May 4, 1965 V. D. ROOSA 3,181,468

FUEL SUPPLY SYSTEM

Filed July 12, 1963 2 Sheets-Sheet 1

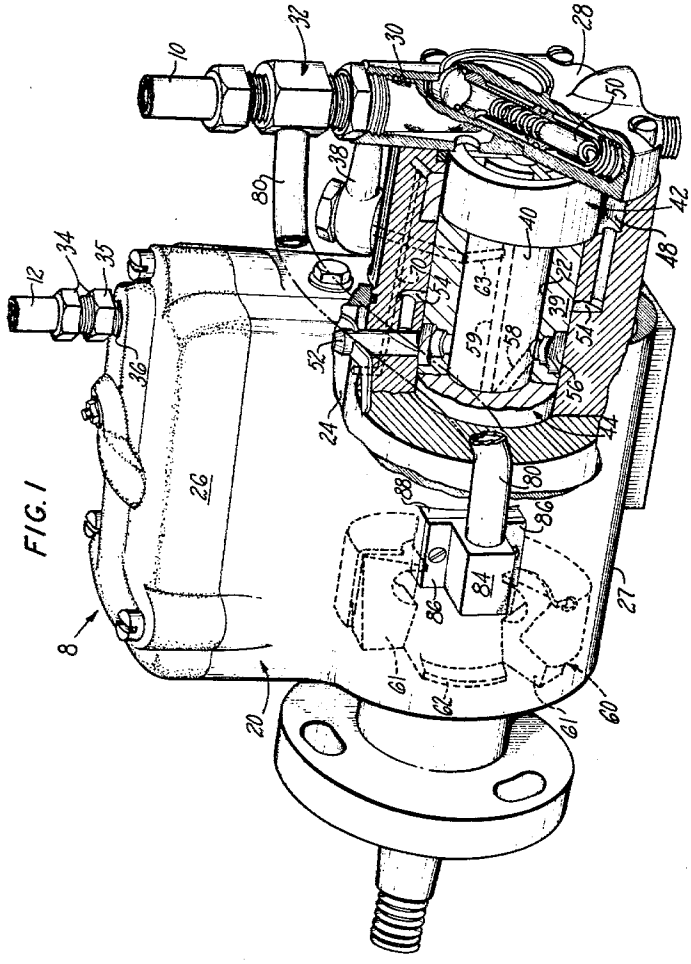


FIG. 1

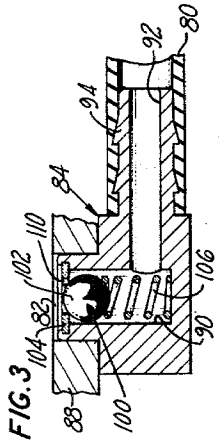


FIG. 3

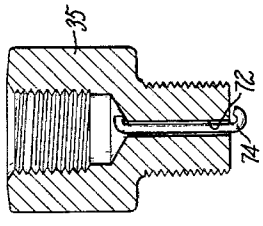


FIG. 2

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May 4, 1965 V. D. ROOSA 3,181,468

FUEL SUPPLY SYSTEM

Filed July 12, 1963 2 Sheets-Sheet 2

FIG. 4

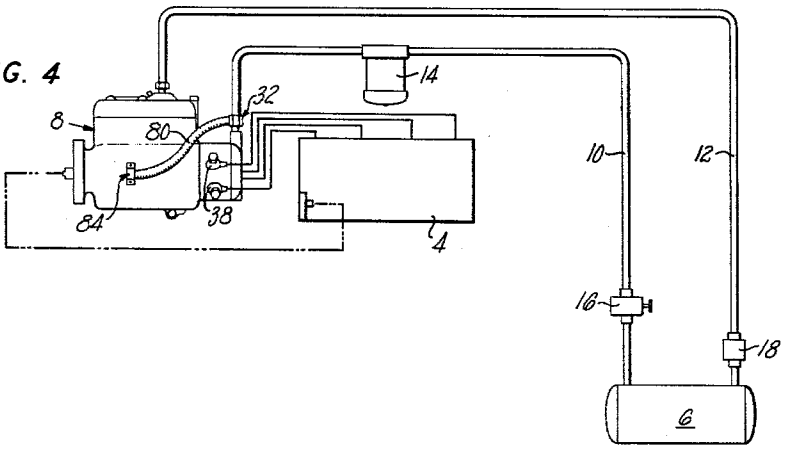
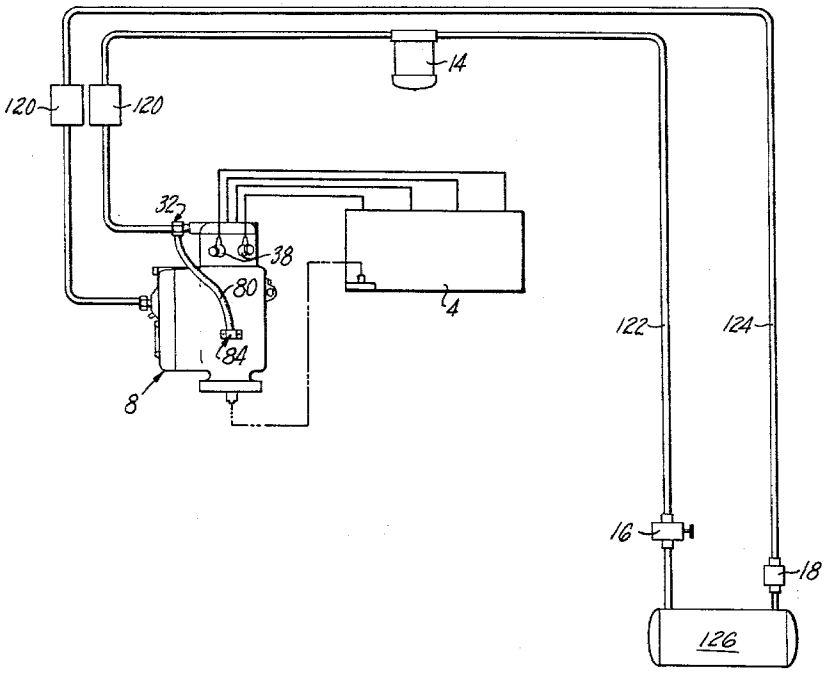


FIG. 5



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FUEL SUPPLY SYSTEM

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11 Claims. (Cl. 103—2)

This invention relates to fuel supply systems for internal combustion engines and more particularly to a fuel pump incorporating an improved arrangement for supplying fuel thereto.

One of the objects of the present invention is to provide a novel fuel pump for internal combustion engines and the like wherein air entrained in the fuel will be effectively separated and discharged from the housing of the fuel pump.

A further object of the present invention is to provide an improved fuel pump suitable for horizontal or vertical mounting and incorporating a novel bypass arrangement which recirculates filtered fuel through the fuel pump housing without returning the fuel to the supply tank.

A still further object of the present invention is the provision of an improved fuel pump which minimizes the need for priming the fuel pump despite the positioning of the fuel supply tank at a lower level than the pump. Included herein is the provision of an improved fuel pump incorporating means for replenishing the fuel in the pump should it be siphoned therefrom while the pump is idle.

A still further object of the present invention is to provide a novel bypass arrangement which may be provided in kit form and is suitable for use in the field modification of pumps.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth, and the scope of the application of which will be indicated in the appended claims.

In the drawings:

FIG. 1 is a perspective view of an exemplary fuel pump constructed in accordance with the present invention, shown with portions broken for illustrative purposes;

FIG. 2 is a fragmental cross-sectional view of a return fitting utilized in the pump of FIG. 1;

FIG. 3 is a fragmental cross-sectional view of a bypass fitting utilized in the pump of FIG. 1;

FIG. 4 is a schematic view of a fuel injection system embodying the invention and wherein the fuel pump is mounted in a horizontal position; and

FIG. 5 is a view generally similar to FIG. 4 but showing a modified form of a fuel injection system embodying the invention wherein the fuel pump is mounted in a vertical position.

Referring to the drawings in detail, there is shown for illustrative purposes a fuel injection system for an internal combustion engine 4 (see FIGS. 4 and 5) incorporating this invention; the system including a fuel supply tank 6, a fuel pump 8 for supplying fuel to the engine 4, inlet and return lines 10, 12 respectively connecting the tank 6 and the pump 8, and a filter 14 located in the inlet line 10. The exemplary fuel system further includes a hand primer 16 provided by suitable pump disposed in the inlet line 10; and a suitable check valve 18

disposed in the return line 12 to prevent the suction of unfiltered fuel out of the tank 6 in the event that the filter 14 should become clogged.

The exemplary fuel pump 8 comprises a casing or housing 20 having a longitudinal bore 22 opening at one end into a chamber or cavity 24 formed in the housing between the cover 26 and bottom 27 thereof. The housing 20 is provided with a plurality of radially disposed discharge ports each having a fitting 38 connected to one of the lines leading to the cylinders of the engine 4. The longitudinal bore 22 is closed by an end cap 28 having an inlet port 30 which is connected to the supply line 10 by means of a suitable fitting assembly 32. The return line 12 is connected with the housing chamber 24 by means of a suitable fitting assembly 34, including a vent plug 35 which is secured in a return port 36 provided in the cover 26 of the housing 20.

Rotatably mounted within a sleeve 39 provided in the bore 22 of the housing is a fuel distributor or rotor 40 having a low pressure fuel supply or transfer pump 42 on the right end thereof and a high pressure charge or injection pump 44 on the left end thereof (as viewed in FIG. 1 of the drawings). For a more detailed description of these pumps 42, 44, reference is made to my U.S. Patent No. 2,641,238 entitled Fuel Pump which discloses transfer and charge pumps of the same general type.

The transfer pump 42 receives fuel from the inlet fitting 32 and discharges fuel into an outlet formed by annular groove 48 provided in housing 20. In the illustrated embodiment, a pressure regulating valve 50 is interposed between the inlet and outlet of the transfer pump 42 to regulate the outlet pressure of the fuel from the transfer pump 42 in accordance with desired characteristics for the particular application of the pump. A more detailed description of the illustrated pressure regulating valve 50 may be found in my U.S. Patent No. 2,883,934 entitled Pressure Responsive Valve for Fuel Pumps.

From the annular channel 48 at the discharge side of the transfer pump 42, fuel is delivered to a rotary type metering valve 52 by means of a passage 54 provided in the housing 20. The metering valve 52 controls the quantity of fuel delivered into the charge pump 44, the outlet side of the metering valve 52 communicating with an annular channel 56 provided in the sleeve 39 which in turn communicates with the inlet of the charge pump 44 through means of a diagonal passageway 58 of distributor 40. From the charge pump 44, high pressure fuel is discharged into axial passageway 59 in the distributor which passage 59 in turn is placed in sequential registry with the discharge ports by means of rotor outlet passages 63, as the distributor 40 rotates whereupon the fuel is delivered to the various cylinders of the engine 4.

Actuation of the metering valve 52 to vary the quantity of fuel flowing into the charge pump 44 and therefore into the cylinders of the engine 4, is controlled by means of a governor 60 illustrated as being of the centrifugal type, mounted on the distributor 40 to the left (as viewed in FIG. 1) of the charge pump 44. The governor 60 includes a plurality of fly weights 61, which when acted upon by centrifugal force, pivot outwardly to thereby move a thrust sleeve 62 which is connected to the metering valve 52 to actuate the same through means of a suitable linkage (not shown) located in the upper portion

of the housing chamber 24. A more detailed description of a governor of the same general type may be found in my U.S. Patent No. 2,887,099 entitled Governor for Fuel Injection Pump.

In order to remove air from the chamber 24 of the pump resulting, for example, from suction leaks, particularly when fuel is being pumped from the supply tank under a negative head such as in the illustrated system of FIGS. 4 and 5, a longitudinally extending passage 70 is provided in housing 20 to communicate at one end with the annular channel 48 at the outlet side of the transfer pump 42 and to communicate at the other end with the housing chamber 24 above the distributor 40. Thus, fuel delivered by the transfer pump is discharged into the pump chamber 24 by means of the annular cavity 48 and longitudinal passage 70, and should air enter into the transfer pump 42, it will pass into the annular cavity 48, and together with a preselected portion of the fuel discharged from the transfer pump 42 enter longitudinal passage 70 and pass into the upper portion of the chamber 24 from whence it will pass through the vent plug 35 and return to the tank 6. The flow passage 72 in the vent plug 35 is restricted by a "wiggle" wire 74 to prevent undue loss of liquid fuel while accommodating the relatively easy discharge of air to thereby maintain a predetermined fuel pressure in the pump chamber 24 as will be subesquently described in greater detail.

In accordance with one aspect of the invention, a bypass conduit 80 is provided in order to substantially reduce the return flow to the tank 6, which, among many other advantages, reduces the quantity of fuel passing through the filter 14 to thereby increase its life. The bypass conduit 80, which may be formed from any suitable tubing, has one end connected to the inlet fitting assembly 32 and the other end connected to a fitting 84 which overlies a bypass outlet port 82 provided in the pump housing 20 to provide communication between chamber 24 and the pump inlet.

As best shown in FIG. 1, return plug 35 is connected to a high point in chamber 24, while the bypass port 82 is located substantially below return plug 35 and radially outwardly of the mounting plate for the governor weights 61. The bypass port 82 is also located at about the horizontal plane through the axis of the distributor 40. Since the governor weights 61 act somewhat as a centrifugal separator to separate the lighter air from the heavier fuel in which it is entrained, the separated air will be urged toward the center of the governor and then will rise to the top of chamber 24. Accordingly, this positioning of the bypass port 82 minimizes the likelihood that air being separated from the fuel will be directed into the bypass port 82 in any substantial quantity where it will be recirculated into the pump through the inlet fitting 32.

This positioning of the bypass port 82 relative to the transfer pump 42 will also insure that (assuming that the pump 8 is horizontally mounted as shown in FIG. 4) a sufficient amount of fuel will remain in the transfer pump 42 when the pump 8 is idle to eliminate the need for priming the pump 8 in order for it to begin pumping fuel, despite any siphoning of the fuel back into the tank due to air leaking in the system.

In the illustrated embodiment, the bypass conduit 80 is connected to the bypass port 82 by means of a fitting 84 having a pair of flanges 86 which are screwed to the boss 88 formed on the housing 20. Referring to FIG. 3, the bypass fitting 84 between the flanges 86 thereof, is provided with a first passage 90 extending at right angles to a second passage 92 and being formed in the nipple portion 94 of the fitting 84 which receives the bypass conduit 80.

In accordance with another aspect of the invention, a check valve generally designated 100 is provided in the bypass fitting 84 for causing (together with the "wiggle" wire 74 in the return vent plug 35) the pump chamber 24 to be pressurized to a predetermined amount, say, 5–9 p.s.i., so as to prevent air from accumulating adjacent the shaft in the governor due to the centrifugal separator action thereof, and to facilitate the driving off, through the vent plug 35, of the air which might accumulate in the pump chamber 24.

In the shown embodiment the check valve 100 includes a ball 102 adapted to engage a seat provided by a washer type member 104 secured in the passage 90 of the bypass fitting 84. The ball 102 is biased to its seat 104, to substantially close passage 90 of the fitting 84, by a spring 106 having one end engaging the ball 102 and the other end engaging the bypass fitting portion at the end of the passage 90 thereof. The biasing force of the spring 106 is such as to provide the desired pressurization in the pump chamber 24 as described above.

In order to minimize the build-up of pressure in the pump chamber 24 during cranking speeds of the engine 4 which would subtract from the actual transfer pump pressure, a bleed passage, or notch, 110 is provided in the seat 104 of the check valve 100 so as to provide communication between the inlet and outlet sides of the check valve 100 when the latter is seated. The bleed passage provided by the notch 110 in the seat 104 of the check valve 100 also facilitates the priming of the pump 8 should priming be necessary by permitting air to pass through by-pass conduit 80 directly into chamber 24.

In use, assuming that the pump 8 is mounted with the distributor 40 extending horizontally, as shown in FIG. 4, the bypass conduit 80 will reintroduce filtered fuel from the pump chamber 24 back into the inlet fitting 32 thereby substantially avoiding what has been the normal return to the fuel tank 6. This reduction of return flow to the tank 6, which may be as much as 90% of the total fuel passing through the pump, not only significantly increases the life of the filter, but also provides a stabilizing effect to the pump temperature; reduces the required size of the conduits and fittings; and eliminates the need for a feed pump in systems where a gravity tank is employed.

After the engine 4 has been operating and is shut off temporarily, an air leak into the system may cause siphoning of the fuel from the pump chamber 24 back into supply tank 6. If the level of the fuel in the pump chamber 24 drops to expose bleed passage 110, a suction break is provided with the result that the siphoning is discontinued and there is left in the transfer pump 42 a sufficient amount of fuel for restarting the pump without repriming. In systems where a hand pump, such as the primer 16, is used, the check valves that are usually included with these primer pumps will provide a further means for preventing siphoning.

If the pump 8 is mounted with the distributor thereof extending vertically, such as is illustrated in FIG. 5, the siphoning problem is magnified. Under such circumstances, when the pump 8 is shut off after operating, an air leak in the system again causes siphoning of the fuel in the pump chamber 24 until the level of the fuel corresponds to the level of the bypass outlet 82 at which time the bleed passage 110 again provides a suction break to prevent further siphoning. However, since the pump 8 is vertically mounted, the transfer pump 42 is then dry and consequently priming would normally be required for restarting the pump.

In order to avoid the need for priming when such a condition occurs, a pair of antisiphon tanks 120 are respectively provided in the inlet and return lines 122, 124, as shown in FIG. 5. If siphoning should take place and the fuel level in the pump chamber 24 drops to a point exposing bleed passage 110, a siphon break will occur with the result that further air leakage into the pump housing will bubble through the supply and/or return lines 122, 124 back into the tank 126 to empty fuel from these lines. The fuel which has been accumlated in the antisiphon tanks 120 will thereupon fall by gravity into the pump chamber 24 to fill the transfer pump 42. It will be apparent that the volume of the antisiphon tanks 120

will vary according to the specific installation and should be sufficient for refilling the pump chamber 24.

From the foregoing it will be seen that the present invention provides an improved fuel pump wherein the housing is pressurized by the fuel of the system to facilitate the expulsion of air that may enter into the pump housing while at the same time providing a unique bypass arrangement whereby return of the pressurizing fuel to the fuel tank is greatly reduced to increase the life of the filters as well as to effect other obvious economies and advantages in the construction, maintenance and performance of the associated fuel system. Moreover, the present invention further provides a fuel injection system which assures that the necessary fuel for priming the pump will be present after periods of idleness and is readily adapted for field modification of existing pumps.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. In a fuel pump for an internal combustion engine and adapted for vertical and horizontal mounting the combination of a housing provided with a chamber having inlet and return ports for connection to a fuel supply tank, said chamber further having a plurality of discharge ports to be respectively connected to a plurality of cylinders of the engine, a fuel distributor in the chamber having means for communicating with said inlet and discharge ports, a bypass outlet port in the housing opening into said chamber and being spaced substantially below said return port when the pump is mounted either vertically or horizontally, and a conduit establishing communication between said inlet and bypass outlet ports to thereby recirculate fuel through the chamber and to bypass the return port.

2. In a fuel pump as defined in claim 1 wherein a restrictor is provided in the return port to restrict the area thereof a predetermined amount.

3. In a fuel pump as defined in claim 2 wherein valve means normally substantially closing the bypass conduit is provided, said valve means being movable to open position in response to fuel pressure in the chamber to thereby permit fuel to pass through the bypass conduit.

4. In a fuel pump for an internal combustion engine and adapted for vertical and horizontal mounting, the combination of a housing provided with a chamber having inlet and return ports adapted to be connected to a fuel supply tank, said chamber further having a plurality of discharge ports to be respectively connected to a plurality of cylinders of the engine, a fuel distributor in the chamber having means for communicating with said inlet and discharge ports, a bypass outlet port in the housing opening into said chamber and being spaced substantially below said return port when the pump is mounted either vertically or horizontally, a conduit establishing communication between said inlet and bypass outlet ports to thereby recirculate fuel in the chamber and to bypass the return port, and a normally closed valve means in said conduit having a valve member movable in response to pressure in said chamber to open position, said valve means including a bleed passage establishing restricted communication across the valve means when the valve member is in a seated position.

5. In a fuel pump for an internal combustion engine and adapted for horizontally mounting the combination of a housing provided with a chamber having inlet and return ports to be connected to a fuel supply tank, said chamber further having a plurality of discharge ports to be respectively connected to a plurality of cylinders of the engine, a rotary fuel distributor and a coaxial low pressure transfer pump disposed in the chamber for delivering fuel from said inlet port to said discharge ports, a bypass port in the housing opening into said chamber positioned substantially at the horizontal plane through the axis of the transfer pump, and a conduit establishing communication between said inlet and bypass ports to recirculate fuel through the chamber and to bypass the return port.

6. In a fuel pump for an internal combustion engine and adapted for horizontal and vertical mounting, the combination of a housing provided with a chamber having inlet and return ports to be connected to a fuel supply tank, said chamber further having a plurality of discharge ports to be respectively connected to a plurality of cylinders in the engine, a rotary fuel distributor in the chamber having means for communicating with said discharge ports, means including a metering valve in the chamber for regulating the flow of fuel from said inlet port to said fuel distributor means, a governor including a plurality of fly weights mounted in the chamber for controlling actuation of said metering valve, a bypass outlet port in the housing opening into said chamber at a location below said return port when the pump is mounted either vertically or horizontally, and an external conduit establishing communication between said inlet and bypass outlet ports to recirculate fuel through the chamber and to bypass the return port.

7. In a fuel pump for an internal combustion engine suitable for horizontal mounting, the combination of a housing provided with a chamber having inlet and return ports to be connected to a fuel supply tank and further having a plurality of discharge ports to be respectively connected to a plurality of cylinders of the engine, a rotary fuel distributor disposed in the chamber having means associated therewith including a coaxial fuel supply pump and a metering valve for delivering fuel from said inlet port to said discharge ports, a governor including a plurality of fly weights mounted in the chamber to rotate with the fuel distributor, a bypass outlet in the housing opening into said chamber positioned at about the horizontal plane through the axis of said supply pump and substantially below said return port with the fuel pump mounted horizontally, and a bypass conduit establishing communication between said inlet and bypass ports to recirculate fuel through the chamber and to bypass the return port.

8. The combination as defined in claim 7 wherein a restrictor is provided in the return port and said bypass conduit includes a normally closed valve means movable to an open position in response to predetermined fuel pressure in the pump chamber.

9. The combination as defined in claim 8 wherein a bleed means is provided in the bypass conduit establishing constant restricted communication between the pump chamber and the inlet port through the bypass conduit.

10. A fuel system for internal combustion engines and the like including in combination a fuel supply tank having an inlet line and a return line, a fuel pump including a chamber having inlet and return ports respectively connected to said inlet and return lines and further having a plurality of discharge ports adapted to be connected to cylinders of the engine, a rotary fuel distributor mounted in the chamber about a vertical axis having means including a coaxial fuel supply pump for delivering fuel from said inlet port to said discharge ports, a bypass port in the pump housing opening into the chamber below said fuel supply pump and said return port, a bypass conduit connecting the bypass port with the inlet port to recirculate a substantial portion of the fuel through the chamber and to bypass the return port, and a tank of predetermined capacity in said return line positioned above the pump for replenishing the fuel in the fuel supply pump to prime the same should the fuel be siphoned therefrom when the pump is idle.

11. A fuel supply system for an internal combustion engine comprising in combination a fuel pump having a chamber provided with inlet and outlet ports, a fuel supply tank positioned at a lower lever than said fuel pump,

inlet and return lines respectively connecting the inlet and outlet ports of said pump to said supply tank, said fuel pump further providing a chamber, a rotary fuel distributor having a coaxial fuel supply pump mounted on a vertical axis within said chamber, a bypass port in the pump housing communicating with the chamber below said outlet port, an external bypass conduit connecting the bypass with the inlet port to recirculate a substantial

portion of the fuel through the chamber and to bypass the outlet port, and a tank of predetermined capacity in said inlet and return lines for replenishing the fuel in the fuel supply pump in the event that the fuel should be siphoned therefrom when the pump is idle.

No references cited.

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