This invention relates to gas combustion apparatus, and as a principal object combines both entrainment means and burner means in a single device, the entrainment means providing both inspirator and mixing functions, and a substantial part of the device serving both the entrainment means as a part thereof and the burner means as a part thereof.

The entrainment device contemplated is of the general type disclosed in the copending application Serial No. 706,956, filed August 18, 1947, by the applicant herein, now Patent No. 2,524,559, and the burner means contemplated is of the type disclosed in copending application of Robert M. Buck, Serial No. 29,272, filed of even date herewith and now matured into Patent No. 2,581,975.

The structures of both said applications include sections of substantial length having annular passageways, such passageway having inspirator and mixing function in the entrainment device, and elongated port function in the burner device. A more particular object of this invention is to provide that such passageway function in the combined device of this application, as above set forth in both described devices, so that the present device will have less length than heretofore necessary in the art, and will be cheaper as well as more compact. Further, previous losses in operation will be reduced, this invention contemplated no conversion of velocity energy to pressure energy.

Another object of the invention is to obtain the above advantages, by structure which is not only simplified as described, but which is unnecessarily produced and permits easy assembly and disassembly, particularly of entrainment and burner portions as will hereinafter appear.

Further objects and advantages will be apparent from the following description and claims, taken in connection with the accompanying drawing which illustrates an embodiment of the invention, parts being broken away to show details of construction.

With reference now to the drawing, the device includes body means including, generally, entrainment and burner portions A and B respectively, and an intermediate portion generally indicated at C which functions as part of both the principal entrainment and burner portions.

The entrainment portion A has an inlet for air under pressure, and thereopposite an outlet for gas without pressure, and effectively includes the intermediate portion C of the body means which provides an elongated passage I preferably of circular section as illustrated to the upstream end of which the air and gas supplies lead.

More particularly, the effective air inlet to this passage is endwise and annular as by way of a nozzle opening at 2, and the gas inlet thereto is coaxial with the air inlet, here shown as lateral and annular as at 3. Structurally, the passage I is principally within the tube 4 which comprises the principal member of the intermediate body portion C, and is internally defined by elongated cylindrical plug means 5, having a shank portion 6 by which it is mounted on the entrainment portion A as indicated, the plug means being concentrically disposed within the tube 4 so that the passageway therethrough is effectively narrowly annular and long relative to its diameter. The relative diameters of the parts adjacent the inlet end of the passageway are such that its effective sectional area enlargement is approximately 100 per cent of the air nozzle opening, as well as abrupt as illustrated, the two openings leading to the passageway being thus substantially equal in size, with coaxial distribution, one about the other.

The plug 5 provides the inner wall of both the nozzle 2 and passage I, and being continuously cylindrical throughout their combined longitudinal extent, the air, jet, or stream as discharged from the nozzle into the passage, is unidirectional, distributed about the plug, and immediately therewith.

The gas stream induced through the opening 3, enters the passage I in annular form, externally confined by the outer wall of the passage and internally confined by the air stream.

Such arrangement effects a long conical interface between the air and the gas, as indicated by the line x—x in the drawing; the upstream extremity of such interface being determined by the outer diameter of the discharge end or mouth of the opening of the nozzle 2, and the downstream extremity of such interface being determined by the outer diameter of the passage I at the discharge end or mouth thereof.

Such interface is obviously of very substantial area, and in actual operation is not sharply defined as intermingling takes place thereof; but it is generally along and of such nature that both superior entrainment of gas in the air and complete intermixing thereof takes place, along the passage I commencing at its upstream end and being completed at its downstream end.

The proportions are such that gas flow may be induced inwardly through the opening 3 and en-
trained into an air jet emerging from the nozzle opening 2 with which it will mix as well as be inspi-
rated, along the passage with completion of sub-
stantial entrainment at the passage mouth or out-
let end. In the drawing the broken line x-x indicates generally the divergence of such jet, the passageway 1 extending from the nozzle suf-

ficiently to be engaged at its mouth, by the jet expanding in the direction of the gas inlet 3.

Further theory on the entrainment functioning may be had by reference to the above identified copending application Serial No. 768,996.

The burner portion B of the device includes a block 7 of refractory material set into a metallic base 8 therefor, by which it may be mounted in the furnace or the like to be served, as by bolts 9.

The block 7 has an enlarged elongated combustion tunnel 10 having an open downstream end and an upstream end into which the passage 1 discharges. Preferably the ports are arranged to provide within the upstream end of the tunnel, a short zone of divergence, the plug 5 having a convergent end 11 and the block 7 having diver-

gence as at 12 thereabout, immediately beyond the downstream end of the passage 1. Ignition means as indicated at 17 may be provided.

The entrainment passage 1 serves as burner port, its length and narrowness being sufficient to prevent back flash, combustion commencing at the mouth of the port, and continuing largely within and along the tunnel 10, with maximum rate and turbulence in the divergent zone adjac-

et the port 1 about the end portion 11 of the plug 5. Further theory on burner functioning in-

cluding ignition and combustion may be had by reference to the above identified copending appli-
cation Serial No. 29,272.

For operation, air under substantial pressure and fuel gas substantially without pressure, are supplied at their respective inlets to the mixing device as indicated in the drawing. In operation the long, narrow, annular passage 1 has dual function.

With respect to entrainment it provides passageway or space along and within which both inspiration of gas by the air stream, and inter-
mixing thereof is had, such entrainment com-
mencing at its upstream end, and continuing throughout its length to completion at its down-

stream or mouth end; the mixture thus produced being proportioned to provide complete and very rapid combustion of the entrained gas in its en-

training air. Because of the annular form of the entrainment passageway, maximum capacity is had, in minimum length.

With respect to burner functioning, the same passage 1 serves as port, its long, narrow, annu-

lar form providing both large capacity for direct delivery of the combustible mixture longitudi-
nally into the combustion tunnel 10 and yet preven-
ting flashback from its mouth.

Flow along the passage 1 is substantially with-

out conversion of velocity energy to pressure en-

ergy, and completion of entrainment is substanc-

ially coincident with commencement of com-

bustion.

Further, the relation of the parts being as illu-

strated and described herein, the same quality of effectively combustible mixture will be auto-

matically maintained throughout a great turn-
down range of the air supply, without flashback, and otherwise with equally efficient operation at the rate determined by the amount of air re-

ceived. The device thus serves as a proportion-

ing mixer, as well as both an inspirator and burner.

In preferred construction as illustrated, the tube C interconnects the entrainment and bur-

ner portions A and B. It has threaded engagement with the burner portion A, with knurled flange 14 both for assembly and positive definition of the gas inlet 3. It fits within the cap 6 of the burner portion B where it is secured as by a set screw 15 seating in an annular recess 16.

What is claimed is:

1. In a device of the class described for en-

trainment and mixture of gas in a high pressure air stream, and combustion of said gas in the air of said stream: body means defining, in aligned contiguous relation, an elongated combustion chamber, adjacent the downstream end of said body means, and open at said end, and passageway to the upstream end of said combustion chamber including an elongated annular por-

tion, terminating at said combustion chamber for discharge thereinto, and an annular air noz-

ze portion adjacent the upstream end of said elongated portion for discharge thereinto, said body means also providing gas inlet to said passageway adjacent said upstream end of said elongated portion, said nozzle and elongated portions being cooperative to provide said entrain-

ment and mixture, and said elongated portion be-

ing of uniform cross-sectional area to preserve velocity therealong and prevent flashback from said combustion chamber.

2. In a device of the class described, for en-

trainment and mixture of gas in a high pressure air stream, and combustion of said gas in the air of said stream: body means defining, in aligned contiguous relation, an elongated combustion chamber, adjacent the downstream end of said body means, and open at said end, and passageway to the upstream end of said combustion chamber including an elongated annular portion, terminating at said combustion chamber for discharge thereinto, and an annular air nozzle portion adjacent the upstream end of said elongat-

ed portion for discharge thereinto, said body means also providing gas inlet to said passageway adjacent said upstream end of said elongated portion, said nozzle and elongated portions being cooperative to provide said entrainment and mixture continuously along said elongated portion with completion at the downstream end thereof, and said elongated portion being of uniform cross-sectional area to preserve velocity therealong and prevent flashback from said com-

bustion chamber.

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ROBERT M. BUCK.

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