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BOOSTER PUMP

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This invention relates to centrifugal booster pumps and particularly to pumps of this class adapted for location in communication with a body of relatively volatile liquid necessitating the incorporation of means for effecting a separation of vapor from the liquid being pumped.

It is an object of this invention to provide an improved arrangement for effecting and maintaining a more complete separation of vapor from the liquid being pumped.

It is a more specific object to provide in combination with a pump of the above type including means for separating the vapor from the liquid, means for introducing the liquid in a separate independent path from the means for returning the separated vapor to the body of liquid in communication with the pump.

Other and more particular objects, advantages and uses of my invention will become apparent from a reading of the specification taken in connection with the appended drawing wherein:

Fig. 1 is a schematic view bringing out to advantage the preferred relationship of my improved construction as part of an aircraft booster pump for moving volatile liquid fuel from the tank to the main fuel pump;

Fig. 2 is an axial broken away section view taken substantially on the line 2—2 of Fig. 3 bringing out to advantage one detailed relationship of structure forming a preferred embodiment of my invention; and

Fig. 3 is a broken away plan view taken substantially on the line 3—3 of Fig. 2.

Referring in greater detail to the figures of the drawing, I have indicated schematically in Fig. 1 an installation on an aircraft incorporating an improved booster pump assembly forming a preferred embodiment of my invention. A plane indicated generally at 10 may include the usual motor-driven main fuel pump 12, the inlet pressure to which is adapted to be maintained above a predetermined value by means of my improved centrifugal booster pump assembly indicated generally at 14 and mounted in communication with the fuel tank carried in the wing of the plane.

In view of the volatile character of the fuel required for aircraft and particularly where high altitude flight is contemplated, it has become necessary to provide for the separation of the dissolved air and incipient vapor from the liquid fuel introduced to the booster fuel pump before the same has the pressure thereof raised for transfer to the main fuel pump. Other proposals have been made heretofore for effecting the separation of this vapor; however, the present ar-

5 rangement is believed to represent a marked improvement over anything that has been known heretofore, particularly as regards the clear-cut manner in which the vapor separation is accomplished and the separated vapor is prevented from again entering the inlet liquid stream.

The booster pump proper indicated generally at 16 and with which my improved liquid guide and vapor separating assembly has particular application may include a housing 18 formed with an impeller chamber 20 receiving a centrifugal impeller 22, having vanes 24 thereon adapted to receive liquid centrally thereof, and raise the pressure of said liquid, discharging the same to a surrounding scroll or volute chamber 26 for discharge through pump outlet 28. The pump may be driven by an electric motor 30. A funnel-like converging inlet throat 32 has a reduced terminal 34 delivering to impeller vanes 24 and an outer enlarged inlet terminal 36 having a propeller-like vapor beater 38, mounted in coaxial relation to the inlet throat 32. This impeller and propeller-like beater assembly functions in conjunction with the converging throat 32 to effect a satisfactory vapor separation under normal circumstances. However, it has been found by experience that separation of this vapor from the liquid is not alone sufficient since if released in the manner heretofore practiced, the same again finds its way back into the inlet liquid stream and is recirculated to the pump, thus lowering the effectiveness of such vapor separation.

Therefore, I have provided, in combination with this impeller and beater assembly, an improved arrangement for directing the incoming liquid and the separated vapor in independent paths, including a liquid inlet guide and vapor outlet guide indicated generally at 40.

An annular chamber 42 is defined by a coaxially extending wall 44, spaced radially outwardly from the periphery of the large terminal portion 36 of the converging throat 32 and arranged to be fastened to the pump housing by means of cap screws 46, the head portions of which engage a transverse wall 48. This transverse wall 48 is formed centrally with a converging funnel-like defining guide 49, having an enlarged inlet terminal 50, and a converged outlet terminal 52, smaller in diameter than the overall diameter of the beater and effective to direct liquid radially inwardly thereof. The wall portions 44, 48, as well as the inlet throat 49 are preferably formed of sheet metal, thus providing a relatively thin cross-section. The outer peripheral wall portion 54, adjacent converged terminal 52 of inlet guide

49, functions to define, with the opposed enlarged inlet 36 of converging throat 32, an inlet opening to annular vapor receiving chamber 42.

It will be noted that since the diameter of inlet guide terminal 52 is smaller than that of inlet terminal 36 of throat 32, vapor passing from the tips of beater 38 and rising thereabove is effectively directed into annular chamber 42 by the rear surface portion 54 of the inlet guide, thus giving added significance to this relationship. Wall 48 is formed with a plurality of ports 56 about which are mounted a corresponding number of tubes or conduits 58 extending in a general axial direction for directing the separated vapor upwardly from annular chamber 42 and discharging the same into the surrounding body of liquid at a selected elevation. Positioned within the confines of these tubular conduits is a screen 60 made in the form of a complete circle and functioning as will be seen, to screen the incoming liquid to converging guide 49. For the very important purpose of assuring the complete separation of the stream of incoming liquid from the returning vapor, partition 62 is mounted about the outer extremities of the tubular vapor conduits 58. This partition or plate-like baffle is likewise preferably made of sheet metal and includes an upstanding axially extending wall portion 64 and a plurality of ports 66 cooperating with the upper terminals of tubular vapor conduits 58. Mounted over the open terminal portion of wall 64 is a second screen 68 having a similar function to that of screen 60. These elements of the liquid inlet guide and vapor return assembly 40 may be fastened together as by spot welding.

From the above it will be apparent that the inlet liquid stream indicated by arrows passes radially inwardly under partition 62 and through screen 60 into communication with centrally converging inlet guide 49 and thence into communication with the radially inward portion of propeller-like beater 38. Similarly the vapor that is separated by the impeller 24, converging throat 32 and beater 38 passes radially outwardly along the tips of the beater and upwardly through the inlet opening into annular chamber 42 defined by inlet terminal 36 and outlet terminal 52. From annular chamber 42 the vapor is directed vertically upwardly through tubular guides 58 to an elevation higher than that of the inlet terminal to the liquid guide assembly, namely that defined by the under side of the partition or plate-like baffle 62 and converging throat 49.

I have shown the axially extending vapor directing conduits 58 as being elliptical-like in shape and including a plurality of conduits and prefer this arrangement in the more specific aspect of my invention; however, I contemplate other equivalent arrangements. These might include circular or other shaped conduits, as well as a large or small number of conduits.

While I have disclosed my invention in connection with certain specific embodiments thereof, this is to be taken by way of example, it being intended that my invention be defined by the appended claims.

I claim:

1. In combination with a centrifugal booster pump, including a centrifugal impeller and a vapor beater located ahead of said impeller effective to separate vapor from incoming relatively volatile liquid before said liquid reaches said impeller, of means defining a liquid inlet guide adapted to place said pump in communication with a body of relatively volatile liquid, said

guide having an inlet terminal located at a first elevation, means defining a separate vapor return guide adjacent said vapor heater effective to direct said separated vapor to a second elevation above said first elevation, to thus prevent said separated vapor from reentering the liquid stream being introduced at said first elevation.

2. In combination with a centrifugal booster pump, including a centrifugal impeller chamber having a centrifugal impeller therein and a vapor beater in advance of said impeller for facilitating the separation of vapor from incoming liquid, means defining an annular chamber surrounding and in communication with the radial extremities of said beater, means defining a liquid inlet path for placing said pump in communication with a body of liquid, said path defining means including an inlet terminal located at a first elevation, a first converging funnel-shaped inlet guide, the converged terminal of said guide having a diameter smaller than the overall diameter of said beater and functioning to direct incoming liquid to the radial inner portion of said beater, the outer periphery of said converged funnel-shaped terminal serving to partially form said annular chamber and to facilitate the introduction of separated vapor to said annular chamber, a second converging funnel-like liquid and vapor guide interposed between said beater and said impeller the larger terminal portion thereof being adjacent the radial extremities of said beater and having a diameter greater than that of said converging terminal of said first funnel-like guide, whereby to further facilitate the introduction of separated vapor into said annular chamber, means defining a separate vapor return path from said annular chamber to said body of liquid, including a conduit having a first terminal portion in communication with said annular chamber and a second outlet terminal portion disposed at an elevation above said first elevation whereby to release said vapor into said body of liquid at a position where the same will not reenter the inlet liquid stream.

3. In a centrifugal booster pump assembly, including means defining a housing having an impeller chamber therein, a centrifugal impeller received in said chamber, a funnel-like converging inlet throat leading axially to said impeller, a vapor beater disposed in advance of said impeller and located in generally opposed relation to the large inlet terminal portion of said funnel-shaped throat, the combination therewith of means facilitating the initial vapor separation and maintaining said separation including means defining a liquid inlet path to said throat, said path defining means including an inlet terminal located at a first elevation, means defining a vapor return path including an annular chamber surrounding and having an inlet opening in communication with the radial extremities of said vapor beater, and means defining a conduit having the inlet terminal thereof in communication with said annular chamber and having an outlet terminal disposed at a second elevation above said first elevation for releasing said separated vapor into communication with said body of fuel at a position where the same will not tend to reenter the stream of liquid being directed to said pump.

4. In a centrifugal booster pump assembly, including means defining a housing having an impeller chamber therein, a centrifugal impeller received in said chamber, a funnel-like converging inlet throat leading axially to said impeller,

a propeller-like vapor beater disposed in advance of said impeller and located in generally opposed relation to the large inlet terminal portion of said funnel-shaped throat, the combination therewith of means facilitating the necessary vapor separation and maintaining said separation including means defining a liquid inlet path to said throat, said path defining means comprising an inlet terminal located at a first elevation, means defining a vapor return path including an annular chamber surrounding and having an inlet opening in communication with the radial extremities of said vapor beater, means defining a conduit having the inlet terminal thereof in communication with said annular chamber and having an outlet terminal disposed at a second elevation above said first elevation for releasing said separated vapor into communication with said body of fuel at a position where the same will not tend to reenter the stream of liquid being directed to said pump and a plate-like baffle or partition separating said liquid inlet path and said vapor return path, said partition having ports therethrough communicating with said outlet terminals of said conduits.

5. In a centrifugal booster pump assembly, including means defining a housing having an impeller chamber therein, a centrifugal impeller received in said chamber, a funnel-like converging inlet throat leading axially to said impeller, a propeller-like vapor beater disposed in advance of said impeller and located in generally opposed relation to the large inlet terminal portion of said funnel-shaped throat, the combination therewith of means facilitating the necessary vapor separation and maintaining said separation including means defining a liquid inlet path to said throat, said path-defining means comprising an inlet terminal located at a first elevation, means defining a vapor return path including an annular chamber surrounding and having an inlet opening in communication with the radial extremities of said vapor beater, means defining a conduit having the inlet terminal thereof in communication with said annular chamber and having an outlet terminal disposed at a second elevation above said first elevation for releasing said separated vapor into communication with said body of fuel at a position where the same will not tend to reenter the stream

of liquid being directed to said pump, a partition separating said liquid inlet and said vapor outlet, and means defining a screen cooperating with said liquid inlet and means defining a screen cooperating with said vapor conduit outlet.

6. In a centrifugal booster pump, including a centrifugal impeller and a vapor beater mounted on and located ahead of said impeller for rotation therewith effective to cause the separation of vapor from incoming relatively volatile liquid before said liquid reaches said impeller; means defining a liquid inlet guide adapted to place said beater and impeller in communication with a body of relatively volatile liquid, said guide having an inlet terminal located at a first elevation, means defining a separate vapor return guide having an inlet in communication with the periphery of said vapor beater and having an outlet located at a second elevation above said first elevation in communication with the said body of liquid, said means being effective to prevent said separated vapor from re-entering the incoming liquid stream being introduced at said first elevation.

7. In a centrifugal pump arrangement, including means defining a pump housing having a coaxial inlet and a peripheral outlet, means defining a centrifugal impeller received in coaxial relation with said inlet, means defining a vapor beater located coaxially ahead of said impeller and mounted thereon for rotation therewith effective to beat out vapor from incoming relatively volatile liquid before said liquid reaches said impeller; means defining a liquid inlet guide leading to said beater and impeller, said inlet guide having an inlet terminal disposed at a first elevation; means defining a vapor return guide including an inlet disposed in communication with the radial periphery of said beater, a plurality of generally coaxially extending conduits having outlet terminals located at a second elevation above said first named elevation; a partition extending transversely of the general axis of rotation of said beater and impeller having openings therethrough for communication with the outlet terminals of said conduits, said partition having an out-turned annular flange about the periphery thereof, a screen supported by said flange and a screen carried by said inlet guide.

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