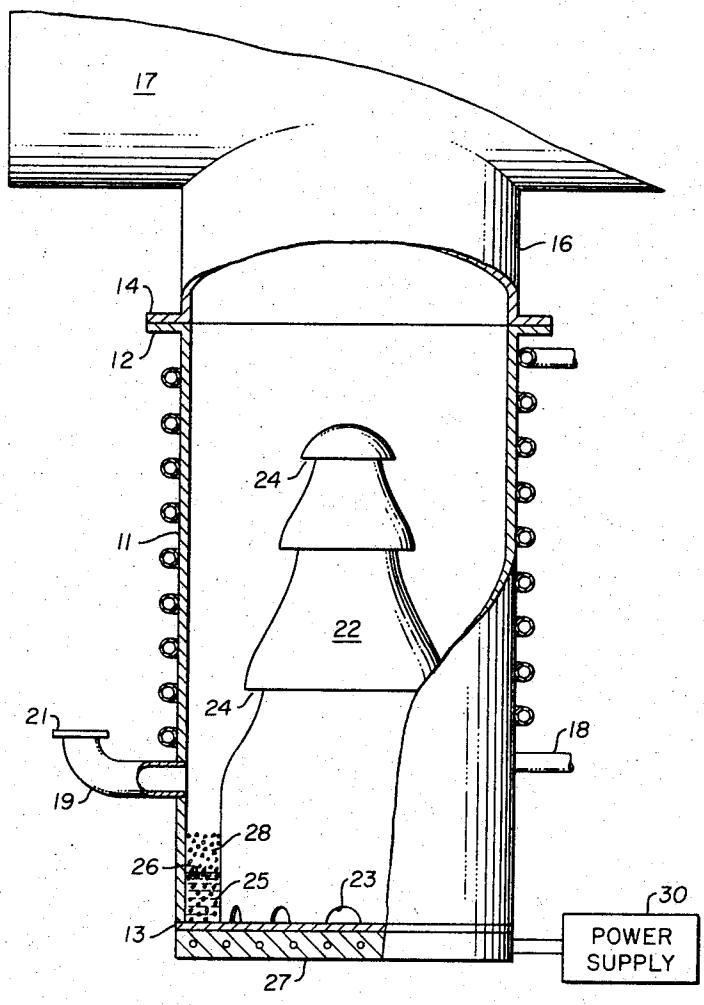
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BACK-STREAMING CONTROL IN A DIFFUSION PUMP

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BACK-STREAMING CONTROL IN A DIFFUSION PUMP

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1 Claim. (Cl. 230—101)

This invention relates to a diffusion type vacuum pump in which a selected granular material is disposed in the boiler well region between the jet stack and the pump housing to a depth greater than the pumping fluid. The material impedes eruptive boiling of the pumping fluid and thus greatly reduces this principal cause of back-streaming of the pumping vapor into the vacuum system.

This invention relates to high vacuum diffusion pumps and more particularly to decreasing the amount of back-streaming experienced in the operation of diffusion pumps whereby higher vacuums may be obtained therewith. The invention described herein was made in the course of, or under, Contract W-7405-eng-48 with the United States Atomic Energy Commission.

Diffusion pumps, which utilize jets of vaporized oil or mercury to withdraw gas from a chamber to be evacuated, are very extensively used to provide high vacuums and many attempts have been made to improve pump performance from the standpoint of reducing back-streaming, i.e., the drifting of pumping fluid vapor into the vacuum chamber being pumped. These attempts at improvement have included the use of specially shaped jet nozzles, the use of special heating devices to superheat the vapor before or during its passage through the nozzles and also the use of a refrigerated cap over the nozzle support structure. Such changes have improved operation of the pumps in some respects but have not eliminated the back-streaming which has continued to present a problem in high vacuum pumping. The rate of back-streaming in fact is believed to be the factor which limits the degree of vacuum which can be obtained with this type of pump.

In most diffusion pumps, the pumping fluid boiler is situated beneath the vapor jets and a portion of the boiling liquid, i.e. the portion between the shell of the pump and the jet forming tubulation which extends upwardly therein, is directly exposed to the vacuum chamber except for the presence of the jets. It has now been found that a principal cause of back-streaming is eruptive boiling in the boiler which impels pumping fluid upwardly towards the jets and ultimately into the region which is being evacuated.

In the present invention, by a fluid pervious filling of a material such as activated alumina granules in the bottom of the pump to a level higher than that of the boiling pumping fluid, a large improvement is made in reducing the amount of back-streaming. For example a reduction to one part from a previous amount of 1,000 to 10,000 parts of back-streaming pump oil has been achieved in a test where the granule filling was largely confined to the exposed portion of the boiler, i.e. the area of the boiler between the jet forming tubulation and the outer shell.

One reason this result is obtained is that the granules mechanically impede the violent upward movement of fluid and break up the large bubbles which otherwise result from eruptive boiling of the liquid in the base of the pump. Also it is believed that nucleate boiling in the presence of activated alumina granules causes vapor to be given off from the liquid in small amounts and in small bubbles thus avoiding the large concentrations of superheat which cause severe eruptive boiling where the granules are not present.

Although activated alumina granules provide excellent

results, other materials in granulated form are also suitable. Tests using glass beads of a size about one fourth inch in diameter produced a large reduction in back-streaming but failed to reach the amount of reduction achieved with the granules of alumina by about one order of magnitude. The reason for less reduction of back-streaming in the instance of the use of glass beads is believed to be that these beads merely produce the mechanical impediment to the production of large bubbles and severe eruptive boiling and do not produce the nucleate boiling obtained with the activated alumina granules.

The invention eliminates the requirement for a cold trap between the diffusion pump and the vessel being evacuated in many applications where it has heretofore been required and this in turn greatly increases the pumping speed in these applications. A further important advantage of the invention is that it may be readily applied to many existing pumps and is not limited only to specially constructed new pumps.

Therefore it is an object of the present invention to increase the efficiency of operation of a diffusion pump.

A further object of this invention is to reduce back-streaming in a diffusion pump.

Another object of the present invention is to increase the degree of vacuum that can be obtained with diffusion pumps.

A still further object of this invention is to reduce the requirement for the use of cold traps in high vacuum pumping.

The invention together with further objects and advantages thereof will be best understood by reference to the following specification in conjunction with the accompanying drawing which is a broken-out view of a typical diffusion pump showing the invention embodied therein.

Referring now to the drawing an upright tubular shell **11** having a flange **12** at the top and a flat base **13** forms the outer shell of the diffusion pump. Flange **12** connects to a flange **14** associated with entrance tube **16** leading to the vacuum chamber **17** which is to be evacuated. Water tubing **18** coiled around the outside of tubular shell **11** cools the diffusion pump to condense the pumping fluid vapor which impacts against the inside surface of the shell. A small connecting tube **19** sealed into the side of the tube **11** near but somewhat up from the base **13** provides for connection to a forevacuum pump by means of flange **21**.

A vapor jet forming tubulation **22**, smaller than the outer tubular shell **11**, is located inside the shell **11** in coaxial relationship thereto and is supported on the base **13**. A series of notches **23** are provided in the lower edge of tubulation **22** to permit pumping fluid **25** to pass between the outside and inside of the tubulation at the bottom thereof. Tubulation **22** has annular nozzles **24** formed therein in the usual manner for diffusion pumps, three such nozzles being employed in the present instance. The nozzles **24** are vertically spaced and are coaxial with the tubulation **22** to provide the customary annular vapor jets directed outwardly and downwardly towards the inside wall of shell **11**. A pumping oil **25** is provided in the bottom of the shell **11** and tubulation **22** to a level **26** which is sufficient to more than cover apertures **23**. An electric heater **27**, coupled to a power supply **30**, is disposed against the base **13** of shell **11** and heats the pumping oil **25**. Vapor from the heated pumping fluid rises into the tubulation **22** and is ejected through the nozzles **24** to form the above-described jets.

Back-streaming arises primarily from the surface areas **26** of the pumping oil **25** outside the tubulation **22**, between the tubulation and the shell **11**. Eruptive boiling in this area may move pumping fluid particles directly into the pumped region thereby limiting the vacuum obtained. The vacuum is further contaminated by the release

of gas molecules which have been absorbed in the pumping fluid. To overcome this condition a filling of small granules **28** is placed in the bottom regions of the pump, at least in the space between the tubulation **24** and the outer shell **11**, to a depth well above the pumping fluid surface level **26**.

The primary purpose of the granules **28** is to physically impede the violent upward movement of pumping fluid which is associated with eruptive boiling and thus the granules may be formed of any material having suitable mechanical strength, heat resistance, and which does not react with the pumping fluid. Glass beads, for example, have been found to be satisfactory. However, particularly good results have been obtained where the granules **28** are formed of activated alumina. As hereinbefore discussed, it is believed that nucleate boiling in the presence of activated alumina causes vapor to be given off in smaller units and reduces the concentrations of superheat which are otherwise present. The activated alumina granules **28** may typically be one-eighth inch in size or somewhat larger. Smaller sizes have been found to be less satisfactory.

The use of the activated alumina particles **28** has been made to reduce back-streaming by a large amount, approximately of the order of one-thousandth to one-ten-thousandth of the amount encountered before the use of the activated alumina.

Many variations are possible within the spirit and scope of the invention and it is not intended to limit the invention except as defined in the following claim.

What is claimed is:

A diffusion pump having an outer shell with a pumping fluid disposed therein together with means for heating said fluid and having an inner tubulation forming at least one vapor jet directed towards said shell and away from the region to be evacuated and wherein said pumping fluid in the annular space between said shell and said tubulation is exposed to said region to be evacuated comprising; a filling of loose granular material disposed in the lower portion of said pump at least in said annular space and exposed directly to said region to be evacuated between said tubulation and said outer shell and extending to a depth greater than the depth of said pumping fluid therein whereby back-streaming is reduced.

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