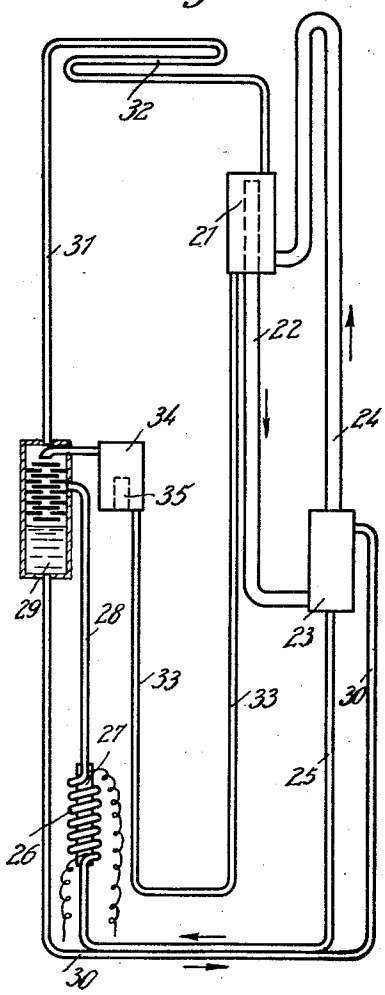
May 31, 1932. E. ALTENKIRCH 1,861,173

ABSORPTION APPARATUS

Filed Jan. 3, 1929 3 Sheets-Sheet 1

Fig. 1



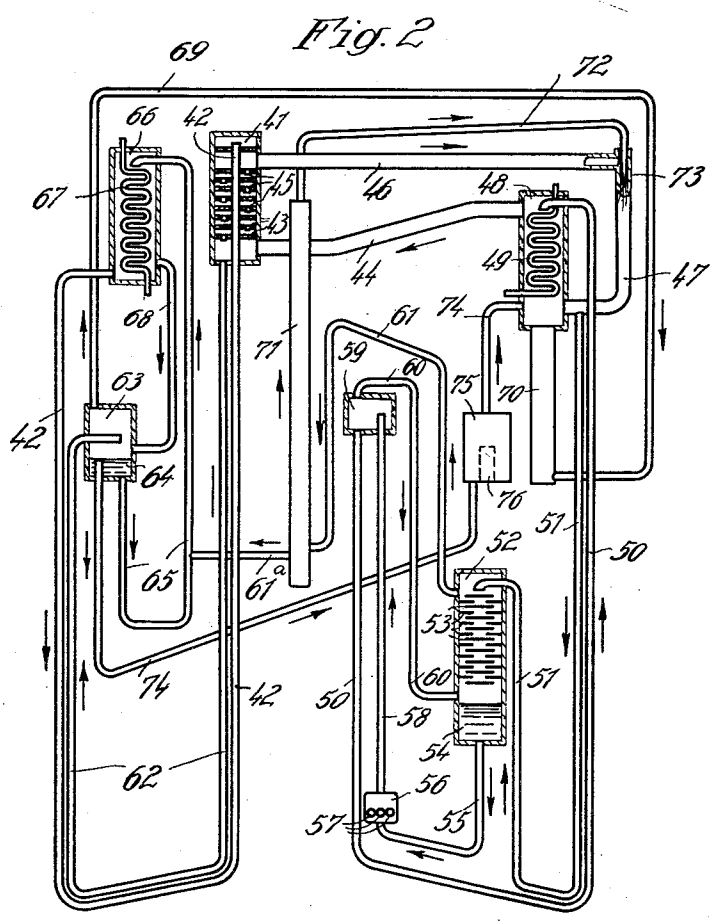
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ABSORPTION APPARATUS

Filed Jan. 3, 1929 3 Sheets-Sheet 2

Fig. 2



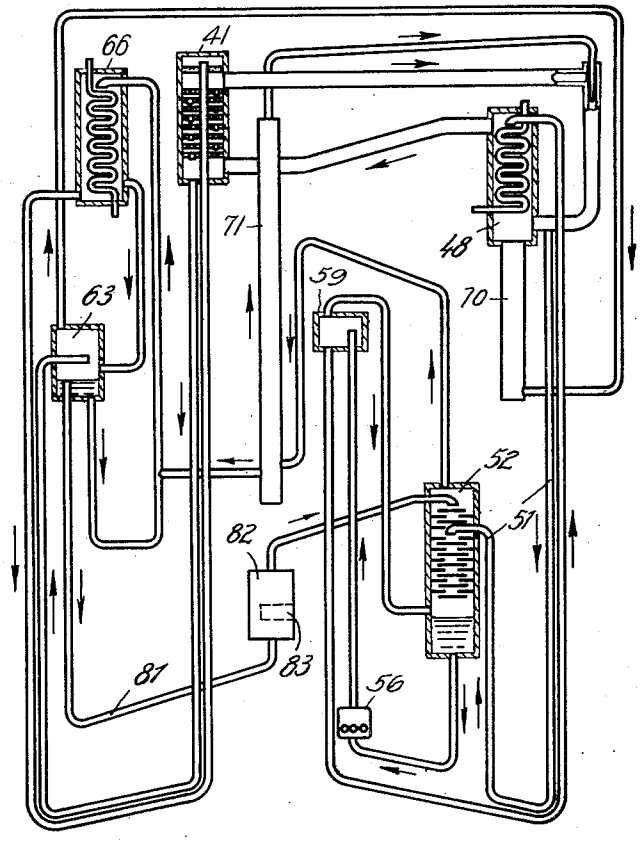
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ABSORPTION APPARATUS

Filed Jan. 3, 1929 3 Sheets-Sheet 3

Fig. 3



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UNITED STATES PATENT OFFICE

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ABSORPTION APPARATUS

Application filed January 3, 1929, Serial No. 329,997, and in Germany January 5, 1928.

My invention relates to improvements in absorption apparatus, of the type for instance shown and described and claimed as to certain particular features in my copending applications Serial No. 99,890, filed April 5, 1926; Serial No. 309,262, filed September 29, 1928, and Serial No. 141,929 filed October 16, 1926, of which the present application is a continuation in part.

In absorption apparatus of this type it is well known to return into the absorber system excess quantities of operating liquid, which during the evaporation in the refrigerator have not been converted into gas or vapor. The pipe provided for the purpose is called the return pipe.

The object of my invention is an improved process of operating such an absorption apparatus provided with a return pipe. According to my invention gas is developed from the liquid operating medium contained in the return pipe by the application of heat. This liquid contained in the return pipe forms an accumulation or a store of liquid operating medium within the apparatus, which does not directly participate in the thermal processes, but which may be drawn upon when needed. The richer this accumulation or store of liquid is in refrigerant, the less refrigerant takes part in the working processes within the refrigerating system, and the poorer it is the more refrigerant participates in these working processes. By adjusting the temperature of this store of liquid it is thus possible to adapt the quantity of refrigerant operating in the machine to the working conditions prevailing at the time. If, for instance, in apparatus of the type in which the gas serving as refrigerating medium evaporates out of an absorption solution in the evaporator, the temperature of this absorption solution drops, owing to small requirement of refrigeration, it becomes richer in gas and thus withdraws a certain quantity of gas from the absorption solution circulating in the generator or boiler and absorber.

A higher temperature is then required for the boiler. In supplying the heat required for the boiler by steam, this is in itself a serious drawback, because the height of the heating steam temperature is limited. The expelled gas is, furthermore, mixed with a quantity of vapor of the solvent which is the larger the higher the temperature, and the quantity of heat to be applied rises with the temperature, because for many binary mixtures, in particular for water and ammonia, the heat of solution is greater at higher temperatures and the heat wasted by radiation also increases. If, however, according to my invention the quantity of gas required by the evaporator is supplemented from a store formed in the return pipe, this detrimental effect on the expulsion temperature and the heat radiation is eliminated.

Similar phenomena develop if the cooling medium by which the reabsorber or the condenser is cooled should, for outside reasons, suffer a drop in temperature. In the customary constructions of such apparatus the reabsorber as well as the condenser have the tendency to fill up with liquid and thus to attract refrigerant working medium. A corresponding quantity of this working medium is thus abstracted from the absorber system and may then be replaced according to my invention. This holds good for apparatus in which the pressure difference is equalized by the admixture of a neutral or inert gas, as well as for apparatus which operate without a neutral gas.

The amount of heat which is saved by replacing the quantity of working medium which is missing in the absorption system, is considerably greater than the quantity of heat which is necessary to maintain the store of liquid in the return pipe at a slightly higher temperature.

If it is desired to obtain higher outputs from an absorption apparatus of any of the types mentioned by increasing the temperature and the amount of heat supplied to the boiler, the concentration of the solution is preferably reduced for this purpose. In such a case the temperature of the store contained in the return pipe is reduced by decreasing the application of heat, so that more working medium is here detained.

The gas bubbles developing in the liquid to be returned may also be used for convey-

ing liquid, which is of particular value, if the vessel into which the liquid is to be returned is located so high, that the pressure difference between the beginning and the end of the return pipe alone is not sufficient to overcome the difference in height.

In the drawings affixed hereto several modifications of apparatus embodying my invention and for carrying out my improved process are illustrated by way of example. All the constructions shown are based upon an absorption apparatus in which the gaseous working medium, such as ammonia, is mixed with gas (such as hydrogen), which is indifferent or inert to the absorption solution and the refrigerant working medium and which is lighter than the gaseous working medium.

In the drawings:

Fig. 1 diagrammatically illustrates a simple apparatus for carrying out my invention,

Fig. 2 represents a refrigerating apparatus operating on the reabsorption principle, and

Fig. 3 represents a third modification differing only slightly from Fig. 2 in certain specific features to be pointed out hereinafter.

Referring to Fig. 1, it will be seen that the gaseous working medium mixed with a lighter inert gas escapes from the evaporator 21 through the pipe 22, which leads to the lower part of the absorber 23. From the upper part of the absorber 23 ascends the gas mixture, which has been freed from the larger portion of the refrigerant working medium and has thus become lighter, through a pipe 24 the highest point of which is located above the gas outlet of the evaporator 21. The pipe 24 opens into the lower part of the evaporator 21. The absorption liquid enriched in the absorber passes through a pipe 25 into the generator or boiler formed by a vertical coil 26 heated by an electric heating rod 27. From here this liquid is conveyed into the rectifier 29 by the gas bubbles developed by means of the ascending tube 28. From the rectifier 29 a pipe 30 leads the impoverished absorption liquid back to the absorber 23, which pipe, through close contact with the already mentioned pipe 25 forms a heat exchanging device. The gaseous working medium separated in the rectifier 29 ascends through a pipe 31 into the condenser 32 and is there condensed. The condensate enters the evaporator (or refrigerator) 21 at its upper end. This evaporator is connected with the upper part of the rectifier 29 (the rectification space) by a U-shaped return pipe 33, in the left hand ascending part of which is connected a storage tank or accumulator 34.

The liquid operating medium not vaporized in the evaporator 21 drains off through the return pipe 33 and passes into the storage tank 34. This tank is equipped with a heating cartridge 35 by means of which the liquid operating medium may be freed from gas to a greater or smaller extent.

It then enters the rectification space of the rectifier 29. As this liquid runs down the plates located here, it comes into repeated contact with the gaseous working medium boiled out of the absorption liquid by the boiler 26 and delivered through the pipe 28, the aforementioned liquid assisting in freeing this gaseous working medium from the admixed vapor of the solvent.

The gas expelled by heating the liquid in the tank 34 passes through the pipe 31 into the condenser 32. The higher the temperature is at which the storage tank 34 is maintained by the heating cartridge 35, the less working medium is detained in the storage tank and the more operates in the refrigerating system.

Fig. 2 of the drawings illustrates a refrigerating apparatus operating on the reabsorption principle in which the circulation of an inert gas is produced by a jet nozzle. Referring to this figure it will be observed that the vapor jet emanates from the nozzle 73 and effects the circulation through the pipe 46 issuing from the evaporator 41. The vapor for this jet is supplied through a pipe 72 from a gas receptacle 71 which in turn is fed from the generator 56 through rectifier 52 and pipe 61. The mixture of inert and refrigerant gas passes from evaporator 41 through a pipe 47 into the lower part of the absorber 48 from the upper part of which the gas mixture poor in refrigerant working medium returns through the pipe 44 to the evaporator 41. The liquid working medium necessary for charging evaporator 41 flows from the reabsorber 66 into the evaporator through a U-shaped pipe 42. The impoverished absorption solution flows from the evaporator through pipe 62, which in close contact with pipe 42 forms a heat exchanging device, into an intermediate tank 63, forms in the lower part of this tank a store of liquid 64 and drains through the pipe 65.

To this pipe 65 is also supplied, through a pipe connection 61^a with the earlier mentioned gas receptacle 71, gaseous refrigerant delivered from the rectifier 52 to receptacle 71. Gas and impoverished absorption liquid ascend together in the pipe 65 and enter the upper portion of the reabsorber 66. The liquid streams within this vessel over the coiled pipe 67 traversed by the cooling water and absorbs the gas, while the absorption heat is carried away by the cooling liquid. The resorber 66 thus acts like the condenser 32 of Fig. 1, since in either case the gaseous phase of the refrigerant is changed into a condensed fluid phase. In the foregoing expression "a condensed fluid phase" the word "condensed" should not be understood to convey alone the specific idea of liquefaction such as

occurs in the condenser Fig. 1, but the term is used in the sense that the refrigerant fluid is "contracted", or made to occupy a smaller space. When a gas is absorbed in a solvent as well as when it is liquefied, it occupies a smaller space than it did when a gas. Therefore, whether the gas is merely absorbed, such as in the resorber 66 in Fig. 2, or liquefied, as in condenser 32 in Fig. 1, in both cases the condition of the fluid is that of a condensed fluid phase, as compared with its gaseous fluid phase.

From the lower part of absorber 48 cooled by a cooling coil 49 the enriched absorption solution passes through a pipe 51 into the gas separating chamber of rectifier 52, in which are provided baffle partitions 53 over which the solution flows down, forming a store of enriched liquid 54 at the bottom of the rectifier. Through a pipe 55 this liquid is returned into the boiler 56, which is heated by an electric heating cartridge 57. The gas expelled by the application of heat ascends, mixed with absorption liquid, in a pipe 58 into the gas separator 59. Gas and absorption liquid separate here. The impoverished liquid returns through the pipe 50 into the absorber 48, while the gas is conducted into the rectifier 52 through a pipe 60. Here the gas passes in counter-flow past the descending rich absorption liquid supplied from the absorber 48, is freed of a considerable portion of its contents of vaporous absorption medium and then escapes from the rectifier 52 through the pipe 61 into receptacle 71 and pipe 61^a described before.

Excess quantities of gas are conducted from the reabsorber 66 into the aforementioned intermediate storage tank 63 through a pipe 68. A further gas pipe 69 serves for the return of these gas remainders into the absorber 48, which they enter from the bottom after they have traversed the lower extension 70 which forms a receptacle for the liquid.

In the intermediate tank 63 is provided an overflow formed by the open end of the return pipe 74. Excess liquid accumulating in the tank passes through this pipe into the absorber 48. In the rising portion of the pipe 74 forming a liquid seal is arranged a storage tank 75 the liquid contents of which can be heated by a heating cartridge 76. The gas bubbles developed thereby from the liquid convey the liquid into the absorber even if the pressure difference existing between the absorber 48 and the auxiliary tank 63 does alone not suffice for overcoming the difference in height. Otherwise the apparatus acts in a similar manner as the apparatus illustrated in Fig. 1, the only difference being that the rectification of the returned solution has been abandoned.

The third modification illustrated in Fig. 3 of the drawings substantially differs from the just described one only by the feature, that the return pipe 81 designed as liquid seal and starting from the auxiliary tank 63 and in the rising portion of which there is again located a storage tank 82 heated by a heating cartridge 83, does not open into the absorber 48, but into the rectification chamber of the rectifier 52. The returned operating medium thus assists in the rectification as long as it is liquid and not heated at all or only moderately so.

Various modifications and changes may be made without departing from the spirit and the scope of the invention.

I claim as my invention:—

1. In a continuously operating absorption apparatus, in combination, a generator, a condenser, an evaporator and an absorber, all of said parts being connected in communication with one another, pipes connecting the generator and the absorber and providing a liquid circulating system, a pipe connecting the evaporator with said liquid circulating system for returning unevaporated working medium from the evaporator into said system, means for heating the returned liquid prior to its entrance into said system for the purpose of developing gas from said liquid, and means for introducing said gas into said system.

2. In a continuously operating absorption apparatus, in combination, a generator, a condenser, an evaporator and an absorber, all of said parts being connected in unrestricted communication with one another, pipes connecting the generator and the absorber and providing a liquid circulating system, a pipe connecting the evaporator with said liquid circulating system for returning unevaporated working medium from the evaporator into said system, means for heating the returned liquid prior to its entrance into said system for the purpose of developing gas from said liquid, and means for introducing said gas into said system, said return pipe being U-shaped to form a liquid seal, said heating means being arranged in the rising branch of said U-pipe.

3. In a continuously operating absorption apparatus, in combination, a generator, a condenser, an evaporator and an absorber, all of said parts being connected in unrestricted communication with one another, pipes connecting the generator and the absorber and providing a liquid circulating system, a pipe connecting the evaporator with said liquid circulating system for returning unevaporated working medium from the evaporator into said system, means for heating the returned liquid prior to its entrance into said system for the purpose of developing gas from said liquid, and means for introducing said gas into said system, said return pipe being U-shaped to form a liquid seal, a storage receptacle for the liquid in the ascending

limb of said U-pipe, said heating means being arranged in said receptacle.

4. In a continuously operating absorption apparatus, in combination, a generator, a condenser, an evaporator and an absorber, all of said parts being connected in unrestricted communication with one another, pipes connecting the generator and the absorber and providing a liquid circulating system, a pipe connecting the evaporator with said liquid circulating system for returning unevaporated working medium from the evaporator into said system, means for heating the returned liquid prior to its entrance into said system for the purpose of developing gas from said liquid, and means for introducing said gas into said system, said return pipe being U-shaped to form a liquid seal, said heating means being arranged in the rising branch of said U-pipe, the part of the rising limb located above the heating point being contracted to such an extent, that in it liquid can be entrained by ascending gas bubbles.

5. In a continuously operating absorption machine the combination with a generator, a device for changing gaseous refrigerant to a contracted fluid phase; an evaporator, an absorber and pipes connecting the generator and absorber and providing a liquid circulating system, of a conduit connecting the evaporator with said liquid circulating system for conducting unevaporated liquid from the evaporator to said liquid circulating system and means for heating a portion of said conduit for the purpose of generating gas therein.

In testimony whereof I affix my signature.

EDMUND ALTENKIRCH.