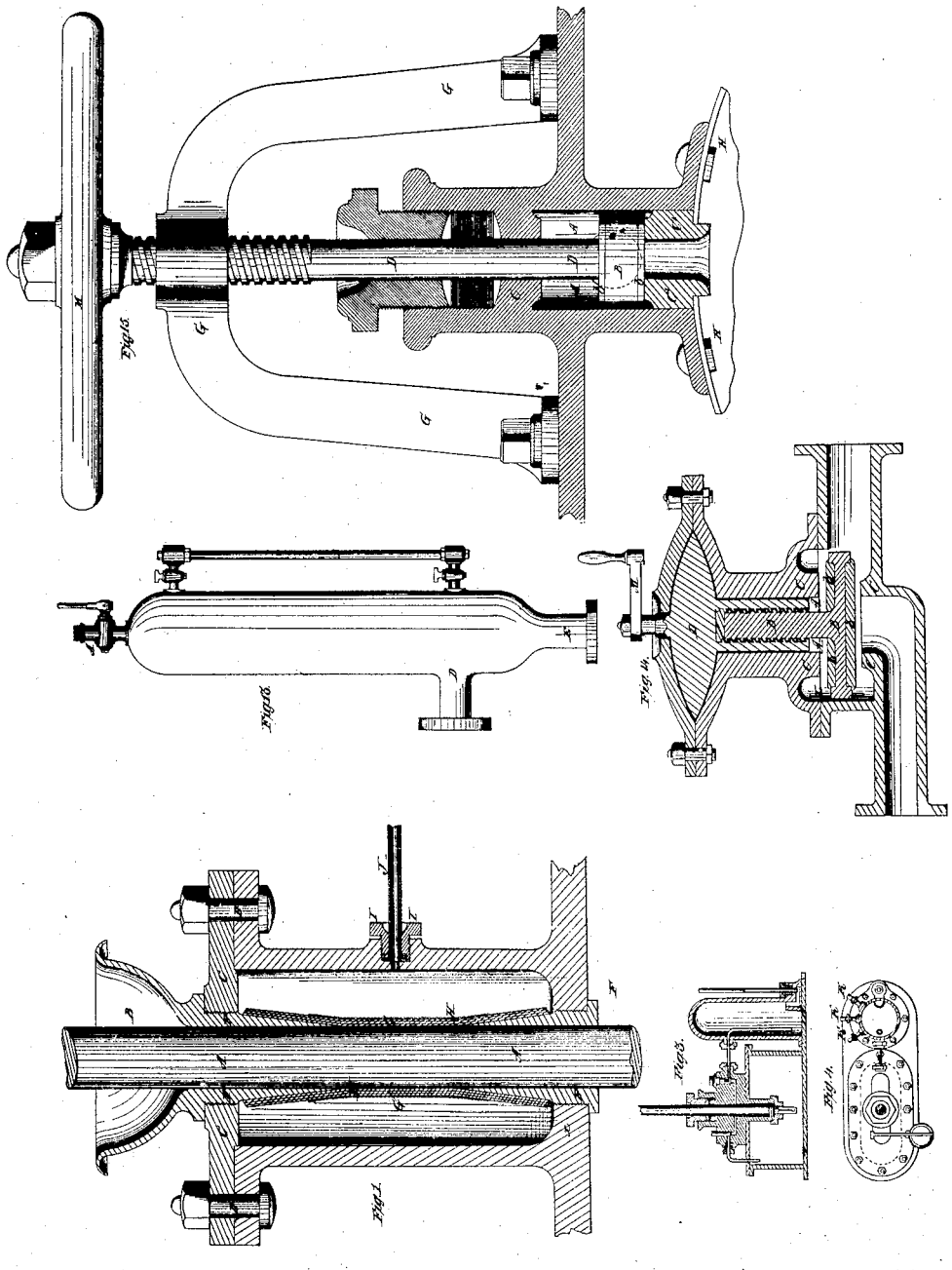
7 Sheets—Sheet 1.

P. V. DU TREMBLEY.

CONDENSER AND STUFFING BOX OF VAPOR ENGINES.

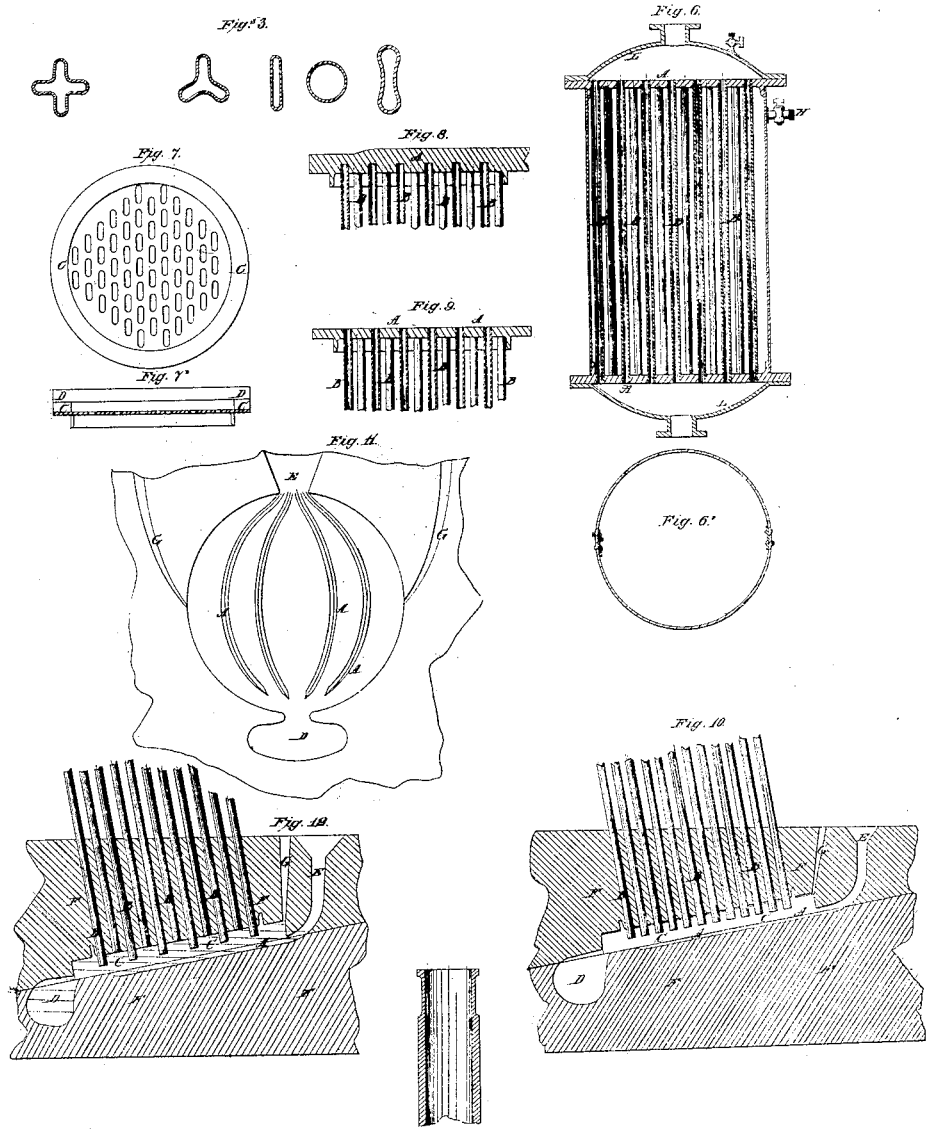
No. 6,929. Patented Dec. 4, 1849.



P. V. DU TREMBLEY.

CONDENSER AND STUFFING BOX OF VAPOR ENGINES.

No. 6,929. Patented Dec. 4, 1849.

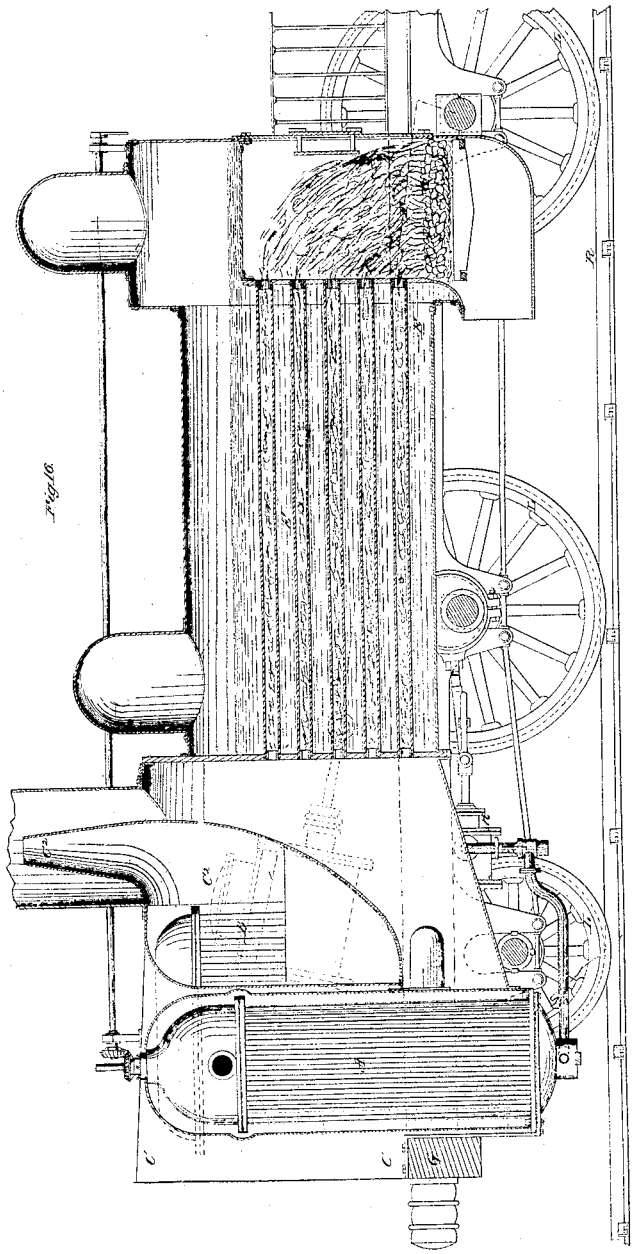


7 Sheets—Sheet 3.

P. V. DU TREMBLEY.

CONDENSER AND STUFFING BOX OF VAPOR ENGINES.

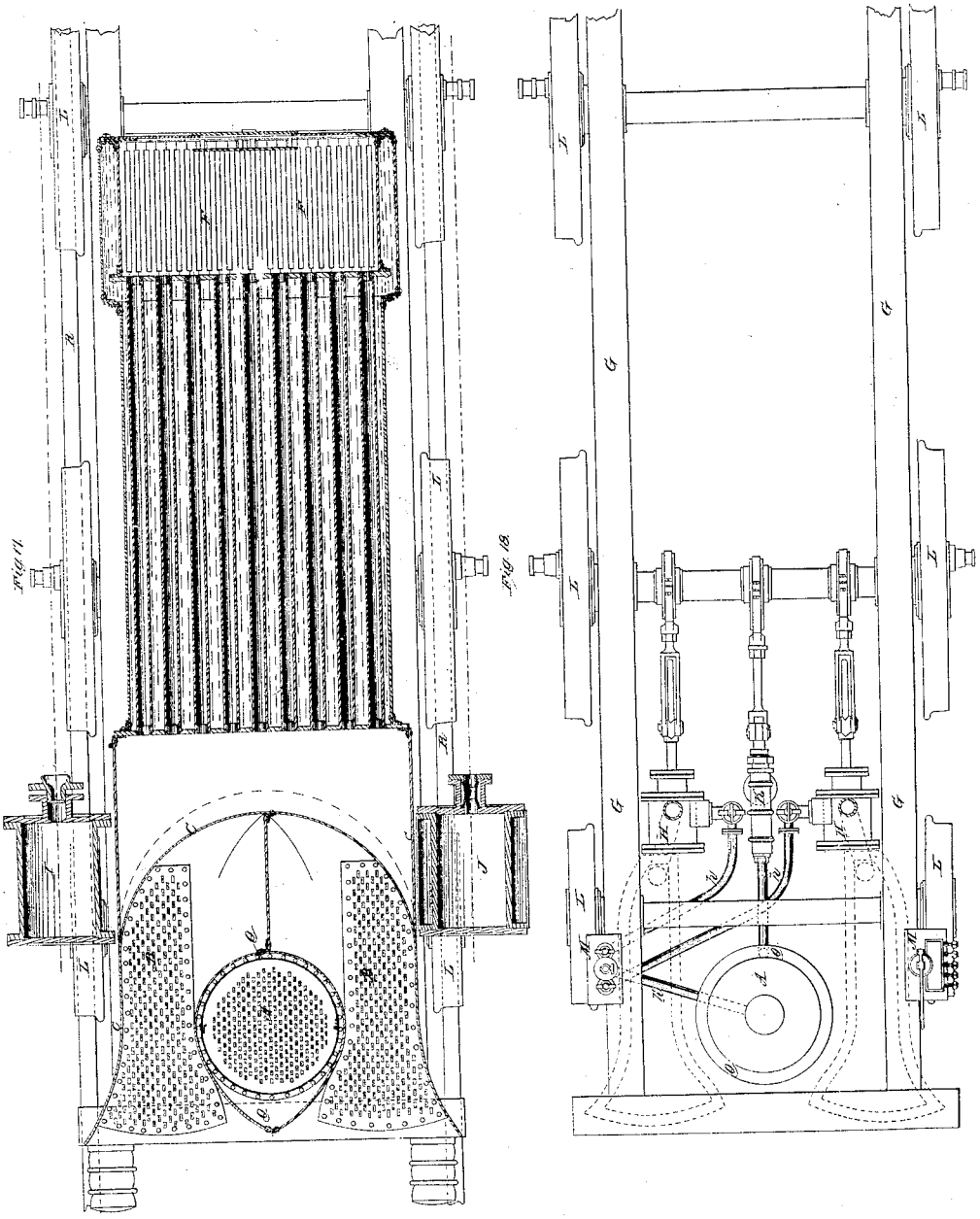
No. 6,929. Patented Dec. 4, 1849.



P. V. DU TREMBLEY.

CONDENSER AND STUFFING BOX OF VAPOR ENGINES.

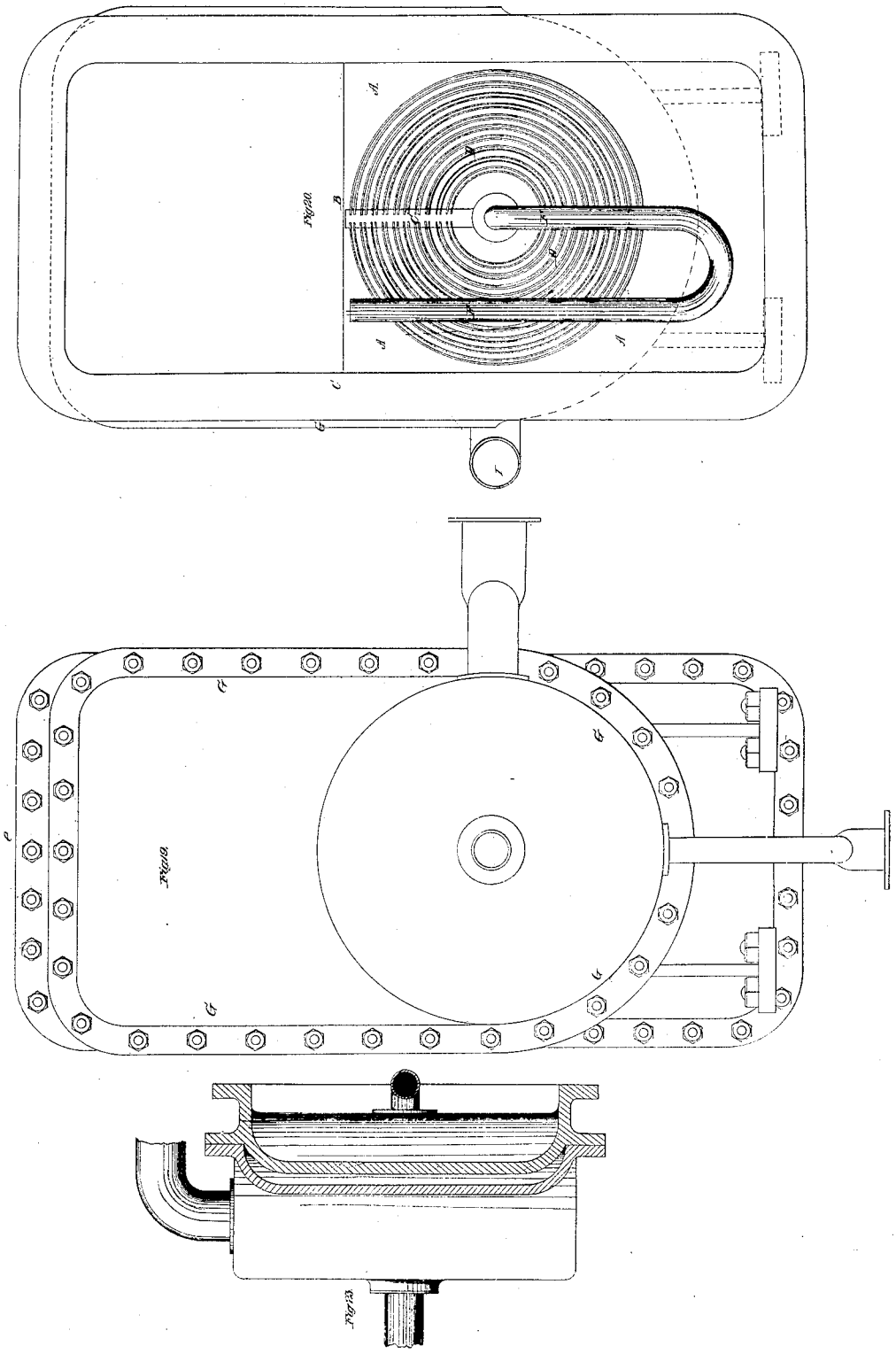
No. 6,929. Patented Dec. 4, 1849.



P. V. DU TREMBLEY.

CONDENSER AND STUFFING BOX OF VAPOR ENGINES.

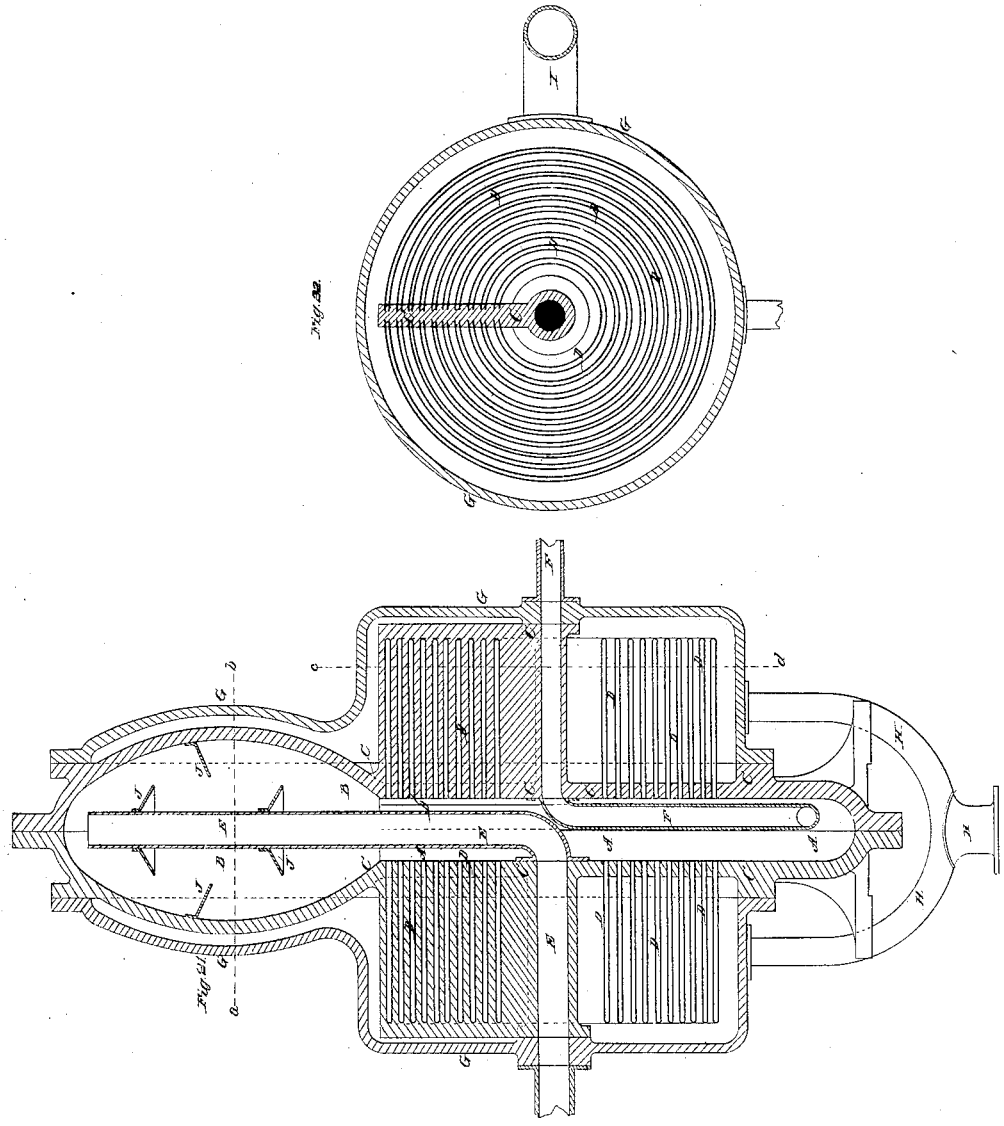
No. 6,929. Patented Dec. 4, 1849.



P. V. DU TREMBLEY.

CONDENSER AND STUFFING BOX OF VAPOR ENGINES.

No. 6,929. Patented Dec. 4, 1849.



P. V. DU TREMBLEY.

CONDENSER AND STUFFING BOX OF VAPOR ENGINES.

No. 6,929. Patented Dec. 4, 1849.

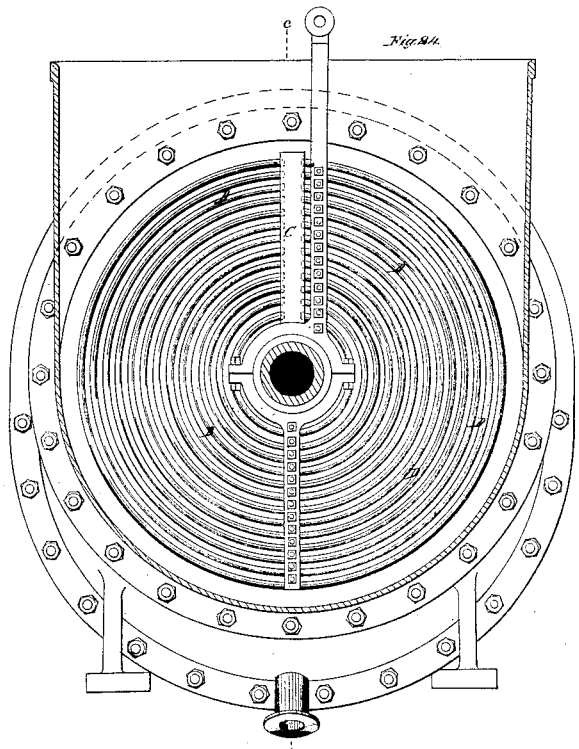


Fig. 4.

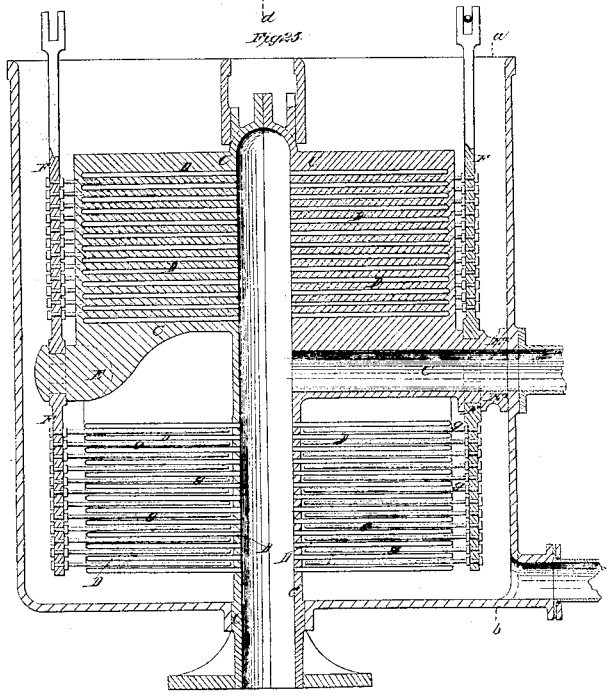


Fig. 5.

UNITED STATES PATENT OFFICE.

JEAN BAPTISTE LOUIS PROSPER VERDAT DU TREMBLEY, OF PARIS, FRANCE.

IMPROVEMENT IN CONDENSERS AND STUFFING BOXES OF VAPOR-ENGINES.

Specification forming part of Letters Patent No. **6,929**, dated December 4, 1849.

To all whom it may concern:

Be it known that I, JEAN BAPTISTE LOUIS PROSPER VERDAT DU TREMBLEY, of Paris, in the Republic of France, civil engineer, a citizen of the French Republic, have invented certain Improvements in Engines to be Worked by Gas-Vapor or Steam, either Separately or in Combination; and I do hereby declare that the following is a full and exact description of my said invention.

In the improved engine which forms the subject of this invention I propose to employ two distinct boilers or generators and two separate cylinders with their appendages, and the piston in one cylinder is acted upon by steam or the vapor of water which is generated in one boiler, and the piston in the other cylinder is worked by the elastic force of the vapor of ether, chloroform, perchloride of carbon, or some other highly volatile liquid which is vaporized in the other boiler or generator. In the following description of the machine I shall always mention sulphuric ether as the volatile liquid to be used; but it will be evident that either of the other liquids or any other moderately-cheap and easily-vaporized liquid may be used in place thereof if desired. As the engine is actuated by the combined force of the vapors of ether or other volatile liquid and water, I denominate it an "etherhydric engine."

The principal parts of the engine are constructed much in the same way as those of the ordinary double-action marine and locomotive steam-engines, according to the purpose for which the engine is intended to be used—that is, it consists of cylinders, boilers, feed-pumps, condensers, air-pumps, and the other necessary appendages. The necessity for making it a double-action engine will be easily understood, as it has already been stated that the engine is worked by means of two different vapors. In one of the boilers steam is generated, which works the piston in the first cylinder, and in the second the vapor of ether is generated, which operates upon the piston in the second cylinder. The first boiler therefore contains water, and is precisely similar to an ordinary steam-boiler, and is heated by fuel in the same manner. The second boiler contains ether and is of a peculiar construction, which will be presently explained. It requires no fuel to vaporize the ether or other volatile liquid, that operation being performed by the heat of the steam which escapes from the steam-cylinder after operating upon the piston therein, as this steam, instead of being condensed by an ordinary condenser, is conducted to the outside of the ether-boiler, where it parts with its caloric to vaporize the ether, and thereby becomes condensed. This phenomenon is caused by a well-known principle in physics, which is that all bodies on passing from a liquid to a gaseous state instantaneously absorb a large quantity of caloric at the expense of contiguous bodies. At the moment, therefore, that the heated steam from the eduction-passage of the steam-cylinder enters the case or outer cylinder that surrounds the ether-boiler the ether, which boils and vaporizes at a much lower temperature than water, becomes rapidly converted into vapor, and by absorbing the caloric of the steam which surrounds it the steam becomes instantly condensed. This condensation of the steam by the simultaneous vaporization of the ether takes place with remarkable rapidity and regularity. The ether-vapor is therefore generated without expense by the steam, which has already done its work, and which has always hitherto been condensed by means of cold water and was considered of no further utility after acting on the piston in the steam-cylinder. The ether-vapor thus produced enters the second cylinder, which is of the same capacity as the first, and there acts with considerable power on the piston contained therein, and on making its escape from the cylinder it passes into a condenser of a peculiar construction, in which it becomes condensed by coming into contact with the metal composing it, the said condenser being kept cool by means of a stream of cold water or a sprinkling of cold water aided by a current of air. The ether thus condensed is then pumped into the ether-boiler in order to serve again for a like purpose. The water in the cylinder surrounding the ether-boiler resulting from the condensation of the steam is also carried back in a warm state to the steam-boiler for the production of fresh steam. It will thus be seen that the same water and ether are used over and over again without sustaining any appreciable loss.

The etherhydric engine differs in the construction of its parts from the ordinary double-cylinder steam-engines in some few particulars, which are as follows, and relate principally to those parts of the engine which come in contact with the ether or etherial vapors: First, the boiler, which I call the "vaporizer" or "generator," and also the "condenser," must be constructed in a peculiar manner, and the mode of forming several of the joints, as well as the packings and stuffing-boxes, is also different, as is also the mode of producing the vacuum in the condenser, and, lastly, the mode of constructing the induction-cock for the vapor. I will now proceed to describe these parts in succesion, leaving out all those which do not possess any features of novelty.

First, the vaporizer or generator.—This vessel is composed, principally, of a large number of copper tubes made by drawing them in a draw-bench without soldering, as is well known. These tubes are fixed at each end to a brass plate, which is cast onto them, as seen in Fig. 6, Sheet I, and are about three and three-fourths feet in length and may be of an ovular, oblong, lenticular, or other suitable form, as shown at Fig. 3, the object being to obtain as great an extent of heating-surface as possible. The tubes thus constructed will bear a pressure of twenty-five atmospheres without being distorted. They ought to be tried at this pressure with a hydraulic press before being used. In practice it is found that from thirty to forty tubes are required to generate sufficient vapor for a power equal to one horse. The end plates which hold these tubes together are cast on the ends of the tubes in the following manner: The tubes, after being all cut to an equal length, are then tinned over at both ends to the extent of about an inch. The ends of these tubes are then filled or stopped up with dry sand and placed vertically at equal distances in a mold-frame—such as is used in foundries—the ends of the tubes being held in plates C, as seen at Fig. 7. The tubes are then covered with sand, which is well rammed in between them and the plates C, so as to form a solid mass to support the tubes when the mold-plate C is removed. The mold-plate C is made from a sheet of copper with holes made therein to receive the ends of the tubes and cut in the required form and of such a thickness as to regulate the thickness of the plate to be cast onto the ends of the tubes, so that when the plate C is removed the tinned ends of the tubes may project the required distance from the sand. A second mold-plate, D, is employed, as seen in Fig 7*, for the purpose of forming a space to receive the molten metal which is to hold the tubes together, and which will, when poured in, cover the ends of the tubes; but this superfluous metal may be removed by means of a planing-machine, and the ends of the tubes will then be left open.

Fig. 8 represents a sectional view of one of the end plates cast onto the ends of the tubes and just as it comes from the mold, the ends of the tubes being closed by the superfluous metal, which, when removed by planing, will leave the ends of the tubes open, as seen in Fig. 9, and when the dry sand is removed from the interior of the tubes they will have a perfectly free passage through them from end to end.

It should be understood that each end of the tubes is secured to one of these plates, which is cast thereon, and when both of the end plates are finished spherical ends or caps *l* must be bolted thereon, as shown in Fig. 6, and the apparatus will be complete.

I would here observe that in casting the metal plates A onto the ends of the pipes some care is required to prevent the molten metal in its passage from melting the ends of the pipes. This inconvenience is obviated in the following very simple manner. The mold-frame, with the tubes B B secured therein, and having the space for the end plates, A, prepared by means of the mold-plates C and D ready for receiving the molten metal, is mounted on a pivot, so that when one of the end plates, A, has been cast on one end of the tubes the frame may be readily turned over to receive the molten metal for the other plate. Instead of bringing the mold into a perfectly vertical position, it is inclined a little on one side, as seen in the sectional view, Fig. 10, in which B B represent the tubes with their ends projecting beyond the sand F of the mold, leaving a space, C, to be filled with the melted metal, which is run into the mold through the gate E, and after running along the channels A A, made in the bottom of the mold, as seen in the plan view, Fig. 11, first fills up the well D, and then gradually fills the mold C, as shown by the horizontal lines in Fig. 12, the air in the mold being allowed to escape through the air-holes G. In this manner it will be seen that no more molten metal comes in contact with the tubes B B than is necessary, and they may therefore be all secured without the liability of being melted during the passage of the metal while running into the molds.

The condenser is manufactured in the same manner as the vaporizer or generator, and therefore requires no further or more detailed description.

The vaporizer or generator above described is inclosed in a jacket made of cast or wrought iron and shown detached in Fig. 6*, the exit steam being conducted into this jacket after it has exerted its elastic force in the steam-cylinder. The generator or vaporizer is furnished with a cock at the upper part, and there is also a gage or level and a feed-pipe at the side, (but not shown in the drawings,) from whence the ether is discharged into the upper part and passes through the lower case. This arrangement greatly facilitates the production of the vapor and the circulation of the ether in the tubes. There is a pipe, H, for conducting the steam from the steam-cylinder to the outer casing of the ether-receptacle, which is

furnished with a safety-valve communicating with the atmosphere, and opens at a moderate pressure in order that in case of accident—such as the rupture of a pipe in the vaporizer or generator—the ether-vapor may easily escape without danger. The ether-condenser is surrounded by but not inclosed in a case which is supplied with fresh water for the purpose of condensing the etherial vapor after it has passed through the engine. The spherical ends of the condenser are provided with suitable openings to receive the tubes which conduct the ether to the apparatus in a state of vapor or from it in a liquid state. It is also provided with a pipe to allow the water of condensation to run into the exhaust-pump, which draws off the air and condensed water from the condenser.

Luting for the stationary parts.—It has been found that minium or ordinary luting or fatty matters cannot be employed for luting or securing the various parts containing ether or ether-vapor; but instead thereof I use a sheet of paper steeped in a thick solution of gum-arabic, as this substance is not acted upon by the ether. In order to prevent the ether from escaping from the glass level or gage, leather washers steeped in solutions of gum-arabic are employed. They must be left exposed to the air until nearly dry, and are then ready for use. Flax steeped in gum-arabic may be employed with equal success. It must be saturated and almost dry, and if joints secured in this manner are left to dry before being exposed to the ether they will be found to be perfect.

Packing for the piston and other moving rods is shown in Fig. 1, Sheet II. Sulphuric ether dissolves and decomposes all kinds of fatty matters and oils, and consequently the ordinary packing made with flax and grease would not prevent its escape. In order to overcome this difficulty, the following contrivance has been adopted: On the cover *x* of the cylinder (see Fig. 1) is cast a box very much like the ordinary stuffing-boxes, with this difference, that it is furnished with a flange to which a lid or cover, C, is secured by bolts D D. To this cover, and also to the bottom part of the box where the piston-rod works, hollow brass cones F F are firmly affixed by screwing or otherwise. These cones are respectively in length one-third the whole length of the box. For instance, if the box be six inches in length from the bottom to the top, each cone must be two inches in length, and when the box is shut they are about two inches apart. Before putting on the cover C a strip or band of strong leather, G, (about seven inches wide if the box be six inches in height, and gradually tapering to a point and sufficiently long to wind three times round the piston-rod,) is taken, and the end and edges of this band are pared thin, after which it is rolled round the rod A and secured there by means of a cord or spring, H. The cover is then bolted onto the box, and by pressing the cover downward the points of the cones F F will be forced between the leather and the piston-rod and made to fit. The bolts by which the cover C is secured to the box facilitate this operation materially. The box is then hermetically closed by inserting a sheet of gummed paper or minium in the joint and tightening the bolts D. An opening is made at the side and carries a projection, I, to which a tube, J, is adapted, which leads from a small pump or hydraulic press with a reservoir for water and compressed air. This small pump is shown at Figs. 3 and 4, and is provided with a safety-valve, which may be weighted, so as to allow of any desired pressure. Several tubes, K K, leading from the water-reservoir, communicate with the several stuffing boxes of the working-rods of the engine. The pump may be worked by hand or by the engine, as desired. When the engine is set to work, water is pumped into all the stuffing-boxes, Fig. 1, and by pressing on the leather band G causes it to fit tight against the cones and the piston-rod A, along which it is desired to prevent escape. As the cones are stationary and the rod only is movable, the leather bears against the rod A for a very limited distance only. It will therefore be conceived that the friction of the rod would not be liable to displace the leather band, even if the two ends of the box did not prevent it from moving.

By means of the hydraulic pump any desired pressure may be brought to bear upon the rod A, and the escape of ether can be thereby effectually prevented. Thus, if the manometer of the ether-generator should indicate a pressure of four atmospheres, it will only be necessary to weight the safety-valve of the hydraulic-press so that it shall not yield to a pressure of less than four atmospheres, and a half, and although the vapor will exert a power of four atmospheres it will be met by a resistance of four and one-half atmospheres and will therefore be prevented from escaping. I would here observe that the friction of metal on damp leather is very small, and that the rods thus worked, far from being rusted or worn away, are well polished; also, that the leather, being surrounded by water, does not become sufficiently heated to be at all injuriously affected. Otside the cover is a cup, B, filled with oil, through which the rod A runs. This kind of packing is more easily made and put in use than those made of flax. In an experimental machine the packing for the steam-cylinder, which was made by an experienced engine-maker with flax and grease, was worn away and replaced four times, while that of the ether-vapor cylinder was not touched and was in a good state of preservation, the two cylinders having worked in conjunction all the time.

In order to produce a vacuum in the ether-condenser, an exhaust-pump similar to those used in condensing-engines is used. The stuffing-box, however, must be similar to the one just described. The piston must be metallic, and instead of allowing the product of con-

densation to escape into the atmosphere, as is the case in steam-engines, the condensed ether and air is conducted into a hermetically-closed reservoir of a capacity equal to one-quarter of that of the condenser. This reservoir, which is shown detached at Fig. 13, is of a cylindrical form, its height being about six times its diameter, and has a tubular projection, D, at the side, communicating with the air-pump, and a similar opening, E, at its lower extremity, communicating with the ether boiler or vaporizer. It has also a stop-cock, A, at top, which leads to the atmosphere.

The reservoir is also provided with a level or gage, B, which shows the height of the ether in the apparatus. On the engine being set to work the air-pump forces into this reservoir (which communicates with the vaporizer) the air and ether which it draws from the condenser. The weight of the air and liquid ether being very different, the air, being the lightest, necessarily rises to the top of the reservoir and accumulates there under a pressure equal to that existing in the ether-boiler, and the ether only passes into this latter, the opening through which it escapes being at the lower end of the reservoir.

As the air drawn from the condenser accumulates at the upper part of the reservoir, the level of the ether in this vessel descends, and may be easily seen by looking at the glass tube B, with which it is provided. It will therefore only be necessary to open the cock A above and let the air escape, which can be done without inconvenience and without stopping the engine. There is no occasion to fear the loss of the ether, as it is cold, and vapor could not be formed under such a pressure. It is only necessary to take care to shut the cock when sufficient air has escaped to allow the level of the ether to rise to the required height. No inconvenience can arise by letting the air accumulate in the reservoir, provided the vessel does not become entirely filled with air, as in that case it would ultimately pass into the vaporizer.

I will now proceed to describe an improved construction of cock which is employed for regulating the passage of the ether from one part of the apparatus to another, and is shown at Fig. 14.

As ether possesses the property of decomposing fatty bodies, the employment of cocks of the ordinary construction for retaining that liquid is attended with difficulty, as the cocks must not be lubricated with oil. The metal will therefore rapidly wear away and cause considerable loss and expense. To remedy this evil, the following contrivance has been devised, and has been found fully to answer the purpose. It has also been found applicable to ordinary steam-engines. A is a way or opening, with two seats, C C, between which the valve B works. This valve, which is made of iron, is covered with lead on both sides, as seen at *b b*, and slides, by means of a nib or stud, in a groove, L, so as to prevent it from turning round, and may be made to rest on or bear against either the lower or upper seat. The valve is moved up and down by means of the valve-rod B*, which is screwed and works in a female screw in the lower part of the stationary piece D, which is turned by means of the handle M. When the valve rests upon the lower seat and closes the communication with the boiler, the piece D presses with equal force against the sides of the aperture in which it turns, and thereby prevents the entrance of air. When, on the contrary, it is desired to open the passage for the steam, the valve is raised, so as to press against the upper seat, and thereby closes the exit-passage. As this valve B is covered with lead at *b b*, it takes the impression of and fits exactly onto the two seats and makes an excellent and perfectly tight joint. Fig. 15 is a sectional representation of another construction of cock, which is, however, precisely similar in principle to that already explained, although somewhat different in form and the arrangement of the parts. A A is a tubular opening having two seats, C C, as before, the valve B being mounted between them and furnished with lead facings *b b*, in order to fit closely against the seats C C and form a perfectly hermetic joint. The valve is mounted on the lower end of a rod or spindle, D, which passes up through an ordinary stuffing-box and is screwed at its upper end. The screwed end of the spindle D works in a female screw made in the top part of the arched frame G, which is bolted onto the top of the vessel H, to which the cock is adapted. M is a wheel or handle affixed to the upper end of the spindle D for the purpose of working the valve.

All that has been hitherto said refers more particularly to marine or stationary engines; and although the arrangements above shown and described have been found to succeed with those kinds of engines, yet it will be at once seen by a practical engineer that many of the above contrivances could not advantageously be employed for locomotive purposes. In order to condense ether-vapor in stationary and marine engines, the metallic surfaces of the condenser are cooled by means of a current of cold water; but in locomotive-engines this means cannot conveniently be employed. The following contrivance has therefore been devised for locomotive-engines: The condenser, similar in construction to that above described, is set vertically, but without any outer casing on that part of the locomotive which is most exposed to the air. Each row of pipes has a cloth stretched tightly over it, and on the upper end is a reservoir which is filled with cold water from the tender. This reservoir supplies water to channels placed between each row of tubes for the purpose of wetting the cloths which cover the tubes or metallic condensing-surfaces. The superfluous water flows into a receptacle below, from whence it may be pumped into the tender to serve again. These surfaces are therefore con-

stantly kept well wetted, and a very strong current of air is produced by the rapid motion of the engine through the atmosphere, and will be continually carrying off the steam which may have been formed by the heat of the ether-vapor inside. As each particle of water on being converted into steam absorbs a large quantity of heat from the ether in the condenser, the ether will be very readily condensed.

As the eduction-steam from the steam-cylinder is used for vaporizing the ether for the second cylinder, some other means than those usually employed must be adopted to excite the draft in the chimney. The method of effecting this object will be best understood by a reference to and an examination of the drawings in Sheets III and IV, in which Fig. 16 represents a longitudinal vertical section of a locomotive with the improvements adapted thereto, and Fig. 17 is a horizontal section of the same. A is the generator for the ether-vapor; B B, the condenser for the ether-vapor. C C is a semicircular casing or jacket open in front like the mouth of a trumpet and terminating in the chimney by a pipe, C′ C′, gradually decreasing in area, as seen best in Fig. 16. By this means the air that enters between the tubes of the condenser is conducted upward into the chimney and creates a strong draft. D D is the smoke-box, E E the ordinary locomotive steam-boiler, and F the fire-box. G G is the framing of the locomotive, and H H the pumps, (seen best in the plan view, Fig. 18;) *h h*, pipes for conducting the ether to the vacuum apparatus M and from thence to the generator A. I is the steam-cylinder, and J the ether-cylinder. K is a pump for drawing off air and water from the casing or jacket Q of the ether-generator A, and L L are the wheels of the locomotive; M, the apparatus for making a vacuum in the condenser, and already described in reference to the other engine. N is a pump for communicating pressure to the packings, which are in contact with ether or its vapor; P, a cock for shutting off the ether-vapor; Q, the outer casing or jacket of the ether-generator, and constituting a condenser of the steam, and R are the rails of the railway.

In the several figures in Sheets V, VI, and VII I have shown a different method of constructing the apparatus for generating the etherial vapor and for condensing the same. Although the plans above shown and described have been found to answer their intended purposes remarkably well, yet, as they are somewhat costly to manufacture and are liable to derangement, I have devised a less costly, stronger, and easier method of constructing the above parts. In place of the copper tubes, which are expensive and tedious to manufacture, I employ concentric cylinders made of sheet-copper and connected to a plate by the same process of casting as that above described for connecting the tubes together. The sheet-copper employed for the above purpose is about the eighth of an inch in thickness and from ten to twelve inches in width. The length of the sheet will of course depend upon the diameter of the cylinder to be produced; but these dimensions may of course be varied and should be left to the discretion of the engineer. The sheet of copper is then doubled or folded lengthwise, so that when so doubled it is only from five to six inches wide, and previous to doubling the sheet of copper a sheet of zinc of the same length as the copper, but only half the width, is placed on the copper, so that when the latter is doubled over the sheet of zinc will be inclosed between the copper. The sheet of copper with the zinc in the middle is then passed through a machine to be formed into a cylinder, after which it is heated until the sheet of zinc is melted out from between the doubled copper sheet, leaving the latter with an annular space betweeen the sides of the copper. A number of cylinders thus made are placed concentrically one within the other in such a manner that they may be about the third of an inch distant from each other. The open edges of these concentric tubes are then carefully coated with tin and the interstices between them filled with molders' sand, a wooden pattern having been previously inserted in such a manner as to leave a space (when it is removed) to receive the molten metal, which is poured in for the purpose of connecting all the concentric cylinders together in the same manner as has been already explained in reference to the tubular generator. The casting having been completed, the superfluous metal must be removed by means of a planing-machine and the upper annular spaces of the cylinders left open, as in the former instance. Upon removing the sand which fills the annular spaces of the cylinders, and also the interstices between them, an apparatus equally applicable either for generating or condensing the vapor is obtained. The apparatus for generating the vapor must be furnished with a chamber or reservoir for containing the vapor, as seen best at Fig. 21 in Sheet VI. It is inclosed in a casing or jacket in the same way as the tubular apparatus already described. One great advantage of this mode of constructing the apparatus is that it has only one joint and is much more manageable and much stronger and firmer than the other. From the peculiar internal arrangement of the generator the liquid ether cannot by any possibility be expelled, and in the condensing apparatus an agitator may be employed, which, by moving about the water that is in contact with the sides or surfaces of the condenser, causes the apparatus to act more effectually.

In Sheet V, Fig. 19 represents a side elevation of the generator. Fig. 21 in Sheet VI is a vertical section of the same, taken in the line *e f* of Fig. 19. Fig. 20, Sheet V, is an internal elevation, one of the side plates of the external casing having been removed to show the concentric cylinders. Fig. 22 represents a transverse vertical section taken through the con-

centric cylinders of the generator in the line *c d* of Fig. 21; and Fig. 23 is a partial section of the vapor chamber or reservoir, taken in the line *a b* of Fig. 21. The generator is composed of two parts precisely similar in construction and bolted together by their flanges, as seen at Fig. 21, leaving a space, A A, between them. B B is the chamber or reservoir for containing the etherial vapor, which rises into it as it is generated by the heat of the steam. C C is the metal plate, which is cast onto the concentric cylinders D D in the manner above explained. E is the tube which conveys the vapor of the ether from the reservoir B to the working-cylinder of the engine, and is furnished with guards or shields J J for the purpose of preventing the liquid ether from being blown out of the generator. F is an inverted siphon-tube for introducing the liquid ether to the generator, and is seen best in Fig. 20. G is a cast-iron jacket or casing inclosing the generator, and into which casing the heated eduction steam from the steam working-cylinder is allowed to enter at different places through the pipes I I. The water resulting from the condensation of the steam from the abstraction of its caloric by the ether in the generator is drawn off through the pipe H.

The condenser, which is constructed very much in the same manner as the generator above described, is shown in Sheet VII. Fig. 24 is a longitudinal vertical section of the condenser, taken in the line *a b* of Fig. 25, which is a transverse vertical section of the condenser, taken in the line *c d* of Fig. 24. C C are the plates which are cast onto the concentric cylinders D D D D, and whereby these latter are held together. G G is the tube which conducts the ether-vapor to the condenser, and in so doing passes through the center of the metal plate, as will be clearly seen in the drawings. An agitator, F, composed of a number of small rods, *g g*, fixed to an arm, is mounted on the center E, and a similar one on the hollow boss E*. These agitators receive an oscillating motion from the engine, and as each of the small rods *g* acts in one of the spaces between the concentric cylinders D D a continual agitation of the water takes place, and the water that has become warmer by contact with the heated surfaces of the condenser is removed. The whole apparatus is inclosed by a casing or jacket made of cast or sheet iron and contains the fresh water for condensing the ether.

I claim—

1. The ether generator or vaporizer and condenser constructed substantially as described, whereby I obtain more perfect joints.

2. Packing the stuffing-boxes by means of leather or other analogous substance surrounding the body to be packed, when the said leather or other substance is surrounded by a chamber containing a fluid under pressure, substantially as described.

In witness whereof I, the said JEAN BAPTISTE LOUIS PROSPER VERDAT DU TREMBLEY, have hereunto set my hand and seal this 19th day of September, 1848.

PROSP. VERDAT DU TREMBLEY. [L. S.]

Witnesses:

J. W. MOFFATT,

FRED. WALKDEN.