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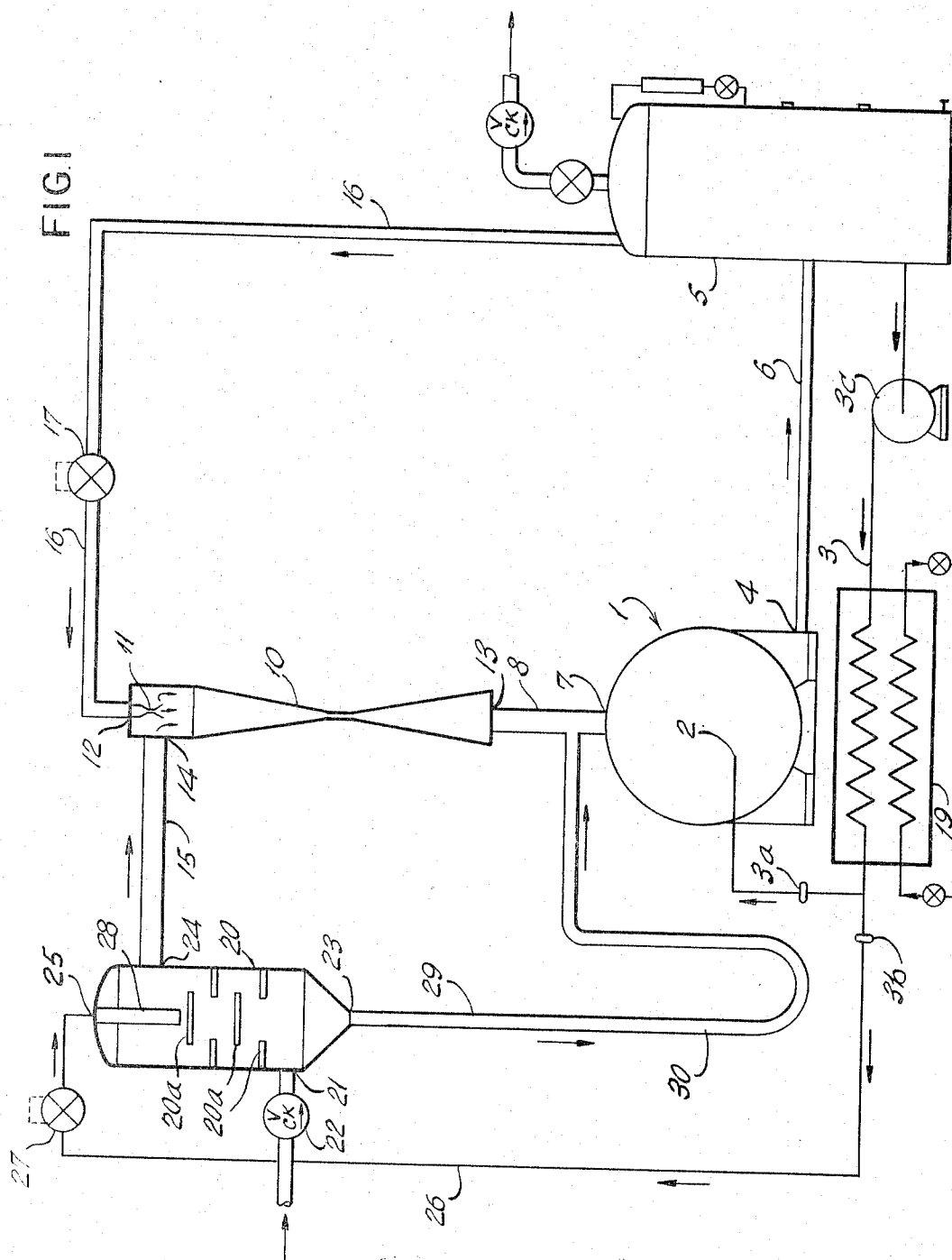
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3,315,879

EVACUATION SYSTEM

Filed April 22, 1966

2 Sheets-Sheet 1



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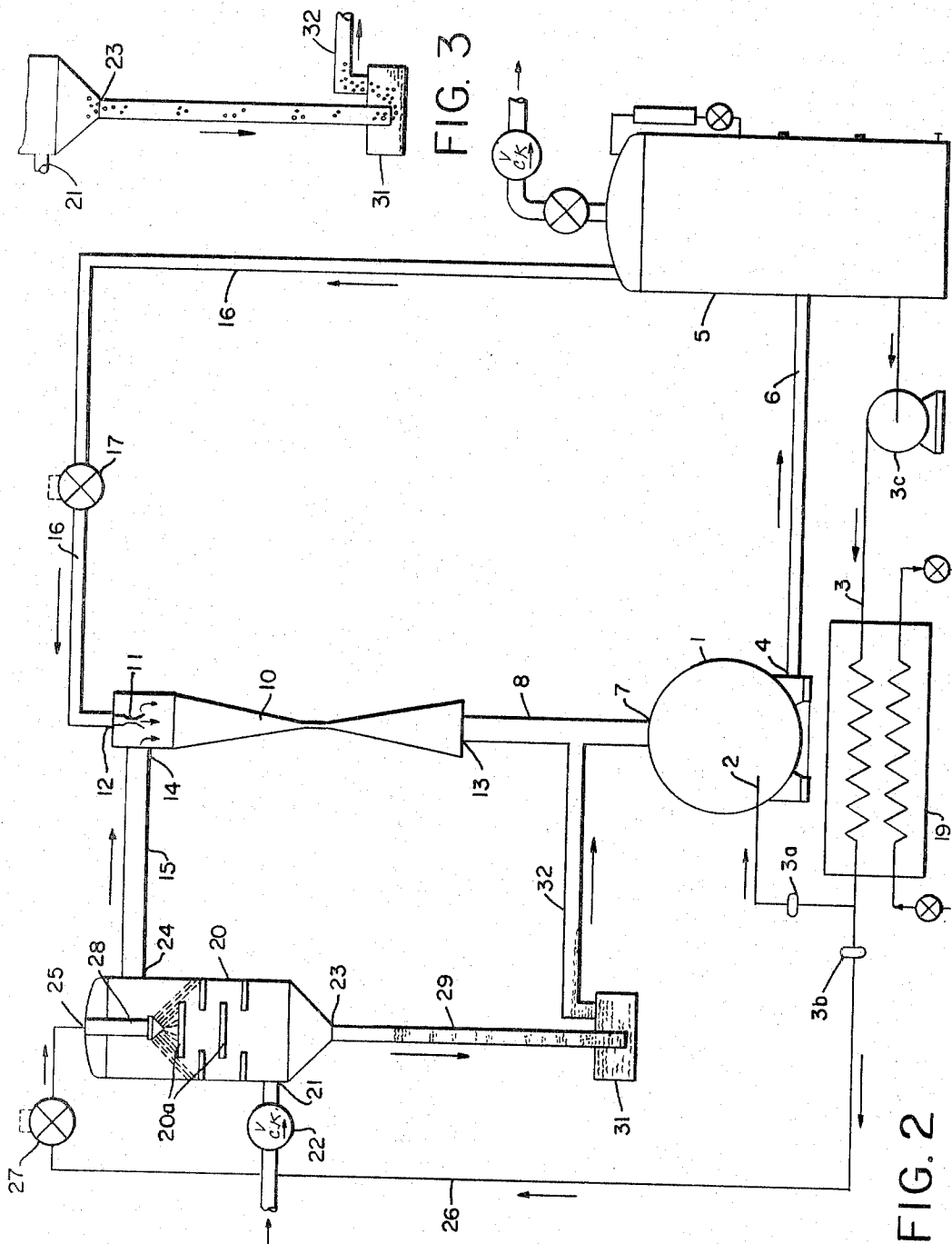


FIG. 2

FIG. 3

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EVACUATION SYSTEM

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12 Claims. (Cl. 230-45)

This application is a continuation-in-part of my application Ser. No. 514,789, filed December 20, 1965, now abandoned.

This invention relates to an evacuation system in general, and more particularly to an evacuation system capable of handling, at high capacity, fluids having liquid and gaseous phases.

In the pipe system or condensers of a turbine driven power plant, for example, vapor and gases may both be present and it is necessary to quickly rid the pipe system or condensers of large volumes of air mixed with vapor and to maintain a high vacuum during the operation of the turbine.

In order to accomplish this quick result, a very large capacity exhauster is necessary to handle both the air and the large amount of vapors associated with it.

It is known, however, that the overall efficiency of an evacuation system handling air mixed with condensable vapors, particularly a system comprising the combination of a first-stage jet diffuser and a second-stage liquid ring pump, will be impaired by the volume of the condensable vapors.

It is, therefore, an object of the invention to provide for this latter type of system an increased capacity for the exhaustion of mixtures having condensable and non-condensable components.

It is a further object of the invention to provide an improved evacuation system capable of handling large amounts of liquids.

It is still a further object of the invention to provide for an evacuation system, comprising a liquid ring pump arranged as a second stage to a first-stage jet diffuser, an increased capacity without using expensive condensing apparatus to effect condensation of the vapors and mechanical check valves to prevent such condensates from reaching the input of the jet diffuser.

In accordance with the invention, the improved evacuation arrangement comprises a liquid ring pump forming a second stage to a first-stage jet diffuser, and separating means connected to the space being evacuated and discharging to the inlets of the liquid ring pump and the jet diffuser, the separating means separating liquid and directing the separated liquid to the inlet portion of the pump so that only non-condensable fluid components reach the inlet of the jet diffuser.

The invention will become more readily apparent from the following description of preferred embodiments thereof shown in the accompanying drawings, in which:

FIG. 1 is a schematic view of an evacuation system embodying principles of the invention;

FIG. 2 is a schematic view of another embodiment of the invention;

FIG. 3 is a fragmentary view showing the liquid trap means of the system of FIG. 2 at a different stage of the operation.

With reference to the figures, in which like parts are designated by the same reference numerals, the system includes a liquid ring pump 1, having sealing liquid supplied thereto at 2 by conduit 3 through a heat exchanger 19 and having the discharge side 4 thereof communicating with a receiver 5 through conduit 6. Receiver 5, in the particular embodiment, is shown as being an air receiver communicating with the atmosphere, but it is understood that the evacuation system of the invention may be used in connection with any type of gas other

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than air. The pump 1 is arranged as the second stage to a first-stage jet diffuser 10 by having the inlet 7 of the pump in communication, through a connecting piece 8, preferably a connecting T, with an outlet of jet diffuser 10. Jet diffuser 10 may be of the type described in U.S. Patent 3,064,878 issued November 20, 1962. Motivating gas or fluid is supplied to a nozzle 11 of jet diffuser 10, through an inlet passage 12 which communicates, through a conduit 16 and valve 17, with receiver-separator 5.

Jet diffuser 10, through inlet 14 thereof and through a supply conduit 15, communicates with an outlet 24 of condenser 20 which forms a separating means for separating condensable components out of the fluid before it reaches the jet diffuser 10. Condenser 20, in its preferred embodiment, is constructed in a manner facilitating rapid condensation and separation of vapors entering therein most efficiently, such as by the provision of a spraying device including nozzle 28 disposed at an upper end portion of the condenser 20. It is to be understood that other means may be used for effecting vapor condensation. Condenser 20 communicates with the space being evacuated (not shown) through an inlet passage 21 and through a check valve 22 which may be manually or automatically controlled. Inlet passage 21 communicates with a bottom portion of condenser 20 so that mixture of condensable and non-condensable components entering the condenser will encounter the liquid sprayed from spraying nozzle 28. Thus, separating means in 20 communicates with supply conduit means 15 upstream of diffuser 10.

In order to enhance condensation of vapors in condenser 20, baffles 20a may be provided. For purposes of illustration, baffles 20a are shown in the form of baffle plates arranged to facilitate reduction of the volume of vapors in the condenser 20, such as by formation of droplets.

As mentioned above, jet diffuser 10 communicates with condenser 20 through an outlet passage 24 of the condenser. The outlet passage 24 is so arranged with respect to inlet passage 21 and the baffle plates 20 that substantially no condensable components can reach the jet diffuser during any part of the operation.

Inlet passage 25 of condenser 20 communicates through valve 27 with branch conduit 26 of conduit 3 which supplies through a second branch sealing fluid to pump 1. Valve 27 may be manually or automatically controlled in response to predetermined pressure associated with the operation of the pump and the diffuser. Preferably, orifices 3a and 3b, which are diagrammatically illustrated, are provided in the branches of conduit 3, respectively, to permit controlled metering of fluid to pump 1 and to condenser 20, respectively. The liquid is pumped by pump 3c from receiver-separator 5 along recirculating conduit 3 on the one hand to pump 1 and on the other hand to separating means 20.

It is within the scope of the invention to feed cooling liquid to the condenser 20 and to the pump 1 from outside sources, such as cold tap water.

Condenser 20 effects condensation of the vapors entering through passage 21. A mixture consisting of the condensable component and/or sprayed liquid falls in the form of water drops to the bottom portion of the condenser and discharges through an outlet passage 23.

Receiver means 5 receives the discharge of pump 1 and separates it into its liquid and gaseous phases simply by permitting the gas to flow out to the atmosphere at the top of receiver 5 while liquid collects at the bottom thereof to be driven out by pump 3c. Cooling means 19 cools the liquid in conduit 3 and may be a surface type of heat exchanger kept cool by salt or other water.

Outlet passage 23 communicates with connecting piece

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8 through a conduit 29 which has formed a loop portion 30 therein as shown in FIG. 1, to form a liquid-trap means. Loop portion 30 is capable of effecting further cooling of the liquid flowing therethrough. Loop portion or trap means 30 acts as a check valve to prevent the return flow of liquid to the jet diffuser and delivers substantially all of it to the suction side 7 of pump 1. In the illustrated embodiment, loop portion 30 is disposed in a vertical plane and below the outlet passage 23.

In another embodiment of the evacuation system according to the invention, the loop portion of the trap means 30 of FIG. 1 is replaced by a small receptacle 31, in which, short of the bottom portion thereof, conduit 29 terminates. The receptacle 29 is designed to have sufficient liquid capacity to substantially fill conduit 29 under high vacuum conditions, as shown in FIG. 2, when jet diffuser 10 is in operation. The water column in conduit 29 furnishes a liquid seal during operation of the jet diffuser. Receptacle 31 communicates with the suction side 7 of pump 1 through conduit 32 which conveys the condensable component and/or sprayed liquid coming from condenser 20.

In the operation of the device, pump 1 is first started up and draws large volumes of air from the space being evacuated. Such large volumes, at pressures above a certain degree of vacuum, are beyond the capability of jet diffuser 10. Therefore, valve 17, which controls the flow of motivating fluid to jet diffuser 10, is maintained closed until a certain degree of vacuum is attained, whereupon valve 17 is opened and jet diffuser 10 is cut into the system. Valve 17 may be arranged to be operated automatically in response to a predetermined degree of vacuum. Concurrently with the opening of valve 17, the flow of cooling or spraying fluid is also initiated into condenser 20 by the opening of valve 27. Valve 27 may be automatically controlled in response to conditions in the vacuum system or manually upon attainment of such conditions. In the particular embodiment, valves 17 and 27 are opened at about 25 or 26 inches of vacuum. After jet diffuser 10 is cut into the system, the vacuum of the system will be brought up to the order of 29 inches, so that a 3 inch gain is obtained. No increase of power consumption is necessary to attain this increased capacity. At the degree of vacuum at which jet diffuser 10 is cut into the system, pump 1, if left alone, would operate beyond its capacity and experience possible damages. On the other hand, by inserting jet diffuser 10 into the system, the overall load becomes divided between pump 1 and jet diffuser 10, while by directing the condensable components over to the pump only non-condensable components go to the jet diffuser whereby increased capacity of the system is achieved.

During the beginning of the evacuation operation, i.e. during the hogging portion of such operation, pump 1 draws fluid through conduit 29 and any condensates collected in loop 30 of FIG. 1 will be cleared by the high velocity flow of the media being evacuated. Upon insertion of jet diffuser 10 into the system, the condensates start to collect in loop 30. The vertical distance of the loop below the condenser 20 is such that it prevents return flow of the condensates toward condenser 20 to sustain the pressure drop developing between pump 1 and jet diffuser 10 during their joint operation, which pressure drop in the illustrated embodiment amounts to about 3 inches of vacuum.

In the embodiment of FIG. 2, under high vacuum conditions, the conduit 29 is substantially filled with liquid to furnish a liquid seal which is necessary to permit operation of the jet diffuser when sustaining a pressure difference between vacuum pump 1 and the jet diffuser.

Under low vacuum conditions during hogging or exhausting before the jet diffuser is cut into the system, the liquid in the receptacle is cleared by the high velocity

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flow of the media being evacuated. The liquid, due to the high velocity flow, assumes the form of a spray, offering very little resistance of flow in the direction of the pump 1, whereby the conduit 29 with its predetermined length and the receptacle 31 forms a check valve permitting flow during low vacuum conditions in the direction of the pump and preventing return flow of liquid that is forming a liquid seal, during high vacuum operation.

In the illustrated embodiments of FIGS. 2 and 3 the conduit 29 and receptacle 31 are disposed in a vertical plane and below the outlet passage 23.

It is within the scope of the invention to provide an improved evacuation system in which a liquid ring pump operates alone without the additional stage, i.e. without the jet diffuser. Under such conditions cooling fluid may be directly introduced into the inlet portion of the pump or, into a condenser connected directly to the inlet portion of the pump without a loop or receptacle between the condenser and the inlet portion.

It is seen that the invention provides an evacuation system comprising the combination of a jet diffuser, a liquid ring pump and a vapor condenser with its associated liquid trap means such as a loop or a receptacle, which combination enhances the capacity of the system to an extent which hitherto has been thought possible only by the use of expensive auxiliary spray jets or surface condensers installed ahead of the jet diffuser and by the use of mechanical check valves instead of the above described liquid-trap means.

Although the invention has been described with reference to specific embodiments thereof, it is not intended that it should be limited to such specific embodiments only, but rather defined by the scope of the appended claims.

What is claimed is:

1. A system for evacuating fluid having liquid and gaseous phases, comprising liquid ring pump means having suction and discharge portions and forming a second stage of the system, jet diffuser means having inlet and outlet portions and forming a first stage of the system, said jet diffuser means having its outlet portion communicating with said suction portion of said pump means, supply conduit means communicating with and feeding the fluid to said inlet portion of said jet diffuser means, and separating means communicating with said conduit means upstream of said inlet portion of said jet diffuser means for separating the liquid phase from the fluid before it reaches said jet diffuser means, said separating means having means communicating with said suction portion of said pump means, so that the separated liquid bypasses said jet diffuser means.

2. A system as claimed in claim 1, wherein said fluid is a mixture of vapors and gases having condensable and non-condensable components respectively forming the liquid and gaseous phases and wherein said separating means sprays liquid through the mixture to condense the condensable components thereof, and supply means supplying spraying liquid to said separating means.

3. A system as claimed in claim 1, including supply means for supplying cooling water to said separating means for condensing the liquid phase therein.

4. A system as claimed in claim 3, further including means communicating said separating means with said pump means and being adapted to form a seal by means of said cooling water between said pump means and said separating means at a predetermined degree of vacuum.

5. A system as claimed in claim 2, wherein said system further comprises means for supplying from the discharged portion of the pump sealing liquid for said pump and spray liquid for said separating means.

6. A system as claimed in claim 1 and wherein a liquid trap means is positioned between and communicates with said outlet of said separating means and said suction portion of said pump means to prevent a back-flow of separ-

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ated liquid to the inlet portion of the jet diffuser means.

7. A system as claimed in claim 6, wherein said liquid trap means includes a loop portion disposed in a substantially vertical plane and below said outlet of said separating means to form a seal between said first and second stage of the system.

8. In a method of operating a first-stage jet diffuser, second-stage liquid ring pump system for evacuating a mixture containing condensable and non-condensable components, the steps of condensing said condensable components from the mixture before it reaches the jet diffuser and directing said condensable components to the inlet of said liquid ring pump.

9. In a method as claimed in claim 8, wherein said condensing step comprises spraying said mixture upstream of said jet diffuser with a portion of the liquid discharged by the liquid ring pump.

10. In a method as claimed in claim 8, wherein said condensing step comprises spraying said mixture upstream of said jet diffuser with liquid derived from a source other than the discharge from the liquid ring pump of said evacuation apparatus.

11. An evacuating system comprising jet diffuser means forming a first stage of the system and having an inlet and an outlet, liquid ring pump means forming a second stage of the system and also having an inlet and an outlet, said inlet of said vacuum pump means communicating with said outlet of said jet diffuser means, supply conduit means communicating with said inlet of said jet diffuser means for supplying thereto a fluid which is evacuated by the system from a given space, said fluid having condensable and non-condensable components, separating means communicating with said supply conduit means upstream of said jet diffuser means for separating the condensable components from the fluid before it reaches said jet diffuser means, said separating means having an outlet through which separated condensable components discharge from said separating means, liquid-trap means communicating with said outlet of said separating means and said inlet of said liquid ring pump means to direct the separated condensable components to the liquid ring pump means while preventing return of liquid to said inlet of said jet diffuser means even when the pressure at said inlet thereof is substantially less than the pressure at said inlet of said liquid ring pump, receiving means communicating with the outlet of said liquid ring

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pump means for receiving fluid discharging from said liquid ring pump means and separating the fluid into its liquid and gaseous phases, recirculating conduit means communicating with said receiving means for receiving liquid therefrom and recirculating the liquid on the one hand to said liquid ring pump means to form sealing liquid therefor and on the other hand to said separating means for condensing condensable components in said supply conduit means, cooling means operatively connected with said recirculating conduit means for cooling the liquid flowing therethrough before the liquid reaches said liquid ring pump and said separating means, and said separating means including a device adapted to bring the cooled liquid from said recirculating conduit means in contact with the fluid flowing along said supply conduit means to said inlet of said jet diffuser means.

12. A system as claimed in claim 6, wherein said liquid trap means includes a reservoir for receiving liquid therein, conduit means for communicating said reservoir with said separating means, said conduit and said reservoir being disposed in a substantially vertical plane and below said outlet of said separating means to form a check valve between said first and said second stage of the system for permitting flow of the liquid phase during low vacuum conditions and for forming a liquid seal therebetween during high vacuum conditions.

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