Aug. 13, 1940. J. REICHART 2,211,547

PRODUCTION OF LIQUEFIED CHLORINE GAS

Filed Dec. 21, 1937 2 Sheets-Sheet 1

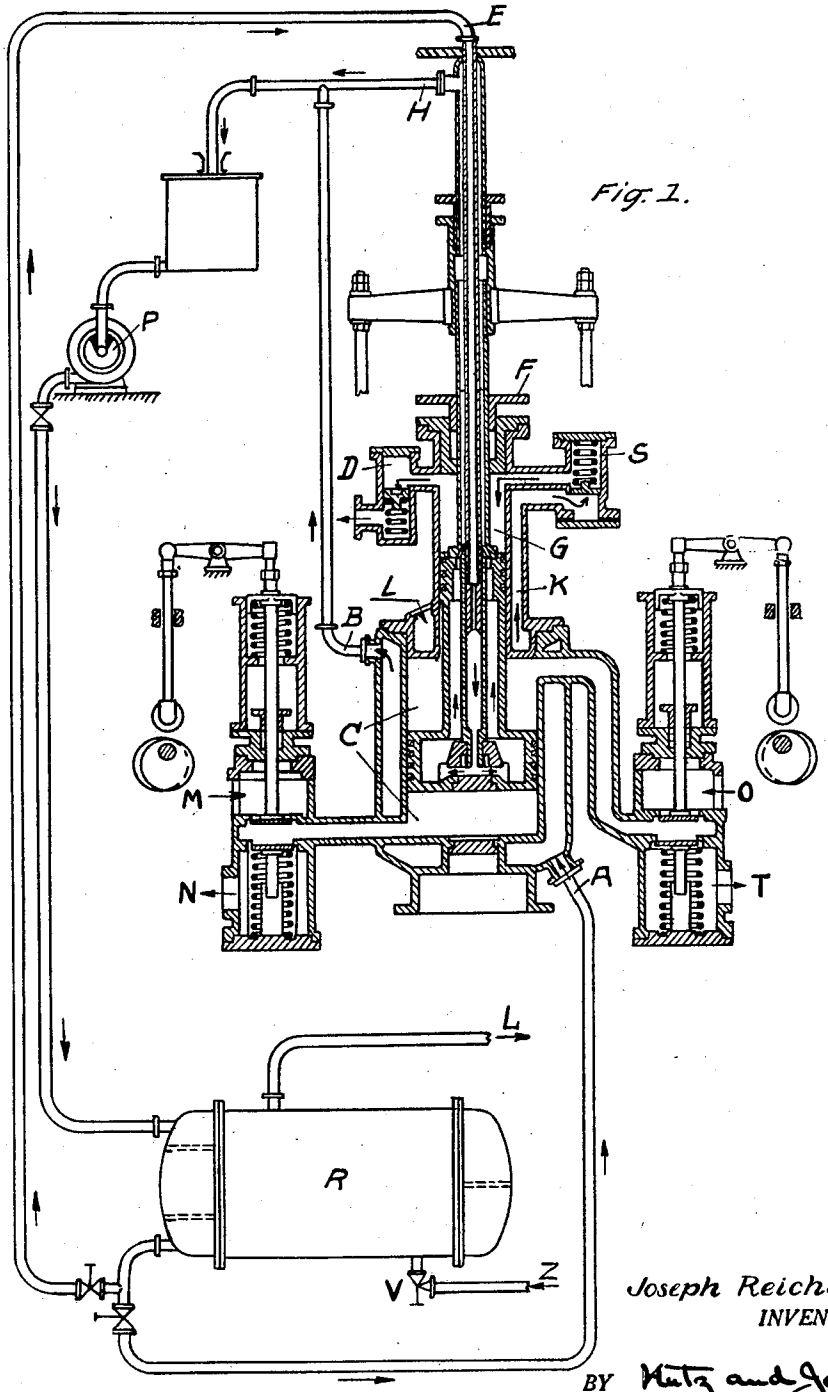

Fig. 1.

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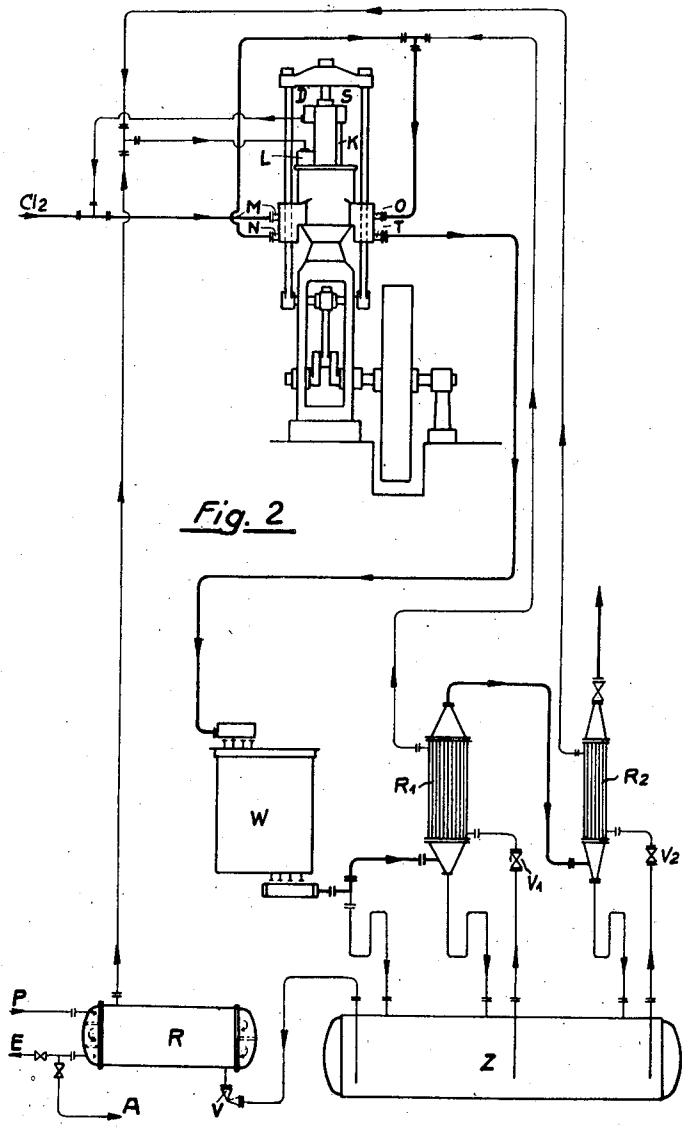

Fig. 2

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Patented Aug. 13, 1940 2,211,547

UNITED STATES PATENT OFFICE

2,211,547

PRODUCTION OF LIQUEFIED CHLORINE GAS

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Application December 21, 1937, Serial No. 180,977
In Germany November 1, 1933

5 Claims. (Cl. 62—175.5)

This invention relates to improvements in the production of liquefied chlorine by compression of chlorine gas.

In the compression of chlorine gas in iron compressors there is the difficulty that the chlorine gas readily becomes heated to such high temperatures that the iron is attacked by the chlorine. This attack commences at 60° C. and increases to such an extent at higher temperatures, as for example 90° C. and more, that the compressor is destroyed in a short time. In order to avoid this drawback it has already been proposed to cool the gas to be compressed by spraying liquefied chlorine into the suction pipe and to pass the said cold gas, before its introduction into the cylinder, through a cooling jacket surrounding the same. By this cooling by a gaseous cooling agent, which moveover is only available in an amount limited by the suction volume, the heat conveyed to the iron walls of the cylinder and the piston by reason of the gas compression and the piston friction is, however, only withdrawn very incompletely. The injurious heat may, however, be led away from the walls much more efficiently by a liquid cooling medium.

According to this invention there is used for leading away the compression and friction heat, a liquid cooling medium remaining liquid at the working temperatures which is cooled by evaporating chlorine or cold chlorine gas or both. Non-aqueous liquids which are not attacked by chlorine or only attacked with difficulty are especially suitable, as for example ice machine oil cooled to 0° C. or less but other oils or organic liquids the solidification point of which is sufficiently low, such as chlornaphthalene, may also be used. The liquid cooling medium, after it has preferably been cooled by cold chlorine gas or liquid chlorine in a device attached directly to the compressor, is pumped through a cooling chamber wholly or partly surrounding the cylinder, the piston and the piston rod. In this manner such a favorable cooling is obtained that the compression proceeds practically isothermally and thus considerable compression work is saved.

A suitable form of apparatus in accordance with this invention is shown in the accompanying drawings as applied by way of example to a two-stage compressor, but the invention is not restricted to the particular form shown. In the drawings, Fig. 1 is a diagrammatic illustration of an apparatus for conducting my process, the compressor herein being shown in vertical section in order to show the details thereof; and Fig. 2 is a diagrammatic illustration of the complete arrangement for carrying out the process of the present invention.

The two stages are arranged in a cylinder C in which a two-stage-piston moves. The lower side of the piston, which leaves the full cross-section free, forms the first stage and the upper side, which leaves only an annular cross-section free, forms the second stage. The cooling medium (cooling oil) is cooled to below 0° C. in an oil cooler R by re-evaporated or expanded cold chlorine, supplied from the liquid chlorine storage tank Z the flow of cold chlorine to the oil cooler being regulated by the valve V. The cooling oil is kept in circulation by means of the pump P. The cooling oil enters at A into the cooling jacket surrounding the walls and bottom of the cylinder and leaves the same at B. The entry of the cooling oil into the piston rod takes place at E and the exit at H. The chlorine sucked in by the first stage at M and the second stage at O and leaves them at N and T respectively is cooled to about 0° C. before the suction valves by sprayed-in liquid chlorine or by admixture with cooled chlorine gas coming from the re-evaporation condensers R_1 and R_2. In the re-evaporation condensers R_1 and R_2 the liquefaction of the compressed chlorine is effected by cooling by means of liquid chlorine released from pressure. W is a water cooled condenser. Above the cylinder C (Figure 1) there is arranged an auxiliary cylinder G which does not take part in the compression of the chlorine gas itself and which has a cross-section only about ⅛ as great as that of the cylinder C. The auxiliary cylinder G, through the cover of which the piston rod of the compressor is led and on which the main stuffing box F is situated, has an automatic suction valve S and an automatic pressure valve D. The suction valve S is connected through a suction channel K attached to the auxiliary cylinder direct to the double-walled cover of the main cylinder on which there is situated the suction attachment L for the auxiliary cylinder which is connected with the chlorine re-evaporator R_2 and to the oil-cooler R. The pressure valve D of the auxiliary cylinder leads back to the suction side M of the first stage of the compressor. The auxiliary cylinder thus sucks in strongly cooled chlorine gas released from pressure through the double-walled cylinder cover and forces it to the suction side M of the first stage of the compressor. By the arrangement of the auxiliary cylinder there is obtained a utilization of the cold of the relatively small amount of re-

evaporated chlorine which is released to atmospheric pressure and thereby cooled to below 30° below zero C. and also a complete unloading of the main stuffing box F because the auxiliary cylinder only moves against the suction pressure of the compressor (atmospheric pressure). The said cooling of the suction gas and the whole cylinder renders it possible in both stages of the compression to select a compression ratio up to more than 1:3 without the average gas temperature in the compressor exceeding 50° C.

It is preferable to construct the pressure valves of both stages as plate valves and to arrange them closely below the suction valves which are actuated from above. In this way the pressure valves are also efficiently cooled by the flow of the suction gas cooled to 0° C.

The compressor is preferably so arranged that the single stages regulatably suck in independently of each other, the fresh gas supplied thereto from the suction side or from the preceding stage together with a variable amount of re-evaporated chlorine supplied to each stage.

The control of the suction valve of the cylinder C and thus the regulation of the compressor is effected in the usual manner by variable cams or eccentrics or the like which lift the suction valve over a small or larger part of the compression stroke (for example up to 75 per cent of the stroke) whereby the capacity of the two stages can be regulated within wide limits.

The regulation of the amounts of re-evaporated chlorine to be supplied to the single stages can be effected automatically by regulating valves V, V_1, V_2 which are controlled in dependence on the temperature of the re-evaporated chlorine by thermostats.

The regulatable compressor ensures a uniform effect and renders possible any desired delivery not only of liquid chlorine but also of chlorine gas from the intermediate stages under any pressure, as for example for chlorination operations, in which only gaseous chlorine is necessary.

What I claim is:

1. In a process for the liquefaction of chlorine gas by compression, the steps which comprise cooling the cylinder and the piston of the compressor by a circulating liquid cooling medium remaining liquid at the working temperatures, cooling the said liquid medium outside the compressor by chlorine in the state of expansion and leading the said chlorine to the suction side of the compressor.

2. In a process for the liquefaction of chlorine gas by compression, the steps which comprise cooling the cylinder and the piston of the compressor by a circulating liquid cooling medium remaining liquid at the working temperatures, cooling the said liquid medium outside the compressor by chlorine in the state of expansion and supplying the said chlorine to an auxiliary cylinder situated between the main cylinder and the main stuffing box, unloading and cooling the main stuffing box by the said chlorine and then leading the said chlorine to the suction side of the compressor.

3. In a process for the liquefaction of chlorine gas the steps which comprise compressing chlorine gas in a compressor, cooling the compressor by circulating a liquid cooling medium remaining liquid at the working temperatures in heat-exchange relation thereto, cooling said cooling medium by the expansion of chlorine and adding the expanded chlorine to the chlorine supplied to the compressor.

4. In a process for the liquefaction of chlorine gas the steps which comprise compressing chlorine gas in a compressor cooling said compressor by circulating a liquid cooling medium remaining liquid at the working temperatures in heat-exchange relation thereto, cooling said cooling medium by the expansion of chlorine, evaporating liquefied chlorine in order to obtain the cooling effect thereof, leading expanded chlorine in heat-exchange relation to the top of said compressor, and then adding the expanded chlorine to the chlorine supplied to the compressor.

5. In a process for the liquefaction of chlorine gas the steps which comprise compressing chlorine gas in two stages in a compressor, cooling said compressor by circulating a liquid cooling medium in heat exchange relation thereto, cooling said cooling medium by the expansion of liquefied chlorine, evaporating further quantities of liquefied chlorine in order to obtain the cooling effect thereof, adding some of the thus evaporated chlorine to the expanded chlorine from the cooling of the cooling medium and leading the same in heat exchange relation to the top of said compressor and then adding the same to the chlorine supplied to the first stage of the compressor, leading the compressed chlorine from the first stage of the compressor to the inlet of the second stage, adding the remainder of said evaporated chlorine to said compressed chlorine, compressing the chlorine in the second stage of the compressor and cooling the compressed chlorine from the second stage of the compressor in order to liquefy the same.

JOSEPH REICHART.