United States Patent

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[33] **Great Britain**
[31] **36,163/67 and 41,938/67**

[54] **FLUID MIXING DEVICE**
4 Claims, 2 Drawing Figs.

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[50] **Field of Search** ..... 137/81.5, 88(Consulted)

[56] **References Cited**

UNITED STATES PATENTS

3,080,886	3/1963	Severson	137/81.5
3,122,165	2/1964	Horton	137/81.5
3,272,214	9/1966	Warren	137/81.5
3,366,130	1/1968	Reader	137/81.5

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ABSTRACT: A fluid-mixing device comprises two inlet channels, one for each of the fluids to be mixed, converging towards an interaction zone, an outlet channel leading from the zone, and two sensing channels one on either side of the outlet channel.

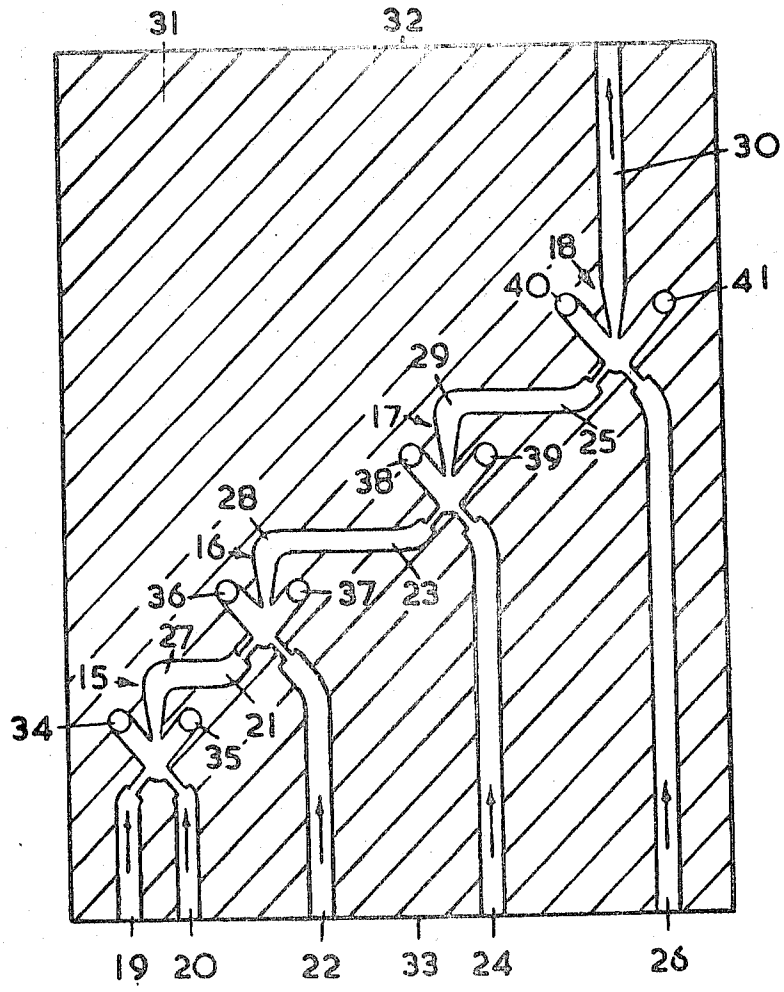


FIG.1

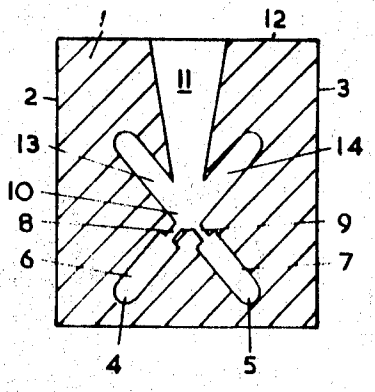
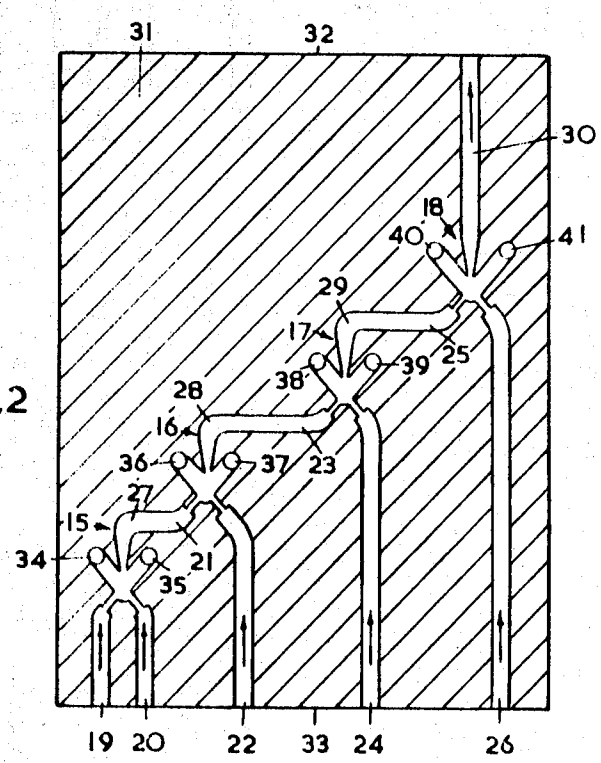


FIG.2



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FLUID MIXING DEVICE

In operation, the two fluids to be mixed are passed along separate supply lines into the inlet channels, and the mass flow rates of the two fluids are adjusted until the pressures in the sensing channels are equal. When this pressure equalisation has been attained, the fluid mixture passes out of the interaction zone through the outlet channel.

A number of these fluid mixing devices may be connected in cascade so that an inlet channel of the second device and each of the subsequent devices is coupled to the outlet channel of the immediately preceding device.

FIELD OF THE INVENTION

This invention relates to a fluid-mixing device for enabling at least two fluids from separate supplies to be mixed in a preselected mass flow ratio.

DESCRIPTION OF THE PRIOR ART

One particular application of the invention is in the mixing of gases for use in flame-cutting and gas-shielded electric arc welding. In flame-cutting processes the constituent gases have previously been mixed in the correct mass flow ratio by the operator observing the flame, and then adjusting the gas supplies accordingly. This is fairly straightforward when using an oxy-acetylene flame because the flame provides a clear visual indication when the oxygen and acetylene are present in the required ratio.

However, the flames of other gas mixtures such as oxygen-propane and oxygen-natural gas do not all provide this clear visual indication, and it is extremely difficult to obtain the required mass flow ratio by observing the flame.

SUMMARY OF THE INVENTION

The present invention aims at providing a fluid-mixing device adapted to give a simple indication of correct or incorrect mixing of the two fluids.

Accordingly the present invention provides a fluid-mixing device which, in its broadest aspect, is as defined in claim 1 of the appended claims.

Fluid mixing devices of this type will be referred to as fluid mixing devices of the type described. The pressure difference may be indicated by any suitable device such as a manometer; and the fluid mixing device may be arranged so that the pressure difference between the sensing channels is zero when the required mass flow ratio is obtained.

Accordingly the present invention also provides a plurality of fluid mixing devices of the type described connected in cascade so that an inlet channel of the second device and each of the subsequent devices is coupled to the outlet channel of the immediately preceding device.

The invention will now be particularly described with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic sectional elevation of a mixing device for two gases to be used in a flame cutting process, and

FIG. 2 is a diagrammatic sectional elevation of a cascade mixing device for mixing two fluids in a preselected mass flow ratio.

Referring to FIG. 1, the mixing device is made out of a block 1 of rectangular cross section, and the drawing is a section through the centre of the block 1 perpendicular to the sides 2 and 3 of the block.

Supply lines 4 and 5, one for each of the two gases, lead into the divergent ends of two inclined inlet channels 6 and 7; and the convergent ends of these channels communicate through nozzles 8 and 9 to an interaction zone 10. An outlet 11 extends from the zone 10 to the forward face 12 of the block 1, and two sensing channels 13 and 14 lead from the zone 10 one on either side of the outlet 11.

The two gases to be mixed are passed from the supply lines 4 and 5 respectively into the inlet channels 6 and 7, and through the nozzles 8 and 9 to interact in the zone 10. The arrangement of the various parts of the mixing device are such that when the mass flow rates of the two gases are in the required ratio, the mixed gases pass out of the zone through the outlet 11, and the static pressures in the channels 13 and 14 are equal. If the mass flow ratio of the two gases deviates from the required value then the output jet of the mixed gases is deflected to one side of the zone 10, and the pressure rises in the sensing channel on that particular side.

The outlets from the channels 13 and 14 are connected to any suitable pressure difference measuring device, such as a manometer, and the operator adjusts the flow in the supply lines 4 and 5 to bring the differential pressure reading of the manometer to zero. This is a simple method of maintaining a gas mixture of a required constituency which is independent of the visual appearance of the mixture flame.

If it is desired to mix two gases in a very large mass flow ratio such as for example 100:2 the problem arises that firstly, there is a lower limit to the physical size of the smaller nozzle, and secondly, with two gas streams differing in magnitude by a large amount the smaller stream tends to be swamped by the larger. These measuring devices operate most accurately when the mass flow ratio has a value in the range from 1:1 to 1:10 which is regarded as a low mass flow ratio.

One way of solving this problem is to modify the mixing device by having a shunt line flowing from the larger supply line to its appropriate inlet channel; this shunt line being arranged to take 2 percent of the larger constituent gas. This 2 percent is then mixed with the smaller constituent gas to provide a 1:1 mass flow ratio which is indicated by the pressure difference measuring device, and the mixed gases are then directed to join the larger supply line downstream from the mixing device. In this way a 100:2 mass flow ratio is obtained although the actual ratio to be measured is 1:1 thereby enabling an accurate pressure differential reading to be obtained.

The mixing device may be made of any suitable material such as metal, epoxy resin, ceramic or plastic.

The supply lines 4 and 5, and the outlets from the channels 13 and 14 may be passed through the block 1 at right angles to the inlet channels 6 and 7, and the channels 13 and 14 respectively.

Referring to FIG. 2, fluid mixing devices 15, 16, 17 and 18 of the type described have inlet channels 19 and 20, 21 and 22, 23 and 24, and 25 and 26 respectively. These mixing devices have outlet channels 27, 28, 29, and 30 respectively which are arranged so that the outlet channels 27, 28 and 29 are coupled to the inlet channels 21, 23 and 25 respectively. The mixing devices are made out of a block 31 of rectangular cross section, and the drawing shows a section through the centre of the block 31 parallel to the major faces of the block. The outlet channel 30 extends to the side 32, and the inlet channels 19, 20, 22, 24 and 26 extend to the side 33.

The mixing devices have sensing channels 34, 35, 36, 37, 38, 39, 40 and 41 and the outlets from the sensing channels in any one fluid mixing device are connected to any suitable pressure difference measuring device, such as a manometer.

The operation of this device is basically similar to the operation of the fluid mixing device illustrated in FIG. 1. The operator adjusts the flow into both inlet channels of the first mixing device to bring the differential pressure reading of the appropriate manometer to zero. Thereafter he adjusts the flow into only that inlet channel of each succeeding device which is not connected to the outlet channel of the preceding device.

A cascade mixing device such as this has certain important advantages. For example, it is particularly suitable for carrying out the continuous mixing of fluids in preselected mass flow ratios. When carrying out continuous mixing it was previously necessary to have flow meters in each fluid line, and the accurate determination of the mixture constituency was determined by the accuracy of each of these meters. The meters are frequently sensitive to pressure and temperature fluctuations, particularly when mixing gases, and the appropriate corrections have to be made from these fluctuations. With this invention it is only necessary to have one flow meter in either one of the inlet channels 19 and 20 to give the correct flow

reading in that channel. Thereafter the mass flow rates in the other inlet channels **22**, **24** and **26** are adjusted in that sequence using the respective manometers for indicating when balancing has been achieved, to provide a fluid mixture of the required composition in the outlet channel **30**. The composition of the final mixture is determined by mass flow ratios of all the stages, which are calibrated beforehand.

Another advantage of this cascade configuration is that it enables a large mass flow ratio to be obtained with a high degree of accuracy. Normally if it is desired to mix fluids in a large mass flow ratio the problem arises that it is extremely difficult to produce a pressure difference measuring device which reads accurately at these large ratios. These measuring devices operate most accurately when the mass flow ratio is small, such as for example 1:1. In our arrangement a large mass flow ratio can be produced by using several fluid mixing devices in cascade, with each device operating at a small mass flow ratio. For example in the illustrated device suppose each fluid mixing device had a mass flow ratio of 1:1. Then it would be seen that the ratios in the outlet channels **27**, **28**, **29** and **30** are 1:1, 1:3, 1:7 and 1:15 respectively. To take the most general case, the final ratio will be given by the expression $(R_1 + 1)(R_2 + 1)(R_n + 1) - 1:1$ where R_1, R_2 ... R_n are the mass flow ratios of successive mixing stages. In this way a very large mass flow ratio may be accurately obtained although the actual ratio being measured in each stage is small, thereby enabling an accurate differential pressure reading to be obtained.

In the illustrated example one fluid is fed into inlets **19** and **20**, and the other fluid is fed into all the other inlets, so that the first fluid is successively diluted as it passes through the various stages.

Another advantage of this cascade configuration is that any suitable combination of fluids can be mixed by feeding in each fluid at the appropriate inlet. The resulting product will be thoroughly mixed because the process is one of successive dilution and mixing.

Although the device as illustrated is formed in one block, it would be quite simple to use separate plug-in elements so that as many extra stages can be added as required to give the desired dilution.

I claim:

1. A fluid-mixing device for mixing fluids in a predetermined ratio comprising at least two inlet channels, one for each of the fluids to be mixed, arranged to direct jets of fluid which impinge on each other to form a combined jet of which the direction of flow is a function of properties of the constituent jets, and which is adapted to flow towards an outlet channel, the respective positions and flow capacities of the inlet channels and outlet channel being so configured that essentially all flow of the combined jet will pass through and essentially along the axis of the outlet channel when the predetermined ratio is present, two sensing channels located one on each side of the axis of the outlet channel so that the differential pressure between the two sensing channels is dependent upon the divergence if any between the direction of flow of the combined jet and the axis of the outlet channel.

2. A fluid-mixing device according to claim **1** in which the pressure difference between the sensing channels is substantially zero when the required mass flow ratio is obtained.

3. A fluid-mixing device according to claim **1** including means for directing a fraction of one of the fluids to be mixed to its appropriate inlet channel, the fraction being chosen to provide a low mass flow ratio in the inlet channels.

4. A plurality of fluid-mixing devices according to claim **1** connected in cascade so that an inlet channel of the second device and each subsequent device is coupled to the outlet channel of the immediately preceding device.