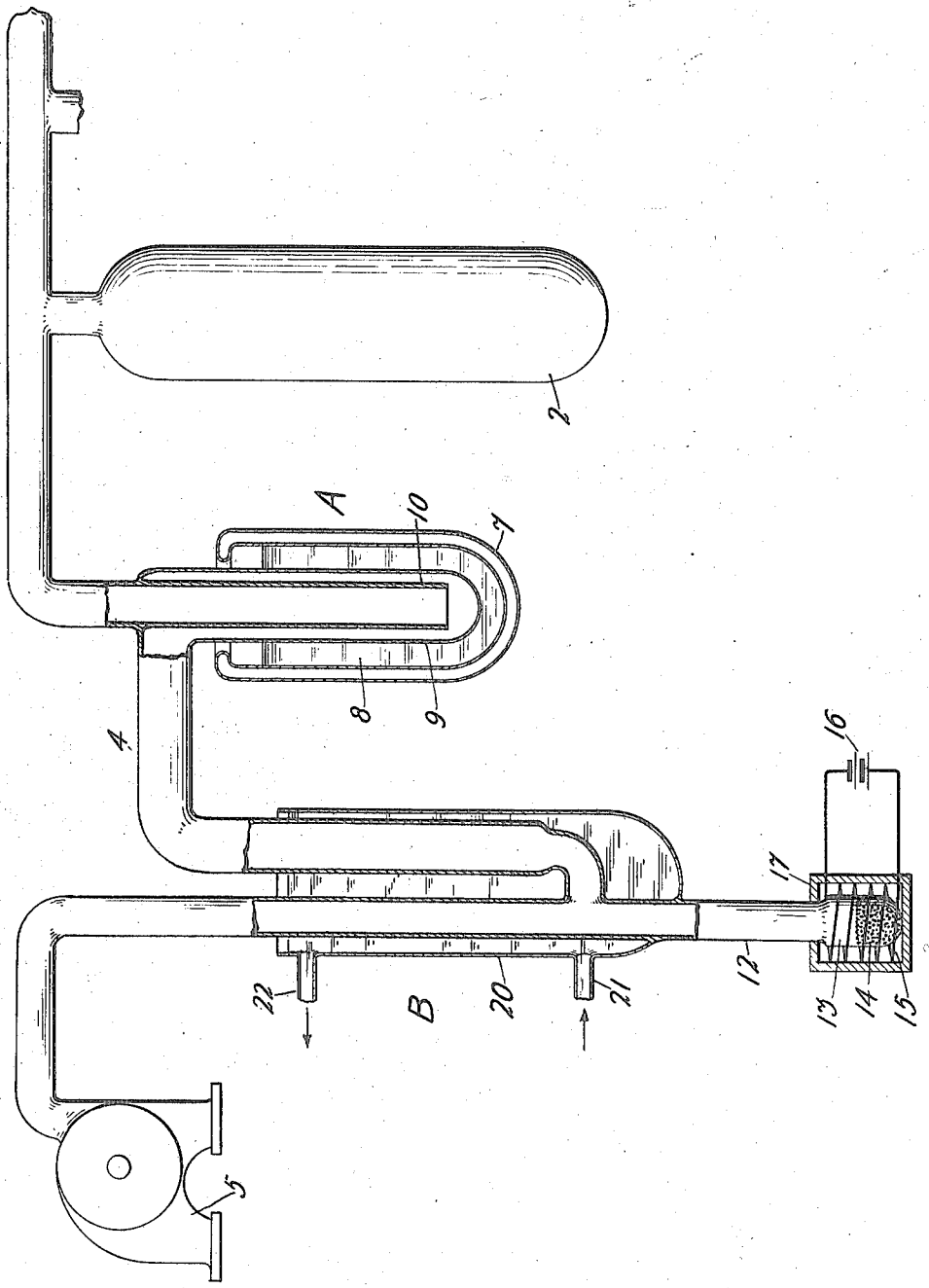
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METHOD OF AND MEANS FOR EXHAUSTING TO LOW PRESSURES.

APPLICATION FILED MAY 8, 1916.

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UNITED STATES PATENT OFFICE.

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METHOD OF AND MEANS FOR EXHAUSTING TO LOW PRESSURES.

Application filed May 8, 1916. Serial No. 96,265.

To all whom it may concern:

Be it known that I, OLIVER E. BUCKLEY, a citizen of the United States, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Methods of and Means for Exhausting to Low Pressures, of which the following is a full, clear, concise, and exact description.

This invention relates to the exhausting of vessels to low pressures, and particularly to a new and improved method and means for this purpose.

It has, of course, been well known that the exhaustion of vessels to low pressures is facilitated by boiling mercury inside of them during the exhausting process. It has been found that in this way, by the use of a comparatively "rough" pump, pressures can be obtained considerably below those to which said pump will exhaust when mercury vapor is not present within the vessel; and it is suppposed that this improvement in results is due to the fact that the mercury molecules, when leaving the vessel which is being exhausted, carry along with them molecules of the air which it is desired to remove.

Attempts, however, to adapt this principle to the exhaustion of vessels which do not contain mercury have disclosed that it is difficult to introduce into the mercury vapor stream the air molecules coming from the vessel to be exhausted. For example, it has been found that when the vessel to be exhausted is connected by a conduit with the conduit carrying the mercury vapor stream, the mercury molecules, instead of carrying along the molecules of air from the vessel, beat back the air molecules and prevent them from leaving the vessel. Attempts have been made to prevent this by introducing the mercury stream into the air stream from the vessel to be exhausted, in a direction substantially parallel to the direction in which the air stream is flowing. Such an arrangement, however, does not give entirely satisfactory results, owing probably to the fact that the mercury molecules, which are moving in all directions, rebound from the walls of the conduit in all directions and beat back the air molecules, although this effect is somewhat lessened if the walls of the mixing chamber are cooled by a water jacket.

The present invention is the result of the discovery that if substantially all of the mercury molecules in the vapor stream are moving in directions substantially parallel with the direction of stream flow at the point where the air molecules from the vessel to be exhausted are introduced, the air molecules are not beaten back by the mercury molecules, but mingle with and are carried along by them. Or stating it another way, if in advance of the point where the air and vapor streams combine, most of the mercury molecules, which are moving transversely to the direction of stream flow, are removed from the stream, then the air molecules are not beaten back, but are carried along by the mercury molecules which are moving in substantially the same direction as the stream flow. The present method may therefore be described as consisting in drawing the gas from the vessel to be exhausted into a vapor stream in which substantially all of the molecules are moving in directions substantially parallel to the direction of stream flow.

This improved method of exhausting vessels to low pressures will be fully understood from the following description of a preferred from of apparatus for carrying it out. This apparatus is shown, to a certain extent diagrammatically, in the accompanying drawing.

In the drawing, the vessel to be exhausted is indicated at 2. A plurality of such vessels may be connected to a conduit 3 leading through a liquid air trap A of well-known form to a conduit 4 connecting with the vapor pump B, hereinafter described in detail. Connected to the vapor pump B is a pump 5, of any suitable type, which need not be capable of exhausting to the extremely low pressures which it is desired to obtain in the vessel 2. The liquid air trap A, as usual, comprises a double-walled vessel 7, having the space between the walls exhausted to a fairly low pressure, which vessel contains liquid air, indicated at 8, into which dips the closed end 9 of the tube 4, into which the end 10 of the tube 3 projects, as shown.

The vapor pump B, by which the method

of exhaustion, forming the subject-matter of this invention, is carried out, comprises a tube or conduit 12 terminating at its lower end in an enlarged portion or bulb 13 containing a suitable liquid 14, such as mercury. The bulb 13 and the mercury 14 may be heated in any suitable manner as, for example, by a heating coil 15 receiving current from a suitable source, such as the battery 16. This heating coil may be of any suitable construction, and is shown as enclosed in a heat-insulating casing 17. The tube 12 communicates with the pump 5, usually referred to as the "fore" pump, as shown. The tube or conduit 4 leading through the liquid air trap A to the tube 3 and the vessel to be exhausted, is connected to the conduit 12 as shown. Provision is made for cooling the conduit 12 from a point considerably below to a point considerably above the place where it is joined to the conduit 4, and also for cooling the lower end of the conduit 4. As shown, this means comprises a water jacket 20 enclosing the portions of conduits 12 and 4 just mentioned. A flow of cold water is maintained through this water jacket 20 through the pipes 21 and 22, as indicated by the arrows.

The apparatus above described operates in the following manner: By the heating of the mercury 14, a mercury vapor stream is caused to pass upward through the tube 12. When this vapor stream first leaves the bulb 13, the mercury molecules are moving in all directions; but when the stream passes upward into that portion of the conduit 12 which is cooled by the cold water in the water jacket 20, those mercury vapor molecules which impinge the cold walls of the conduit are condensed and are removed from the vapor stream, eventually flowing down the walls of the tube 12 back into the bulb 13. The result is that the mercury vapor molecules which proceed upward through the conduit 12, are for the most part moving substantially in the direction of stream flow. When this vapor stream passes the point in the conduit 12 to which the conduit 4 is connected, most of the mercury vapor molecules go on, and not only do not beat back the air molecules seeking to enter from the conduit 4, but actually engage with and carry along said air molecules upward through the upper part of the conduit 12. As this mixture of air and mercury molecules passes upward through the cooled portion of the conduit 12, most of the mercury vapor molecules are condensed on the walls of said conduit and but little mercury vapor is mixed with the air which finally reaches the forepump 5. The water jacket 20 also serves to condense on the walls of the lower end of the conduit 4 some of the mercury vapor which may have passed into that portion of the apparatus. The liquid air trap A condenses any other mercury vapor which may work back through the tube 4 to that point, and also serves in the usual manner to condense any vapors coming from the vessels to be exhausted.

From the foregoing description of the manner in which the apparatus shown operates, it will be apparent that it is highly advantageous to have the conduit carrying the mercury vapor stream cooled in advance of the point at which the air is introduced by the communicating conduit which extends to the vessel to be exhausted. This feature is an essential part of the present invention.

What is claimed is:

1. The method of exhausting gas containing vessels which consists in drawing the gas from the vessel to be exhausted by a stream of vapor from which molecules moving in directions other than substantially parallel to the path of the stream have been removed whereby substantially all of the molecules in the stream are moving in approximately parallel directions.

2. The method of exhausting gas containing vessels to low pressures, which consists in producing a stream of vapor, substantially reducing the number of molecules in said stream which are moving in paths not substantially parallel to the direction of stream flow, and then drawing gas from the vessel to be exhausted into said vapor stream.

3. In apparatus for exhausting gas containing vessels to low pressures, means, including a conduit, arranged to provide a stream of vapor, means for leading to said stream gas from the vessel to be exhausted, and means for removing from said vapor stream, in advance of the place at which the gas from the vessel to be exhausted is led thereto, substantially all molecules whose paths are not substantially parallel to the direction of stream flow.

4. In apparatus for exhausting gas-containing vessels to low pressures, a source of vapor, a conduit through which said vapor passes, a branch conduit communicating with said first named conduit and adapted for connection with the vessel to be exhausted, and means for cooling the first named conduit at a portion in advance of the place at which said branch conduit connects with said first named conduit.

5. In apparatus for exhausting gas-containing vessels to low pressures, a source of vapor, a conduit through which said vapor passes, a branch conduit communicating with said first-named conduit and adapted for connection with the vessel to be exhausted, and means for cooling said first-named conduit at portions in advance of and beyond the place at which said branch conduit connects with said first-named conduit.

6. In apparatus for exhausting gas containing vessels to low pressures, a source of vapor, a conduit through which said vapor passes, a branch conduit communicating with said first named conduit and adapted for connection with the vessel to be exhausted, and means for cooling the first named conduit and the branch conduit from points in advance of the place of union to a point beyond the place of union.

7. In apparatus for exhausting gas containing vessels to low pressures, a conduit terminating in a bulb containing mercury, means for heating said bulb and the mercury therein, a branch conduit communicating with said first named conduit and adapted for connection with the vessel to be exhausted, and means for cooling the first named conduit and the branch conduit from points in advance of the place of union to a point beyond the place of union.

8. Apparatus for exhausting gas-containing vessels to low pressures comprising in combination, a gas pump, conduit means arranged to provide a path of gas flow from the vessel to be exhausted to said pump, means for increasing the flow of gas along said path comprising a mercury reservoir, means for vaporizing the mercury in said reservoir, means for limiting the translational molecular movements in said vapor to substantially parallel paths to form a non-diffuse vapor stream and for directing said stream along a portion of the path of gas flow, and means for condensing said mercury vapor between its point of introduction into the path of gas flow and said pump, said means being arranged to permit the return of the condensed mercury to the reservoir.

In witness whereof, I hereunto subscribe my name this 5th day of May A. D., 1916.

OLIVER E. BUCKLEY.