United States Patent

[11] 3,581,509

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[21] Appl. No. **869,817**
[22] Filed **Oct. 27, 1969**
[45] Patented **June 1, 1971**
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[54] **MOISTURE REMOVAL APPARATUS**
2 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **62/5**
[51] **Int. Cl.** **F25b 9/02**
[50] **Field of Search** 62/5

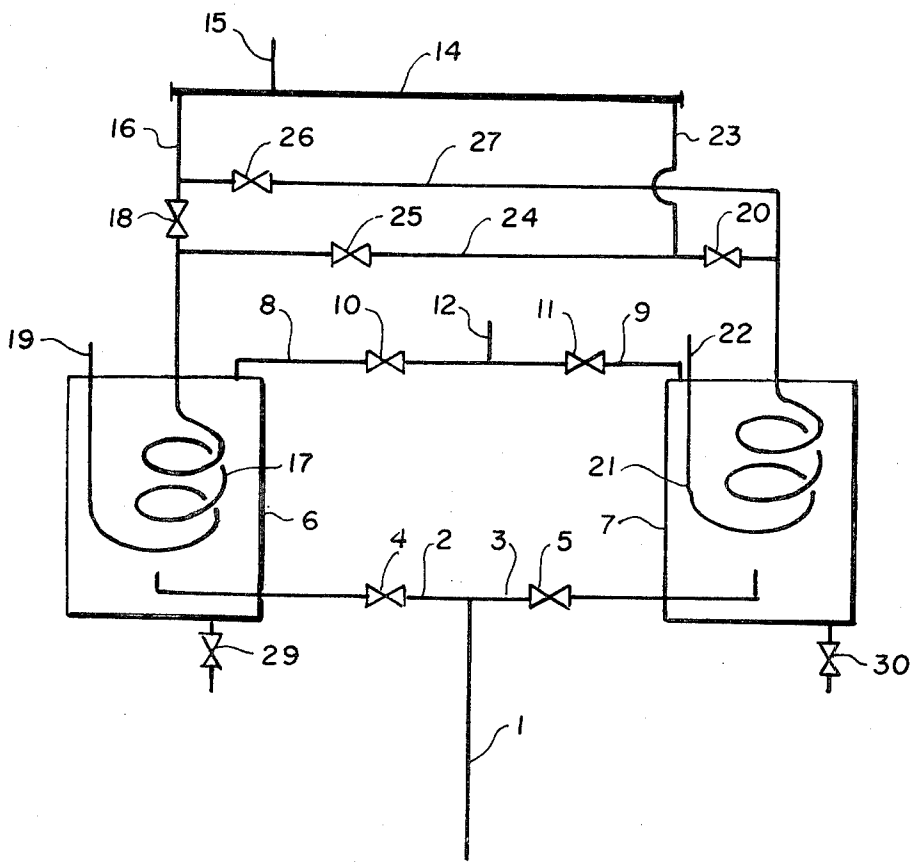
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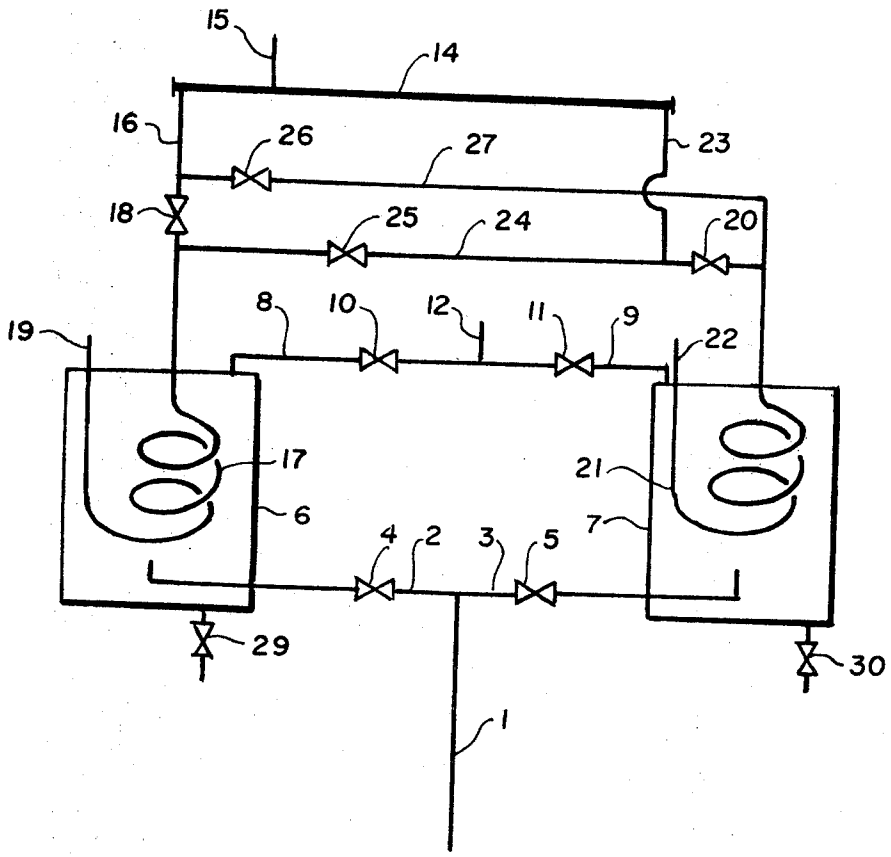
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ABSTRACT: The apparatus comprises a pair of heat exchangers and a vortex tube which provides both hot and cold air from a source of compressed air. The cold air is used on one heat exchanger to freeze the moisture out of the gas and after ice has built up in the heat exchanger hot air is introduced to melt the ice. During this melting period the wet gas and the cold air are passed through the other heat exchanger.



PATENTED JUN 1 1971

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MOISTURE REMOVAL APPARATUS

In many metallurgical operations continuous analysis of off gas is employed as a control means. Such gas frequently contains moisture, usually in fluctuating amounts. Calculation and utilization of the concentrations of the components of the gas are facilitated when they are based on a dry gas. Normally, the amount of gas required for analysis is only a few cubic feet per hour but for some purposes this must be moisture-free to an exceedingly low level, that is to say, a moisture concentration of a few parts per million. Further, it is frequently the case that moisture removal must be effected in rather close proximity to the apparatus being controlled—a blast furnace, basic oxygen steelmaking furnace or the like—in surroundings and under conditions unfavorable to the operation and maintenance of precision equipment.

It is an object of my invention therefore to provide apparatus for removing moisture to a very low level from a wet gas stream which is to be analyzed. It is another object to provide such apparatus which effects continuous removal of moisture. It is another object to provide such apparatus which operates by freezing out the moisture and then melting the solid frozen product. It is still another object to provide such apparatus which operates satisfactorily in a mill atmosphere under mill conditions. Other objects of my invention will appear from the description thereof which follows.

I have invented a simple and effective apparatus containing no moving parts suitable for the objects above mentioned. It is operated by compressed air and utilizes a vortex tube to provide the cold and heat necessary for continuous operation. An embodiment of my invention presently preferred by me is illustrated in the attached schematic figure to which reference is now made.

My apparatus is intended to lower the moisture content of gas to the parts per million range, as I have mentioned. It is convenient to remove the bulk of the moisture, down to about 1 percent, by conventional means. The wet gas containing 1 percent or so of moisture is introduced into my apparatus through pipe **1** which branches into pipes **2** and **3** which, in turn, lead into heat exchangers **6** and **7**, respectively. Pipe **2** is provided with a valve **4** and pipe **3** with a valve **5**. Moisture-free gas from heat exchanger **6** is delivered through pipe **8** to gas outlet pipe **12** and from heat exchanger **7** through pipe **9** also to gas outlet pipe **12**. Pipe **8** is provided with valve **10** and pipe **9** is provided with valve **11**.

Heat exchangers **6** and **7** are provided with hot and cold heat exchange gas, preferably air, from vortex tube **14** in the way to be described. The vortex tube **14**, which is also known as a Ranque-Hilsch tube, is of the same type as that shown in U.S. Pat. No. 1,952,281, and is commercially available. Compressed air from a source not shown is introduced into the vortex tube **14** through inlet **15**. The action of the vortex tube, which is described in the patent above mentioned, separates the incoming air into a cold fraction which is discharged through pipe **16** and a hot fraction which is discharged through pipe **23**. Pipe **16** is connected to a heat transfer coil **17** inside heat exchanger **6** through valve **18**. The other end **19** of heat exchanger coil **17** is open to the atmosphere. Hot air pipe **23** is connected through valve **20** to a heat exchanger coil **21** inside heat exchanger **7**. The other end **22** of heat exchanger coil **21** is open to the atmosphere.

Pipe **23** on the upstream side of valve **20** is connected to

pipe **24** which in turn is connected through valve **25** to pipe **16** on the downstream side of valve **18**. Pipe **16** on the upstream side of valve **18** is connected through valve **26** and pipe **27** to pipe **23** on the downstream side of valve **20**. Heat exchanger **6** is provided at its bottom with a drain valve **29** and heat exchanger **7** at its bottom with a drain valve **30**.

The operation of my apparatus will now be described with respect to the figure. Vortex tube **14** is supplied through inlet **15** with compressed air under a pressure preferably of 40 pounds or more per square inch. It is not necessary that the air pressure exceed about 100 pounds per square inch. The vortex tube **14** requires this air in the amount only of about 2 cubic feet per minute to dry gas at the rate of about 70 cubic feet per hour. The cold air discharged through pipe **16** has a temperature in the neighborhood of −30° F. and this cold air, with valve **18** open and valve **26** closed, passes through coil **17** and into the atmosphere from its open end **19**.

Wet gas to be analyzed is introduced into heat exchanger **6** by opening valve **4** in pipe **2** and closing valve **5** in pipe **3**. The wet gas impinges on the cold surface of heat exchanger coil **17** and the moisture freezes thereon. The substantially moisture-free gas is withdrawn through pipe **8** and open valve **10** into pipe **12**. Valve **9**, of course, is closed.

When coil **17** is covered with ice to the point that heat transfer from the gas drops off valve **18** is closed and valve **25** is opened. This allows hot air from pipe **23** to flow through coil **17** and out its open end **19**, melting the frozen moisture on coil **17**. Drain valve **29** is opened and the melted moisture flows out. While this defrosting is taking place, valve **4** is closed and valve **5** is open so that the wet gas is introduced into heat exchanger **7**. Likewise, valve **20** is closed and valve **26** is opened so that cold air from vortex tube **14** passes into heat exchanger coil **21**. The gas stream is thus continuously dehydrated either in heat exchanger **6** or heat exchanger **7** and the frozen moisture is melted in the heat exchanger not in use.

I claim:

1. Apparatus for removing moisture from a gas to be analyzed comprising a heat exchanger, means for introducing wet gas to be analyzed into the heat exchanger and means for withdrawing dry gas to be analyzed therefrom, a vortex tube, means for introducing a heat exchange gas under pressure into the vortex tube, means for selectively conducting cold heat exchange gas from the vortex tube into the heat exchanger to freeze moisture out of the wet gas to be analyzed and hot heat exchange gas from the vortex tube into the heat exchanger to melt the frozen moisture therein.

2. Apparatus for removing moisture from a gas to be analyzed comprising first and second heat exchangers, means for introducing wet gas to be analyzed alternately into the first and the second heat exchangers, means for withdrawing dry gas to be analyzed alternately from the first and the second heat exchangers, a vortex tube, means for introducing a heat exchange gas under pressure into the vortex tube, means for conducting cold heat exchange gas from the vortex tube alternately to the first and the second heat exchangers to freeze moisture out of the gas to be analyzed, means for conducting hot heat exchange from the vortex tube alternately to the second and the first heat exchangers to melt the frozen moisture therein, and means for withdrawing moisture alternately from the second and the first heat exchangers.