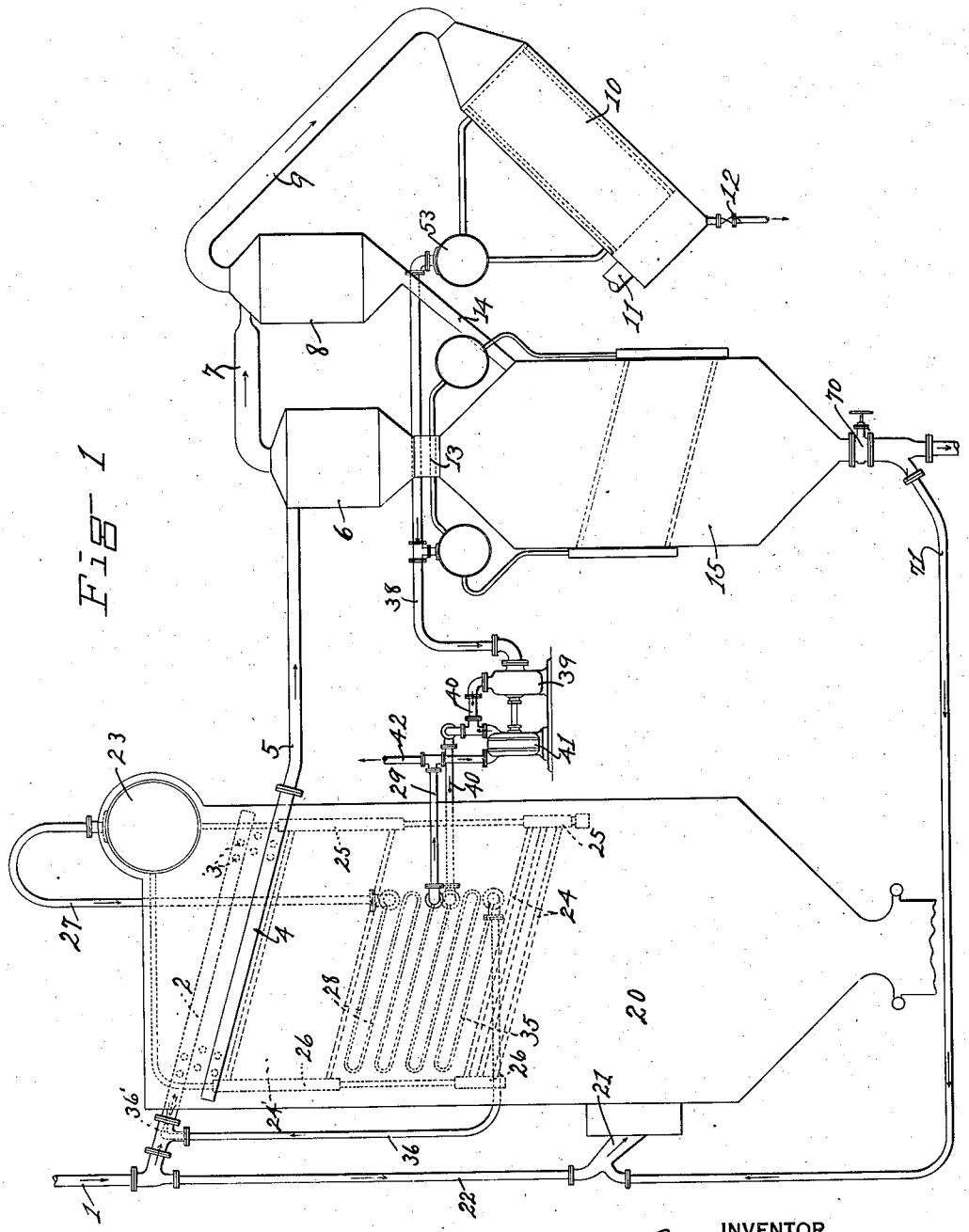
May 17, 1932. C. E. LUCKE 1,858,834

PULVERIZED COAL CARBONIZATION PROCESS

Filed Oct. 30, 1928 4 Sheets-Sheet 1

Fig. 1



INVENTOR
Charles E. Lucke
BY
Gifford & Scull
ATTORNEYS

May 17, 1932. C. E. LUCKE 1,858,834

PULVERIZED COAL CARBONIZATION PROCESS

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Fig. 3

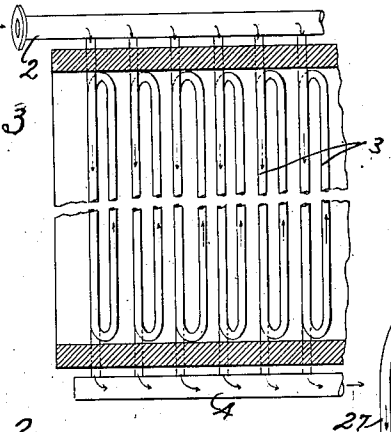
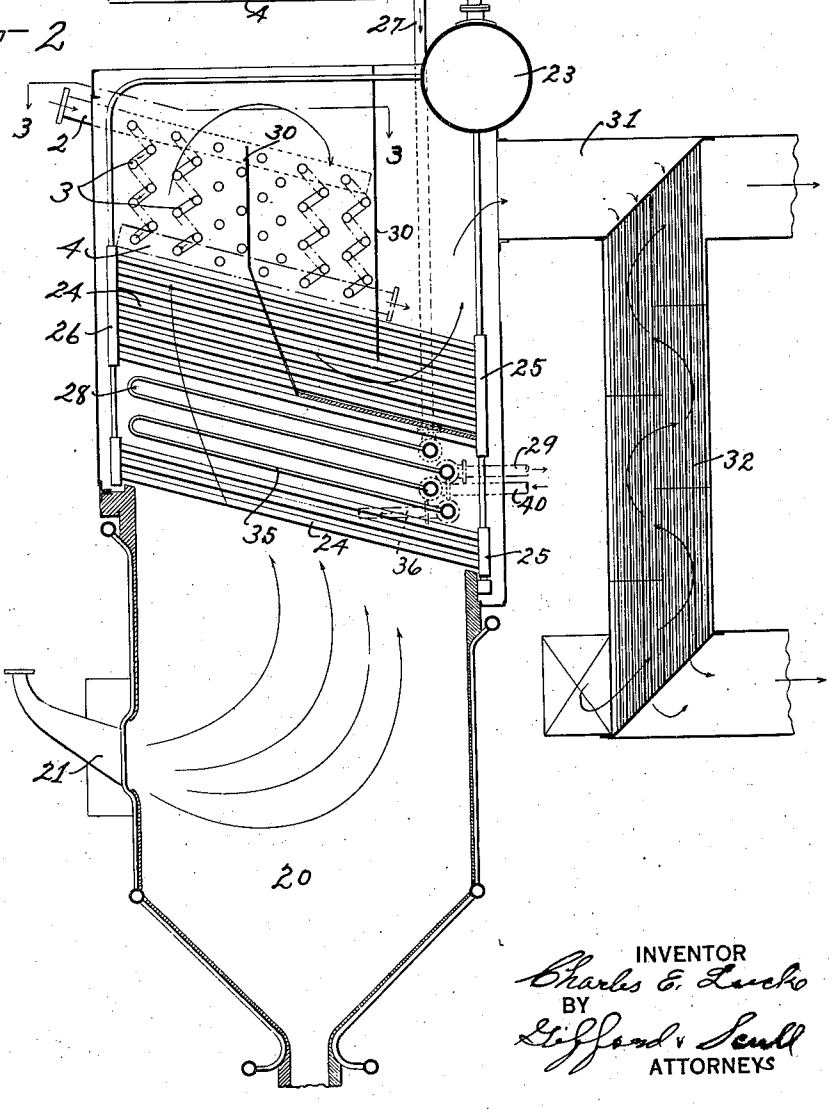


Fig. 2



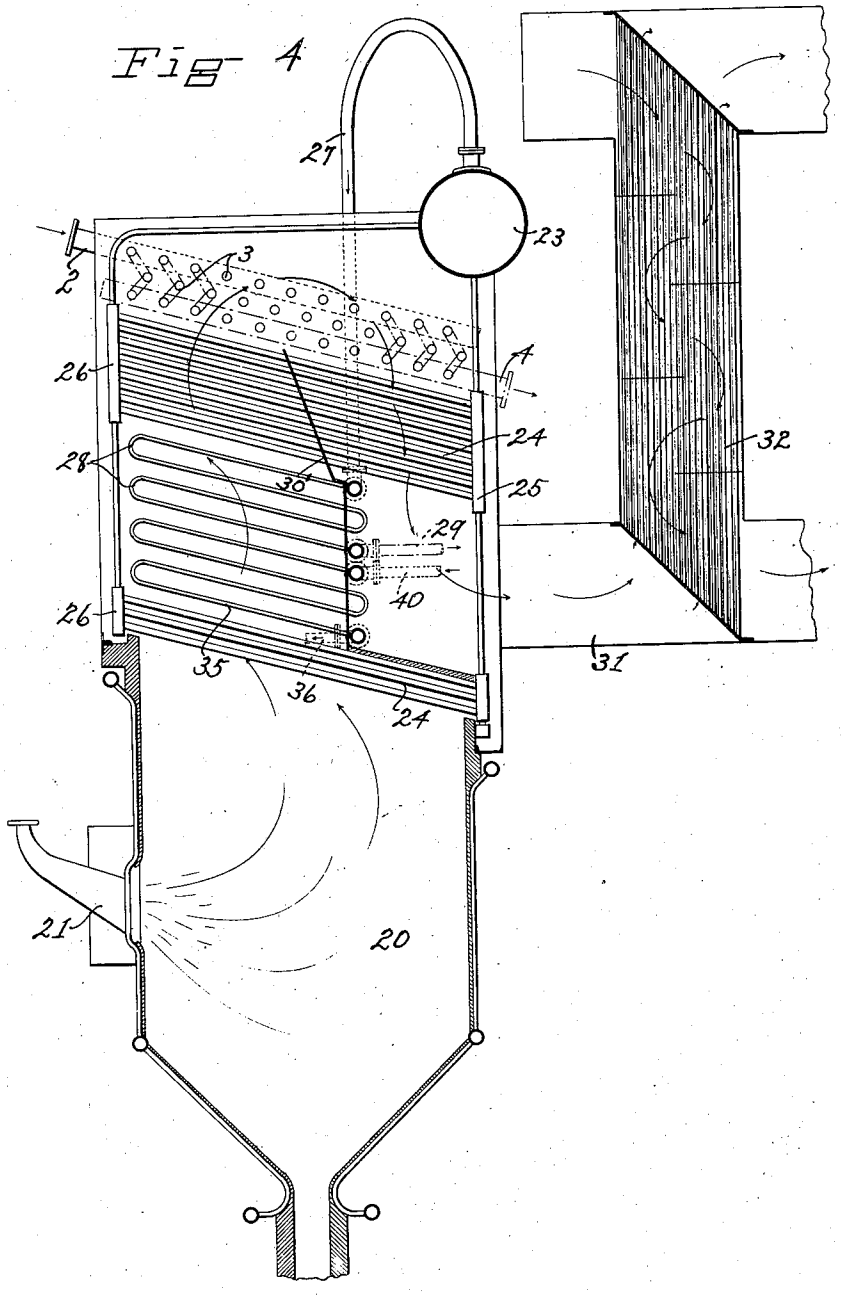
INVENTOR
Charles E. Lucke
BY
Gifford & Scull
ATTORNEYS

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Fig 4



INVENTOR
Charles E. Lucke
BY
Gifford & Scull
ATTORNEYS

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PULVERIZED COAL CARBONIZATION PROCESS

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Fig 6

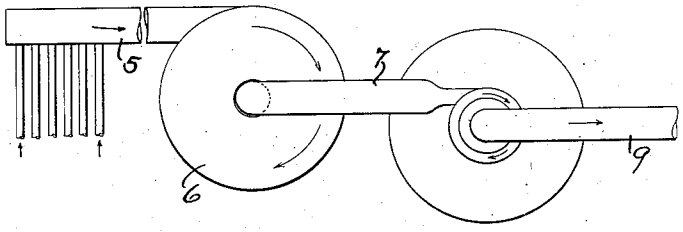
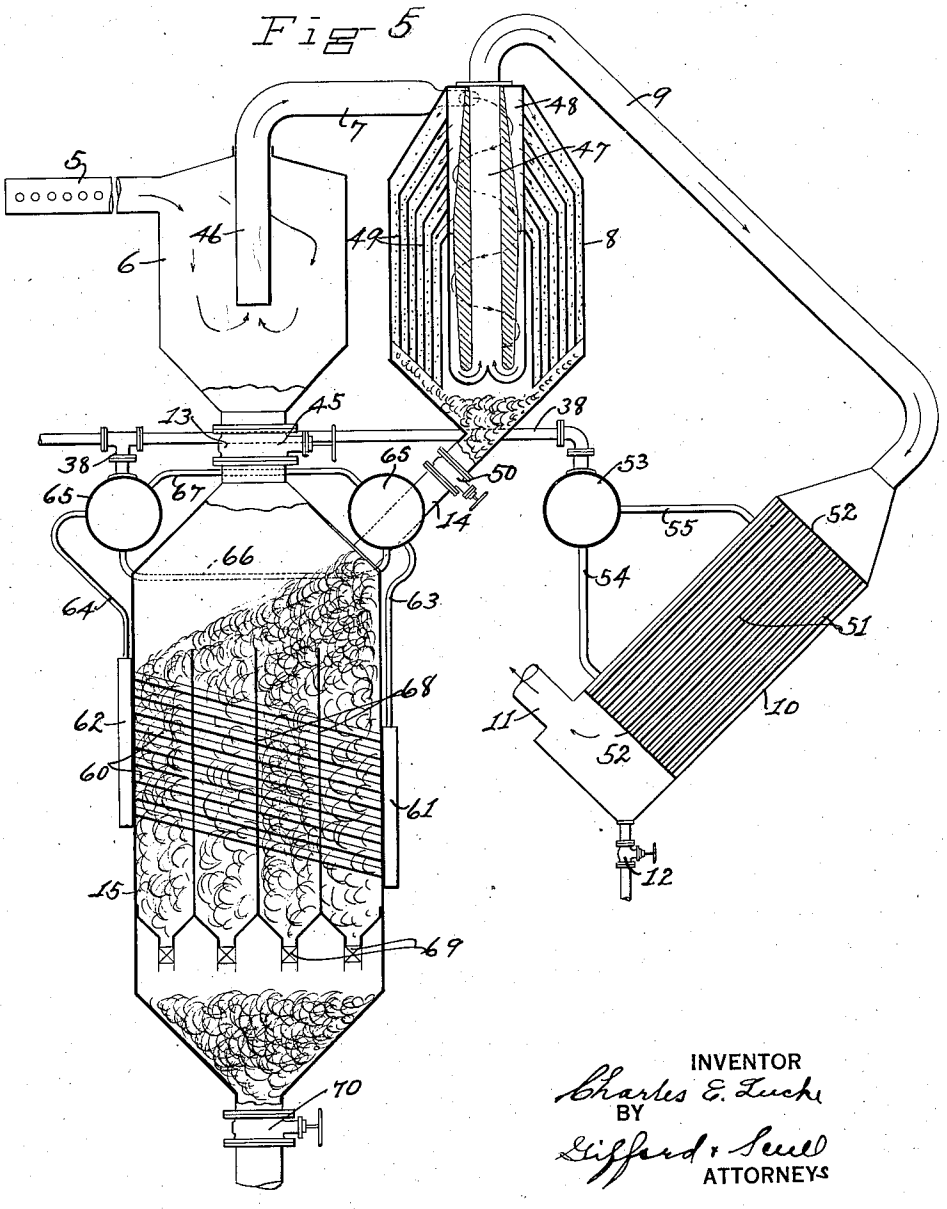


Fig 5



INVENTOR
Charles E. Lucke
BY
Gifford & Seull
ATTORNEYS

Patented May 17, 1932 1,858,834

UNITED STATES PATENT OFFICE

CHARLES E. LUCKE, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY

PULVERIZED COAL CARBONIZATION PROCESS

Application filed October 30, 1928. Serial No. 316,083.

This invention relates to a process and apparatus for treating pulverized coal so as to produce valuable products and at the same time generate steam for power purposes.

The invention will be understood from the description in connection with the accompanying drawings in which Fig. 1 is a side view, partly diagrammatic, showing an illustrative arrangement of apparatus for carrying out the invention; Fig. 2 is a vertical section showing the high pressure boiler; Fig. 3 is a section along the line 3—3 of Fig. 2; Fig. 4 is a vertical section similar to Fig. 2, showing a modification of the boiler; Fig. 5 is a vertical section showing separators and low pressure boilers; and Fig. 6 is a plan view of the separators.

In the drawings reference character 1 indicates a pipe or conduit from a source (not shown) of powdered coal, leading to the inlet header 2 of a coal carbonizer that comprises tubes 3 that may pass back and forth across the gas path of the high pressure water tube boiler terminating in the carbonizer outlet header 4. A pipe 5 leads from the outlet header 4 tangentially into the cyclone separator 6, from which a pipe 7 leads to another separator 8, from the upper portion of which an outlet pipe 9 leads to a low pressure boiler 10. A gas outlet 11 is provided at the lower portion of the boiler 10 and a valved liquid outlet pipe 12 is provided at the bottom thereof. Conduits 13 and 14 lead from the bottom of the separators 6 and 8, respectively, to the low pressure boiler 15.

The furnace 20 (Figs. 1, 2 and 3) of the boiler is provided with fuel by means of one or more burners 21 and a water tube boiler of the Babcock & Wilcox type is illustrated in position above the furnace 20. A branch pipe 22 leads from the powdered coal pipe 1 to the burners 21.

A water tube boiler is provided with the usual steam and water drum 23, banks of inclined tubes 24 and 24′, downtake headers 25 and uptake headers 26 connected to the drum 23. A pipe 27 leads from the steam space of the steam and water drum 23 to the high pressure superheater 28, from which a pipe 29 leads away.

The boiler may be provided with baffles 30 (Fig. 2) to make three passes of the gases across water tubes, the gases passing through the conduit 31 and thence through the air heater 32 to the stack. The boiler may, however, be provided with a baffle 30′ (Fig. 4) to make a two pass path of the furnace gases across water tubes or be otherwise baffled. A low pressure steam superheater 35 may be located between banks of inclined tubes 24, this superheater being provided with an outlet pipe 36 that leads into the carbonizer header 2 with a jet or spray 36′ to cause the steam to operate as a conveyor for the pulverized coal particles in suspension, the steam also reacting with the products as will be more fully described below.

A steam pipe 38 leads from the low pressure steam boilers 10 and 15 to a steam compressor 39, from which an outlet pipe 40 leads to the inlet of the superheater 35. The compressor 39 is driven by a high pressure steam turbine 41 by steam that enters it from a branch pipe extending from the steam outlet 29. The exhaust steam from the turbine 41 passes through the pipe 40 into the low pressure superheater 35. The remainder of the high pressure steam generated in the boiler may pass through the steam pipe 42 for power generating or other purposes.

The separators 6 and 8 and the low pressure steam boilers 10 and 15 are shown more in detail in Figs. 5 and 6. A gate or valve 45 is provided in the conduit 13 at the lower end of the cyclone separator 6. An extension 46 from the outlet 7 projects downwardly into the cyclone separator 6 and the larger solid particles are not carried through the pipe 7. The separator 8 is provided with a central pipe 47 tapering along the outside from the

middle toward both ends and is surrounded by a cylinder 48 spaced from the pipe 47 to provide the tapering annular spaces between the two, which first increase and then decrease the velocity, the cylinder 48 being perforated above the narrowest portion of the annular space between the pipe 47 and cylinder 48. Concentric partitions 49 are provided around the cylinder 48 having conical upper ends fitting around the perforated part of the cylinder 48, so that the mixture of solid particles and the gases or vapors in which they are suspended entering tangentially the annular space from the pipe 7 is separated by centrifugal force, the solid particles passing out through the perforations and between the partitions 49 to the lower portion of the separator 8, while the velocity is increasing, and the gases passing to the lower ends of the pipe 47 at a decreasing velocity, as indicated by the arrows, and thence upwardly through the pipe 47 with further decrease of velocity and out through the pipe 9. A gate or valve 50 is provided in the conduit 14 between the separator 8 and the boiler 15.

The low pressure boiler 10 comprises inclined tubes 51 connected at their ends to tube sheets 52, so that the hot gases and vapor passing through the pipe 9 then pass through the tubes 51 and heat them, thereby becoming cooler and condensing some of the vapor. The tubes 51 are surrounded with water that enters from the steam and water drum 53 through the circulator tubes 54. The steam or mixture of steam and water passes through the circulator tubes 55 to the steam and water drum 53. The water level in the boiler 10 can be maintained about the middle of the steam and water drum 53 in any convenient way.

The low pressure steam boiler 15 comprises inclined tubes 60 connected to downtake headers 61 and uptake headers 62 that are connected by nipples 63 and 64, respectively, to the steam and water drums 65. The water spaces of the steam and water drums 65 are connected by one or more pipes 66 and the steam spaces thereof are connected by one or more pipes 67. The water level in the boiler 15 may be kept at about the middle of the drum 65 in any convenient way. Vertical partitions 68 extend across the tubes 60 and the spaces between the lower ends of these partitions are provided with valved outlets 69 and a valved outlet 70 for coke is provided at the lower end of the boiler casing. A branch 71 may extend from the outlet 70 to the burners 21.

The operation is as follows:

The pulverized coal enters from the pipe 1, together with superheated steam from the pipe 36, into the carbonizer comprising the header 2, tubes 3 and header 4, which carbonizer is heated by hot gases after they have passed across some of the steam generating tubes of the boiler to give the gases a suitable temperature. The carbonizer is indicated as being located in the gas passes, where the gases are hot enough to heat the coal to a temperature somewhere between about 900° F. and 1500° F. and not so hot as to damage the tubes. Volatile products are distilled off from the coal in suspension, thus producing coke in suspension with which the steam present may react in part to form water gas when a sufficiently high temperature is maintained. The process products including the hydrocarbons that have been distilled off, uncombined steam and coke particles with or without some water gas pass through the pipe 5 tangentially into the cyclone separator 6 where the heavier solid particles of coke are separated and pass into the low pressure boiler 15 through the conduit 13. The gaseous and vapor products and the lighter solid particles pass through the pipe 7 into the second separator 8 where the finer particles are separated and pass through the conduit 14 into the boiler 15. The hot gases, residue, steam and volatilized hydrocarbons pass through the pipe 9 into the low pressure boiler 10 where they are cooled, the uncondensed gases passing through the gas outlet pipe 11 to gas washers or purifiers, and the condensed liquid hydrocarbons and water being withdrawn through the valved outlet pipe 12. The heat given up by the gasous and vapor products in the tubes of the boiler 10 generates steam that collects in the steam and water drum 53, and then passes through the pipe 38 along with steam from the boiler 15 through the steam compressor 39 to the low pressure superheater 35, and thence through the pipe 36 into the carbonizer.

The hot coke particles passing through the conduits 13 and 14, pass into the boiler 15 between the partitions 68. The valves 69 at the bottom of the partitions are adjusted so that the particles of coke remain in contact with or pass slowly along the outside surfaces of the tubes 16, long enough to give up their heat to the same, and thereby generate low pressure steam. The rate at which particles of coke pass along the outside of the tubes 60 over their whole length can be regulated by adjusting separately each of the valves 69. The steam produced in the boiler 15 is not necessarily of the same pressure as that produced in the boiler 10 as reducing valves, not shown, can be used between either or both of these boilers and the pipe 38. A portion or all of the coke that passes out through the outlet 70 can be passed through the pipe 71 and burned in the burners 21 for generating steam in the high pressure boiler. High pressure steam may be used to supplement the supply of low pressure steam when necessary by a connection not shown, or at times it may entirely replace low pressure steam as for example

when starting the system. It is understood that any other source of low pressure steam may be used as for example the exhaust of turbines, engines, pumps and the like, or steam bled from stages of a turbine, and when available steam has sufficient pressure it need not be passed through the compressor. While a steam turbine type of turbo-compressor is shown it is also understood that any other type may be used such as the steam jet type or the cylinder type.

I claim:

1. A coal carbonization process which comprises entraining pulverized coal in a stream of superheated steam to form an attenuated column, removing the fluid and solid products of carbonization from said column, burning some of the removed products to produce high pressure superheated steam and heat for carbonization, extracting some heat from remaining products for the production of low pressure steam, using some of the high pressure steam to compress the low pressure steam, joining the compressed low pressure steam with the high pressure steam after utilization in effecting compression, and then superheating the aforesaid combined steam with some of the heat from the burning products.

2. A coal carbonization process which comprises entraining pulverized coal in a stream of superheated steam to form an attenuated column, removing the fluid and solid products of carbonization from said column, burning some of the removed solid products to produce high pressure superheated steam and heat for carbonization, extracting some heat from remaining products for the production of low pressure steam, using some of the high pressure steam to compress the low pressure steam, joining the compressed low pressure steam with the high pressure steam after utilization in effecting compression, then superheating the aforesaid combined steam with some of the heat from the burning solid products.

3. A coal carbonization process which comprises entraining pulverized coal in a stream of superheated steam to form an attenuated column, removing the fluid and solid products of carbonization from said column, burning some of the removed solid products to produce high pressure superheated steam and heat for carbonization, extracting sensible heat from the products for the production of low pressure steam, using some of the high pressure steam to compress the low pressure steam, joining the compressed low pressure steam with the high pressure steam after utilization in effecting compression, and then superheating the aforesaid combined steam with some of the heat from the burning products.

4. A coal carbonization process which comprises entraining coal in a stream of superheated steam to form an attenuated column, removing the fluid and solid products of carbonization from said column, utilizing the sensible heat in said products for creating low pressure steam, burning some of the products of carbonization for producing high pressure superheated steam and heat for carbonization, and superheating the low pressure steam with some of the heat of the burning products after compressing said low pressure steam with high pressure steam.

CHARLES E. LUCKE.