

Oct. 5, 1965

O. P. STEELE III

3,209,818

THERMAL BARRIER

Original Filed March 24, 1958

2 Sheets-Sheet 1

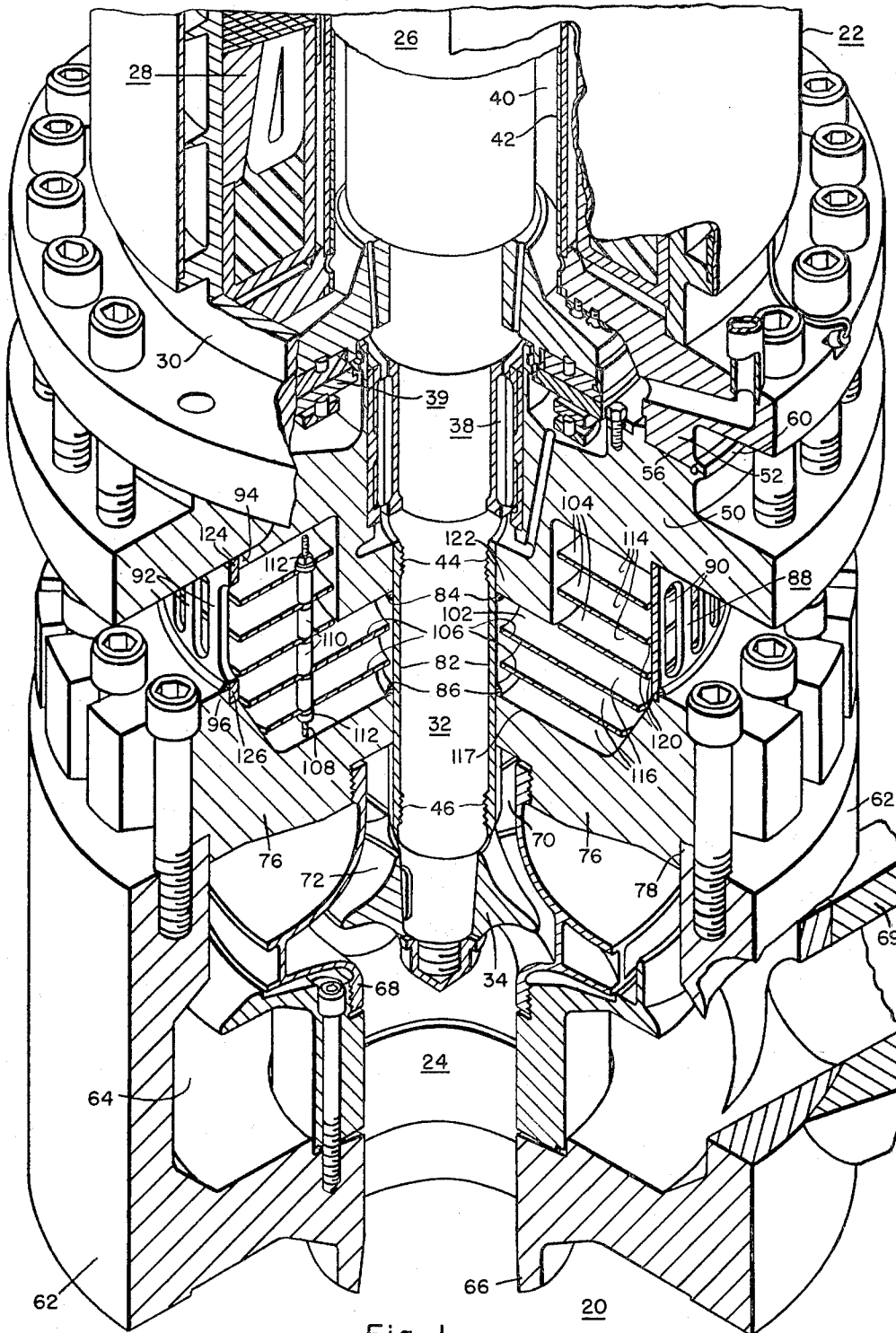


Fig. 1.

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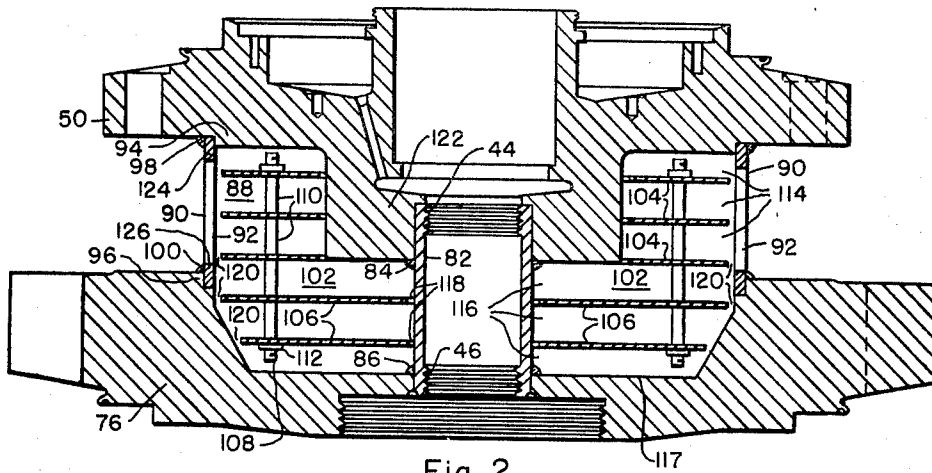


Fig. 2.

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3,209,818

THERMAL BARRIER

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Continuation of application Ser. No. 723,485, Mar. 24, 1958. This application May 15, 1961, Ser. No. 112,162

10 Claims. (Cl. 165—135)

This application is a continuation of application Serial No. 723,485, filed March 24, 1958, now abandoned.

The present invention relates to a thermal barrier for spaced components, such as those found in a motor-pump unit, which components are to be maintained at differing temperatures, and more particularly to a thermal barrier which requires no auxiliary systems for operation and which is adapted for operation in an area of relatively high temperature gradient.

Heretofore, it has been the practice in a motor-pump unit, or the like, to reduce the flow of heat from the pump casing to the motor casing, when the unit is employed for pumping fluid at elevated temperatures, by means of an annular cavity formed in the wall or flange separating the pump casing from the motor housing. This arrangement, however, resulted in the development of severe thermal stresses in the separating wall or flange due to the high temperature gradient across the wall or flange. These stresses were particularly severe in that portion of the flange adjacent the outer periphery thereof due to differences in radial expansion between that portion of the flange adjacent the pump casing relative to that portion adjacent the motor housing. As a result, the outer peripheral edge of the separating wall or flange, that is to say that portion between the outer periphery of the cavity and the radial edge of the flange, had to be relatively thick in order to withstand the thermal stresses developed therein. However, the usage of these relatively thick portions occasioned by known thermal barriers provided additional heat transfer paths between the pump casing and the motor housing of the motor pump unit and, therefore, reduced the temperature gradient or differential which could be maintained therebetween. Consequently, additional cooling means were required for the motor section, and wear of the associated components thereof was accentuated particularly in the shaft bearing or antifrictional means usually mounted in the motor housing at a position adjacent the thermal barrier.

In view of the foregoing, an object of the present invention is the provision of a novel and efficient thermal barrier of the character described.

Another object of the invention is the provision of a thermal barrier having novel means associated therewith for minimizing thermal stresses developed in the thermal barrier.

A further object of the invention is the provision of a thermal barrier having means associated therewith and permitting differential radial expansion of the spaced component parts with which the thermal barrier is utilized and which are maintained at differing temperatures.

Still another object of the invention is the provision of a thermal barrier adapted for use in areas of relatively high temperature gradient.

Another object of this invention is to provide an effective thermal barrier for use in apparatus wherein a source of cooling water is not available.

Another object of this invention is to provide an effective thermal barrier for use in apparatus wherein a rotatable shaft cannot be exposed to the ambient atmosphere.

A still further object of the invention is the provision of a thermal barrier having novel means associated therewith for removing heat therefrom and for spacedly sup-

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porting one of the aforesaid components relative to the other component.

These and other objects, features and advantages of the invention will be elaborated upon during the forthcoming description of an illustrative form of the invention, with the description being taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is an isometric view of the thermal barrier arranged in accordance with the invention and shown in an illustrative application in connection with a motor-pump unit, with parts thereof having been broken away for purposes of illustrating the invention; and

FIG. 2 is a cross-sectional view of the thermal barrier illustrated in FIG. 1 of the drawings and taken generally along reference lines II—II thereof.

Referring now more particularly to FIGS. 1 and 2 of the drawings, the illustrative form of the invention shown therein is adapted for use with a motor pump unit 20 comprising an upper motor section 22 and a lower pump section 24. The motor pump unit 20 is utilized in this example for pumping a liquid metal at a temperature of about 1300° F.

The motor section 22 includes a rotor 26 and a stator 28 which are mounted within a motor housing or motor casing means denoted generally by the reference character 30. The rotor 26 is mounted upon a driving shaft 32 to the lower end of which a pumping impeller 34 is secured. The driving shaft 32 is mounted for rotation upon a pair of antifrictional devices, for example, sleeve-type bearings, one of which is designated by the reference character 38 and downward thrust of the impeller 34 and driving shaft 32 is absorbed by a thrust bearing arrangement 39. The bearing 38 in this arrangement is similar to that described and claimed in a copending application of B. Cametti et al., entitled "Bearing and Mounting Therefor," Serial No. 637,181, filed January 30, 1957, now Patent 2,956,841 and assigned to the present assignee.

The bearing 38 is arranged for lubrication by the liquid metal being handled by the motor pump unit 20 and substantially filling the rotor cavity 40. The rotor 26 thus is immersed in the fluid being pumped; however, the stator 28 is isolated therefrom by a hermetically sealed enclosure or stator can 42. The rotor cavity 40 communicates with the interior of the pump section 24 by means of the normal clearances provided between the driving shaft 32 and the adjacent components of the motor pump unit. Leakage along these clearances, however, is limited by a pair of labyrinthine seals 44 and 46 of known design.

The lubricant flowing through the motor section 22 is purified by means of a cold trap (not shown) which prevents the precipitation of oxides and other materials from the liquid metal in other portions of the motor housing. When thus assembled, the motor housing 30 is closed at its lower end by means of the pump section mounting flange or end plate 50. The upper end of the housing 30 similarly is closed by a closure member or end plate (not shown). In those applications wherein the motor pump unit is handling a liquid metal or other hazardous material, the junctions 56 between the housing 30 and the motor housing mounting flange 52 and the lower closure or mounting flange 50 are hermetically sealed by means of an annular weld container denoted generally by the reference numeral 60. A suitable weld container for this purpose is described and claimed in Patent 2,805,789, issued September 10, 1957, to E. J. Kreh, Jr., et al., and assigned to the present assignee.

The pumping section 24 comprises a casing means 62 having a diffuser 64 in which the impeller 34 is mounted. The impeller 34 is of conventional design and thus is adapted for drawing fluid being pumped through an inlet port 66 of the motor pump unit, which port communi-

cates with eye 68 of the impeller. From the impeller, the fluid passes into the diffuser 64 and exits from the motor pump unit by way of the outlet port 69. Adjacent the upper surface of the impeller 34, a suctional cavity 70 is formed in the pump casing 62 and communicates with the interior of the impeller 34 by means of one or more openings 72. With this arrangement, the downward thrust occasioned by the pumping action of the impeller 34 is balanced in a known manner. A necessary amount of the fluid being pumped is conducted, for lubricational and internal cooling purposes, into the rotor cavity 40 by means of seepage flow via the labyrinthine seals 44 and 46.

The upper opening of the pump casing 62 is closed by means of a mounting flange or closure 76. The junction 78 between the closure and the upper end of the pump casing 62, in the event that the motor-pump unit 20 is employed for handling hazardous materials as aforesaid, can be hermetically sealed by means of a weld container (not shown), such as that indicated heretofore.

The construction and assembly of the motor-pump unit 20 and of the aforementioned cold trap is described in detail in a copending application of O. P. Steele III et al., entitled "Regenerative Cold Trap," Serial No. 637,210, filed January 30, 1957, now Patent 2,964,659 and assigned to the present assignee. Accordingly, a more detailed description of the motor-pump unit and associated components is deemed unnecessary.

In accordance with the invention, the lower end plate or mounting flange 50 and the pump casing closure or end plate 76 are joined in spaced relation to a relatively short connecting tube or sleeve 82, which partially supports the motor section 22. The tube 82 forms a closely fitting sleeve for the adjacent portion of the driving shaft 32 and is provided at its inner periphery thereof with the labyrinthine seals 44 and 46 described previously. Between closures 50 and 76 there is provided an intermediate necked-down portion separating the closures 50 and 76 and illustrated herein as the lower end 122 of the closure 50 and a driving shaft sleeve 82. The sleeve 82 is secured to the closures 50 and 76 by means of annular welds 84 and 86, respectively, which perform the added function of hermetically sealing the junctions between these components and the sleeve 82.

The major proportion of the weight of the motor section 22, however, is borne primarily by a short tubular member 88, which is provided with a plurality of relatively closely spaced, vertical slots 90. The vertical slots 90 thus form, in effect, a plurality of supporting columns 92 formed from the tubular member 88. These columns 92 then will bear the major proportion of the weight of the motor section 22 when the motor pump unit 20 is operated in its vertical position, as shown in FIG. 1. The tubular member 88 is mounted coaxially of the driving shaft 32 and is positioned between a pair of shoulders 94 and 96 formed respectively on the confronting surfaces of the closures 50 and 76. When thus positioned, the tubular member 88 is secured to the closures 50 and 76, respectively, by a pair of annular welds 98 and 100 (FIG. 2).

Referring now also to FIG. 2, an annular space or recess 102 enclosed between the closures 50 and 76 and between the tubular members 82 and 88 is provided with a "static" thermal barrier means therein. The thermal barrier means of this invention is referred to herein as "static" to depict the fact that no external cooling means, such as a source of cooling fluid, and no moving parts are required to achieve heat removal and to prevent the flow of convection currents in the aforementioned space from the relatively hot housing portion 76 to the relatively cool member 50. In furtherance of this purpose the thermal barrier means includes a plurality of spaced, polished, annular discs 104 and 106 which extend laterally between the relatively hot closure 76 and the relatively cool closure 50. The tubular member 82 is dis-

posed at the inward end of the recess 102 to prevent communication between the recess 102 and the interior of the housing of the motor-pump unit 20. The supporting columns 92 are disposed about the outer periphery of the recess 102. The discs 104 and 106 desirably are fabricated from stainless steel and are spaced along the vertical dimension of the annular space 102 in order to minimize convection currents therein. Additionally, inasmuch as the discs 104 and 106 are polished, the transfer of heat by radiation across the space 102 from the pump casing closure 76 to the motor housing closure 50 likewise is minimized. The annular discs 104 and 106 are supported in their spaced relation by means of three or more vertically disposed rods 108. The spacing between adjacent discs 104 and 106 actually is maintained by a plurality of relatively short spacer tubes 110 through which the supporting rod 108 is inserted. When thus positioned, the assembly is secured by pairs of retaining nuts 112 which are threadedly secured to the ends respectively of the rods 108.

The use of the slotted tubular member 88 permits free circulation of air to those spaces 114 which are enclosed between the upper group of annular discs 104 so that heat in the spacer 114 is transferred to the ambient atmosphere. However, the lower and larger spacings 116 which are adjacent the annular discs 106 are in only limited communication with the slots 90 of the tubular member 88 by reason of their insertion within a generally circular, or annular, depression 117 of the pump casing closure 76. This communication is determined by the relatively small clearances 118 and 120 (FIG. 2) remaining between the discs 106 and the driving shaft sleeve 82 and the pump casing closure 76, respectively. With this arrangement, then, a relatively stagnant volume of air is maintained within the spaces 116 and between the pump casing closure 76 and a downwardly extending tubular projection 122 of the lower motor housing closure 50, respectively. Heat transfer across the spaces 116 then is reduced to a considerable extent by the stagnation of the air therein.

The spaces 114 communicate freely, as aforesaid, with the slots 90 of the tubular member 88. Therefore, a portion of the heat which inevitably is transferred to the bottom motor housing closure 50, for example, by the central supporting sleeve 82, can be removed by the circulation of air through the slots 90 and through the spaces 114 formed between the upper annular discs 104.

As stated previously, the slotted tubular member 88 produces a relatively large number of short vertical substantially independent columns 92, as better shown in FIG. 1 of the drawings. When thus formed, these columns 92, in effect, are joined at their upper and lower ends to a pair of ring members 124 and 126, respectively. During the operation of the motor pump unit 20 when employed for pumping fluid at a relatively high temperature, the pump casing 76 and associated components will expand radially to a considerably greater extent than the bottom motor housing closure 50 and its associated components. However, the aforesaid ring members 124 and 126, being secured in relatively good heat-conductive relation to the closures 50 and 76, respectively, and being formed of similar materials, for example, stainless steel, will expand differentially but to the same extent, respectively, as the closures to which they are secured. The differential expansion between the ring members 124 and 126 will be absorbed by flexure of each of the supporting columns 92. However, inasmuch as each column will be bent along its longitudinal axis, only a relatively small stress will be induced in each of the columns 92 and will not be sufficient to produce severe thermal stresses which may result in permanent deformation thereof.

A different result would attain if the tubular member 88 were solid and were thus subjected to severe circumferential stresses resulting from differential ex-

pansion between the closures 50 and 76. Moreover, there are no stresses developed in the supporting columns 92 due to the temperature gradient thereof in the vertical direction inasmuch as the bottom closure 50 and associated components of the motor section 22 form a very large heat sink as compared to the heat loss to the surrounding air by the columns 92. It should be pointed out in passing that the upper and lower ends of the driving shaft sleeve 82 are not subjected to a significant amount of differential expansion since the sleeve 82 is positioned at the central portions of the closures 50 and 76, respectively. Accordingly, little or no circumferential stress is induced in the sleeve 82. With this arrangement, then, the only heat-conductive paths between the pump casing closure 76 and the adjacent motor housing closure 50 is through the relatively thin driving shaft sleeve 82 and the spaced supporting columns 92.

From the foregoing, it will be seen that a novel and efficient thermal barrier has been disclosed herein. Although the thermal barrier of the invention has been described primarily in conjunction with the motor-pump unit 20, it will be appreciated that this barrier, if desired, can be utilized between any pair of spaced components which are desired to be maintained at considerably differing temperatures. It follows, then, that the foregoing descriptive and illustrative materials are presented for purposes of exemplifying the invention and are not to be interpreted as limitative thereof.

Accordingly, numerous modifications of the invention will occur to those skilled in the art without departing from the spirit and scope thereof. Moreover, it is to be understood that certain features of the invention can be employed without a corresponding usage of other features thereof.

Accordingly, what is claimed as new is:

1. In a sealed motor-pump unit, a generally hollow sealed housing, said housing having a relatively hot pump portion and a relatively cool motor portion, means for preventing the transfer of heat from said relatively hot portion to said relatively cool portion, said means including an inwardly extending annular recess formed on the exterior of said housing and disposed between said motor and pump housing portions, said housing having a tubular housing portion disposed at the inward end of said recess to prevent communication between said recess and the interior of said housing, said tubular housing portion connecting the interiors of said pump and said motor portions, a rotatable shaft for said motor-pump unit, said shaft extending through said tubular housing portion, static heat flow impeding means disposed in said recess for preventing the flow of heat from said relatively hot portion to said relatively cool portion, said recess being substantially freely communicable with the ambient atmosphere to permit the flow of heat from the recess to the ambient atmosphere.

2. In a sealed motor-pump arrangement, the combination comprising a pump unit maintained at a relatively higher temperature, a motor unit maintained at a relatively lower temperature, sealed casing means for said motor unit and for said pump unit, said casing means including spaced opposed annular end plates, a static thermal barrier disposed between said end plates, said thermal barrier including a hollow tubular element extending generally transversely of said end plates and secured at its ends respectively to said end plates to enclose the openings in said end plates and to permit communication between the interiors of said pump unit and said motor unit, and static means for dividing the space included between said end plates and adjacent said tubular element into a first relatively stagnant area disposed adjacent said casing means for said pump unit and into a second area freely communicable with the ambient atmosphere, said dividing means including a barrier means disposed between said first and said second areas to limit flow therebetween.

3. A thermal barrier comprising a first housing member maintained at a relatively higher temperature, a second housing member to be maintained at a relatively lower temperature, said members being spacedly disposed and having generally opposed surfaces respectively, said surfaces being subject to different relative thermal expansions, a tubular supporting element extending generally transversely of said surfaces and secured adjacent its ends respectively to the central portions of said members to space said first member from said second member, additional supporting means extending generally transversely of said surfaces and spaced outwardly of said supporting element, said supporting means having at least one opening therethrough, and means for dividing the space included between said supporting element and said supporting means into a first relatively stagnant area and into a second area freely communicable with said opening, said first area being disposed generally adjacent said first member and said second area being disposed generally adjacent said second member.

4. A thermal barrier comprising a first member maintained at a relatively higher temperature, a second member to be maintained at a relatively lower temperature, said members being spacedly disposed and having generally opposed surfaces respectively, said surfaces being subject to different relative thermal expansions, a spacing element extending generally transversely of said surfaces and secured adjacent its ends respectively to the central portions of said members to space said first member from said second member, a second spacing element having at least one opening therethrough and extending generally transversely of said surfaces and spaced outwardly of said first spacing element, said surface of said second member having a central projection extending towards said first member whereby said second member is joined to said first spacing element, said projection being spaced from said second spacing element and from said first member, and static means dividing the space included between said first and said second spacing elements into a first relatively stagnant area and into a second area freely communicable with the opening in said second spacing element, said first area being disposed generally between said first member and said second member projection, said second area being bounded generally by said second member, by said second member projection and by said first stagnant area.

5. A static thermal barrier comprising a first member maintained at a relatively higher temperature, a second member to be maintained at a relatively lower temperature, said members being spacedly disposed and having generally opposed surfaces respectively, said surfaces being subject to different relative thermal expansions, a first supporting element extending generally transversely of said surfaces and joined at its ends respectively to the central portions of said members to space said first member from said second member, a plurality of substantially independent second supporting elements extending generally transversely of said surfaces and spaced outwardly of said first supporting element, said second supporting elements being spaced from one another and each being joined at its ends to said first and said second members respectively to support at least partially one of said members relative to the other of said members, said surface of said second member having a central projection extending toward said first member whereby said second member is joined to said first supporting element, said projection being spaced from second supporting elements and from said first member, a first group of annular discs disposed generally between said first and said second supporting elements and extending generally parallel with said first member, a second group of annular discs disposed between said second member projection and said second supporting elements, said second group of discs being disposed generally parallel to said second member and adjacent the spaces between

said second supporting elements, and means for supporting said discs in spaced relation to one another, said discs being disposed to divide the space included between said first and said second supporting elements into a stagnant first area between said second member projection and said first member and into a second area freely communicable with the spaces between said second supporting elements.

6. In a sealed hollow housing member having two spaced hollow regions with the interiors thereof connected together by a hollow necked-down portion and having one of said regions subjected to relatively high temperature, said necked-down portion having at least a portion of its exterior surface exposed to the ambient atmosphere, static thermal barrier means having at least a portion thereof exposed to the ambient atmosphere and disposed between said one region and the other of said regions for preventing the transfer of heat therebetween, said thermal barrier means including flow dividing means disposed adjacent said necked-down housing portion and extending generally laterally therefrom, said flow dividing means being shaped to obstruct the flow of convection currents adjacent said necked-down portion from said one region to said other region.

7. In a sealed hollow housing member having two spaced hollow regions with the interiors thereof connected together by a hollow necked-down portion and having one of said regions subjected to relatively high temperature, said necked-down portion having at least a portion of its exterior surface exposed to the ambient atmosphere, static thermal barrier means having at least a portion thereof exposed to the ambient atmosphere and disposed between said one region and the other of said regions for preventing the transfer of heat therebetween, said thermal barrier means including flow dividing means disposed adjacent said necked-down housing portion and extending generally laterally therefrom, said flow dividing means including a plurality of annular discoidal members closely receiving said necked-down portion in the openings thereof, respectively, and disposed to extend laterally from said necked-down portion between said housing regions to prevent the flow of convection currents adjacent said necked-down portion from said one region to said other region.

8. In a sealed hollow housing member having two spaced hollow regions with the interiors thereof connected together by a hollow necked-down portion and having one of said regions subjected to relatively high temperature, said necked-down portion having at least a portion of its exterior surface exposed to the ambient atmosphere, static thermal barrier means having at least a portion thereof exposed to the ambient atmosphere and disposed between said one region and the other of said regions for preventing the transfer of heat therebetween, said static thermal barrier means including a plurality of heat radiating surfaces disposed adjacent said necked-

down portion to radiate heat transmitted thereto from said one region and from said necked-down portion directly to the ambient atmosphere.

9. In a sealed motor-pump unit, a hollow housing having two spaced hollow regions with the interiors thereof connected together by a hollow necked-down portion and having one of said regions subjected to relatively high temperature, said necked-down portion having at least a portion of its exterior surface exposed to the ambient atmosphere, static thermal barrier means having at least a portion thereof exposed to the ambient atmosphere and disposed between said one region and the other of said regions for preventing the transfer of heat therebetween, said thermal barrier means including flow dividing means disposed adjacent said necked-down housing portion and extending generally laterally therefrom, said flow dividing means being formed to prevent the flow of convection currents adjacent said necked-down portion from said one region to said other region.

10. In a sealed hollow housing member having two spaced hollow regions with the interiors thereof connected together by a hollow necked-down portion and having one of said regions subjected to relatively high temperature, static thermal barrier means disposed between said one region and the other of said regions for preventing the transfer of heat therebetween, said thermal barrier means including flow dividing means extending generally laterally from said necked-down portion to prevent the flow of convection currents adjacent said necked-down portion from said one region to said other region, a plurality of spaced supporting members extending between said regions and disposed outwardly of said flow dividing means, whereby said flow dividing means and said necked-down portion communicate with the ambient atmosphere through the spaces between said supporting members.

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