No. 654,577. Patented July 24, 1900.

G. H. ABRAMS.

REFRIGERATING MACHINE.

(Application filed May 9, 1896.)

(No Model.) 3 Sheets—Sheet 1.

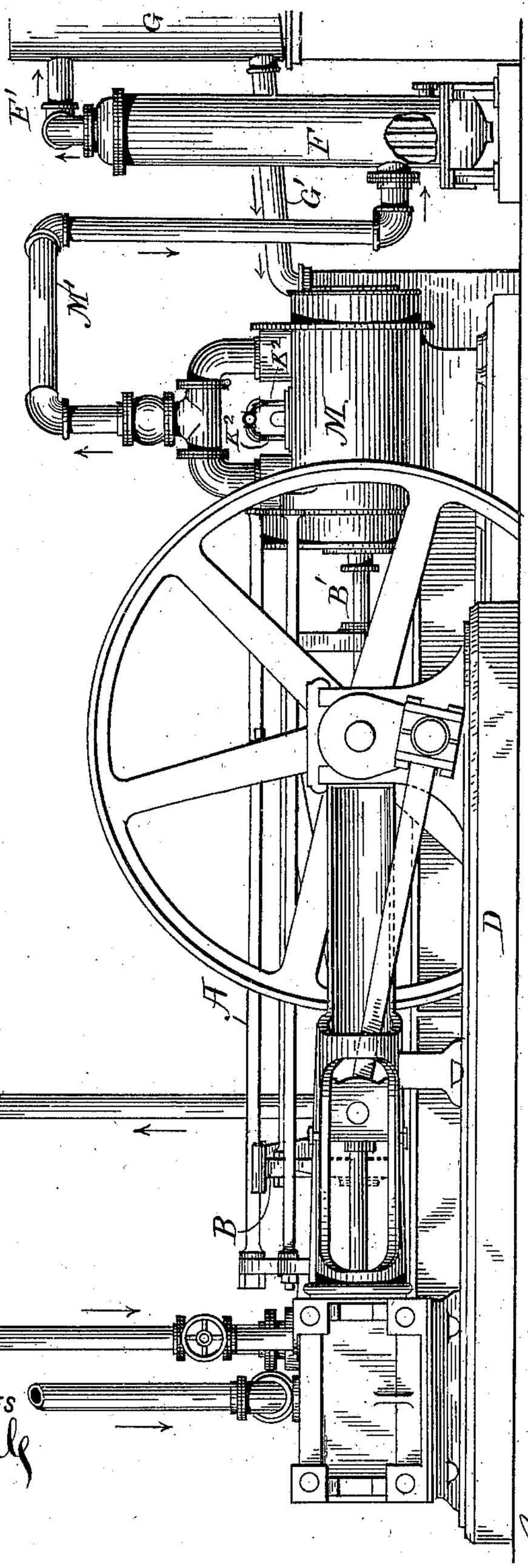

Fig. 1.

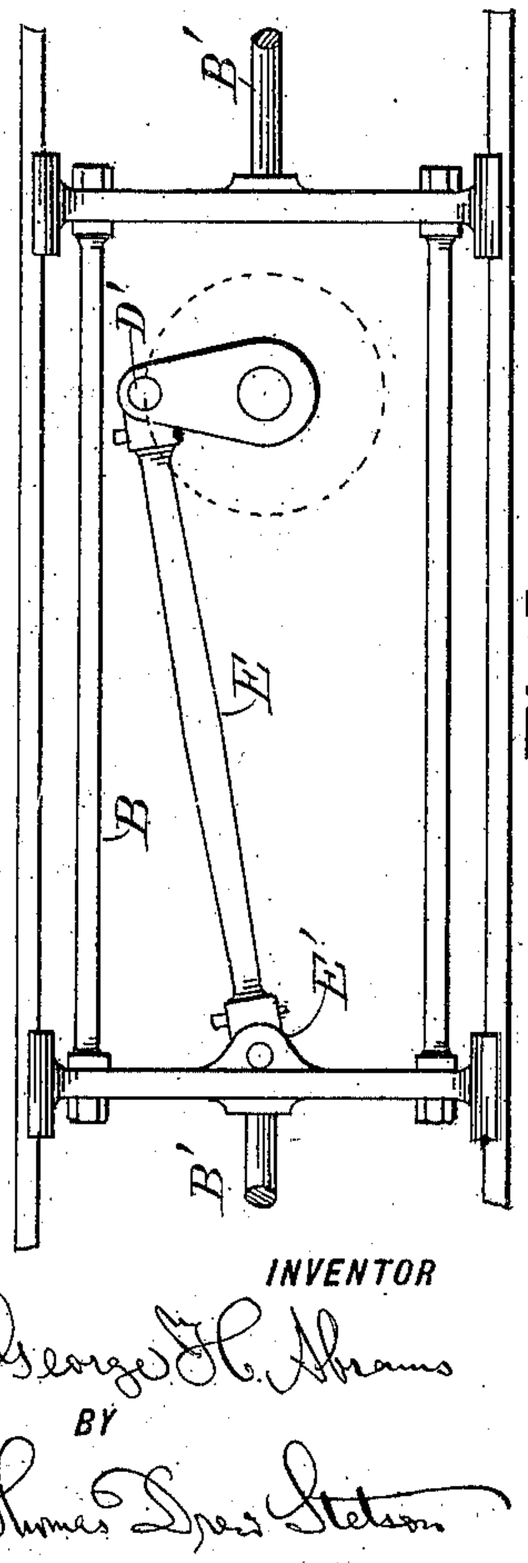

Fig. 6.

WITNESSES

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(Application filed May 9, 1896.)

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3 Sheets—Sheet 2.

Fig. 2.

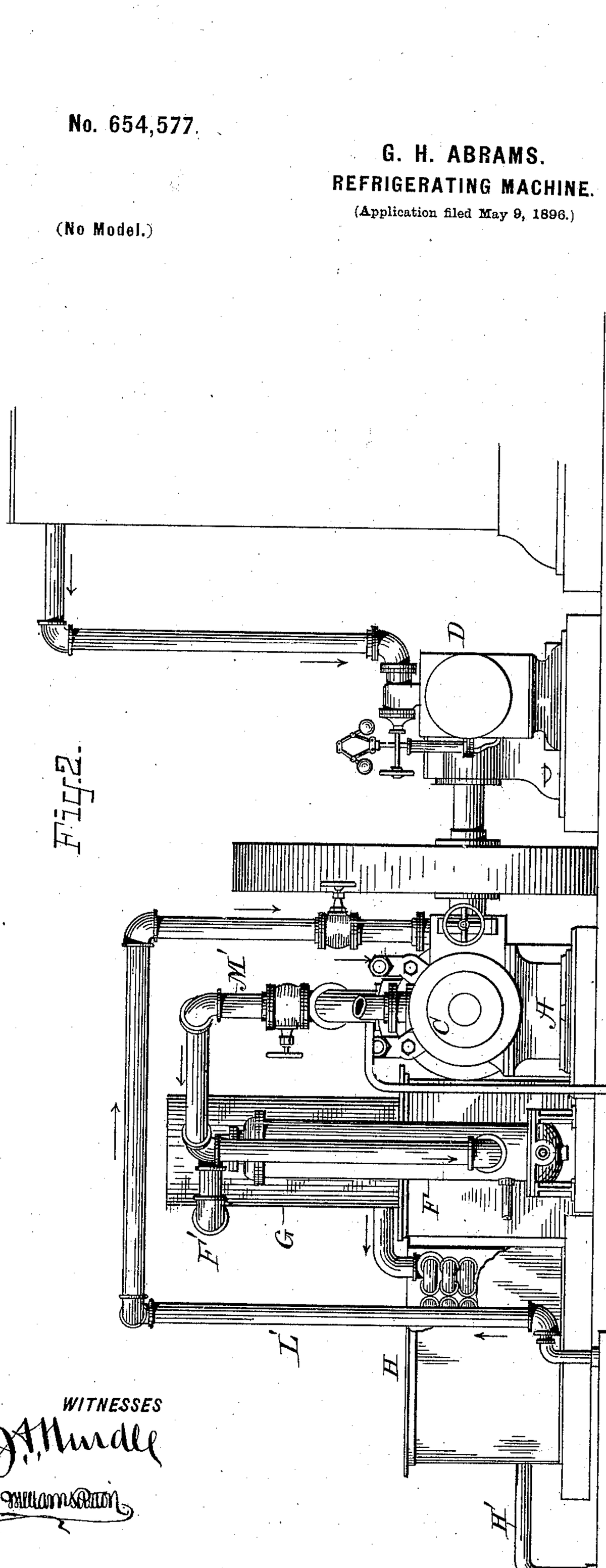


Fig. 3.

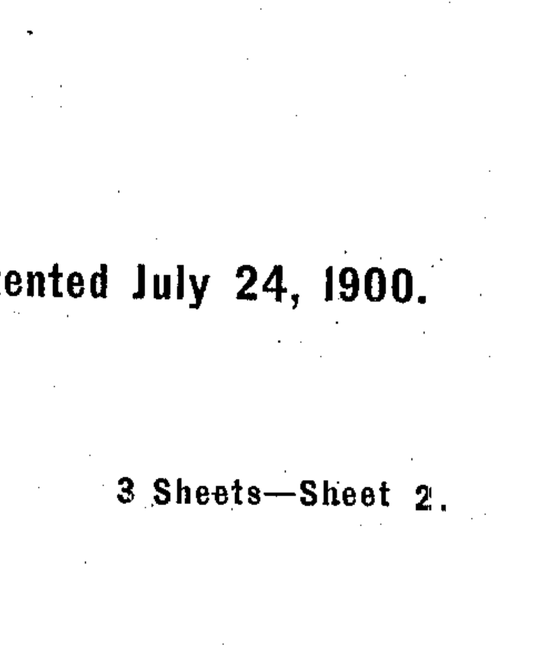
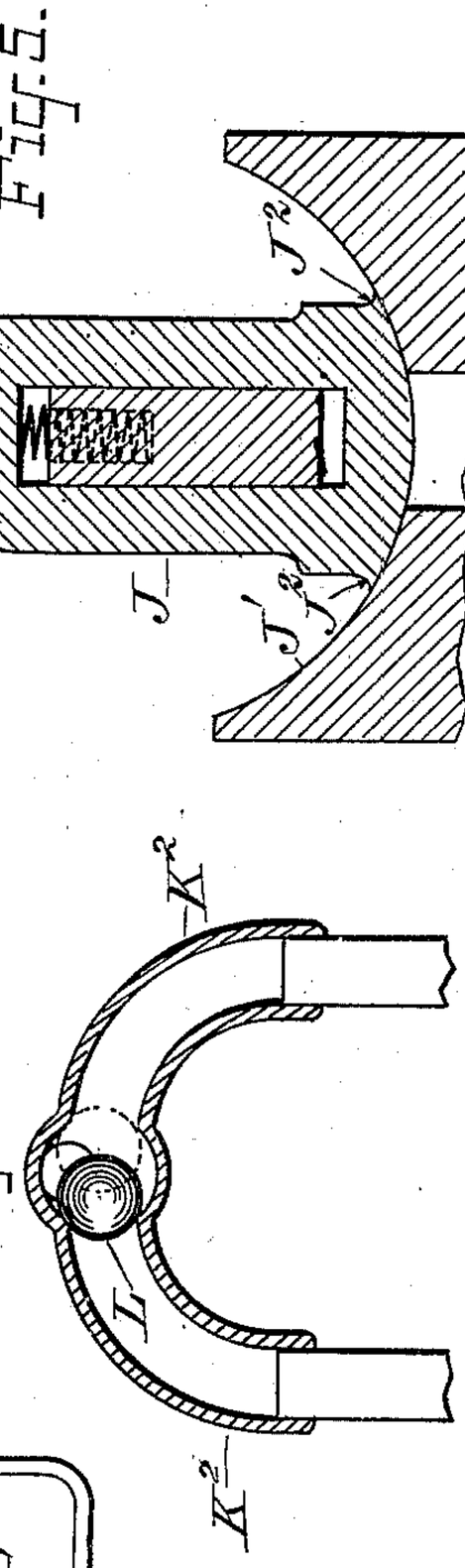


Fig. 4.



WITNESSES

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No. 654,577. Patented July 24, 1900.

G. H. ABRAMS.

REFRIGERATING MACHINE.

(Application filed May 9, 1896.)

(No Model.) 3 Sheets—Sheet 3.

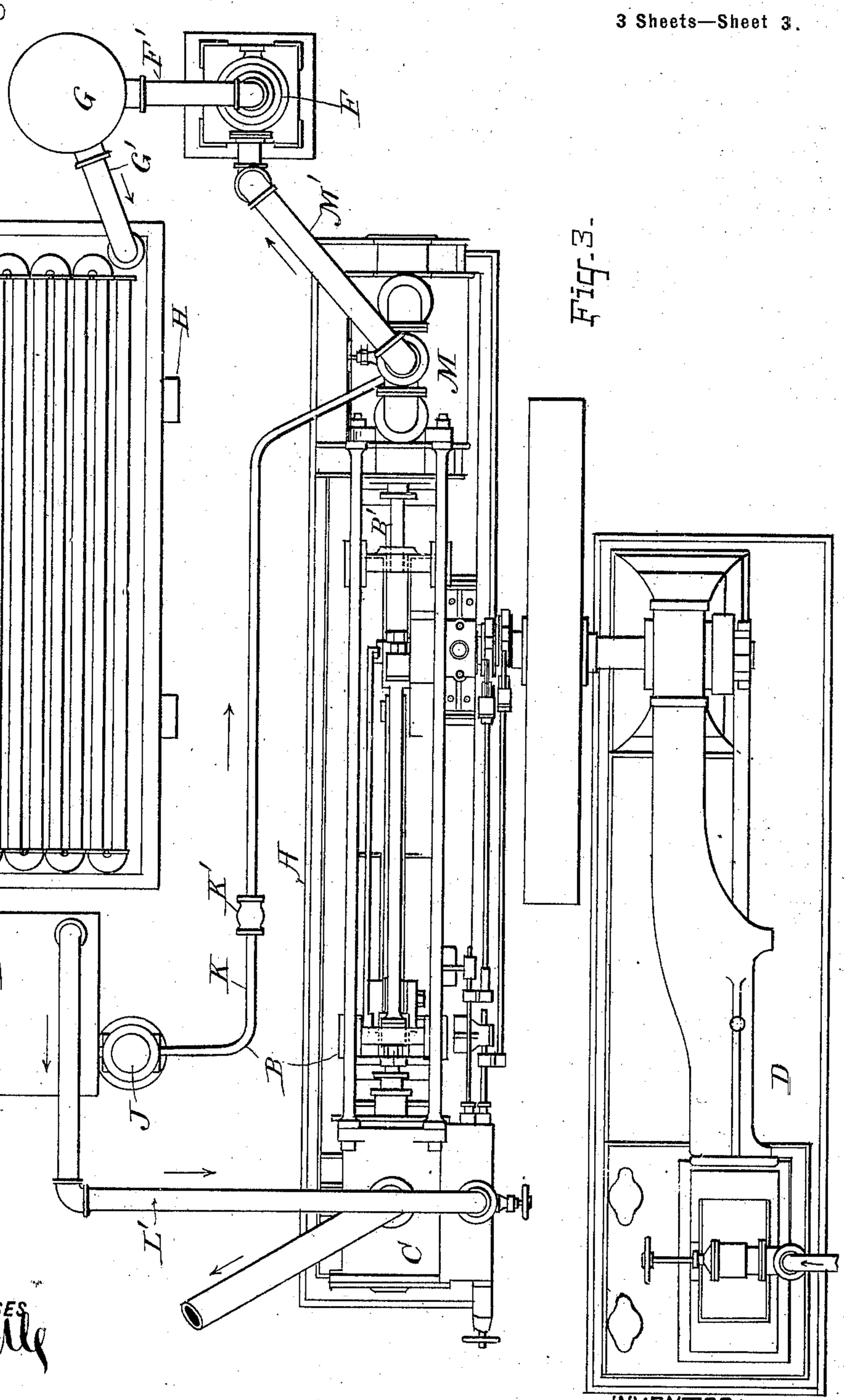

Fig. 3.

WITNESSES
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William Seton

INVENTOR:
George H. Abrams
BY Thomas Spencer Seton
ATTORNEY

UNITED STATES PATENT OFFICE.

GEORGE H. ABRAMS, OF NEW YORK, N. Y.

REFRIGERATING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 654,577, dated July 24, 1900.

Application filed May 9, 1896. Serial No. 590,805. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. ABRAMS, a citizen of the United States, residing in New York, (Brooklyn,) Kings county, in the State of New York, have invented a certain new and useful Improvement in and Relating to Refrigerating-Machines, of which the following is a specification.

The improvement applies to that class of refrigerating apparatus in which gaseous matter is compressed by mechanical force and the heat of compression abstracted and the gas then allowed to expand and to call for heat, so as to powerfully lower the temperature of all surrounding bodies. I use ordinary atmospheric air for such purpose. I have devised a peculiarly efficient and convenient arrangement of mechanism by which the expansion of the compressed air after the heat has been conveyed away contributes by a direct connection to the motion of the compressor, and another motor serving auxiliary thereto furnishes the remainder of the power required.

The accompanying drawings form a part of this specification and represent what I consider the best means of carrying out the invention.

Figure 1 is a general side elevation, Fig. 2 an end elevation, and Fig. 3 a plan view of the entire apparatus. The remaining figures show portions on a larger scale. Fig. 4 is a vertical section showing a valve which aids in bringing moisture to lubricate the interior of the compressor-cylinder. Fig. 5 is a vertical section showing my provision for clearing ice from the valve-seats. Fig. 6 is a side elevation showing certain portions detached.

Similar letters of reference indicate corresponding parts in all the figures where they appear.

A indicates the stationary framing.

B′ B′ are piston-rods which are in line with each other and each firmly attached to a central open frame B and to pistons, (not shown,) which, it will be understood, work with proper tightness, one in the compressor M, provided with suitable valves, which by the reciprocations of the piston laterally take in and compress and discharge a large volume of atmospheric air. The cylinder C, which incloses the other piston at the other extremity of the apparatus, is equipped with valves to properly control the admission of the tensely-compressed air and to cut off the same, as is managed in utilizing the mechanical action of steam, and allow its expansion to impel the piston, and thereby aid to operate the compressor. The remainder of the power required to drive the compressor is received through a steam-engine D, which may be of any ordinary pattern and need not be described at length. The power is communicated from the crank-pin D′ through a connecting-rod E to a strong knuckle E′, properly located in the frame B. The air is taken into the compressor through ordinary self-acting valves. (Not shown.) This air may be the ordinary air from out of doors or from the interior of the building, or it may be air colder and less charged with moisture and dust, which has just been utilized in the apparatus. The compression develops by well-known laws a high degree of sensible heat, which must be removed, so that the low temperature desired may be attained by the expansion of the air after such removal. I take away the heat from this air by a series of instalments with the advantage that the first instalment is removed under such conditions that it may be utilized. I will describe it as serving to heat a small quantity of water to a high temtemature to serve for feeding steam-boilers.

The compressed air containing its fully-developed heat of compression is delivered through the pipe M′ into an upright vessel F, in which by being circulated in close relation with a small quantity of water carrying either the water or the air through small thin pipes and allowing the other fluid to move through the spaces between the water is usefully heated and the air temperature commences to be lowered. This is the first instalment of the cooling of the air. A pipe F′ conveys the slightly-cooled air still under the full pressure into a second cooling vessel G, where its temperature is further lowered. From this vessel the cooling-water is delivered heated to a less degree than that which is discharged from the vessel F. I can utilize this water from the second vessel G, but it must be for uses which do not require a very high temperature. The compressed air is delivered from this vessel G through a pipe G′ into the

condenser proper, (marked H,) where it circulates through pipes surrounded by a liberal flow of cold water. I have not deemed it necessary to show the water connections. It will be understood that the cold water is admitted in liberal quantities at one point and circulates through the spaces between the pipes, so as to cool the compressed air in the pipes very efficiently, the water flowing out only slightly warmed. I make no attempt to utilize the heat from this condenser. The air flows from the condenser through the pipe H′ into a fourth and final cooler I, in which it is exposed directly to a supply of flowing water, which cools the air very nearly to the temperature thereof. Where water can be commanded at 70° Fahrenheit, the air can be cooled down to 80° Fahrenheit.

J is a trap. I prefer that set forth in the patent to S. B. Hunt, dated January 20, 1880, No. 223,648, but any efficient trap which will perform the ordinary functions of retaining the air and delivering the water by the buoyant power of the latter acting on a float connected to the discharge-valve may serve.

K is a pipe, which may be of small diameter, leading from a point in the interior of the trap above the valve, but at so low a level that it is sure to deliver water or air liberally mingled with water. This pipe leads to a fork at the mid-length of the compressor, the two arms being marked K^2. A suitable chamber at the junction of the forks K^2 with the pipe K contains a ball-valve L, which is loosely fitted. As the piston reciprocates it induces variable conditions with regard to pressure in these branches K^2 and also through the pipe K above the valve K′. During a brief period while the piston is traversing the interval between the mouths of the pipes K^2 the ball-valve L prevents the air from flowing past it. The valve K′ at all times prevents any backflow downward through the pipe K into the trap J, and there is a period of greater or less length in each movement of the piston during which the mouths of the pipes K^2 are relieved from pressure. During such period the strong pressure remaining in the trap will force the water or the wet air up past the valve K′ and into the interior of the compressor. These conditions should be so adjusted by properly loading the valve K′ that the apparatus will only deliver a small quantity of water or air mingled with water into the cylinder near the mid-length at each stroke. Its effect is to "lubricate" the interior of the compressor. It is not essential that the load on the valve K′ be adjusted with extreme nicety, because even if a large excess of water came into the compressor through this passage the excess would be delivered through the pipe M′ with the strong current of compressed air which is delivered near the termination of each stroke. The arrangement insures that the rubbing-surfaces of the piston and cylinder shall be always moistened. Furthermore, the arrangement tends to realize the condition, also important in an economical point of view, that the clearance at each end of the cylinder shall be occupied mainly by water as the piston terminates its stroke and commences the return stroke at either end of the cylinder.

Returning now to the main body of the air which flows out of the condenser through the higher passage, such air, now thoroughly cooled, but still maintaining its pressure, flows from this second cooler through a pipe L′ into the valve-chest of the compressed-air motor C. In this important member of the mechanism it exerts its expansive force to contribute to the action of the compressor. The valves J are worked by eccentrics on the main shaft through the medium of rods which may be in all respects similar to the corresponding portions of engines actuated by steam, but the valves are peculiar in their provisions for scraping the surfaces J′ and loosening and removing any ice which may form.

During the four successive cooling operations any moisture which is in the air is liable to be condensed and to accumulate on the inner surfaces of the several vessels and passages. With ordinary air from the external atmosphere such water collects rapidly on the surfaces of the pipes in the condenser H. Gravity causes it to descend from all the several surfaces into the bottoms of the chambers and passages. I so arrange the vessels and passages that there is a continuous descent from the second cooling vessel G quite to the trap.

I claim as my invention—

1. In air-compression systems for both heating and refrigerating, the combination with the alined compressing and expanding pistons in separate and relatively-detached cylinders and directly connected together, said cylinders having pipe K with expanded portions to constitute a valve-chamber with a spherical valve therein, of a prime motor connected therewith, a heat-exchanger and a condenser through both of which the tensely-compressed air is conveyed in successive instalments before delivery to the expansion-cylinder, a trap receiving the condensed water from the air, and a pipe leading therefrom and connecting with the compression-cylinder through a branch to deliver charges of fluid thereto at either end thereof, substantially as herein specified.

2. In air-compression systems for both heating and refrigerating, the combination with the alined compressing and expanding pistons in separate and relatively-detached cylinders and directly connected together, of a prime motor connected therewith, a heat-exchanger and a condenser through both of which the tensely-compressed air is conveyed in successive instalments before delivering to the expansion-cylinder, a trap receiving the condensed water from the air, a pipe leading from such trap and connecting with the compressing-cylinder through branches lead-

ing to opposite ends thereof, said branches having an expanded portion to constitute a valve-chamber together with a freely-movable spherical valve adapted to seat itself to close either of said branches according to the movement of the piston, substantially as herein specified.

3. In air-compression systems for both heating and refrigerating, the combination with the alined compressing and expanding pistons in separate and relatively-detached cylinders and directly connected together, of a prime motor connected therewith, a heat-exchanger and a condenser through both of which the tensely-compressed air is conveyed in successive instalments before delivery to the expansion-cylinder, a trap receiving the condensed water from the air, a pipe leading therefrom adjacent to the water-line and connected with the compression-cylinder through branches leading to opposite ends thereof, said branches having an expanded portion to constitute a valve-chamber together with a freely-movable spherical valve adapted to seat itself to close either of said branches according to the movement of the piston, and a check-valve located in said water-pipe, substantially as herein specified.

4. In air-compression systems for both heating and refrigerating, the combination with the alined compressing and expanding pistons in separate and relatively-detached cylinders and directly connected together, said cylinders having a pipe K with expanded portions to constitute a valve-chamber with a spherical valve therein, of a prime motor connected therewith, a heat-exchanger, a condenser and chamber I in relatively-descending relation and to which all the tensely-compressed air is conveyed in successive instalments before delivery to the expansion-cylinder, a trap receiving the condensed water from the air, a pipe leading therefrom and connected to the compression-cylinder through branches leading to opposite ends thereof, together with a freely-movable spherical valve adapted to seat itself to close either of said branches according to the movement of the piston and a check-valve located in said water-pipe, substantially as herein specified.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

GEORGE H. ABRAMS.

Witnesses:
J. B. CLAUTICE,
M. F. BOYLE.