VAPOUR VACUUM PUMPS

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This invention relates to vapour vacuum pumps in which vapour from a heated working fluid passes to nozzles from which vapour jets emerge and serve to entrain air or other gas from a system or vessel to be exhausted.

It is frequently desirable in such pumps to interpose a baffle or baffles between the pump mouth and the system being pumped to limit the extent to which vapour can enter the system being pumped. The baffles or baffle parts can be arranged to be very well thermally insulated inside the vacuum region and the vapour quantities condensing on them are small so that a very small rate of heat extraction will suffice to chill them. The invention also provides a method of and means for heating the baffles, or parts thereof, when desired, as, for example, for de-frosting purposes.

According to the present invention, for the purpose of cooling or heating baffles or portions thereof in a vapour vacuum pump, use is made of the Peltier cooling effect or the reversed current heating effect, respectively, at one or more thermo junctions in good thermal contact with portions of the baffle.

For convenience it may be recalled that if by the application of an external potential difference, a current is compelled to flow through a thermojunction in the direction of the thermo-electric E.M.F. which would normally result from heating the junction, an extraction of heat or cooling effect is experienced at the junction which is known as the Peltier effect.

Any circuit involving a thermojunction inevitably includes a second thermojunction or its equivalent, and the current must flow through this in the opposite sense from that of its flow through the first junction. The second junction experiences a heating effect comparable to the cooling effect experienced by the first.

With conventional thermojunctions the heating and cooling effects described are very small and are to some extent masked by the ordinary resistance heating effect always present when a current flows in a practical circuit.

Developments in the field of semi-conductors, however, have recently made available certain materials capable of providing cooling effects far more powerful than were previously possible—over 40° C. of refrigeration being obtainable by a suitable selection of materials, for example, by the use of p type and n type bismuth telluride as referred to in Journal of Electronics, vol. 1, first series, No. 2, September 1955, page 218, on which appears an article entitled "Thermo Electric Application of Semi-Conductors," by H. J. Goldsmid.

Such devices are extremely compact, continuous in operation and provide their cooling effects without the aid of machinery or the circulation of fluid. Their heat extraction capacity remains limited, but in utilising the effect in accordance with the present invention the limitation is comparatively unimportant for the reasons already given.

The application of the invention will enable water cooled diffusion pumps to attain lower ultimate pressures with greater freedom from working fluid vapour in the vacuum system than was previously possible without the use of expensive and complicated mechanical refrigeration equipment or of cold traps requiring the regular replenishment of a coolant, but a greater immediate benefit may prove to be its application to air cooled diffusion pumps.

Air cooled diffusion pumps which lend themselves very conveniently in many fields of application because of their freedom from the need for a water supply, have previously suffered from the disadvantage that they could not be cooled quite to room temperature by air cooling, so that a slow distillation of pumping fluid from the pump to the vacuum system, usually at room temperature, was often inevitable. The use of air cooled pumps is thus made impossible in all cases where system contamination cannot be permitted and mechanically refrigerated baffles or traps requiring a coolant are uneconomic.

The invention makes possible the simple provision of compact cold baffles above such pumps, rendering their performance superior to that of similar water cooled pumps with water cooled baffles and equivalent to that of water cooled pumps equipped with similar cold baffles.
bodily the invention may be built into compact mobile pumping sets dependent solely on an electricity supply.

Various applications of the invention will be described as examples with reference to the accompanying drawings in which:

Figure 1 shows an accessory for mounting ahead of a vapour vacuum pump and accommodating baffles to be cooled and in which water cooling is employed,

Figure 2 shows a construction alternative to that of Figure 1 and in which air cooling is employed,

Figure 3 shows a further construction including illustration of air water cooling,

Figure 4 is a plan in section on the line X—X of Figure 3;

Figure 5 shows a particular construction of baffle element; and

Fig. 6 is a fragmentary detail illustrating one form of water cooling arrangement substitutable for the air cooling arrangement 28 in the species of Figs. 3 and 4.

Referring to Figure 1 of the drawings, a vacuum pump P provided with a cooling water coiled pipe CP is surrounded by a baffle housing which comprises a body or core containing two separate rings of copper pipe 2 and 3 emerging separately from the pot through gland seals 4 and 5 which are insulated by a suitable selection of gland material from the pot 1 and therefore from each other.

The baffle assembly consists of a thick copper ring 6 supporting a number of annular copper discs 7 and one plain copper disc 8 by means of three copper struts 9 brazed or soldered to the copper ring and to the discs.

The baffle assembly which is plated and polished to reduce radiation heat gain, is supported between the two rings of pipe 2 and 3 by a number of suitably spaced ribbons or strips of thermojunction material 10, 11, 12 each having the cold junction situated where the strip is secured to the copper ring and in good thermal contact with the copper ring, for example as shown at 13.

Cooling water is supplied to the two rings of pipe 2 and 3, taking care that the water does not provide a too low resistance electrical path between them, and a suitable E.M.F. from a source S is also applied to the pipes. The thermo-couple hot junctions are maintained near cooling water temperature and the cold junctions experience a refrigerating effect which chills the copper ring and baffle assembly in the desired manner.

Current is supplied to the rings 2 and 3 so that it will flow through the strips 10, 11 and 12 in parallel and if owing to an electrically conducting water supply, it is difficult to insulate the two water cooled rings from each other, one only may be water cooled and the second replaced by a copper ring electrically insulated from but thermally well connected to the first ring.

The construction shown in Figure 2 is similar to that of Figure 1 but it will be seen that the rings of copper pipe 2 and 3 of Figure 1 have been replaced by two turned copper rings 14 and 15 which form part of the wall of the pot 1 and are electrically insulated from the pot and from each other by insulating gland rings 16, 17, 18 and 19 which also form vacuum tight seals at the various junctions. The copper rings 14 and 15 are cooled by external cooling fins 20, 21 over which a draught of air is forced as directed if desired. The actuating E.M.F. from a source S is applied between these rings and the action is otherwise as described with reference to Figure 1. Simply for clarity in the drawing, the details of the baffle plate assembly and the pump P (Fig. 1) have been omitted from Figure 2.

A developed form of baffle cooling arrangement is shown in Figures 3 and 4 but the principle of cooling employed is as already described with reference to Figures 1 and 2. The construction shown in Figures 3 and 4 is intended to meet a number of conditions which have to be taken into consideration because of the very small heat extraction capacity of the thermojunctions. Thus, the cooled part of the baffle should have as small a thermal mass as possible so that cooling can be reasonably rapid and the surface of the cooled part of the baffle should be smooth enough to allow radiation falling on it and not too great as otherwise the amount of incident radiation may become excessive. Again the cooled part of the baffle should be designed so that, as far as possible, multiple re-reflections of radiant heat falling on the baffle, which re-reflections lead to increased absorption of radiant heat could be avoided and preferably the cooled part of the baffle should have a radiation shield between it and the hot parts of the associated pump.

Referring now to Figures 3 and 4, copper hot junction terminal blocks 22 and 23 are provided to the pot 1 by screws 24, electrically insulated gaskets 25 and gas sealing gaskets 26 being provided. Air cooling by vanes 28 is illustrated in Figs. 3 and 4, but it will be understood that the invention in its broader aspects is not limited to any particular type of cooling means, and that other cooling means, such as by a pipe 27 (Fig. 6) for conveying cooling fluid, such as water, in thermal conducting relation with said thermojunction means 22, 29, may be employed in lieu of the air cooling means shown in Figs. 3 and 4.

The terminals T are connected to a suitable source of electrical supply as indicated at S. The accessory again is combined with a vacuum vapour pump as indicated at P, Fig. 3, and more fully in Fig. 1. Bar's 29 of thermojunction material, for example bis-muth telluride, are welded or otherwise strongly secured to the blocks 22 and 23 and to a shallow cup shaped baffle 30 below which a radiation shield 31 is disposed.

The working principles already described apply to the construction shown in Figures 3 and 4 and, while this construction enables all the desirable conditions outlined above to be met, it provides the further advantage that a stage of conventional baffling, at room temperature or cooling water temperature, is provided by the radiation shield 31 in conjunction with the walls of the baffle body before the back migrating vapour molecules from the pump reach the cooled baffle member at all. The amount of vapour to be condensed by the cooled baffle member is therefore reduced.

In the constructions described with reference to Figures 3 and 4, the use of two small pillars or beams of rectangular section have been described, and it has been assumed that the two junctions to the common baffle part extract heat exactly as would a single junction and the shapes described are constructionally convenient. A baffle assembly larger than that described would absorb more radiant heat from its surroundings and might therefore require a greater heat extraction rate. This can be achieved by using pillars of thermojunction material of greater cross section and providing a greater current flow through them, or by substituting for each pillar a number of similar pillars in parallel and providing a proportionately increased current flow. Since the currents required are rather high, i.e. five to ten amperes for a three to four inch diameter baffle element, whilst the necessary voltages are very low, it may be found convenient to divide the baffle element into two or more electrically insulated sections each cooled by a single pair of pillars of thermojunction material and suitably to connect all the pillars in series. Such a construction is shown in Figure 5 in which the baffle element consists of sections 32, 33 and 34 which are彼此 interconnected but insulated from each other by insulators 35. Thermojunction elements 36, 37, 38, 39, 40 and 41 are strongly attached to the baffle sections as shown. This baffle is mounted so that current supplied to the thermojunction element 36 will flow via baffle section 32 to the element 37, thence direct to section 38, then via section 33 to the element 39 and from that element direct to element 40 and via baffle section 34 to element 41.

Cooled baffles constructed in accordance with the present invention are cooled by the refrigerating action pro-
duced when a current flows in an appropriate direction across a junction or junctions of suitable materials. If the direction of the current is reversed, then the analogous heating effect is produced quite apart from and in addition to the resistance heating ordinarily associated with current flow. The cooled parts of a baffle embodying the invention are preferably of light construction and may be rapidly heated up to ambient temperature, or if desired to a higher temperature within the safe limits for the constructional materials, merely by reversing the flow of the current and suitably adjusting its value. This facility for producing local heating is advantageous for de-frosting purposes, for example.

The difficulties, discussed earlier in this specification, associated with conventional cooled baffles, are thus removed. It becomes practicable to mount a cooled baffle on the system side of the isolation valve whenever desired or to open an unvalved system incorporating a baffle to atmosphere with the knowledge that the baffle can be rapidly brought up to and held at a temperature which ensures freedom from the sort of contamination discussed.

Alternative constructional details and materials of course be used in carrying out the invention, dependent upon specific requirements arising from the application of the invention to particular forms of pump.

I claim:
1. In combination, a vapor vacuum pump having an inlet end, a baffle at said inlet end, thermojunction means in thermal conducting relation with said baffle, and means connected with said thermojunction means for passing an electric current therethrough in such direction as to cool said baffle.
2. In combination, a vapor vacuum pump having an inlet end, a baffle at said inlet end, thermojunction means in thermal conducting relation with said baffle, and means connected with said thermojunction means for passing an electric current therethrough in such direction as to cool said baffle.
3. In combination, an assembly comprising a vacuum pump having an inlet end, a baffle at said inlet end, and thermojunction means in thermal conducting relation with said baffle, piping for conveying cooling water, said piping being in thermal conducting relation with said thermojunction means, said piping also being electrically connected to said thermojunction means and being connectable to a source of electrical power for passing current through said thermojunction means in such direction as to effect cooling of said thermojunction means.
4. In combination, an assembly comprising a vacuum pump having an inlet end, a baffle at said inlet end, and thermojunction means in thermal conducting relation with said baffle, piping for conveying cooling water, said piping being in thermal conducting relation with said thermojunction means, said piping also being electrically connected to said thermojunction means and being connectable to a source of electrical power for passing current through said thermojunction means in such direction as to effect heating of said thermojunction means.
5. In combination, a vapor vacuum pump having an inlet end, a baffle housing at said inlet end, a baffle assembly within said housing, thermojunction means in thermal conducting relationship with said baffle assembly, and means electrically connected with said thermojunction means for passing an electric current therethrough in such direction as to cool said baffle assembly.
6. In combination, a vapor vacuum pump having an inlet end, a baffle housing at said inlet end, a baffle assembly within said housing, thermojunction means in thermal conducting relationship with said baffle assembly, and means electrically connected with said thermojunction means for passing an electric current therethrough in such direction as to heat said baffle assembly.
7. In combination, a vapor vacuum pump having an inlet end, a baffle assembly and a housing for said baffle assembly at said inlet end, air cooled members supported from said housing, electrically insulated and vacuum tight seals between said air cooled members and said housing, at least one thermojunction means in thermal conducting relationship with said baffle assembly and said air cooled members, said air cooled members being electrically connected with said thermojunction means and being connectable to a source of power for passing electric current through said thermojunction means in the direction to effect cooling of said baffle assembly.
8. In combination, a vapor vacuum pump having an inlet end, a baffle assembly and a housing for said baffle assembly at said inlet end, air cooled members supported from said housing, electrically insulated and vacuum tight seals between said air cooled members and said housing, at least one thermojunction means in thermal conducting relationship with said baffle assembly and said air cooled members, said air cooled members being electrically connected with said thermojunction means and being connectable to a source of power for passing electric current through said thermojunction means in the direction to effect heating of said baffle assembly.
9. In combination, a vapor vacuum pump having an inlet end, a baffle assembly and a housing for said baffle assembly at said inlet end, water cooled members supported from said housing, electrically insulated and vacuum tight seals between said water cooled members and said housing, at least one thermojunction means in thermal conducting relationship with said baffle assembly and said water cooled members, said water cooled members being electrically connected with said thermojunction means and being connectable to a source of power for passing electric current through said thermojunction means in the direction to effect cooling of said baffle assembly.
10. In combination, a vapor vacuum pump having an inlet end, a baffle assembly and a housing for said baffle assembly at said inlet end, water cooled members supported from said housing, electrically insulated and vacuum tight seals between said water cooled members and said housing, at least one thermojunction means in thermal conducting relationship with said baffle assembly and said water cooled members, said water cooled members being electrically connected with said thermojunction means and being connectable to a source of power for passing electric current through said thermojunction means in the direction to effect heating of said baffle assembly.

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