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S. C. NAIFEH
SMOKE CONTROL

3,095,272

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2 Sheets-Sheet 1

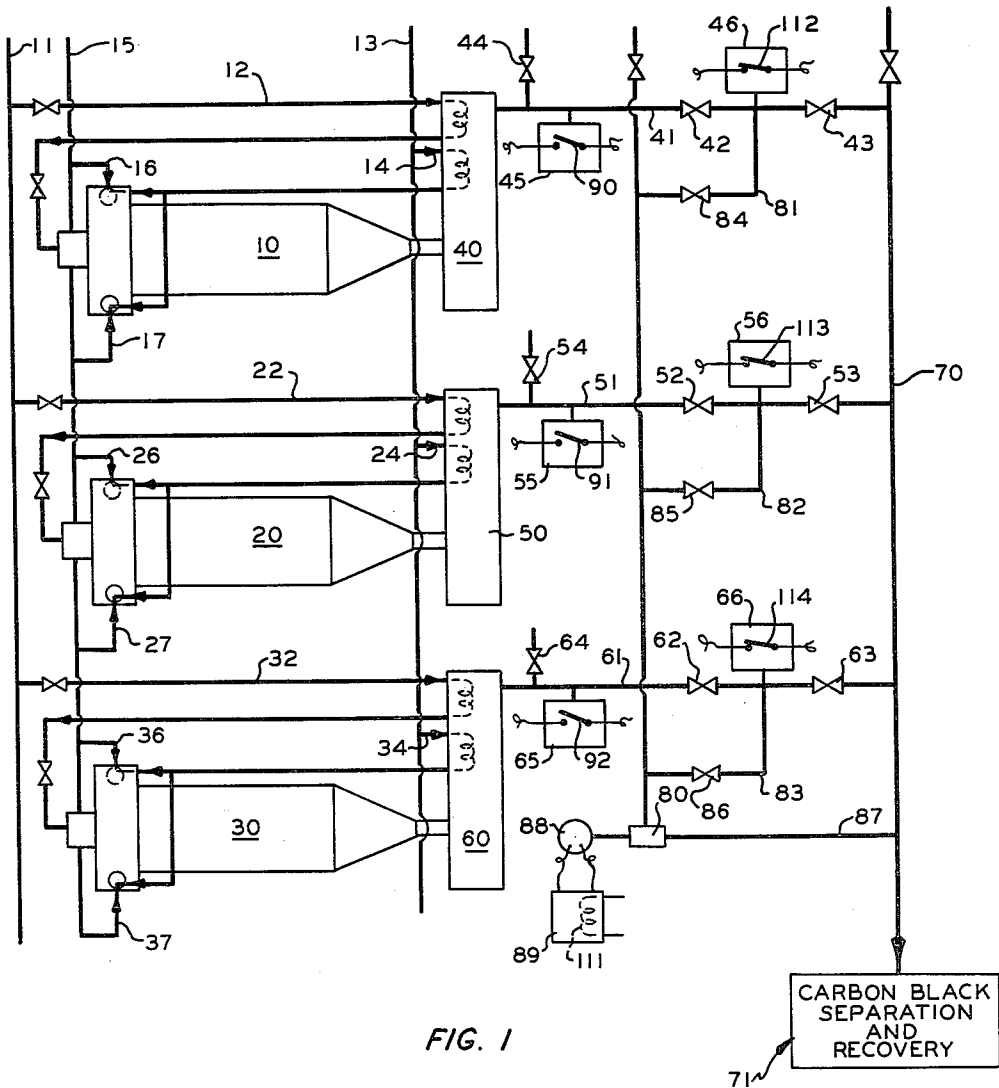


FIG. 1

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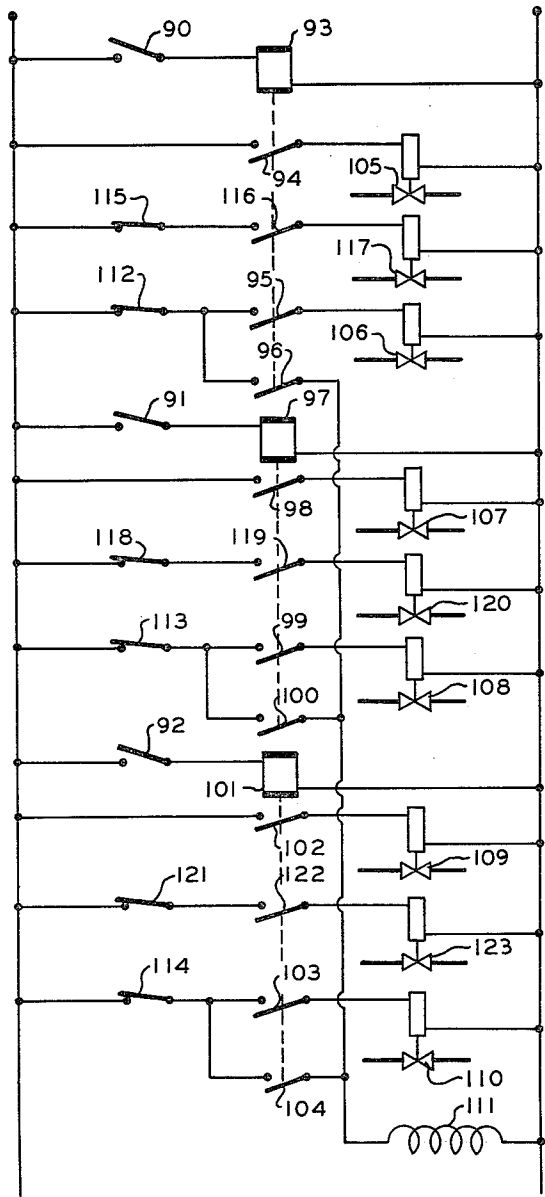


FIG. 2

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SMOKE CONTROL

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9 Claims. (Cl. 23-209.4)

This invention relates to smoke control. In one aspect, the invention relates to means for preventing backflow from a smoke header to a feeding conduit. In another aspect, the invention relates to means for producing carbon black from a plurality of reactors and preventing backflow from a smoke header to the reactors and associated equipment. In another aspect, the invention relates to a method for preventing backflow through a conduit from a smoke header. In another aspect, the invention relates to a method for producing carbon black utilizing a plurality of reaction zones and preventing backflow from a common header zone to the reaction zone and interconnecting zones. In another aspect, this invention relates to automatic means for actuating equipment to prevent backflow from a smoke header through a feeding conduit.

When a plurality of reactors are used to produce carbon black, commonly a smoke header is utilized to collect the effluent from several reactors and conduct it to equipment for further recovery and treatment. Occasionally it is necessary to shut down one or more of the reactors for a period of time. To prevent backflow of carbon black from the header to the reactor and associated equipment, it is necessary to close the conduit connecting the effluent of the reactor with the header. Since the effluent gases are hot while the reactor is in operation, the valve used to close this conduit cannot be manufactured to form a seal tight enough to prevent some flow of gas therethrough. This flow of gas is undesirable because it may be obnoxious to workers in the area and also results in uncontrolled release of carbon black.

An object of this invention is to prevent backflow of smoke from a smoke header when the pressure in the feeding conduit is reduced.

Another object of this invention is to provide an improved carbon black process utilizing a plurality of reactors and preventing backflow of smoke from a header when one reactor is shut down.

Another object of this invention is to provide improved apparatus for producing carbon black including a plurality of reactors, connected with a single smoke header and means to prevent backflow of smoke from the header through a reactor and its associated equipment when that reactor is shut down.

Another object of this invention is to provide automatic control of means for preventing backflow from a smoke header to a feeding conduit.

Other aspects, objects and the advantages of my invention are apparent in the written description, the drawing and the claims.

According to my invention means are provided for preventing leakage from a conduit communicating with a smoke header comprising a pair of valves spaced apart in the conduit and a compressor, the suction of which communicates with the conduit between the valves and the discharge of which communicates with the header. Backflow is prevented by producing a buffer zone in the conduit by substantially restricting the flow area at two locations and withdrawing the fluid from the buffer zone and discharging into the header.

Also, according to my invention, there are provided means for producing carbon black including a plurality of reactors feeding a single smoke header through a plurality of conduits, a pair of valves spaced apart in each of the conduits and a compressor, the suction of which

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communicates with the space between each of the pairs of valves and the discharge of which communicates with the header. Leakage is prevented when one of the carbon black reactors is shut down by producing a buffer zone in one of the conduits adjacent the header, which constitutes a collection zone, by substantially restricting the flow area at two locations and reducing the pressure between these locations by withdrawing fluid therefrom and passing it into the collection zone.

Further, according to my invention, when the pressure between the valves (within the buffer zone) is reduced below a predetermined minimum the suction discharge from that location is closed and the compressor is no longer activated by that portion of the system. Automatic means can be used to close the valves (create the buffer zone), start the compressor and open the compressor suction when the pressure in the feeding conduit is reduced below a predetermined minimum and to close this suction and deactivate the compressor driving means when the pressure between the valves is reduced below a second predetermined minimum.

FIGURE 1 is a schematic representation of a carbon black producing system including a plurality of reactors and a single smoke header.

FIGURE 2 is a diagrammatic representation of a circuit for automatic operation of the smoke control system of my invention.

In FIGURE 1, reactors 10, 20 and 30 are connected through preheaters 40, 50 and 60 with smoke header 70. Reactant feed line 11 is connected through pipe 12, through preheater 40 to the inlet of reactor 10. Similar pipes 22 and 32 are provided for reactors 20 and 30. Air supply 13 is connected through pipe 14 with preheater 40 and the tangential inlets of reactor 10. Similar pipes 24 and 34 are provided for reactors 20 and 30. Fuel supply line 15 is connected with the tangential inlets of reactor 10 through pipes 16 and 17, and similarly with reactor 20 and 30 through pipes 26 and 27 and 36 and 37. The effluent from reactor 10 passes through preheater 40 and conduit 41 into header 70. Valves 42 and 43 are provided in conduit 41 while a vent valve 44 provides an outlet therefrom. A first pressure-detecting means 45 and a second pressure-detecting means 46 are provided as shown. Similar pairs of valves 52 and 53 and 62 and 63 and vent valves 54 and 64 and first and second pressure-detecting means 55 and 56 and 65 and 66 are provided in conduits 51 and 61. Header 70 discharges to carbon black processing system 71.

A compressor 80 is connected by suction lines 81, 82 and 83 with conduits 41, 51 and 61, respectively. Valves 84, 85 and 86 are provided in the suction lines as shown. The discharge 87 of compressor 80 is connected with header 70. A driving motor 88 for compressor 80 is provided with starting means 89.

In operation a reactant such as an aromatic liquid petroleum hydrocarbon is fed through reactant feed line 11 and pipes 12, 22 and 32 to the axial inlets of reactors 10, 20 and 30, in each instance being heated by passing in heat exchange with the effluent from the corresponding reactor. Hot products of combustion are fed to the reactors through the various tangential inlets thereof as shown by uniting a mixture of air and fuel supplied through air supply 13 and fuel supply 15. The air supply in each instance, as fed through pipes 14, 24 and 34, is heated by heat exchange with the effluent products from the reactors while the fuel is fed through pipes 16, 17, 26 and 27, and 36 and 37 to mix with the air to form a combustible mixture which burns and supplies hot gaseous products of combustion tangentially into the reactors to heat the reactant therein and produce carbon black therefrom.

The effluent from the reactors passes through conduits 41, 51 and 61 into smoke header 70, vent valves 44, 54

and 64 and compressor suction valves 84, 85 and 86 being closed and pairs of valves 42 and 43, 52 and 53, and 62 and 63 being open. When it is necessary to take a reactor off production, the reactant feed to that reactor is cut off and the fuel and air tangential feed is reduced to about 25 percent of normal capacity. The vent valve is opened and the pair of valves in that conduit closed, the corresponding suction valve opened and the compressor started. The tangential feed to the reactor can then be shut off completely without any leakage of smoke back through the reactor system.

As the compressor withdraws fluid from the space between the valves there is an accumulation of carbon black on the inlet side of the valve adjacent the smoke header. In many instances this accumulation is sufficient to cause a complete shutoff at this point and the operation of the compressor can be discontinued. In some instances it may be necessary to operate the compressor intermittently to withdraw a very small amount of leakage through the valve into the conduit.

It is sometimes desirable to provide automatic control of the smoke leakage prevention apparatus. This can be accomplished through the use of the electrical circuit illustrated in FIGURE 2. In this circuit, switches 90, 91 and 92 are pressure-actuated switches controlled by pressure-detecting means 45, 55 and 65, respectively. Each of these switches closes when the pressure in the corresponding conduit falls below a predetermined minimum. Similar circuits are provided, controlled by each of these switches. The apparatus includes relay 93 controlling contacts 94, 95 and 96, relay 97 controlling contacts 98, 99 and 100, and relay 101 controlling contacts 102, 103 and 104. Solenoid valves 105, 106, 107, 108, 109 and 110 and coil 111 are actuated by these contacts, as shown. Switches 112, 113 and 114 are actuated by pressure detecting means 46, 56 and 66, respectively, being normally closed and adapted to open when the corresponding pressure is reduced below a predetermined amount. When this system is used, valves 42, 43, 52, 53, 62 and 63 are normally open, air pressure-closed valves, while valves 84, 85 and 86 are normally closed, air pressure-opened valves. Valve 105 controls the flow of air from a source of air under pressure (not shown) to valves 42 and 43, valve 107 similarly controls the flow of air to valves 52 and 53, and valve 109 similarly controls the flow of air to valves 62 and 63. Valves 106, 108 and 110 control the flow of air to valves 84, 85 and 86, respectively. Coil 111 is the actuating coil for starting means 89.

If, for example, reactor 10 is to be shut down, the oil feed through line 12 is cut off and the tangential feed through lines 16, 17 and 14 reduced to about 25 percent of normal. Vent valve 44 is opened. This results in a reduction in pressure in conduit 41. When the pressure is reduced sufficiently switch 90 closes, thus energizing relay 93 closing contacts 94, 95 and 96. When contacts 94 are closed solenoid valve 105 is opened, thus applying air pressure to valves 42 and 43 to close them. The closing of contacts 95 open solenoid valve 106 to apply pressure to valve 84 to open it. The closing of contacts 96 complete a circuit through coil 111 of starting means 89, thus starting driving motor 88 and compressor 80. In this way any smoke which leaks from header 70 through valve 43 is removed through suction 81 and compressor 80 to discharge line 87 back into header 70 and this smoke is thus prevented from flowing outward through valve 42 since the pressure in conduit 41 between valves 42 and 43 is maintained slightly below atmospheric. The carbon black which settles and filters on the header side of valve 43 often is sufficient to effectively stop leakage past this point. When this occurs the pressure within the conduit between valves 42 and 43 drops to a lower value, below the point at which switch 112 opens, thus interrupting the circuit to solenoid valve 106 allowing it to close, thus stopping the supply of air to valve 84 allowing it also to close. At the same time the circuit is interrupted

to coil 111 allowing driving means 81 and therefore compressor 80 to be stopped. Since coil 111 also is in the circuit with contacts 100 of relays 97 and contacts 104 of relay 101, this device can be actuated independently of any one reactor system. That is, it remains running as long as the actuating circuit of any one of the control sections is energized.

In the system described above, the vent valve is actuated manually and would be closed manually if desired after the compressor is in operation. If it is desired to operate this vent completely automatically, an additional contact is placed on each relay and an additional pressure switch placed either in conjunction with the first pressure-detecting means of each system or with a separate pressure-detecting means. In the circuit which controls the system of reactor 10, this is indicated by the circuit which includes pressure switch 115, relay contacts 116 and solenoid valve 117. With this circuit switches 90, 112 and 115 all are actuated at different pressures. Switch 90 is actuated by the reduction in pressure which occurs when the tangential fuel air supply is reduced to about 25 percent of normal. When this occurs, in addition to the operation of the valves 42, 43, 84 and compressor 80, etc. as described above, contacts 116 also close thus energizing solenoid valve 117 which opens to allow the application of air under pressure to valve 44, which is a normally closed valve opened by the application of air pressure. Following this operation, when the tangential supply of fuel and air to the reactor is cut off, there is an additional pressure drop, substantially to atmospheric pressure. When this occurs, switch 115 opens thus breaking the circuit to solenoid valve 117 allowing it to close and consequently allowing vent valve 44 to close. As described above, switch 112 opens at a pressure below atmospheric.

The operation of the circuits associated with reactors 20 and 30 is substantially the same as described above, the switches 91, 113 and 118 being actuated by the pressures in conduit 51 while the switches 92, 114 and 121 are actuated by the pressures in conduit 61.

To simplify the description of my invention many details of the equipment utilized have been omitted or shown schematically. Suitable carbon black reactors are described in United States patents, such as Ayers, Re. 22,886, June 3, 1947; Krejci, 2,375,795, May 15, 1945; Krejci, 2,564,700, August 21, 1951; and Krejci, 2,641,534, June 9, 1953. Suitable carbon black separation and recovery systems are also shown in issued patents, as for example in Wood, 2,776,725, January 8, 1957. Although many hydrocarbons are suitable as the feed for converting to carbon black, a preferred feed stock in an aromatic gas oil having a BMCI between about 90 and about 120. A preferred fuel for the tangential feed is a dry residue natural gas.

Reasonable variation and modification are possible within the scope of my invention which sets forth method and apparatus for preventing backflow from a smoke header through a conduit which feeds it, especially in the conversion of hydrocarbons to carbon black, by utilizing a pair of valves in the conduit, drawing a suction on the space between the valves and returning the fluid that is removed to the header and automatic means for controlling such process and apparatus.

I claim:

1. Means for preventing leakage from a smoke header, comprising a conduit communicating with such header, a pair of valves spaced apart in said conduit, a compressor, a suction conduit for said compressor communicating with said conduit between said valves, and a discharge for said compressor communicating with said header.

2. Means for producing carbon black comprising a plurality of carbon black reactors, a smoke header, a plurality of conduits, each conduit communicating with one of said reactors and with said header, carbon black recovery means communicating with said header, a pair

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of valves spaced apart in each of said conduits, a compressor, a suction conduit for said compressor communicating with each of said conduits between said valve, and a discharge for said compressor communicating with said header.

3. Means for preventing leakage from a smoke header comprising a conduit communicating with said header, a pair of valves spaced apart in said conduit, a compressor, a suction conduit for said compressor communicating with said conduit between said valves, a discharge for said compressor communicating with said header, detection means for determining when flow ceases through said valve nearest said smoke header, and means to discontinue flow through said suction conduit responsive to said detection means.

4. Means for producing carbon black comprising a plurality of carbon black reactors, a smoke header, a plurality of conduits, each conduit communicating with one of said reactors and with said header, carbon black recovery means communicating with said header, a pair of valves spaced apart in each of said conduits, a compressor, a suction conduit for said compressor communicating with each of said conduits between said valves, a discharge for said compressor communicating with said header, detection means for determining when flow ceases through said valve of each pair of valves nearest said smoke header, and means to discontinue flow through said suction conduit responsive to said detection means.

5. A method for preventing backflow to a conduit from a smoke header comprising the steps of producing a buffer zone in said conduit by substantially restricting the flow area of said conduit at two locations, reducing the pressure in said buffer zone below atmospheric by withdrawing fluid from said buffer zone and passing said fluid into said smoke header.

6. A method for producing carbon black comprising the steps of converting a hydrocarbon to a smoke comprising carbon black in a plurality of reaction zones, passing said smoke from each of said reaction zones through a separate conducting zone to a single smoke collection zone, preventing backflow of smoke from said collection zone to one of said conducting zones during an interval when the corresponding reaction zone is not in operation by producing a buffer zone in said one conducting zone adjacent said collection zone by substantially restricting the flow area of said one conducting zone at two locations, reducing the pressure in said buffer zone below atmospheric by withdrawing fluid from said buffer zone and passing said fluid into said collection zone.

7. A method for preventing backflow through a conduit from a smoke header comprising the steps of producing a buffer zone in said conduit by substantially restricting the flow area of said conduit at two locations,

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reducing the pressure in said buffer zone below atmospheric by withdrawing fluid from said buffer zone and passing said fluid into said smoke header, continuing to withdraw said fluid from said buffer zone until carbon black deposited at said location adjacent said smoke header reduces flow therethrough to an insignificant amount, and thereafter discontinuing the withdrawal of said fluid from said buffer zone.

8. A method for producing carbon black comprising the steps of converting the hydrocarbon to a smoke comprising carbon black in a plurality of reaction zones, passing said smoke from each of said reaction zones through a separate conducting zone to a single smoke collection zone, preventing backflow of smoke from said collection zone to one of said conducting zones during an interval when the corresponding reaction zone is not in operation by producing a buffer zone in said one conducting zone adjacent said collection zone by substantially restricting the flow area of said one conducting zone at two locations, reducing the pressure in said buffer zone below atmospheric by withdrawing fluid from said buffer zone and passing said fluid into said collection zone, continuing to withdraw said fluid from said buffer zone until carbon black deposited at said location adjacent said smoke header reduces flow therethrough to an insignificant amount, and thereafter discontinuing the withdrawal of said fluid from said buffer zone.

9. Means for producing carbon black comprising a plurality of carbon black reactors, a smoke header, a plurality of conduits, each of said conduits communicating with one of said reactors and with said header, carbon black recovery means communicating with said header, a pair of valves spaced apart in each of said conduits, a compressor driving means for said compressor, a separate suction conduit for said compressor corresponding with and communicating with each of said conduits between said valves, a discharge for said compressor communicating with said header, a first pressure-detecting means in each of said conduits between the corresponding reactor and valves, second pressure-detecting means in each of said conduits between said valves, means responsive to the pressure detected by each of said first means to close said valves, open the corresponding suction and actuate said driving means to start said compressor, means responsive to the pressure detected by said second detection means to close said suction and deactivate said driving means when the pressure detected by said second means falls below a predetermined minimum.

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