A. STEPHENSON.

STORING OF GASES UNDER PRESSURE.

APPLICATION FILED NOV. 7, 1916.

1,230,531. Patented June 19, 1917.

Fig. 1.

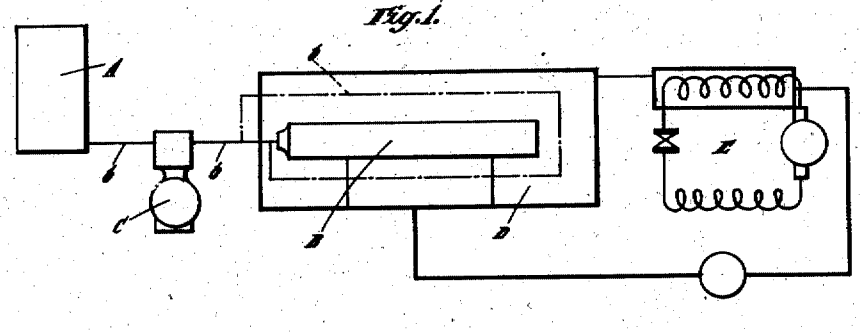


Fig. 2.

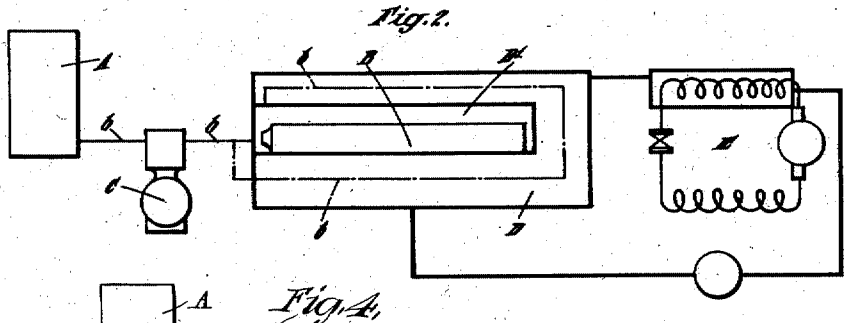


Fig. 4.

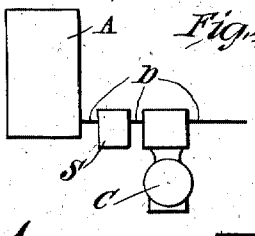
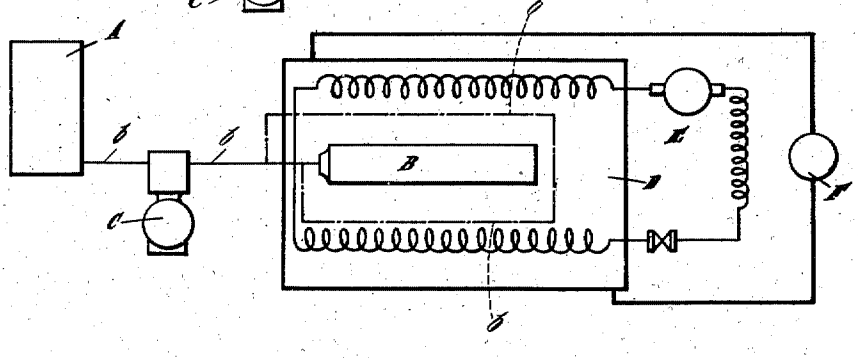


Fig. 3.



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UNITED STATES PATENT OFFICE.

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STORING OF GASES UNDER PRESSURE.

1,230,531. Specification of Letters Patent. Patented June 19, 1917.

Application filed November 7, 1916. Serial No. 130,083.

To all whom it may concern:

Be it known that I, ARTHUR STEPHENSON, a subject of the King of Great Britain, residing at 268 South Lambeth road, Lambeth, in the county of London, England, have invented certain new and useful Improvements in or Relating to the Storing of Gases Under Pressure, of which the following is a specification.

This invention relates to the storing of gases in cylinders or other receptacles or chambers that contain a solvent, solvents or other absorbent material for the said gases. The invention is particularly although not exclusively applicable to the filling or storing of acetylene under pressure in cylinders or other receptacles containing acetone or other suitable solvent or absorbent material such as carbon or charcoal which is sensitive in its power of solution or absorption to temperature and to pressure. In the charging or filling of these cylinders as at present carried into practice the gas is produced at a comparatively low pressure (usually less than 2 atmospheres absolute) and is forced under increased pressure into the cylinder by a compressor or pump. The process of compressing or pumping to the increased pressure required and the absorption of acetylene by the solvent is attended by an appreciable production of heat. In order to remove the major portion of the heat generated in compression, the process of compression is accomplished in stages and means are adopted for removing as much heat as possible between the respective stages of compression, the number of stages being dependent upon the ultimate pressure to which it is required to store the gas and the method employed for removing the heat. The maximum storage pressure of acetylene in cylinders at present allowable in Great Britain is one hundred and fifty pounds per square inch although the maximum pressure allowed in some countries is as high as fifteen atmospheres. The time occupied for the charging of cylinders by the aforesaid method is considerable and varies with the power of solution, absorption or occlusion possessed by the solvent or absorbent material at any particular temperature and pressure. The solvent or absorbent power increases with increase in pressure but decreases with increase in temperature. Hence it will be seen that any increase in temperature of the cylinder or the contents thereof such as results from the gas having been insufficiently cooled during compression, from a high atmospheric temperature, from the generation of heat when the gas is absorbed or taken into solution or from any other cause, militates appreciably against any reduction in the time required for the filling or charging operation and enhances the liability to explosion or dissociation of the gas under pressure.

According to the present invention these disadvantages are avoided by subjecting a receptacle containing a solvent or absorbent material to a temperature considerably below normal and in connecting the said receptacle with a compressor, pump, accumulator or equivalent apparatus adapted to supply the gas at a pressure which may be approximately equal to or greater than the ultimate pressure desired or allowed in the receptacle but which may if desired be lower than the said ultimate pressure. In one method of carrying this invention into practice the receptacle is subjected to a temperature at or below that at which the gas becomes liquid when subjected to the pressure adopted or required. For example with acetylene it has been found that by compressing the gas up to a pressure of one hundred and fifty pounds per square inch and adjusting the temperature as applied to the storage receptacle, to between —5° F. and —10° F., a receptacle having a capacity of 2½ cubic feet can be charged in from 3 to 5 minutes and one having a capacity of 200 cubic feet can be charged in about 90 minutes. Receptacles of these capacities would each take about three days to charge by the methods heretofore employed. Means are adopted for determining the volume or amount of gas delivered to the receptacle so that the amount of the charge can be governed or limited. When the receptacle is to be fully charged this volume or amount will be such that when the temperature of the receptacle is restored to normal atmospheric (other essential conditions having been observed), the pressure under which the gas shall be stored within the receptacle will be the pressure allowed or desired. It will be understood that such conditions vary with the gas under treatment, the nature of the solvent or absorbent material, the pressure allowable and the normal atmospheric tem-

perature for the time of the year and for the geographical location. It is to be understood that the application of cold may be made prior to or concurrently with the charging of the receptacle and that the latter may have previously been in part filled by the ordinary methods; as the time taken in the early stages of charging or filling by the ordinary method is short compared with that required for the final stages and as the complete charging or filling is effected by the improved method, the total time occupied is substantially reduced.

In the accompanying drawing, Figures 1, 2 and 3 show in a purely diagrammatic manner different forms of apparatus that may be employed for carrying the method of charging into effect, and Fig. 4 is a fragmental diagrammatic view illustrating the position of the separator.

In this drawing A represents the source of supply of the gas, B a portable cylinder to be charged and *b* the pipe leading from the source of supply to the cylinder. C is the aforesaid compressor or pump. In Fig. 1 the cylinder B is placed in a chamber D containing the cooling medium connected to a suitable refrigerating apparatus (indicated at E) of any suitable or well known type, the outlet valve or cock of the cylinder being opened for admitting the gas from the pipe *b* connected thereto. In Fig. 2 the cylinder with its valve open or removed is placed within an inner chamber D′ connected to the pipe *b* so that this chamber contains at atmosphere of the gas to be charged. The arrangement shown in Fig. 2 would not be used when the pressure and temperature are such as to liquefy the gas. If desired the refrigerating apparatus may be so constructed as to cool the gas prior to its entry into the cylinder or chamber, for example by passing the pipe *b* through the chamber as indicated by broken lines, by a self intensive or other known or suitable method. It will be clear that more than one cylinder or other receptacle can be charged at the same time either from one or several compressors. In Fig. 3 the expansion coils of the refrigerating apparatus are arranged within the chamber D which contains a brine solution in contact with the cylinder B. A pump or circulator F serves to keep the brine solution in motion. In another arrangement the chamber D′ may be dispensed with and the expansion coils of the refrigerating apparatus be situated within the chamber D which contains an atmosphere of the gas; in this case not only is the gas cooled prior to its entry into the cylinder, but the gas itself in the chamber D serves as the medium for communicating the cold from the refrigerator to the cylinder. When refrigerating apparatus of the compound type is employed the early stages of the refrigerating process may be employed in refrigerating the cylinder and its contents and also if desired the supply pipe, while the final stages are employed solely for liquefying or assisting to liquefy the gas; or conversely the early stages may be employed for liquefying or assisting to liquefy the gas and the final stages employed for refrigerating the cylinder and its contents. In a slightly modified method the refrigerating plant may be used only for liquefying the gas prior to its entry into the receptacle, the conversion of the liquid into gas during its entry into the receptacle being relied on to reduce the receptacle and the solvent or absorbent material to the desired low temperature.

It will be obvious that the improved method apart from diminishing the dangers attending the charging of the cylinders, also results in a great saving in expense from considerations of the great reduction of time required for charging.

In a further slightly modified method the cylinder or other receptacle which may or may not contain solvent or absorbent material, instead of being supplied with gas direct from the source of supply may be connected to an accumulator chamber which is subjected to low temperatures as aforesaid and which contains solvent or absorbent material. The cylinder or other receptacle is also preferably but not necessarily subjected to low temperatures and when the pressure therein reaches the desired amount upon the accumulator chamber and its contents returning to normal temperature or being heated to beyond normal temperature, the receptacle is disconnected from the accumulator chamber. The pressure at which the gas is supplied to the said chamber may be high as aforesaid or it may be below the pressure at which the gas will be stored in the receptacle at normal temperature. Two or more of the said accumulator chambers may be used and may be caused to operate alternately or in succession.

A suitable separator may be provided in any position between the source of supply and the storage receptacle, for the extraction or removal from the gas, prior to its entry into the storage receptacle, of impurities of higher boiling points such as moisture or ammonia gas.

As illustrated in Fig. 4, the separators may be located between the source of supply of gas A and the compressor or pump C, so that as the gas passes to the pump, the impurities of higher boiling point than the gas itself will be extracted. Of course, it is to be understood that it is only important that this separator be located between the source and the receptable to be filled and not in any particular relation to the pump.

In cases where the gas is supplied to the

receptacle at a lower pressure than the ultimate pressure desired or allowed in the receptacle, the supply pressure need not of necessity exceed the comparatively low pressure at which the gas is generated. In this case it is possible to charge the receptacle without the necessity of using a compressor by merely connecting the receptacle to the source of supply, if desired however a low pressure pump or centrifugal fan may be used.

What I claim and desire to secure by Letters Patent of the United States is:—

1. The method of storing under pressure gases which are absorbed with appreciable production of heat, which comprises introducing the gases into a receptacle containing a solvent or absorbent substance, abstracting the heat of absorption and maintaining the receptacle and its contents at a temperature considerably below normal during the absorption.

2. A method of storing gases under pressure, consisting in subjecting a receptacle containing a solvent or absorbent substance or material to a temperature considerably below normal and in supplying the gas to the said receptacle at a pressure not greater than the ultimate pressure to be obtained in the receptacle when the latter and its contents return to normal atmospheric temperature.

3. The method of storing under pressure gases which are absorbed with appreciable production of heat, which comprises compressing the gases, introducing the compressed gases into a receptacle containing a solvent or absorbent substance, abstracting the heat of compression and the heat of absorption of the gases and maintaining the receptacle at a temperature considerably below normal.

4. A method of storing gases under pressure, consisting in subjecting a receptable containing a solvent or absorbent substance or material to a temperature considerably below normal, and in supplying the gas to the said receptacle at a pressure substantially lower than the ultimate pressure to be obtained in the receptacle when the latter and its contents return to normal atmospheric temperature.

5. A method of storing gases under pressure, consisting in subjecting a receptacle containing a solvent or absorbent substance or material to a temperature considerably below normal, and in cooling the gas prior to its entry into the receptacle.

6. A method of storing gases under pressure, consisting in liquefying the gas prior to its entry into a receptacle containing a solvent or absorbent substance or material and in utilizing the low temperature resulting from the conversion of the gas from its liquid to its gaseous form within the receptacle, to cool the said receptacle and its contents to a temperature considerably below normal.

7. A method of storing gases under pressure, consisting in connecting a receptacle in which the gas is to be stored to an accumulator chamber containing a solvent or absorbent substance or material, supplying said chamber with the gas and subjecting it to a temperature considerably below normal.

8. A method of storing gases under pressure, consisting in cooling the gas to a temperature considerably below normal and in extracting or removing from the gas impurities or components of higher boiling point prior to the entry of the gas into its storage receptacle.

In witness whereof, I herewith affix my signature.

ARTHUR STEPHENSON.

Corrections in Letters Patent No. 1,230,531.

It is hereby certified that in Letters Patent No. 1,230,531, granted June 19, 1917, upon the application of Arthur Stephenson, of Lambeth, England, for an improvement in "Storing of Gases Under Pressure," errors appear in the printed specification requiring correction as follows: Page 2, line 120, for the word "separators" read *separator S;* same page, line 128, for the word "receptable" read *receptacle;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 4th day of September, A. D., 1917.

[SEAL.]

R. F. WHITEHEAD,

Acting Commissioner of Patents.

Cl. 23—29.