April 23, 1940. W. J. JACOBSSON 2,198,341

BLOWPIPE

Filed April 17, 1937

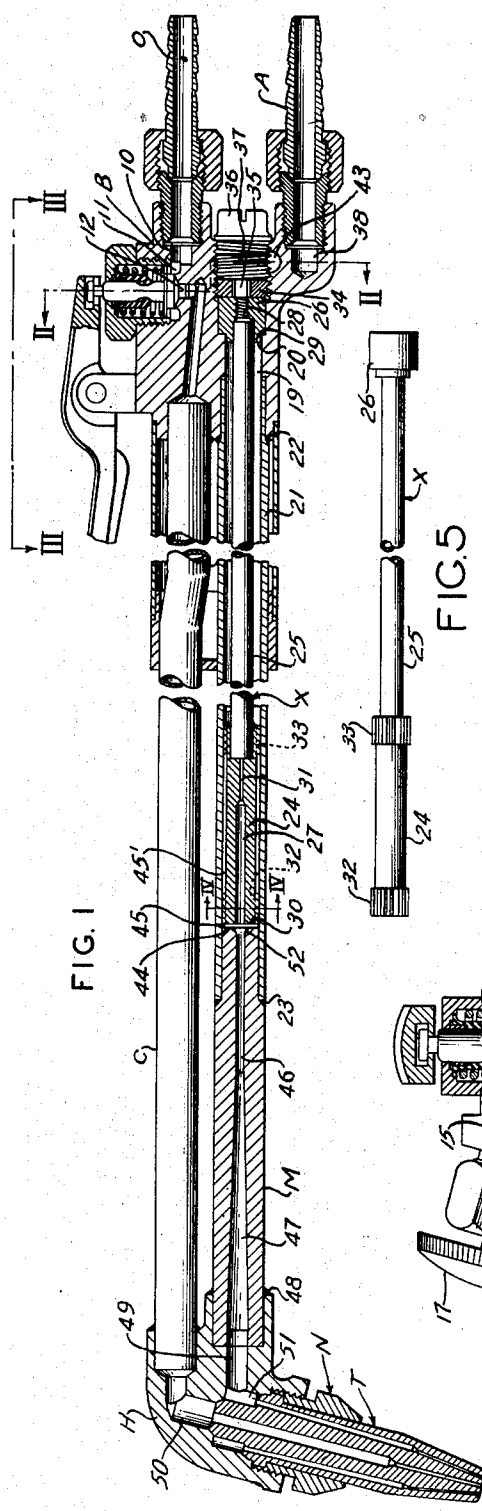


FIG. 1

FIG. 5

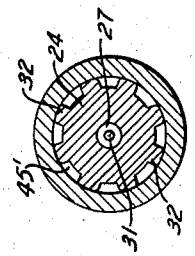


FIG. 4

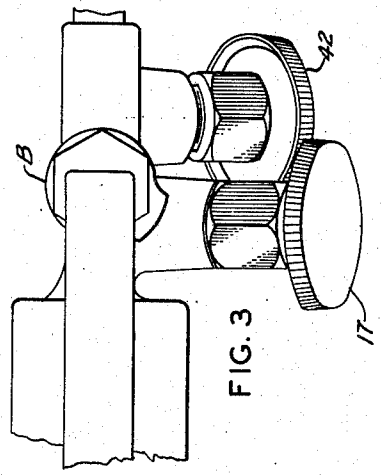


FIG. 3

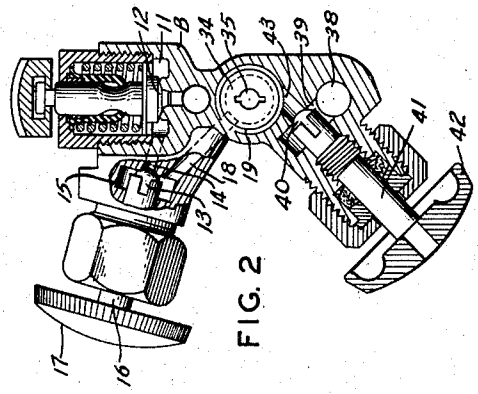


FIG. 2

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BLOWPIPE

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Application April 17, 1937, Serial No. 137,419

13 Claims. (Cl. 158—27.4)

This invention relates to a blowpipe, and more particularly to a blow pipe which is adapted to use medium pressure fuel gas efficiently and without danger of flashbacks.

This invention is closely related to the invention disclosed and claimed in the copending joint application of the present inventor and Samuel R. Oldham, Serial No. 137,420 for Blowpipe, filed April 17, 1937.

A flashback is a recession of the flame inside the blowpipe where it continues to burn. If the rate at which the gas mixture leaves the blowpipe tip always exceeds the rate of propagation of the flame, flashbacks will not occur. It is accordingly important to maintain a rate of mixed gas travel at the blowpipe tip which is greater than that of the flame propagation. With fuel gas at moderate or low pressures and combustion-supporting gas at high pressure, it is customary to use the pressure of the combustion-supporting gas to aspirate the fuel gas, to effect the mixing, and also to impart to the mixture the necessary rate of travel. With fuel gas and combustion-supporting gas at more nearly the same pressure, aspiration, mixing, and mixture speed are not so effectively attained by means of the combustion-supporting gas pressure.

One object of the invention is therefore to provide a blowpipe wherein effective mixing and the required rate of mixture travel can be attained without aspirating one gas by means of the other. Another object is the provision of such a blowpipe which will be flashback-resistant. A further object is the provision of such a blowpipe in simple, rugged, and easily maintained form.

Other objects and novel features of the invention will be apparent from the following description taken with the accompanying drawing, in which:

Fig. 1 is a view partly in longitudinal section and partly in side elevation, showing a blowpipe constructed in accordance with the invention;

Fig. 2 is a cross section of the blowpipe taken on the line II—II of Fig. 1;

Fig. 3 is a fragmental plan view of the blowpipe as seen from the line III—III in Fig. 1;

Fig. 4 is a cross section of a part of the blowpipe taken on the line IV—IV of Fig. 1; and

Fig. 5 is a side elevation of the nozzle assembly of the blowpipe.

According to the present invention, a blowpipe is provided having an improved preheat gas mixing assembly whereby flashbacks are prevented. The preheat gas mixing assembly includes a unitary nozzle assembly comprising a nozzle, an elongated conduit, and a rear block, all rigidly connected together in coaxial series alignment and disposed in an elongated cavity within the blowpipe to provide a mixing gap, two concentric gas passages back of the nozzle and a metering constriction in each gas passage near the mixing gap. An especially designed mixing throat and expansion passage are also provided.

For convenience, the words "oxygen" and "acetylene" will be used in this specification to denote respectively any appropriate cutting and combustion-supporting gas and any appropriate fuel gas.

The embodiment of the invention which is illustrated in the drawing shows a cutting blowpipe having inlet means for oxygen and acetylene and outlet means for a combustible mixture of oxygen and acetylene. The blowpipe comprises a head H and a valve block B, which are connected together by a cutting oxygen tube C, and by a combustible mixture conduit M and an elongated tube 21. Nipples O and A supply the valve block B with oxygen and acetylene respectively. A hollow nut N attaches the usual cutting tip T to the blowpipe head H in well-known manner.

Oxygen, entering the blowpipe through the nipple O, flows through a passage 10 to an annular valve chamber 11 in the valve block B. Passage of oxygen from the annular chamber 11 to the cutting oxygen tube C is regulated by a valve 12 which may be operated by any known or convenient valve operating construction: for instance, a lever-opened, spring-closed mechanism such as that illustrated. Passage of oxygen from the chamber 11 to the combustible mixture conduit M is regulated by a valve 13.

A duct 14 in the valve block B connects the annular chamber 11 with a valve chamber 15 in which the valve 13 is operated by a valve stem 16 and a handle 17 thereon. Combustion-supporting oxygen may accordingly be prevented from entering the valve chamber 15 by closing the valve 13 against the valve seat provided by the end of the duct 14, whereas opening the valve 13 will permit combustion-supporting oxygen to enter the valve chamber 15. A cross passage 18 connects the valve chamber 15 with a bore 19 in the valve block B ahead of an annular shoulder 20 therein, the purpose of which will be explained later.

The bore 19 extends completely through the valve block B and the opening therethrough continues forwardly through a tube or large conduit 21 which is gas-tightly connected to the valve block as by silver-soldering at 22. This conduit

extends forwardly to the mixture conduit M (later to be described) to which its forward end is gas-tightly connected as by silver-soldering at 23. Thus, the bore 19 in the valve block and the large conduit 21 together form an elongated cavity extending continuously through the valve block B and forwardly to the mixture conduit M. This elongated cavity is adapted to contain a large volume of oxygen which acts to inhibit flashbacks by extinguishing backfires.

The nozzle assembly X is concentrically disposed within the elongated cavity. It comprises a nozzle 24, an elongated conduit 25, and a rear block 26, all rigidly connected together in coaxial series alignment and removably disposed in the elongated cavity. A longitudinal passage 27 extends substantially axially through the nozzle 24, and a longitudinal passage 28 extends substantially axially through the rear block 26, each passage being a continuation of the passage through the conduit 25. An annular shoulder 29, formed on the rear block 26 adjacent its forward end, contacts the internal shoulder 20 of the bore 19 and thereby limits the axial position of the unitary assembly within the elongated cavity and also positions the nozzle 24 axially of the elongated cavity. Contact between the annular shoulders 20 and 29 seals the continuous passage through the nozzle assembly from the annular passage between the elongated conduit 25 and the elongated cavity ahead of the rear block 26 and prevents passage of gas from the elongated cavity on one side of the rear block to the other, except through the passage 28.

The passage 28 through the rear block 26 is internally threaded in order that an instrument may be inserted therein for withdrawing the unitary assembly from the elongated cavity. An ordinary long machine screw will serve for this purpose.

The nozzle 24 is long and may be substantially cylindrical in form, but is relatively short as compared to the lengths of the elongated cavity and the elongated conduit 25. The major portion of its forward end is a plane surface transverse to the axis of the nozzle. In the embodiment here particularly illustrated and described, the nozzle 24 has a plane forward end 30 standing substantially perpendicular to or at right angles to its axis. The passage 27 therethrough is long and may be constricted for a short distance, as at 31, to provide a metering orifice. Although the nozzle 24 has a substantially uniform external diameter throughout most of its length, a series of radial projections 32 adjacent its forward end and a second series of radial projections 33 adjacent its rear end contact the inner wall of the large conduit 21, thereby spacing the nozzle with its external peripheral surface a uniform distance from the conduit and centering it therein to provide a continuous gas passage of substantially uniform cross-sectional area extending along the outside of and along the full length of said nozzle. The rear block 26 being designed to fit exactly within the bore 19, the entire nozzle assembly is thus accurately centered in the elongated cavity.

Since the nozzle assembly is positioned within the blowpipe by being slidably inserted into the elongated cavity from the rear, it is obvious that the bore 19 in the valve block B must be of a size to permit passage of the nozzle therethrough. It is also obvious that the reduction in diameter occasioned by the formation of the annular shoulder 20 in the bore 19 must be sufficient to prevent passage of the rear block 26.

The bore 19 in the valve block B is internally threaded at its rear end, and a locking screw 34 may be screwed into the bore to bear upon the rear face of the rear block 26 and thus lock the unitary assembly in place. The locking screw has a central passage 35 therethrough resembling a keyhole, through which gas may pass to the passage 28 in the rear block, and into which a tool may be inserted to turn the locking screw in the internal threads of the bore.

A threaded plug 36 having an external kerf in its head is screwed into the end of the bore 19 in the valve block B to close the bore. The length of the bore is such as to provide a space between the end of the threaded stem portion of the plug 36 and the locking screw 34 when both are in operative position. Thus a chamber 37 is formed in the bore 19 between the locking screw and the plug.

The means including the cross passage 18 by which oxygen is conveyed to the annular passage between the elongated conduit 25 and the large conduit 21 has already been described.

Acetylene, entering the blowpipe through the nipple A, flows through an acetylene passage 38 in the valve block B to an acetylene valve chamber 39 in which a valve 40 on a valve stem 41 is operated by a handle 42. The valve 40 controls passage of acetylene from the valve chamber 39 through a passage 43 leading therefrom to the chamber 37 in the valve block. Thus, by opening the valve 40 acetylene is free to flow from the valve chamber through the passage 43 into the chamber 37 and thence through the central passage 35 in the locking screw 34, through the passage 28 in the rear block, and through the elongated conduit 25 to the nozzle 24.

From the foregoing, it will be clear that, when the nozzle assembly X is in place and the threaded plug screwed into the end of the bore 19, there are two long concentric gas supply passages in the blowpipe back of the mixing point. One comprises the chamber 37 and the axial passage through the nozzle assembly X, namely: the central passage 35 in the locking screw, the passage 28 in the rear block, the elongated conduit 25, and the passage 27 in the nozzle, including the metering orifice 31. The other comprises the space between the nozzle assembly and the elongated cavity in the blowpipe, namely: the annular space between the elongated conduit 25 and the inner wall of the large conduit 21, and the space surrounding the nozzle. Both gas supply passages are long, have large capacity, and are adapted to contain a large volume of gas. Both gas supply passages provide a resilient cushion behind the mixing point because their dimensions are so large relative to the restricted passages through valves 13 and 40, when open, that the effect when a backfire occurs is a retardation of the explosion wave due to the inertia of the large volumes of gases in the gas supply passages, which resist passage backward through the valves, and hence act as pneumatic cushions to drive the backfiring gases forward again after extinguishment.

When the nozzle 24 is in place, the plane face 30 at its forward or discharge end is spaced a very short distance from the rear end of the mixture conduit M which has a corresponding plane face 44 which also serves as the front face of a gap 45 which is thus formed between the parallel faces 30 and 44. The width of the gap 45 is quite small.

In some instances, it is only 1/64 of an inch, or less. The gap 45 therefore forms a metering constriction in the oxygen line between the mixing point and the cushion in the oxygen supply line which is provided by the large volume of oxygen contained in the space between the large conduit 21 and the elongated conduit 25.

Under certain conditions it is found desirable to provide the metering constriction in the oxygen supply line between the mixing point and the cushion by narrowing the clearance between the nozzle and the wall of the large conduit 21. Such a constriction is illustrated at 45' and extends the entire length of the nozzle 24. The width of the gap 45 need not then be so small, since the clearance which has just been described becomes the critical constriction.

Passage of the proper quantities of acetylene and oxygen, respectively, to the blowpipe tip is assured by the metering orifice 31 in the nozzle, and by the metering constrictions 45 or 45', described above. With such properly proportioned metering constrictions, no greater volumes of gas can be supplied to the blowpipe tip than the blowpipe is designed to burn efficiently and without flashbacks. Although the passages through and along the outside of the nozzle are constricted for gas measuring purposes, they are not constricted to such an extent as to prevent the free flow of gas and the free rearward passage of backfires therethrough.

An axial mixing throat 46 extends from the rear face 44 of the mixture conduit M forwardly to the entrance of an axial expansion passage 47 which diverges at a small angle until it reaches the forward end of the mixture conduit. The latter is attached to the blowpipe head H, as by silver-soldering at 48, and a short passage 49 in the head connects the end of the expansion passage 47 to a tip cavity 50 in the head at a point 51 therein from which the combustible gas mixture may pass conveniently through the tip T. Thus the mixing throat 46 extends in continuation of the axial passage 27 in the nozzle; and its diameter may be substantially the same as that of the passage 27. Under certain conditions, it may be of advantage to make the diameter of the mixing throat 46 smaller or larger than that of the passage 27. The rear end of the mixing throat 46 may be flared or beveled, as indicated at 52, and is positioned directly opposite to the open end of the passage 27 in the nozzle 24.

Acetylene passing forwardly through the passage 27 is projected axially across the gap 45 toward the mixing throat. At the same time oxygen passes inwardly of the gap, thus moving toward the column of acetylene at right angles thereto from all sides before the acetylene reaches the mixing throat. There is substantially no injector action, but it is found that very effective mixing takes place when one gas moves through a narrow gap toward a column of the other gas at right angles thereto and on all sides thereof. Furthermore, it is not required that either gas be at a higher pressure than the other, and it is quite possible that both gases may mix effectively when they are at substantially the same pressure.

Blowpipes constructed in accordance with the invention produce an exceedingly steady flame. Should a backfire occur it will first enter the mixture conduit M, which is formed of a metal having high heat conductivity and which has exceedingly thick walls. The mixture conduit will therefore extract and dissipate much of the backfire heat quite rapidly. The danger that this part may be damaged or burnt out is accordingly minimized. Next the backfire must pass through a constriction in either gas line, such as the metering orifice 31 in the fuel gas line, or the constriction provided by the gap 45 or the space 45' between the nozzle and the large conduit. The cushioning effect of the large volumes of gas in each supply line back of the nozzle tends to drive the backfire forwardly of the blowpipe again. When a backfire passes the metering constriction provided by gap 45 or space 45' and enters the voluminous annular oxygen chamber, the backfiring gases are immediately burned in the large excess of oxygen and fail to become a flashback. Similarly, if any backfiring gas passes the metering constriction in the fuel gas line, it is smothered by the fuel gas in the elongated conduit 25.

The cutting oxygen valve 12 is made in conical form in order that it will necessarily open gradually and facilitate operation of the blowpipe in starting a cut.

From the foregoing, it will be apparent that a simple, rugged, and easily maintained blowpipe has been provided in which thorough mixing is effected without aspiration and in which flashback resistance is effectively maintained.

The form of the invention here described and illustrated in the accompanying drawing is disclosed merely to indicate how the invention may be applied. Other forms, differing in detail but not in principle from that here shown and described, will, of course, suggest themselves to those skilled in the art.

I claim:

1. In a medium pressure blowpipe, a mixture conduit having therein a mixing throat and a passage in continuation of the mixing throat, said mixture conduit having a plane surface perpendicular to the mixing throat at its rear end; a valve block having an opening therein; and a tube gas-tightly sealed about the end of the mixing throat in said mixture conduit and about the end of the opening in said valve block, said tube having a combustion-supporting gas passage therein; in combination with a unitary assembly comprising a nozzle having a uniform external diameter throughout substantially its entire length, an elongated conduit, and a rear block, all rigidly connected together in coaxial series alignment, said nozzle and said rear block having fuel gas passages therethrough in continuation of the passage through said conduit, said nozzle also having a plane forward end disposed at right angles to the axis of the passage therethrough; means for spacing said nozzle from the end of the mixing throat; and means for spacing said conduit and said nozzle from said tube to provide two long gas chambers behind the nozzle and to provide continuous gas-passage means of substantially uniform cross-sectional area extending along the outside of and along the full length of said nozzle to permit the free passage of backfires into the annular chamber surrounding said elongated conduit and within said tube.

2. A blowpipe having an elongated cavity therein forming a combustion-supporting gas passage and a combustible gas mixture passage ahead of said combustion-supporting gas passage, said mixture passage having a plane rear end substantially perpendicular to the axis thereof, in combination with an elongated conduit disposed substantially coaxially within the elongated cav-

ity forming a fuel gas passage, and a nozzle comprising a cylinder attached to the forward end of said elongated conduit within the elongated cavity in said blowpipe, said cylinder having a longitudinal passage therethrough in continuation of the passage through said elongated conduit, said cylinder also having a forward face substantially perpendicular to the passage therethrough and spaced from the rear end of said mixture conduit to provide a mixing gap, said cylinder likewise having about its periphery adjoining each end thereof a plurality of radial projections for contact with the interior wall of the elongated cavity in said blowpipe to position said nozzle within the elongated cavity, and said cylinder having a uniform external diameter throughout substantially its entire length.

3. In a blowpipe, in combination, a valve block; a head; and a tip carried by said head; means providing an elongated gas passage interposed between said valve block and said head, a forward portion of said gas passage comprising a gas mixture conduit having therein an axial mixing throat and an axial expansion throat in continuation of said mixing throat, and a rear portion of said gas passage comprising a combustion-supporting gas conduit; a nozzle disposed within said elongated gas passage behind said mixing throat, said nozzle having a longitudinal fuel gas passage extending completely therethrough and a plane forward end disposed at right angles to the axis of said fuel gas passage, said nozzle having a substantially uniform external diameter throughout its length, and the external wall of said nozzle being spaced from the internal wall of said elongated gas passage to permit the flow of gas along the outside of said nozzle, and the free passage of backfires along the outside of said nozzle into a backfire extinguishing chamber in back of said nozzle; and means for spacing the forward end of said nozzle and the rear end of said mixture conduit in close juxtaposition.

4. In a blowpipe including a tube; a nozzle having a uniform external diameter throughout substantially its entire length and having a longitudinal fuel gas passage therethrough and a plane forward end disposed at right angles to the ax's of the longitudinal passage, the external peripheral surface of said nozzle and the internal wall of said tube being adapted to provide, when said nozzle is disposed within said tube in spaced relation to the internal wall thereof, continuous combustion-supporting gas-passage means of substantially uniform cross-sectional area extending along the outside of and along the full length of said nozzle whereby backfires may pass freely along the outside of said nozzle; in combination with a mixture conduit in spaced, coaxial relation with said nozzle, said mixture conduit havi g therein a mixing throat and an expansion throat therebeyond.

5. For use with a blowpipe having an elongated cavity therein, a unitary assembly comprising a nozzle having a uniform external diameter throughout substantially its entire length, an elongated conduit, and a rear block, all rigidly connected together in coaxial series alignment, said nozzle and said rear block having longitudinal passages therethrough in continuation of the passage through said conduit, and said nozzle having a plane forward end substantially perpendicular to the axis of the longitudinal passage therethrough, said nozzle also having radial projections on its peripheral surface adjoining each end thereof.

6. In a medium pressure blowpipe, in combination, a valve block; a head; and a tip carried by said head; an elongated gas conduit interposed between said valve block and said head, a forward portion of said gas conduit comprising a heavy walled combustible gas mixture conduit comprising a metal of high heat conductivity, and a rear portion of said gas passage being adapted to hold a large volume of combustion-supporting gas; a nozzle of less length than the rear portion of said gas conduit disposed therein to provide an elongated chamber in the rear thereof, said nozzle having a uniform external diameter throughout substantially its entire length and being uniformly spaced from the internal wall of said gas condiut to provide a combustion-supporting gas passage along the outside of and along the full length of said nozzle adapted to permit free passage of backfires into said chamber, and said nozzle having a longitudinal fuel gas passage therethrough and a plane front face substantially perpendicular to said fuel gas passage spaced a predetermined distance from the rear end of said mixture conduit; means for supplying a fuel gas to said nozzle passage; and means for supplying a combustion-supporting gas to the rear portion of said elongated gas passage behind said nozzle.

7. A medium pressure blowpipe having an elongated cavity therein, in combination with a nozzle disposed in said cavity in uniformly spaced relation to the internal walls thereof, said nozzle having a substantially longitudinal passage therethrough and a plane front face substantially perpendicular to the axis of such passage, and having a uniform external diameter throughout substantially its entire length, said nozzle having a length less than the length of said cavity and being so disposed therein as to provide a voluminous chamber in the rear of said nozzle adapted to contain a volume of gas to extinguish backfires, and the space surrounding said nozzle between the external wall thereof and the internal wall of said cavity being adapted to permit the free passage of backfires therethrough; means for supplying a combustion-supporting gas to said elongated cavity, said means being restricted relative to said cavity; and means for supplying a fuel gas to such nozzle passage.

8. A blowpipe having an elongated cavity therein forming a combustion-supporting gas passage and a combustible gas mixture passage ahead of said combustion-supporting gas passage, said mixture passage having a plane rear end perpendicular to the axis thereof, in combination with a unitary assembly disposed in said cavity, said assembly comprising a nozzle, an elongated conduit, and a rear block, all rigidly connected together in coaxial series alignment, said nozzle and said rear block having fuel gas passages therethrough in continuation of the passage through said conduit, said nozzle having a plane front face substantially perpendicular to the passage therethrough spaced from the rear end of said mixture conduit to provide a mixing gap, said nozzle having a uniform external diameter throughout substantially its entire length, and said nozzle having a length less than the length of said cavity and of said elongated conduit and being uniformly spaced from the internal wall of said cavity to permit the free passage of backfires along the outside of said nozzle, the space in the rear of said nozzle surrounding said elongated conduit and within said cavity, and the

passage through said elongated conduit, being adapted to contain large volumes of gas to extinguish backfires.

9. In a blowpipe: the combination of a voluminous elongated oxygen conduit; a combustible gas mixture conduit ahead of said oxygen conduit; a nozzle having a uniform diameter throughout substantially its entire length disposed within said oxygen conduit, said nozzle having a fuel gas passage therethrough, and said nozzle having radial projections adjoining each end thereof adapted to contact the inner wall of said oxygen conduit; said nozzle having a length less than the length of said oxygen conduit and being spaced from the internal wall thereof and from the rear end of said mixture conduit sufficiently to permit the passage of a backfire along the outside of said nozzle, but being so disposed in said oxygen conduit as to provide a voluminous chamber in the rear of said nozzle adapted to contain a volume of oxygen for instantaneously completing the combustion of backfiring gases; means for supplying oxygen to said elongated oxygen conduit; and means for supplying a fuel gas to said nozzle passage.

10. In a blowpipe having a cavity, inlet means for oxygen and fuel gas, and discharge means for a combustible mixture of said oxygen and said fuel gas, the combination comprising a mixer nozzle having a uniform diameter throughout substantially its entire length disposed within said cavity in said blowpipe providing an oxygen conducting passage extending between the external periphery of said nozzle and the inner wall of said cavity, said passage being adapted to permit backfires to pass freely therethrough the full length of said nozzle; means providing a passage for conducting fuel gas longitudinally through said nozzle; said blowpipe being provided with a mixing gap adjacent to the discharge end of said nozzle for receiving and mixing said oxygen and said fuel gas; and backfire extinguishing means comprising a large-volume chamber communicating with said oxygen conducting passage, said chamber being adapted to contain a relatively large volume of oxygen to extinguish backfires which enter therein from said oxygen conducting passage.

11. In a medium pressure blowpipe having a cavity, inlet means for oxygen and fuel gas, and discharge means for a combustible mixture of said oxygen and said fuel gas, the combination comprising a mixer nozzle disposed within said cavity in said blowpipe, said nozzle having a discharge end and a flat front face at said discharge end substantially perpendicular to the axis of said nozzle, and said nozzle having a uniform external diameter throughout substantially its entire length; means providing an oxygen conducting passage extending the full length of said nozzle between the external periphery thereof and the inner wall of said cavity, said passage being adapted to permit backfires to enter freely therein; means providing a passage for conducting fuel gas longitudinally through said nozzle; a plurality of radial projections adjoining each end of said nozzle adapted to contact the inner wall of said cavity; said blowpipe being provided with a mixing gap adjacent the discharge end of said nozzle for receiving and mixing said oxygen and said fuel gas, the front wall of said gap being substantially flat and parallel to said nozzle front face; and backfire extinguishing means comprising a large volume chamber communicating with said oxygen conducting passage, said chamber being adapted to contain a relatively large volume of oxygen to extinguish backfires which enter therein from said oxygen conducting passage.

12. In a blowpipe: the combination of a voluminous combustion-supporting gas conduit; a combustible gas mixture conduit ahead of said combustion-supporting gas conduit and aligned therewith, the rear end of said mixture conduit comprising a plane surface perpendicular to the longitudinal axis thereof; a mixing nozzle having a uniform external diameter throughout substantially its entire length and having a longitudinal fuel gas passage therethrough, disposed in said combustion-supporting gas passage adjoining the forward end thereof, said nozzle having a plurality of radial projections on its periphery adjoining each end thereof contacting the internal wall of said combustion-supporting gas conduit whereby the external surface of said nozzle and the internal wall of said combustion-supporting gas conduit are uniformly spaced from one another to provide a continuous free passage for the straight line flow of backfires along the outside of and along the full length of said nozzle, the forward end of said nozzle comprising a plane surface perpendicular to the longitudinal axis thereof and spaced slightly from the rear end of said mixture conduit to provide a mixing gap.

13. A blowpipe having a tubular cavity therein; a conduit in said cavity with its external wall spaced from the internal wall of said cavity; a mixing nozzle carried by said conduit on the forward end thereof, the external side wall of said nozzle being uniformly spaced from the internal wall of said cavity to provide a straight passage therebetween extending the full length of said nozzle, said nozzle having a passage therethrough in communication with said conduit; means for supplying combustion-supporting gas to the space between the external wall of said conduit and the internal wall of said cavity whereby such gas flows straight past said nozzle the full length thereof without changing direction; means for supplying fuel gas to said conduit whereby such gas flows through said nozzle passage; said nozzle having a forward end comprising a plane surface perpendicular to the direction of flow of gas within and without said nozzle; and a combustible gas mixture conduit having a rear end comprising a plane surface substantially parallel to and spaced from the forward end of said nozzle; the space between the rear end of said mixture conduit and the forward end of said nozzle, and the passage between the external side wall of said nozzle and the internal wall of said cavity being adapted to permit the free passage of backfires therethrough into the portion of said cavity behind said nozzle.

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