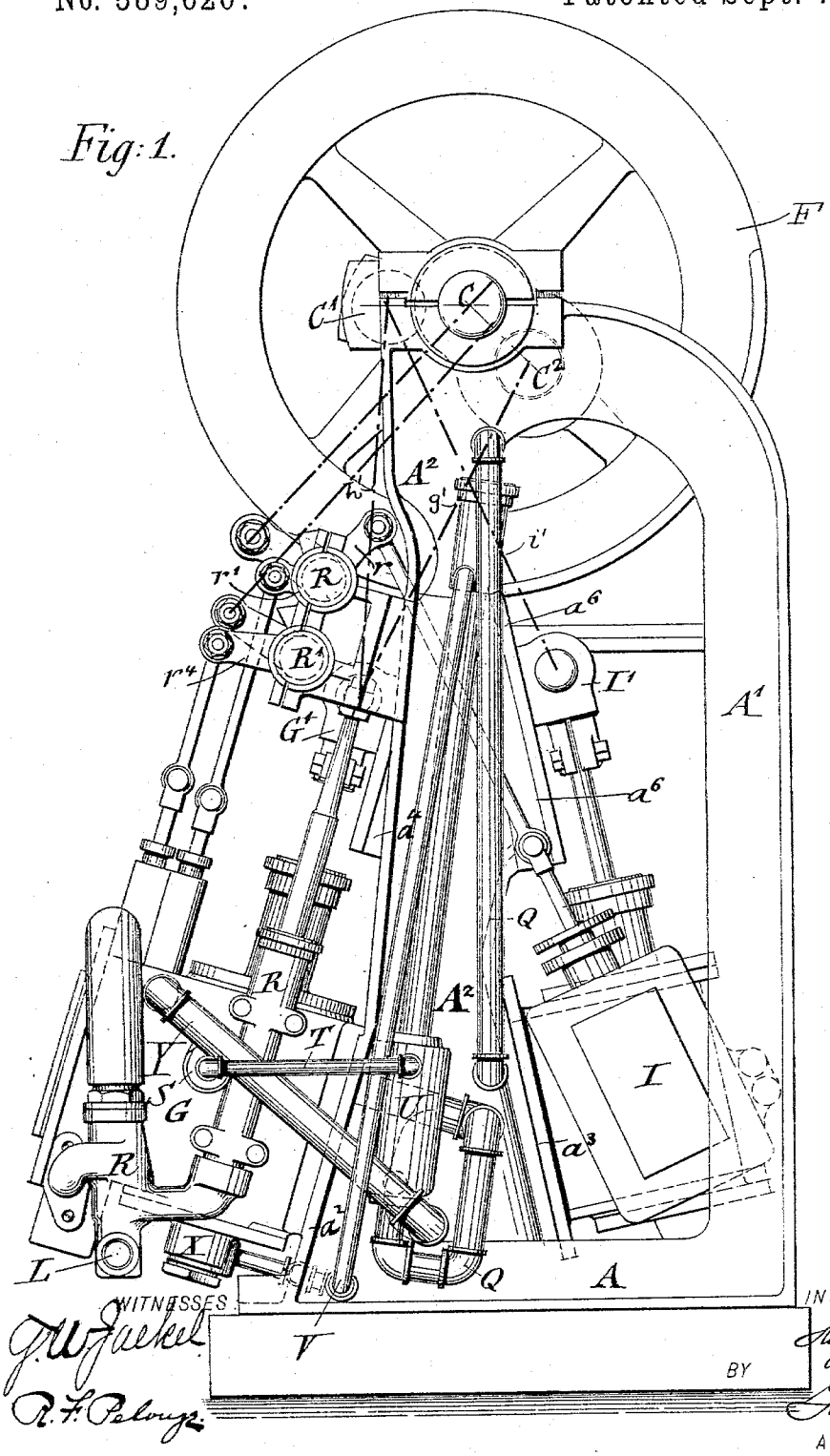
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H. B. ROELKER.

COMPRESSED AIR REFRIGERATING MACHINE.

No. 589,620. Patented Sept. 7, 1897.

Fig. 1.



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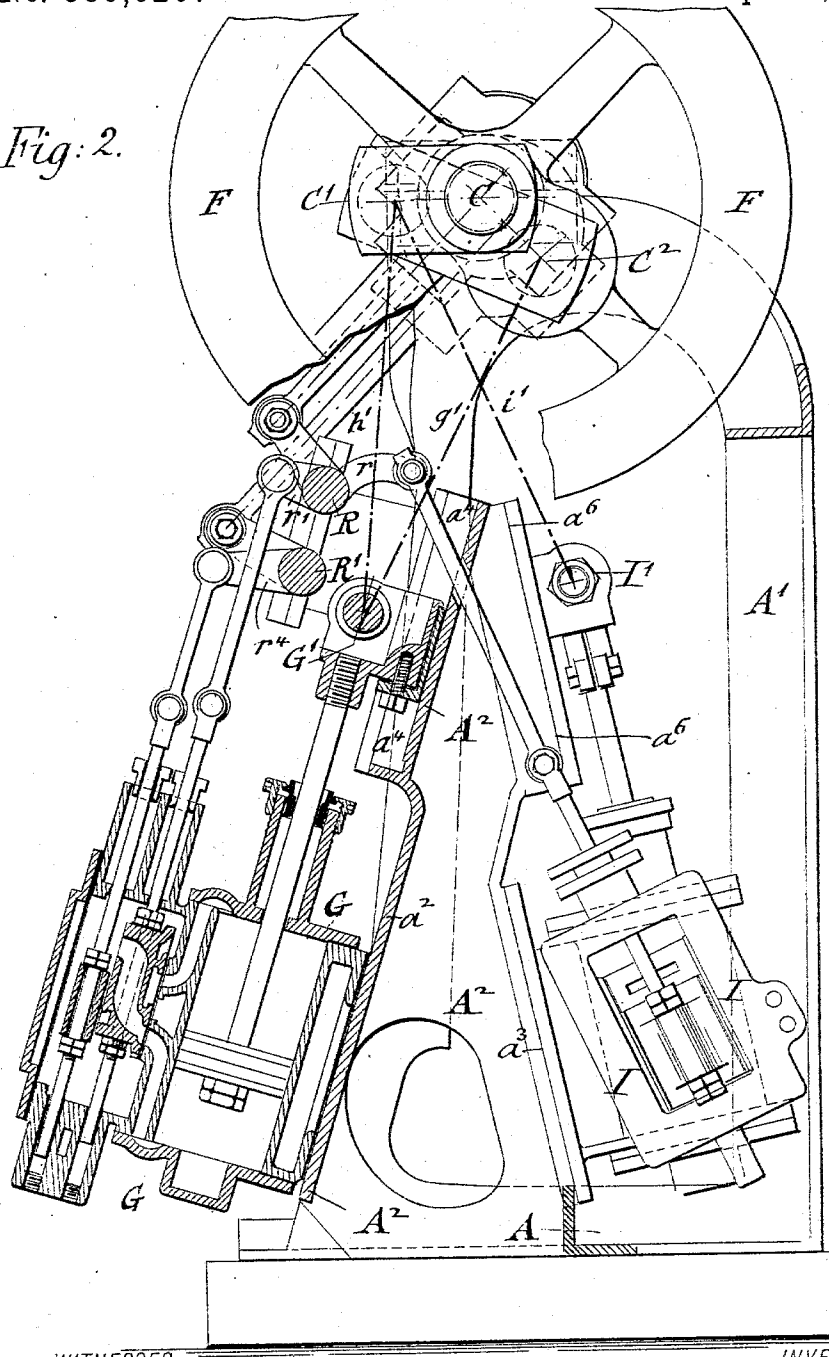
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Fig: 2.



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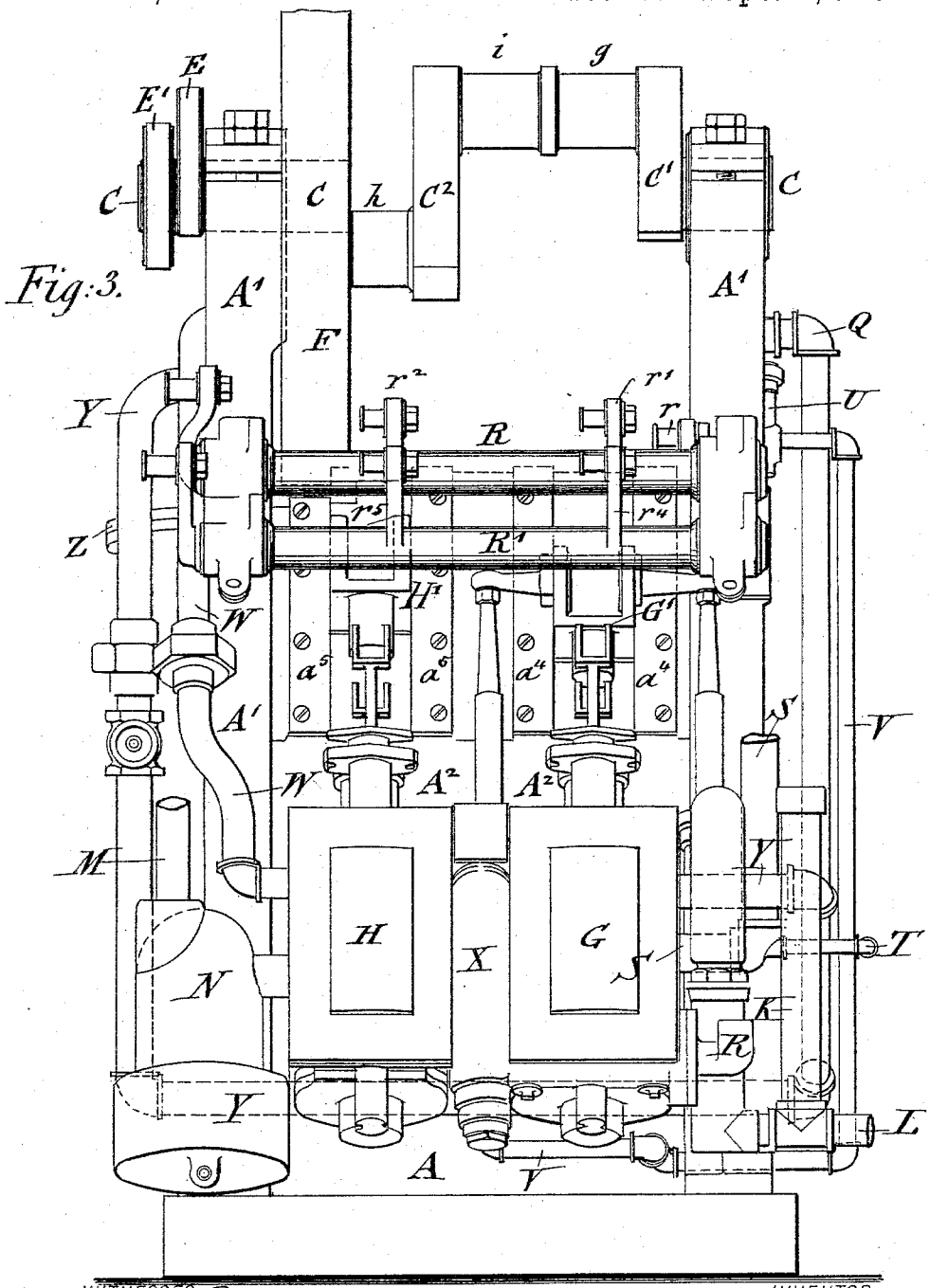
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Fig. 3.



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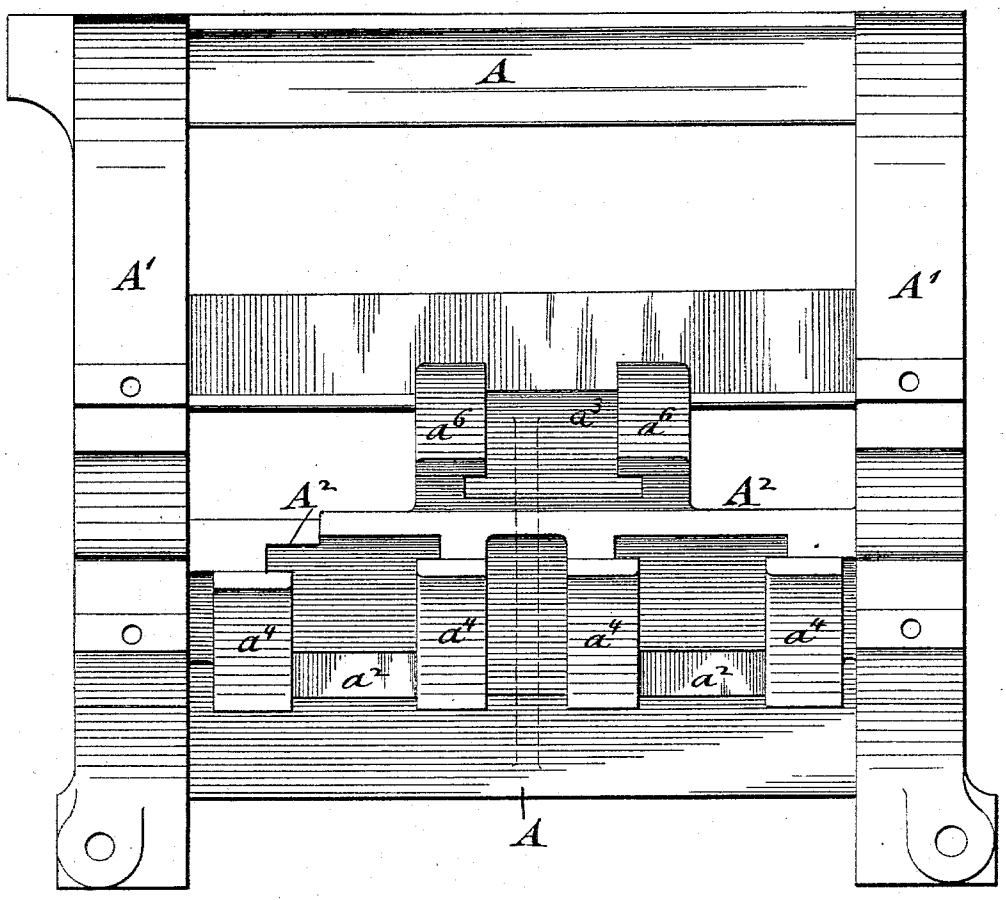
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H. B. ROELKER.

COMPRESSED AIR REFRIGERATING MACHINE.

No. 589,620. Patented Sept. 7, 1897.

Fig: 4.



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UNITED STATES PATENT OFFICE.

HUGO B. ROELKER, OF NEW YORK, N. Y.

COMPRESSED-AIR REFRIGERATING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 589,620, dated September 7, 1897.

Application filed December 24, 1896. Serial No. 616,836. (No model.)

To all whom it may concern:

Be it known that I, HUGO B. ROELKER, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Compressed-Air Refrigerating-Machines, of which the following is a specification.

This invention relates to certain improvements in the refrigerating-machine known as the "Allen compressed-air refrigerating-machine," for which Letters Patent No. 252,921 were granted January 31, 1882. In that machine air is artificially refrigerated by mechanical expansion of the same in a cylinder with a piston and with distributing-valves, which piston, by a piston-rod, cross-head, &c., is linked to a crank-shaft which offers resistance by being also connected to an air-compressor. The air-compressor takes air which is contained in a system of refrigerating and conveying pipes and which is of considerably more than atmospheric pressure and compresses it, thereby heating the air in direct proportion to the labor expended upon it by the compressor. Then it forces the hot compressed air into a cooling-coil surrounded by circulated water, and the cooled compressed air is then led to the expander-cylinder, where the valves admit the same into the cylinder and upon the piston in the same during a portion of the stroke. Then they shut off the inlet and the continuation of the motion of the piston to the end of the cylinder expands the air at diminishing pressure and causes refrigeration of the same proportionate to the labor performed by the piston during the expansion. In addition to the compressor, cooling-coil, and expander there is required in such a machine a steam-engine which supplies the excess of power which the compressor requires above that supplied by the expander, also the power required to overcome friction. There is also a primary air-pump which takes air from the atmosphere and charges the refrigerating-pipe system with the initial air-pressure; also a water-pump which supplies the circulating cooling-water; also a trap which removes the atmospheric water from the air put in by the primary air-pump; also one trap which removes the lubricating-oil from the expanded refrigerated air before this enters the cold pipes; also various pipes for conveying water and air to the various operations.

My invention is designed to carry out these objects; and it consists of a refrigerating-machine in which two air compressing and expanding cylinders are arranged alongside of each other at the front of the machine, while the steam-cylinder is arranged at the rear of the same, said cylinders being inclined toward each other and provided with cross-heads and connecting-rods linked to cranks on a crank-shaft above the cylinders, which cranks are arranged at an angle of one hundred and twenty to one hundred and fifty degrees toward each other.

The invention consists, further, of a refrigerating-machine in which the air compressing and expanding cylinders are arranged in the front and the steam-cylinder at the rear of the machine, a crank-shaft supported above said cylinders and cranks on said crank-shaft, and two eccentrics at the outer end of said crank-shaft, the angles formed by the center line of the air-cylinder and steam-cylinder supplying, in connection with the angles at which the cranks are placed toward each other, the required valve motions, so that the five slide-valves of the three cylinders are driven by two rock-shafts, each of which is actuated by one of the eccentrics on the crank-shaft.

The invention consists, further, of certain details of construction and combination of parts, which will be fully described hereinafter and finally pointed out in the claims.

By the practical use of the Allen compressed-air refrigerating-machine it was found that machines which are to be used on vessels and which require a comparatively small refrigerating power must occupy the smallest possible floor-space and must be able to run at a high number of revolutions at a high primary air-pressure and with almost absolute noiselessness. These machines also have to run at fast or slow speed with uniform motion, so as to require little balancing effect from a fly-wheel and with small strain on bearings. In the machine constructed by me and in which my inventions are applied these especial necessities are obtained by the peculiar placing together of the compressor and

expander cylinders and of a steam-cylinder at certain angles of center lines and by crank-pin angles, so that the stresses exerted by their pistons nearly balance and exert but little pressure on the fixed bearings and require only a small balance-wheel when working at slow speed. These same angles make it possible to use slide-valves (also of peculiar construction) instead of the usual conical lift-valves for the inlet and the outlet of the air-compressor and to do this without additional multiplication of moving parts. These slide-valves of the compressor provide a full air-inlet opening from the air-suction pipe during the suction-stroke, then a complete closing off during the act of compression, then an opening to the high-pressure part while the piston pushes the compressed air out, then a complete closing off while the high-pressure air in port and clearance expands to suction-pressure during the first return movement of piston, and then again a full suction-opening from the air-suction pipe, all this for a double-acting cylinder. The fixed bearings are placed outside of all the crank-pins because this still further relieves them from the unbalanced portion of the crank-pin pressures by dividing them always upon both the bearings instead of increasing the strain by extra leverage, as is done when the crank-pins are located outside of fixed bearings which are at comparatively close distances.

Other practical advantages are obtained by the exposed position of the air-cylinders, which require closer looking after than any other part of an air ice-machine. This combination makes it possible to run the machine noiselessly at high speed and with high pressures with little wear of parts and little attention, and at the same time a lightness and smallness are obtained by the compact position of parts, which all make this combination a very useful one.

The drawings accompanying this application show practically all parts composing this machine, but the minor parts, upon the arrangement of which I do not lay stress, are not lettered.

In the accompanying drawings, Figure 1 represents a side elevation of my improved dense-air refrigerating-machine. Fig. 2 is also a side elevation, partly in section, through one of the air-cylinders and its slide-valves and the supporting-frame of the machine. Fig. 3 is a front elevation of the machine, and Fig. 4 is a plan view of the supporting-frame of my improved refrigerating-machine.

Similar letters of reference indicate corresponding parts.

Referring to the drawings, A represents the supporting-frame of my improved refrigerating-machine, which is composed of two upright side standards A′, that are connected at their base portion and at the upper ends. The base and side standards A′ are transversely connected by a web A^2, which is cast with two inclined seats a^2 at its front part and an inclined seat a^3 at its rear part, which seats serve as supports, respectively, for the air compressing and expanding cylinders G and H and a steam-cylinder I. The side standards A′ are further provided at their upper ends with journal-bearings for a crank-shaft C, which is provided between the side standards with two cranks C′ C^2 on the crank-shaft C, a fly-wheel F, and with two eccentrics E E′ at the outer end of the shaft C. To the front seats a^2 of the transverse web A^2 are attached, sidewise of each other and at suitable inclination to the transverse plane passing through the center of the crank-shaft, the air compressing and expanding cylinders G and H, while the steam-cylinder I is supported in the rear seats a^3 of the supporting-web A^2, as shown in Fig. 2. Above the inclined seats of the cylinders are arranged on the transverse web A^2 inclined guides a^4 a^5 a^6 for the cross-heads G′, H′, and I′ of the air and steam cylinders. The piston-rods of the three cylinders are separately connected to their corresponding cross-heads, and the latter linked by connecting-rods g' h' i' to crank-pins g, h, and i on the cranks C′ C^2, as shown in dotted lines in Fig. 3.

The proper angle of inclination at which the air and steam cylinders are to be supported toward each other on the transverse web A^2 of the frame is preferably an angle of from twenty-five to fifty degrees. The valve-faces of the steam-cylinders I are arranged at right angles to the valve-faces of the air-cylinders, as shown in Figs. 1 and 2, which, in connection with the inclination of the air and steam cylinders toward each other, permits that the connecting-rod of the slide-valve of the steam-cylinder can be applied to an arm on the same rock-shaft to which the connecting-rods of the main valves of the air-cylinders are applied. The relative positions of the steam-cylinder I to the air expanding and compressing cylinders G and H also furnish a favorable angle for balancing the power which is supplied by the steam-cylinder and the air-expanding cylinder with the force consumed by the air-compressing cylinder during each rotation of the crank-shaft.

The air-expanding cylinder H is provided with the usual main slide-valve and cut-off valve, while the air-compressing cylinder G is provided with a main slide-valve and with a top slide-valve similar to a cut-off valve, instead of the usual conically-seated lift-valves. The crank C′ of the air-compressing cylinder G is arranged at an angle of from one hundred and twenty to one hundred and fifty degrees to the crank C^2 of the air-expanding cylinder H, so that a single eccentric E and a single rock-shaft R, with arms r r' r^2, can operate the main slide-valves of the steam-cylinder and of the air compressing and expanding cylinders for producing the proper distribution of pressure and exhaust. The second eccentric E′ and a second rock-shaft

R′, with arms r^4 r^5, are arranged for operating the top slide-valves of the air compressing and expanding cylinders, so that the air-pressure is cut off at the proper point in the latter before expansion and that the air-compressing cylinder be opened to the general air-pressure when the piston has compressed the air to the pressure prevailing in the compressed-air cooler.

It appears from the foregoing, therefore, that the two eccentrics E E′, which are arranged at the outer end of the crank-shaft C, operate, in connection with the two rock-shafts R R′, the five slide-valves of the three working cylinders G, H, and I, which act on the crank-shaft C at different angles and crank positions.

The other accessories of the machine are located as follows: The casing containing the cooling-coil submerged in water is located under the eccentrics E E′ and is visible on the drawings only by a few flange-outlines on Figs. 1 and 3. The primary air-pump is attached to the left side of the air-compressor G, Fig. 3, and the water-circulating pump to the right side of the same compressor, Figs. 1 and 3. The atmospheric water-trap is located at the front part of the frame-casting, as shown in Fig. 1, and the lubricating-oil trap at the left of expander-cylinder H in Fig. 3.

The other accessories of the machine are located as follows: A pipe (marked Y) conveys the compressed hot air to the cooling-coil, which is contained in the water-filled casing Z. This is visible on the drawings only by a few outlines in Figs. 1 and 3. The pipe which conveys the water-cooled compressed air from this cooling-coil to the expander-cylinder is marked W, Fig. 3.

The primary air-pump X, Fig. 3, is composed of a plain plunger-pump with two valves and is shown in the left-hand side of the water-jacket of the air-compressor G. It draws air from the atmosphere and conveys it through a pipe V, Figs. 1 and 3, to the atmospheric water-trap U, Figs. 1 and 3, from the lower end of which the dry primarily-compressed air is conveyed by the pipe T, Figs. 1 and 3, to the inlet-pipe S of the compressor G, which pipe comes from the refrigerated system conveying the air back to another manipulation in the ice-machine. The water-circulating pump R, Figs. 1 and 3, is shown on the right hand of the same compressor. It is constructed as a usual plunger-pump with two valves. It receives water through suction-pipe L with vacuum-barrel K. It delivers cooling-water first into the jacket of the air-compressor, and from this the water passes through the pipe Q to the atmospheric water-trap U and then to the water-casing Z of the cooling-coil, after which it runs off through a pipe. (Not shown.) The refrigerated air passes out from the expander-cylinder directly through the lubricating-oil trap U, Fig. 3, and is conveyed to its work by the pipe M, Fig. 3.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In a compressed-air refrigerating-machine, the combination of air compressing and expanding cylinders arranged alongside of each other at one side of the machine, a steam-cylinder arranged at the other side of the machine, the air-cylinders and the steam-cylinder being arranged at an angle of twenty-five to fifty degrees toward each other, a crank-shaft supported above the cylinders and two cranks on said crank-shaft arranged at an angle of one hundred and twenty to one hundred and fifty degrees toward each other, one crank being linked to the piston-rod of the air-expanding cylinder and the other to the piston-rods of the steam and air compressing cylinders, substantially as set forth.

2. In a compressed-air refrigerating-machine, the combination of an air compressing and an expanding cylinder and a steam-cylinder arranged on an upright frame, a crank-shaft supported above said cylinders, three crank-pins on said crank-shaft, one connected with the connecting-rod of the air-expanding cylinder and the other two with the connecting-rods of the steam and air compressing cylinders, said crank-shaft being supported in journal-bearings of the supporting-frame outside of said cranks, substantially as set forth.

3. In a compressed-air refrigerating-machine, the combination, with an upright supporting-frame, of air compressing and expanding cylinders arranged at one side, and a steam-cylinder arranged at the other side of said frame, the two air-cylinders being supported at a suitable angle of inclination toward the steam-cylinder, a crank-shaft supported above the air and steam cylinders, an eccentric on said crank-shaft, a rock-shaft operated by said eccentric on said crank-shaft, and connecting-rods between the rock-shaft and the slide-valves of the air and steam cylinders, substantially as set forth.

4. In a compressed-air refrigerating-machine, the combination, with an upright supporting-frame, of air compressing and expanding cylinders arranged at one side, and a steam-cylinder arranged at the other side of said frame, the two air-cylinders being supported at a suitable angle of inclination toward the steam-cylinder, and the valve-face of the air-cylinders located at right angles to the valve-face of the steam-cylinders, a crank-shaft supported above the air and steam cylinders, an eccentric on said crank-shaft, a rock-shaft operated by said eccentric on said crank-shaft, and connecting-rods between the rock-shaft and the slide-valves of the air and steam cylinders, substantially as set forth.

5. In a compressed-air refrigerating-machine, the combination, with an upright supporting-frame, of an air-compressing, an air-expanding and a steam cylinder, a crank-

shaft supported above said cylinders and provided with three crank-pins, one for the connecting-rod of the air-expanding cylinder and the other two for the connecting-rods of the steam and air compressing cylinders, two eccentrics on said crank-shaft, two rock-shafts operated by said eccentrics, and connecting-rods between the main and top slide-valves of the three cylinders so that said slide-valves are operated by two rock-shafts only, substantially as set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

HUGO B. ROELKER.

Witnesses:
PAUL GOEPEL,
GEO. W. JAEKEL.