Feb. 14, 1933. M. R. KARGE 1,897,907

REFRIGERATING UNIT

Filed Feb. 8, 1932 2 Sheets-Sheet 1

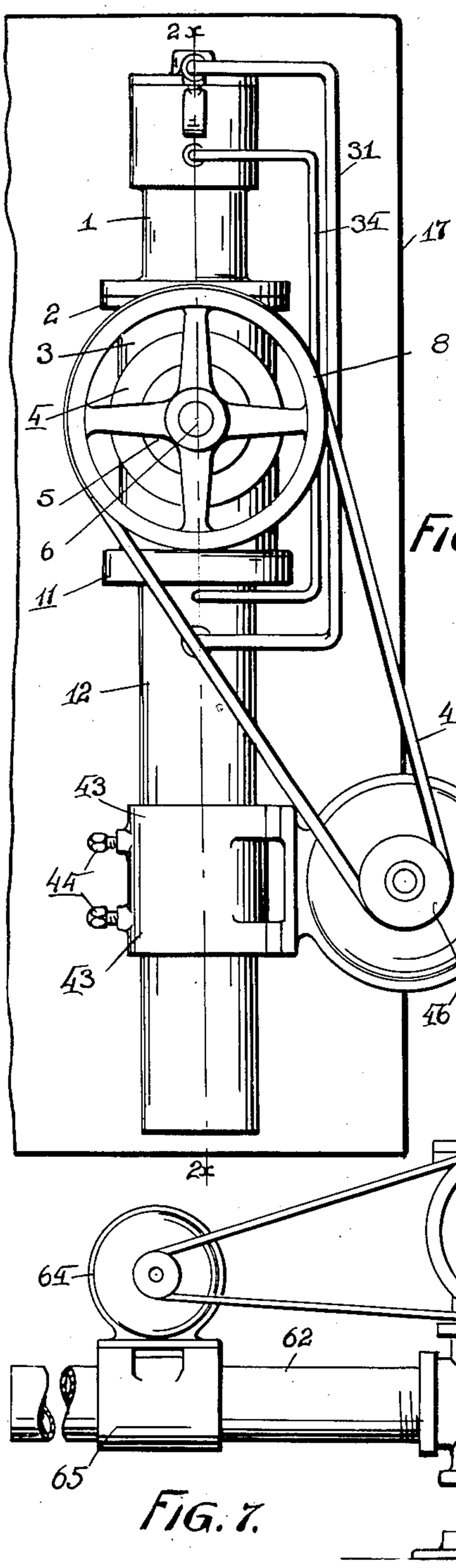

FIG. 1.

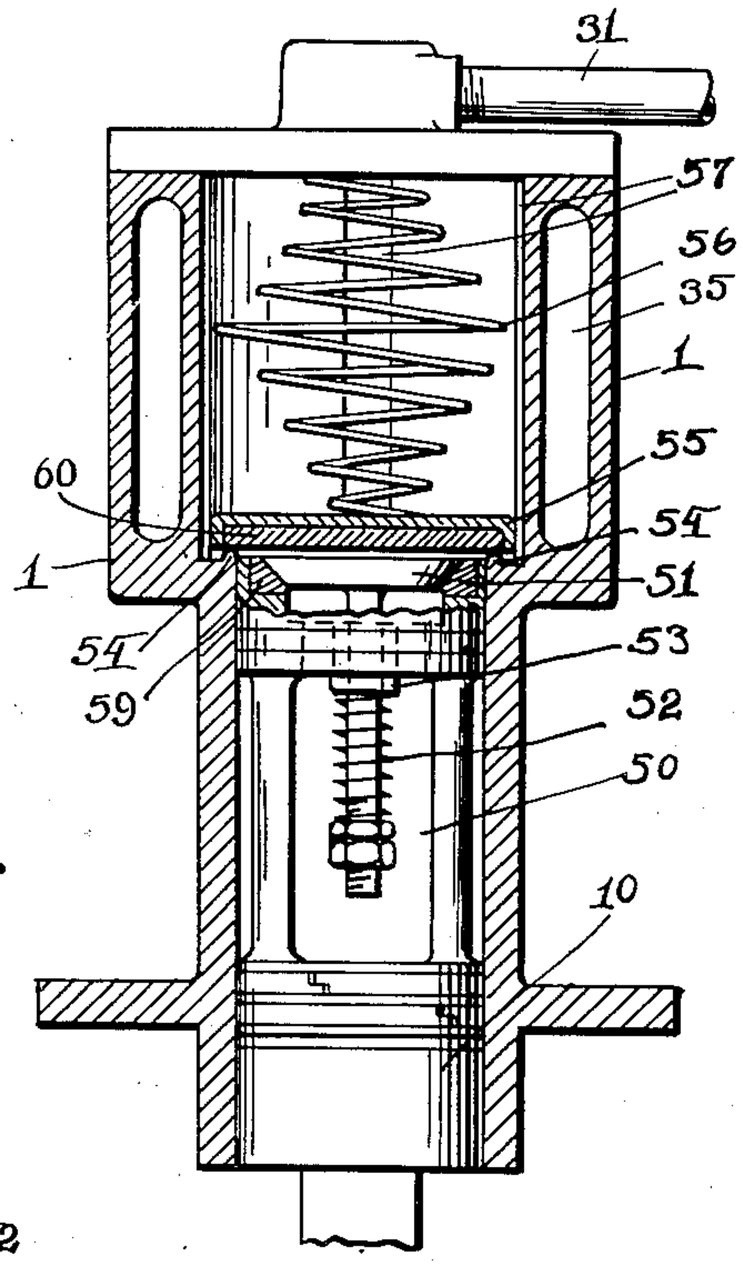

FIG. 5.

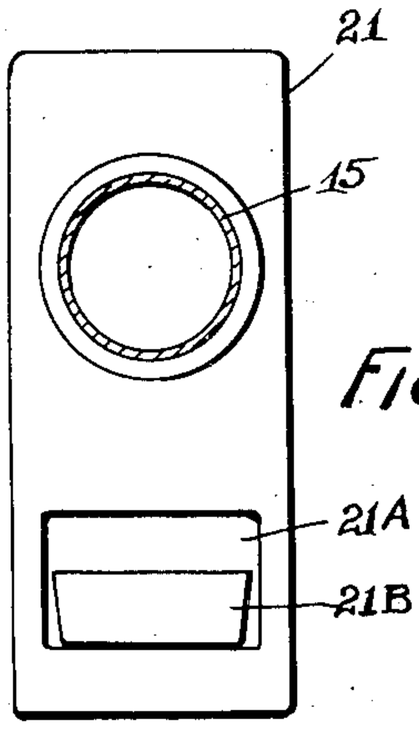

FIG. 6.

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FIG. 7.

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REFRIGERATING UNIT

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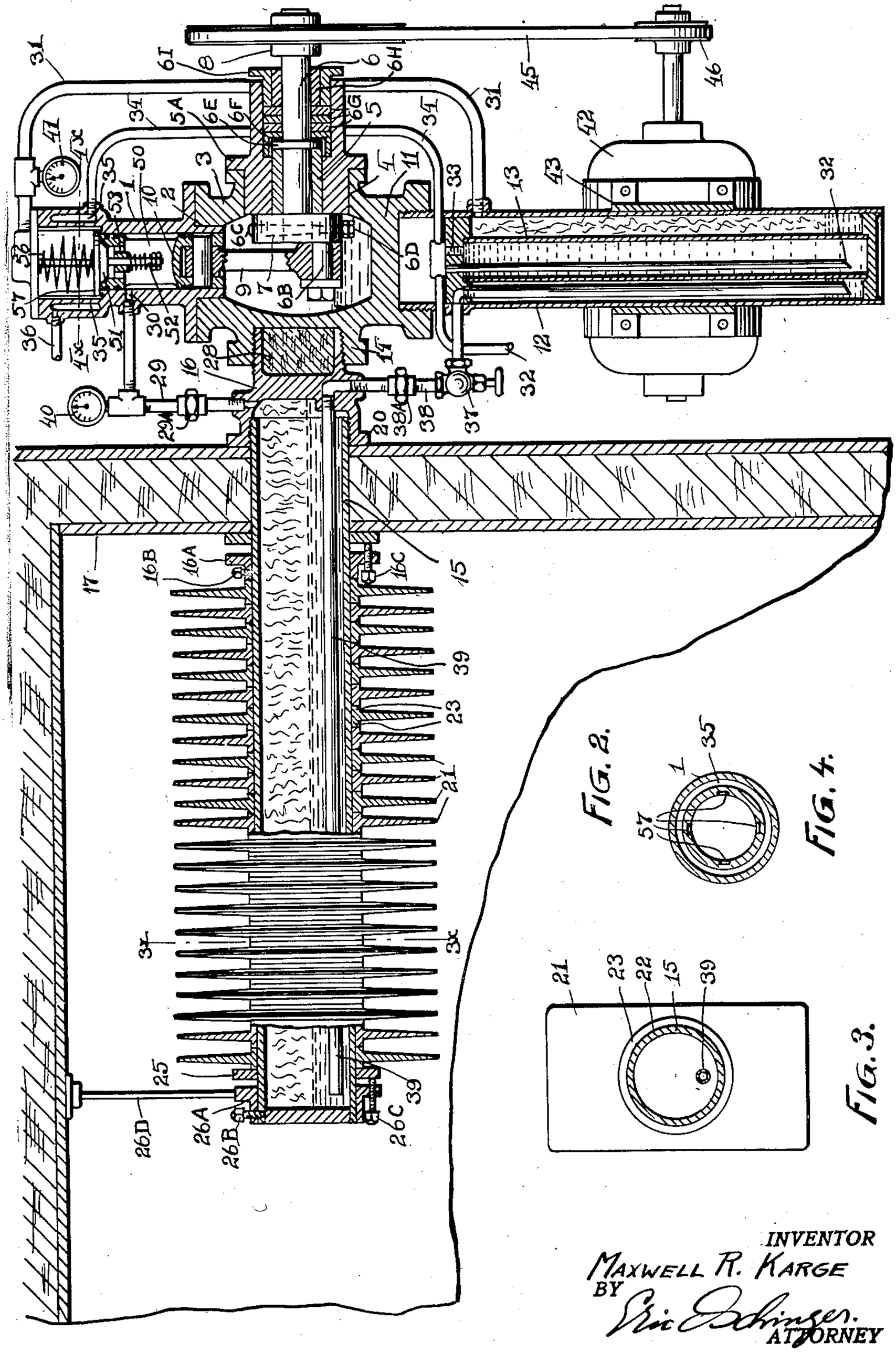

FIG. 2.

FIG. 4.

FIG. 3.

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REFRIGERATING UNIT

Application filed February 8, 1932. Serial No. 591,550.

This invention relates to refrigerating units and has for its object to provide a new and improved construction for such a unit which will make it highly efficient in operation and compact in construction.

A further object of this invention is to so construct the refrigerating unit that it can be mounted on any refrigerator compartment as a complete unit and installed thereon at a minimum cost.

Another object of the invention is to construct the unit in such a manner that it can be completely assembled at the factory and after being tested can be shipped to its destination and installed in its assembled form in any refrigerating compartment, thus eliminating costly assembly and installation work and adjustment of the refrigerating unit outside of the factory.

Another object of the invention is to combine the compressor, condenser and evaporator into a selfsupporting unit with the evaporator forming the supporting member.

Another object of this invention is to so construct the unit that the evaporator forms a single pivotal support for the compressor and condenser.

Another object of this invention is to construct the unit so that the connecting member between the compressor, condenser and evaporator is formed by the crank case of the compressor.

Another object of the invention is to construct the unit so that the axis of rotation of the crank shaft of the compressor is in line with the single pivotal support of the unit with the crank shaft located close to the support in order to eliminate as much as possible any vibration of the unit during the operation thereof.

Another object of this invention is to so construct the unit that the electric motor for the operation thereof may be adjustably mounted on the condenser thereof.

Another object of this invention is to provide the evaporator with a series of cooling fins which are removably attached thereto.

Another object of this invention is to taper the cooling fins toward the periphery thereof to hasten the melting of the ice crust during the defrosting period.

Another object of the invention is to so construct the unit that the operating cycle of the cooling medium automatically balances itself between its high and low pressure.

Another object of the invention is to provide a novel compressor construction having a piston which cooperates with a continuous intake in the cylinder in order to provide a constant and efficient compression of the cooling medium.

Another object of this invention is to provide the valves of the compressor of the unit with soft metallic seats in order to balance the operation thereof.

Another object of the invention is to provide the crank shaft of the compressor with a novel single bearing.

Another object of the invention is to provide the evaporator tube with novel clamping means which permit a quick and easy mounting of the tube in the wall of a refrigerator compartment.

Another object of the invention is to provide the evaporator tube with novel clamping means with which the removable fins are firmly clamped in place on the periphery thereof.

Another object of this invention is to so attach the condenser to the crank case of the compressor that part of the heat given off by the condenser will keep the lubricating oil in the crank case in a fluid state.

All these and other objects of the invention will become more readily apparent from the detailed description thereof which follows, reference being had to the accompanying drawings in which

Figure 1 is an end elevation of the refrigerating unit as it appears when installed on the outside of a refrigerating compartment.

Figure 2 is a vertical sectional view of the refrigerating unit and a portion of the compartment on which it is installed, the section being taken on the line $2x$—$2x$ of Figure 1.

Figure 3 is a vertical sectional view of the evaporating tube, the section being taken on the line $3x$—$3x$ of Figure 2.

Figure 4 is a horizontal sectional view of the compressor cylinder, the section being taken on the line 4*x*—4*x* of Figure 2.

Figure 5 is an enlarged detail sectional view of the cylinder and piston of the compressor of the refrigerating unit.

Figure 6 is an end elevation of a modified form of the cooling fins.

Figure 7 is a view in elevation of a modified form of the refrigerating unit.

In the several figures of the drawings like reference numerals indicate like parts.

The refrigerating unit forming the subject matter of my present invention comprises a combination of a novel compressor, condenser and evaporator which are rigidly mounted and connected together in such a manner that the unit operates at a high efficiency and can be completely assembled, adjusted and tested at the factory and shipped in its finished state to be installed at its destination for any type of refrigeration at a minimum cost and labor. The cooling medium used in the refrigerator is preferably ammonia because of its low boiling point and consequently higher efficiency compared with other cooling mediums.

As illustrated in Figures 1 and 2, the compressor has its cylinder 1 mounted on the open top 2 of the hollow cross member 3 which forms the crank case for the compressor. In the open side 4 of the hollow cross member 3 is provided the bearing 5 for the crank shaft 6. On the inner end of the crank shaft 6, within the hollow cross member 3, is provided the crank 7 and on the outer end of the crank shaft is mounted the pulley 8 by which the compressor is driven. A connecting rod 9 connects the crank 7 with the piston 10 which is mounted to reciprocate in the cylinder.

The tubular condenser is mounted in the closed bottom 11 of the cross member 3 and comprises the tube 12 which is threaded or otherwise fastened into the cross member and depends downwardly therefrom. Within the tube 12 is mounted the cooling tube 13 in which circulates the condensing water as will hereinafter be described.

The tubular evaporator is mounted in the closed side 14 of the cross member 3 and comprises the tube 15 which is threaded or otherwise fastened into the cross member 3 either directly or by means of the threaded connecting member 16. The tubular evaporator provides the supporting arm for the refrigerator unit and is adapted to project thru a suitable hole in the wall 17 of the refrigerating compartment 18. A flange 16 is slidably mounted on the tube 15 and is adapted to rest against the inside of the wall 17 of the refrigerator compartment. This collar or flange is firmly held against the wall by means of the clamping flange 16A which is rigidly fastened to the evaporator tube by means of suitable set screws 16B. Clamping screws 16C provided in the clamping flange 16A are then threaded against the flange 16 to force this flange against the wall and hold the tube rigidly in place in the wall. In this way the evaporator tube is firmly anchored in the wall of the refrigerator compartment.

On the tubular evaporator are mounted a series of cooling fins 21, 21. These fins are made up of plate members having a suitable outline and an opening 22 encircled on each side by a boss 23. The hole 22 and the bosses 23 thus form a short sleeve which is made to fit snugly over the periphery of the evaporator tube to make perfect metal to metal contact between the fins and the tube so as to eliminate any possible insulating air space between the fins and the evaporator tube. The fins are preferably cast of aluminum, although other metals may be used if found to be desirable. The unequal expansion and contraction between steel tube and aluminum is compensated for by making the bosses of the cooling fins, which are of aluminum, of a thickness which will cause the expansion and contraction of the heavier body of aluminum formed by these bosses and the fins surrounding it to expand and contract the same amount as the thin steel wall of the evaporator tube on which the fins are mounted. In this way the fins provide an efficient heat conductor for the evaporator tube at all temperatures.

The fins, as above pointed out, are preferably cast and their surface is left rough in order to increase the radiating surface thereof. If it is desired to quickly cool a solid substance, a small body of liquid, semi-liquid or a solid substance, the fins may be provided with an opening 21A as illustrated in Figure 6. The consecutive openings in the fins then form a shelf in which a pan 21B, containing the substance, may be supported close to the evaporator tube and in contact with the cooling fins. The sides of the fins taper from the spacing bosses to the perimeter thereof so that each fin is thinner at the edge than it is near the evaporator tube. In defrosting the evaporator, the ice then begins to melt first on the edges of the fin so that the water from the melted ice on the edges of the fin immediately begins to flow over the remainder of the fins and helps to melt the ice from the inner surface of the fins.

After all the fins are telescoped over the tubular condenser they are held in place thereon by means of a suitable locking sleeve 25 which is slidably mounted on the end of the evaporator tube 15. A locking sleeve 26A is fastened to the outer end of the evaporator tube 15 by means of suitable set screws 26B and in a flange surrounding this locking sleeve are provided the clamping screws

26C which are threaded against the locking flange to force this flange against the last of the cooling fins and firmly clamp all of the fins between this flange and the locking sleeve 16A near the inner end of the evaporator tube. The locking sleeve is suspended from the ceiling of the compartment by means of the hanger 26D to provide additional support for the evaporator within the compartment.

While I have shown and described the evaporator as being supported within a refrigerator compartment, it is understood that the evaporator may be mounted in a tank for the purpose of cooling a liquid body such as brine. In fact the unit may be used in any type of refrigerating installation.

The evaporator tube is shown attached to the cross member 3 by means of the connecting member 16 which is threaded or otherwise fastened into the cross member with one end and in turn has the end of the evaporator tube threaded or otherwise fastened into its opposite end. An insulating wall 28 is formed in the end of the connecting member 16 in order to reduce to a minimum any absorption of heat by the end of the evaporator from the cross member 3 and the crank case formed by it. As will be seen from an inspection of Figure 2, the intake end of the condenser 12 is located directly below the bottom of the crank case formed by the cross member 3, and the ammonia gas, after it has been superheated by the compressor, enters the condenser tube just below the cross member and gives off enough heat to keep the lubricating oil with the crank case in the proper fluid condition, thus counteracting any cooling effect the connection of the evaporator tube may have on the cross member.

A pipe line 29 connects the evaporator 15 with the intake 30 of the compressor 1 and the evaporated ammonia gas in the evaporator is drawn off thru this line and compressed and superheated by the compression in the cylinder 1. The compressed and superheated ammonia gas is forced by the compressor thru the pipe line 31 to the condenser 12 where the superheated ammonia gas is condensed into liquid form by the water column or coil 13 located within the condenser. The water column or coil 13 has the condensing water fed into the bottom thru the inlet 32 and after it has absorbed some of the heat of the superheated ammonia gas during the condensing process, leaves the water column or coil near the top thru the outlet 33. The water from the condenser is then fed thru the pipe line 34 to the water jacket 35 which surrounds the upper portion of the compressor cylinder in order to carry off some of the heat generated in the compressor cylinder in the compression of the ammonia gas. The cooling water leaves the water jacket of the cylinder of the compressor thru the outlet 36.

The condensed ammonia gas leaves the condenser near the outer end or bottom thereof and passes thru the throttle valve 37, where its pressure is reduced, into the pipe line 38 which feeds the condensed low pressure ammonia to the evaporator. There the condensed ammonia passes thru the tube 39 within the evaporator tube 15 to the far end thereof where it is allowed to enter the evaporator tube to again evaporate and absorb thru the cooling fins 21 any heat contained in the refrigerator compartment 18.

In the pipe lines 29 and 38 are provided the union connections 29A and 38A respectively. These union connections make it possible to disconnect the evaporator tube from the compressor and the condenser so that the evaporator tube can be detached from the cross member 3 for shipment. The tube, when disconnected, may be fully charged with the cooling medium so that when it is attached to the cross member and connected by means of the union connections 29A and 38A, the unit is immediately ready for operation as it would have been if the evaporator tube had never been detached from it.

A low pressure gauge 40 in the pipe line 29 and a high pressure gauge 41 in the pipe line 31 indicate the high and low pressures of the ammonia gas in the refrigerating system. These gauges indicate by their pressure how the system operates and the throttle valve 37 is used to regulate the flow of the ammonia to fix the high and low pressures depending on the refrigeration needed. The refrigerating unit is balanced so that the same quantity of evaporated ammonia gas is drawn off the evaporator as is fed into it in liquid or condensed form.

The refrigerator unit is driven by an electric motor 42 which is mounted on the sliding base 43. This base can be adjusted up or down on the condenser tube 12 and fastened thereto by means of suitable set screws 44. An endless belt 45 connects the motor pulley 46 with the compressor pulley 8 to operate the compressor.

The length and diameter of the evaporator tube may be increased or decreased within the capacity of the compressor in order to provide the desired surface or cooling area for the refrigerator compartment or space or medium to be cooled. If more refrigeration is necessary than can be furnished by one unit, two or more of the units may be attached to the compartment and operated independently or jointly, depending on whether the full refrigerating capacity of all units is to be used constantly or intermittently.

In locations where the degree of heat in the condensing water which is fed to the condenser makes it necessary to use a large volume of water in order to secure the desired

condensing effect on the superheated ammonia gas, the condensing tube 12 may be made longer in order to provide the additional capacity for the condensing water.

The fact that the refrigerator unit is supported on a single pivotal point provided by the evaporator tube makes it possible to increase the length of either the evaporator or condenser or both and mount the unit in the vertical position illustrated in the drawings or in any angular or even horizontal position. In this way the installation of the unit can be made to suit any and all conditions.

In Figure 5 I have illustrated in an enlarged detail sectional view the construction of the compressor forming part of the refrigerating unit. As heretofore pointed out, the compressor has a novel piston construction which provides a continuous intake into the cylinder of the compressor. As illustrated in Figure 5, the piston 10 is provided with an elongated open chamber 50 and the intake 30 in the cylinder of the compressor is located with relation to this chamber in the piston so that the ammonia gas from the evaporator can enter thru the intake 30 into the chamber 50 without interruption during the reciprocation of the piston. The chamber in the piston is thus constantly filled with ammonia gas from the evaporator and on the suction stroke of the piston this gas is forced thru the poppet valve 51 carried in the top of the piston 10. The valve 51 is located directly above the piston chamber and its valve stem 52 is mounted and guided in a suitable valve guide 53 provided in the piston chamber.

The upper portion of the cylinder 1 is slightly enlarged and in the lower end of this enlarged section is provided the concentric valve seat 54 on which the disc valve 55 is adapted to be seated. The disc valve is normally held seated on the valve seat by means of the valve spring 56 which is located between the top of the valve and the end of the cylinder.

In the wall of the enlarged section of the cylinder are provided the by-pass channels 57, 57 thru which the ammonia gas passes from the under side of the disc valve to the upper side thereof after entering the cylinder thru the piston valve 51. As heretofore pointed out, the refrigerator system is regulated by means of the throttle valve 37 in the pipe line 38 connecting the condenser with the evaporator and this regulation secures a difference in the pressures in the evaporator on one side and the condenser and compressor on the other side. The pressure in the evaporator is thus comparatively low and may be, for example, 15 pounds pressure, while at the same time the pressure in the compressor and condenser would be about 150 pounds pressure. The valve spring 58, surrounding the valve stem 52 of the piston valve 51, is adjusted so that the low pressure gas admitted into the piston chamber will open the valve and allow the gas to enter the cylinder to be compressed therein above the disc valve 55.

For the purpose of silencing the operation of the piston and disc valve provided in the cylinder, the valve seat surrounding the valve 51 is formed of a soft metallic or non-metallic ring seat 59. An aluminum seat has been found to be very practical for this purpose. In the disc valve 55 the bottom thereof is provided with a soft metallic seat member 60 which seats itself on the seat 54.

The crank shaft assembly is provided with a bearing on but one side of the crank case. This makes it necessary to provide the crank shaft with a bearing which gives the shaft a large bearing surface. As illustrated in section in Figure 2, the crank shaft 6 is made up by having the crank disc 7 shrunk thereon and the crank pin 6B shrunk into the crank disc. The shrink fit of the crank disc and the crank pin is reinforced by a tapered pin 6C which passes thru the crank disc and the crank and crank pin shrunk into it. Lock nuts 6D lock the tapered pin 6C in place in the crank disc. Also shrunk onto the crank shaft 6 is the collar 6E and the portion of the shaft between the crank disc and collar is mounted to rotate in the babbitt bearing 5. A cup washer 6F surrounds and overhangs the collar 6E and keeps the inner packing disc 6G from frictional contact with the collar. A second babbitt bearing 6H surrounds the outer end of the crank shaft 6 and is formed in the packing gland 6I which holds the packing discs in place between the two bearings. The complete crank shaft and bearing assembly is mounted in the bearing support 5A so that the complete crank shaft assembly can be bodily removed from the crank case therewith.

In Figure 7 I have illustrated the refrigerating unit for use in an expansion cooling system. In this modified form of the unit, the compressor is mounted on top of a T connection 61, while the condenser 62 is attached to the side of this connection and projects laterally therefrom. A tubular reservoir or expansion tank 63 is attached to the bottom of the T connection in such a way that the condensed ammonia from the condenser will flow into the reservoir or expansion tank and accumulate therein.

The motor 64 for driving the compressor is mounted on a sliding base 65 which in turn is adjustably mounted on the condenser 62. The refrigerating unit is supported by a suitable base or flange 66 which is fastened to the expansion tank 63.

I claim:

1. A refrigerating unit including a compressor and a condenser attached thereto, an

evaporator projecting laterally from said combined compressor and condenser and forming a supporting member therefor.

2. In a refrigerating unit the combination of a compressor having a crank case, a condenser mounted on said crank case in a vertical plane to said compressor and a supporting member extending laterally of said compressor and condenser to support said compressor and condenser intermediate the ends thereof.

3. A refrigerating unit comprising a connecting member, a compressor mounted on said connecting member and extending in one direction, a condenser mounted on said connecting member and extending in another direction and an evaporator mounted on said connecting member and extending therefrom between said compressor and condenser.

4. A refrigerating unit comprising a hollow connecting member forming a crank case, a compressor mounted on top of said crank case, a condenser suspended from the bottom of said connecting member and an evaporator projecting from the side of said connecting member.

5. A refrigerating unit comprising a compressor, condenser and evaporator, a T-shaped connecting member rigidly and angularly connecting said compressor, condenser and evaporator with relation to each other.

6. A refrigerating unit comprising a compressor, a condenser suspended from the bottom of said compressor, an evaporator tube rigidly connected to said compressor and condenser and projecting laterally therefrom, clamping means provided on said evaporator tube for clamping said evaporator tube in a horizontal position and supporting said compressor and condenser angularly thereto.

7. A refrigerating unit adapted to be suspended on a wall and comprising a compressor, a condenser suspended from said compressor, an evaporator tube connected to said compressor and condenser intermediate thereof and adapted to project thru said wall, a series of cooling fins removably attached to the surface of said evaporator tube on one side of the wall and supporting means for supporting said compressor and condenser on the other side of the wall.

8. In a refrigerating unit the combination of a compressor, a condenser tube supported on said compressor, and a motor slidably mounted on said condenser tube for operating said compressor.

9. In a refrigerating unit the combination of a compressor having a crank case containing lubricating oil, a condenser tube having its intake end attached to the bottom of said crank case to warm the bottom of said crank case and the lubricating oil located above it.

10. A refrigerating unit comprising a hollow cross member forming a crank case, a compressor having a crank and crank shaft mounted to one end of said cross member with its crank located within said cross member, a condenser mounted to said cross member at the end opposite to said compressor and in line therewith, an evaporator tube mounted to said cross member to one of the ends intermediate of said compressor and condenser and at right angles thereto, said crank shaft of said compressor being mounted to rotate in said cross member in the end opposite to said evaporator tube.

11. In a refrigerating unit the combination of a compressor having a crank case, an evaporator projecting from said crank case to have said crank case form the connecting member between said compressor and said evaporator.

12. In a refrigerating unit the combination of a compressor having a crank case, an evaporator tube rigidly mounted on said crank case at right angles to said compressor to provide a supporting arm for said compressor and its crank case and an insulating wall between the end of said evaporator tube and said crank case.

13. In a refrigerating unit adapted to be supported on a wall the combination of a compressor, an evaporator tube rigidly connected to said compressor and forming a supporting arm therefor, said evaporator tube being adapted to project thru said wall and clamping means provided on said evaporator tube to clamp said evaporator tube in place in said wall with the evaporator tube projecting from the inside of the wall and the compressor located on the outside of the wall.

14. In a refrigerating unit the combination of a connecting member, a compressor mounted on top of said connecting member, a condenser mounted to project laterally from said connecting member and a liquid receiver attached to the bottom of said connecting member and a motor mounted on said condenser for operating said compressor.

15. In a refrigerating unit the combination of a connecting member, a compressor mounted on top of said connecting member, a liquid receiver mounted to the bottom of said connecting member and providing a support for said connecting member, and a condenser mounted on said connecting member and projecting laterally therefrom between said compressor and liquid receiver.

16. In a refrigerating unit the combination of a T connecting member, a compressor mounted to one end of said T connecting member, a condenser mounted to another end of said connecting member, a liquid receiver mounted to the third end of said T connection member and a motor supported on said condenser.

17. In a refrigerating unit the combination of a tubular evaporator of the expansion

type anchoring means provided on said evaporator for fixedly mounting said evaporator and a compressor mounted to the end of the evaporator and fixedly supported thereby.

18. In a refrigerating unit the combination of a tubular condenser, anchoring means associated with said condenser for fixedly mounting said condenser and a compressor mounted to the end of said condenser and fixedly supported thereby.

19. In a refrigerating unit the combination of a vertical tubular condenser, a compressor mounted on top of said condenser and a horizontal tubular evaporator projecting laterally from said condenser below said compressor.

20. In a refrigerating unit the combination of a hollow crank case, four supporting sockets provided in the wall of said crank case, a compressor cylinder mounted in one of said sockets, a connecting rod bearing provided in another of said sockets, an evaporator mounted in the third of said sockets and a condenser mounted in the fourth of said sockets.

21. In a refrigerating unit the combination of a central connecting member, a compressor, a condenser and an evaporator mounted on said central connecting member and radially projecting therefrom.

22. In a refrigerating unit the combination of a compressor, a connecting member having an insulating chamber at one end and a connecting chamber at the other end, said connecting member with its insulating chamber being attached to said compressor and an evaporator mounted to said connecting chamber.

23. In a refrigerating unit a compressor and condenser rigidly connected end to end and a pivotal supporting member projecting laterally from said compressor and condenser for supporting said compressor and condenser in a vertical plane.

24. A refrigerator unit comprising a self-contained compressor unit, a tubular self-contained evaporator unit supportably attached to said compressor unit with one end thereof so as to be individually removable therefrom, and a tubular selfcontained condenser unit supportably attached to said compressor unit with one end thereof so as to be individually removable therefrom.

25. A refrigerator unit comprising a self-contained compressor unit, a tubular self-contained evaporator unit supportably attached to said compressor with one end thereof so as to be individually removable therefrom, a tubular selfcontained condenser unit supportably attached to said compressor unit with one end thereof so as to be individually removable therefrom and a motor unit supportably attached to said refrigerator unit so as to be individually removable therefrom.

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