R. MEWES.

PROCESS OF LIQUEFYING AIR AND SEPARATING OUT OXYGEN.

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980,813. Patented Jan. 3, 1911.

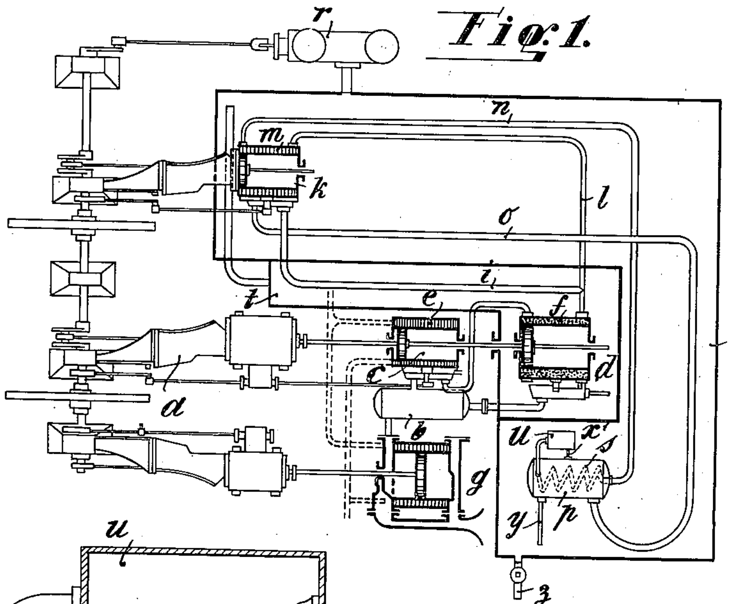

Fig. 1.

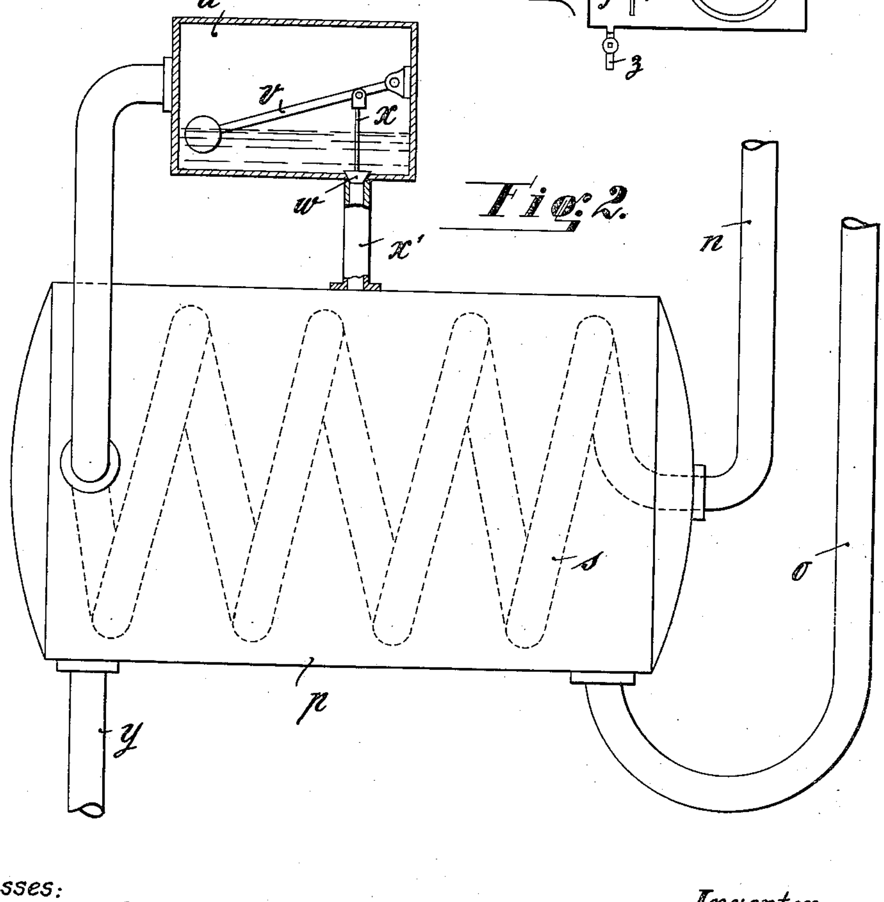

Fig. 2.

Witnesses:

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UNITED STATES PATENT OFFICE.

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PROCESS OF LIQUEFYING AIR AND SEPARATING OUT OXYGEN.

980,813. Specification of Letters Patent. Patented Jan. 3, 1911.

Application filed March 2, 1906. Serial No. 303,800.

To all whom it may concern:

Be it known that I, RUDOLF MEWES, a citizen of the German Empire, and resident of Berlin, Germany, have invented certain new and useful Improvements in Processes of Liquefying Air and Separating Out Oxygen, of which the following is a specification.

This invention has for its object a process of liquefying air and separating gases with a partial recovery of the energy consumed by the compression. It differs from older and similar processes very materially in that respect that for the purpose of reducing the pressure behind the expansion chamber in the exhaust port of the expansion engines (piston engines, Laval or Parson's turbines or the like) the expanded gases are not sucked off by the compressor, but by a special device (suction pump or the like), thus producing a partial vacuum in order not to let cold expanded gases reënter into the compressor, but to drive them out into the open air after using them as far as possible as a cooling medium for the process itself, in order to obtain in this way a mixture of fluids rich in oxygen. This is greatly facilitated by not sending back the expanded gases into the circuit, but by driving them out after an almost perfect exchange of heat has taken place. The new technical effects gained in this way over older processes for liquefying air in which the expanded gases, after having done their work, are led off under atmospheric pressure, consist in the first place therein that, in consequence of the greater lowering of the pressure, the falling of the temperature is correspondingly greater, that secondly the engine is not stopped as is the case with Siemens and other similar devices by a great lowering of the temperature, but thirdly also therein that the liquefied gases, which are partly evaporated again in the process itself, are evaporated at a suitably reduced pressure of less than one atmosphere, and in quantities corresponding with the vapor tensions of the component parts of the mixture of fluids. For instance, as experiments by Dewar, Estreicher, Baile, Olszewski have shown, (*conf.* "*Zeitschrift für Komprimierte und Flüssige Gase*", 2nd year, number 12, page 180) nitrogen has at —195° C. a vapor tension of 740 mm., oxygen a tension of 142 mm. By producing a reduced pressure above a fluid the temperature is at once lowered, if sufficient heat is not admitted for the evaporation of the quantities of fluids sucked off. It is evident that,—as in the present process the temperature, by producing a reduced pressure by means of a suction pump, can easily be lowered down to —200° or still farther, and as at these temperatures the proportion of the vapors of both fluid parts is greater than 740/142, therefore greater than 5—it is necessary to evaporate over five times as much nitrogen as oxygen. This proportion becomes greater with the lowering of the temperature and is according to Olszewski at —214° 60/3.8, or 16. By producing a vacuum of 60 mm., which is technically easy, 16 times as much nitrogen as oxygen will be evaporated, therefore leaving nearly pure oxygen. The process is therefore suited for separating out directly almost pure liquid oxygen, and by its distillation correspondingly pure gaseous oxygen.

The accompanying drawing shows in Figure 1 a diagrammatic view of a plant for the liquefaction of air according to the present process, and in Fig. 2 an example of the fluid separator.

In the compression cylinder *g* all the gas sucked into it, and which previously has been freed of moisture, is compressed while being cooled as far as possible to, for instance, 5 atmospheres and pressed into the reservoir *b*. From the reservoir *b* one of the compression cylinders *c*, provided with a cooling jacket *e*, which cylinder is to be of a suitable size, sucks in a part of the compressed gas, and compresses the same to 25 atmospheres, and presses the high tension gas into the jacket *f* of the expansion cylinder *d*, which is fed from the reservoir *b* and expands a part of the gas compressed to 5 atmospheres and thereby does useful work. In consequence of this a great lowering of the temperature takes place, whereby the walls of the cylinder and also the high tension gases in the cylinder jacket *f* are greatly cooled. The exhaust gases of the expansion cylinder *d* pass into an insulated box, which surrounds the cylinder, from which they are carried off by a suction pump into the open air, so that behind the outlet of the cylinder *d* the pressure is below the atmospheric, and with this lowering of the pressure the lowering of the temperature is increased. A part of the high tension gas, cooled in the jacket *f*, is now led into the second expansion cylinder k through the pipe i which passes through the box t, and is further cooled in its passage through the box t by the cold gases coming from the cylinder d. The air expanded in the cylinder k escapes through the pipe o into the finishing cooler p. The other part of the high tension gases, greatly cooled in f, is led off, through the conduit l, into the jacket m of the cylinder k and, after being cooled here, through the pipe n into another cooler p, through which the tube n passes in spiral windings s. The cold exhaust gases, on leaving the apparatus, effect in consequence of this device a still further cooling of the high tension gases and are then led into the box q, which surrounds the finishing cooler p and the second expansion cylinder k, together with the pipes n and o, and are sucked off from this box through the suction pump r together with the exhaust gases of the first expansion cylinder d, so that also behind the outlet of the cylinder k the pressure is below the atmospheric, the lowering of the pressure is therefore still considerably greater as in the first case and consequently also the lowering of the temperature. The high tension air or gas liquefied in the spiral s of the pipe n is caused to enter through a fluid separator u of any suitable nature into the finishing cooler p. In Fig. 2 a fluid separator suitable for the purpose is shown. It consists of a closed vessel in which a float valve v is adapted by rising to open the valve w through the agency of the rod x. When the valve w is opened the liquid air accumulated in the closed vessel flows down through the pipe x' into p, from which it passes through the pipe y into the box q, in which the pressure is maintained below that of the atmosphere by means of a spiral suction pump r (Fig. 1), so that through the evaporation of a part of this fluid, in consequence of the vacuum in the said chamber, the temperature of the same, and finally that of the liquid air in the spiral, is cooled down to the temperature of the vacuum. By regulating the degree of the vacuum, it is possible, with this process, to cause almost only nitrogen to evaporate and but little oxygen, the cooling power of the evaporated nitrogen being at the same time utilized for the production of new fresh liquid air, so that a fluid mixture is directly obtained, which is almost pure, or very rich in, oxygen, and which can be used as such at once, or for the production of gaseous oxygen according to any existing process for the separation of gases. The liquid oxygen is drawn off through the cock z.

What I claim as my invention and desire to secure by United States Letters Patent is:—

1. A process for liquefying air and separating out oxygen which comprises compressing air into a reservoir, cooling the same, expanding said compressed air into a rarefied space, and maintaining the rarefaction of said space by continuously removing said expanded air without completing the cycle, substantially as, and for the purpose, set forth.

2. The hereinbefore described process, which consists in compressing air into a reservoir, and cooling the same, further compressing a part of said compressed air cooling said further compressed part by the expansion of the other part of said compressed air, cooling a part of said further compressed air by the expansion of another part thereof, and exhausting said expanded air into a vacuum, substantially as, and for the purpose, set forth.

3. The hereinbefore described process which consists in compressing air into a reservoir and simultaneously cooling the same, further compressing a part of said compressed air, cooling said further compressed air by the expansion of the other part of said compressed air, exhausting the said expanded part of the compressed air into a rarefied space, further cooling the further compressed air by the expansion of a part thereof, and expanding said further compressed air and the said expanded part thereof into a rarefied space, substantially as, and for the purpose, set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

RUDOLF MEWES.

Witnesses:

WOLDEMAR HAUPT,

HENRY HASPER.