United States Patent [19]

Matthews et al.

[11] **3,741,165**

[45] **June 26, 1973**

[54] **WATER-COOLED BURNER AND FEEDSTOCK INJECTION ASSEMBLY FOR CARBON BLACK REACTOR**

[75] Inventors: **Roy S. Matthews**, Sunray; **Billy E. Willis**, Houston, both of Tex.

[73] Assignee: **Continental Carbon Company**, Houston, Tex.

[22] Filed: **Sept. 29, 1971**

[21] Appl. No.: **184,934**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 59,962, July 31, 1970.

[52] **U.S. Cl.** **122/6.5**
[51] **Int. Cl.** **F22b 37/00**
[58] **Field of Search** 122/6.5, 6.6

[56] **References Cited**

UNITED STATES PATENTS

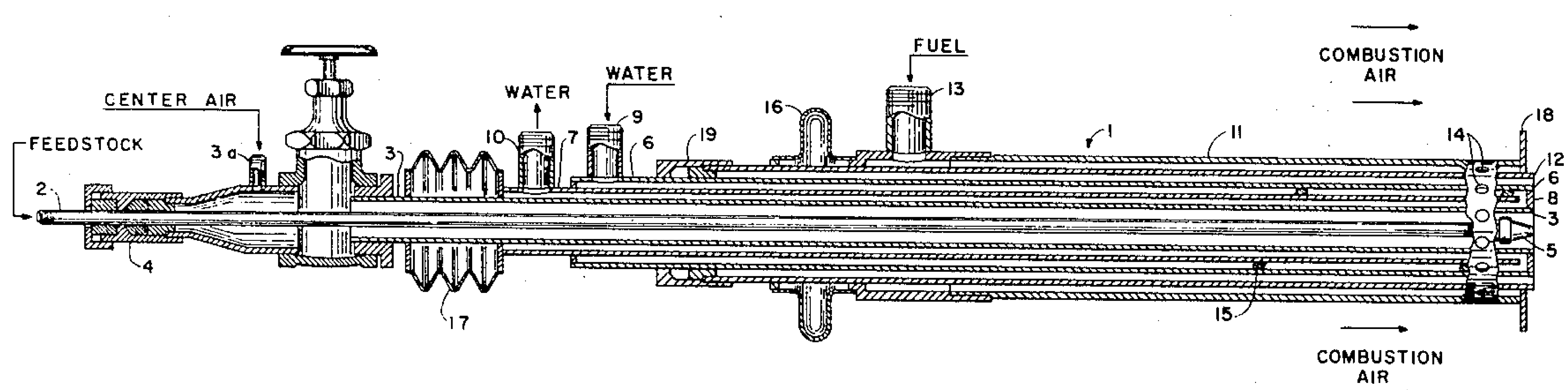
2,632,503 3/1953 Bailey 122/6.5
3,236,281 2/1966 Bain et al......................... 122/6.5 X
3,559,623 2/1971 DeCamps............................. 122/6.5

Primary Examiner—Kenneth W. Sprague
Attorney—Jerry B. Peterson et al.

[57] **ABSTRACT**

A burner and feedstock injection assembly for a carbon black reactor having a cooling-water jacket surrounding the center air pupe (which surrounds the center feedstock pipe). Means are included within the jacket for imparting a whirling motion to the water as it circulates through the portion of the jacket which is subjected to maximum heat of fuel combustion. Preferably, the jacket includes an expansion joint mounted outside the reactor toward the upstream end of the assembly.

4 Claims, 3 Drawing Figures



PATENTED JUN 26 1973

3,741,165

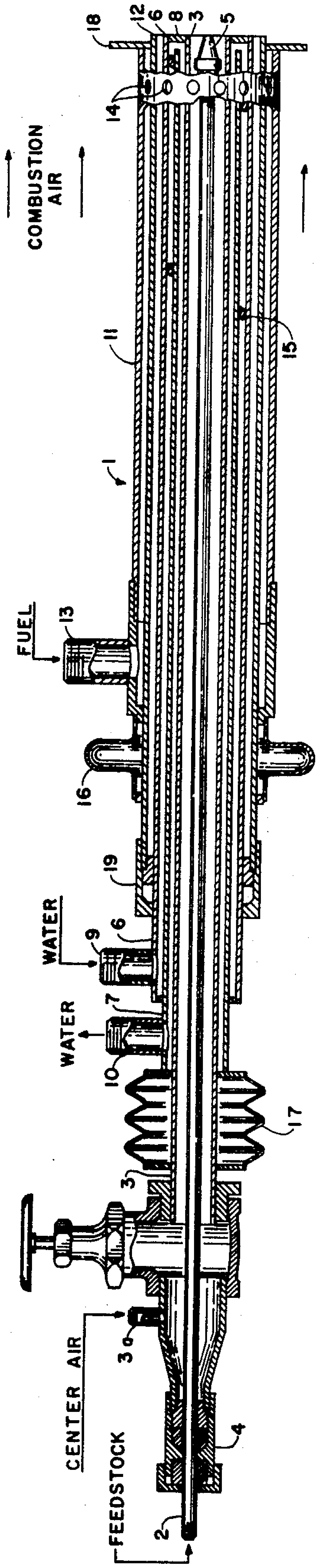


FIG. 1

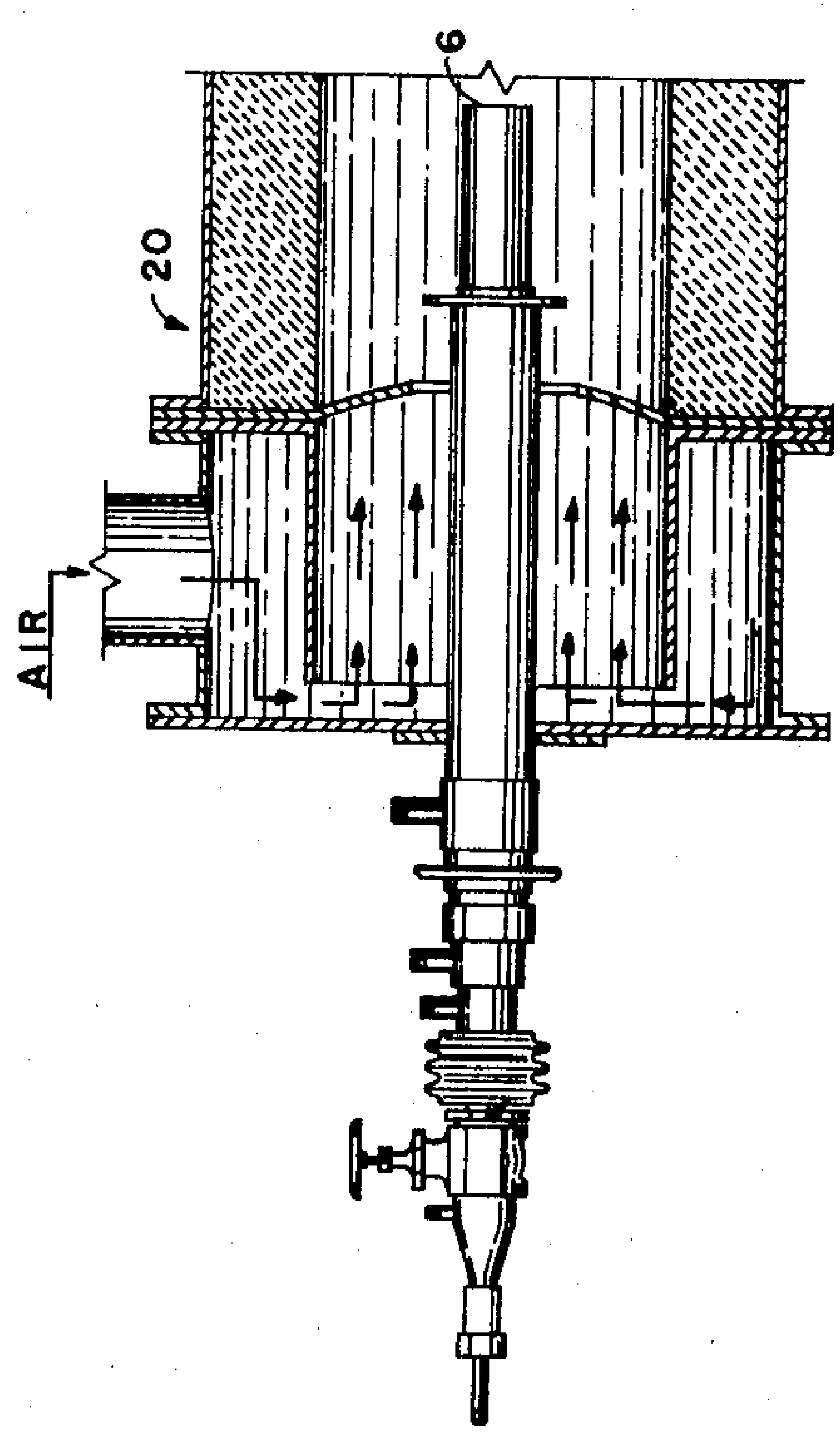


FIG. 3

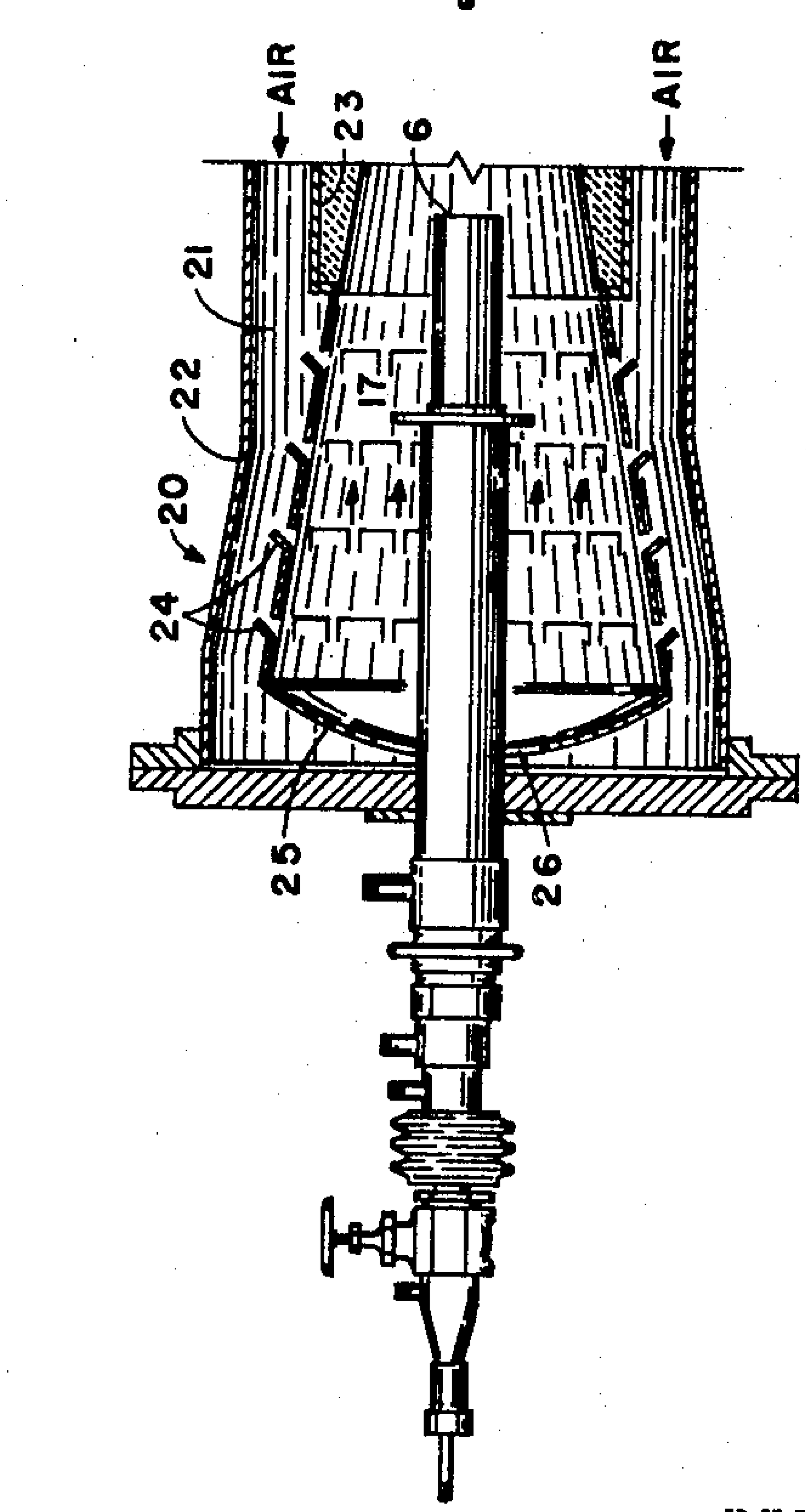


FIG. 2

INVENTORS
ROY S. MATTHEWS
BILLY E. WILLIS

BY *Jerry B. Peterson*
ATTORNEY

WATER-COOLED BURNER AND FEEDSTOCK INJECTION ASSEMBLY FOR CARBON BLACK REACTOR

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of Ser. No. 59,962, filed July 31, 1970.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the production of carbon black by the injection of a suitable hydrocarbon feedstock into an elongate reaction or combustion chamber containing high-temperature flames and gases, and more particularly to a novel water-cooled burner and feedstock injection assembly for burning a gaseous or liquid hydrocarbon as fuel to provide the heat necessary for the pyrolysis of the feedstock to form carbon black.

2. Description of the Prior Art

This invention is an improvement over the assembly of U.S. Pat. No. 3,443,761 and is designed to minimize or eliminate damage to the feedstock nozzle and the axial air pipe which results from overheating when the feedstock and the axial air pipe of that patent are shoved into the reactor (for reasons which will be explained hereinafter).

Applicants do not claim that water-cooled carbon black burners are novel per se. For example, U.S. Pat. Nos. 2,659,662, 2,895,804, 3,003,854 and 3,490,869 show water-cooled carbon black burners; however, it will be noted that as to all of these patents the burner design and method of water cooling is vastly different from applicants' invention.

SUMMARY OF THE INVENTION

This invention is a burner and feedstock injection assembly for a carbon black reactor having a cooling jacket surrounding the center air pipe (which surrounds the center feedstock pipe). Means are included within the jacket for imparting a whirling motion to the cooling medium as it circulates through the portion of the jacket which is subjected to maximum heat and combustion. Preferably, the jacket also includes an expansion joint mounted outside the reactor toward the upstream end of the assembly.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational view, partly in section, illustrating the preferred embodiment of the burner and feedstock injection assembly;

FIG. 2 is a longitudinal view, partly in section, of one form of a suitable carbon black reactor including the preferred burner and feedstock assembly;

FIG. 3 is a longitudinal view, partly in section, showing another suitable form of a carbon black reactor including the preferred burner and feedstock injection assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, burner and feedstock injection assembly **1** will first be described. The feedstock line is center pipe **2** which is slideably mounted within axial pipe **3** and sealed therefrom by means of suitable packing glands included within closure member **4.** The downstream end of center pipe **2** is provided with a

suitable spray nozzle **5,** which can be any conventional commercially available nozzle.

The upstream end of axial pipe **3** may be provided with a pipe **3***a* for introduction of air into the annulus between the center pipe and the axial pipe, for the purpose of assuring that feedstock does not pass into the annulus.

The tip of nozzle **5** terminates in approximate flush relationship with axial pipe **3.**

Pipe **6,** axial pipe **3,** tubular member **7** and end plate **8** define a jacket through which a cooling medium can flow, preferably entering through pipe **9** and exiting through pipe **10,** but possibly entering through pipe **10** and exiting through pipe **9.**

The annulus between tubular member or pipe **11** and pipe **12** provides a passageway for a hydrocarbon fuel such as natural gas, which is introduced through pipe **13** and enters the reactor through aperture **14** and makes contact with combustion air as shown.

A spiral baffle **15** is included to impart a whirling motion to the cooling medium in order to provide better heat exchange to prevent the formation of damaging hot spots. Preferably, this baffle is positioned and designed as shown in order that it also can function as a spacer. Although it is preferable to position the baffle **15** between pipe **6** and tubular member **7,** as shown, it would be possible to position the baffle between axial pipe **3** and tubular member **7.**

Expansion joints **16** and **17** are preferably included to allow for expansion and contraction resulting from temperature changes.

Circular disc **18** is rigidly affixed to pipes **11** and **12.** The primary purpose of the disc **18** is to prevent blowout of the flame under operating conditions.

Pipe **6** is slideably mounted within the assembly by means of closure member **19** so that the entire subassembly comprising center pipe **2** and the jacket may be (and normally is) extended into the reactor in order that feedstock nozzle **5** can be positioned within the reactor at a predetermined point downstream of disc **18.** Such adjustment of the position of the feedstock injection nozzle within the reactor makes it possible to optimize the primary reinforcing quality of carbon black as expressed by tinting strength and treadwear resistance as well as to adjust the structure properties. Within limits, the further the feedstock nozzle is extended into the reactor of FIG. **2**, the higher the tinting strength and treadwear index, and the lower the structure of the black. The jacket for cooling medium allows greater flexibility in adjusting these properties, because the feedstock nozzle can be extended further into the combustion zone without burning up the axial pipe **3** and nozzle **5.**

FIGS. **2** and **3** show the preferable positioning of the burner and feedstock injection assembly in the upstream end of an elongate tubular carbon black reactor **20.** Preferably, the assembly is slideably mounted in the reactor so that the positioning of the assembly within the reactor can be varied in order to optimize the combustion pattern for any given reactor configuration and any total charge of fuel and oxygen-containing gas.

Although the specific design of the elongate tubular carbon black reactor is not critical to the practice of this invention, we prefer the design shown in FIG. **2,** which is designed for the production of tread grades of black; however, FIG. **3,** which is designed for the production of carcass grades, could also be used.

Referring to FIG. 2, preheated air passes through annulus 21 formed by shell 22 and inner tube 23. Portions of the air enter the interior of the reactor through louvers 24 in combustion air device 25. A portion of the combustion air also enters the reactor through annular opening 26. The downstream end of the reactor can be of any suitable design, as for example FIG. 1 of U.S. Pat. No. 3,256,065 or FIG. 1 of U.S. Pat. No. 3,256,066.

The preheated combustion air enters the reactor of FIG. 3 as shown. The downstream end of the reactor of FIG. 3 can be of any convenient design, as for example FIG. 1 of U.S. Pat. No. 2,976,127.

Although we have shown and described the invention as including means for using a gaseous fuel, it will be readily apparent to those skilled in the art that different fuels and/or means for introduction of fuel could be used. For example, the fuel oil burner and feedstock injection assembly of U.S. Pat. application Ser. No. 59,961, filed July 31, 1970 by Burton F. Latham and William B. Crull could be used in combination with the jacketed subassembly of this invention.

With the subassembly (center pipe 2 plus the jacket) pulled back into the burner as shown in FIG. 1, water cooling is not essential. As the subassembly is pushed into the reactor, circulation of cooling water becomes increasingly important and the required volume of water increases.

EXAMPLE 1

Table I below lists typical operating conditions which have been satisfactorily employed for pilot-plant operations of extended duration while using the burner and feedstock injection assembly of FIG. 1 in a reactor substantially as shown in FIG. 2. The cooling medium used was water, which was passed through an automobile radiator in order to cool it for recirculation to the jacket. Natural gas was used as fuel at air-to-gas ratios of about 14.5 and total combustion air rates of about 150,000 standard cubic feet per hour. The feedstock was a conventional carbon black oil consisting of a highly-aromatic thermal tar.

TABLE I

Run No.	1	2	3	4	5	6	7	8	9	10
Grade	HAF	HAF	HAF	HAF–HS	HAF–HS	SAF	SAF	SAF	ISAF	ISAF
Extension length[1], inches	22	36	42	16	34	29	40	42	20	40
Coolant temp, °F. inlet	–	–	–	109	190	137	184	–	108	194
Outlet	135	204	247	140	200	142	224	240	118	203
Coolant circulation rate, gallons per min.	12.0	12.1	11.1	–	–	–	12.0	12.0	–	–
Coolant pressure, psi	32	38	49	35	68	70	33	38	–	70
Atmospheric temp, °F.	55	72	70	87	98	95	52	55	45	93
Iodine number	89	85	68	91	90	140.1	146	114	116.3	122.0
DBP	123.8	122.4	122.3	153.9	121.3	113.4	116	116.6	125.4	113.0

[1] Distance from disc 18 to tip of nozzle 5.

EXAMPLE 2

Tables II and III below show the effects of extension length upon various properties of carbon black during pilot plant operations, using recirculating water as the coolant as in Example 1. Natural gas was used as fuel at an air-to-gas ratio of about 15 to 1 and a total combustion air rate of about 150,000 standard cubic feet per hour. The feedstock was a conventional carbon black oil consisting of a highly-aromatic thermal tar having an API gravity of 2.3.

TABLE II

HAF-HS Run No.	A	B	C	D
Extension Length, Inches	50	38	26	14
Coolant Temp., °F. Inlet	182	139	158	142
Outlet	200	151	167	147
Coolant Circulation Rate, GPM	39	39	39	39
Coolant Inlet Pressure, psi	74	72	72	73
Atmospheric Temp, °F.	96	87	93	103
Feedstock Oil Rate, GPM at 60°F.	222.0	230.0	231.1	229.7
Feedstock Additive, ppm potassium (To control DBP)	None	None	2	5
Iodine No.	89.5	90.5	88.5	89.5
DBP Absorption	118.2	121.2	121.2	121.1

Note: In runs A and B, water was sprayed on the radiator to improve the cooling of the water from the jacket prior to recirculation.

TABLE III

ISAF-HM Run No.	A	B	C	D
Extension Length, Inches	50	38	26	14
Coolant Temp., °F. Inlet	185	153	159	126
Outlet	202	167	167	131
Coolant Circulation Rate, GPM	39	39	39	39
Coolant Inlet Pressure, psi	75	73	73	73
Atmospheric Temp., °F.	98	98	90	87
Feedstock Oil Rate, GPM at 60°F.	182.6	194.9	189.7	179.0
Feedstock Additive, ppm potassium	None	5.0	2.4	15.0
Iodine No.	119.5	123.5	124.5	123.5
DBP Absorption	112.6	115.3	116.4	114.2

Note: In runs A and B, water was sprayed on the radiator to improve the cooling of the water from the jacket prior to recirculation.

EXAMPLE 3

Table IV below lists operating conditions which have been employed for commercial production of HAF carbon black while using the burner and feedstock injection assembly of FIG. 1 in a reactor substantially as shown in FIG. 2. Water was used as the cooling medium at pressures of about 45–55 psi, inlet temperatures of about 120°–125° F. and outlet temperatures of about 140°–145° F. A heat exchanger was used to cool the water for recirculation to the jacket. Natural gas was used as fuel at air-to-gas ratios of about 15 and at combustion air rates of about 180,000 standard cubic feet per hour. The feedstock was a conventional carbon black oil consisting of a highly-aromatic thermal tar.

TABLE IV

Run No.	1	2	3	4	5	6	7
Extension Length, Inches	24	28	32	36	40	44	48
Feedstock Oil Rate, GPH	311	304	302	296	296	291	289
Iodine No. of Loose Black	83	83	85	85	82.5	95	85

Without water cooling, the nozzle **5** and the end of axial pipe **3** will burn up in a matter of hours or even minutes if the extension length is greater that about 20 inches. Using the water-cooled jacket, operations can be extended almost indefinitely using extension lengths as shown in the Tables above.

While we have thus described the preferred embodiments of the present invention, many variations will be suggested to those skilled in the art. The foregoing description and examples should therefore not be considered limitative; and all such variations and modifications as are in accord with the principles described are meant to fall within the scope of the appended claims.

Having thus described our invention, we claim:

1. In a combination of a burner and feedstock injection assembly concentrically disposed within the upstream end of an elongate, substantially tubular carbon black reactor; said assembly including a center pipe for introduction of feedstock into the reactor; means defining the outer portion of the assembly for introducing fuel into said reactor in a pattern surrounding the assembly in the vicinity of the downstream end of the center pipe; and means for introducing combustion air into the reactor; the improvement comprising:

a double-walled circular jacket surrounding the center pipe, the downstream end of said jacket being sealed from the reactor at a point approximately flush with the downstream end of the center pipe;

a tubular member inserted within the jacket to a point immediately upstream of the sealed end of the jacket;

a conduit for introducing or removing a cooling medium into the outer portion of the jacket between said tubular member and the outer wall of the jacket;

a conduit for removing or introducing said cooling medium from the inner portion of the jacket; and

whirling means inserted within said jacket for imparting a whirling motion to the cooling medium.

2. The combination of claim **1** in which the center pipe-jacket subassembly is slideably mounted within the assembly.

3. The combination of claim **2** in which said whirling means comprises a spiral baffle inserted in the outer portion of the jacket, said baffle being designed and sized so as to act additionally to space the tubular member within the jacket.

4. The combination of claim **3** in which the jacket additionally includes an expansion joint mounted outside the reactor on the upstream end of the jacket.

* * * * *