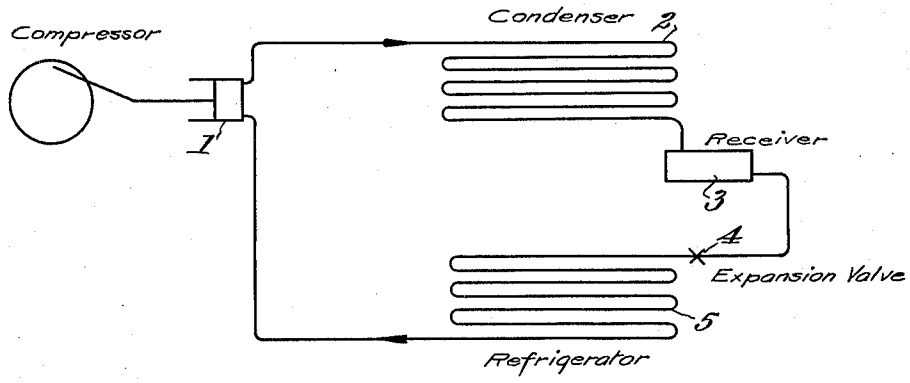
June 10, 1924. 1,497,615

H. E. THOMPSON

REFRIGERATING SYSTEM

Filed June 2, 1923



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Patented June 10, 1924. 1,497,615

UNITED STATES PATENT OFFICE.

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REFRIGERATING SYSTEM.

Application filed June 2, 1923. Serial No. 643,050.

To all whom it may concern:

Be it known that I, HAROLD E. THOMPSON, a citizen of the United States, residing at Clendenin, in the county of Kanawha and State of West Virginia, have invented certain new and useful Improvements in Refrigerating Systems, of which the following is a specification.

This invention relates to refrigerating systems, and comprises a novel refrigerating system including also certain novel products utilized in connection therewith.

As is well known, a refrigerating system of the cyclical type comprises as its essential parts a compressing device, as for example a motor-driven compressor pump; a cooling coil or equivalent means for liquefying the compressed gas; a vaporization or expansion equipment where heat is absorbed from brine or other surrounding medium during vaporization of the liquid; and a refrigerant possessing such physical properties as to enable it to pass alternately and repeatedly between the liquid and vapor phases under the pressure and temperature conditions obtaining in the cycle. A typical system of this kind is diagrammatically illustrated in the accompanying drawing wherein 1 indicates a motor-driven compressor; 2 a condenser; 3 a receiver for the liquefied refrigerant; and 4 an expansion valve through which the refrigerant is permitted to vaporize at a controlled rate into the refrigerating coil or equivalent device 5, whence it is returned to the compressor 1, thus completing the cycle. The present invention relates to refrigerants for use in a system of this kind, and comprises certain novel refrigerants of the hydrocarbon type, these refrigerants comprising either iso-butane in a state of commercial purity; or such mixtures consisting essentially of iso-butane and propane or their equivalents as will function under the ordinary conditions of use in a refrigerating cycle like a simple hydrocarbon, as more fully described hereinafter.

It has long been recognized that certain hydrocarbons, and especially those of the paraffin series, are well adapted for use as refrigerants and possess certain advantages for such use arising more especially from their non-corrosive, non-toxic and highly stable nature. There are in commercial use three general types of refrigerant, each having its natural field of utility, to wit (1) ethyl chlorid and sulfur dioxid for moderate refrigeration and especially for small units such as are used for household and similar purposes; (2) ammonia for more intense cooling; and (3) carbon dioxid for the most intense cooling. Of the paraffin hydrocarbons which are now commercially available, butane corresponds in a very general way to ethyl chlorid and sulfur dioxid; propane to ammonia; and ethane to carbon dioxide; and references to the employment of each of these hydrocarbons in a refrigerating cycle exist in the patent and other literature. The present invention in its preferred embodiment involves the employment in a refrigerating cycle, either in a state of commercial purity or in certain appropriate admixtures, of iso-butane.

My investigations of the components of certain natural gases have shown that the fraction which has been heretofore universally regarded as butane, and which does in fact correspond in proximate chemical composition to butane in that it contains four carbon atoms linked to hydrogen in the proportion indicated by the formula C_4H_{10}, possesses a rather wide boiling range, instead of the fixed or narrow range characteristic of a pure hydrocarbon. This observation suggested the probability of the presence in this fraction of an isomeric body; and further investigations, involving the isolation of a fraction corresponding closely to the formula C_4H_{10} and its re-fractionation, have enabled me to isolate in commercial quantities a hydrocarbon having like normal butane the formula C_4H_{10} but a boiling range of -11.5 to $-12.5°$ C. This is a commercial grade of iso-butane, a body whose probable existence in natural gas has been both affirmed and denied, but has not to my knowledge been demonstrated heretofore. I have demonstrated not only its existence in a natural gas, but its presence therein in such quantities, amounting in a specific case to 10–20 per cent of the total butane content, as will render it commercially available for refrigeration and other purposes. The iso-butane can of course be isolated, by proper precautions, in any desired degree of purity: the particular material above referred to as having been isolated and used by me in a refrigerating cycle contained upward of 90 per cent iso-butane, about 3 per cent of

propane, and small but undetermined proportions of normal butane and possibly traces of other hydrocarbons.

As a refrigerant it possesses within its natural refrigerating range marked advantages over any other refrigerant known to me. In common with the other paraffin hydrocarbons it possesses the advantages of non-corrosiveness, non-toxicity and chemical and physical stability. As compared with other paraffin hydrocarbons available for refrigeration purposes it operates at much lower head pressures than ethane or propane, and permits obtaining a decidedly higher refrigerating capacity in a given machine than is possible with normal butane. As compared with normal butane it possesses the further important advantage of affording a positive or superatmospheric pressure on the suction side of the compressor; whereas normal butane under ordinary operating conditions gives a negative pressure (partial vacuum) at this point. This last mentioned characteristic is highly objectionable for a variety of reasons, but more especially because it is apt to lead to a slow inward leakage of air, which as it gradually accumulates in the system tends to trap in the condenser, building up high head pressures with corresponding reduction of the mechanical efficiency of refrigeration; reducing the cooling efficiency of the condenser; and possibly eventuating in the production of an explosive mixture. It will be understood that these disadvantages persist however minute this air leakage may be, since the air gradually accumulates over a period of weeks or months of continuous operation at progressively lessening mechanical efficiency. Iso-butane possesses therefore the great advantage over normal butane of rendering possible a maintained efficiency of refrigeration.

The above mentioned advantages inhere not only in iso-butane but in mixtures consisting essentially of iso-butane and certain lower boiling refrigerants, such as propane. Propane for example boils at about —45° C. and its use of course involves pressures which are relatively high, and in certain types of equipment, undesirable. Iso-butane added in any substantial or material proportion to propane will reduce this head pressure; and irrespective of the proportion added it will not lead to negative suction pressures. Hence its use in conjunction with propane affords possibilities of controlling the refrigeration temperature, or the refrigerating capacity at constant temperature, throughout a comparatively wide range.

A further marked advantage possessed by iso-butane as compared with normal butane for admixture with propane or equivalent lower boiling refrigerants, is that the boiling point of the iso-butane, which as above stated is of the order of —12° C., is distinctly below the average temperature of the brine (where used) with the result that there is no tendency of the iso-butane to fractionate out from the mixture at one point in the cycle, which tendency is strongly marked in case normal butane is used under like conditions. It follows from this that mixtures of iso-butane with a lower boiling diluent, of which propane is a type, function in all important respects like a simple body. For this purpose it will be apparent that the iso-butane might be diluted with any non-reactive refrigerant, and specifically with any hydrocarbon having a lower boiling point, of such order as to avoid unnecessarily or undesirably high head pressures. For example, propylene, boiling at about —50° C., might replace propane either wholly or in part as a diluent for the iso-butane.

In preparing such mixtures the proportions may be varied as desired according to the requirements of the specific case, from pure iso-butane on the one hand, to propane or its equivalents containing substantial proportions of iso-butane on the other hand. For example mixtures containing 80 per cent of propane with 20 per cent of iso-butane; and 90 per cent of propane with 10 per cent of iso-butane; have been found to operate satisfactorily in practice; exhibiting a high refrigerating capacity, a materially lower head pressure than propane, and the operating advantages of a simple hydrocarbon. By substantial proportions of iso-butane I mean such proportion as will import to the mixture properties differing to a material extent from those of pure propane or equivalent gas, as for example, a distinct lowering of the undesirably high condenser pressure.

Iso-butane under controlled cracking conditions yields gaseous mixtures containing iso-butylene, usually in addition to hydrogen and unchanged iso-butane. Iso-butylene has a boiling point of the same order as iso-butane, and may therefore replace iso-butane either wholly or in part for the purposes of this invention, and to that extent is to be regarded as an equivalent thereof. Iso-butane however, pure or in admixture with another hydrocarbon of the physical type of propane constitutes the preferred embodiment of my invention.

I claim:

1. The hereindescribed refrigerant having a boiling point substantially above —45° C. but affording positive suction pressures at ice-forming temperatures, said refrigerant possessing the essential refrigerating characteristics of a simple body and comprising a substantial proportion of iso-butane.

2. The hereindescribed refrigerant having a boiling point substantially above —45° C.

but affording positive suction pressures at ice-forming temperatures, said refrigerant possessing the essential refrigerating characteristics of a simple body and comprising a substantial proportion of iso-butane and a lower boiling diluent.

3. The hereindescribed refrigerant having a boiling point substantially above —45° C. but affording positive suction pressures at ice-forming temperatures, said refrigerant possessing the essential refrigerating characteristics of a simple body and comprising a substantial proportion of iso-butane and a lower boiling hydrocarbon diluent.

4. The hereindescribed refrigerant comprising iso-butane and propane.

In testimony whereof I affix my signature.

HAROLD E. THOMPSON.