June 17, 1947. R. S. GAUGLER 2,422,401

GENERATOR ARRANGEMENT FOR ABSORPTION REFRIGERATING SYSTEMS

Filed March 6, 1943 2 Sheets-Sheet 1

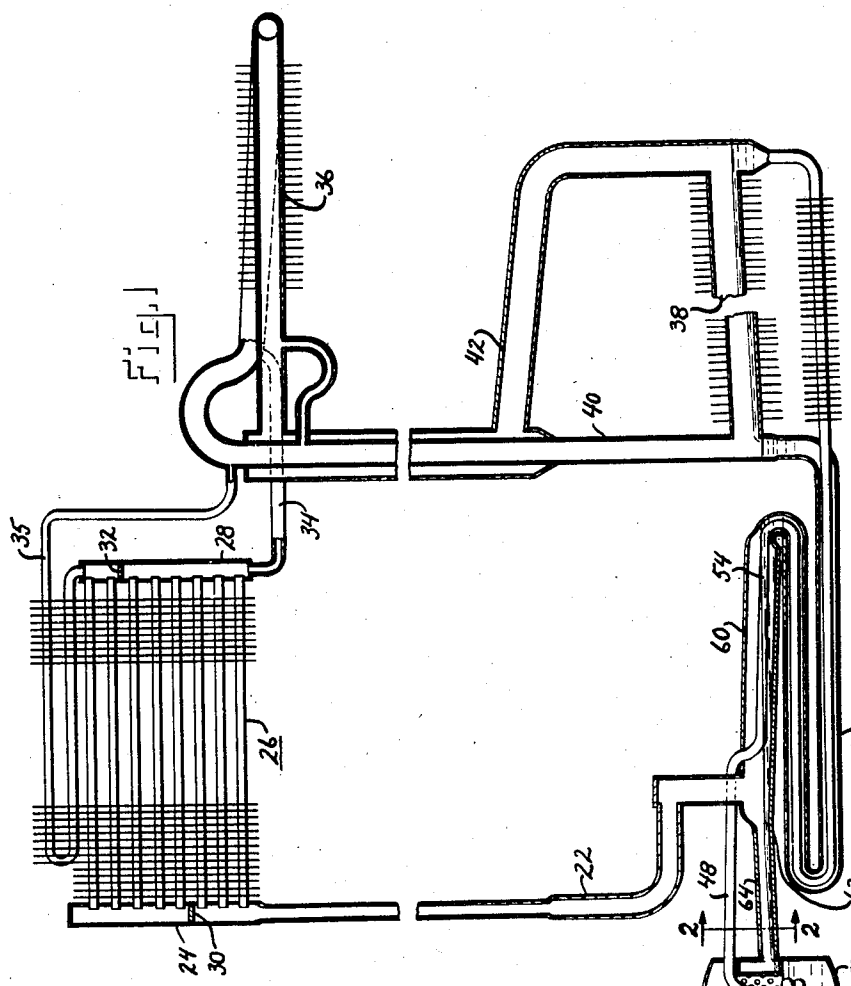


FIG. 1.

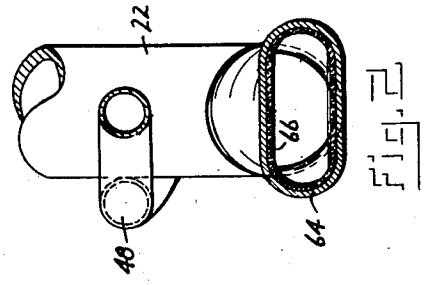


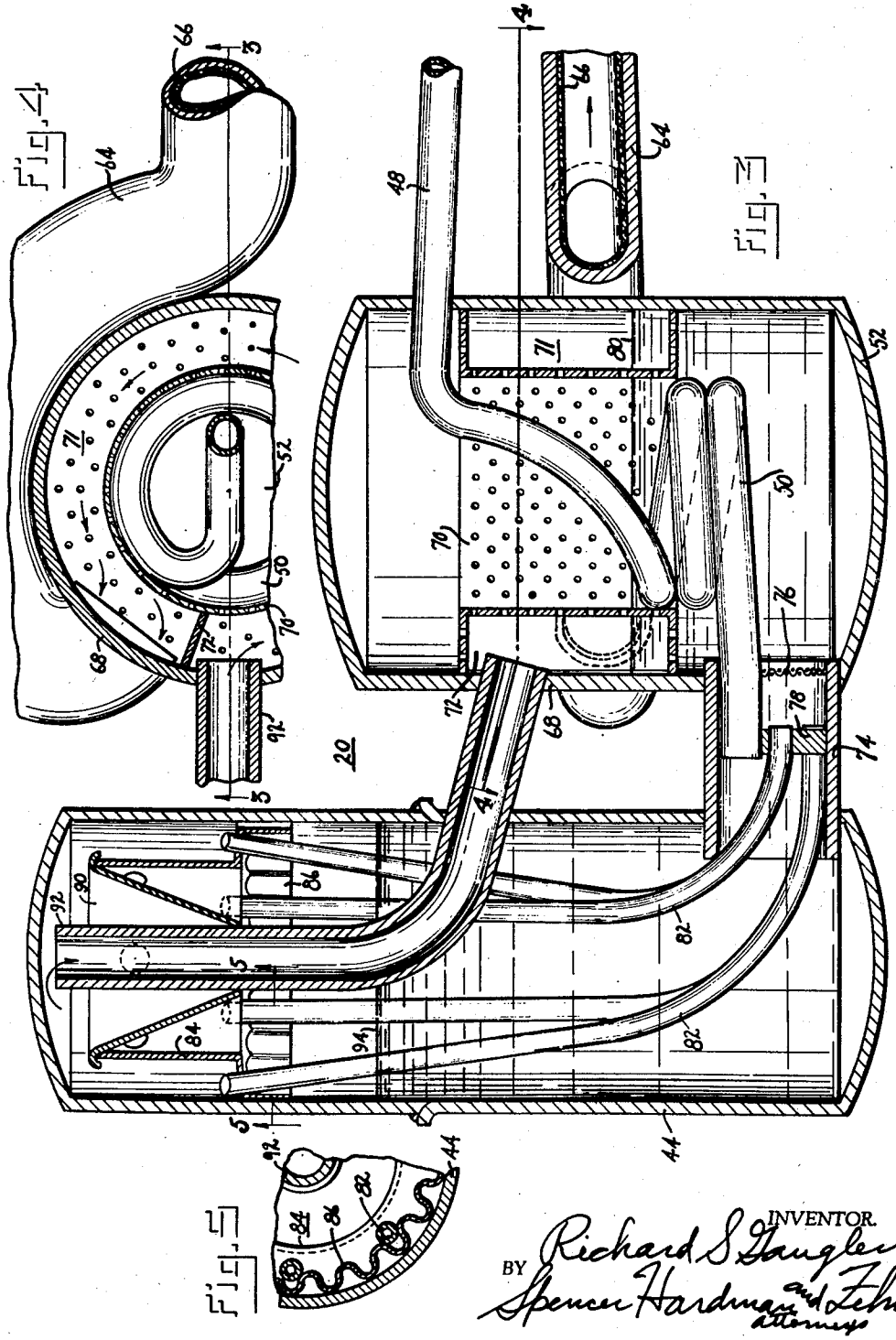
FIG. 2.

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GENERATOR ARRANGEMENT FOR ABSORPTION REFRIGERATING SYSTEMS

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8 Claims. (Cl. 62—119.5)

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This invention relates to refrigerating apparatus and more particularly to absorption refrigeration systems.

In absorption refrigeration systems the vaporizing means is called upon to separate ammonia vapor from the rich liquor and also to raise the weak liquor so that it will flow into the absorber by gravity. Heretofore it has been customary to heat both the weak liquor and the vapor lift means directly by the gas flame in order to accomplish both functions. The position and size of the flame was adjusted to obtain the proper proportion between these functions. It has also been suggested to heat the vapor lift means alone by the gas flame and using the discharge from the vapor lift means to heat the rich liquor. Also, in order to increase the amount of ammonia vapor generated and to decrease the amount of water vapor generated, the vapor from the generator has been bubbled through the rich liquor prior to its entrance into the generator. I have found that these features make difficult the problem of obtaining the proper supply of rich liquor to the generator at various rates of heating.

It is an object of my invention to provide means for forcing the liquid into the generator in proper proportion to the rate of vaporization.

It is another object of my invention to provide means for heating the weak liquor in the generator directly by the flame and employing the heat from the hot weak liquor to operate the vapor lift means.

It is still another object of my invention to provide an efficient vaporizing means wherein the hot vapor from the generator passes in close proximity directly above the surface of the rich liquor for a sufficient distance to remove substantially all of the water vapor from the hot vapor and to replace it with a greater amount of ammonia vapor.

These objects are attained by providing a vaporizing means which includes a generator provided with a vapor lift means extending upwardly through the interior of the generator and being of such a size as to properly proportion the amount of rich liquor brought in by the vapor lift means to the amount of heat supplied to the generator. I also provide an improved type of interchanger and analyzer wherein the vapor from the generator is caused to flow a considerable distance directly above the rich liquor flowing to the generator. Interior wall portions of capillary material as well as a flat bottom increase the liquid surface so that a high degree of interchange between the vapor and the rich liquor is obtained without bubbling the vapor through the rich liquor.

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Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a view partly diagrammatic and partly in section of a refrigerating system embodying one form of my invention;

Fig. 2 is an enlarged sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged sectional view of the generating means shown in Fig. 1, taken along the lines 3—3 of Fig. 4;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3; and

Fig. 5 is a fragmentary sectional view taken along the line 5—5 of Fig. 3.

Referring now to the drawings and more particularly to Fig. 1, there is shown an absorption refrigerating system including a vaporizing means generally designated by the reference character 20 from which the ammonia vapor flows upwardly through the conduit 22 to a header 24 provided at one end of the air-cooled condenser 26. The opposite end of the condenser 26 is provided with another header 28 and tubes provided with cross fins extend between the headers. A transverse wall 30 is provided in the header 28 just above the third tube from the bottom while a transverse wall 32 is provided in the header 28 just above the sixth tube from the bottom. By this construction, the simple condenser, which is made up of straight tubing, cross fins and headers, may be used to provide serial flow through the condenser.

For example, the ammonia vapor which rises through the conduit 22 to the header 24, will be stopped by the transverse wall 30 and required to flow from left to right through the three lower tubes to the header 28. The uncondensed vapor which reaches the header 28 will be caused to flow from right to left in the fourth, fifth and sixth tubes from the bottom by reason of the transverse wall 32. Any uncondensed vapor which passes through these tubes will be forced to flow from left to right in the seventh and eighth tubes from the bottom until the vapor again reaches the header 28. The condensed vapor will collect in the bottom portion of the header 28 and flow through the conduit 34 to the evaporating means 36.

The evaporating means 36 forms a portion of

the inert gas circuit which includes the absorber 38 and the hydrogen conduit 42 through which hydrogen rises from the absorber 38 to the evaporator into which the condensed ammonia in the evaporator vaporizes or diffuses. The combined ammonia and hydrogen then flows downwardly through the conduit 40 which is in heat exchange relationship with the hydrogen conduit 42 for the greater portion of the distance, so that the hydrogen is cooled and the mixture of hydrogen and ammonia vapor heated on its way to the absorber 38.

A second connecting conduit 35 connects the upper portion of the ammonia and hydrogen conduit 40 with the upper portion of the condenser. This connecting conduit includes a looped portion extending through the upper portion of the fins of the condenser and connects to the top of the header 28. Under low temperature condensing conditions, hydrogen collects in the upper portion of the condenser from the conduit 40. But under high temperature condensing conditions, the ammonia vapor travelling upwardly through the condenser pushes the hydrogen ahead of it through the conduit 35 into the inert gas circuit to raise the total pressure and the capacity of the system.

The vaporizing means 20 includes a tall container 44 forming the generator, the bottom of which is heated by a gas burner. Weak liquor flows out of the bottom of the generator through the weak liquor pipe 48 which includes a coiled heat exchange portion 50 within the receiver 52 and a second heat exchange portion 54 which extends within the rich liquor conduit 56 in order to form a heat interchanger on its way to the right or upper portion of the absorber 38. The weak liquor is cooled by the interchanger and by the fins on the weak liquor conduit below the absorber before it begins its flow through the absorber 38 from the upper end to the lower end thereof.

In the flow through the absorber the weak liquor strips the ammonia vapor from the mixture of hydrogen and ammonia and enters the rich liquor conduit 56 as rich or strong liquor. This rich liquor is heated in its passage through the rich liquor conduit 56 by the weak liquor flowing through the weak liquor conduit 54 in the opposite direction. In the portion 60, the top of the rich liquor conduit 56 is above the liquid level. The weak liquor conduit 54 extends adjacent the bottom of the portion 60 and heats the rich liquor in the portion 60 sufficiently to cause some vaporization. This vapor flows directly along the top wall of the portion 60 to the vapor conduit 22.

The highest point of the rich liquor conduit 56 is designated by the reference character 62. Here the rich liquor conduit is joined to a section of flattened tubing 64 which forms a portion of the analyzer. This tubing is flattened on top and bottom and sloped downwardly at a slight angle toward the receiver 52 so that the rich liquor will spread over the wide bottom of the portion 56, so as to present a thin film of liquid of large surface area to the hot vapor from out of the receiver 52. The flattened top of the portion 56 causes the hot vapor to remain in close contact with the surface of the liquid in its flow through the portion 64. This reduces the path of molecular travel between the vapor and the liquid surface, thereby increasing the amount of water vapor which enters the liquid and the ammonia vapor which leaves the rich liquor.

This analyzing effect is further improved by providing the interior of the walls of the portion 64 with a coating 66 of some suitable capillary material or means, preferably of non-compacted, sintered, powdered iron which is bonded firmly to the walls of the portion 64. This sintered, powdered iron is preferably bonded together and to the inside of the walls of the portion 64 by the use of sufficient amounts of ferrophosphorus powder thoroughly mixed with the iron to provide a product containing about 2% phosphorus or less after sintering.

Referring now more particularly to Figs. 3 and 4, the analyzer portion 64 is shown curved around the receiver and enters the receiver to discharge the rich liquor therein at the point designated by the reference character 68 adjacent the generator 44. Providing a passage 71 extending around the interior of the receiver is a metal spool-shaped member 70 which is shown as being formed of perforated metal. However, this spool may be made of screen material or of non-compacted porous sintered iron or other metal which may be similar to the coat 66. The spool is provided with a dividing wall 72 at one side of the entrance 68. The rich liquor entering the receiver normally fills the receiver to a point above the bottom of the spool member 70 but below the entrance 68 of the portion 64. The liquor readily flows through the walls of the spool. The coil heat exchange portion 50 of the weak liquor conduit is located just below the level 80 of rich liquor in the receiver 52 and serves to heat the rich liquor to drive off some vapor therefrom which passes through the walls of the spool into the passage 71.

Connecting the bottom portion of the receiver 52 and the bottom of the generator 44 is a short piece of tubing 74 containing a screen 76 at the end extending into the receiver and the dividing wall 78 adjacent its mid-portion. The inlet end of the weak liquor conduit 48 extends from the receiver through the wall 78 and terminates. Beginning at the wall 78 are the tubes 82 which form vapor lift means for pumping rich liquor from the receiver 52 into the generator container 44. These tubes 82 extend along the tube section 74 and thence upwardly through the interior of the generator without contacting the walls of the generator 44 at any point. The upper ends of these tubes are uniformly spaced around the walls of the generator and extend through the skirt of a separator member 84 which is provided in the upper portion of the generator 44. The skirt 86 of the separator member 84 is crimped and is lodged against the walls of the generator.

The upper ends of the tubes 82 extend outwardly at a slight angle so that as the slugs of rich liquor and vapor are discharged, the rich liquor will be directed against the upper walls of the generator, thence the rich liquor will flow down the walls of the generator. This results in counterflow heating of the generator by the gas flame, since the hottest products of combustion heat the hottest portion of the weak liquor which is hottest at the bottom and becomes progressively cooler at higher levels. The coolest liquid in the generator container 44 is the rich liquor discharged by the vapor lift means against the top walls of the container. By giving up their heat to the walls of the container 44, the products of combustion become cooler as they rise so that complete counterflow heating is provided. All other heating of the strong solution is accomplished by counterflow heating by the generator vapor and the weak liquor. Any

portions of liquor which splash off the walls of the generator will be caught by the vertical portion of the separator **84** and directed to the walls of the generator by the flange and the crimped skirt. The size of the crimps in the skirt are shown exaggerated for the purpose of illustration. By this arrangement the upper walls of the generator are cooled by the rich liquor and the heat removed assists in vaporizing the ammonia in the rich liquor. The cone-shaped member **90** serves to centralize the vapor discharge tube **92** with respect to the separator **84**. It overhangs the top of the separator **84** sufficiently to prevent liquid from splashing into the vapor discharge pipe **92**. It also prevents liquid from the surface of the liquor **94** in the generator from splashing into the vapor discharge **92**. The separator is provided with holes for allowing the vapor from the liquid **94** to pass through the separator and around the top of the cone-shaped member in close contact with the top of the generator and into the vapor discharge pipe **92**.

By making the tubes **82** of the proper size and proper number, the proper proportioning between the liquid drawn into the generator and the vaporizing of the liquid in the generator may be obtained for compartively wide ranges of generator load and heating. Inasmuch as the vapor lift tubes are heated only by the weak liquor in the container **44**, the delivery of rich liquor is responsive to the temperature of the weak liquor in the generator container **44**. This serves as a compensating effect because as the weak liquor in the generator container becomes weaker, it also becomes hotter, while when the weak liquor becomes richer, it also becomes cooler. Thus when the weak liquor in the generator container is weaker, more rich liquor will be delivered to it and when the weak liquor is richer, less rich liquor will be delivered. This obviously has a tendency to maintain a relatively constant concentration of weak liquor in the generator container **44**. The delivery of rich liquor into the generator is also responsive inherently to the concentration of the rich liquor in the receiver.

The vapor discharge pipe **92** extends downwardly through the generator and extends through the side wall thereof into the adjacent side wall of the receiver where it discharges in between the bottom and top of the spool member **70** on the opposite side of the partition wall **72** from the entrance **68**. By this arrangement the vapor must travel all the way around the spool-shaped member **70** above the surface of the rich liquor **80** so that the rich liquor will absorb some of the water vapor and in doing so will give off ammonia vapor. By this arrangement in addition to its liquid storage function, the receiver also provides a disentrainment space and provides additional vaporization by using the heat of the vapor. The remaining vapor will then enter the portion **64** where there will be a further stripping of the water vapor and vaporization of ammonia from the rich liquor.

It should be noted that the vapor lift means **82** performs all the lifting functions in the system and through the heat of liquid in the generator provides the sole means for the circulation of the weak and rich liquor. A further advantage of my system is that the vapor from the generator is not caused to bubble through the rich liquor in order to effect the interchange of water and ammonia vapor. This reduces the problems of proportioning the flow since the fluctuating liquid levels in

the receiver and analyzer tends to disrupt and make uncertain the normal flow of vapor out of the generator. It is also a source of noise. My vaporizing means on the other hand operates smoothly and quietly.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. A vaporizing means comprising a container, a vapor lift duct extending from the lower portion of the container up through the interior of the container and having an opening adjacent the upper portion of the container, means for directing the fluid discharged from the vapor lift duct against the walls of the container, and liquid catching means extending substantially to the sides of the container and provided with narrow outlet means directly against the sides of the container for catching the liquid fluid and causing it to flow down the sides of the container.

2. Refrigerating apparatus including a container, an absorber, separate conduit means extending between said absorber and the lower portion of said container for conducting weak liquor from the container to the upper portion of the absorber and for conducting rich liquor from the absorber to the container, vapor lift means for lifting the rich liquor in said conduit means and discharging it in said container, said conduit means conveying the rich liquor having a portion adjacent said container above the liquid level adjacent the outlet of the absorber, means for conducting vapor from the container and discharging it into the portion of the rich liquor conduit adjacent the container, and means for removing said vapor from said rich liquor conduit means after flowing in counter-current fashion above the rich liquor therein, said rich liquor conduit means containing capillary means extending upwardly from the surface of the rich liquor into contact with the vapor flowing above the surface of the liquor.

3. Refrigerating apparatus including a container, an absorber, separate conduit means extending between said absorber and the lower portion of said container for conducting weak liquor from the container to the upper portion of the absorber and for conducting rich liquor from the absorber to the container, vapor lift means for lifting the rich liquor in said conduit means and discharging it in said container, said conduit means conveying the rich liquor having a vapor and liquid contact portion adjacent said container with its upper portion above and its bottom surface below the liquid level adjacent the outlet of the absorber, means for conducting vapor from the container and discharging it in the portion above the liquid level of the rich liquor conduit adjacent the container, and means for removing said vapor from said contact portion of the rich liquor conduit means at a second point above the liquid level after flowing in counter-current fashion above the rich liquor therein, the portion of said rich liquor conduit means partially above the liquid level having a wide substantially flat bottom and top arranged close together for providing a large liquid surface in close intimate contact with the vapor.

4. An absorption refrigerating system including a refrigerating circuit comprising a generator provided with a vapor lift means for bringing in rich liquor, a weak liquor outlet and a vapor out-

let, a receiver for holding a body of rich liquor provided with means connected to said vapor lift means for delivering rich liquor thereto and with means for receiving vapor from the generator vapor outlet, an analyzer constituting an individual element distinct from the receiver for conducting rich liquor to the receiver and vapor from the receiver, and weak liquor conduit means extending from said weak liquor outlet into heat exchange relation with the rich liquor in said receiver.

5. A vaporizing means including a first container, a second container spaced from and located at the side of the first container, conduit means extending from the upper portion of the first container to the second to transfer vapor thereto, a tube connecting the lower portion of the two containers, a dividing wall in said tube having openings therein, a vapor lift duct having its lower end extending into one of the openings in said dividing wall and opening into said second container and having its upper end extending into the upper portion of the first container.

6. A vaporizing means including a first container, a second container, conduit means extending from the upper portion of the first container to the second to transfer vapor thereto, a second conduit means connecting the lower portion of the two containers, a dividing wall in said second conduit means having openings therein, a vapor lift duct having its lower end etxending into one of the openings in said dividing wall and opening into said second container and having its upper end extending into the upper portion of the first container, and a liquid tube having one end extending through said second container into another of said openings in said dividing wall.

7. A vaporizing means comprising a container, liquid catching means extending substantially to

the sides of the container and provided with narrow outlet means directly against the sides of the container for catching liquid and causing it to flow down the sides of the container, and vapor lift means extending to and discharging liquid into said liquid catching means.

8. A vaporizing means including a container adapted to be filled to a normal liquid level, a volatile liquid supply conduit means connected to the lower portion of the container, a plurality of small vapor lift ducts connecting with said liquid supply conduit means beneath said normal liquid level and extending upwardly therefrom through the liquid, the greater portion of said vapor lift ducts being beneath said normal liquid level, said vapor lift ducts having their upper ends widely distributed and forming discharge outlets adjacent the outer wall of the container, said upper ends being directed upwardly and outwardly at such angles that the liquid will be discharged upwardly from each of said ducts directly against different outer wall portions of the container above the normal liquid level.

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