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PUMP FOR USE WITH NEAR BOILING FLUIDS

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Fig. 1

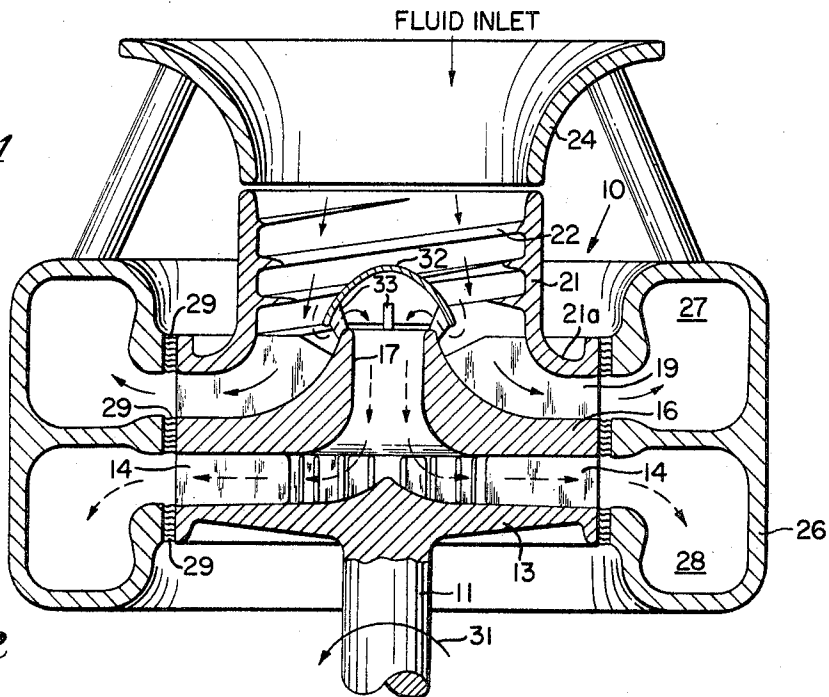
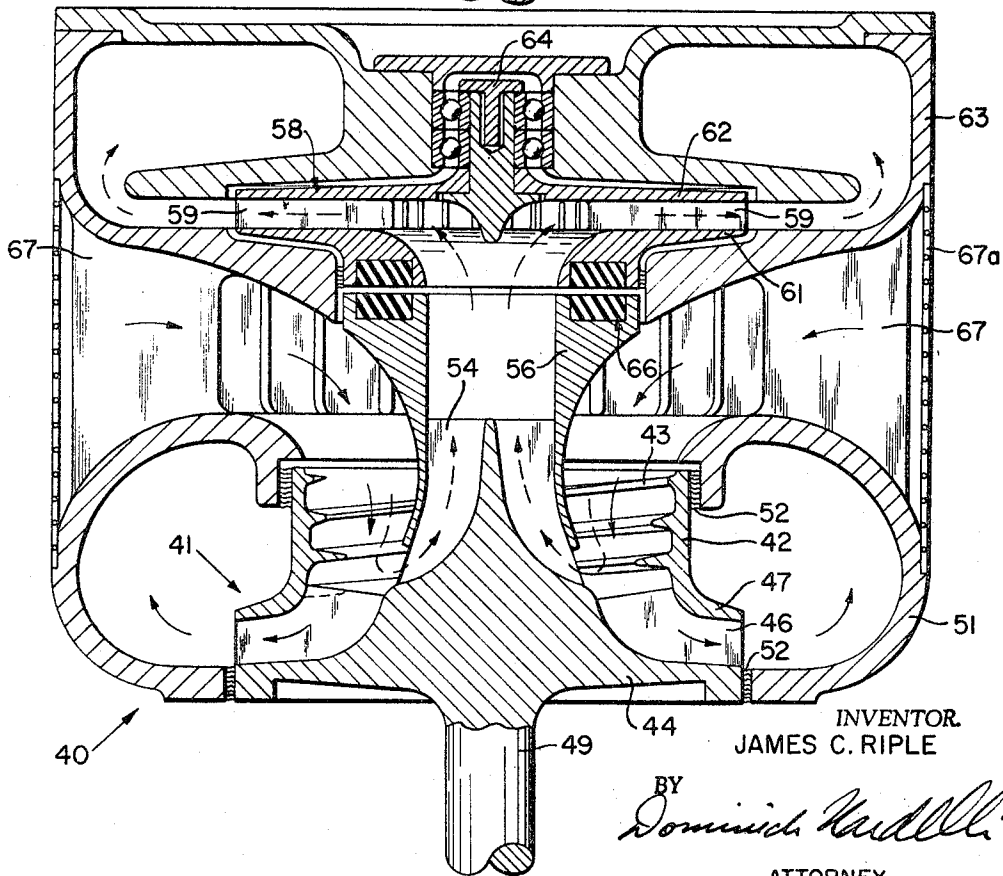


Fig. 2



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PUMP FOR USE WITH NEAR BOILING FLUIDS
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5 Claims

ABSTRACT OF THE DISCLOSURE

A centrifugal pump for pumping near boiling fluids and having a hubless inducer for whirling the liquid phase outwardly to a rotating liquid impeller and having an axial passageway for guiding the vapor phase to a vacuum means that sucks the vapors from the core of the hubless inducer.

This invention relates generally to centrifugal pumps and, more particularly, to pumps incorporating means for preventing vapor lock.

Whenever near boiling fluids, such as gasoline or other highly volatile liquids are being pumped, vapor could be released in the vicinity of the pump inlet especially when the temperature of the fluid is increased or when the inlet pressure is lowered. Tank-mounted boost pumps on aircraft encounter this problem when flying, especially in the initial climb conditions since the temperature of the fuel is relatively warm and the ambient pressure decreases.

The prior art suggests placing a hole along the axis of the pump that opens to the atmosphere. However, this arrangement also causes the liquid phase to pass also through the hole, since no means are provided to deflect the liquid therefrom.

An object of this invention is to provide an improved liquid pump wherein is provided a means for separating the liquid phase from the vapor phase and then guiding the phases to separate passageways.

Another object of this invention is to provide an improved liquid pump wherein is provided a suction to drain the vapor phase from the pump to prevent the accumulation of the vapor phase therein.

Another object of this invention is to provide in the improved pump in the above-mentioned object a means for automatically stopping the suction action whenever there is no vapor phase to drain off.

Briefly, the invention includes two centrifugal impellers, preferably axially disposed, and a hubless inducer. The hubless inducer causes the phases to separate by forming a vapor core within the liquid phase. An axial opening is provided so that the vapor phase passes through to one of the impellers which functions as a vapor compressor to provide the necessary suction to drain off the vapors. Another opening is provided radially disposed from the axial opening so that the liquid phase passes through to the other impeller to be pumped from the system. In one embodiment a clutch means is also provided between the vapor impeller and the power means to allow the vapor impeller to freewheel when liquid is present therein so that the power requirement may be kept to a minimum.

Other objects, features and advantages of the invention are presented in the following description and claims, and illustrated in the accompanying drawings, in which:

FIG. 1 schematically shows an axial cross-section of one embodiment of the invention; and

FIG. 2 schematically shows an axial cross-section of another embodiment of the invention including the clutch means for allowing one impeller to free-wheel.

Referring to the drawings and to FIG. 1, in particular,

the axial section schematically shows a centrifugal pump 10 incorporating the features of this invention. The pump 10 includes a shaft 11 which rotates about its axis and to which is integrally formed a disk 13. On disk 13 are integrally formed a plurality of radially extending fins 14 uniformly disposed about the axis of the shaft 11. The fins 14 are also integrally formed to an apertured disk 16 having an axially disposed aperture 17. In turn, a plurality of radially extending fins 19 are integrally formed on disk 16 opposite the fins 14, and the fins 19, in turn are integrally formed to a hubless inducer 21. The hubless inducer 21 has suitable vanes 22, disposed internally, for reasons that will be explained hereinafter. A suitable fluid inlet duct 24 is disposed coaxially with the inducer 21. The duct 24 is preferably fixed relative to the impeller 21 and suitable seals (not shown) would be provided therebetween.

The hubless inducer 21 has a radially extending flange 21a which, together with fins 19 and disk 16, forms the liquid phase impeller and disk 16, fins 14, and disk 13 form the vapor phase impeller. A stationary scroll 26 is provided around both impellers and has two passageways, a liquid phase passageway 27 and a vapor phase passageway 28, which receives the liquid phase and vapor phase, respectively, from the respective impellers. Suitable seals 29 are provided between the scroll 26 and the periphery of the respective disks 13 and 16 and flange 21a of the inducer 21.

The shaft 11 is rotated, for example, in the direction of arrow 31 by suitable power means (not shown). This causes liquid to be sucked into the inlet duct 24, and, in turn, into the hubless inducer 21. The arrows indicate the paths of fluid flow. Within the inducer 21 the vanes 22 cause the liquid to rotate therewith forcing the liquid outwardly leaving a core filled with vapor. The liquid readily is forced outwardly into the scroll passageway 27 by the rotating fins 19. The fins 14 are also rotating and since this impeller is conventionally designed to pump vapor, a negative pressure is formed within the axial aperture 17. The vapor phase that forms the vapor core within the hubless inducer is sucked into the aperture 17 and outwardly into passageway 28. An axially disposed hemispherical shield 32, supported by suitable struts 33, covers the aperture 17 and is spaced therefrom to form an annualr passageway for the vapor phase to pass through to aperture 17. The shield 32 prevents any liquid moving near the axis of rotation from entering directly into aperture 17 without being affected by the centrifugal force of the inducer 21. Thus, the pump 10 prevents the build up of vapor within the inducer 21 by first separating the liquid from the vapor and then positively removing the liquid phase and also the vapor phase from the inducer 21.

However, in the embodiment shown in FIG. 1 there is the possibility that no vapor may be formed within the pump. Then liquid would be pumped through both impellers. Under most conditions this would not be detrimental since the vapor scroll passageway 28 could communicate with the inlet 24. However, since power required to pump vapor is negligible relative to the power required to pump liquid, the system would need to be designed to handle much more than the minimum required power since the power transferred to any liquid entering passageway 28 is wasted.

Referring to FIG. 2, there is shown another embodiment of the invention wherein the peak power requirement when no vapor is present is substantially the same as when vapor is present. A pump 40 is shown having a fluid impeller 41 to which is attached a hubless inducer 42 having internally disposed vanes 43. The impeller 41 includes a disk 44, fins 46 and a flange 47 that extends radially outward from the inducer 42. Power to rotate

the impeller 41 is transmitted through a shaft 49. Around the fluid impeller 41 is disposed a liquid outlet scroll 51 and suitable seals 52 are provided therebetween.

On the end of the shaft 49 extending into the hubless inducer 42 are formed, for example, four splines 54. Over the splines 54 is fixed a sleeve 56. Coaxial with sleeve 56 is disposed a vapor phase impeller 58 having radially extending fins 59 fixed to an apertured disk 61 on one side and to a disk 62 on the other side. Around the vapor phase impeller 58 is disposed a vapor outlet scroll 63 which supports with the aid of suitable bearings a short shaft 64 fixed to disk 62. Suitable seals (not shown) are provided between the impeller 58 and scroll 63. Scrolls 51 and 63 are connected together by a plurality of struts 67 to provide a fluid inlet for the pump. A suitable screen 67a surrounds the struts 67.

The vapor phase impeller 58 is made to rotate with the liquid phase impeller 41 by a suitable clutch means 66 (schematically shown) between sleeve 56 and disk 61. The clutch means 66 has the characteristics of slipping when the required torque transmitted thereacross is higher than a given value. Then when the torque requirement drops below the given value there is no slippage and both impellers 41 and 58 rotate at the same speed. Clutch means 66 could be, for example, a coupling, consisting of two permanent magnets forming a synchronous drive for transmitting operating torque with no slip, plus a magnetic hysteresis drive to facilitate re-engagement as required.

The pump 40 operates very similar to pump 10. When shaft 49 is rotated by suitable means (not shown) the liquid to be pumped enters through the inlet passageway formed between the struts 67 to the inducer 42. Within the inducer 42 the liquid and vapor phases are separated and the liquid phase is moved axially towards the liquid impeller 41 by vanes 43 in the hubless inducer 42. The impeller 41 forces the liquid into the liquid outlet scroll 51. The vapor phase hugs the sleeve 56 and is sucked into the four openings formed by the four splines 54 and the sleeve 56. The suction is provided by the vapor impeller 58 since the clutch means 66 causes impeller to rotate at the same speed as the liquid impeller whenever no liquid is disposed within the impeller 58. As in pump 10, the vapor is forced into the vapor outlet scroll 63.

As long as the vapor impeller rotates a suction is being formed within the sleeve 56. Then if no vapor is present within the inducer 42, there would be a tendency that liquid would be drawn through the splines 54 to the impeller 58. However, since liquid is much heavier than vapor, the torque required to rotate the impeller 58 would be greater when liquid is present therein. However, the clutch means 66 can only deliver torque up to a given value. Thus, the impeller 58 stalls absorbing little or no power and the liquid would not be pumped therethrough. Then when vapor is again formed in the inducer 42, the liquid would be drawn out of the sleeve 56 by the liquid impeller 41. Now with the liquid removed the clutch means 66 will rotate the impeller 58 and, in turn, the vapor would be drawn from the inducer 42. Since liquid cannot be pumped by impeller 58, the power requirement of pump 40 is relatively constant and is approximately equal to the power required to pump liquid through impeller 41.

From the foregoing, explanation of the invention modifications and changes therein will become evident to those skilled in the art. Accordingly, the invention is not limited to the specific details of the described exemplary embodiment, but only as indicated by the scope of the following claims.

What is claimed is:

1. A centrifugal pump comprising:
 - an impeller disposed to rotate about an axis, a hubless inducer means coaxially disposed with said impeller;
 - fluid inlet means for guiding fluid into one end of said inducer opposite of said impeller,
 - said hubless inducer means being disposed to rotate with said impeller to cause the fluid passing axially therethrough to separate into the liquid phase and the vapor phase,
 - suction means for forming a suction to drain any of the vapor phase separated by said inducer means before the vapor phase is drawn into said impeller, and
 - means controlling said suction means in response the presence of the vapor phase in said inducer means to form a suction when the vapor phase is present and not to form a suction when no vapor phase is present in said inducer means.
2. A centrifugal pump comprising:
 - a first impeller disposed to rotate about an axis, a hubless inducer means coaxially disposed with said impeller;
 - fluid inlet means for guiding fluid into one end of said inducer opposite of said first impeller,
 - said hubless inducer means being disposed to rotate with said first impeller to cause the fluid passing axially therethrough to separate into the liquid phase and the vapor phase,
 - suction means for forming a suction to drain any of the vapor phase separated by said inducer means before the vapor phase is drawn into said first impeller,
 - said suction means including:
 - a second rotating impeller disposed to pump vapor, and
 - conduit means for a fluid inlet to said second impeller and having an inlet end disposed coaxial with said inducer means so that the vapor phase enters therein.
3. The pump of claim 2 wherein a baffle is disposed in way of said inlet end of said conduit means to prevent any liquid phase from entering therein.
4. The pump of claim 2 wherein:
 - means are provided for stopping said second impeller from rotating when only the liquid phase is present in said inducer means and for starting the rotation of said second impeller when the vapor phase is present in said inducer means.
5. The pump of claim 2 wherein:
 - said second impeller is disposed to rotate also about said axis,
 - said conduit means is disposed on said axis,
 - and clutch means are provided between said impellers for stopping said other inducer when only the liquid phase is present in said inducer means.

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U.S. Cl. X.R.