July 17, 1956 E. W. CONRAD 2,755,133

VARIABLE AREA SPRAY BAR

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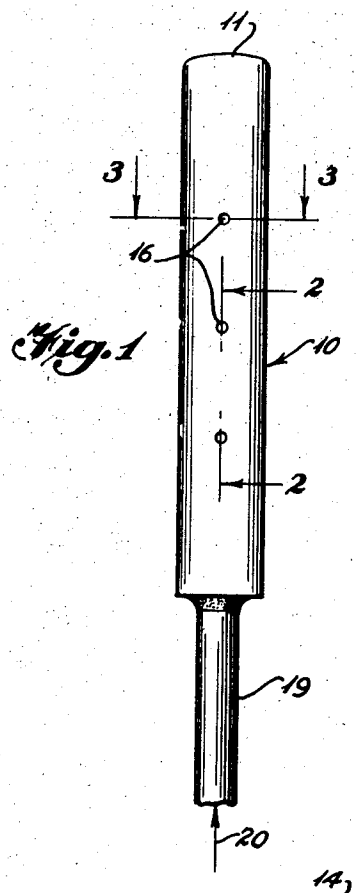


Fig. 1

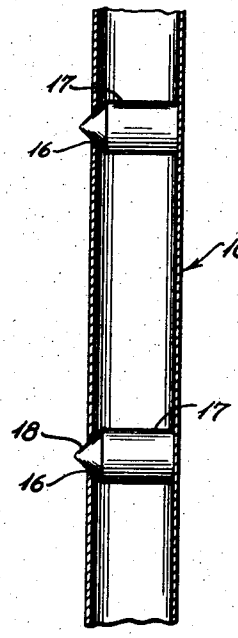


Fig. 2

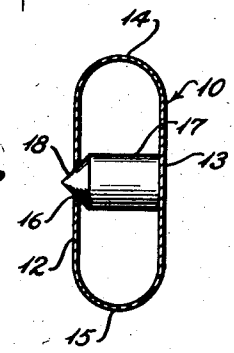


Fig. 3

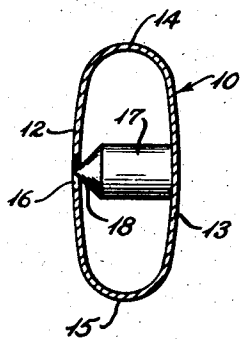


Fig. 4

INVENTOR

Earl W. Conrad

BY Walter S. Paul.

ATTORNEYS

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VARIABLE AREA SPRAY BAR

Earl W. Conrad, Berea, Ohio, assignor to the United States of America as represented by the Secretary of the Navy

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8 Claims. (Cl. 299—107.3)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a fuel spray device wherein the area of the nozzle is automatically varied as a function of fuel pressure.

Within the flight envelope of the present turbojet and ram jet engines of aircraft, ram air density variations occur on the order of 13 to 1. Operation at constant fuel-air ratio, therefore, requires a 13 to 1 variation in fuel flow. It is further understood, that in present afterburners, the maximum fuel flow is approximately 40 times greater than the minimum required fuel flow. Hence, with simple orifice spray bars, the maximum fuel pressure would be about 1600 times the minimum pressure. Inasmuch as a simple fixed orifice spray requires a pressure of approximately 15 pounds per square inch for suitable fuel spray, the use of such spray bars in afterburners would require fuel pressures varying from 15 to 24,000 pounds per square inch. Present afterburner fuel pumps operate, however, at a maximum fuel pressure of only about 300 pounds per square inch, and the fuel pressure at minimum flow is only a fraction of 1 pound per square inch. The fuel pressure at minimum flow is not adequate, therefore, for fuel spray and atomization by a fixed spray bar.

It is an object of this invention, therefore, to achieve suitable spray and atomization characteristics within present fuel pump pressure limitations for all flow rates required in jet afterburners, by producing an automatic change in effective flow area of the nozzle with changes in fuel pressure.

It is another object of this invention to provide a spray bar for afterburners which will automatically provide an extremely wide range of fuel flow nozzle areas.

Another object of this invention is to provide a spray bar with flexible walls having ports therein, and having needle valves mounted on said walls, opposite each port, whereby the effective area of the ports is varied by movement of said valves when the wall is flexed by changes in pressure.

Other and more specific objects and advantages of this invention will become apparent after a careful consideration of the following detailed description and the appended claims taken in connection with the accompanying drawings, in which:

Fig. 1 is a view showing a preferred embodiment of this invention;

Fig. 2 is an expanded cross sectional view of the invention taken through the line 2—2 in Fig. 1;

Fig. 3 is a cross sectional view of the invention taken through the line 3—3 of Fig. 1, and

Fig. 4 is a view similar to Fig. 3, showing the device under increased pressure.

Reference is now made to Figs. 1 to 4 of the drawing. The variable area spray bar, or nozzle, of this invention comprises a flattened, thin wall tube **10** having a sealed

end **11**. In cross section, as seen in Figs. 3 and 4, the tube is seen to comprise two flattened portions **12** and **13**, and curved portions **14** and **15**. The flattened portion **12** of the tube **10** is provided with a series of aligned orifices, or ports **16**, while metering pins **17**, having conical surfaces **18**, are mounted opposite said orifices **16** on the flattened portion **13**. The spray bar **10** is connected to a suitable fuel conduit **19**, through which fuel is pumped to the spray bar, as indicated by the arrow **20**, from a convenient source (not shown).

The tube **10** is constructed of a strong, thin, flexible sheet metal. A material found to be suitable for the purpose of the spray bar was found to be Inconel having a thickness of approximately twenty-thousandths of an inch. Any other material may be used, however, and for certain applications, plastic materials or rubber may be suitable.

The metering pins **17** each have a larger diameter than the orifices **16**, but the conical surfaces **18**, which extend therethrough, provide a positive seat on the inner edge of said orifices, and under conditions of no fuel pressure in the tube **10**, the orifices **16** are sealed.

As seen in Fig. 4, when the fuel pressure within the tube **10** increases, as required under operating conditions of a jet engine, the cross sectional area of the tube **11** tends to expand into the shape of a circle, and the distance between the portions **12** and **13** of the tube **10** increases. It becomes apparent, therefore, that the metering pins **17** move away from the orifices **16**, and that the effective area of the orifices, as determined by the position of the conical surface **18**, relative thereto, is increased with an increase in fuel pressure. Similarly, a reduction of fluid pressure from a given pressure level will tend to return the tube to its original shape and cross sectional area, and thus move the metering pin **17** towards the orifice **16** to reduce the effective area thereof.

Since an increase in pressure on the inner walls of a tubular member of any cross sectional configuration will tend to increase the cross sectional area thereof, and since a circle has the greatest area for any given perimeter of a geometric body, it is obvious that many configurations will be suitable for the cross sectional shape of the tube **10**. For the application of the spray bar, it is only necessary that the metering pins **17** and the orifices be orientated on a diameter which will tend to increase upon the application of an increased pressure.

It is seen that if the metering pin **17** and the orifices **16** were positioned, respectively, on the portions **14** and **15** of the tube **10**, the effective area of the orifices would decrease with an increase in pressure. This result would follow since the distance between portions **14** and **15** would decrease as the tube expanded in cross section, and the metering pins would be moved toward the orifices. This arrangement may be utilized where it is desired to maintain a substantially constant fluid flow under condition of varying fluid pressure.

The performance of the illustrated spray bar has proved successful in that satisfactory fuel spray and atomization characteristics were achieved over a wide variation of fuel pressure, and in that the variation of fuel flow with respect to pressure increase was substantially the same as the variation of fuel flow with respect to pressure decrease. The spray bar of this invention permits suitable fuel spray and atomization over a much wider range of fuel flows than is possible with any known afterburner fuel systems.

Having thus described the invention, it is apparent that many modifications and variations will become readily apparent to those skilled in the art. It is the intent, therefore, that this invention be limited only by the scope and spirit of the appended claims.

What is claimed is:

1. A variable area spray nozzle comprising a relatively thin-walled tubular member of non-circular cross section, one end of said tubular member being sealed and the other end adapted to be connected to a source of fluid under pressure, an orifice in a wall portion of said tubular member which is closer to the axis of said member than other portions thereof, a pin in said tubular member extending from a wall portion thereof opposite said first mentioned wall portion and seating in said orifice at low pressures, whereby upon a progressive increase in pressure within said tubular member said tubular member tends to become circular in cross section and said pin is progressively withdrawn from its seat.

2. The apparatus as defined in claim 1 wherein the pin has a conical end.

3. The apparatus as defined in claim 1 wherein the two wall portions mentioned are closer together than any other two wall portions.

4. The apparatus as defined in claim 3 wherein the pin has a conical end.

5. A substantially closed thin-walled tube, said tube being of non-circular cross section, means adapted to connect said tube to a source of fluid under pressure, an orifice in the wall of said tube and a pin in said tube, fixed to a wall thereof, and alined with said orifices and seated thereon, said pin and orifice being located on a minor axis of the cross section of said tube, whereby upon an increase in fluid pressure said tube will tend to become circular in cross section and said pin will be progressively withdrawn from its seat.

6. The apparatus as defined in claim 5 wherein said tube has an oval cross section.

7. The invention as defined in claim 6 wherein the end of the pin which seats on the orifice is conical.

8. The apparatus as defined in claim 5 wherein the end of the pin which seats on the orifice is conical.

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