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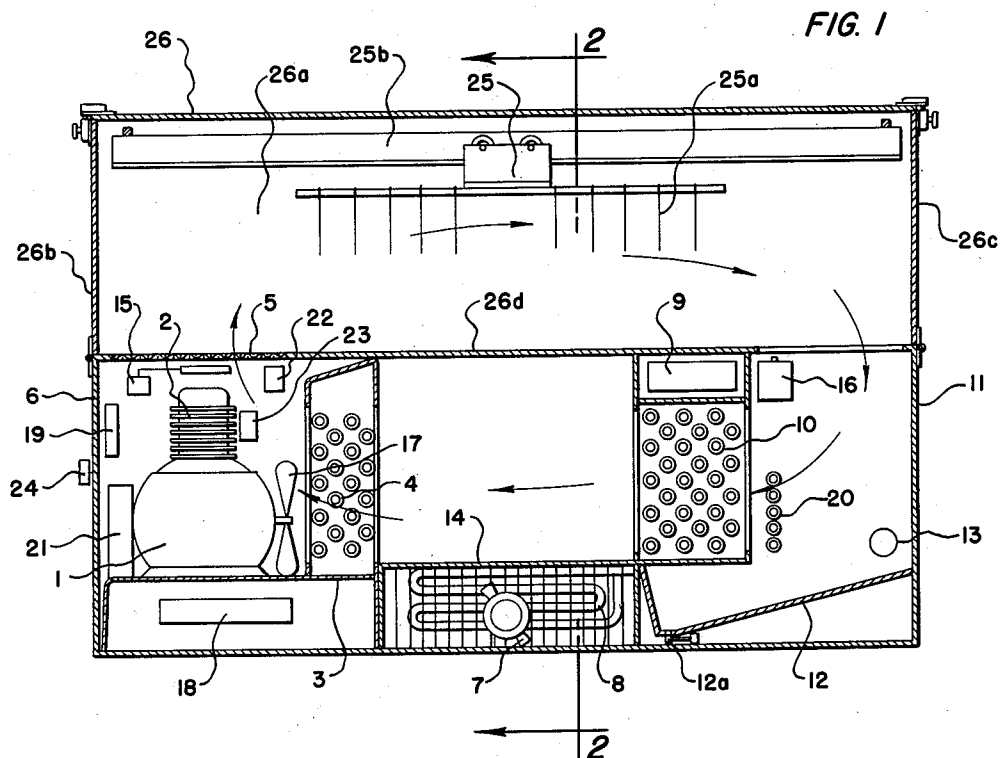
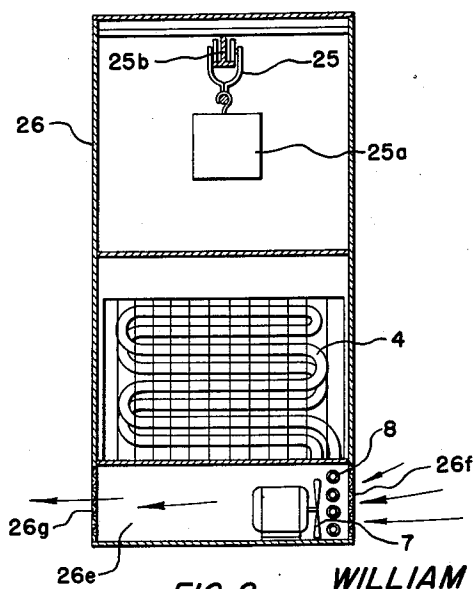
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2,570,808

LOW-TEMPERATURE DRYING APPARATUS

Filed Dec. 12, 1947

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

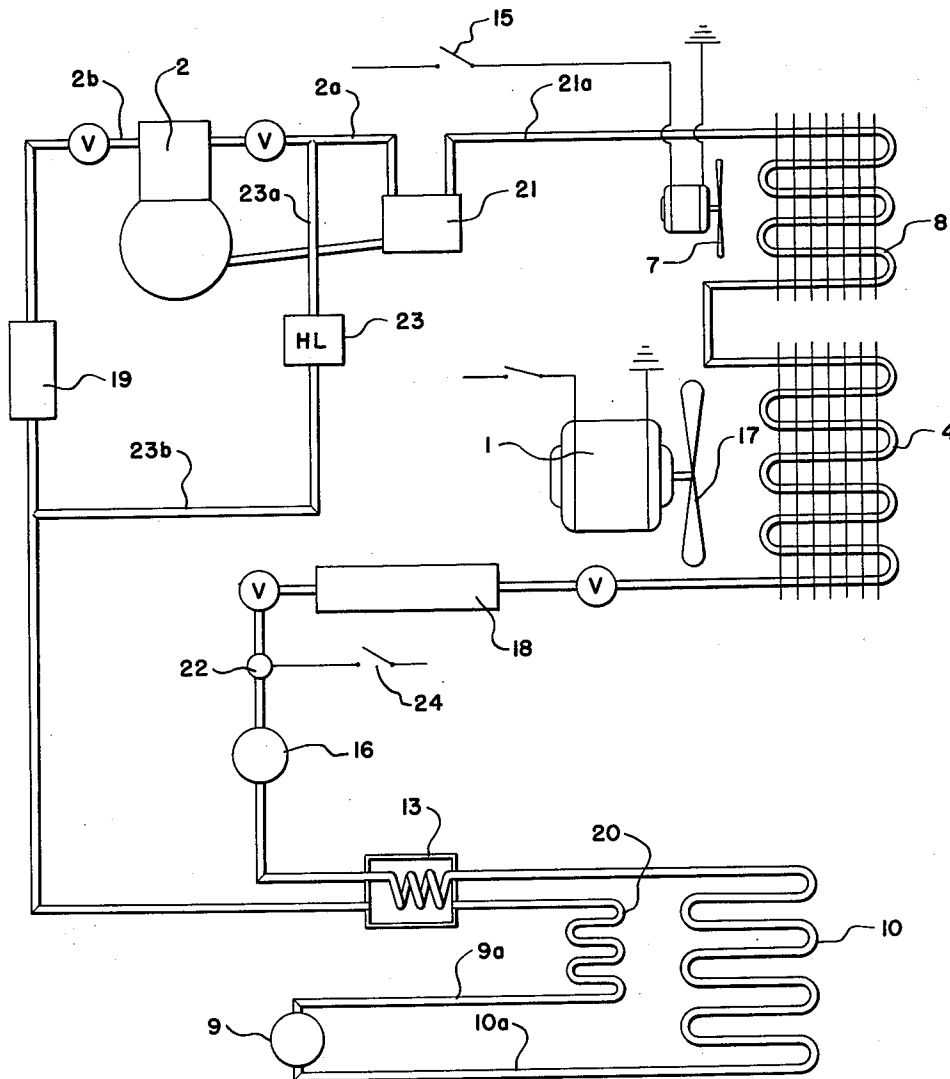


FIG. 3

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LOW-TEMPERATURE DRYING APPARATUS

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8 Claims. (Cl. 34-48)

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My invention relates to a low temperature drying apparatus more particularly for the dehydration of various objects and materials such as photographic film or the like, and the objects of my invention are:

First, to provide a low temperature drying apparatus of this class which appreciably reduces the time required in properly drying photographic film or other materials.

Second, to provide an apparatus of this class employing two condensers in series, one of which remains in an enclosure wherein air is recirculated, whereby the other condenser communicating with external atmosphere or other cooling medium relieves the recirculated air of mechanical heat generated by the compressor in connection with said condensers, or any excess heat in the medium over and above that required to maintain the required drying temperature.

Third, to provide an apparatus of this class which is fully automatic and maintains continuous flow of air therein by recirculating the same continually so that the moisture content of the outside air does not reduce the efficiency of said apparatus in drying film or other objects placed therein.

Fourth, to provide an apparatus of this class in which a high, low pressure switch in connection with the inlet and outlet of the compressor thereof used in combination with a solenoid valve at the outlet of the receiver of said apparatus, permits all of the refrigerant to be pumped down and condensed into the receiver and retained therein during periods when the apparatus is inoperative or shut off effectively preventing the building up of high pressure on the suction side of the compressor so that the seal of an open type unit is not damaged with the consequent loss of refrigerant, thus reducing maintenance cost.

Fifth, to provide an apparatus of this class in which a substantially conventional refrigerating means is employed in combination with an auxiliary condenser whereby the refrigerating means is confined and the auxiliary condenser is externally cooled so that the circulating medium which is continually recirculated within the enclosure of the apparatus operates at a constant temperature due to the release of excess heat from said medium through said auxiliary condenser which compensates for the heat generated in the compressor of said refrigerating means, plus any additional heat not required in or by the medium;

Sixth, to provide a drying apparatus of this

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class which is provided with enclosed compressor, condenser and evaporator units through which air is recirculated and which maintains a temperature of the evaporator below the dew point of the recirculated medium so that moisture may be constantly relieved from various objects within the enclosure provided for the drying process;

Seventh, to provide an apparatus of this class having an enclosure in which a compressor, a condenser and an evaporator are positioned, whereby air may be recirculated through articles being dried then through said evaporator and backwardly through said condenser which reheats the air relieved of latent and sensible heat by said evaporator so that the temperature of the air is raised after passing said evaporator and thereafter delivered to the articles being dried, which themselves operate as an evaporative cooling medium;

Eighth, to provide a low temperature drying apparatus of this class in which temperature and moisture conditions are automatically controlled in accordance to the requirements of the materials being dried, whereby photographic film, or other similar materials, are processed without causing the same to curl or become deformed due to excess temperature;

Ninth, to provide a low temperature drying apparatus of this class in which the sole source of power and heat is a standard high pressure refrigeration condensing unit wherein the evaporator thereof condenses moisture from the material being dried while the condenser thereof reheats the drying medium preliminary to the conduction thereof around the material being dried;

Tenth, to provide an apparatus of this class which is very simple and economical of construction in proportion to its utility, efficient in operation and which will not readily deteriorate or get out of order.

With these and other objects in view as will appear hereinafter, my invention consists of certain novel features of construction, combination and arrangement of parts and portions as will be hereinafter described in detail and particularly set forth in the appended claims, reference being had to the accompanying drawings and to the characters of reference thereon, forming a part of this application in which:

Figure 1 is a longitudinal sectional view of my low temperature drying apparatus; Fig. 2 is a transverse sectional view thereof, taken from the line 2-2 of Fig. 1 and Fig. 3 is a diagrammatic view of the electrical and refrigerating

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mechanism of my low temperature drying apparatus.

Similar characters of reference refer to similar parts and portions throughout the several views of the drawing

The motor 1, compressor 2, frame 3, condenser 4, grille 5, enclosed duct 6, fan 7, auxiliary condenser 8, surge chamber 9, evaporator 10, circulating duct 11, drain pan 12, heat exchanger 13, separate auxiliary duct 14, auxiliary thermostat 15, refrigerant expansion control 16, fan 17, receiver 18, strainer and drier 19, drier coil 20, oil trap 21, solenoid valve 22, high-low pressure switch 23, control switch 24, film carrier 25 and the drier casing 26 constitute the principal parts and portions of my low temperature drying apparatus.

The diagrammatic view in Fig. 3 of the drawing illustrates the compressor 2 which is driven by the motor 1. This compressor 2 is provided with an outlet tubular conductor 2a passing into the oil trap 21 which gravitates oil expelled from the compressor 2 into the crank case thereof. Communicating with said oil trap 21 extending therefrom is the tubular conductor 21a which communicates with the interior of the auxiliary condenser 8 which is in communicative series with the main condenser 4. This main condenser 4 communicates directly with the receiver 18, the outlet of which is controlled by the solenoid valve 22 having a manual switch 24 for operating same. The refrigerant expansion control 16 communicates with the solenoid valve 22 and the evaporator 10 between which the heat exchanger 13 is positioned for increasing the thermal efficiency of the cycle. The outlet of the evaporator 10 communicates with the tube 10a directly connected to the surge chamber 9 having an outlet tube 9a communicating with the drier coil 20 which communicates through the heat exchanger 13 and is connected to the strainer and drier 19 which communicates with the inlet 2b of the compressor 2. Communicating with the outlet 2a of the compressor 2 is a tubular conductor 23a arranged to actuate the high pressure switch in the high-low switch 23. The inlet side of the compressor communicates with the tube 23b, and operates the low pressure switch in the high-low switch 23. Referring to Fig. 1 of the drawing it will be noted that the compressor 2, fan 17, condenser 4, and evaporator 10 are all enclosed and isolated from outside atmosphere. The air in the casings 26 is maintained therein and continually recirculated through the evaporator 10, condenser 4, grille 5, and processing duct 26a, while the fan 7 together with the auxiliary condenser 8 communicate with opposite sides of the casing 26 and are in conductive relation with the outside atmosphere or the auxiliary condenser 8 may be associated with a water cooling medium controlled by a solenoid valve or the like as desired. The casing 26 is provided with doors 26b and 26c arranged to permit film carrier 25 to be loaded with film 25a and this carrier 25 is mounted on a track 25b in the upper portion of the casing 26, providing facility in moving said carrier 25 when loading and unloading the same. It will be here noted that if desired, several of the grille 5 may be provided, or other suitable means for holding the film in the casing 26 may be employed. The grille 5 is positioned over the compressor 2 which is operated by the motor 1 and this motor 1 also operates the fan 17 causing air to pass as indicated by arrows in Fig. 1 of the

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drawing as hereinbefore described, and as the air passes through the evaporator 10, the condensate therefrom drips to the drip pan 12 and drains from the bottom portion 12a thereof.

The operation of my low temperature drying apparatus is substantially as follows:

During operation of the motor 1 the fan 17 is continually operated and the compressor 2 is also continually operated by said motor 1. The compressor 2 operates in a substantially conventional manner common to that of various refrigeration systems for circulating the refrigerant gas, compressing it and passing it through the auxiliary condenser 8 and the main condenser 4 whereby loss of heat changes it to a liquid and passes into the receiver 18 from which it passes to the evaporator 10. As the air passes from the fan 17 it passes upwardly through the grille 5 and into the processing compartment 26a of the casing 26 in which film 25a may be positioned around which said air travels. The air is then circulated into the circulating duct 11, which directs the air toward the drier coil 20 and into the evaporator 10 which operates at a temperature below the dew point of the circulating medium, whereby moisture conducted from the film 25a is collected and condensed on the evaporator 10 from which it drops onto the inclined drain pan 12 and is eliminated therefrom by gravitation. Thus, the evaporator 10 relieves the air of latent and sensible heat in its passage toward the condenser 4 which operates as a reheater for raising the temperature of the air preliminary to its passage through the grille 5 and over the film 25a in the processing compartment 26a of the casing 26. It will be here noted that the casing 26 entirely encloses all of the refrigerating means with the exception of the auxiliary condenser 8 and fan 7 operating the same.

The enclosed duct 6 is arranged to enclose the compressor 2 and adjacent mechanism while the circulating duct 11 closes the opposite end of the drying apparatus and the lower side 26d of the processing compartment 26a of the casing 26 provides the baffle arranged to direct the air from the evaporator 10 to the condenser 4. The lower portion of this casing 26 is provided with a duct 26e through which air may pass as indicated by arrows in Fig. 2 of the drawing, and this duct 26e is provided with grilles 26f and 26g at opposite ends thereof providing a foraminous wall through which air is circulated very freely by the fan 7. Thus, outside atmosphere is employed in connection with the auxiliary condenser 8 to throw away heat generated by the motor 1 and compressor 2. It will be here noted that the condenser 4 is of sufficient capacity to balance the operation of the evaporator 10, and that it is necessary to maintain the evaporator 10 at a certain temperature slightly below the dew point of the circulating medium in the casing 26 in order to relieve said circulating medium of moisture picked up from the film 25a or other objects being dried in the compartment 26a.

Without the auxiliary condenser 8, each cycle of operation would add the temperature generated by the motor 1 and compressor 2 until the temperature became so high that condensation on the evaporator 10 would cease. Thus, low temperature must be maintained in the evaporator 10, and the mechanical heat generated by the motor 1 and the compressor 2 must be eliminated from the interior of the casing 26. This is accomplished by the operation of the auxiliary thermostat 15 at the outlet of the enclosed duct 6 on the down-

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stream side of the motor 1 and the compressor 2. As the combined temperature at the outlet of the condenser 4 and the compressor 2 reaches a certain value, the auxiliary thermostat 15 initiates operation of the fan 7 which exchanges heat from the auxiliary condenser 8 and throws the same away externally of the casing 26 so that a constant temperature is automatically maintained within the drying compartment 26a of the casing 26, promoting pick-up of moisture from the objects being dried and the condensation of said moisture from the circulating medium at the surface of the evaporator 10. The disposition of the thermostatic switch 15 permits the fan 7 to be operated in advance of the movement of the overheated air to the condenser 4 whereby the excess heat is removed from the refrigerating system before the air again reaches said main condenser 4.

It will be here noted that the solenoid valve 22 when in closed position retains all the refrigerant in the receiver, and when the valve is open, the refrigerant may pass through the entire system so that said solenoid valve is a normally closed valve when de-energized. The high-low pressure switch 23 automatically controls the refrigerating system wherein high pressure in the outlet 2a of the compressor 2 shuts off operation of the compressor 2 by de-energizing the motor 1. When the solenoid valve 22 is closed, the compressor 2 operates until all the refrigerant is pumped down into the receiver 18 during which time the suction pressure falls to a certain degree in relationship with the high-low switch 23 which automatically discontinues operation of the motor 1. Thus, low pressure remains on the inlet side 2b of the compressor 2 preventing the rupture of a seal on the inlet side of the compressor such as that of an open type unit.

Though I have shown and described a particular construction, combination and arrangement of parts and portions, I do not wish to be limited to this particular construction, combination and arrangement but desire to include in the scope of my invention the construction, combination and arrangement substantially as set forth in the appended claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a low temperature drying apparatus of the class described the combination of a compressor, a main condenser, an evaporator, a casing for said compressor, condenser and evaporator, an auxiliary condenser externally of the casing, adapted to communicate with an outside cooling medium and cooling medium control means adapted to subject said auxiliary condenser to said outside cooling medium when the temperature inside said casing rises above a predetermined value, a circulating fan inwardly of said casing adapted to progressively circulate air in said casing from said evaporator through said condenser.

2. In a low temperature drying apparatus of the class described the combination of a casing, a compressor in said casing, a circulating fan in said casing, a condenser in said casing spaced from said fan, an evaporator in said casing spaced from said condenser, duct means in said casing arranged to confine the flow of air therein from said evaporator then through said condenser, and an auxiliary condenser in series ahead of said first mentioned condenser, adapted to communicate with a cooling medium externally of said casing and cooling medium control means adapted

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to subject said auxiliary condenser to said outside cooling medium when the temperature inside said casing rises above a predetermined value.

3. In a low temperature drying apparatus of the class described, the combination of a casing, a compressor in said casing, a circulating fan in said casing, a condenser in said casing spaced from said fan, an evaporator in said casing spaced from said condenser, duct means in said casing arranged to confine the flow of air therein from said evaporator then through said condenser, and an auxiliary condenser externally of said casing in series ahead of said first mentioned condenser, adapted to communicate with a cooling medium externally of said casing, a control for said auxiliary condenser having thermostatic switch means internally of said casing at the outlet of said first mentioned condenser.

4. In a low temperature drier of the class described, the combination with a casing, having a processing compartment therein, a compressor, a circulating fan, a condenser, and an evaporator in said casing adjacent said processing compartment, duct means in said casing arranged to direct air in continuity through said processing compartment into said evaporator through said condenser past said compressor, backwardly into said processing compartment, of an auxiliary condenser communicating with said first mentioned condenser and in series therewith and ahead thereof in the refrigerant circuit positioned externally of enclosed portion of said casing whereby said auxiliary condenser is receptive to a cooling medium externally of the enclosed portions of said casing in which said compressor, condenser, evaporator, and processing compartments exist and cooling medium control means adapted to subject said auxiliary condenser to said outside cooling medium when the temperature inside said casing rises above a predetermined value.

5. In a low temperature drier of the class described, the combination with a casing having a processing compartment therein, a compressor, a circulating fan, a condenser, and an evaporator in said casing adjacent said processing compartment, duct means in said casing arranged to direct air in continuity through said processing compartment into said evaporator through said condenser past said compressor, backwardly into said processing compartment, of an auxiliary condenser communicating with said first mentioned condenser and in series therewith and ahead thereof in the refrigerant circuit positioned externally of enclosed portion of said casing whereby said auxiliary condenser is receptive to a cooling medium externally of the enclosed portions of said casing in which said compressor, condenser, evaporator, and processing compartments exist and cooling medium control means adapted to subject said auxiliary condenser to said outside cooling medium when the temperature inside said casing rises above a predetermined value, a drip pan below said evaporator, and means for conducting condensate therefrom.

6. In a low temperature drying apparatus of the class described, the combination of a casing, a compressor in said casing, a circulating fan in said casing, a condenser in said casing spaced from said fan, an evaporator in said casing spaced from said condenser, duct means in said casing arranged to confine the flow of air therein from said evaporator then through said condenser, and an auxiliary condenser in series with said first mentioned condenser positioned intermediate said compressor and said first mentioned condenser, a

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secondary cooling medium communicating with said auxiliary condenser medium therein, a control for said external cooling medium having means thermally responsive to the circulating drying medium in the casing, said control including a thermostatic switch having means beyond the drying medium outlet of said first mentioned condenser, whereby rise in temperature internally of said casing operates said switch which initiates operation of said external cooling medium for exchanging heat from said auxiliary condenser to said external cooling medium, thereby disposing of excess heat from said drying medium.

7. In a low temperature drying apparatus of the class described, the combination of a casing, a circulating fan in said casing, a condenser in said casing spaced from said fan, an evaporator in said casing spaced from said condenser, a compressor communicating with said condenser and said evaporator, duct means in said casing arranged to confine the flow of air therein from said evaporator, then through said condenser, and an auxiliary condenser in series with said first-mentioned condenser, positioned intermediate said compressor and said first-mentioned condenser and located outside said casing, a secondary cooling medium communicating with said auxiliary condenser, a control for said external cooling medium having means thermally responsive to the circulating drying medium in said casing, said control including a thermostatic switch having means beyond the drying medium outlet of said first mentioned condenser, whereby rise in temperature internally of said casing operates said switch, which initiates operation of said external cooling medium for exchanging heat from said auxiliary condenser to said external cooling medium, thereby disposing of excess heat from said drying medium.

8. In a low temperature drying apparatus of the class described, the combination of a casing, a circulating fan in said casing, a condenser in

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said casing spaced from said fan, an evaporator in said casing spaced from said condenser, a compressor for operating said condenser and said evaporator, duct means in said casing arranged to confine the flow of air therein from said evaporator, then through said condenser, and an auxiliary condenser in series with said first-mentioned condenser, positioned intermediate said compressor and said first-mentioned condenser, and disposed outside said casing, a secondary cooling medium communicating with said auxiliary condenser medium, a control for said external cooling medium having means thermally responsive to the circulating drying medium in the casing, said control including a thermostatic switch having means inside said casing, whereby rise in temperature internally of said casing operates said switch, which initiates operation of said external cooling medium for exchanging heat from said auxiliary condenser to said external cooling medium, thereby disposing of excess heat from said drying medium.

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