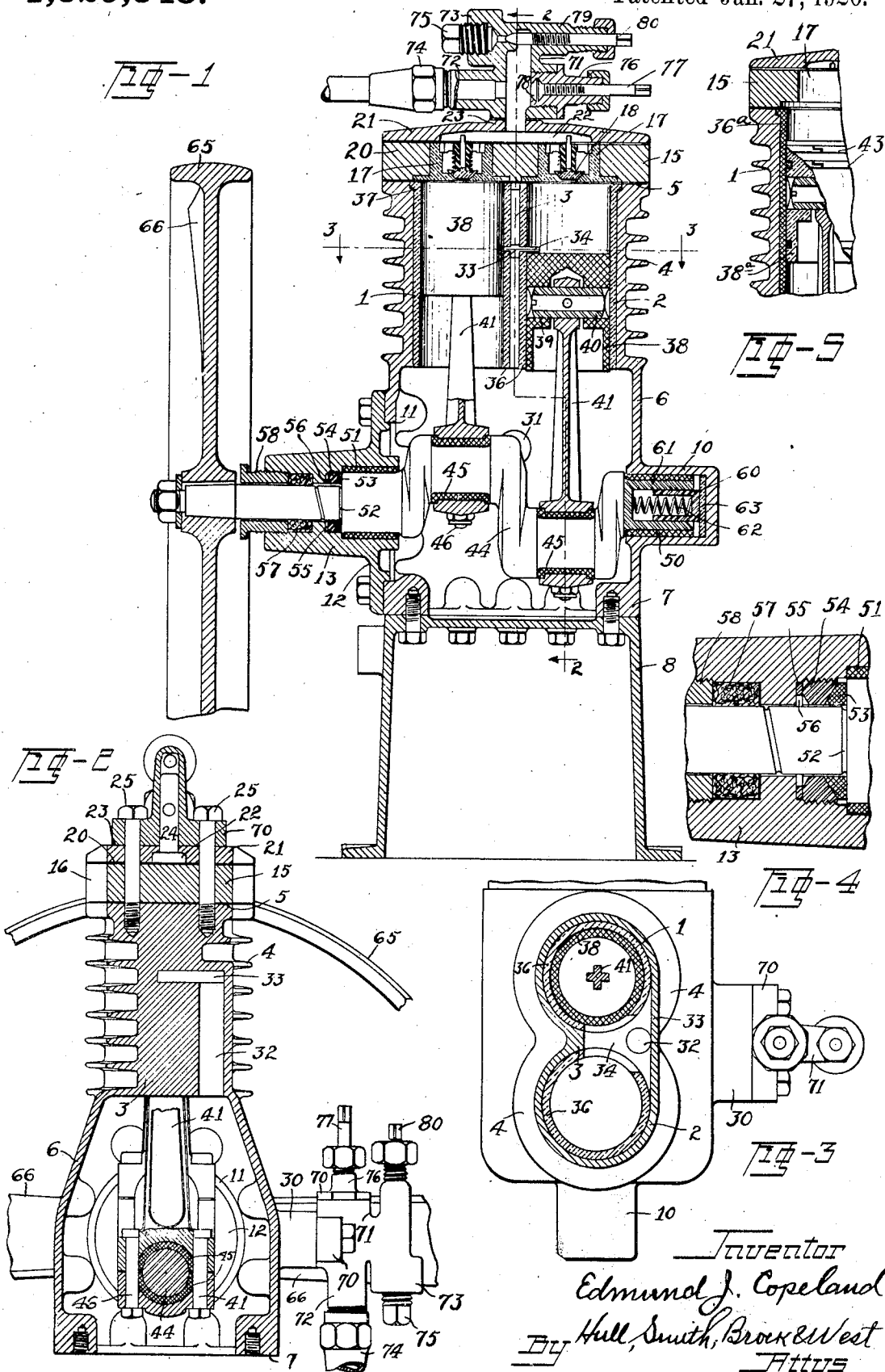


E. J. COPELAND,
REFRIGERATING APPARATUS.
APPLICATION FILED JAN. 31, 1918.

1,329,348.

Patented Jan. 27, 1920.



UNITED STATES PATENT OFFICE.

EDMUND J. COPELAND, OF DETROIT, MICHIGAN, ASSIGNOR TO KELVINATOR CORPORATION, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

REFRIGERATING APPARATUS.

1,329,348.

Specification of Letters Patent.

Patented Jan. 27, 1920.

Application filed January 31, 1918. Serial No. 214,605.

To all whom it may concern:

Be it known that I, EDMUND J. COPELAND, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented a certain new and useful Improvement in Refrigerating Apparatus, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

This invention relates to refrigerating apparatus and particularly to a compressor for use with such apparatus. The invention has especial reference to refrigerating apparatus intended for domestic use, and hence required to operate with little or no attention, although not necessarily limited thereto.

Many attempts have been made to produce a domestic refrigerating apparatus in order to dispense with the need of periodic icing, to secure a lower and more uniform temperature than can be secured with ice, and either to decrease or certainly not to increase materially the expense, but the conditions to be suited are rather numerous and very rigid. The device must be inexpensive to construct and install since otherwise it will not be adopted; it must be safe against leaks, explosions and fires, both when running continuously and when left alone for long periods of time; it must be capable of running without attention since such attention as it gets will be irregular and unskilled; it must be air cooled in order to reduce the cost of its installation, to prevent the waste of water, and to avoid danger of freezing in cold weather; and it must be so constructed as to start instantly and operate properly even after being left unused for long periods of time.

Hitherto the only type of refrigerating apparatus even partly fulfilling these requirements has been the so-called "compression liquefaction" type, wherein a liquid of low boiling point is evaporated in a suitable coil or chamber located in the inclosure to be cooled, the vapor of such evaporation being withdrawn by a mechanical pump and delivered under pressure into a radiator external to the said inclosure where its latent heat of evaporation is given up and its liquid condition restored. Such a system has been known theoretically for more than fifty years, and numerous large plants are in suc-

cessful operation in every country, but practically every effort to apply this system to domestic refrigeration has been unsuccessful owing to a failure in some one or more of the particulars above enumerated. The two chief difficulties heretofore encountered have been concerned with the corrosion and lubrication of the compressor; corrosion, because during the quiescent period, especially during the winter when most users do not operate the device, the pistons become corroded tightly to the cylinder walls and the rotating parts stuck fast in the bearings so that subsequent use of the device, if possible at all, can occur only after long and expensive overhauling; and lubrication since most compressors require a lubricant not only for the shaft bearings but for the purpose of forming a tight seal between the pistons and cylinder walls, which lubricant gradually becomes entangled in the refrigerant requiring complicated expedients for its separation therefrom and also becomes worn out by use and leaks away around the compressor shaft so as to permit leakage of refrigerant at this point and necessitating refilling which means unsealing the system.

The objects of the present invention are the provision of a compressor of such construction that the use of lubricant shall be unnecessary; the provision of a compressor of such nature as always to remain tight under all conditions of temperature and pressure; the provision of a compressor constructed in such manner and of such materials as to be proof against corrosion or sticking; while further objects and advantages will become apparent as the description proceeds.

The essence of my invention consists in the use of certain metals or combinations of metals which will run against each other under wide extremes of temperature and in contact with the corrosive refrigerant without lubrication; and the particular metal which I prefer to use, although without limiting myself solely thereto, is that metal which is described and claimed in the Letters Patent of Emery G. Gilson, No. 1,071,044 dated August 26, 1913, and No. 1,177,407 dated March 28, 1916, which metal is at present sold by The General Electric Company under the name "genelite." This metal will run against certain bronzes and against

hardened steel without perceptible wear and without sticking even at high temperatures, especially in case it be used in contact with members of substantially the same coefficient of expansion.

As an example of the use of my invention in the case of pistons and cylinders, I make one of the same from the said genelite, preferably employing a composition containing approximately:

Copper	68% to 73%
Tin	18% to 13%
Lead	10% to 8%
Graphite	8% to 4%

although these portions are not invariable, and a small amount of other substances such as zinc could also be employed. The other member is preferably a kind of bell-metal bronze, as for example:

Copper	79% to 83%
Tin	14% to 18%
Zinc	2% to 1%
Lead	2% to 1%

which possesses the necessary hardness and smoothness of surface to run well with the genelite while having approximately the same coefficient of expansion. Either the piston or the cylinder can be made of the graphite-containing material, the other member being made of the bronze or other hard substance; and the cylinder preferably takes the form of a sleeve pressed into the bore of a cast iron block. The action of the graphite is to coat the surfaces of piston and cylinder bore with a lubricating and sealing coating. The refrigerant which I prefer to use is sulfur dioxide, which is wholly without corrosive action upon the substances mentioned, although the same is substantially true of all other refrigerating media with which I have so far experimented.

My invention also extends to the construction of crank shaft and wrist pin bearings which shall be free from the need of lubrication, and these likewise I preferably make of a non-ferruginous graphite-containing metal such as the same genelite, rubbing against steel; and the sealing of the crank shaft against refrigerant leakage is also conveniently effected by the same substances.

It will be obvious that the employment of these metals for the purpose in view can be effected in a multitude of ways, and that I do not restrict myself either to the particular metals herein mentioned or to any particular construction of compressor or arrangement of operating parts; also that I do not even restrict myself to the use of a compressor of the reciprocating type, inasmuch as my improvements can equally well be used in connection with a rotary pump; however, for the purpose of showing at least

one operative structure wherein my invention is embodied I will now describe in detail the parts illustrated in the accompanying drawing, which shows a reciprocating piston type of compressor.

In this drawing, which it will be understood is illustrative merely and not limiting upon me, Figure 1 represents a longitudinal vertical sectional view through a preferred design of compressor embodying my invention; Fig. 2 is a sectional view taken on the broken line 2—2 of Fig. 1 and looking in the direction of the arrows; Fig. 3 is a horizontal sectional view taken on the line 3—3 of Fig. 1 and looking in the direction of the arrows; Fig. 4 is an enlarged detail view of the shaft-sealing arrangement; and Fig. 5 illustrates a slight modification.

Describing the illustrated construction more at length and with relation to the characters of reference on the drawing, the particular compressor shown comprises two cylinders, 1 and 2, bored parallel to each other in a single cast iron block, the cylinders being separated by a narrow web 3 and surrounded by integral air cooling flanges 4. At one end, hereafter called the head end, this block is faced as shown at 5 in a plane transverse to the cylinder axes, while at its opposite end the cylinder block is integral with the hollow crank case 6, whose side opposite the cylinders, hereafter called the base, is squared off as shown at 7 for the hermetic reception of a suitable base such as shown at 8. One end of the crank case 6 is formed with a hollow integral boss 10 whose axis is perpendicular to the cylinder axis, and the opposite wall of the crank case is formed with an aperture 11 concentric with said boss and adapted to have the bearing plate 12 hermetically bolted thereto. Projecting from the outer face of the plate 12 is a hollow boss 13 whose bore is in line with the boss 10 and coöperates with that boss in the reception of the crank shaft, whose preferred method of mounting and sealing will be described hereafter. To the faced portion 5 is hermetically clamped the cylinder head 15, also preferably flanged as shown at 16 for air cooling purposes and carrying the valve cages 17 and valves 18. The particular construction of these valves and cages is not important to the present invention, although I preferably employ the construction and arrangement described and claimed in the application of Fred J. Heideman filed January 14, 1918, Serial No. 211,750.

The upper side of the cylinder head 15 is faced as shown at 20 for the reception of the top plate 21 whose lower surface is formed with a longitudinal channel 22 communicating with the valve cages 17, 17 and whose upper surface is formed with a seat 23 traversed by an aperture 24 which communi-

cates with this channel. To the seat 23 is clamped a fitting for the outlet pipe, said fitting preferably containing certain valves, passages, and openings for definite purposes to be hereafter described. The fitting, top plate and cylinder head are conveniently secured together by suitable bolts 25, 25 tapped into the head end of the cylinder block.

The side of the crank case is formed with a laterally extending boss 30 traversed by a bore 31 communicating with the crank case interior and faced at its outer end for the reception of a fitting for the inlet pipe, which fitting is preferably identical with the fitting to which the outlet pipe is connected. The cylinder block is also formed at a point adjacent to both cylinders with a longitudinal passageway 32 opening into the crank case at the one end and terminating at its opposite end in an enlargement 33 which opens into the cylinders by means of ports 34 intermediate the ends of the cylinder bores.

Each cylinder is lined with a sleeve 36 of the bell-metal bronze heretofore described, the upper end of each sleeve being formed with a flange 37 clamped in a groove in the cylinder block by engagement with the head 15. Slidably mounted in each sleeve is a piston 38 of the usual elongated type formed of self-lubricating metal as previously described and having therein transverse apertures 39 adapted for the reception of the hardened-steel piston-pin 40 rigidly clamped to the upper end of the connecting rod 41. The length of each piston is such that upon the conclusion of its downward stroke the port 34 is uncovered to admit fluid to the cylinder bore.

The crank shaft 44 is of the usual two-throw type and made of steel, while the head of each connecting rod is split and chambered for the reception of the bushings 45 which are also preferably made from a graphite-containing non-ferruginous metal which may be the same as that used for the pistons. Suitable means are provided to prevent the bushings from rotating relatively to the connecting rod, such as notching the same for the reception of the connecting bolts 46.

The interior of the bosses 10 and 13 are reamed for the reception of journal bushings 50, 51 also preferably of the same graphite-containing metal, these bushings being preferably cylindrical so as to permit endwise movement of the crank shaft, and directly in front of the bushing 51 the crank shaft is reduced in diameter to form the abrupt shoulder 52 against which rests the bearing-ring 53, also preferably of the same graphite-containing metal and having its outer face formed upon the segment of a sphere concentric with the crank shaft axis. This spherical surface contacts with the

complementary surface of a hardened steel ring 54 threaded into the interior of the boss 13, leakage past the threads being prevented by a suitable gasket 55 which in turn rests against an internal shoulder 56 formed in the bore. I have also shown the boss 13 as formed outside of the shoulder 56 with a chamber 57 filled with soft packing held in place by the gland 58 and lubricated from the outside in order to assist the ring 53 in its sealing action; although I know by experience that such a ring will maintain its sealing action without assistance for a great many months and perhaps indefinitely.

For holding the shaft snugly against this ring and pressing the ring closely to its seat I have shown the inner end of the shaft as provided with a hardened steel button 60 slidably mounted in a recess 61 and held in outward position by a spring 62, the head of the button resting against a thrust plate 63 located in the end of the boss 10 and formed either of bronze, genelite, hardened steel, or any other suitable material. The outer end of the shaft is provided with a fly wheel 65 whose spokes 66 are shown as inclined to provide a fan action and assist in keeping the cylinders cool.

Numerous compressors constructed in accordance with these drawings and description have been operated continuously in practical service for several months without attention or leakage, and even without sticking or squeaking although their running temperature is so high as to be extremely painful to the touch.

The inlet and outlet fittings here shown each consists of a bronze casting having a base flange 70 integral with the hollow body 71. Projecting from one side of the body are a pair of hollow bosses 72, 73, one of which is threaded for the reception of a thimble 74 by means of which is attached the inlet or outlet pipe as the case may be, the other being internally threaded for the attachment of a plug 75. Opposite the boss 72 is formed a threaded opening adapted for the reception of the bonnet 76 in which is rotatably mounted the valve stem 77 having at its inner end a valve member 78 by which the opening through the boss 72 can be closed. Opposite the boss 73 is formed the internally threaded neck 79 receiving the threaded needle valve 80 by means of which to close the opening through the boss 73. With this arrangement it is a simple matter to close off the pipe line by screwing down the valve 78, after which the fittings can be detached and the compressor instantly removed for purpose of repair without the loss of any refrigerant fluid. One or both of the plugs 75 can also be removed and replaced by pressure gages, either temporarily or permanently, by means of which to ascertain the conditions within the sys-

tem and the efficiency of the compressor. Also one of the bosses 73 forms a convenient point of attachment for a refrigerant tank with which to fill the system originally or to replenish leakage therefrom.

In Fig. 5 I have shown a modification consisting of a reversal of substance between the cylinder sleeve and the piston therein, this arrangement being particularly useful in case piston rings are to be used. In this construction the cylinder sleeve 36^a is formed of the self-lubricating metal and the piston 38^a of bronze, its surface being further shown as formed with circumferential grooves receiving the bronze piston-rings 43.

While I have described in detail the particular embodiment illustrated in these drawings, I have done so merely to illustrate one operative device in which my improvements can instantly be embodied but without meaning that the constructions and arrangements here shown are essential to the employment of such improvements and without intending to limit myself to such details of construction or arrangement which may be varied from in wide degree within the scope of my invention and within the purview of the claims hereto annexed. Certain features of my invention described herein and included generically in the claims hereof are recited and covered in a specific manner in my copending application filed July 22, 1918, Serial No. 246,119.

Having thus described my invention, what I claim is:

1. A compressor for refrigerating apparatus comprising relatively movable elements one of which is composed of a non-ferrous, porous metal having a solid lubricant disseminated therein.

2. A compressor for refrigerating apparatus comprising relatively movable elements one of which is composed of a non-ferrous metal containing free graphite.

3. A compressor for sulfur dioxide comprising relatively movable elements one of which is composed of a non-ferrous alloy consisting largely of copper and containing free graphite.

4. A compressor for refrigerating apparatus comprising its working chamber and moving element formed of non-ferrous metals of substantially the same coefficient of expansion, the metal of at least one of those members containing free graphite.

5. A compressor for sulfur dioxide comprising its working chamber and moving element formed of non-ferrous alloys consisting largely of copper, both members having substantially the same coefficient of expansion and at least one of the same containing a solid lubricating agent integrally disseminated therein.

6. A compressor for corrosive refrigerant

media comprising a chambered part and a moving part therein, one of said parts having a working surface consisting substantially of copper, 79 to 83%; tin, 18 to 14%; zinc, 2 to 1%; and lead 2 to 1% and the other part having a working surface consisting substantially of copper, 68 to 73%; tin, 12 to 14%; lead, 8 to 10%; and the remainder free graphite disseminated through the mass.

7. A compressor for corrosive refrigerant media comprising a cylinder part lined with bell-metal bronze and having therein a closely fitting moving element of genelite.

8. A compressor for sulfur dioxide comprising an air cooled cylinder lined with bronze and a reciprocable tight-fitting piston of genelite.

9. In refrigerating apparatus, a compressor for corrosive fluids comprising a chambered part and a moving part closely fitting said chambered part, wherein one of said parts is of bronze and the other of genelite.

10. The combination, in a compressor for corrosive gases of a chambered part of bronze and a closely fitting moving part therein formed of a porous, soft metal alloy having finely divided carbon distributed throughout its mass, the metal being largely in excess of the carbon.

11. The combination, in a compressor for corrosive gases of a chambered part of bronze and a closely fitting moving part therein whose working surface is composed of an alloy of copper with softer metals and having finely divided graphite distributed through its mass, the proportion of alloy being largely in excess of the graphite.

12. The combination, in a compressor for corrosive gases of a chambered part of bronze and a closely fitting moving part therein formed of an alloy of copper, tin, and lead having finely divided graphite distributed throughout its mass.

13. The combination in a compressor for corrosive gases, of a chambered part and a movable part therein, each of said parts consisting of an alloy of tin and lead with a preponderance of copper, and one of said parts also having a solid lubricant, as graphite, distributed therethrough.

14. The combination in a compressor for corrosive gases, of a chambered part and a movable part therein, each of said parts consisting of an alloy containing not less than about 70% of copper, between about 10% and about 20% of tin, and not more than about 10% of lead, one of said parts also having from about 4% to about 8% of finely divided graphite distributed through the alloy mass.

15. In a refrigerant compressor, the combination of a pair of relatively movable parts, one of which consists of a bronze

composition having finely divided graphite disseminated therethrough, the other of which consists of a hard metal free from graphite.

- 5 16. A refrigerant compressor comprising relatively movable contacting parts composed of bronzes of substantially the same

coefficient of expansion, one at least of said bronzes having at least 4% of finely divided free graphite uniformly disseminated there- 10 through.

In testimony whereof, I hereunto affix my signature.

EDMUND J. COPELAND.