(No Model.) 4 Sheets—Sheet 1.

# F. L. McGAHAN.

## APPARATUS FOR CONDENSING EXHAUST STEAM.

No. 462,271. Patented Nov. 3, 1891.

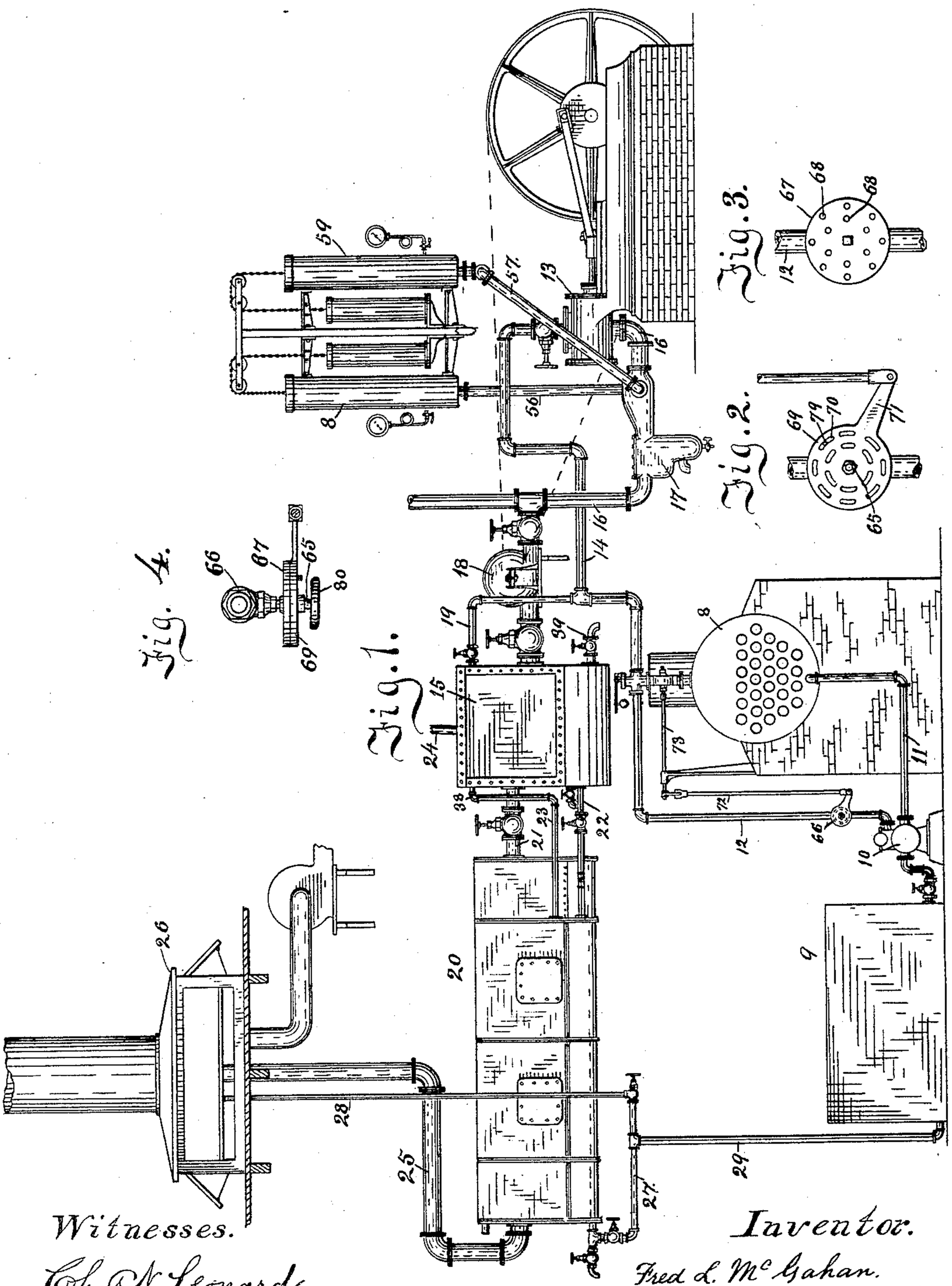


Fig. 1.




Fig. 3.




Fig. 2.

Fig. 4.

Witnesses.
Chas N. Leonard.
A. M. Hood.

Inventor.
Fred L. McGahan.
By H. P. Hood
Atty.

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# F. L. McGAHAN.

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Fig. 5.

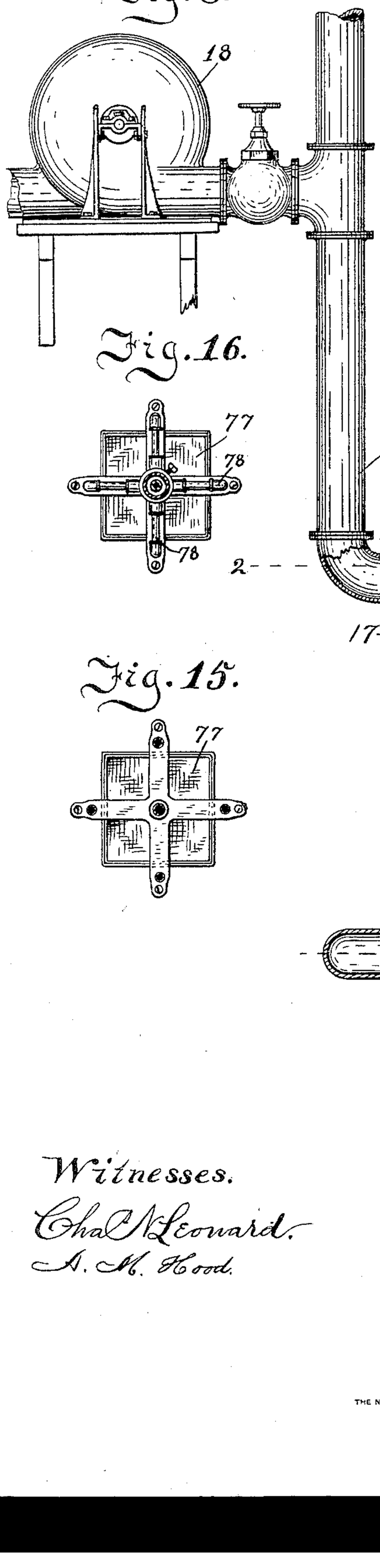



Fig. 16.




Fig. 15.




Fig. 6.

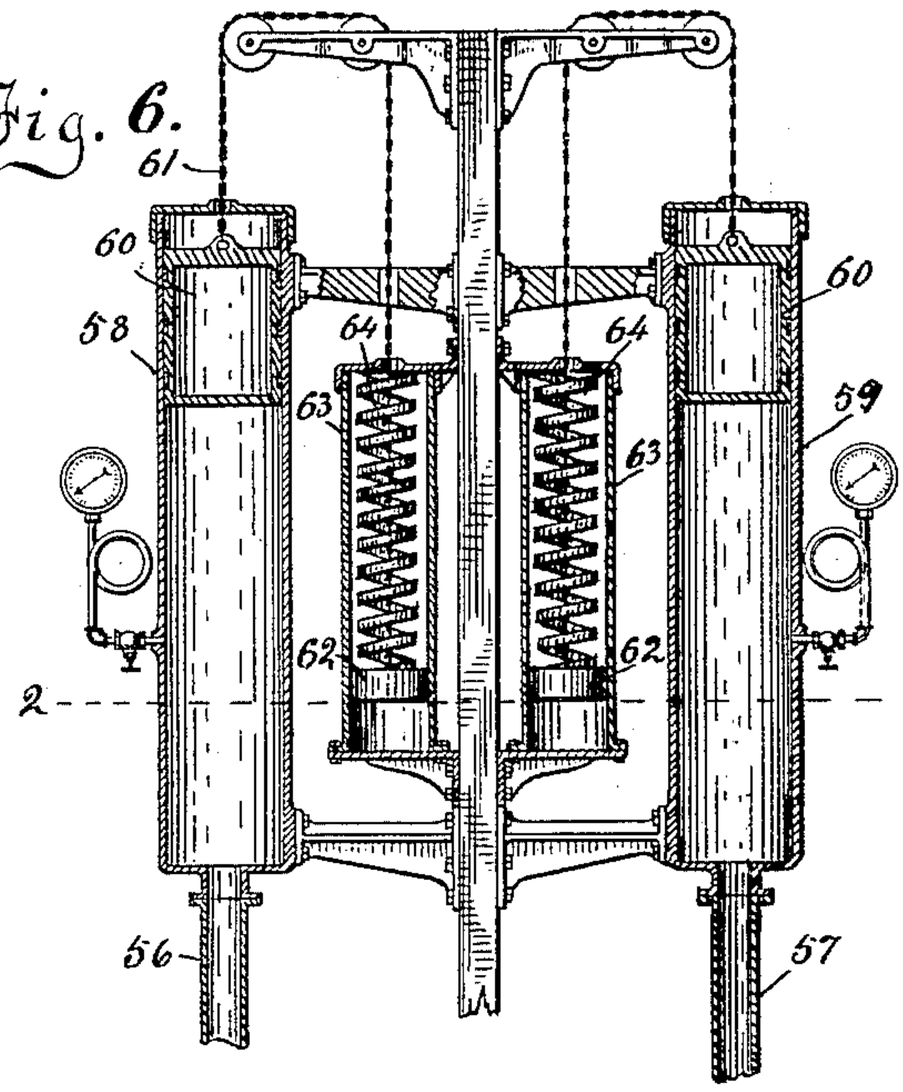
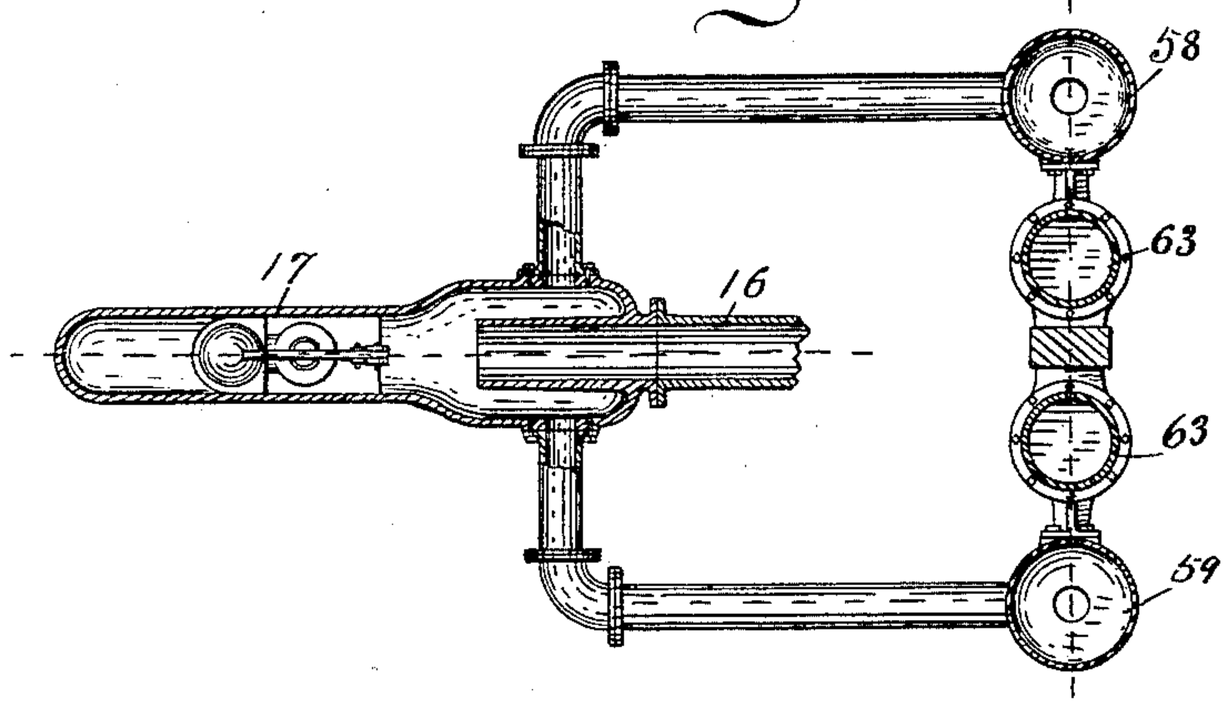



Fig. 7.




Witnesses.
Chas. L. Leonard.
A. M. Hood.

Inventor.
Fred. L. McGahan.
By H. P. Hood.
Atty.

(No Model.) 4 Sheets—Sheet 3.

# F. L. McGAHAN.

## APPARATUS FOR CONDENSING EXHAUST STEAM.

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Fig. 8.

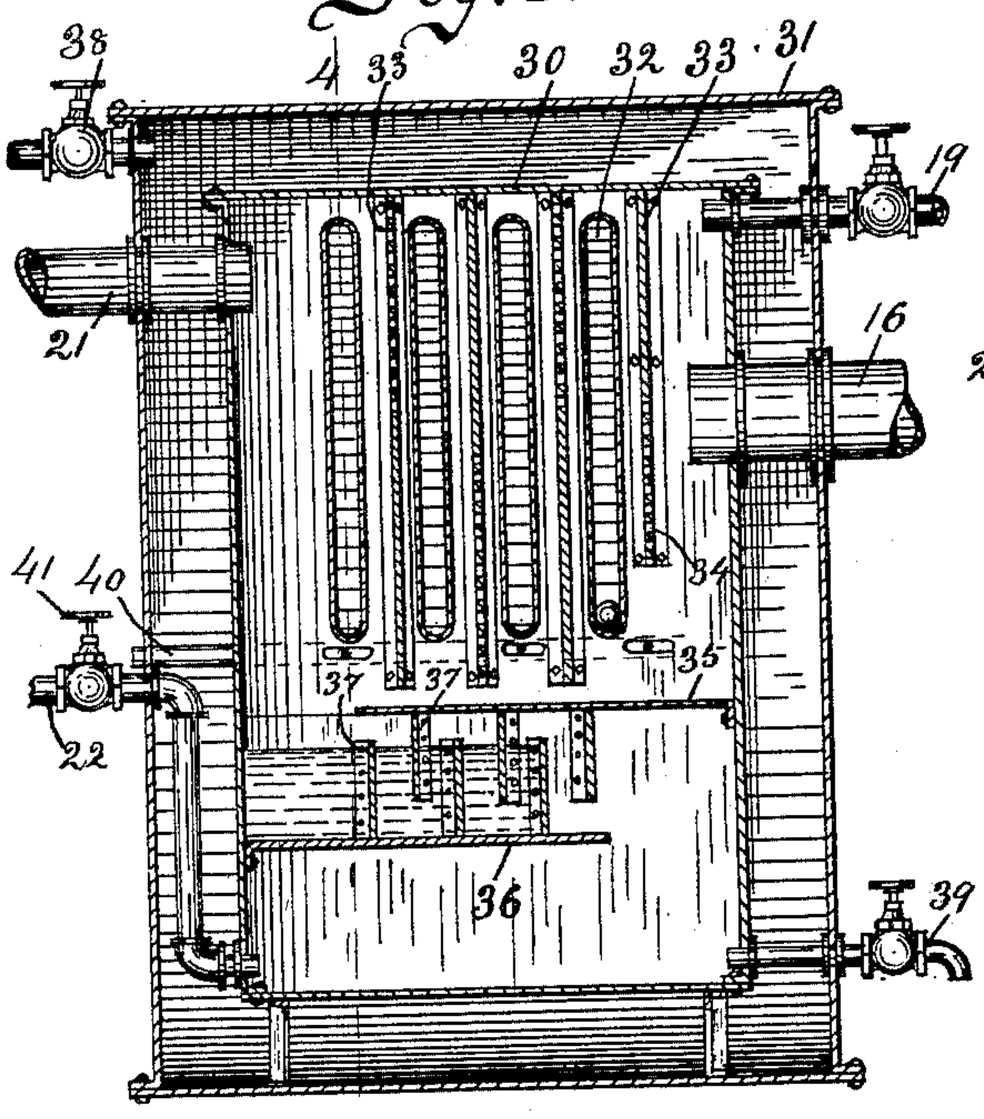
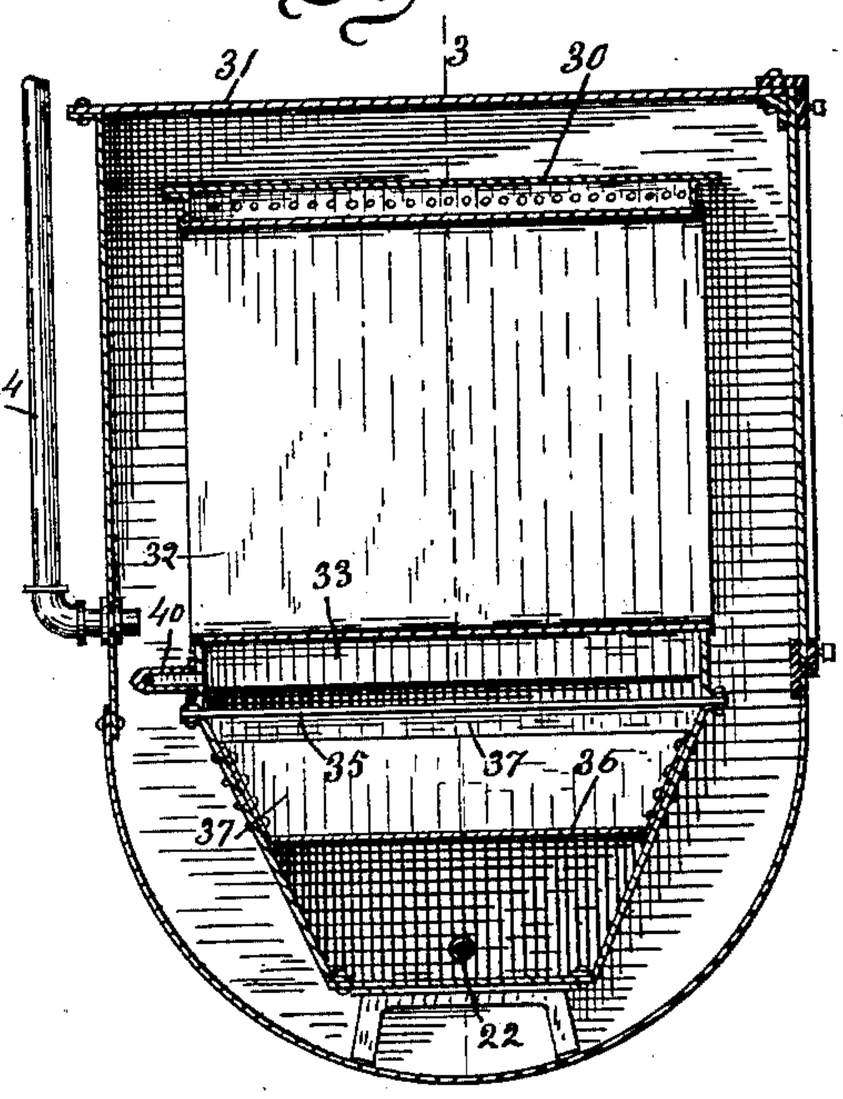



Fig. 9.



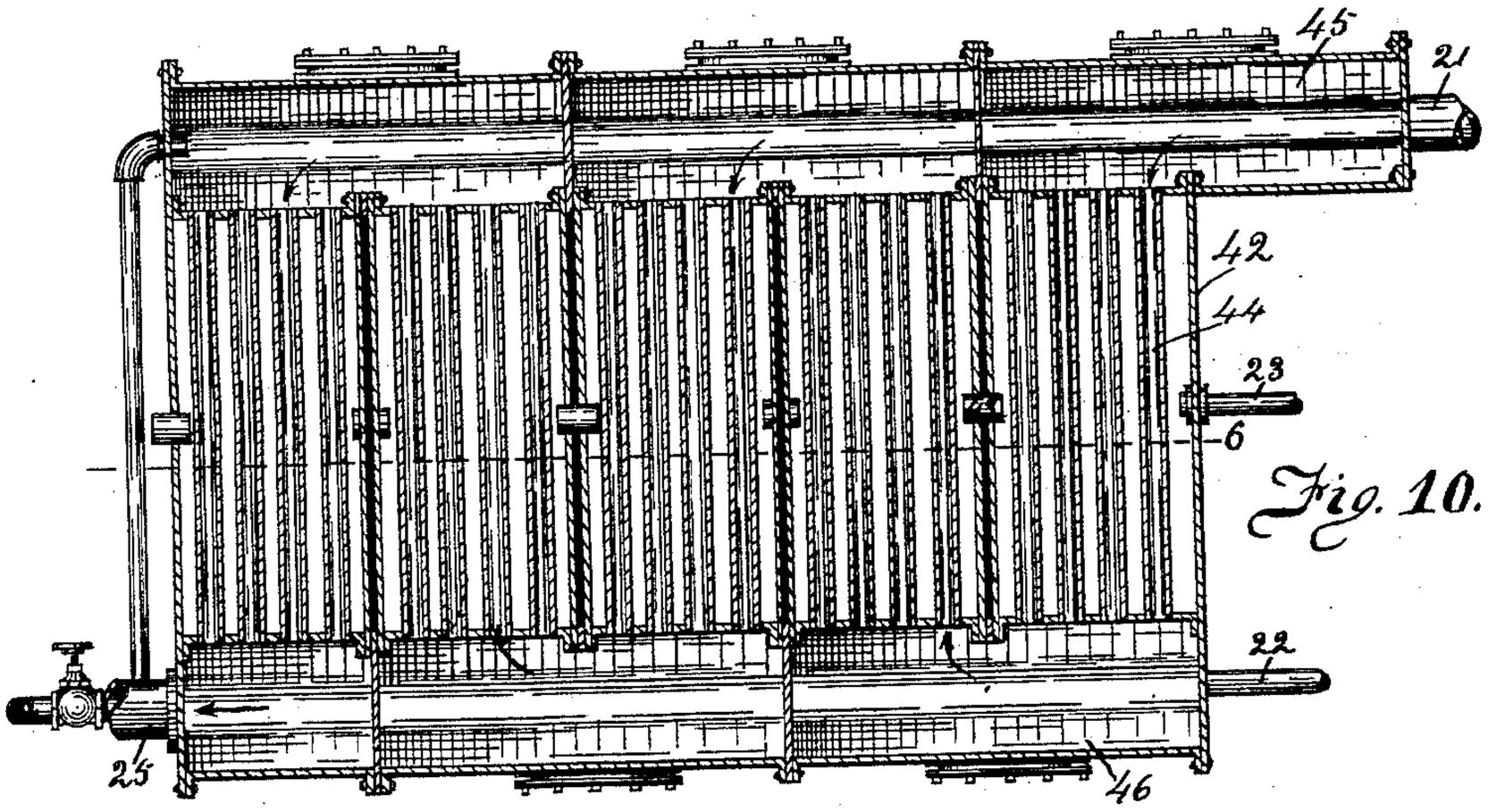




Fig. 10.

Witnesses:
Chas. S. Leonard.
A. M. Hood.

Inventor.
Fred. L. McGahan.
By H. P. Hood,
Atty.

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# F. L. McGAHAN.

## APPARATUS FOR CONDENSING EXHAUST STEAM.

No. 462,271. Patented Nov. 3, 1891.

Fig. 11

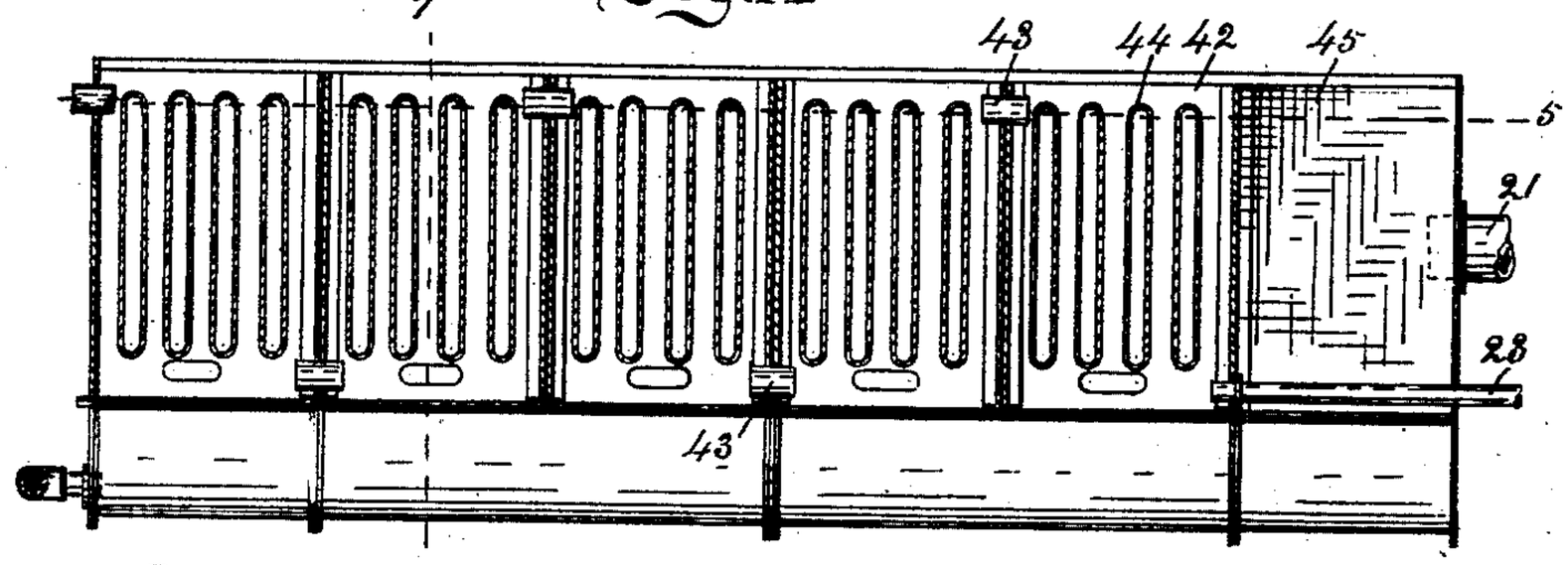



Fig. 12.

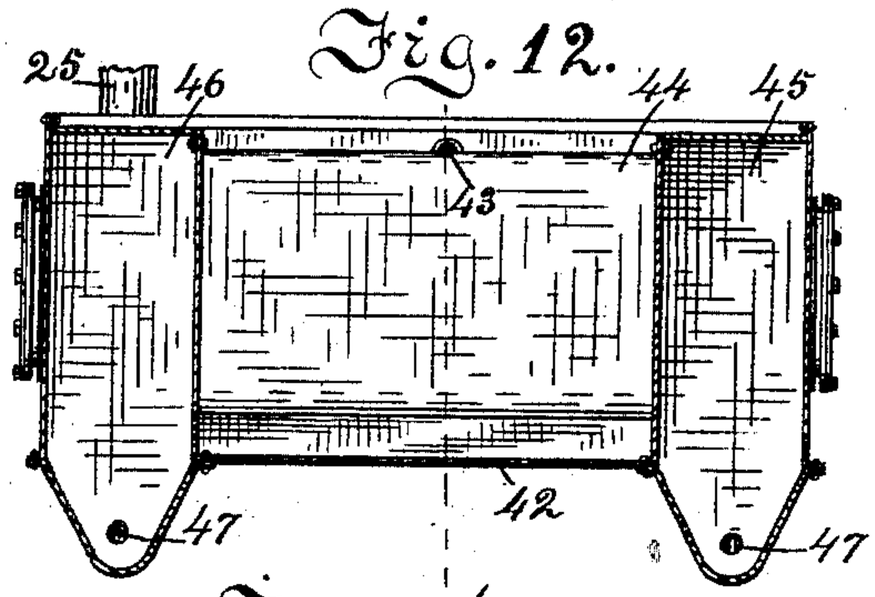



Fig. 13.

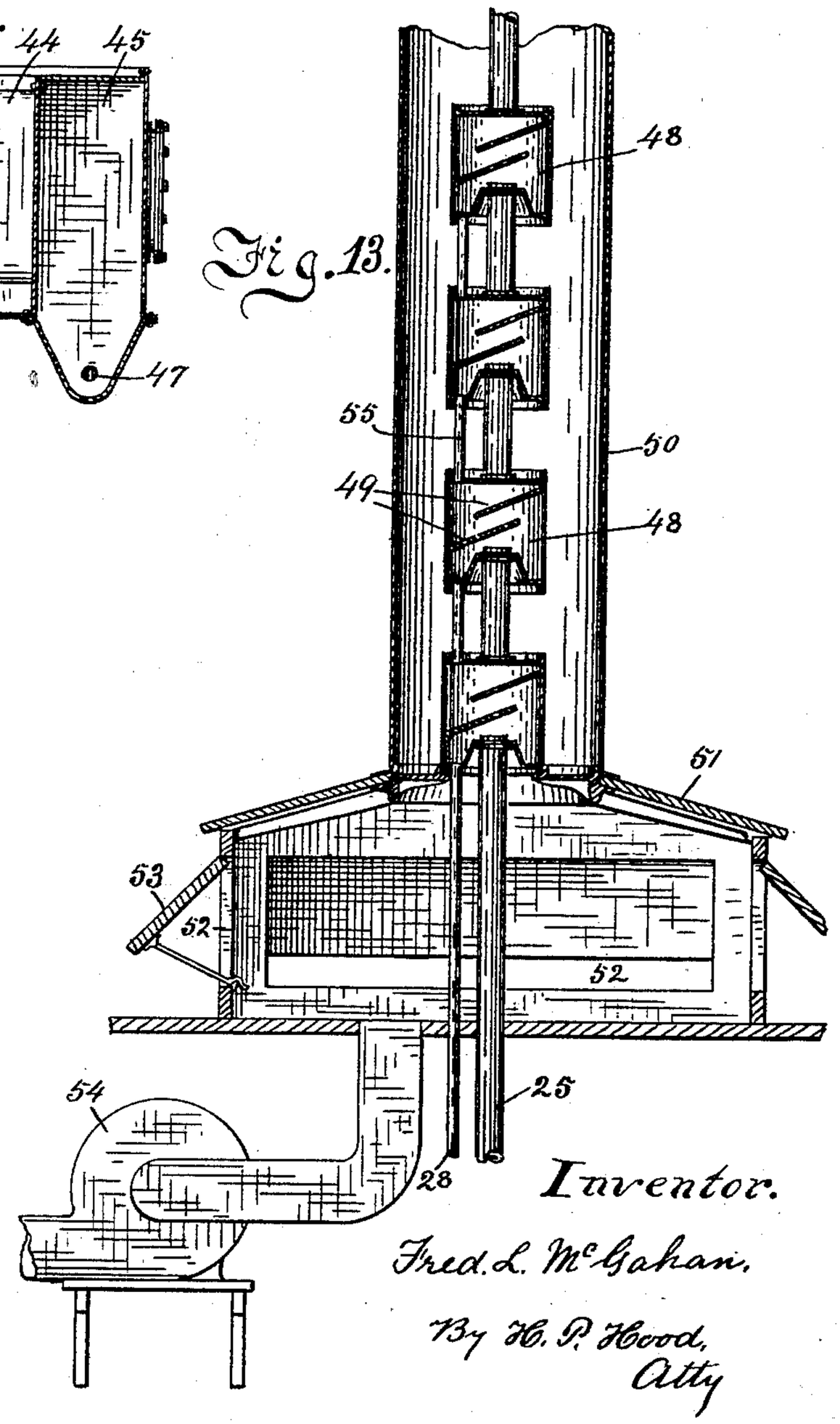
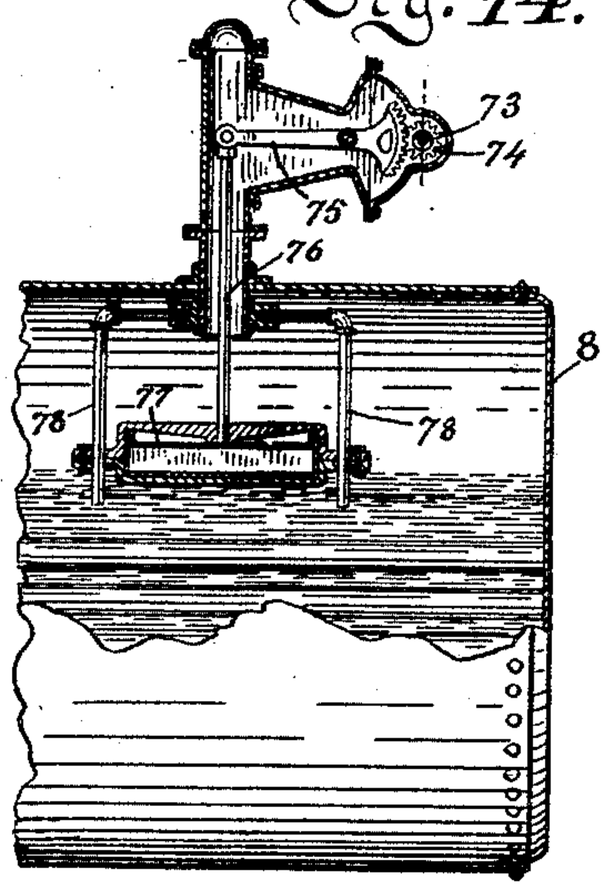



Fig. 14.




Witnesses.

Chas. S. Leonard.

A. M. Hood.

Inventor.

Fred. L. McGahan.

By H. P. Hood,

Atty

# UNITED STATES PATENT OFFICE.

FRED. L. McGAHAN, OF INDIANAPOLIS, INDIANA.

## APPARATUS FOR CONDENSING EXHAUST-STEAM.

SPECIFICATION forming part of Letters Patent No. 462,271, dated November 3, 1891.

Application filed January 19, 1891. Serial No. 378,280. (No model.)

*To all whom it may concern:*

Be it known that I, FRED. L. McGAHAN, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented a new and useful Improvement in an Apparatus for Condensing Exhaust-Steam and Supplying Boilers with Pure Water, of which the following is a specification.

My invention relates to an improved apparatus by means of which the exhaust-steam from a steam-engine is condensed and returned to the boiler.

The object of my improvement is to provide, arranged in series for co-operative action, first, means to prevent any back-pressure on the engine which would be otherwise due to the retardation or confinement of the exhaust-steam; second, to provide improved means for separating from the exhaust-steam any oil which may be carried over from the steam-cylinder; third, to provide an improved condenser for condensing the exhaust-steam by means of cold water; fourth, to provide means for condensing such of the exhaust-steam as may escape from the cold-water condenser by means of an air-current, and, fifth, to provide improved means for controlling the throttle-valve of the steam-pump which supplies the boiler with water, the whole forming an apparatus by means of which the exhaust-steam from an engine is returned to the boiler in the shape of pure water, all as hereinafter fully described.

The accompanying drawings illustrate my invention.

Figure 1 is a diagram or elevation illustrating the entire apparatus. Figs. 2 and 3 are elevations, on an enlarged scale, of the means for controlling the throttle-valve of the steam-pump. Fig. 4 is a plan of the same. Figs. 5 and 6 are elevations, partly in section, of the means for preventing back-pressure on the engine. Fig. 7 is a horizontal section of the same on the line 2, Figs. 5 and 6. Fig. 8 is a vertical longitudinal section of the oil-separator on the line 3, Fig. 9. Fig. 9 is a vertical transverse section of the oil-separator at the line 4, Fig. 8. Fig. 10 is a plan of the cold-water condenser at the line 5, Fig. 11. Fig. 11 is a vertical longitudinal section of the cold-water condenser on the line 6, Fig. 10. Fig. 12 is a transverse section of the cold-water condenser on the line 7, Fig. 11. Fig. 13 is a vertical section of the air-blast condenser. Fig. 14 is a sectional view showing the interior of the boiler and the float for controlling the throttle-valve of the steam-pump. Fig. 15 is a plan of the float, and Fig. 16 a plan of the float and its guides.

In the diagram Fig. 1, 8 designates the boiler, 9 the water-tank, and 10 the steam-pump which supplies the boiler from the water-tank through the pipe 11. The pump is supplied with steam from the boiler through the pipe 12. The engine 13 is connected with the boiler by the steam-pipe 14. The oil-separator 15 receives the exhaust-steam from the engine through pipe 16, which is provided with a condense-water trap 17 and an exhaust-fan 18. The oil-separator is also connected with steam-supply pipe 14 by a pipe 19. The cold-water condenser 20 is connected with the oil-separator by the exhaust-steam pipe 21, the condense-water pipe 22, and the cold-water-supply pipe 23, which receives its supply of cold water through the oil-separator from the supply-pipe 24. The exhaust-steam, after passing through the cold-water condenser, passes through pipe 25 to the air-blast condenser 26. The water of condensation which collects in the oil-separator, the cold-water condenser, and the air-blast condenser passes through pipes 22, 27, 28, and 29 to the water-tank 9.

The oil-separator consists of a closed tank 30, surrounded by a water-jacket 31, Figs. 8 and 9. Tank 30 is provided with a series of flattened tubes 32, passing transversely through the tank and open at both ends. Arranged alternately with the tubes 32 and parallel therewith is a series of removable partitions 33. Partitions 33 are provided at their upper and lower edges, alternately, with a series of perforations 34. The inlet exhaust-steam pipe 16 and the outlet exhaust-steam pipe 21 are arranged on opposite sides of tank 30 and at right angles to the tubes 32 and partitions 33. Arranged below tubes 32 and partitions 33 are a pair of horizontal partitions 35 and 36, each extending only a part of the length of the tank in opposite directions and having secured to their opposed surfaces a series of baffle-plates 37. The

purpose of the tubes 32 is to permit a free circulation of the water contained in the water-jacket 31 and supplied through the cold-water-supply pipe 38 through the tank 30, so that the vaporized oil entering by the exhaust-pipe 16 may be quickly condensed and thrown down upon the horizontal partition 35. The purpose of the partition 36 and baffle-plates 37 is to form a water seal from the condense-water, as illustrated in Fig. 8, so as to prevent the passage of steam, oil, or gummy sediment therefrom into the lower part of the tank.

For the purpose of cleaning out any sediment from the water which may be deposited in the lower part of tank 30 the upper part of the tank is connected with the live-steam-supply pipe 14 by pipe 19 and is provided with a blow-off valve and pipe 39. The condense-water which collects in tank 30 is discharged through the pipe 22, the arrangement being such that when pipe 22 is open the condense-water will stand in tank 30 level with the lower edges of the partitions 33.

For the purpose of drawing off the oil which may float upon the surface of the water in tank 30 a discharge-pipe 40 is connected with the interior of the tank a little above the normal level of the condense-water therein, and the oil is discharged by closing valve 41 in pipe 22, thus causing the water in tank 30 to rise above its normal level and be discharged with the oil carried thereon through pipe 40.

The cold-water condenser into which the steam enters through pipe 21 is constructed as follows: A series of water-reservoirs 42, secured together side by side and communicating alternately at the top and bottom through short pipes 43, and having each a series of flues 44 open at both ends and extending through the tank from end to end, is connected at opposite ends with a series of steam-chambers 45 and 46, the arrangement being such that the exhaust-steam enters the first of the series of chambers 45 through pipe 21, passes from thence through the flues 44 of the first of the series of reservoirs 42 into the first of the series of chambers 46, then back through the second series of the flues 44 to the second of the series of chambers 45, and so on until finally discharged through the exhaust-steam pipe 25. The reservoirs 42 are kept full of cold water through the water-supply pipe 23, which may be supplied from any convenient source. The water of condensation collects in the lower part of the steam-chambers 45 and 46, passing from one to the other through perforations 47, Fig. 12, and out through the waste-pipes 27 and 29 to tank 9. The air-blast condenser, into which such of the exhaust-steam as is not condensed in the water-condenser passes through pipe 25, is constructed as follows: A series of connected chambers 48, provided interiorly with baffle-plates 49, is centrally arranged in an air-shaft 50, extending vertically from a trunk 51, erected, preferably, on the roof of a building in which the apparatus is contained, and having on each side openings 52, which may be tightly closed by doors 53, the purpose being to create a current of air through the air-shaft 50 by means of a natural circulation, which may be supplemented or superseded by an air-blast from the fan 54. The water of condensation which collects in chambers 48 passes from the uppermost to the lowest one through drain-pipes 55, and from thence through pipes 28 and 29 to the water-tank 9.

For the purpose of aiding the maintenance of a partial vacuum in that portion of pipe 16 which is between the exhaust-fan 18 and the steam-cylinder, in case the movement of the fan should be momentarily interrupted by the slipping of its driving-belt, I connect with the exhaust-pipe, by means of pipes 56 and 57, a pair of cylinders 58 and 59. Said cylinders are each provided with a nicely-fitted piston 60, which is connected by means of chain 61 with a piston 62, loosely mounted in cylinder 63, which contains a spiral spring 64, the arrangement being such that when the pistons 60 are near the upper ends of their respective cylinders the springs 64 rest between the heads of their respective cylinders and the pistons 62, so that as the pistons 60 move downward the springs 64 are put in tension and the pistons 60 when released are raised by the recoil of the springs.

For the purpose of automatically controlling the action of the feed-water pump 10, I mount upon the shaft 65 of the throttle-valve 66 a disk 67, having a series of perforations 68. Said disk is secured rigidly to the shaft of the throttle-valve, so as to turn therewith. I also mount loosely upon shaft 65, and opposed to disk 67, a second disk 69, having a series of slotted perforations 70, which register with the perforations 68 in disk 67. Disk 69 is provided with an operating-lever 71, which is connected, by means of a connecting-rod 72, shaft 73, pinions 74, Fig. 14, segment-lever 75, and rod 76, with a float 77, mounted on vertical guides 78 within the boiler and resting on the surface of the water therein. The arrangement of disks 67 and 69 is such that when a pin 79 is inserted in one of the perforations 68, passing through one of the slots 70 in disk 69, said disk may be turned or oscillated a short distance without affecting the throttle-valve, but will, on being moved farther in either direction, engage pin 79, and thus turn disk 67 and open or close the valve, as the case may be. By this mechanism, pin 79 being removed, the throttle-valve may be opened any desired distance by means of the hand-wheel 80 and the pump started. When the boiler has been filled to the desired height, pin 79 is inserted in one of the perforations 68, and, disk 69 being oscillated by the movements of the float 77, the valve is not affected by the rise and fall of the water in the boiler within certain narrow limits; but when those

limits are exceeded the movement of the float is communicated to the valve and the speed of the pump is increased by the falling of the water-level and decreased by its rising.

In operation, the engine being started and fan 18 thereby put in motion, a partial vacuum is formed in the exhaust-pipe 16 and cylinders 58 and 59. Pistons 60 in said cylinders yield to the pressure of the atmosphere until said pressure is balanced by spring 64. Should the speed of the exhaust-fan be momentarily interrupted by the slipping of its belt or otherwise, pistons 60 are at once drawn upward in their respective cylinders by the recoil of spring 64, thus maintaining a vacuum in the exhaust-pipe. The exhaust-steam from the engine passing into the vacuum formed by the exhaust-fan and being driven by said exhaust-fan forward through the condensing apparatus, the piston of the engine is relieved from back-pressure. The exhaust-steam, passing from the fan and carrying more or less vaporized oil, enters tank 30 of the oil-separator through pipe 16 and is projected against the first of the vertical partitions 33 and passes through perforations 34, and thence over and around the first of the flattened tubes 32, and thence alternately through and around the remaining partitions 33 and tubes 32, passing out of the oil-separator through the pipe 21. The cold water entering water-jacket 31 through pipe 38 from any suitable source surrounds tank 30 and circulates through tubes 32, thus reducing the temperature and causing a deposit of all the oil carried by the exhaust-steam in tank 30 upon or above the horizontal partition 35 therein. The first water of condensation forming in tank 30 fills the spaces between the partitions 37 and prevents the escape of the steam in that direction, and as the water continues to form the lower part of the tank is filled with condense-water until the level of pipe 22 is reached, when the surplus passes off through said pipe. The exhaust-steam enters the first of chambers 45 of the water-condenser 30 and passes alternately from one side to the other of the condenser through pipes 44 until it escapes through pipe 25, as before explained, into the chambers 48 of the air-blast condenser. By this means all of the steam which escapes from the engine is condensed and conducted to tank 9, from whence it is pumped into the boiler to be again converted into steam. The boiler being continually supplied with pure water, the difficulties and dangers arising from the deposit of sediment therein are avoided.

I am aware that the exhaust mechanism, the separator, the cold-water steam-condenser, the muffler or air-condenser, and the means for controlling the steam-valve of the steam-pump may be used as separate and independent inventions, and therefore I do not herein make specific claims therefor, but reserve them for separate applications; but I believe the arrangement of these several instrumentalities in series, as herein shown and described, to be new and useful, and therefore

I claim as my invention—

In an apparatus for condensing exhaust-steam and supplying pure water to boilers, the combination of the steam-boiler, the steam-engine connected therewith, the oil-separator, the cold-water condenser, and the air-blast condenser, each constructed substantially as shown and described and arranged in series, as set forth, the exhaust-fan connected with the exhaust-pipe of the engine and with the oil-reservoir, as set forth, the water-tank arranged to receive the water of condensation from the condensers, and the pump arranged to force the water from said tank into the boiler, all arranged to co-operate substantially as and for the purpose set forth.

FRED. L. McGAHAN.

Witnesses:
V. M. HOOD,
H. P. HOOD.