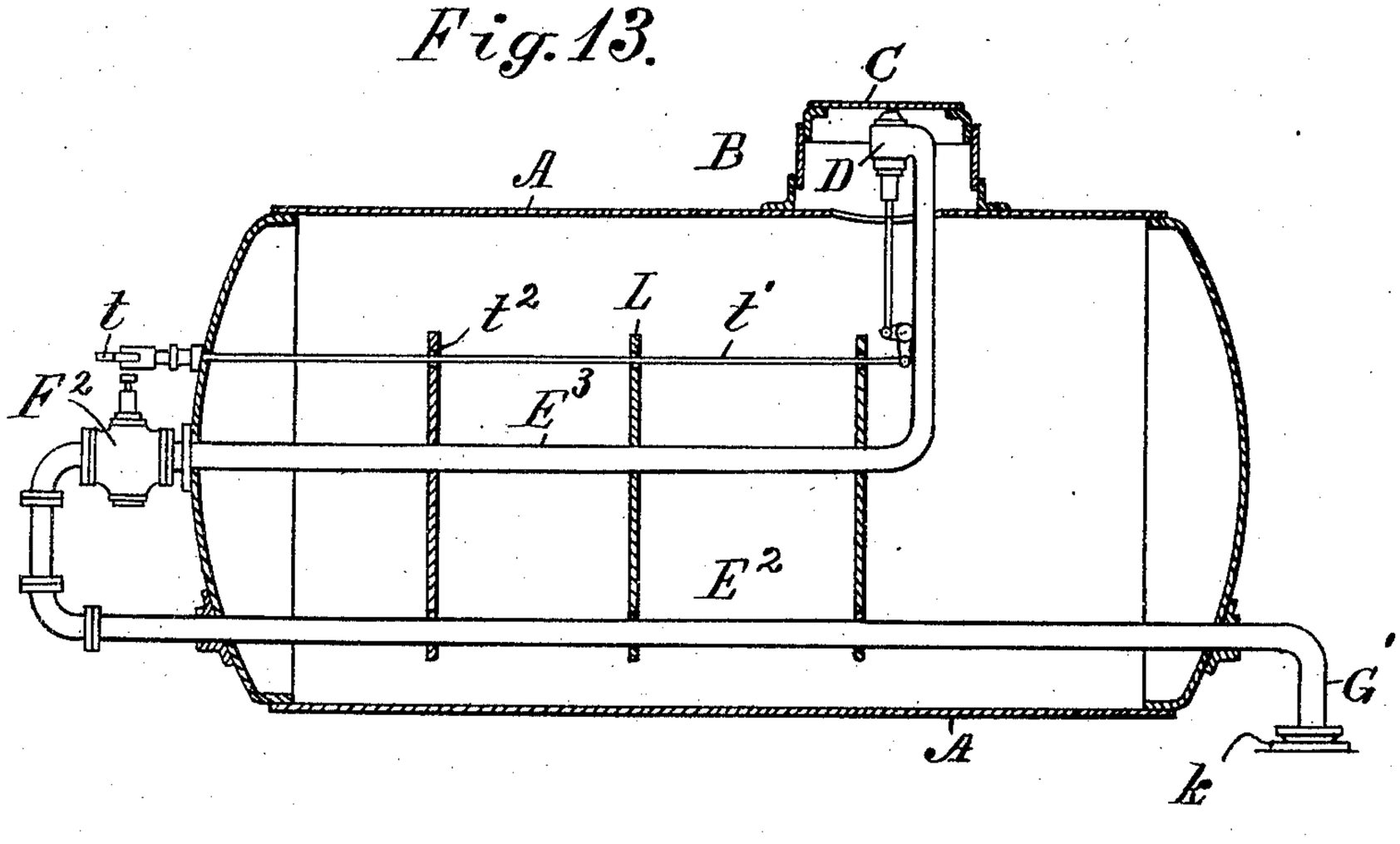



*Fig. 14.*

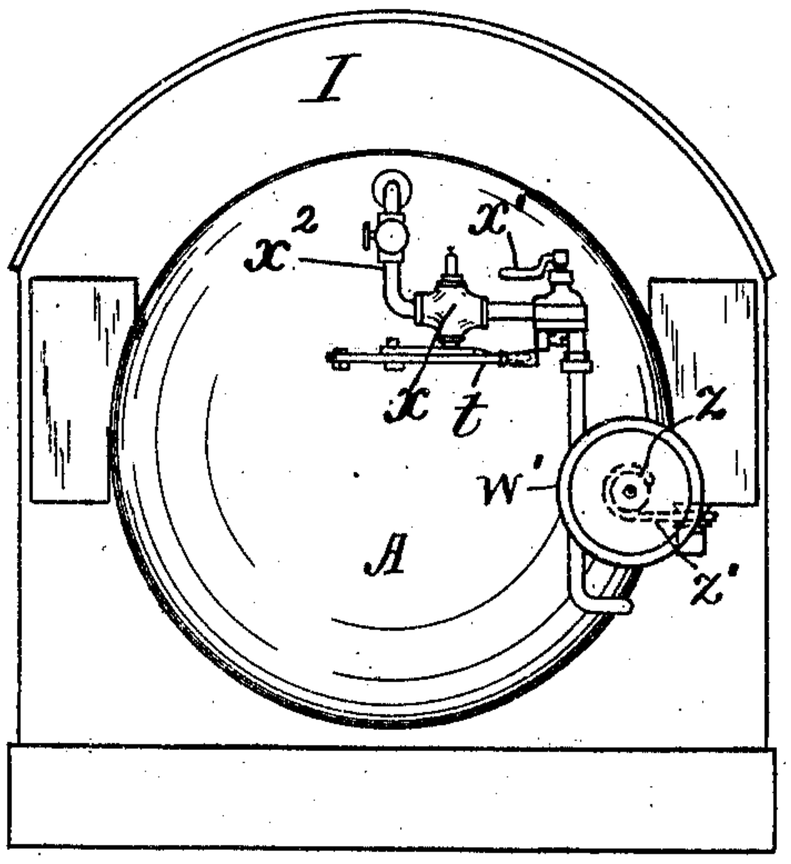
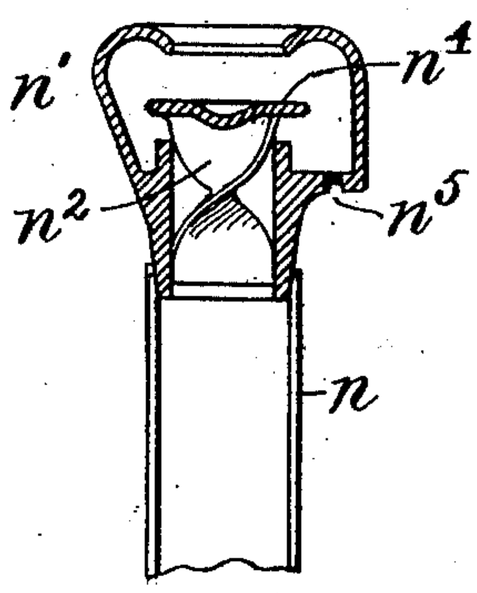



*Fig. 15.*




Witnesses:
L. Lee.
J. Walter Greenbaum.

Inventors:
George L. Wall,
Victor W. Shepard, by
Thomas L. Crane, atty.

# UNITED STATES PATENT OFFICE.

GEORGE L. WALL AND VICTOR JAMES SHEPARD, OF LIMA, OHIO, ASSIGNORS TO LIMA LOCOMOTIVE AND MACHINE COMPANY, OF LIMA, OHIO, A CORPORATION OF OHIO.

## STEAM-STORAGE LOCOMOTIVE.

976,522. Specification of Letters Patent. **Patented Nov. 22, 1910.**

Application filed November 18, 1909. Serial No. 528,649.

*To all whom it may concern:*

Be it known that we, GEORGE L. WALL, residing at 1103 West High street, Lima, county of Allen, and State of Ohio, and VICTOR J. SHEPARD, residing at 119 South Baxter street, Lima, county of Allen, and State of Ohio, both citizens of the United States, have invented certain new and useful Improvements in Steam-Storage Locomotives, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to that class of locomotive which is operated without fire or heat-generating appliances, by providing a steam-tank of sufficient capacity to hold water and steam at a relatively high pressure and temperature, which steam is utilized for a certain period of time for supplying the engine-cylinders. In such steam storage locomotives the steam-tank is charged for a period of operation by filling it with water to a suitable level and then injecting steam into the tank, preferably in contact with the water, so as to condense the steam and heat the water to a relatively high temperature and store up the necessary energy to operate the locomotive for a period of time by delivering the steam at a reduced pressure to the cylinders. The steam-tank upon the locomotive is, of course, supplied with steam at a suitable station where the steam is generated and delivered to the tank through a hose or pipe connection.

The invention relates to various details of construction which are described and claimed herein and which produce an efficient and economical apparatus.

The invention will be understood by reference to the annexed drawing, in which—

Figure 1 is a side elevation of the locomotive; Fig. 2 is a front elevation of the same upon a larger scale; Fig. 3 is a cross section of the steam-tank upon line 3—3 in Fig. 4, which is a longitudinal section of the tank at the middle line; Fig. 5 shows the under side of part of the steam injection pipe; Fig. 6 is a front elevation of the steam-cylinders and their steam-connections to the steam-tank; Fig. 7 is an elevation of one of the side-frames; Fig. 8 is a perspective view of the hood for covering the steam-connections; Fig. 9 is a plan of the two engine-cylinders and their connecting-arms, the top-plate of one being cut away; Fig. 10 is an elevation of the expansion-saddle; Fig. 11 is a sectional view of the relief-valve; Fig. 12 is a sectional view of the automatic drip-valve; Fig. 13 is a section of the tank showing an alternative arrangement for the cylinder-pipe; Fig. 14 shows the end of the tank inside of the cab; and Fig. 15 is a vertical section of the exhaust-head.

*a* designates the side-frames, connected at the rear ends by beam *b* and at the front ends by beam *c*, both of which carry footboards *d*. The frame is formed to receive boxes for two axles *e* carrying driving-wheels *f* provided with crank-pins *g* and *g'*.

*The steam-tank.*—The steam-tank A is of cylindrical form and is supported at the forward end upon the extension members or arms *i* which form a joint connecting the cylinders together at the middle line of the locomotive. These arms rest upon the frame *a* and their junction is made by flanges *j* and suitable bolts. The tops of the cylinder-arms *i* are made level or flat and bracket-seats *s* are extended from the rear sides of the same forming, when the arms are bolted together, an extended flat seat upon which a bracket-block is bolted, such bracket-block having a foot *r* secured to the seats *s*, a curved seat *r'* upon which the front corner of the steam-tank A rests, and a flange $r^2$ fitted to the front end of the steam-tank and secured rigidly thereto by rivets *s'*. The foot of the bracket thus covers the joint of the two cylinder-arms and greatly strengthens them when secured thereto. The top of each cylinder is furnished with a steam-chest seat T having the usual exhaust-port *m'* with steam-ports at the sides thereof, and a steam-chest port T' connected by a passage *k'* with a steam-inlet orifice *k* upon the upper side of the arm adjacent to the central joint of the arms, as shown in Fig. 9.

By the extension of the bracket-block over the joint of the cylinder-arms and its rigid connection therewith, the tank is connected directly at its forward end to the cylinder-arms, and as the cylinder steam-pipe is extended from the front end of the tank to the steam-inlets *k*, the construction greatly promotes the durability of the joints between the steam-pipe and the cylinders. The rear end of the tank is supported loosely upon the frames so as to permit it to expand and contract freely as the tank is heated and

cooled. This rear support consists of an expansion-saddle having arms J and braces J′ secured to the tank, and boxes K at its opposite ends embracing loosely the top bars of the frames A so as to play freely thereon. The tank is formed, as shown in Fig. 4 with a dome B which is used both as a receptacle for the throttle-valve and as a means of entrance to the tank, as it has an opening in the top provided with a removable cover C through which access may be obtained to the tank, thus avoiding the expense of providing an additional manhole and cover. The dome B is set adjacent to forward end of the tank, and a throttle-valve D is supported within the same, and a cylinder steam-pipe E is shown in Fig. 1 inclined downwardly and forwardly from the same to the head of the tank, where it passes through a flange E′ to a reducing-valve F which is set close to the head of the tank where the tank is supported by the tank-bracket *s*.

A pipe G extends downward from the reducing-valve and is formed with branches H connected to the steam-inlets *k* upon the cylinder-arms. The front end of the tank is set adjacent to the rear ends of the steam-cylinders and the steam-pipe G thus requires to be recurved backwardly under a part of the reducing-valve, in order to reach the steam-inlets, which are formed upon the cylinder-arms *i* about the middle of their width. The steam-exhaust-pipe *n* is sloped to the front of the tank about the middle of its height, and then extends straight upwardly above the top of the tank. The exhaust-stack *n* has an exhaust-head $n^2$ in which a centrifugal water-extractor is inserted, consisting of the spiral partition $n^3$ having the cap $n^4$ upon the top to deflect the exhaust-steam radially into the annular chamber $n^5$ from which any water escapes by drip-outlet $n^6$.

The tank is provided with a series of transverse swash-plates L to prevent the sudden surging of the water toward either end of the tank, upon grades. The plates are fitted to the sides of the tank, but formed at the sides and bottom with straight edges *l′* forming passages next the shell of the tank for the movement of the water, and the intermediate edges of the plates are attached to the inner walls of the tank by angle-irons L′.

Each swash-plate is shown extended nearly to the top of the tank, and is provided midway of its height at one side of the center with a large aperture M for the passage of fluid, the apertures being alternated in their positions in the successive plates so as to prevent the fluid from rushing through these apertures simultaneously.

The forward end of the series of swash-plates is located beneath the dome at a suitable point to clear the cylinder-pipe E. A steam charging-pipe N is inserted through one head of the tank near the bottom and extended through the several swash-plates, and provided upon its under side as shown in Fig. 5 with numerous jet-holes N′, from which steam can be discharged into the water in the tank. The inlet of this tank is provided with a cock $N^2$ to which, in practice, the steam hose is connected for charging the tank. The rear end of the tank is inclosed by a cap I, and the throttle-lever *t* is hinged upon the rear end of the tank and connected to the throttle D by the usual rod *t′* which passes through holes $t^2$ in the swash-plates. The reverse-lever *u* and its segment *u′* are also shown in dotted lines in the cab for operating the links in the usual manner. See Fig. 1.

*The engines.*—The cylinders *h* are formed with the arms *i* connected at the middle line of the locomotive by flanges *j* and suitable bolts. The arms are provided on top with the steam-inlets *k* extending into the passage *k′* in the arm to supply the steam-chests *l* with steam, and upon their forward sides the arms are provided with exhaust-outlets *m;* and an exhaust-stack *n* is extended upward therefrom being connected by branches *n′* to the exhaust-outlets *m*, as shown in Fig. 2. These outlets connect with the exhaust-ports *m′* by passage $m^2$, which lies below the level of the exhaust-outlet and exhaust-ports, and the condensed water drained therefrom in the manner hereinafter described.

Each of the cylinder-arms is provided upon (see Fig. 6) its under side adjacent to the cylinder-body with a seat *o*, and the top of each frame is provided with a deep depression having a seat *a′* to fit the seat *o*, as shown in Figs. 1 and 7.

A flange *o′* is extended beneath the cylinder-arm adjacent to the inner side of the frame and secured thereto by bolts *p′*, and lugs *q* are extended from the sides of the cylinder-arms at the ends of the seat *o* and secured to the top of the frame by bolts *p*. (See Fig. 6). The tank contains steam at much higher pressure than the engines are constructed to use, and in order to avoid breaking the cylinders if such pressure reaches them, by any failure of the reducing-valve, I provide relief-valves P upon both ends of each cylinder as shown in Figs. 1, 2, and 9. Any suitable relief-valve may be used. The valve-box or casing of the relief-valve shown in Fig. 11, has a threaded shank to screw into the head of the cylinder close to the cylinder-wall, and an outlet passage P′ which is kept normally closed by the valve P, which opens outwardly and is pressed toward its seat by a spring $P^2$. The valve-box has a cap Q screwed thereon with an adjusting screw Q′ fitted through

the same to regulate the pressure of the spring $P^2$, the screw having a lock-nut $Q^2$ to secure it when adjusted.

The valve-box has outlets $P^3$ for the escape of fluid when the valve opens. The valve is set by adjusting the screw Q′ to permit the discharge of water at any pressure above the working pressure of the cylinder.

To discharge the water which condenses from the exhaust-steam, the lowest part of the passage $m^2$ is provided with an automatic drip-valve shown in Figs. 6 and 12, the valve-box R having a threaded shank for inserting it through the bottom of the arm $i$ into the passage $m^2$.

The valve R′ opens inwardly and is held normally open by a weak spring $R^2$ adjusted to yield and permit the valve to close under the pressure of the exhaust steam, so as to prevent any escape of the same through this valve; but the spring operating, when the engines are not in action, to open the valve and permit any water of condensation to escape from the exhaust-passage $m^2$. When the engines are in operation the water is blown out by the exhaust-steam, but this valve operates to discharge any water which drips or accumulates in the exhaust-passage when the engines are stopped.

The reducing-valve F is provided with a steam-gage F′ to indicate the pressure of the steam delivered to the cylinders.

A hood is provided upon the front of a locomotive to inclose the reducing-valve and the pipes which convey the live-steam so as to protect them from radiation, the hood having a portion $z$ extended upward from the front beam $c$, a portion $z'$ sloped backwardly therefrom and a level portion $z^2$ at the top which contacts with the front end of the tank about the middle of its height. The exhaust-stack passes through the hood-portion $z^2$ and slopes backwardly inside of the sloping-portion $z'$. The hood has side-plates $z^3$, one of which is provided with a door Z, which can be opened to inspect the steam-gage F′.

*The brakes.*—Means is provided for actuating the brakes $v$ upon the drivers $f$ either by hand or by steam, the connections from the steam brake-cylinder $w$ and from the hand-wheel $w'$ being made to the same lever $w^2$, which is connected with the brake-toggle in the usual manner.

In order that the brakes may be operated by steam when the throttle is closed and not be dependent for steam upon the reducing-valve F, it is necessary to provide a separate reducing-valve $x$ for supplying steam under reduced pressure directly to the steam brake-cylinder $w$ when the throttle D is closed. (See Fig. 14.)

A lever $x'$ is shown in the cab for admitting steam to the steam brake-cylinder from a special steam-pipe $x^2$, and the piston-rod from such cylinder is connected to the brake-lever $w^2$ by the link $y$, so that when the lever $x'$ is actuated the brakes $v$ are put in operation.

The hand-wheel $w'$ is provided with a chain-sheave $z$ from which a chain $z'$ is connected by a rod $z^2$ to the upper end of the brake-lever $w^2$, so that the brakes may be operated by hand when desired.

The tank is protected by a lagging or any non-conducting coating, as indicated at A′ in Fig. 3.

*Operation of the locomotive.*—To charge the locomotive, it is placed near to a steam charging boiler and is supplied with water to a suitable level, as may be indicated by gage-cocks or the glass-gage $y'$ in Fig. 4, where the primary water-line is indicated by the dotted line $y^2$ in that figure. Live steam is then admitted to the perforated pipe N and the supply of steam continued until the water in the boiler is heated and the space above the same filled with steam at the desired pressure, say 150 pounds or more.

The condensation of steam materially raises the water level during such charging operation. The reducing-valve F is set to furnish steam at a suitable reduced pressure, as 65 pounds per square inch, to the cylinders, which are made larger than those in a locomotive using high-pressure steam, so as to secure the desired power. When the cylinders are supplied with steam at such regulated pressure, the relief-valves P are adjusted by means of the screw Q′ to remain closed until such pressure is exceeded. The locomotive is then ready for operation, and the cylinders are safely supplied with steam at the regulated pressure, and then operated until the pressure in the tank falls to an ineffective point.

We have claimed herein the provision of a reducing-valve upon the high-pressure steam-pipe when extended outside of the tank, and a cylinder-pipe connecting such reducing-valve to the inlets of the engine-cylinders; and it is immaterial whether the pipe which conveys the high-pressure steam from the throttle-valve to the reducing-valve be extended through the front or rear head of the storage-tank. Fig. 1 shows it extended through the front head where the cylinder-pipes can branch directly from the reducing-valve to the cylinder-inlets; but an alternative construction can be employed as shown in Fig. 13, which serves to reheat the steam after its pressure is reduced.

In Fig. 13, the high-pressure steam-pipe is marked $E^3$ and is extended through the rear head of the storage-tank, and a reducing-valve $F^2$ is fitted thereto close to the rear head.

A cylinder-pipe $E^2$ is connected with the reducing-valve and extended through both heads and through the entire length of the

tank, being provided with branches G′ at its forward end to connect with the steam-inlets K.

It is understood that the temperature of the steam falls as the pressure is reduced by the reducing-valve, and the extension of the cylinder-pipe $E^2$ through the tank operates to reheat the steam in some measure before it is delivered to the cylinders.

It will be understood that the exhaust-stack discharges no smoke but only steam, and that the water-extractor is useful to separate any water of condensation from the steam so that it may be discharged separately from the stack. A pipe may be connected with the drip-outlet $n^5$, to discharge the water at any suitable point.

Having thus set forth the nature of the invention what is claimed herein is:

1. In a steam-storage locomotive, the combination, with the side-frames and wheels supporting the same and the steam-storage tank carried thereby, of engine-cylinders having arms connected together and fitted upon the under side to the tops of the frames, the arms having a flat top and formed each with the saddle-bracket *s* projected horizontally from the rear edge of the arm and a saddle block secured upon the said arms and saddle-brackets across the joint of the arms to reinforce their connection and the tank secured rigidly to such saddle.

2. In a steam-storage locomotive, the combination, with side-frames and a plurality of axles with driving-wheels supporting the same, of engine-cylinders having arms connected together and provided upon their under sides with seats fitted to the upper sides of the frames near their forward ends, lugs upon the arms at the ends of such seats with bolt through the same into the frames, the arms having a flat finished seat upon the top, a tank-bracket secured rigidly upon the said seat across the joint of the arms thus reinforcing their connection, a steam-tank connected rigidly at its forward end to the tank-bracket, and a saddle supporting the tank upon the frames near the rear end of the tank.

3. In a steam-storage locomotive, the combination, with the side-frames and wheels supporting the same, of engine-cylinders having the arms *i* connected together and fitted upon the under side to the tops of the frames, each arm having upon the top a steam-inlet for one of the cylinders, the storage-tank mounted upon the frame; and having upon the top a steam dome with the throttle-valve supported therein, a high-pressure pipe extended from the throttle to the exterior of the tank, a reducing-valve upon such cylinder-pipe outside of the tank, and branches extended from the reducing-valve to the steam-inlets of the two cylinders.

4. In a steam-storage locomotive, the combination, with the side-frames and wheels supporting the same, of engine-cylinders having the arms *i* connected together and fitted upon the under side to the tops of the frames, each arm having upon the edge an exhaust outlet F with an exhaust-stack extended upward therefrom, and an exhaust-head upon such stack having a water-extractor therein and an annular chamber to receive such water with an outlet for the escape of the same, thereby preventing the accumulation of water in the cylinder-arm.

5. In a steam storage locomotive, the combination, with the frames, of cylinders secured to the frames near their forward ends with arms connected at the middle line of the locomotive, steam-inlets upon the tops of the arms and exhaust-outlets upon the front sides of the arms, a steam storage tank mounted upon the frame with its forward end adjacent to the rear ends of the cylinders, a cylinder-pipe extended from the tank through the front head of the same, a reducing-valve and steam-gage upon said pipe at the front end of the tank, branch-pipes connecting the reducing-valve with the steam-inlet, a steam-exhaust-stack connected with the exhaust outlets and inclined backwardly to the tank in front of the reducing-valve and upwardly above the tank, and a hood applied to the front of the tank and inclosing the reducing-valve, the branch-pipe, the lower part of the exhaust-pipe and its connections to the exhaust-outlets.

6. In a steam-storage-locomotive, the combination, with the steam-storage-tank having upon the top a steam dome, of a composite saddle comprising a bearing-block having a curved seat fitted to the tank and a flat foot upon its under side, and two members or arms divided at the middle, with a flat finished seat upon the top fitted to and connected by the said foot, and having steam-cylinders upon their outer ends provided with the steam-chest seats having valve exhaust-openings *m′* and steam-inlet-openings T′, the said arms being provided upon the top adjacent to the joint with the steam-inlet orifices *k* connected by ducts *k′* within the arm to the steam-inlet-openings T′, and upon the front side with the exhaust orifices *m′* connected by ducts $m^2$ with the exhaust-openings *m′*, a cylinder-pipe extended from the steam-dome through the tank to its exterior, a reducing-valve upon the cylinder-pipe outside of the tank, branches extended from the reducing-valve to the steam-inlet orifices *k* supplying the cylinders with steam at a definite working pressure, and a relief-valve upon the head of each cylinder set to open slightly above such definite pressure, and opening outwardly when required to relieve water or steam pressure within the cylinders.

7. In a steam-storage-locomotive, the com-

bination, with the steam-storage-tank having upon the top a steam-dome of a composite saddle comprising a bearing-block having a curved seat fitted to the tank and a flat foot upon its under side, and two members or arms divided at the middle, with a flat finished seat upon the top fitted to and connected by the said foot, and having steam-cylinders upon their outer ends provided with the steam-chest seats having valve-exhaust-openings $m'$ and steam-inlet-openings T′, the said arms being provided upon the top adjacent to the joint with the steam-inlet orifices $k$ connected by ducts $k'$ within the arm to the steam-inlet-openings T′, and upon the front side with the exhaust orifices $m$ connected by ducts $m^2$ with the exhaust-openings $m'$, an exhaust-pipe having branches connected to and extending upwardly from the exhaust-openings $m'$, and the ducts $m^2$ falling below the level of the exhaust orifices $m$, and having each at its lowest point an automatic drip-valve opening outwardly, allowing the water condensed from the exhaust steam to escape.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

GEORGE L. WALL.
VICTOR JAMES SHEPARD.

Witnesses:
LAWRENCE R. WRIGHT,
WALTER B. CARNES.