

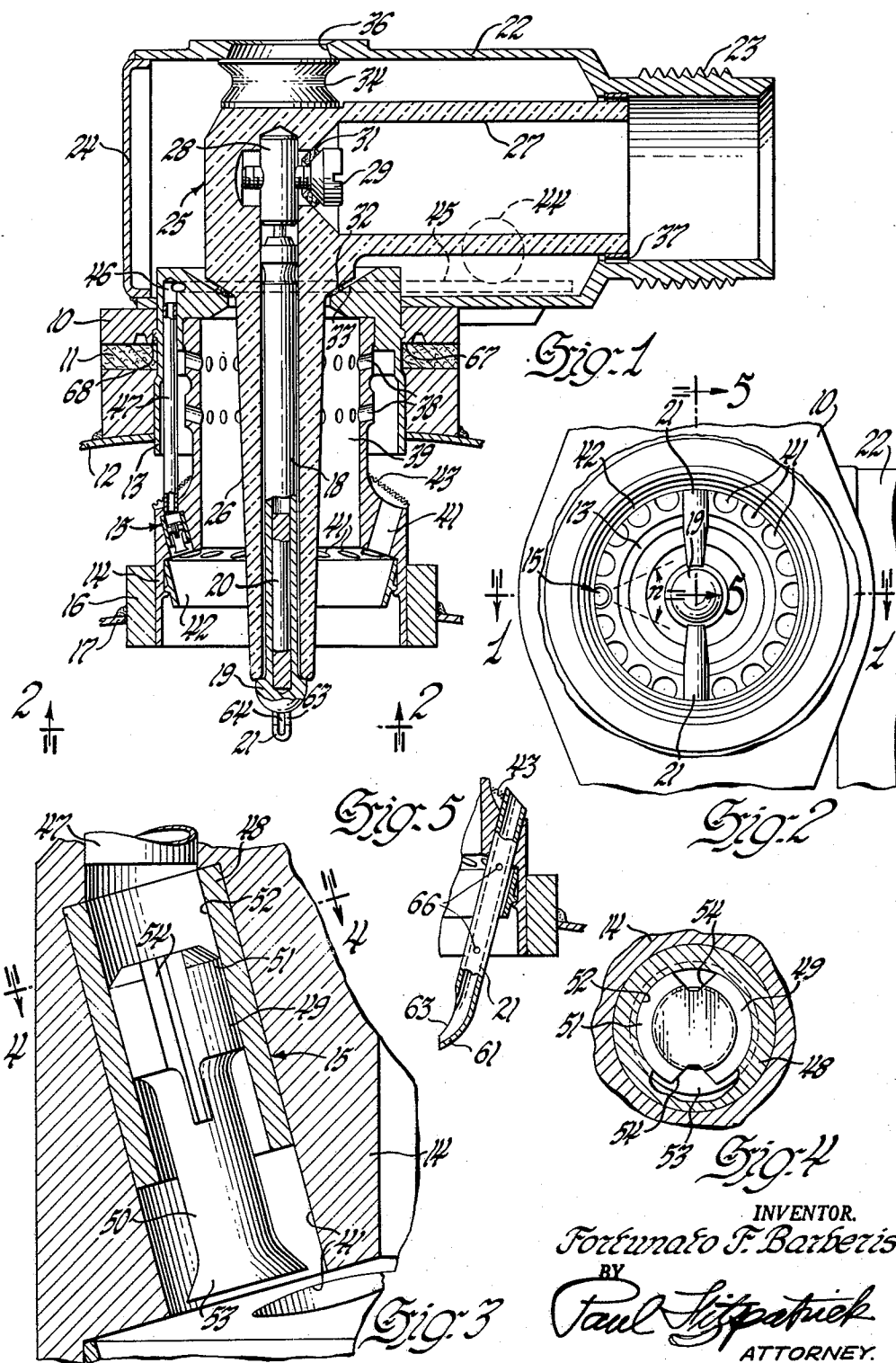
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F. F. BARBERIS

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TORCH IGNITER

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INVENTOR.
Fortunato F. Barberis
 BY
Paul J. Lipatnick
 ATTORNEY.

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3,090,200

TORCH IGNITER

Fortunato F. Barberis, Flint, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Continuation of application Ser. No. 641,396, Feb. 20, 1957. This application Nov. 17, 1961, Ser. No. 155,231

4 Claims. (Cl. 60—39.82)

This application is a continuation of my application Serial No. 641,396, filed February 20, 1957, now abandoned.

My invention relates to torch igniters such as are used for starting or maintaining combustion in gas turbine engines and the like, and particularly to an improved arrangement for providing a superior readily ignitable fuel air mixture at the spark gap including a new spray tip specially suited for use in such igniters.

By way of background, gas turbine, ram jet, and rocket engines may be ignited simply by an electric spark which jumps a gap in the combustion chamber and ignites the fuel sprayed from the nozzle or nozzles of the engine. More consistent and rapid ignition may be obtained with an igniter of the torch type in which the igniter includes means for providing a spray or mist of fuel in combination with an electric spark igniter so that the fuel supplied to the igniter provides a torch-like flame. The present invention is directed to this type of igniter and is particularly concerned with improving the distribution of fuel adjacent the spark gap and preventing discharging an excess of fuel in such a way that it flows over the parts of the igniter. The invention also provides a relatively simple and compact structure as compared to the generality of known torch igniters.

The principal objects of the invention are to improve the ignition of combustion apparatus, to provide a simple and reliable igniter of the torch type, and to provide an extremely simple and compact spray tip particularly suited to the requirements of torch igniters. The spray tip as such is the subject of my divisional application for "Spray Tip," Serial No. 228,462, filed October 4, 1962.

The nature of the invention and the advantages thereof will be more clearly apparent to those skilled in the art from the succeeding detailed description of the preferred embodiment of the invention and the accompanying drawings thereof.

FIGURE 1 is a sectional view of an igniter taken on the plane indicated by the line 1—1 in FIGURE 2.

FIGURE 2 is a partial view of the electrode end of igniter viewed in the direction indicated by the line 2—2 in FIGURE 1.

FIGURE 3 is a greatly enlarged view of a fragment of FIGURE 1 illustrating the spray tip.

FIGURE 4 is a fragmentary sectional view taken on the plane indicated by the line 4—4 in FIGURE 3.

FIGURE 5 is a fragmentary sectional view taken on the plane indicated by the line 5—5 in FIGURE 2.

The embodiment of the igniter illustrated herein is intended for use in a combustion apparatus having an outer wall on which the igniter is mounted and an inner wall spaced therefrom and defining a combustion zone. The igniter extends across the space between the walls and through the inner wall. This sort of installation is well known and is illustrated, for example, in U.S. Patent 2,526,169.

The igniter comprises a mounting plate or pad 10 having holes (not shown) by which it may be fixed by bolts or studs over a gasket 11 on the outer surface of the outer wall 12 of a combustion chamber. An apron 13 fixed in the pad extends through the outer wall.

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An annular shell 14 fixed in the apron 13 projects through a ferrule 16 in the wall 17 of the flame tube or combustion liner within which combustion of the engine fuel takes place. A fuel spray tip 15 is mounted in the shell 14, the igniter comprises a center electrode 18 having a round tip 19 which constitutes one electrode of a spark gap. The center electrode is hollow and contains an aluminum plug 20 for liquid metal cooling of the tip of the electrode. Two side electrodes 21 which project from the shell 14 and are grounded thereby constitute the other side of the spark gap.

The upper end of electrode 18 projects into a brazed sheet metal shield 22 which includes a threaded portion 23 for connection of the high tension ignition conduit. The shield is brazed to the pad 10 and the end opposite the threaded portion 23 is closed by a brazed cover plate 24. The electrode 18 is mounted within part 26 of an elbow insulator 25 of suitable ceramic material which extends from the tip 19 into the shield 22. Insulator 25 includes a tubular portion 27 which receives the high tension lead. The electrode 18 is fixed to a fitting 28 which is cross-drilled and tapped to receive a terminal screw 29, the head of which seats against a gasket 31. The terminal screw 29 retains the electrode within the insulator and is engaged by the terminal of the high tension lead (not shown).

The insulator 25 seats against a gasket 32 which bears against a shoulder 33 extending inwardly from apron 13, and is retained by an annular sealing spring 34 fitted between the upper surface of the insulator and the top of shield 22. The margins of the shield 22 around an opening 36 coaxial with the center electrode are crimped downwardly to clamp the sealing spring against the insulator and the insulator against shoulder 33, thus fixing the insulator in place. A wavy spring ring 37 steadies the outer end of insulator portion 27 in the shell.

The upper portion of shell 14 within the apron 13 is provided with two rows of air entrance holes 38 which are directed somewhat spirally so that combustion chamber jacket air entering the annular space 39 between the shell and the insulator 26 is given a swirling motion around the axis of the plug. This swirling air flows through the shell and out the open end past the electrodes 19, 21. The lower portion of the shell which pilots into the combustion liner is offset to a larger diameter than the upper portion and a ring of holes 41 extend through the offset. The electrodes 21 are mounted in two of these holes and the spray tip assembly 15 in a third hole. The remaining holes 41 are open for passage of air directly from the combustion chamber air jacket into the lower end of the shell. A fire ring 42 is mounted within the shell adjacent the openings 41 and spaced sufficiently from the lower end of the shell to be protected from raw engine fuel spray and air flowing within the combustion chamber. An annular screen 43 of wire mesh is mounted over the entrances of openings 41. This screen is a flame arrester and also reduces the velocity of the air entering the shell through openings 41.

Fuel is supplied to the spray tip 15 from an inlet connection 44 in the shield 22. This connection may have suitable fittings for coupling to a fuel line and may include a filter and a resistance valve (not shown) in accordance with known practice. Fuel flows from the connection 44 through drilled passages 45 extending through the wall of the shield 22 and the upper end of skirt 13. Passage 45 enters a vertical passage 46 through the skirt within which is brazed a small tube 47 (see also FIGURE 3) discharging into the spray tip 15.

The spray tip assembly 15 comprises a tubular body 48 mounted in the hole 41 and a plug 49 pressed into

the body. The plug includes an upper portion 51 which fits closely within the bore 52 in the body 48, an intermediate neck portion 50 of reduced diameter extending from the portion 51, and a flaring or conical target portion 53 just inside the lower end of hole 41 in the shell. Two diametrically opposite grooves 54 in the plug provide orifice passages of very small cross section through which the fuel flows and is discharged parallel to the axis of the spray tip. The fuel, which is preferably at from 30 to 100 pounds per square inch pressure, flows from the passages 54 and impinges on the conical target 53 which breaks it up into a fine mist or spray. This fuel mist is mixed with the swirling air entering through the holes 38 and the additional air from the holes 41 and projected through the open end of the shell into the combustion chamber. It may be noted that the grooves 54 are in a plane at right angles to the plane passing through the spray tip and the center electrode. The spray developed by the jet from each of the passages 54 is confined to a zone of less than 180 degrees around the axis of the spray tip so that there is a spray-free zone in the direction of the center electrode and no direct spray is projected onto insulator 26. This spray-free zone is indicated by the lines *n* in FIGURE 2. The side electrodes 21, which are directly opposite each other as shown in FIGURE 2, are tubular and are brazed into two of the openings 41 in the shell 14. These extend inwardly into proximity with the center electrode 19 and are curved as shown at 61 at the spark gap end. The inner surface of the tube is cut away at 63 through the wall of the tube to provide a channel or U-shaped end 64 on each side electrode. Each side electrode has four small openings 66 through the wall. Air flowing through these electrodes from the combustion chamber jacket is discharged at the spark gap. This air flow draws fuel-air mixture generated by the spray tip 15 into the openings 66 and thus discharges it directly from the channel end 64 of the side electrodes into the spark gap. This direct discharge into the spark gap greatly facilitates ignition of the fuel mixture at low temperatures.

Presumably, the operation of the device will be apparent, but may be reviewed briefly. With the igniter installed in the engine, when the need for the ignition of the main combustion fuel arises, a suitable ignition generator which is connected to the center electrode is energized and develops a spark across the gaps between the center electrode 19 and the side electrodes 21. At the same time fuel is supplied through the inlet 44 to the spray tip 15. Because of the air flow in the combustion chamber through the usual openings (not illustrated) in wall 17, there is a slight pressure drop between the combustion chamber jacket and the interior of the flame tube which causes air to flow through openings 38 and 41. This air is loaded with fuel sprayed from the tip 15 and ignited by the spark. The resulting flame is projected into the combustion chamber liner and continues to burn as long as fuel is supplied to the tip 15. Once the torch flame is burning, the current may be turned off. The fuel supplied to the igniter may be discontinued as soon as the combustion in the engine is established, or it may be allowed to continue to burn to act as a pilot flame if desired.

It may be desirable to describe briefly the process of assembly of the igniter. The upper portion of the assembly comprising pad 10, shield 22, cover 24, and fuel connector 44 is brazed in a furnace and then finished by final machining. The lower or tip portion comprising apron 13, shell 14, tube 47, screen 43, and side electrodes 21 is also furnace brazed and finished by machining.

The insulator 25 containing the center electrode is then inserted into shield 22 through the large opening in pad 10. The shell tip is inserted into the pad 10, which is crimped at 67 against rib 68 on the apron. Portion 36 of the shield is crimped to load spring 34 and fix the in-

insulator firmly. Hole 45 is drilled to connect inlet 44 with tube 47. The spray tip assembly 15 is then pressed into bore 41. It will be seen that this structure is quite simple, rugged, and readily assembled.

The spray tip is quite small. In the illustrated embodiment, the outside diameter of tube 48 is about .08 inch. The preferred proportions for the spray tip are as illustrated, although the structure may be varied, as by changing the cone angle of the target to vary the cone angle of the spray. The structure of the tip is particularly suited to provide a very compact spray tip adapted for flows of about one gallon per hour. It also, because of the spray-free zone, prevents direct spray into the spark gap.

The fuel-air mixture, cooled by evaporation of the fuel, supplied through side electrodes 21, cools these electrodes as well as the center electrodes as long as fuel is supplied to the igniter.

The advantages of the invention in providing an improved torch igniter will be apparent to those skilled in the art. The invention is not to be considered as limited by the detailed description of the preferred embodiment, as various changes may be made within the scope of the invention.

I claim:

1. A torch igniter comprising, in combination, an annular shell having an open end adapted to extend into a combustion apparatus through a wall thereof, a center electrode disposed on the axis of the shell adjacent the open end, a tubular side electrode extending from the shell and terminating adjacent the center electrode to define a spark gap therewith, the side electrode being adapted to communicate with a source of air external to the said wall and conduct the air to the termination points of the side electrode and being open toward the spark gap, entrance means defined by the shell external to the said wall to admit air thereto for flow through the shell and from the open end thereof, a spray tip mounted in the shell and adapted to spray atomized fuel into the air flowing through the shell, and means for supplying fuel to the spray tip, the side electrode having lateral entrance openings therein to receive the fuel-laden air and conduct it to the spark gap.

2. A torch igniter comprising, in combination, an annular shell having an open end adapted to extend into a combustion apparatus through a wall thereof, a center electrode disposed on the axis of the shell adjacent the open end, a side electrode extending from the shell and terminating adjacent the center electrode to define a spark gap therewith, entrance means defined by the shell external to the said wall to admit air thereto for flow through the shell and from the open end thereof, a spray tip mounted in the shell and adapted to spray atomized fuel into the air flowing through the shell to the spark gap, the spray tip comprising a tubular body, a plug therein having a conical tip flaring in the direction away from the body, and means in the body defining two orifice passages extending axially of the tip and located to jet fuel against opposite sides of the conical tip to generate a divided conical spray having a spray-free zone in the direction of the center electrode, and means for supplying fuel to the spray tip.

3. A torch igniter comprising, in combination, an annular shell having an open end adapted to extend into a combustion apparatus through a wall thereof, a center electrode disposed on the axis of the shell adjacent the open end, tubular side electrodes extending from the shell and terminating adjacent the center electrode to define a spark gap therewith, the side electrodes being adapted to communicate with a source of air external to the said wall and conduct the air to the termination points of the side electrodes and being open toward the spark gap, entrance means defined by the shell external to the said wall to admit air thereto for flow through the shell and from the open end thereof, a spray tip mounted

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in the shell and adapted to spray atomized fuel into the air flowing through the shells to the spark gap, the spray tip comprising a tubular body, a plug therein having a conical tip flaring in the direction away from the body, and means in the body defining two orifice passages extending axially of the tip and located to jet fuel against opposite sides of the conical tip to generate a divided conical spray having a spray-free zone in the direction of the center electrode, and means for supplying fuel to the spray tip.

4. A torch igniter comprising, in combination, an annular shell having an open end adapted to extend into a combustion apparatus through a wall thereof, a center electrode disposed on the axis of the shell adjacent the open end, tubular side electrodes extending from the shell and terminating adjacent the center electrode to define a spark gap therewith, the side electrodes being adapted to communicate with a source of air external to the said wall and conduct the air to the termination points of the side electrodes and being open toward the spark gap, entrance means defined by the shell external to the said wall to admit air thereto for flow through the shell and from the open end thereof, a spray tip mounted

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in the shell and adapted to spray atomized fuel into the air flowing through the shell, the side electrodes having lateral entrance openings therein to receive the fuel-laden air and conduct it to the spark gap, the spray tip comprising a tubular body, a plug therein having a conical tip flaring in the direction away from the body, and means in the body defining two orifice passages extending axially of the tip and located to jet fuel against opposite sides of the conical tip to generate a divided conical spray having a neutral zone in the direction of the center electrode, and means for supplying fuel to the spray tip.

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