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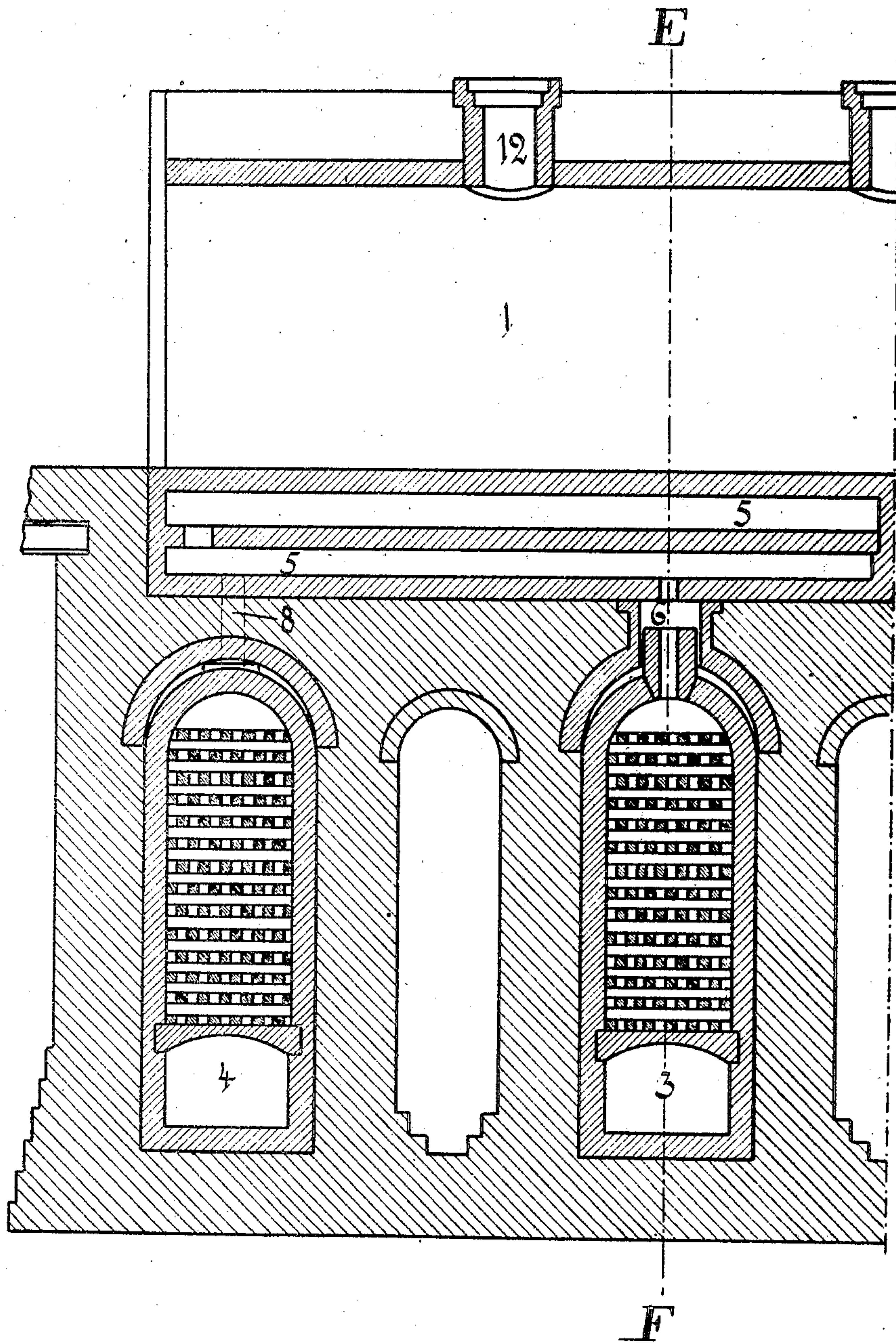
PATENTED APR. 17, 1906.

H. KOPPERS.  
COKE OVEN.

APPLICATION FILED SEPT. 7, 1904.

4 SHEETS—SHEET 1

*Fig. 1*



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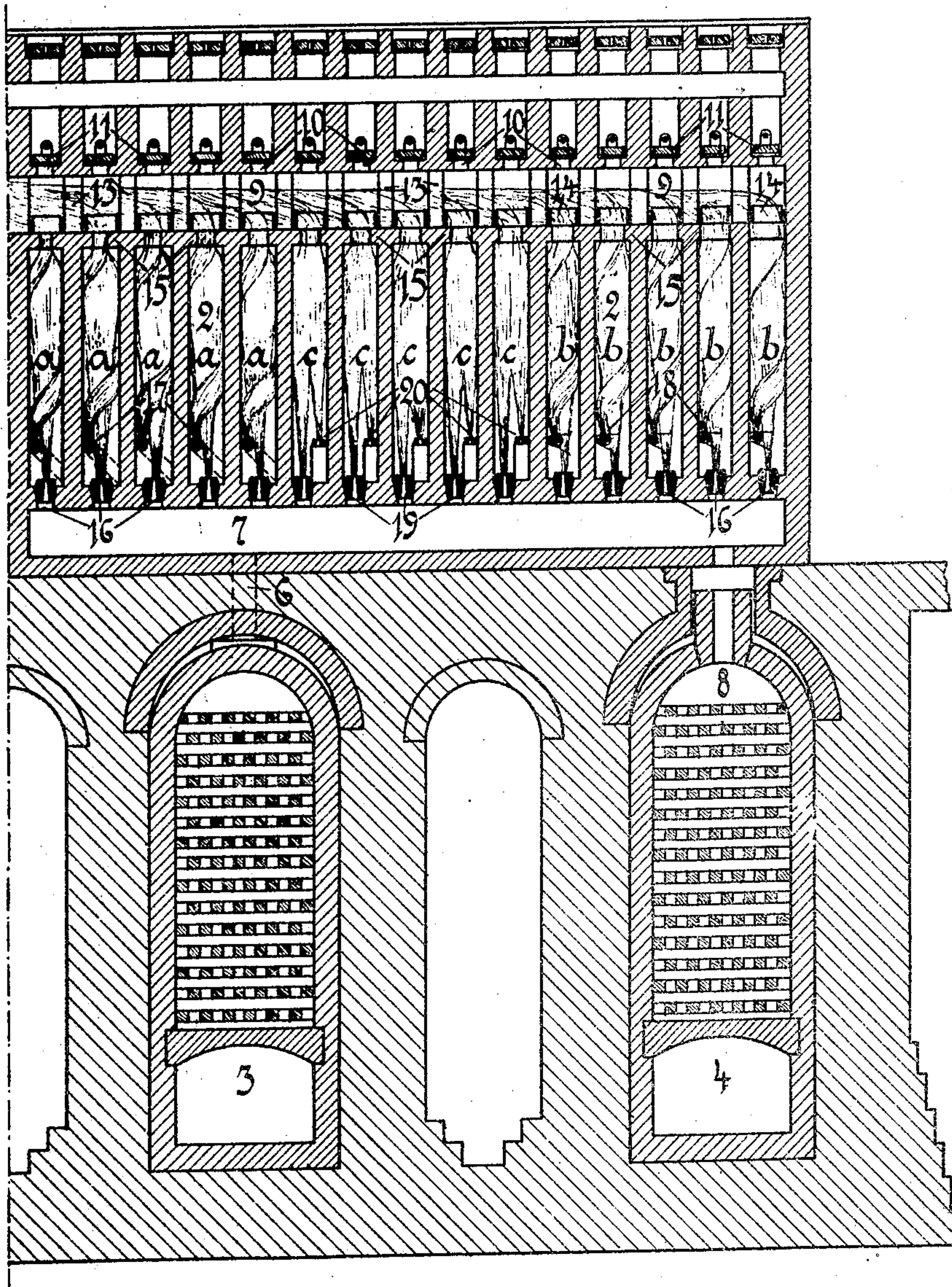
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**Fig. 2**

4 SHEETS--SHEET 2.



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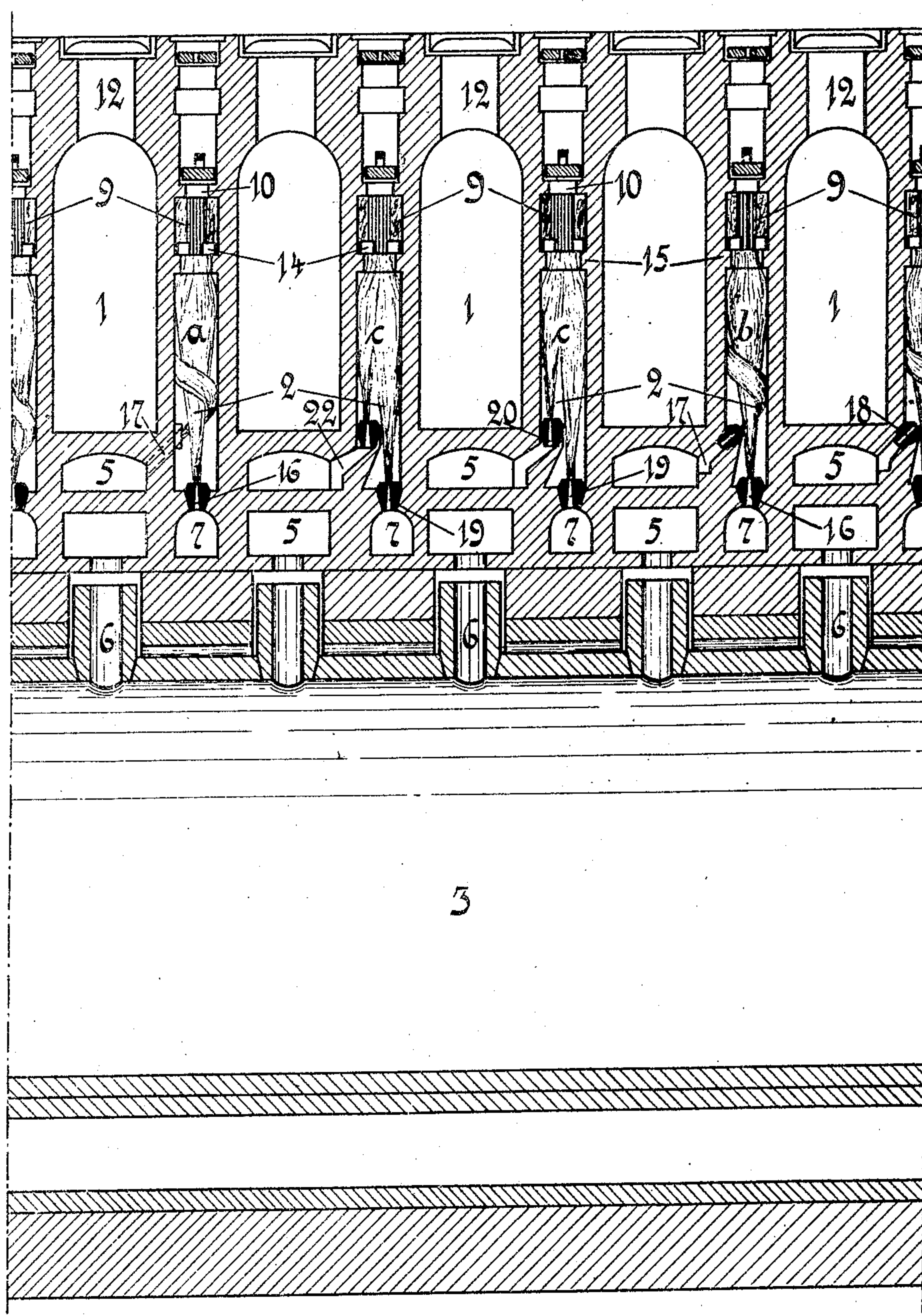
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4 SHEETS—SHEET 3.

*Fig. 3*



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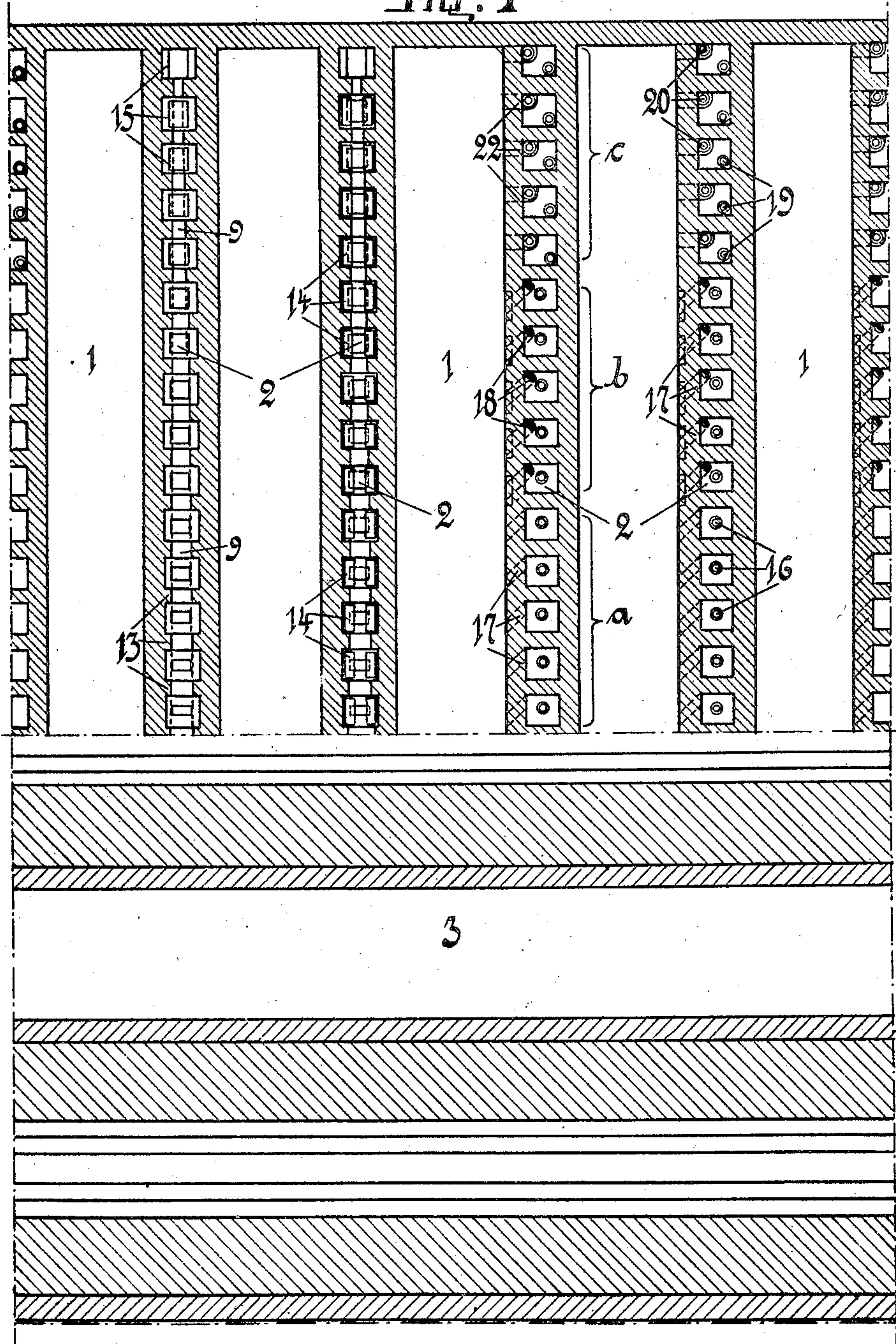
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4 SHEETS—SHEET 4.

Fig. 4



Witness:  
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# UNITED STATES PATENT OFFICE.

HEINRICH KOPPERS, OF ESSEN-ON-THE-RUHR, GERMANY.

## COKE-OVEN.

No. 818,266.

Specification of Letters Patent.

Patented April 17, 1906.

Application filed September 7, 1904. Serial No. 223,607.

*To all whom it may concern:*

Be it known that I, HEINRICH KOPPERS, civil engineer, a subject of the German Emperor, residing at 81 Wittingstrasse, Essen-on-the-Ruhr, in the Empire of Germany, have invented certain new and useful Improvements in Coke-Ovens, of which the following is a specification.

Coke-ovens of the usual kind have generally presented the great defect of want of uniformity in the heating effect both within the separate heating-flues and throughout an entire group of such flues arranged in series. As regards the separate flues, this want of uniformity manifested itself in the accumulation of heat at places where it was most prejudicial, so that thin or jet flames were formed, which the refractory material was unable to withstand for any considerable time. Within a group of flues arranged in series the heating-flues adjacent to the chimney, and therefore more accessible, were attacked too vigorously, while those farther removed did not experience sufficient effect. In the coke-oven which forms the subject of this invention all these defects are obviated, owing to the capacity for regulating the heating within wide limits as regards both uniformity and intensity, and this in a single flue or in a whole group of heating-flues.

The novel coke-oven is, as is usually the case, a regenerative furnace; but the principle is also applicable to other systems in which regeneration is not resorted to, and the uniform heating obtained in accordance with the invention permits of the employment of air which has been preliminarily heated to a large extent, so that an extremely rational and systematic operation is possible with the least possible injury to the refractory material. This novel coke-oven is illustrated in the accompanying drawings, in which—

Figure 1 represents a vertical section through the furnace along the axis of a coal-chamber. Fig. 2 is a vertical section on the axis of a group of heating-flues arranged in series. Fig. 3 is a cross-section through the furnace upon the line E F, Fig. 1. Fig. 4 is a horizontal section through the coke-chambers and heating-flues, with plan of the nozzle arrangement.

As usual in regenerative furnaces, the coke-chambers 1 and the heating-flues 2 are

built over the air-regenerators 3 and the gas-regenerators 4. Below the sole of the coke-chambers 1 are arranged the air-distributing passages 5, which are in communication with the air-regenerators 3 by the intermediary of vertical passages 6. Below the heating-flues 2 are situated the gas-distributing passages 7, which are connected with the gas-regenerators 4 by means of vertical passages 8. The further connection of these vertical passages with the heating-flues forms a portion of this invention and is hereinafter explained. The upper horizontal passage 9 extends over the heating-flues 2 and conducts the combustion-gases into the chimney. Vertically above each heating-flue an opening 10 is provided and is adapted to be closed by a cover 11. The coke-chambers are furnished with the customary charging-apertures 12.

The principle of the invention is as follows: Experience has demonstrated that the chimney-draft acts very differently in the heating of a group of heating-flues arranged together, according as they are more or less readily accessible to this draft, and that within the separate heating-flues, owing to the premature combustion which usually takes place, an undesirable and prejudicial accumulation of heat takes place in the lower parts of the walls of the heating-flues, the thin or jet flames which are thereby formed frequently attacking the refractory material to a large extent. This invention removes these defects by completely controlling the action of the chimney-draft upon the heating-flues of a group and within each flue by the retarded mixing of gas and air, owing to the fact that definite paths are assigned to both these substances necessary for combustion by means of positive guides, so that they are only able to mingle at the top of the coal charge.

As the varying action of the chimney-draft upon the gas and air distribution, the combustion, and the velocity of the heating-gases in the separate flues is so much the greater according as the upper horizontal passage is narrower, while, on the other hand, the stability of the whole structure only admits of a small cross-section for it, one of the great advantages furnished by this invention is that it insures the uniform heating of a group by the capability of altering the



cross-section of this passage. This result is attained owing to the fact that the connecting or bond course 13 rising between two heating-flues is made continuous, but in the middle is recessed to such an extent as is necessary for passage of the gases at the proper place. At the place at which the chimney-draft comes in these recesses are of a width corresponding to the sum of the combustion substances to be conducted through here and narrow on the heating-flues removed therefrom. In order to obviate the detrimental effect of this current of gas, which widens out so gradually upon the separate heating-flues, the bonds 13 are preferably thickened in such a manner that they form lateral projections 15. The narrowing of the heating-flues that is thereby produced is approximately inversely proportionate to the restrictions of the horizontal passage, so that the increased suction effect of the gradually-reinforced gas-current is counterbalanced by the diminishing surface of attack of the separate heating-flues. This influence on the separate heating-flues may be regulated by means of slides 14, arranged above, or by equivalent means operated from above by altering the free cross-section in the one sense or the other. These slides 14 are not able to slide and fall down, owing to the projecting bond part upon which they are guided.

In coking many coals the furnace walls of the coke-chambers must run conically, so that the exit end is wider. In certain cases the ovens are as much as twenty per cent. wider toward the exit end. Consequently more coal lies upon this width than upon the narrow end of the oven, so that the heat required by the former is greater. The oven is accordingly divided in such a manner that the place at which the draft changes is no longer in the middle, but is displaced to the wider side. By this means the coking takes place more uniformly with a better utilization of the heat. The formation of the upper horizontal passage is an improvement for such coke-ovens to the extent that the recesses widening out in correspondence with the increasing quantities of gas no longer lie symmetrically with the center of the oven, but from the place at which the change of draft takes place decrease proportionately toward the ends of the oven. The restrictions already referred to and produced by the projecting bonds then vary with the recesses of the horizontal passage only in the inverse sense, so that they likewise lie unsymmetrically relatively to the center of the oven. The action of the restricted horizontal passage and of the restrictions of the heating-flues is otherwise exactly the same as in the other coke-furnaces. Within a single heating-flue the same idea of effecting uniform heating by

the displacement of the combustion zone to the top of the coal charge is carried out by conducting the air and the gas in the manner of a nozzle. Figs. 2, 3, and 4 illustrate three constructional examples of this, which are of course only applied to the same furnace by way of explanation, as in practice only one of the arrangements represented would be incorporated in one coke-oven.

The heating-flues (designated *a*) represent an arrangement for the positive guidance of the gas and air, which is already protected to me by United States Patent No. 753,146. The novelty which is here claimed consists only in the combination with the other already-explained means for producing and controlling a uniform heating throughout the entire furnace. The gas flows upward through a nozzle 16 into the middle of the flue. The air, on the other hand, is conducted into the flue from the distributing-passage 5 through a passage 17, lying obliquely to the axis of the heating-flue both in plan and in elevation. The gas ascending at the center is therefore incased in the stream of air which moves upward in ascending helical convolutions. Combustion preferably takes place not on the wall of the flue, but in the center of the same. The heating-flues *b* themselves constitute an important improvement, their gas and air supply being for the rest constructed quite in accordance with the heating-flues *a*; but in this case a special nozzle 18 is arranged in the air-passage. While, however, in the case *a* only the admission of gas can be regulated by the insertion of different nozzles, in the arrangement designated *b* it is possible to vary both the quantity of the gas to be supplied and that of the air and also their ratio one to the other by means of interchangeable nozzles. The heating-flues (marked *c*) comprise an arrangement of nozzles for answering the same purpose—that is to say, retarding the mingling by positively conducting the gas and air. In this arrangement 19 represents the gas-nozzles; 5, the air-passages; 20, the air-nozzles. The gas enters the heating-flue 2 through the interchangeable nozzle 19, which is situated in one corner of the sole of the heating-flue. In the other angle is situated the likewise interchangeable air-nozzle 20, which closes an obliquely-ascending passage 22, which connects the air-supply passage 5 with the heating-flue 2. This same passage may also be given an inclined position in plan relatively to the axis of the oven when by this means the setting of the tuyer-stones would be facilitated or when there are other constructional reasons for adopting this step. At the upper end the inclined direction of the passages 22 becomes vertical, so that even without the employment of special nozzles the air is conducted vertically up-



ward in the heating-flue. It has also proved advantageous to give to the passage 22 a cross-section widening downwardly, so as to permit of forcing through any pieces of char-  
 5 motte falling down by means of bars introduced through upper apertures. A special feature is that, as shown by the drawings, accessibility to all parts of the coke-oven is obtained in accordance with this invention. In  
 10 the flues designated *c* the gas and air ascend vertically and parallelly directly side by side. Besides the effect of the displacement of the combustion zone to the summit of the coal charge, which is common with the other ar-  
 15 rangements, this arrangement shows in practice a more efficient prevention of the formation of thin or jet flames. In all the three arrangements (marked *a*, *b*, and *c*, respec-  
 20 tively) the end of the air-admission passage is preferably arranged at the top of the sole of the coal-charging chamber 1. It is, however, a point to be determined in practice whether this extreme position of the air-noz-  
 25 zle, or its position on the sole of the heating-chamber 2 beside the gas-nozzle, or some other intermediate position is the most ad-  
 vantagous. The present coke-oven, with its capacity for regulation for uniform heat-  
 30 ing an entire group of heating-flues arranged in series, owing to the possibility of altering the cross-section of the passage for the gases of combustion, and in the separate heating-  
 35 flues in accordance with the constructions *a b c* by suitable displacement of the combustion zone, presents an extremely effective utilization of the heat, together with the greatest possible amount of protection for the refractory material even in the case of  
 40 air which has been preliminarily heated to a large extent, suitable dispositions of course being made according as a regenerator is employed or not.

What I claim, and desire to secure by Letters Patent of the United States, is—

45 1. A coke-oven having vertical heating-flues and a common open upper horizontal passage for the combustion-gases, said heating-flues at the point where they pass into the said passage being restricted by projec-  
 50 tions of the bond courses, means for causing the air to ascend vertically at one angle of the heating-flue, and the gas at the opposite angle, guides for giving such paths to the gas and to the air within the separate heating-  
 55 flues that the combustion zone is displaced to the top of the coal charge.

2. A coke-oven having a horizontal open passage and separate heating-flues, said heating-flues at the point where they pass into  
 60 said passage being restricted, and having bond courses rising within the horizontal passage constructed to present recesses between the separate heating-flues which recesses have a cross-section corresponding to

the sum of the combustion-gases, passing 65 therethrough substantially as described and for the purpose set forth.

3. A coke-oven having an upper horizontal open passage and heating-flues, said flues at the point where they pass into said pas- 70 sage being restricted by projections of the bond courses, said projections being small in the flues remote from the chimney and thence widening out toward the chimney, substantially as described and for the pur- 75 pose set forth.

4. A coke-oven, having an open horizontal passage and heating-flues, said heating-flues at the point where they pass into the upper horizontal passage being restricted by pro- 80 jections of the bond course, which restrictions are narrow at the end remote from the chimney and thence widen out toward the chimney and slides upon the projections so as to permit of adjusting the apertures of the 85 heating-flues, substantially as described and for the purpose hereinabove set forth.

5. A coke-oven, having horizontal passages, heating-flues, bond courses rising with- in the horizontal passages, and presenting 90 recesses between the separate heating-flues, which recesses have a cross-section corresponding to the sum of the combustion-gases passing therethrough, said heating-flues where passing into the upper horizontal pas- 95 sage presenting restrictions caused by projections on the bond courses and which are narrow at the end remote from the chimney and thence widen out toward the chimney, substantially as described and for the pur- 100 pose hereinabove set forth.

6. A coke-oven, having a horizontal passage, heating-flues, bond courses rising with- in the horizontal passage and presenting re- 105 cesses between the separate heating-flues, which recesses have a cross-section corresponding to the sum of the combustion-gases passing therethrough, said heating-flues where they pass into the upper horizontal passage presenting restrictions formed by 110 projections on the bond courses, which restrictions are narrow at the end remote from the chimney and thence widen out toward the chimney, and slides on the projections to permit of adjusting the apertures of the heat- 115 ing-flues, substantially as described and for the purpose hereinabove set forth.

7. A coke-oven, having a horizontal pas- 120 sage, heating-flues and means whereby the air ascends vertically in one angle of the heating-flue and the gas in the opposite angle for the purpose of forming the combustion zone at the top of the coal charge, substantially as described and for the purpose herein- 125 above set forth.

8. A coke-oven, having a horizontal pas- sage, heating-flues and means whereby the air ascends vertically in one angle of the heating-



flue and the gas in the opposite angle, and  
interchangeable nozzles permitting of regu-  
lating the quantities of gas and air passing  
through and their ratio one to the other, sub-  
stantially as described and for the purpose  
hereinabove set forth.

In testimony whereof I have hereunto set

my hand, in presence of two subscribing wit-  
nesses, this 19th day of August, 1904.

HEINRICH KOPPERS.

Witnesses:

WILLIAM ESSENWEIN,  
PETER LIEBER.