Dec. 2, 1930. O. H. HERTEL 1,783,190

CARBONIZING APPARATUS

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Fig. 1.

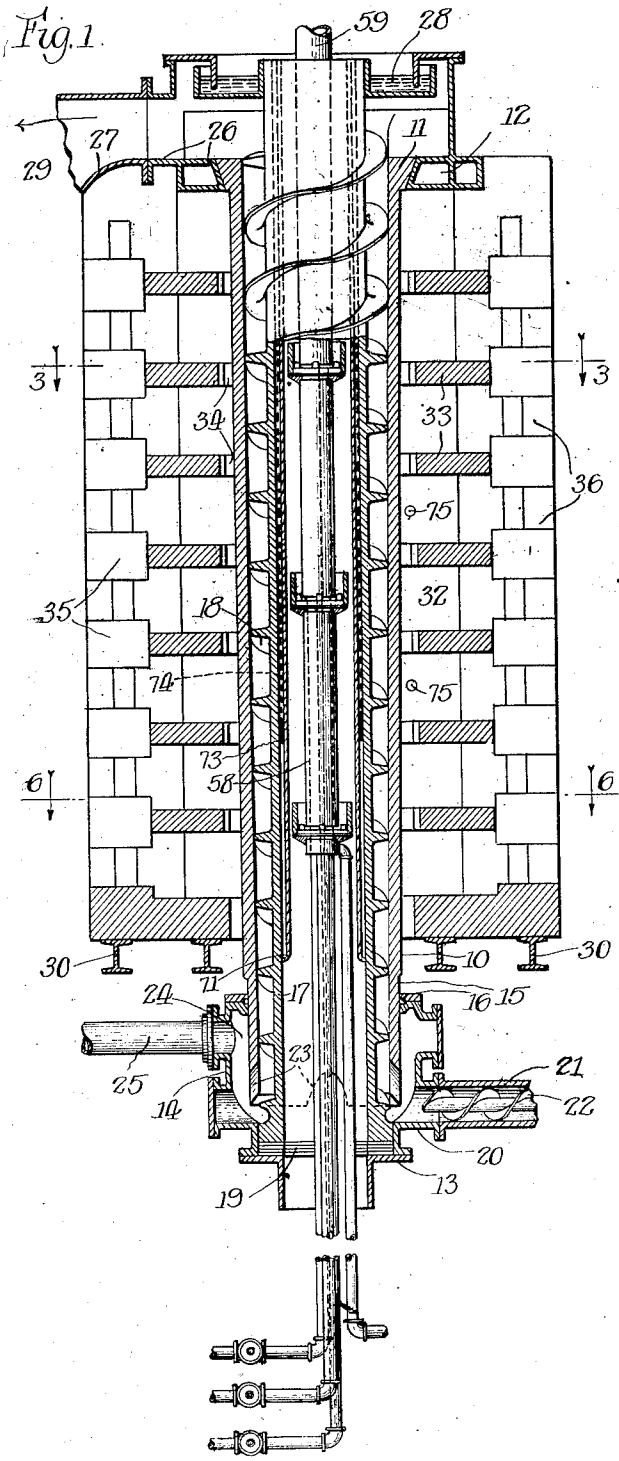
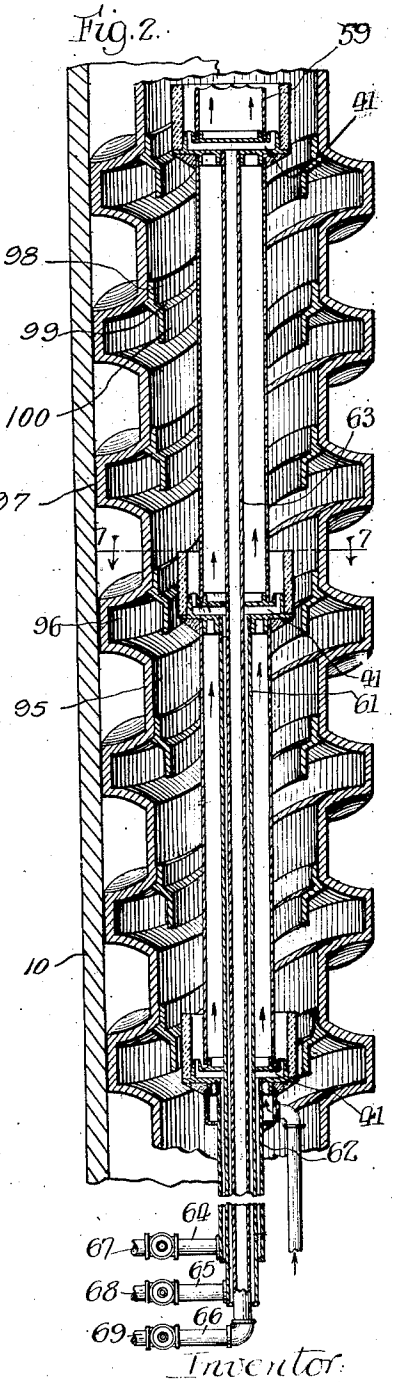


Fig. 2.



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Fig. 3.

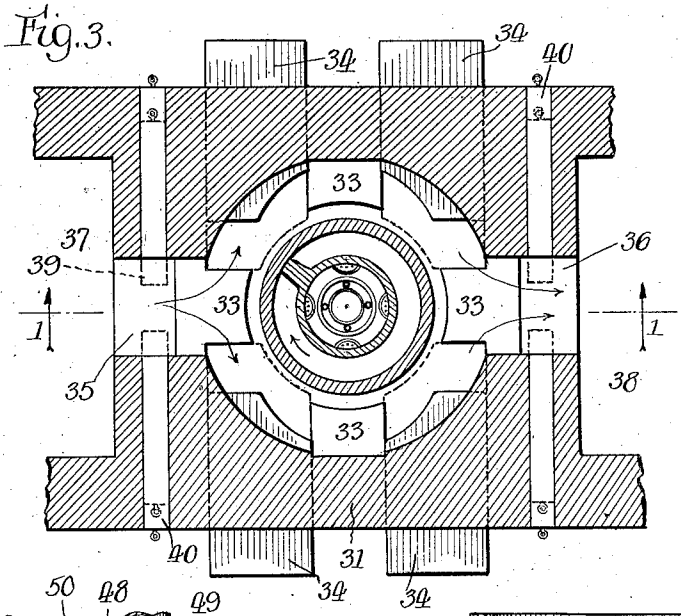


Fig. 4.

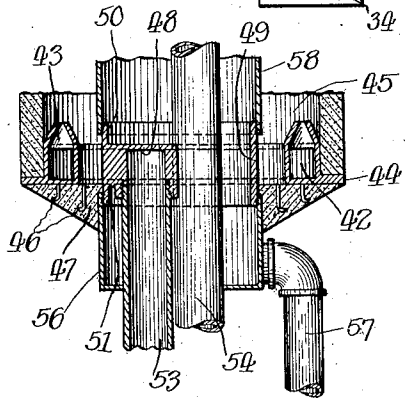


Fig. 5.

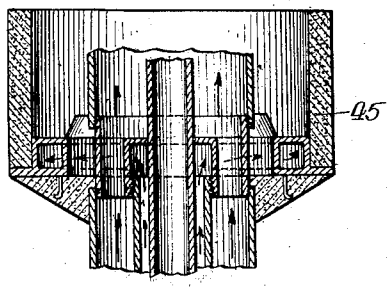


Fig. 7.

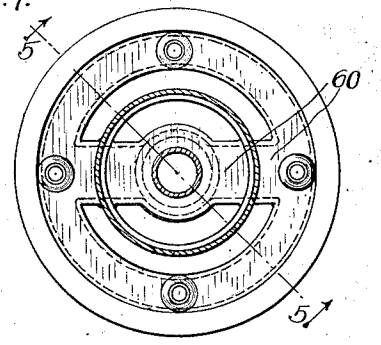
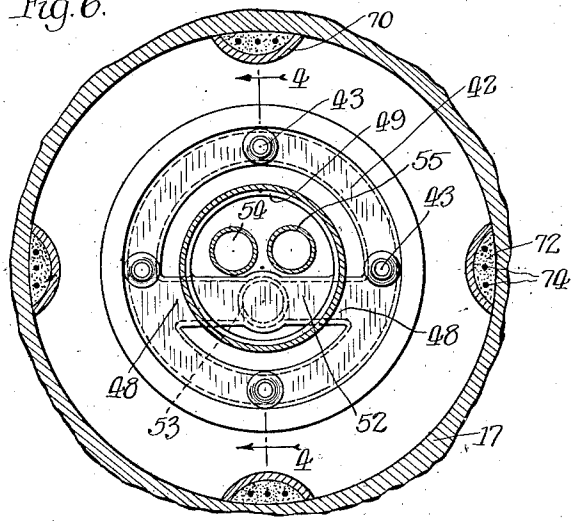


Fig. 6.



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CARBONIZING APPARATUS

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Fig. 8.

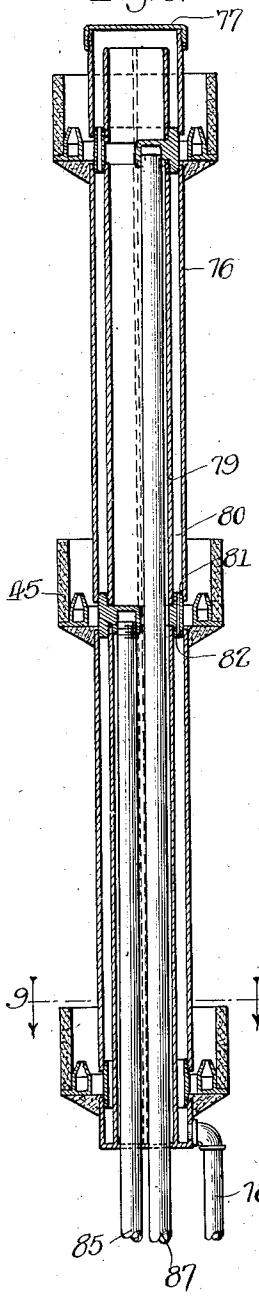


Fig. 9.

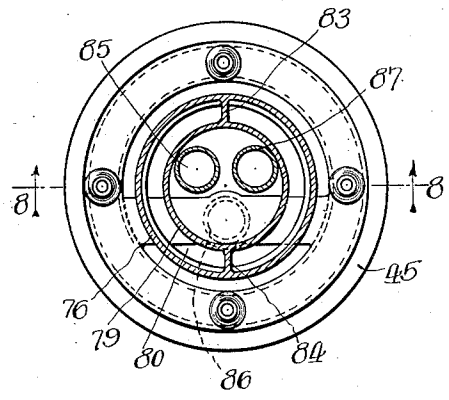


Fig. 11.

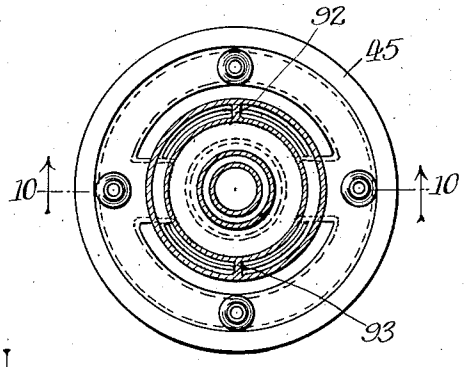
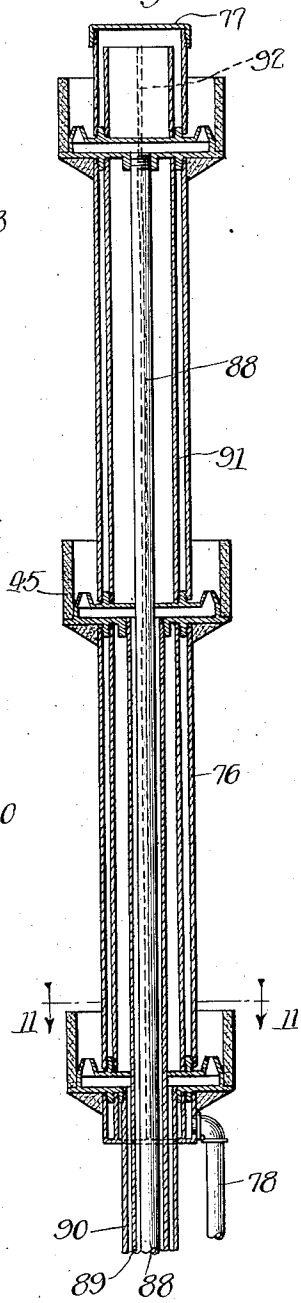


Fig. 10



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UNITED STATES PATENT OFFICE

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CARBONIZING APPARATUS

Application filed May 7, 1925. Serial No. 28,614.

This invention relates generally to carbonizing apparatus and in particular to apparatus for the continuous carbonization of coal in a retort equipped with a screw conveyer.

Heretofore, in the coking art, little or no practical success has attended the use of screw conveyers to effect a continuous carbonization process. In a prior patent to Irving F. Laucks, No. 1,713,840 dated May 21, 1929, there has been disclosed a means by which a screw conveyer may be successfully operated without the difficulties which have beset others in the attempted application thereof. Therein it has been set forth that the secret of success is the overcoming of the sticking of the plastic coal to the rotor at the time when it is coked at the hotter outside walls of the retort and thus free from adherence thereto. Said patent discloses a burner within said rotor adapted to heat the rotor at the zone where the coal is plastic at least to the same degree of temperature as, and preferably hotter than, the corresponding outer wall of the retort, whereby to coke the coal adjacent the rotor while the same adheres to the retort wall.

In the apparatus described in said patent, no means is provided to control the temperature for any considerable length of the retort, with the result that in order to obtain the requisite heat for the purpose of the invention in one portion of the rotor, a greater heat is necessarily obtained in other portions than is found in the corresponding levels at the opposite outside wall of the retort. Such a condition results in the production of two grades of coke in the same zone, (1) that which is adjacent the outer wall, and (2) that which is adjacent the inner wall. In some types of apparatus this condition may result in a single lump of coke having two distinct grades therein each being due to the temperature of the particular wall with which it was in contact. Such non-uniform coke is most undesirable.

In apparatus embodying the present invention, it is aimed to secure a uniform product at both walls, and to so control the temperatures at both retort walls and the rate of progression of coal through the retort, that an exorthermic coke is produced. By this I mean to say that the heating of the coke is substantially slow at first so that the coal arrives at a decomposition temperature at which certain components of the coal break down giving off heat thereby. It has been found that, to permit coal to decompose exothermically, gives a better grade of coke than is obtained by permitting it to be too rapidly heated to force the decomposition. Consequently, it is possible to obtain a uniform and desirable coke by having equal temperatures on both sides of the carbonization chamber and by controlling said temperatures with relation to the progress of the coal through the retort. After coal has passed through the carbonization process of the plastic zone, there is no longer any danger of plastic coal sticking to the rotor, since the plastic stage has been passed. The use of a rotor in the after stages is not required since the coal has been coked, and has assumed a self-sustaining physical form in distinction from the prior granular and plastic stages. Therefore, it is possible to discharge the coked material soon after the coking stage has been attained. This permits spreading the plastic zone over a considerable length of retort, in which length the inner and outer temperatures should be controlled to be maintained substantially the same on both sides of the retort at any particular zone.

It is the object of the present invention to provide a continuous carbonizing apparatus having a plastic zone, the external bounds of whch are maintaned uniformly and substantially at the same temperatures at opposite points thereof.

Another object of the invention is to provide a vertical retort with a hollow screw conveyer therein in which the conveyer is heated to substantially the same temperature as the opposite outer wall at any particular level.

Still another object is to provide means for heating the inside of the rotor to maintain the temperature thereof at a predetermined heat at predetermined zones.

A further object of the invention is to pro-

vide a system of control which cooperates with independent means for heating the opposite sides of a retort space to substantially the same temperatures.

A particular object of the invention is the provision of a heating device having alined fuel burners thereon individually controlled.

A still further object of the invention is to provide said heating device with a cooling means to permit proper feeding of fuel to each of said alined burners.

Other and ancillary obects and advantages of my invention will be apparent in the following description of an exemplary embodiment thereof, designed and constructed to provide means for accomplishing all the foregoing objects, as illustrated in the accompanying drawings in which

Figure 1 shows a longitudinal cross section of a vertical carbonizing apparatus having a screw conveyor in a tubular retort.

Fig. 2 shows a longitudinal sectional enlarged view of the burner shown in Fig. 1, and also an alternative form of hollow screw rotor specially adapted for cooperation with said burner.

Fig. 3 shows a horizontal cross section of the apparatus of Fig. 1 being taken substantially on the line 3—3 thereof.

Fig. 4 shows a cross section of the lower burner of Fig. 1, along the line 4—4 of Fig. 6.

Fig. 5 shows a cross section of the middle burner of the modified construction of Fig. 2, along the line 5—5 of Fig. 7.

Fig. 6 shows a fragmental horizontal cross section of the rotor and burner on the line 6—6 of Fig. 1.

Fig. 7 shows a plan view of the burner of Fig. 5, being a cross-section on the line 7—7 of Fig. 2.

Fig. 8 shows a longitudinal section of a burner capable of being cooled by means of an evacuated chamber surrounding the feed pipes.

Fig. 9 is a cross sectional view of the burner of Fig. 8 along the line 9—9 thereof.

Fig. 10 is a burner construction like that of Fig. 2 provided with the same vacuum chamber as is shown in Fig. 8.

Fig. 11 is a cross sectional view of the burner of Fig. 10 along the line 11—11 thereof.

In the drawings there is shown a retort of a suitable type for continuous carbonization. A furnace is shown for heating said retort at the exterior wall thereof, said furnace being arranged to provide variable zones as desired to control the temperature of the retort wall in corresponding zones. Other means are shown to heat said retort internally in zones corresponding to the external heating.

More specifically, I provide a tubular retort 10 of circular cross section which tapers slightly toward one end. An enlarged tapered ring 11 at the other end of said retort fits snugly in a corresponding opening in a framework 12, thereby to suspend the retort vertically with the lower end free. Directly below said retort is a base 13 upon which is supported an annular casing 14. The lower end of the retort 10 is truly cylindrical in form, as shown at 15, to fit into said casing. A suitable packing 16 is provided for sliding movement between the casing of the retort as the vertical relation of the fixed supports 12 and 13 may vary from the hot to the cold condition of the apparatus. Within the retort 10, and supported on the base 13 inside the casing 14, is a rotor 17 having flights thereon formed by a continuous helical fin 18 from end to end, said flights closely fitting the sides of the retort. Suitable bearing means, as ring plates 19, between the rotor and the base 13 are provided to permit rotation thereof by suitable means not shown.

Means is provided for feeding coal through the retort. Herein the casing 14 has a floor 20 above which a feeding conduit 21 is connected. The conduit contains a screw conveyer 22, and both are sufficiently long so that the coal therein is an effectual seal at the bottom of the retort. The end of the retort 10 terminates above the floor 20 and is provided with a number of triangular notches 23 circumferentially about its peripheral shell to permit the escape of gases therefrom if required. The casing 14 is so constructed as to form a chamber 24 above the end of the retort, into which chamber a pipe 25 is connected for the withdrawal of gases when desired. The coal, after being processed, may be discharged at the top over a floor 26 and down an incline 27 for further disposition. The upper portion of the retort has a suitable water seal 28 and is sufficiently roomy for the collection of gases which flow away from the apparatus at the top in the direction indicated by the arrow 29. The specific means for receiving the gases of course forms no part of this invention.

Heating means for the outside of the retort comprise a brickwork structure supported on I-beams 30. The structure is arranged with a plurality of horizontal zones formed by fixed and movable baffles disposed in an annular chamber about the retort 10. The arrangement is indicated in Figures 1 and 3. The brickwork structure is substantially rectangular, having furnace walls 31 forming an annular chamber 32. Situated at various levels along the retort are fixed baffles 33 arranged in a vertical series comprising in each level 4 baffles arranged at 90 degrees. Each of the baffles 33 projects from the furnace walls 31 into close proximity to the retort 10, yet each is separated therefrom to prevent a cooling spot which would result from actual touching. Along the side of one pair of opposite fixed baffles 33 are four mov-

able horizontal baffles 34 which may be drawn in and out of the annular chamber 32 through suitable slots in the furnace walls in the front and the rear. Said baffles are shown in Figure 3 as being in the drawn-out position so as to connect two adjacent horizontal zones into substantially one zone. In dotted lines baffles 34 are shown in closed position to form in conjunction with the fixed baffles 33 a partition between adjacent zones. There are also vertically alined sets of ports 35 and 36, each port being vertically located between the vertically adjacent baffles 33 at the two sides of the retort. On one side, the vertically alined ports 35 lead into a combustion chamber 37 shown in part only, and on the other side the corresponding ports 36 lead to a waste gas chamber 38 similarly shown. Movable vertical baffles 39 contained in slots 40 are used to vary the opening of the ports as desired. From the front and rear face of the furnace all the baffles may be readily changed to vary their positions to affect the character of the zones within the annular furnace chamber 32 surrounding the retort 10.

Within the rotor I provide heating means likewise adapted to vary the heat in zones along the length of the rotor. Vertically alined heating means in said rotor are provided in the form of fuel burners 41 having each an annular construction to correspond to the circular rotor 17. Each of the burners 41 has an anular shell 42 with burner holes 43 therein about the circumference. In Figs. 4 and 6 the lower burner of Fig. 1 is shown having four such burner holes. A shelf or flange 44 projects outwardly from the shell 42 and carries thereon a refractory ring 45 extending upwardly above the tips of the burner holes 43. Hooks 46 projecting from the bottom of the burner serve to carry a refractory clay or lining 47 on the under side of the burner. The annular burner shell 42 is fed with fuel through a passage in a supporting shell 48 connecting it integrally to a nipple structure which is concentric with the burner.

The nipple structure comprises a cylindrical member 49 having threaded end flanges 50 and 51. The supporting shell 48 is continuous through the cylindrical member 49 as shown at 52. It will be observed that the shell 48—52 is nonradial of the concentric members. Within the cylindrical member 49 the shell is tapped for a feed pipe 53 to furnish gas through the shell to the burner holes 43. In the present instance, the cross shell 48—52 transversely intersects the nipple structure and is tapped centrally thereof for the feed pipe 53. The off-center position of the shell inside the nipple permits a number of other fuel feed pipes to pass through said burner in nested relation. Each of the burners above the described burner is of similar construction, the parts being suitably proportioned to permit of the feed pipes being contained within the circle of the burner. In the present instance three such burners are used. Three feeding pipes 53, 54, and 55 are nested in a triangular relation.

In order to avoid overheating the fuel mixture in said pipes prior to reaching the burners, cooling means is provided comprising a coolant pipe surrounding the feed pipes. The flange 51 on the lower burner 41 (Fig. 4) has a header 56 screwed thereto through which pass the fuel feed pipes. A coolant feed pipe 57 enters the header for the introduction of air, steam or water as may be desired. The upper flange 50 of said burner has screwed thereto a length of pipe 58 which at the other end is screwed to the lower flange of the next burner, and so on. Thus each pipe 58 in succession supports and spaces adjacent burners with relation to each other and forms the whole into a rigid structure of alined burners with a cooled feeding system. At the top of the alined burners, a length of pipe 59 projects through the rotor for the removal of the coolant. The burner structure may be supported either from the top or from the bottom, and may be movably supported for vertical adjustment through the rotor as desired.

In place of the nested relation of feed pipes as shown in Figs. 1, 4 and 6, I provide a second form as shown in Figs. 2, 5 and 7. Herein (Fig. 7) the cross shell 60 of each burner is radial thereof and at the center a feed pipe 61 is screwed thereinto. Each of the other burners is similarly constructed. This relation calls for concentric feed pipes shown as 62, 61 and 63 respectively for the bottom, middle and top burners. At each burner the external pipe leading thereto is screwed into the cross shell 60 and the next inner pipe passes through the burner by any suitable construction. By this arrangement, each fed pipe is in part cooled by the feed pipe outside the same. According to the conditions to be employed in the use of the burner, it may or may not be necessary to provide the coolant pipe as above described. For the purpose of illustration, however, each of the burners is provided with the same nipple structure and the coolant pipe is shown substantially as in the first form. The lower ends of the concentric feed pipes terminate in a suitable construction to provide independent feeders 64, 65 and 66 with control valves 67, 68 and 69 therefor.

Inside the rotor (Figs. 1 and 6) arcuate shells 70 are welded to the wall longitudinally thereof to form pockets. A suitable closure 71 is provided at the bottom of each pocket. These shells form wells extending to the top of the rotor and are filled with a suitable heat conducting medium such as common salt or a fused substance, for example, lead as in-

dicated at 72. These wells serve as containers for suitable temperature sensitive means, such as pyrometers 73. Extensions 74 from each pyrometer reach to the top of the rotor for connection therefrom to an indicating device (not shown). Other pyrometer means indicated generally by the numerals 75 are employed in the outside furnace zones to determine the temperature thereof.

A further modification of the burner cooling means is shown in Figs. 8–11, as applied to the two disclosed types of burner construction. Primarily, the purpose of a coolant flow is to delay the transfer of heat from the burner to the feeding means. The flow of coolant removes the heat as the same is conducted through the walls of the outside pipe. However, it is possible by limiting the capacity of the intervening medium to transfer heat, to use the fuel flow itself as the coolant. This, of course, involves a balance between the heat conducted inwardly and the heat removed by the flow of fuel. The proper balance is obtained by exhausting the intervening air to a more rarified state. The apparatus is adapted for this by closing the external pipe 76, Fig. 8 as by the cap 77 and providing an exhausting pipe 78 leading to the closed chamber. An inner pipe 79 may be provided if desired concentrically with the outer pipe 76 so as to provide an annular chamber 80 about the circular shell of the inner pipe in which the feed pipes are contained. The inner pipe is suitably secured internally of the flanges 81 and 82 of the nipple construction in any suitable manner. The inner pipe 79 is open ended and terminates near the cap 77 and the annular space 80 and the interior of the inner pipe 79 are in communication at this point. The exhaust pipe 78 communicates with the annular space 80 and, of course, exhausts the space within the pipe 79 which contains the fuel feed pipes. In the construction of the concentric pipe arrangement, diametrical wedges 83 and 84 are formed between the inner and the outer pipes so that the annular space is divided into two semi-annular chambers. The provision of these two chambers and the inner chamber of pipe 79 assures a continuous path over the length of the body of any air or gas which may leak into the exhausted chamber by reason of defects therein. The passage of gas or air so acquired will augment the cooling action by flow as a coolant rather than destroy it which might otherwise result from a more simple construction.

Fig. 8 shows particularly the burner construction having the nested feed pipes 85, 86 and 87 similar to the burner shown in Fig. 1. Fig. 10 shows particularly the arrangement of Fig. 2 having the concentric feed pipes 88, 89 and 90. An inner pipe 91 is arranged concentrically with the outer pipe 76, the burner-carrying nipple, of course, being suitably constructed for receiving said pipes and for maintaining the chambers formed by said pipes and by webs 92 and 93.

In Fig. 2 there is shown an alternative form of rotor. The rotor comprises the tubular shaft 95 and the two helical hollow threads 96 and 97 thereon. The hollow threads are preferably integral with the rotor and are in open communication with the interior thereof. By this construction the rotor flights may be heated directly from the burner more uniformly than the flights 18 of the rotor in Fig. 1, in which case they are heated mainly by conduction. To facilitate heating the hollow flights a deflecting baffle is constructed within the rotor to direct the gases from the burners into the hollow flights. The baffle may assume a variety of forms, that herein illustrated being a spiral baffle following the course of the threads. The baffle has one portion 98 secured to the rotor wall 95, internally directed portion 99 and a downwardly projecting portion 100. The hot gases from the heaters arranged along the rotor in flowing upwardly through the rotor are caught by the baffles and deflected into the hollow flights, thereby heating them directly.

In operation of the above described carbonizing apparatus the combustion of fuel for heating the retort is brought about in chamber 37. The movable vertical baffles are adjusted to pass the heating gases from the chamber 37 through the required zones of the furnace to the exit chamber 38. The gases enter by ports 35, split into two paths about the retort 10, and unite for exit through the ports 36. The movable horizontal baffles may be adjusted to enlarge any particular zone. By the arrangement of baffles the furnace may be made substantially uniformly heated in part, or may be made into a down-draft or an updraft furnace, or may be partitioned for any combination of these various types of heating. By means of the pyrometers 75, proper heating is determined and when balanced for the desired process, the inside burners are accordingly controlled to equalize the temperature internally of the rotor to correspond to that at the opposite points externally thereof. The coolant for the internal burner may be air, which is thus preheated for use in the burners or in the furnace, if desired. At each burner the direct play of the flames on the rotor zones is prevented by the annular tile 45, and each upper burner is protected from the direct heat of a lower burner by the refractory material 47. Thus a mixture of air and gas may be fed to the burners with no danger of back-burning caused by overheating of the burners themselves.

In the apparatus of the drawings the coal is fed in the granular state to the lower end of the rotor. As the rotor turns slowly, the material enters the retort, is heated, and soon

begins to get plastic. It is aimed to have the lower burner so arranged within the retort that the coal in the plastic stage passes through the narrow annular retort space with equal temperatures on both sides thereof. The temperature is allowed to increase as the coal progresses through the retort and decomposition begins at some particular zone of the retort. It is further aimed to allow the carbonization to proceed as a natural exothermic decomposition without forcing the same by the application of high temperatures to the zones of the retort. Consequently a relatively uniform temperature may exist along the length of the retort for a certain zone until the coke begins to cease its exothermic decomposition, when slightly more heat should be applied. Both the inside and the outside heating means are under control to effect the proper heating of the retort according to the decomposition of the coal. After passing the plastic stage the coal begins to set to coke. It is the intention that the setting to coke shall take place uniformly and simultaneously at both walls of the retort in order to prevent sticking of coal which is still plastic to a cooler wall and in order to secure a uniform grade of coke at both walls. By the time the coke has reached a self-sustaining structure the danger of sticking to the rotor will have passed, although carbonization may not have been completed, volatile matter still being left within the coal. At this point the material may be discharged from the rotor section of the retort and further treated as desired to remove volatile matter after having passed down the incline 27.

While I have described in general the nature of the invention and have illustrated an exemplary embodiment thereof, it is to be understood that the description and the drawings are in no way to be construed as a limitation of the invention short of the scope thereof as expressed in the appended claims.

I claim as my invention:

1. A carbonizing apparatus comprising, in combination, a cylindrical retort, a tubular rotor in said retort having helical flights thereon filling the space between the walls of the rotor and the walls of the retort, said rotor being operated to convey material from end to end through the retort, means outside the retort for heating said retort in zones, and means within said rotor for heating the retort in zones, said means including controls to equalize the temperature inside and outside at the several zones.

2. A carbonizing apparatus comprising, in combination, a cylindrical retort, a rotor in said retort having helical flights thereon filling said retort, said rotor being operated to convey material through the retort from end to end, means outside the retort for heating said retort, and a plurality of separately controlled means within the rotor for heating said rotor to a temperature determined by the temperature at the outside of the said retort.

3. A carbonizing apparatus comprising, in combination, a tubular retort, a conveying rotor in said retort, heating means for the retort outside thereof, and a plurality of separately controlled spaced burners in said rotor arranged to control the temperature at the inside of the retort in accordance with the temperature at the outside.

4. A carbonizing apparatus comprising, in combination, a tubular retort, a conveying rotor in said retort, means outside the retort to heat the retort, and a plurality of longitudinally spaced heating means to heat the inside of the rotor including separate controls to regulate the temperature thereof in zones.

5. A carbonizing apparatus comprising, in combination, a tubular retort, a hollow conveying rotor in said retort having helical flights thereon, a plurality of longitudinally spaced burners within said rotor, separate controlling and supply means for each burner, and cooling means in the rotor for the supply means.

6. A carbonizing apparatus comprising, in combination, a tubular retort, a hollow conveying rotor in said retort having helical flights thereon, a plurality of longitudinally spaced burners within said rotor, and separate supply means for said burners, whereby to control the temperature longitudinally of the retort at the rotor wall.

7. A carbonizing apparatus comprising, in combination, a tubular retort, a conveying rotor in said retort having helical flights thereon, a plurality of longitudinally spaced heating means associated with said rotor, and means for controlling independently each of said heating means to control the temperature longitudinally of the retort at the rotor wall.

8. In a carbonizing apparatus having a tubular opening therein surrounded by a carbonizing chamber, a heating device in said opening comprising, in combination, three fuel burners of annular form separate feeding means and separate controlling means for each burner, a refractory ring for each burner between the burner openings and the circular wall of the carbonizing chamber, refractory material on the under side of the two top-most burners, and cooling means for the separate feeding means, said heating device being movable as a unit longitudinally in the tubular opening.

9. In a carbonizing apparatus having a tubular opening therethrough surrounded by a carbonizing chamber, a heating device in said opening comprising, in combination, a main pipe adapted for the flow of a coolant therethrough, a plurality of alined burners, each burner having burner holes disposed annul rly about said pipe, separate supply

means for each burner within said coolant pipe communicating therethrough to the respective burners, separate controls for the fuel passing through said supply means, protective means to protect the walls of said carbonizing chamber from the direct flames of the burners, and other protective means to protect the upper burners from the direct heat of the lower burners.

10. In a carbonizing apparatus, a heating device comprising, in combination, a plurality of alined fuel burners, a hollow member confining said burners, independent supply means for each burner, and a coolant pipe surrounding said supply means in part to protect said means from the heat of said burners.

11. In a carbonizing apparatus, a heating device comprising, in combination, a plurality of alined annular burners, a hollow member confining said burners, and independent supply means for each burner, said supply means being arranged within the circle of one of said burners.

12. In a carbonizing apparatus, a heating device comprising, in combination, a plurality of alined annular fuel burners, a hollow member confining said burners, independent supply means therefor, said means being nested within a circle, a coolant pipe surrounding all of said nested means, each burner having passed therethrough a supply means for each of the burners therebeyond, each of said supply means passing through the coolant pipe.

13. In a carbonizing retort having a member forming a tubular passage therethrough, a heating device in said passage comprising, in combination, an annular burner, a refractory ring on said burner disposed between the burner openings and the walls of the tubular member, whereby to prevent direct play of the flame thereon.

14. In a carbonizing apparatus having a tubular member passing vertically through the retort chamber thereof, a heating device in said member comprising, in combination, a burner, a second burner over said first burner, and refractory material carried by said second burner on the under side thereof to prevent back burning of the fuel within the burner.

15. A carbonizing apparatus comprising, in combination, a retort, a hollow rotor in said retort, hollow helical threads on said rotor within the carbonizing space in the retort to convey coal therethrough, burners in said rotor adapted to produce hot gases therein, and a baffle arranged in the rotor adjacent each rotor thread to direct the hot gases into said threads to effect direct heating thereof.

16. A carbonizing apparatus comprising, in combination, a retort, a tubular member in said retort, a hollow projection on said member extending into the carbonizing space of said retort, the hollow portion of said projection and said tubular member being in open communication, a burner in said tubular member adapted to produce hot gases therein, and a baffle so arranged adjacent the hollow projections as to direct the hot gases into said projection for direct heating thereof.

In testimony whereof, I have hereunto affixed my signature.

OTTO H. HERTEL.