F. PUENING.

COKING COAL.

APPLICATION FILED NOV. 30, 1917.

1,419,908.

Patented June 13, 1922.

3 SHEETS—SHEET 1.

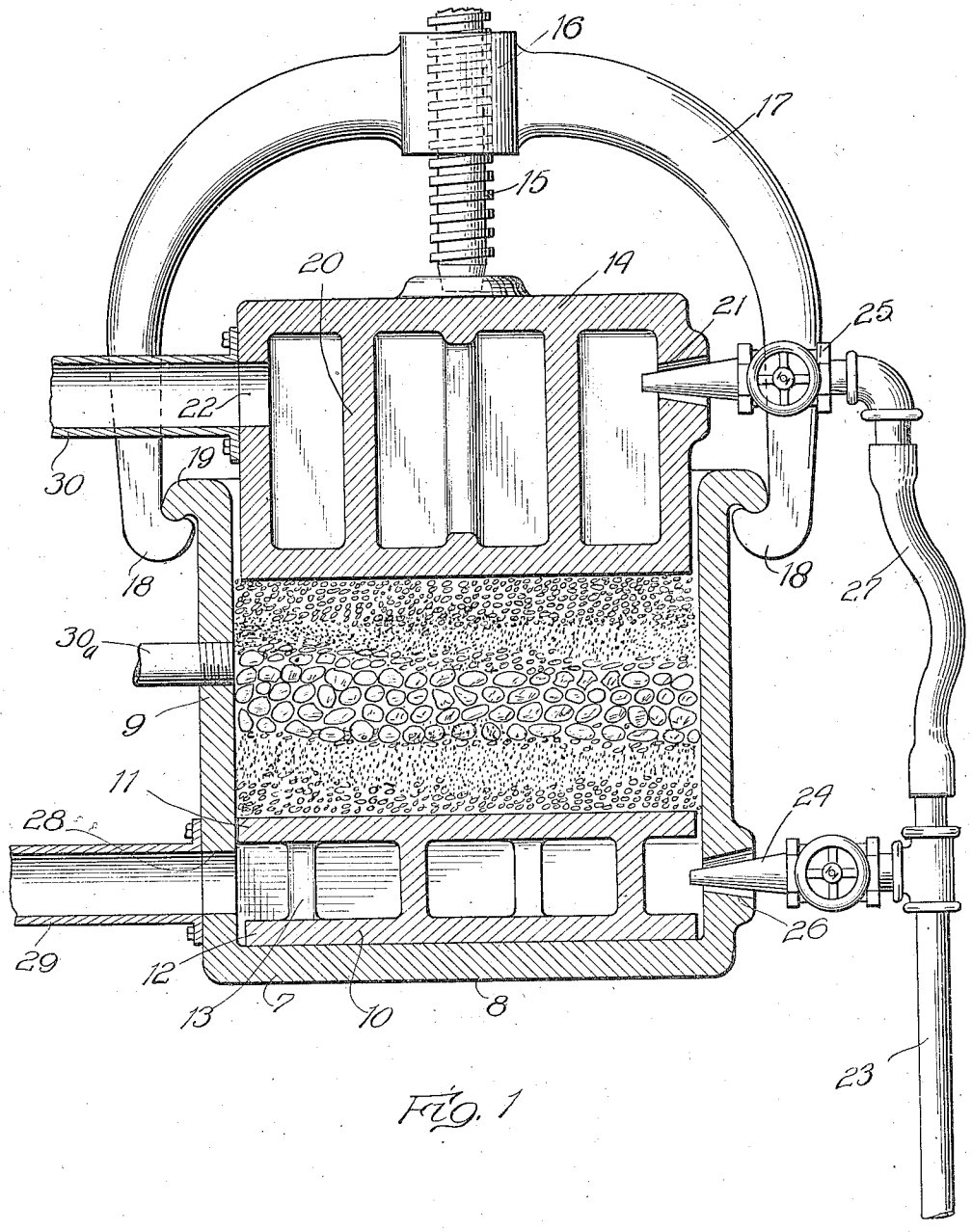


FIG. 1

Inventor

Franz Puening

by Rector Hibben Davis & Macrae

His Attys

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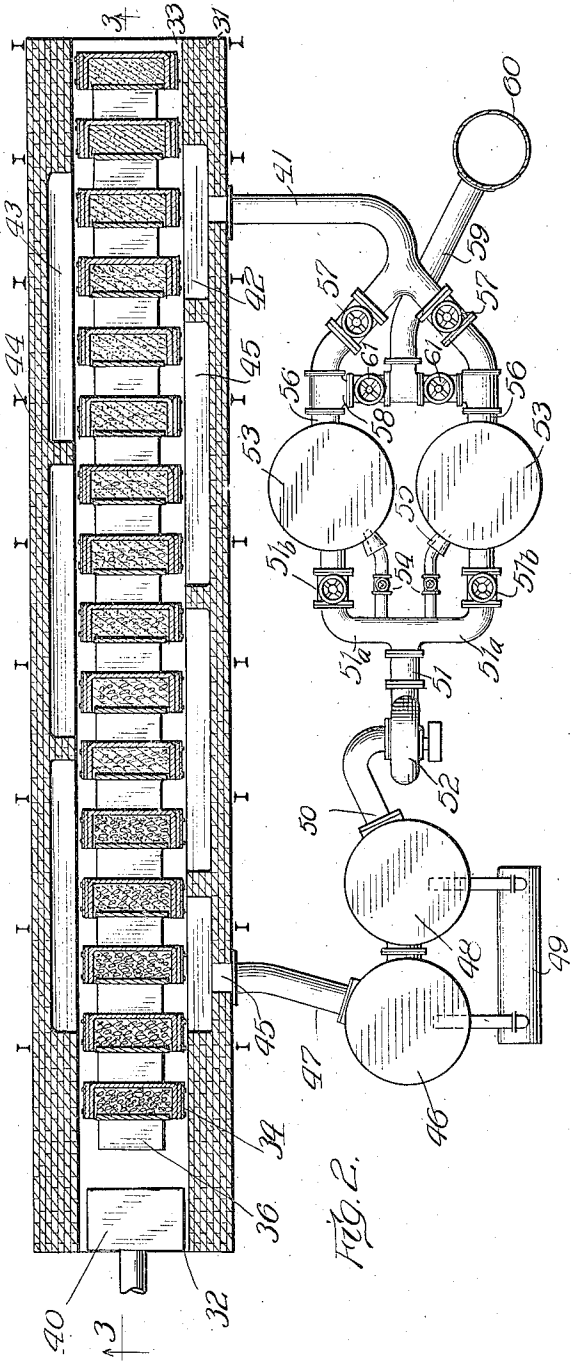


Fig. 2.

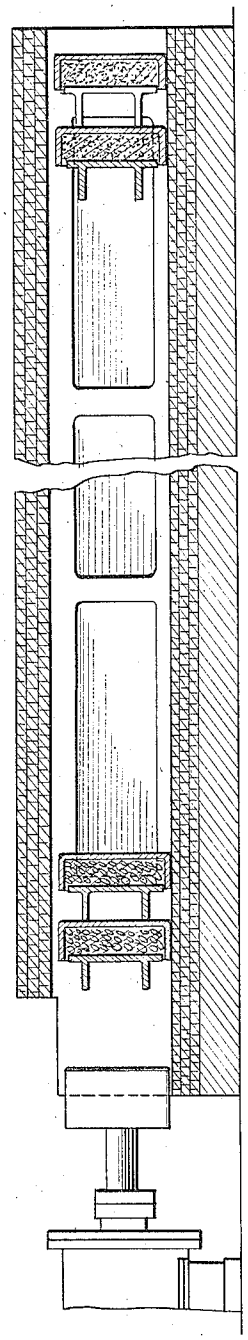


Fig. 3.

Inventor

Franz Puening

by Rector Hibben Davis & Macrae

His Attys.

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3 SHEETS—SHEET 3.

Fig. 4

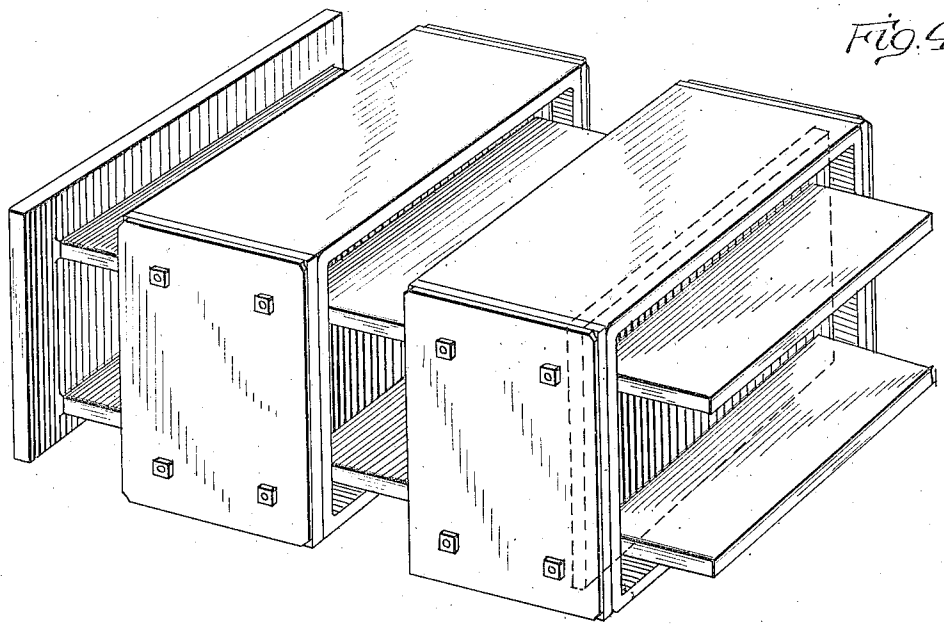


Fig. 5

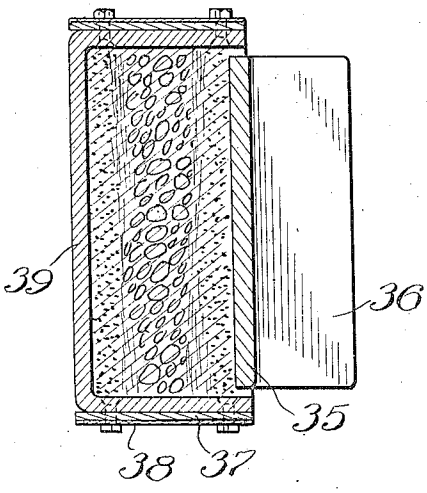
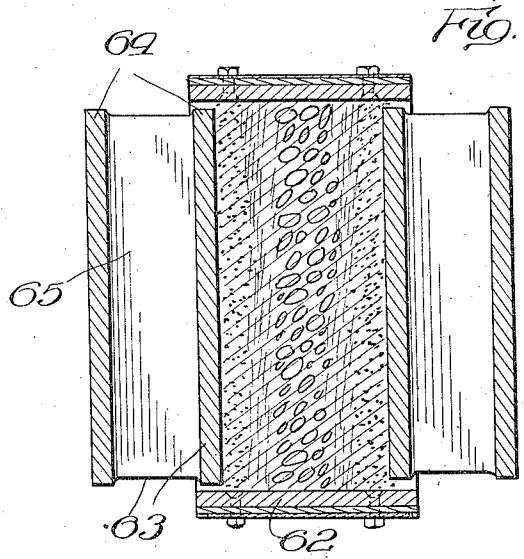


Fig. 6



Inventor

Franz Puening

by Rector Hibben Davis & Macauley

His Attys.

UNITED STATES PATENT OFFICE.

FRANZ PUENING, OF PITTSBURGH, PENNSYLVANIA.

COKING COAL.

1,419,908. Specification of Letters Patent. Patented June 13, 1922.

Application filed November 30, 1917. Serial No. 204,578.

To all whom it may concern:

Be it known that I, FRANZ PUENING, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Coking Coal, of which the following is a specification.

In the preparation of soft coal for domestic and similar uses by coking, it has been found desirable to leave a certain proportion of the volatile components in the coke for the reason that if the treatment is carried as far as in coke for metallurgical uses the material is very difficult to ignite and therefore inconvenient to use. When the object of the coking is domestic fuel, therefore, it has been customary to coke at a comparatively low temperature to stop the elimination of the volatile matters at a suitable point. Where the coking is performed without changing the bulk of the material, as where the operation is carried out in ordinary retorts, it is found that the exterior of the body of coal is first coked forming a rigid shell which is gradually extended inward as the coking proceeds. But as the operation is accompanied by the elimination of a large quantity of volatile matters, shrinkage takes place throughout the body of the coke, and, since the exterior form and size of the body is maintained by the rigid shell, the elimination of the volatile matter and consequent shrinkage results in the formation of cracks and fissures so that the product is friable and a large portion thereof during handling is disintegrated. In order to avoid this objectionable feature of the coking operation, it has been proposed to squeeze or compress the coke as the volatile matters are driven off and for this purpose a follower or plunger has been introduced into the retort and pressure applied thereto as the coking proceeds. But it has been found that the rigid shell formed next the walls of the retort through which heat is transmitted prevents or seriously interferes with the movement of the plunger and only yields by becoming disintegrated and therefore in a condition unsuitable for domestic use. It is the object of my invention to obviate the objection just referred to and to make the compression of the fuel during distillation practicable. For this purpose the coking heat is applied only to the plunger and to the wall opposite the same, the intermediate walls along which the plunger is moved being unheated. It follows from this method of procedure that the rigid shell of coke is formed only on the plunger and on the opposite wall of the container, the coal on the surrounding intermediate wall maintaining its plastic condition until the operation of coking is substantially completed. In the accompanying drawing and in the following specification I have described a preferred process and apparatus for carrying out my invention. It is to be understood, however, that the specific disclosure is for the purpose of exemplification only and that the scope of the invention is defined in the following claims in which I have endeavored to distinguish it from the prior art so far as known to me without, however, relinquishing or abandoning any portion or feature thereof.

Referring now to the drawing, Fig. 1 illustrates in central section a simple form of device for carrying out my invention; Fig. 2 is a plan view of a more elaborate apparatus for the same purpose; Fig. 3 a vertical section partly in elevation on the line 3—3 of Fig. 2; Fig. 4 a perspective on an enlarged scale of certain elements of the apparatus shown in Figs. 2 and 3; Fig. 5 a vertical section on an enlarged scale of one of the units of Fig. 2 and Fig. 6 a similar view of a modification.

Referring first to the simpler embodiment of my invention shown in Fig. 1, it will be seen to comprise a receptacle 7 for the coal to be coked having a stationary end wall 8 and parallel stationary side walls 9 which are made of a more or less refractory material, such as, for example, cast iron. In the lower end of this receptacle is a circulation block 10 comprising upper and lower plates 11, 12, and spacing members or walls 13 which permit free communication from one side to the other of said block for the circulation of heating gases in a manner presently to be explained. In the open end of the receptacle is mounted a plunger or follower 14 which is movable towards and from the bottom of the receptacle by means of a screw 15 extending through a nut 16 in yoke 17, which may be connected to the receptacle by the hooked ends 18 thereon engaging the flange 19 of the receptacle. Any well known means may be employed for turning the screw. The plunger is hollow and like the circula-

tion block provided with baffle walls 20 which impose a circuitous flow on the heating gases which are admitted to the interior of said plunger through the opening 21, and escape through the opening 22 thereof. Combustible gas is fed from a suitable source through pipe 23 to burners 24, 25, burner 24 being located in an opening 26 opposite the flues or circulation passages of the circulation block 10 in the receptacle, and burner 25 projecting through opening 21 in the plunger referred to above. The supply pipe is connected to burner 25 by a flexible tube 27 which permits the movement of the plunger. The openings 21, 26 are of sufficient size to admit about the burners the amount of air required for combustion of the fuel gas supplied through said burners, and the mixture of air and gas being ignited the follower and the circulation block are heated to a coking temperature. The receptacle 9 is formed opposite the opening 26 with an exhaust opening 28 through which the products of combustion from the circulation block flow into the outlet pipe 29. An outlet pipe 30 takes care of the gases from the follower. While I have described specific means for heating the follower from the end of the receptacle opposite thereto, it will be obvious that other means may be employed for the purpose. The essential of the construction is that the fuel is heated on the two sides thereof where the pressure is transmitted to the fuel and is unheated on the remaining sides. As the body of coal is heated up on the top and bottom a portion of the volatile contents thereof is vaporized, the gases and vapors escaping through pipe 30^a or about the plunger, which fits the receptacle loosely, or about the circulation block which also fits loosely in the receptacle. A rigid shell of coke gradually forms on the heated surfaces becoming thicker as the operation progresses. Pressure is applied to the plunger which is slowly fed inward as the coking proceeds and as the volatile components of the coal escape. The walls 9 of the receptacle being unheated there is no rigid shell formed against them such as would impede or interfere with the movement of the follower. Furthermore the fluid or molten components of the fuel during the coking operation are constantly pressed and forced into the rigid shell of coke and into the uncoked coal tending to fill up the pores and openings thereof not only by the fluid material itself but by the solid deposit left as the molten material is volatilized.

Turning now to the coking apparatus illustrated in Figs. 2 to 5 inclusive, 31 is a tunnel or passage shown as of an ordinary brick construction which is open at its opposite ends 32, 33 and of uniform diameter throughout for a purpose which will presently appear. The coal to be coked is placed in a series of receptacles or containers 34 which are of a cross section to substantially fill the passage or tunnel and each of which is provided with a plunger 35, see Fig. 5, which substantially fills the open side of the container. Each plunger is formed or provided with spacing webs 36 of such depth as to provide a sufficient space or opening between the plunger and the next adjacent receptacle for the heating gases which are supplied to the tunnel as hereinafter described. The containers are heat insulated as to two of their side walls, the insulation being shown in Fig. 5 as comprising asbestos insulating material 37 surrounded by sheet iron 38. The bottom 39 of the container as well as the plunger or follower and two other side walls are left uninsulated. The receptacles are arranged in series within the tunnel, as shown in Fig. 2, after being filled with coal and are spaced from each other by the webs upon the followers. A plunger 40 operated by any suitable mechanism is reciprocated at one end of the tunnel, being withdrawn to permit the insertion of the successive containers and fed forward to traverse the containers along the tunnel and at the same time to provide the required amount of pressure upon the material within the containers. If a greater pressure is desired than the resistance due to the friction of the containers in the passage permits, a plunger similar to plunger 40 or other means may be used at the other end of the furnace to provide the necessary counter-pressure. The tunnel is heated by hot gases fed thereto at 41 which enter the recess 42 in the wall of the tunnel and are distributed along the same. They then pass across the tunnel through the spaces between the receptacles into the wall chamber 43 which permits a longitudinal movement of the gases along the tunnel. This movement, however, is intercepted by the partition wall 44 which causes the gases to again cross the tunnel between the receptacles into the recess or chamber 45. By similar construction to that just described, the gases are caused to travel back and forth through the tunnel between the receptacles of the series until at last they are drawn off through the exhaust opening 45. As above observed the receptacles are uncovered as to their ends and plungers, but heat insulated about their side walls and two of the latter walls are further protected from the heated gases by the walls of the furnace. The material within the containers, therefore, receives the greater portion of its heat through the end walls and plungers of the containers and but little heat through the side walls, with the result that there is little or no distillation or coking along the side walls but it substantially all takes place in the layers of coal adjacent the

plunger and end walls of the receptacles. The effect on the coal is the same as that described in connection with the simpler form of construction shown in Fig. 1.

The heating gases injected into the tunnel through the pipe 41 are augmented during their passage through the tunnel by the products of distillation from the coal in the containers and are thoroughly enriched thereby at the time they leave the opening 45. From this opening the gases are conducted to a condenser 46 through the pipe 47 and thence through a second condenser 48 which is in communication through pipes 50, pump 52, pipe 51 and branches 51^a with the respective gas stoves 53, 53. The condensate from condensers 46, 48 is collected in tank 49.

Each branch pipe 51^a is provided with a branch 54 leading to a burner 55 in the stove to which said pipe 51^a is directly connected. While one of the stoves is employed in heating the gas for circulation through the tunnel the other stove may be in process of heating up by burning the gas introduced thereto by its burner. Each stove is connected by pipe 56, 56 to the pipe 41 by which the gases enter the tunnel, as above described, and each such branch pipe 56 is provided with a valve 57 by which the flow of gases therethrough may be shut off. Each pipe 56 is also formed with a branch 58 and said branches are connected by a common flue 59 to a stack 60. When a stove is being used to heat the gases for the tunnel its valves 57 and 51^b are open so that the gases from the coolers 46, 48 pass through pipe 50, pump 52, pipe 51, valves 51^b, stove 53, pipe 56 and conduit 41 to the tunnel. At the same time a portion of the gases, which contain a large percentage of combustible matter, is diverted through pipe 54 to the burner 55 of the other stove and burned, the products of combustion passing from the latter said stove through pipe 58 and flue 59 to the stack. Valves 61 are provided for controlling the passage of products of combustion to the stack.

In this embodiment of my invention the receptacles containing the coal are continuously supplied to the end 32 of the tunnel and fed therethrough under pressure by the piston 40, the coal being gradually heated as it slowly approaches the hottest zone of the furnace adjacent the inlet pipe 41. The volatile products escape from the receptacles about the edges of the followers and as hereinbefore stated mingle with the heating gases and are drawn off, their heavier portions condensed and collected in tank 48, and the remainder utilized for heating the stoves, the tunnel or for other purposes where heat is required.

Instead of the container having a fixed end wall 39, as shown in Fig. 5, and a single follower, I may employ a container such as shown in Fig. 6 having only fixed side walls and a pair of followers cooperating therewith from opposite sides. The container proper 62 may be, except for the absence of the end wall, precisely similar to that heretofore described, but the followers 63 are double ended, each follower cooperating with two containers. For this purpose the followers each consist of a pair of end plates 64 connected by one or more webs 65 which will readily permit the passage of gases between the end plates. It will be understood that this form of container may be used in the tunnel substantially in the same manner as the form of container shown in Fig. 5 is used, a series thereof being constantly propelled through the furnace under pressure, there being a follower between each pair of successive receptacles, said follower having a head or plate operating in each member of the pair.

In the specific apparatus described the coal in the container is subjected to an increasing heat until it is coked to the desired extent. The follower and end wall, or pairs of followers as the case may be, are maintained at a temperature so much higher than that of the side walls that the coal is coked by the heat transmitted from the former of said walls, forming in contact therewith rigid layers of coke which are gradually increased in thickness until the whole mass of coal is coked to the desired extent, so that the faces of said mass of coal in contact with the follower and end walls may be said to be coking faces, as distinguished from the faces in contact with the side walls to which relatively little heat is transmitted, and adjacent which the mass remains more or less mobile until the coking is substantially completed. The latter said walls may therefore be referred to as non-coking. As the followers are free to move inward and are constantly under pressure, and as the body of the coal is diminished due to the driving off of the volatile components thereof, the mass is condensed by a movement of its particles in a direction substantially normal to the coking surfaces, the fluent components being forced into the pores and crevices of the coal and coke and thus leaving on volatilization a residue therein, and forming a dense mass of fuel which is sufficiently firm to resist disintegration under ordinary handling, and contains sufficient volatile residue to be readily ignited in use. Obviously other forms of apparatus than those described might be employed, the essence of the invention being independent of the particular apparatus employed and being set forth in the following claims.

I claim:

1. A process of coking coal which con-

sists in segregating a body of coal to be coked, exerting pressure on portions of the surface thereof and thereby moving such portions inward toward the center of the body and transmitting more heat to a portion of the surface on which pressure is exerted than to the remaining surface of the material.

2. A process of coking coal which consists in enclosing the coal in a receptacle having a movable wall forcing said wall against the coal during coking, and heating the movable wall to a higher temperature than that of the walls along which it moves.

3. A process of coking coal which consists in enclosing the coal in a receptacle having a movable wall forcing said wall against the coal during coking, and transmitting to the movable wall more heat than is transmitted to the surrounding wall of the receptacle.

4. A process of coking coal which consists in enclosing the coal in a receptacle, supplying a coking temperature to a portion only of the surface of the body of coal, and forcing the portion of the surface to which said coking temperature is applied inward as the coking proceeds.

5. In an apparatus for the purpose described stationary side walls, a follower, an end closure opposite the follower, and means for heating the follower to a higher temperature than that of the side walls.

6. In an apparatus for the purpose described stationary side walls, a follower, an end closure opposite the follower, and means for transmitting to the follower a greater amount of heat than is received by the side walls.

7. In an apparatus for the purpose described stationary side walls, a follower, an end closure opposite the follower, and means for transmitting to the end wall a greater amount of heat than is received by the side walls.

8. In an apparatus for the purpose described, a furnace having a passage therethrough, a series of containers movable longitudinally of said passage, each comprising members movable relatively to each other lengthwise of the passage, means for transmitting pressure between the adjacent members of successive containers, means for applying pressure to the outer member of the end container, and means for heating the passage.

9. In an apparatus for the purpose described, a furnace having a passage therethrough, means for heating the passage, a series of containers movable longitudinally of the passage and each comprising a hollow member and a follower member therein, said members being movable relatively to each other longitudinally of the passage, means for spacing the containers apart and for transmitting pressure from a member of each container to the adjacent member of the next container, and means for inserting pressure on the outer member of the end container.

10. A process of forming coke which consists in enclosing a body of coal and applying a coking heat to portions of its surface to coke the mass while the remaining surfaces are maintained at a lower temperature, and condensing the mass in a direction substantially normal to the surfaces to which the coking heat is applied.

11. A process of forming coke which consists in maintaining portions of the surface of a mass of coal above a coking temperature, and other portions of the surface below such temperature, and condensing the mass by moving portions of its particles more remote from the more highly heated surfaces toward and in a direction substantially normal to the latter.

12. A process for forming coke which consists in establishing a mass of coal, transmitting a coking temperature to a restricted area of the surface of said mass and forcing said area inward towards the center of the body of coke as the coking proceeds.

13. A process of coking coal which consists in interposing a mass of coal between a pair of relatively movable members, heating said members above a coking temperature and effecting the coking of the coal by a coking temperature transmitted by these members only.

14. A process of coking coal which consists in locating a mass of coal between a pair of relatively movable members progressively and uniformly coking the coal from one member toward the other and moving said members toward each other to compress the mass as the coke is formed.

15. A process of coking coal which consists in arranging a mass of coal between relatively movable members, heating said members to the coking temperature and advancing them toward each other, without coking the coal between said members by heat applied otherwise than therethrough.

FRANZ PUENING