United States Patent [19]
Windelbandt

[11] **3,883,290**
[45] **May 13, 1975**

[54] **APPARATUS FOR THE PRODUCTION OF HOT GASES**

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[22] Filed: **Nov. 3, 1972**

[21] Appl. No.: **303,601**

[30] **Foreign Application Priority Data**

Nov. 11, 1971 Germany 2155055
June 27, 1972 Germany 2231345

[52] **U.S. Cl.** **431/168;** 432/222
[51] **Int. Cl.** **F23d 11/04**
[58] **Field of Search** .... 431/353, 243, 168; 432/222; 110/8 R

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[57] **ABSTRACT**

This disclosure relates to an apparatus for producing hot gases which may be advantageously utilized in the shrinking of plastic foils although it is readily useable in other environments. The apparatus utilizes a radial blower which produces an annular twisting current of air within a guide pipe with there being mounted within the interior of the air current means for supplying jets of a fuel gas and ignition means for periodically igniting the jets of fuel gas in a manner wherein ignition of the fuel gas is assured and complete combustion thereof is effected within the apparatus so that the possibility of explosions is eliminated and the hot gases discharging from the apparatus are free of flame. The flow of air currents also provides an insulating boundary layer which maintains the exterior of the apparatus at a temperature only slightly greater than ambient temperature.

12 Claims, 7 Drawing Figures

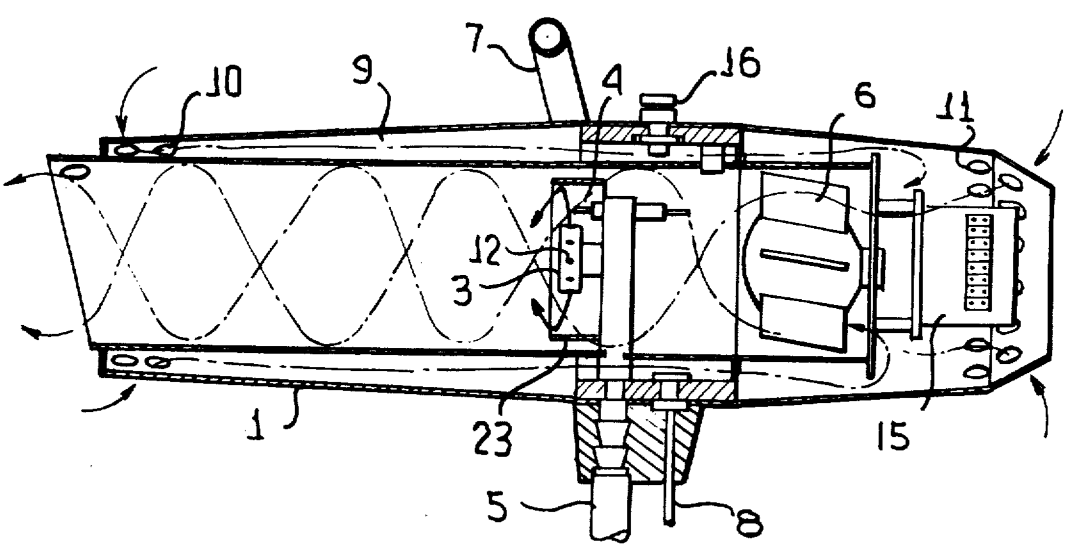


FIG. 1

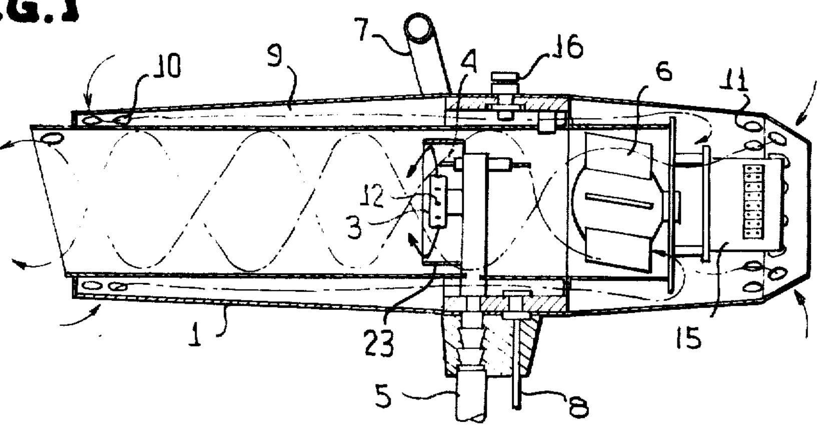


FIG. 2

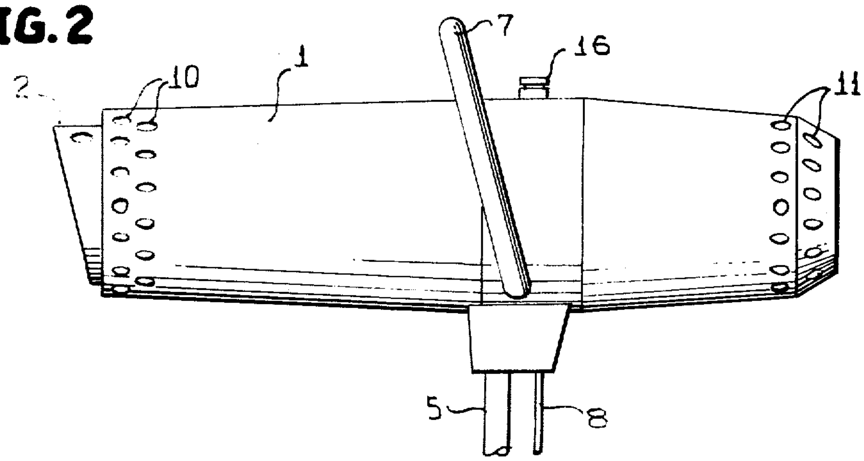


FIG. 3

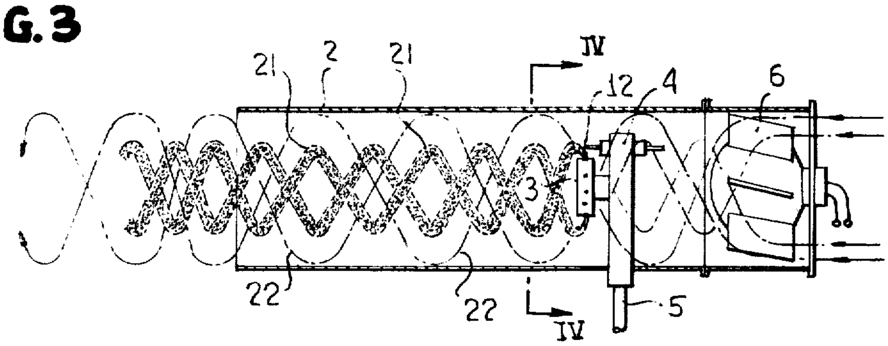
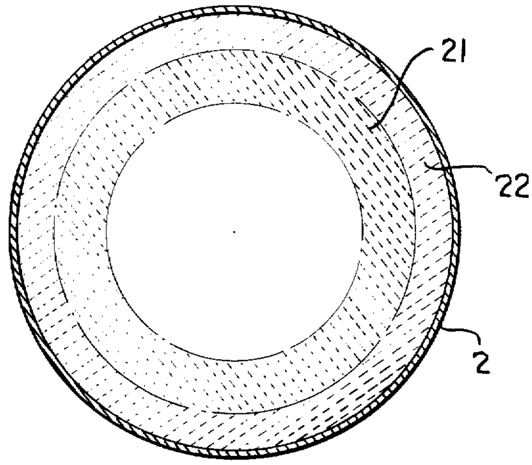


FIG.4



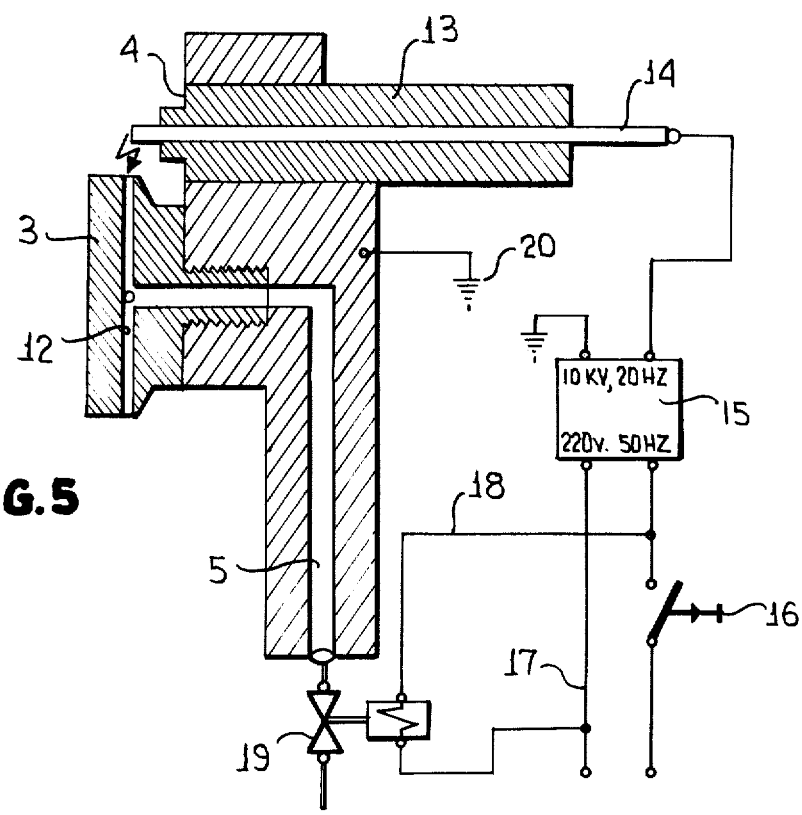


FIG.5

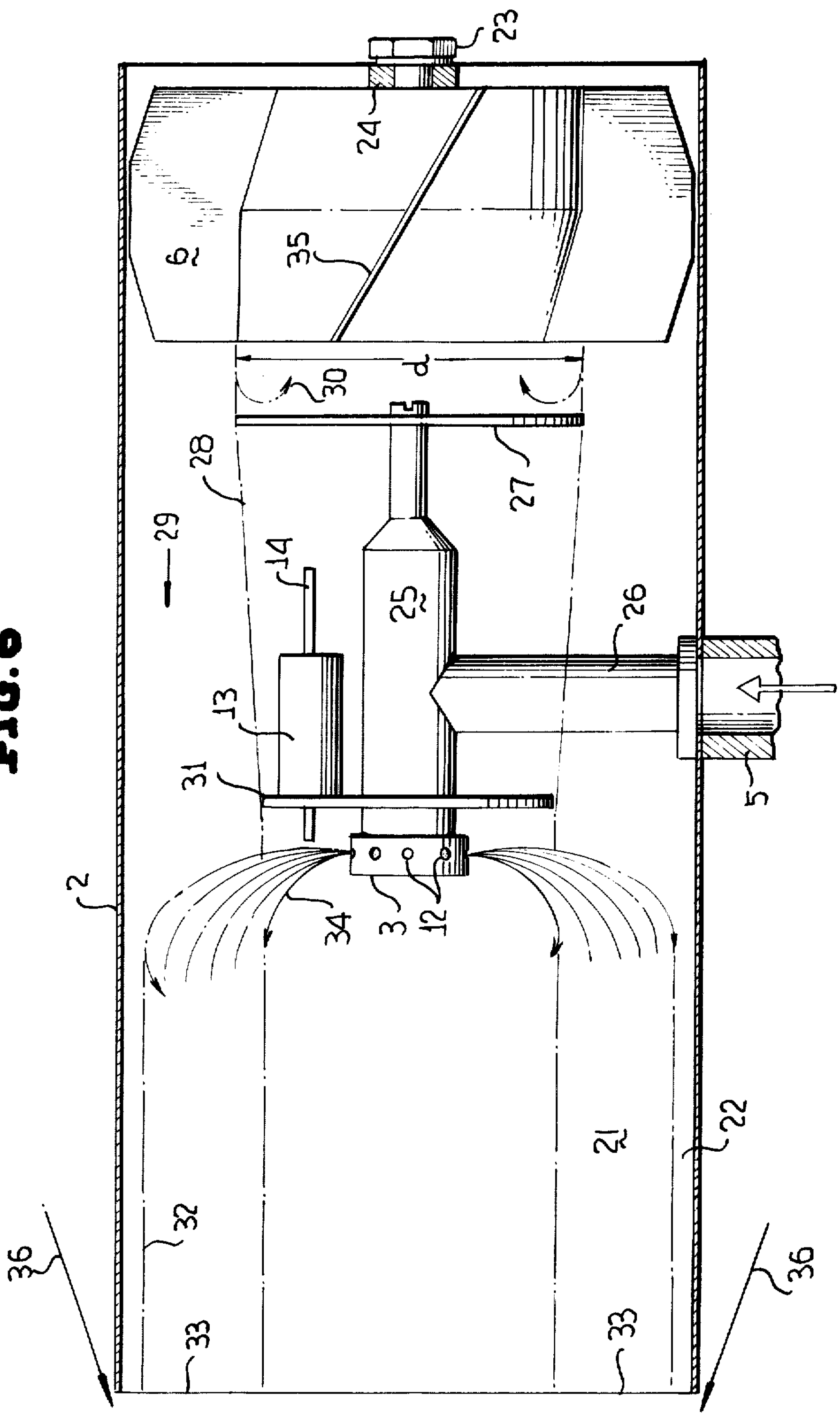
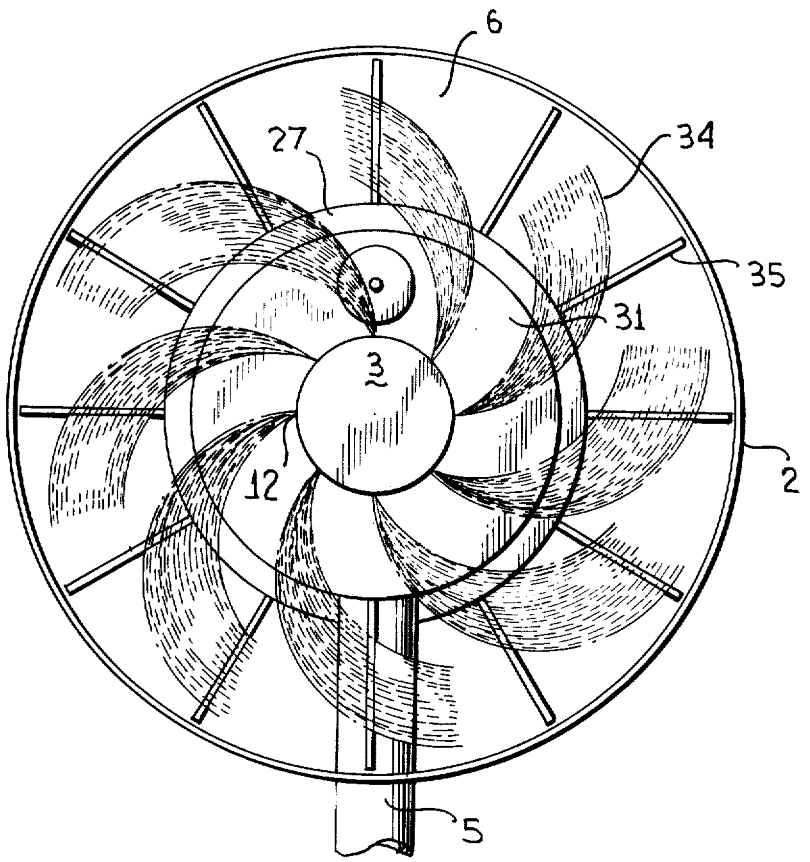


FIG. 6

FIG.7



APPARATUS FOR THE PRODUCTION OF HOT GASES

The invention relates to an apparatus for the production of hot gases, consisting of a guide pipe, a burner arrangement disposed concentrically in the pipe and connected with a supply pipe for fuel gas, an ignition arrangement for the burner, and an axial blower disposed behind the burner.

BACKGROUND OF INVENTION

The German published application OS 20,03,173 discloses an apparatus for the production of hot gases, which apparatus is used for shrinking of thermoplastic plastic sheets. The prior apparatus consists of a perpendicularly standing, pipe-like housing, which has a pipe elbow pointing horizontally at its upper end. In the lower part of the apparatus a radial blower is disposed, which directs combustion air toward a pipe-shaped combustion chamber disposed concentrically inside the housing, and which serves at the same time as support for a fuel gas pipe provided with a burner. A spark plug provided with two electrodes is disposed at an axial distance from the burner in the combustion chamber.

In the case of the prior apparatus, a laminar flow of relatively even density results from the use of a radial blower and a perforated intermediate bottom. If the fuel gas inserted into this air flow is ignited, a number of jets of flames, depending on the number of burner nozzles, continuing in a straight line will result, which flame jets with a certain quantity of fuel gas project out of the mouth of the housing. The combustion is thus very imperfect. At the same time a considerable heating of the housing elbow results. Since it is also largely dependent on coincidence whether and when a sufficiently dosed fuel gas-air mixture teaches the ignition arrangement, frequently undesirable explosions will result. The apparatus thus has a high number of uncertainty factors and cannot be considered as an accident-free apparatus.

SUMMARY OF THE INVENTION

Generally, the invention is based on the objective of creating an apparatus for the production of hot gases, which will avoid the deficiencies of the prior apparatus, especially an apparatus which also is suitable to a great advantage for the shrinking treatment of plastic wraps. The invention starts out from the realization that the solution of the problem is to be found in an improvement of the flow conditions on the one hand and in the improvement of the ignition conditions on the other hand.

In order to achieve a better combustion with the existing excess of air, provision was made according to the invention that the exit opening of the axial blower is connected with the guide pipe in concentric alignment and without interposition of a reversing member. As a result, a spinning flow free of breakdowns is produced which causes an excellent turbulence of the fed-in fuel gas. Add to this, that the fuel gas will not spread out over the entire cross section of the guide pipe as a result of the flow resistances in the burner, but will pass through a concentrically smaller cross section. The developed stream of hot gas is surrounded at the same time by a wreath of air current, which insulates the wall of the guide pipe against too intensive heating.

A further insulating effect with simultaneous preheating of the combustion air will be achieved advantageously by the fact that the guide pipe is encompassed by a concentric housing of a larger diameter, which has air inlet apertures at its front end, and that the annular conduit formed by the guide pipe and the housing is connected with the blower inlet as an additional air inlet conduit.

A further important characteristic of the invention consists in the fact that the ignition arrangement disposed in the air current of the axial blower is constituted by an electrode pin connectable with the ignition voltage and the burner housing, connected to ground, and likewise disposed in the air stream of the axial blower, and that at least one of the exit conduits of the burner is directed in the area of the electrode pin.

While explosions always occur in the case of the prior apparatus, whereby a considerable part of the fuel gas does not burn and on the other hand the r.p.m. of the ventilator or the flow speed of the combustion air must be throttled, in the case of the embodiment according to the invention there always is a faultless ignition without spark lag. It turns out, that whenever the fuel gas emerges from the burner about in the direction of the ignition arrangement, the voltage of the electrode pin very quickly ionizes the gas stream, and makes possible a spark-over to the burner serving as ground. At the same time, the spark-over gap can be relatively large, as compared to the case of an ordinary spark plug so that the mixture of fuel-gas can be ignited with certainty without explosions and without the combustion air being influenced in regard to its volume or its energy of flow.

It turned out that the hollow cylindrical axial flow develops two distinct cylindrical boundary layers, namely an inside boundary layer within which a return or suction current is formed, and an outside boundary layer which runs more or less far away from the wall of the guide pipe, depending on the discharge velocity of discharge energy of fuel emerging from the burner nozzle.

In order to prevent hot gas from reaching the winding of the axial blower as a result of the suction current occurring and of influencing it unfavorably, provision is made according to a further development of the invention, that a concentric circular disk is disposed at a distance in front of the hub of the axial blower on the exit side, the diameter of which disk is about equal to that of the hub, namely about two-thirds of the diameter of the guide pipe.

This circular disk does not impede the spinning current of the air supplied by the axial blower. Rather, it flows unimpeded in a direction toward the discharge opening of the guide pipe.

Advantageously the burner is attached on a central plate, which is disposed at a distance in front of the circular disk and which plate has a somewhat smaller diameter as compared to the disk.

It was found that the spinning current of the air is likewise neither impeded nor reversed by the insertion of this plate, and the control range of the apparatus could be considerably enlarged with a decreased gas output. As a result of the flow cross section being decreased in relation to the guide pipe, there will be a high flow velocity which on the one hand produces a suction current at the mouthpiece of the apparatus and on the other hand assures an increased heat transfer by means of turbulence upon striking a plastic foil that is to be shrunk.

With the above and other objects in view that will hereinafter appear, the nature of the invention will be more clearly understood by reference to the following detailed description, the appended claims and the several views illustrated in the accompanying drawings:

IN THE DRAWINGS:

FIG. 1 is a longitudinal sectional view through the portable hot gas producing apparatus.

FIG. 2 is a side view of the apparatus according to FIG. 1.

FIG. 3 is a schematic presentation of the flow conditions in the apparatus.

FIG. 4 is a schematic cross sectional view through the flow medii, taken along the line IV—IV in FIG. 3 and showing the temperature zones.

FIG. 5 is a schematic illustration of the burner and the ignition arrangement.

FIG. 6 is a longitudinal sectional view through a guide pipe of the apparatus according to the invention.

FIG. 7 is a transverse sectional view taken generally along the line VII—VII in FIG. 6.

In FIGS. 1 and 2 there is illustrated a portable apparatus for the production of hot gases in order to shrink plastic wraps with the hot gases, which wraps have been placed on goods stacked on pallets.

Essentially the apparatus consists of a housing **1**, a guide pipe **2** for the hot gas produced, a burner **3**, an ignition arrangement **4**, a fuel gas conduit **5**, an axial blower **6** having a motor of the external rotor type, and a handle **7** as well as electric supply cables **8**.

The blower **6** disposed in the rear part of the housing **1**, is an axial blower disposed concentrically in the front part of the housing **1**, and a discharge opening of which opens into the guide pipe. Between the guide pipe **2** and the housing **1** a chamber **9** in the shape of an annular gap has been formed. At the front end of the housing **1** there are staggered openings **10**. The blower **6** sucks in air through the openings **10** and the chamber **9**. Additional air is received through openings **11** at the rear end of the housing **1**. The combustion air leaves the blower in the form of a spinning current. Such a spinning current has a density which increases from the axis outward as a result of the centrifugal forces. In the area of the axis the density practically equals zero.

The end of the gas conduit **5**, bent in an axial direction has mounted thereon the burner **3** having radial discharge conduits **12** opening radially outwardly in front of the axial blower **6**. The ignition arrangement **4** is provided for the burner **3**. The ignition arrangement, as shown in FIG. **5** on an enlarged scale, consists of an electrode pin **14** resting in a ceramic insulating holder **13**, the free end of which projects into the area of the extension of one of the discharge conduits **12** of the burner **3**. The electrode pin **14** is connected with an ignition device **15** which transforms a usual electric alternating current into a high voltage ignition current of about 10KV and 20 Hz. In one of the phases of the supply conduit, a command key **16** is disposed.

Parallel with the electric supply line **17**, is a circuit **18** for the controlling operation of a magnetic valve **19** incorporated in the fuel gas conduit **5**. The fuel gas conduit **5** itself forms a ground or is grounded at a point **20**.

Whenever the proper electric lead is connected by operation of the command key, the magnetic valve **19** is opened and fuel gas flows from the burner **3** into the combustion air delivered by the axial blower **6**. At the same time a periodic spark-over from the electrode pin to the burner **3** takes place whereby the stream of fuel gas emerging in the direction of the electrode pin is ionized and as a result a particularly quick and sure spark-over together with delay-free ignition takes place.

After the ignition, a complete combustion of the fuel gas-air mixture takes place on a relatively very short section. The fuel gas, as shown in FIG. **3**, is likewise given a spinning movement, whereby the current of fuel gas has a more or less large diameter depending on its flow energy.

FIG. 3 shows schematically in heavy lines the course of the flow of the fuel gas-air mixture or of the current **21** of hot gas and the flow **22** with pure air. It turns out that close to the housing axis there is no flow. The fuel gas-air mixture, after flowing a short distance burns completely, becoming a hot gas, and forms as shown in FIG. **4**, a wreath-shaped spinning gas current **21** with a temperature of about 1000°C. This very hot gas current is sheathed by the air current **22** which, as experiments have shown, has a considerably lower temperature and which contributes in keeping the guide pipe **2** relatively cool. Practical experiments indicate the guide pipe **2** having a temperature of about 120° to 140°C. In FIG. **1** there is shown in the area of the burner **3** a guide ring **23** surrounding the burner **3** and the ignition arrangement **4**. The guide ring serves to achieve a mechanical reversal of the fuel gas with the most favorable, selected flow diameter. Whenever the diameter of the selected guide ring **23** is too small, this results in an incomplete combustion with a helically guided and emerging flame. In the case of a correct selection of the diameter of the guide ring the temperature distribution shown in FIG. **4** results. It may be more advantageous to throttle the combustion conduit **5** instead of using the guide ring.

As a result of the fact that the blower **6** obtains part of its air supply through the annular chamber **9**, the housing will be cooled additionally from the outside. At the same time the combustion air is preheated to a small degree.

Experiments show, that the new apparatus provides for a faultless explosion-free ignition and complete combustion of the fuel gas, and is very well suited as a hand tool for shrinking of packaging foils. The practical arrangement of the stirrup shaped handle **7** also contributes to this.

In FIG. **6** there is shown a modified construction of the apparatus according to the invention. In this case the housing **1** is not shown.

The blower **6** is mounted concentric with the guide pipe **2** on a bridge **24** connected firmly with the guide pipe **2**. The diamaeter *d* of the hub of the blower **6** is approximately two-thirds of the diameter of the guide pipe **2**.

The burner **3** is attached to the holder **25**, which extends axially in the guide pipe **2**, and is mounted on a bridge **26**, through which the fuel gas supply conduit **5** is guided. On the rear end of the holder **25**, a concentric circular disk **27** is attached at a small distance in front of the hub of the axial blower **6** on the discharge side, the diameter *d* of the disk being equal to the diameter of the hub, so that the periphery of the circular disk **27** touches the inner boundary layer **28** of the conveyed air current **29**, but does not impede it.

The air, supplied by the axial blower **6**, flows as a hollow cylindrical rotational current **29** through the guide pipe **2** past all sides of the circular disk **27**. A concentric suction current, occurring in front of the circular disk **27**, i.e., in the area of the holder **25**, is returned into the air flow and does thus not reach the area of the motor winding of the axial blower **6**. Simultaneously, a part **30** of the flow **29** is conducted along the boundary layer **28** inward together with cold air into the area of the axial blower **6** and there acts as a cooling current.

Immediately behind the burner **3**, i.e. upstream from it, a likewise concentric plate **31** is attached to the holder **25**, the diameter of the plate **31** being smaller than that of the circular disk **27**, but the periphery of which likewise extends to the boundary layer **28**, the inside diameter of which is somewhat smaller in this area.

The plate **31**, while serving as a mounting bracket for the ignition arrangement **4**, which includes an insulation holder **13** made of ceramic, and an ignition electrode **14**, also effects a sharply defined boundary layer in the burner area.

The air current **29** supplied by the axial blower revolves around its longitudinal axis and forms a hollow cylinder, the inside limit of which is the boundary layer **28** and the outside limit being defined by the inside wall of the guide pipe **2**.

The fuel gas is injected radially from the burner **3** into this hollow flow cylinder. Depending on the kinetic energy of the current of the fuel gas [flow cross section $= f$ (gas-pressure, nozzle cross section)], a hot gas hollow cylinder **21** consisting of a flame and hot combustion gases is formed after ignition, the inside boundary layer of which again corresponds to the line **28**, and the outside boundary layer of which is designated by **32**. The temperature inside the boundary layers **28** and **32** is approximately 900°C. Between the boundary layer and the wall of the guide pipe **2** there is an additional flow in the form of a hollow cylinder **22** of air. This latter air flows has such a strong insulating effect, that the guide pipe **2** remains almost cold and has a temperature of 30°C plus ambient temperature. The width of this hollow cylinder **22** is, for example, about 5mm.

If a wide-meshed screen etc., were inserted at the section **33—33**, then the rotating cylindrical current would be disturbed and the guide pipe would be heated to about 500°C.

As shown in FIG. **7**, because of the twist energy of the air current supplied by the axial blower **6**, an approximately helicoidal or pinwheel-like flame picture **34** results in front of the radial blades of the blower **6**. The drawing clearly shows the insulating air cylinder **22** as well as the space inside the boundary layer **28** which is free of fuel gas. The flame zone extends axially only a few centimeters, so that no flames emerge from the guide pin.

It has been found that the area of control of the apparatus for the production of hot gas could be considerably extended, especially in case of decreased gas output, by inserting plate **31**.

The decrease of the flow cross section at this point, as compared to the guide pipe **2** results in a high flow velocity, which on the one hand produces a suction current at the mouthpiece of the apparatus and on the other hand insures a correspondingly increased heat transfer by means of turbulence upon striking a plastic foil that is to be shrunk. The suction current **36** will cause an additional cooling of the mouthpiece at the cross section **33—33**.

I claim:

1. Apparatus for the production of hot gases comprising an elongated guide pipe having a longitudinal axis and a discharge opening, a burner disposed concentrically within and relative to said guide pipe, said burner including nozzle means for directing fuel generally radially outwardly of the longitudinal axis, conduit means for connecting said burner nozzle means to a source of combustible fuel, ignition means adjacent said burner for igniting the combustible fuel being discharged from said burner nozzle means, an axial blower disposed concentrically within and relative to said guide pipe for creating a swirling air stream through said guide pipe toward said discharge opening, said swirling air stream including low volume air flow along said longitudinal axis and higher volume air flow radially outwardly therefrom, said burner and ignition means being disposed between said blower and said discharge opening, and said ignition means being disposed within said area of low volume flow whereby fuel directed radially outwardly of said nozzle means toward said guide pipe when ignited creates flames directed radially outwardly from said burner into the swirling air stream created by said blower for discharge through said discharge opening.

2. The apparatus as defined in claim **1** wherein said ignition means includes electrode pin means for igniting the combustible fuel being discharged from said burner nozzle means, means for creating an ignition spark through said electrode pin means for igniting the combustible fuel within said area of low volume flow, electromagnetic valve means for opening and closing said conduit means, and electrical circuit means which includes said electromagnetic valve means and said electrode pin means.

3. The apparatus as defined in claim **1** including a generally cylindrical shroud surrounding said elongated guide pipe.

4. The apparatus as defined in claim **1** including a generally cylindrical shroud surrounding said elongated guide pipe, said shroud being at least in part in spaced relationship to said elongated guide pipe, and aperture means in said shroud adjacent the discharge opening of said elongated guide pipe for drawing air therethrough by said axial blower between said shroud and said elongated guide pipe whereby said shroud is maintained relatively cool during the operation of said apparatus.

5. The apparatus as defined in claim **1** wherein a generally circular disk is disposed within said elongated guide pipe between said axial blower and said burner for assisting in the creation of the low volume air flow of said swirling air stream.

6. The apparatus as defined in claim **1** including a pair of generally circular disks disposed concentrically within said guide pipe, one adjacent said axial blower and one remote therefrom for assisting in the formation of the low volume air flow of said air stream.

7. The apparatus as defined in claim **1** wherein said nozzle means include a plurality of generally radially outwardly directed nozzle openings.

8. The apparatus as defined in claim **2** wherein said nozzle means include a plurality of generally radially outwardly directed nozzle openings.

9. The apparatus as defined in claim **2** including a generally cylindrical shroud surrounding said elongated guide pipe, said shroud being at least in part in spaced relationship to said elongated guide pipe, and aperture means in said shroud adjacent the discharge opening of said elongated guide pipe for drawing air therethrough by said axial blower between said shroud and said elongated guide pipe whereby said shroud is maintained relatively cool during the operation of said apparatus.

10. The apparatus as defined in claim **2** wherein a generally circular disk is disposed within said elongated guide pipe between said axial blower and said burner for assisting in the creation of the low volume air flow of said swirling air stream.

11. The apparatus as defined in claim **4** wherein a generally circular disk is disposed within said elongated guide pipe between said axial blower and said burner for assisting in the creation of the low volume air flow of said swirling air stream.

12. The apparatus as defined in claim **4** wherein said nozzle means include a plurality of generally radially outwardly directed nozzle openings.

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