June 27, 1950 A. G. BROWN 2,512,916

METHOD AND APPARATUS FOR EFFECTING EXPANSION OF GAS

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Fig. 1.

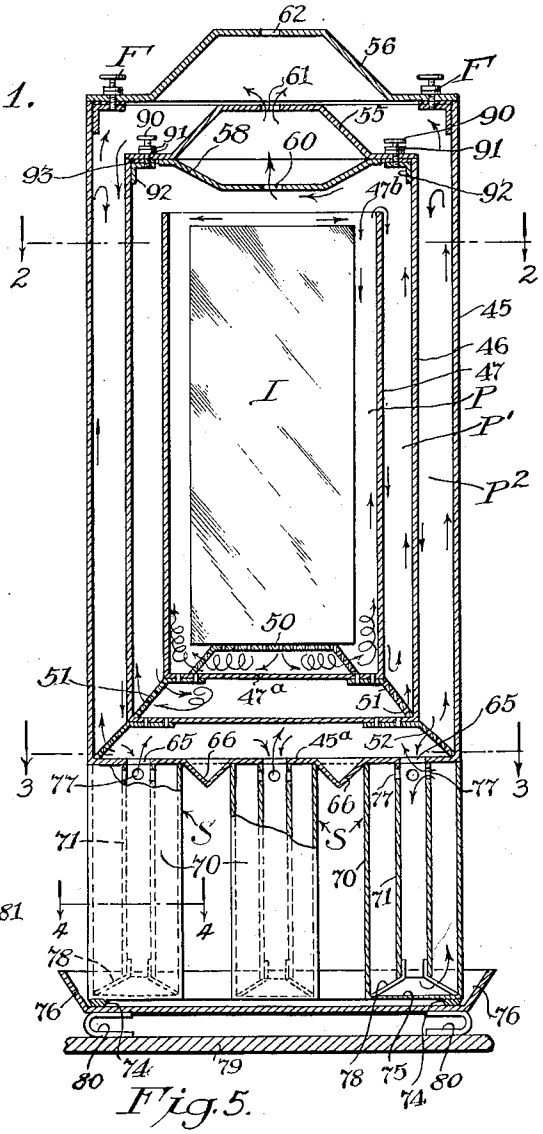


Fig. 6.

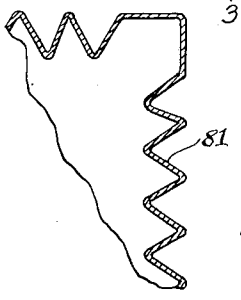


Fig. 4.

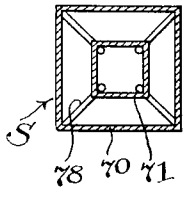
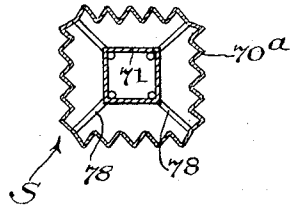


Fig. 5.



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Fig. 2.

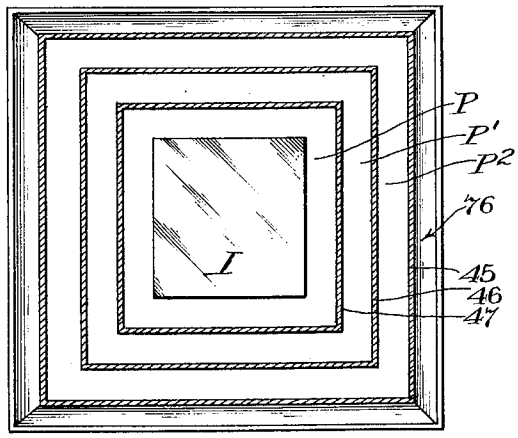
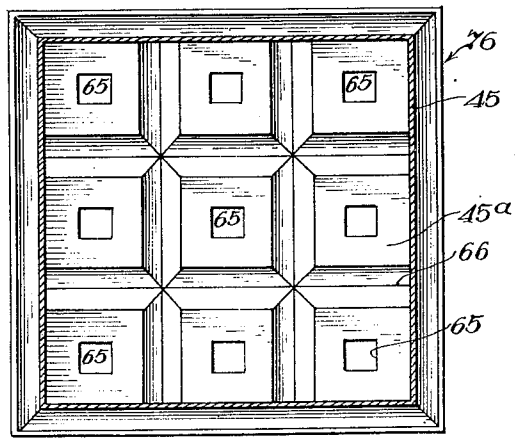


Fig. 3.



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METHOD AND APPARATUS FOR EFFECTING EXPANSION OF GAS

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Application April 9, 1943, Serial No. 482,400

1 Claim. (Cl. 62—91.5)

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My invention has to do with the treatment and control of expansible gases. In its more particular aspects, but without being so limited, my invention contemplates method and apparatus for so controlling and treating carbon dioxide (CO_2) gas as to utilize all or at least a major part of its latent properties of expansion.

It is well known, of course, that CO_2 is one of the most compressible of industrial gases, being capable of expanding to many hundred times its original stored volume. I find, however, that fullest benefit cannot be taken of the potential or latent expansive characteristics of this gas by those methods and means presently known in the art, which methods and means employ only a single expansion from the solid to the gaseous state.

By my invention, I aim to provide method and apparatus capable of deriving from expansible gases, and particularly CO_2 gas, maximum efficiency as a refrigerant.

Still further advantages are to be derived from my invention and how those as well as the foregoing specifically named objects are attained will become clear to those skilled in this art from the following detailed description of presently preferred procedures and forms of apparatus in which the invention may be carried out. I wish it understood at the outset, however, that, in its broader aspects as defined by the appended claims, my invention is not to be confined to the details of apparatus and method now to be described except insofar as those details may be specifically recited in the claims, since the invention is susceptible of being practiced in other manners and by other specific forms of apparatus.

Generally speaking, I carry my invention into practice by sublimation of CO_2 from the solid to a gaseous state and then so controlling and treating the gas as to subject it to a series of expansion steps. I carry out cycles of alternate expansion and cooling until practically all the latent energy is derived from the gas. I here use the term "latent energy" to describe those properties of expansion which, while possessed by the gas, have not heretofore been developed to a point of utilization for power, refrigerant or other purposes.

In the following description I shall describe my invention as adapted to one of the many uses to which it may be put, namely as a refrigerating unit, and for that purpose reference will be made to the accompanying drawings, in which:

Fig. 1 is a vertical section of a refrigerating unit embodying my invention;

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Fig. 2 is a section on line 2—2 of Fig. 1;

Fig. 3 is a section on line 3—3 of Fig. 1;

Fig. 4 is a section on line 4—4 of Fig. 1;

Fig. 5 is a section similar to Fig. 4 but showing a variational form; and

Fig. 6 is a fragmentary section showing a variational form of wall structure.

In Figs. 1 to 6, inclusive, I show an adaptation of my invention as a refrigerating unit. In this application of the invention I so control the movement and treatment of the gases as to cause them successively to be exposed to heat exchange surfaces of different temperatures whereby to effect the multiple expansion to which, in its broader aspects, my invention is directed.

Here I show a unit which may be placed in any area to be refrigerated. Within an outer casing **45** I nest two inner casings **46**, **47** in such spaced relationship as to provide gas passageways P_1, P_2 therebetween.

Within innermost casing **47**, and with its sides and ends spaced from the sides, top and bottom of said casing to provide gas passageway P, I dispose a block of solidified CO_2 (dry ice), here designated by the reference letter I. Block I is supported on a perforated table **50**, through the perforations in which gas is free to circulate. Casing **47** is supported at its bottom in spaced relation to the bottom of casing **46** by perforated corner brackets **51** and the bottom wall of casing **46** is supported in spaced relation to bottom wall **45***a* of casing **45**.

The top end **47***b* of innermost casing **47** is open but the top ends of casings **46**, **45** are capped by domed covers **55**, **56**, respectively, detachably mounted on said casings by screw clamps F to be described. Cover **55** has an inner baffle **58**, and there are restricted outlet ports **60**, **61**, **62**, respectively, through baffle **58**, cover **55** and cover **56** to permit escape of gas as will be described.

Bottom wall **45***a* is provided with a plurality of openings **65**, for a purpose to be described, and has corrugations **66** to increase the surface area.

Beneath bottom wall **45***a* and in communication with the openings **65**, I provide a plurality of sub-units S, only one of which I shall describe since all are of the same construction. While I show nine of these sub-units, this number may be varied in particular units. Each sub-unit S consists of an outer casing **70** whose top periphery fits in fluid tight engagement against the under surface of bottom wall **45***a* and whose bottom wall **75** is spaced, by spacers **74**, about a half inch above the floor of a drip pan **76**. The space

around the sides and under the outer casings **70** is open to air circulation. Concentrically in each casing **70** I provide a tube **71** whose top periphery fits snugly against the under surface of bottom wall **45***a*, around an opening **65**, and whose bottom end is spaced from bottom wall **75** by corner brackets **78**. Each tube **71** is of relatively smaller cross-section than casings **70** whereby to provide a gas passageway therebetween, and four holes **77**, one through each side wall, are provided adjacent the top end of each tube **71**. Pan **76** may be supported, as by corner brackets **80**, upon, for instance, a base **79**, which may be the floor of an enclosure to be refrigerated.

In Fig. 5 I show a variational way in which the outer tube **70***a* of each sub-unit S may be constructed. Here I show the outer casing **70***a* as being corrugated to provide greater surface area. In other respects the unit is the same as before described.

In Fig. 6 I show a variational form which the various casing walls before described may take. Here, instead of being plane as the walls of casings **45**, **46**, **47** are shown, said walls may be corrugated as shown at **81** to provide greater surface area.

I shall now describe the operation of my refrigerating unit illustrated in Figs. 1 to 6, inclusive.

As the solid CO_2 is sublimated, the resultant heavy gas passes downwardly through the perforated table **50** and, beginning its expansion, forms a somewhat spiral, slowly upwardly moving stream of gas along passageway P, the gas formed along the sides of block I moving slowly downwardly along the sides of the block into this upwardly moving stream. The expansion of this upwardly moving stream is accelerated by contact with the inner surface of casing **47**. Upon reaching the top of passageway P, some of the gas, by contact with the cooler gas moving downwardly adjacent block I, will be relatively cooled and will again recirculate in the manner described and some of it will pass over the top edge of casing **47** and will thence move downwardly again through passageway P_1 along the outer surface of casing **47** towards the space beneath wall **47***a*, and as it further expands by exposure to the relatively warmer inner surface of the side wall of casing **46**, will move upwardly in a somewhat spiralling stream along the inner surface of the side wall of casing **46**. Upon reaching the top of passageway P_1, the cover **55** and baffle **58** will deflect the gas inwardly and some of it will be recirculated in both passageways P and P_1. After these cycles of recirculation take place to the required extent, some of the gas will pass out through ports **60**, **61** into passageway P_2, along which it flows downwardly towards partition **45***a*. Some of this gas will, upon further expansion, flow upwardly along the inner surface of the side wall of casing **45** and some of it will pass on downwardly through openings **65** into the sub-units S, entering the tubes **71**, thence passing downwardly thereof, through the opened lower ends and thence upwardly between the tubes **71** and casings **70**, re-entering tubes **71** through openings **77**. Upon thus re-entering, some of the gas will be drawn into the cooler gas moving downwardly through the tubes **71** and will thus be subjected to recirculation, and some of it will pass out through openings **65** and will there be drawn into gas moving downwardly into another or other sub-units or will pass upwardly through passageway P_2 into the gas moving upwardly in that passageway. After going through a number of those cycles of alternate expansion and cooling, the gas will eventually pass out through opening **62** in the top of outer casing **45**.

While I show only two casings **46**, **47** nested within the outer casing **45**, I wish it understood that this number may be increased and a plurality of sets of nested casings may be utilized within a single outer casing **45** if desired, depending upon the desired capacity and economy of a given unit.

This gas circulation is continuous until the block I is exhausted and it will be observed that in each cycle the gas is alternately expanded and cooled due to being exposed to heat transfer media of relatively different temperatures. I thus obtain multiple expansion and contraction of the gas until the maximum efficiency is derived therefrom, with the result that the total refrigerating properties derived from a given quantity of Dry Ice are far in excess of those properties heretofore obtained.

The clamps F for securing the covers to the various casings are each comprised of a screw **90** which is threaded through lock nuts **91** and, after passing through a hole in the cover, is threaded into a hole provided in an angle bracket **92** welded or otherwise suitably secured to the inner surface of the side wall of the carrying casing, a suitable sealing gasket **93** being provided between each bracket and cover.

This application is a continuation in part of my application Serial Number 457,553, filed September 7, 1942, now abandoned.

I claim:

Refrigerating apparatus comprising a cabinet having side walls providing heat transfer surfaces, a pair of nested casings within the cabinet, the side walls of the casings providing heat transfer surfaces and being spaced apart and from the side walls of the cabinet to provide gas passageways therebetween, means supporting a supply of solidified CO_2 with its side walls spaced from the side walls of the innermost casing, a partition in the cabinet beneath the casings, said partition providing a space below the casings in communication with the outermost passageway, holes through the partition, and a plurality of sub-expansion members each in communication with one of the holes and each consisting of a pair of tubes nested with their side walls spaced apart to provide a gas passageway therebetween, the innermost tube of each sub-expansion member being in communication at its top end with one of said openings and being in communication at each of its end portions with the gas passageway therearound.

ALFRED G. BROWN.

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