No. 705,926. Patented July 29, 1902.

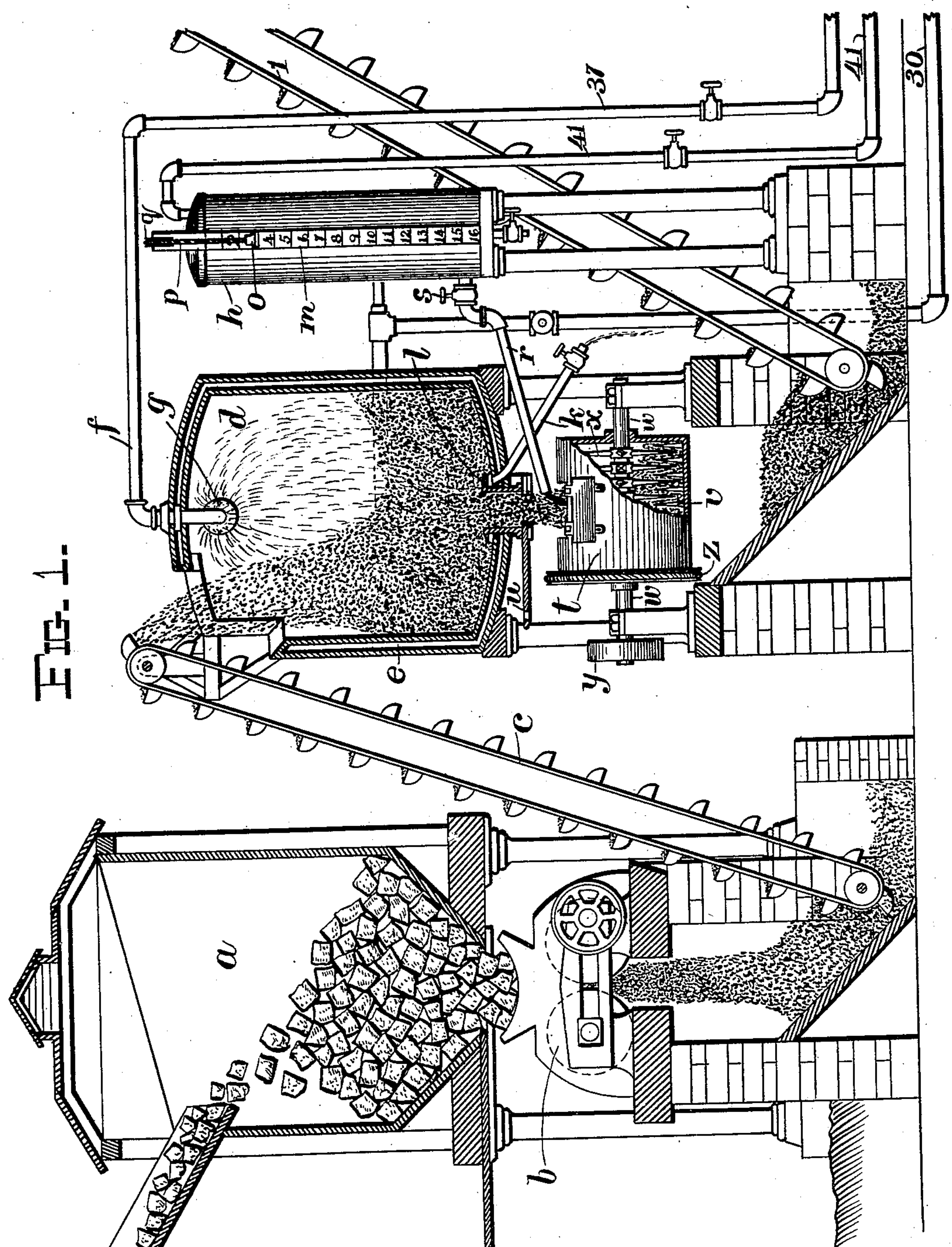
J. HEMINGWAY.

CONTINUOUS PROCESS OF COKING COAL.

(Application filed Oct. 21, 1901.)

(No Model.) 5 Sheets—Sheet 1.

FIG. 1.



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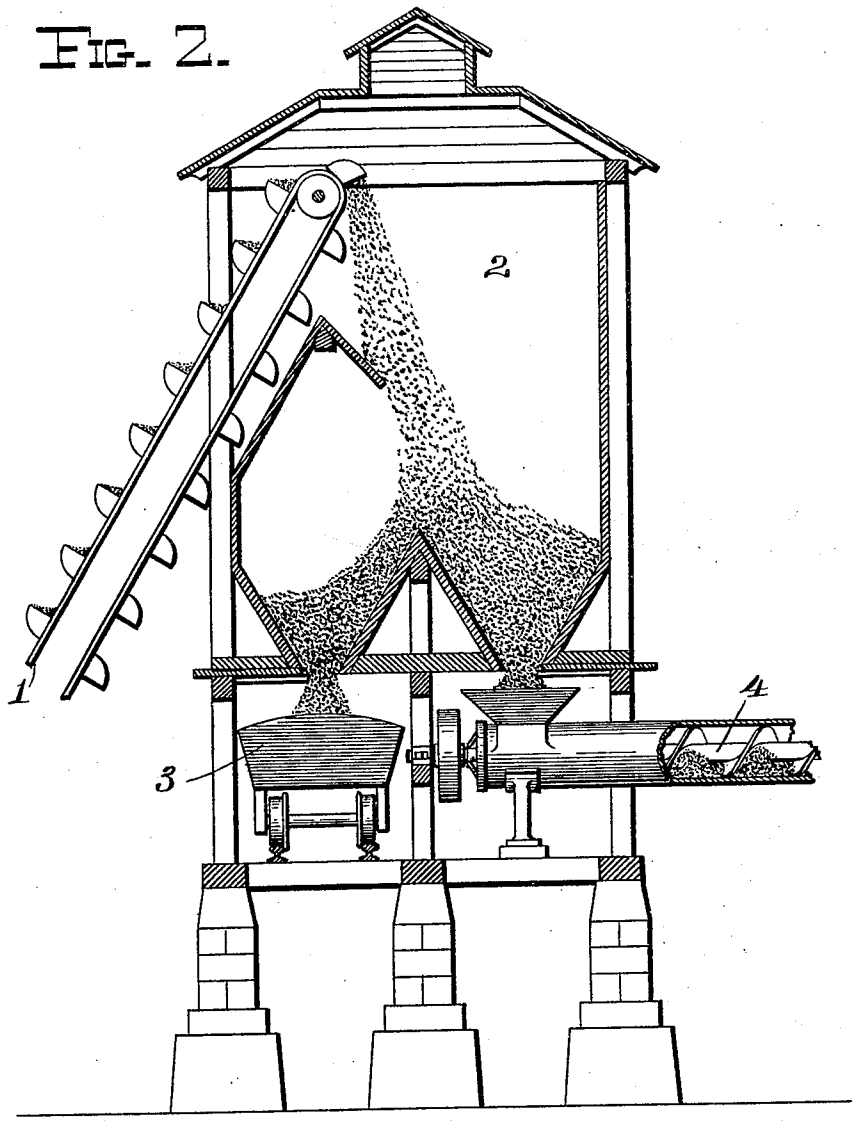
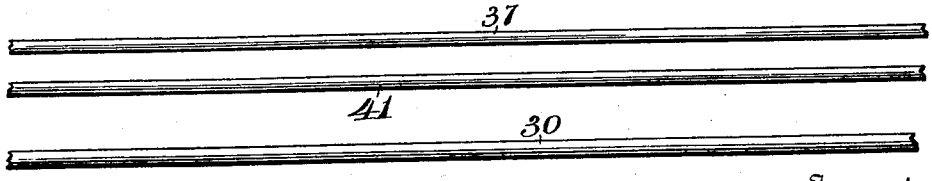
(No Model.) 5 Sheets—Sheet 2.

FIG. 2.





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(No Model.) 5 Sheets—Sheet 3.

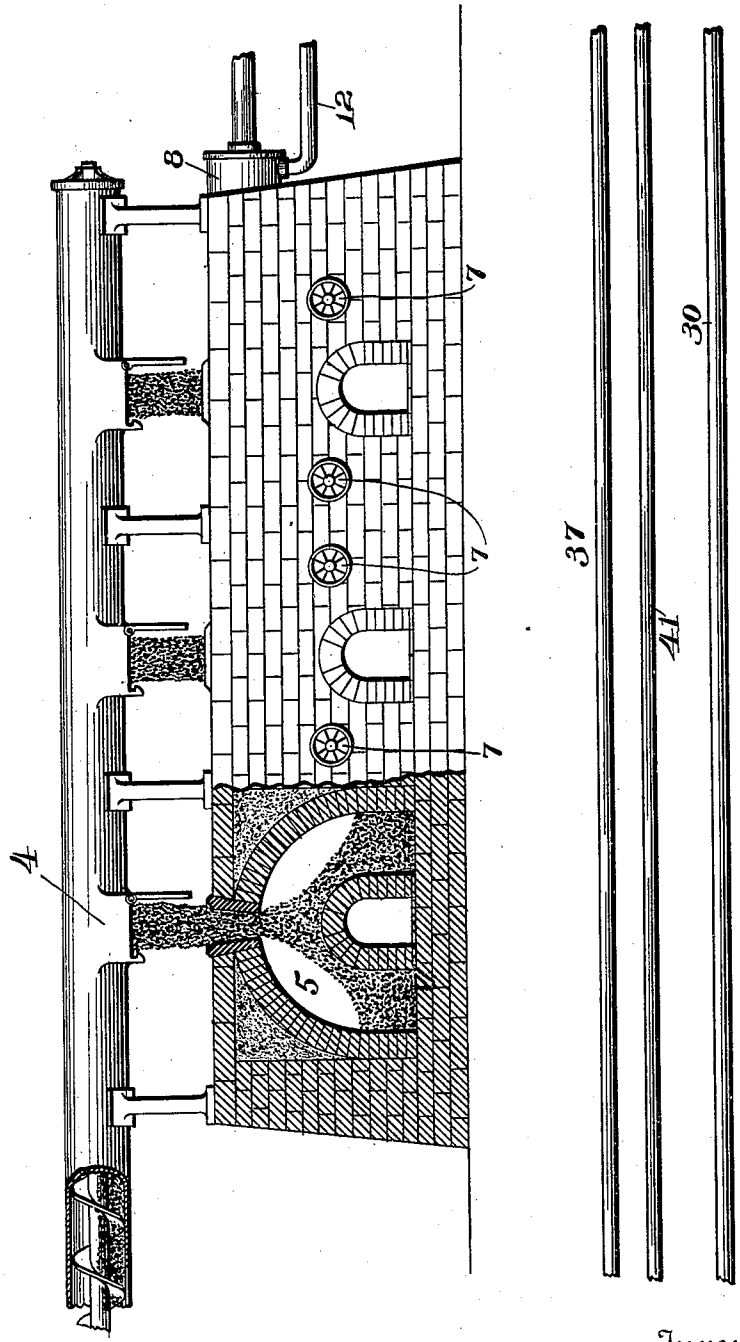

Fig. 3.

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(No Model.) 5 Sheets—Sheet 4.

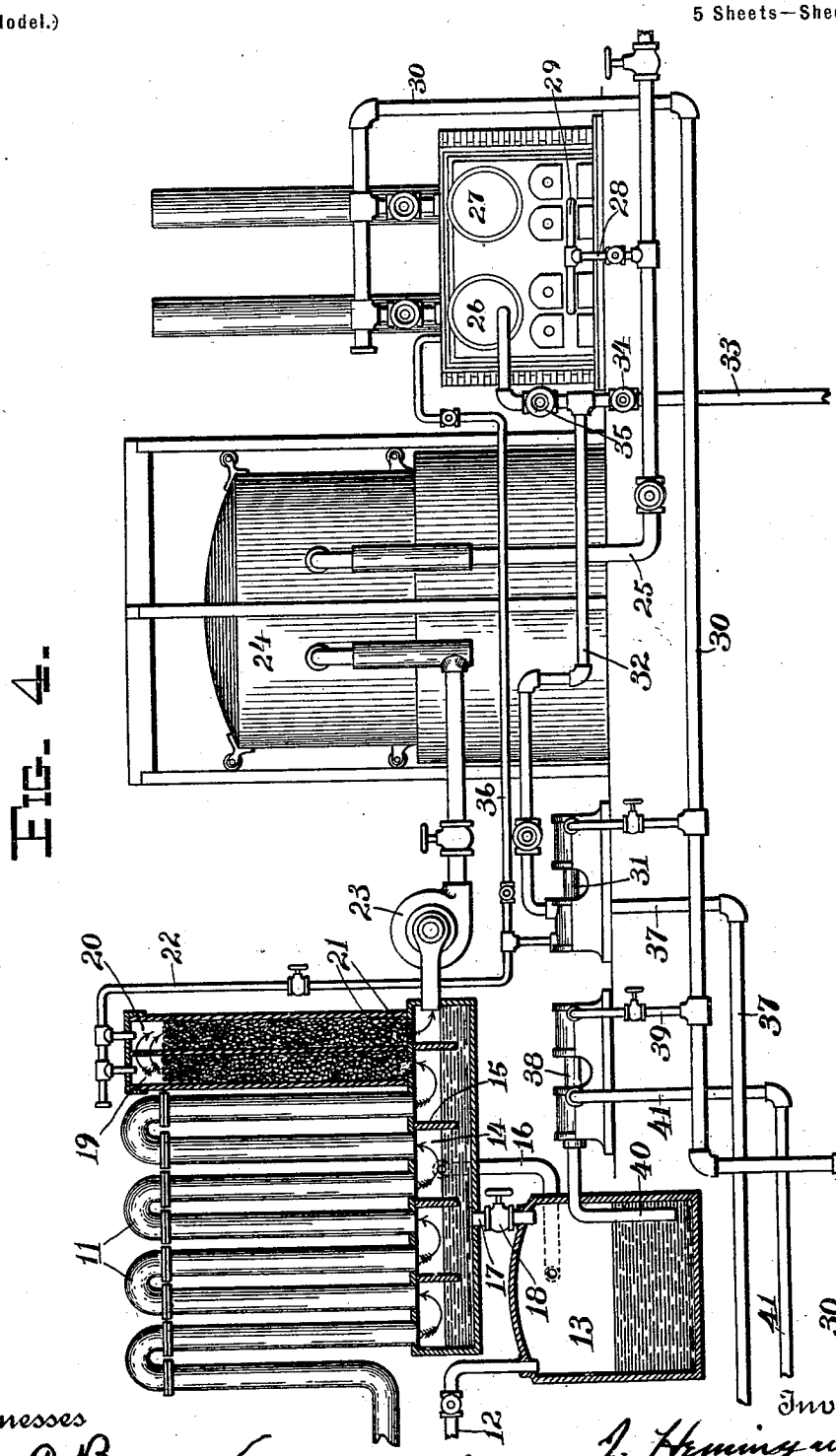

FIG. 4.

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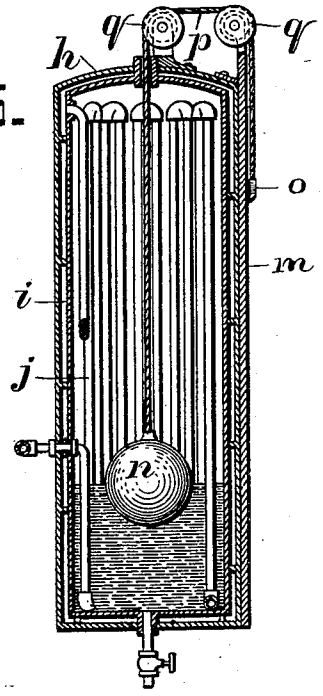
(Application filed Oct. 21, 1901.)

(No Model.) 5 Sheets—Sheet 5.

FIG. 5.



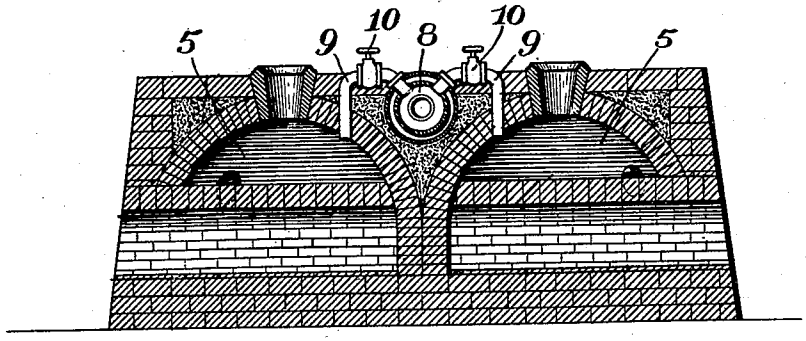


FIG. 6.

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UNITED STATES PATENT OFFICE.

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CONTINUOUS PROCESS OF COKING COAL.

SPECIFICATION forming part of Letters Patent No. 705,926, dated July 29, 1902.

Application filed October 21, 1901. Serial No. 79,455. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH HEMINGWAY, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Continuous Processes of Coking Coal; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in continuous processes for making metallurgical coke, and it is especially designed to be used in connection with what are commonly called "non-cokable" bituminous or semibituminous coals—that is to say, coals which will either not coke at all or will produce such an inferior quality of coke that the coals are of no commercial value for the purpose of making coke.

It is well understood, of course, that the anthracite coals or those coals which contain practically no volatile constituent, but are composed of carbon, ash, and other non-volatile impurities, will not coke, and that, on the other hand, other coals which contain a certain proportion of volatile constituents will coke freely and easily. This latter class are bituminous and semibituminous coals, although as a matter of fact prior to my invention a great many of these coals would not produce a merchantable article of coke, so that for convenience the bituminous and semibituminous coals may be divided into cokable and non-cokable coals.

Cokable coals are those which become softened when heated to the temperature of incipient decomposition and which when in a semiviscid or pasty condition will swell into a spongy mass and give off bubbles of gas which burn with a bright flame. After the volatile constituents have been entirely driven off the results are firm, hard, spongy masses of coke which are very porous and the best grades of which have a metallic luster. Non-cokable coals are those which in burning do not cinder or cake together in any considerable degree and which when strongly heated in a closed retort do not fuse together and unite to form a solid coherent coke. Of course these two classes shade into each other by almost imperceptible degrees of variation, running from the coals which readily yield the best quality of coke to those which upon heating do not frit together at all or in a very slight degree, but yield simply dust and highly friable masses, so that when drawn from the coke-ovens they will almost crumble to dust.

The object of my invention is to produce metallurgical coke from coals hitherto considered incapable of producing such an article.

By "metallurgical coke" I mean one that can be used in glass-furnaces and other metallurgical work, and not coke that can be used merely as a heat-producing fuel.

The chief characteristics of metallurgical coke are that it shall be free from sulfur and other deleterious substances and that it shall be sufficiently firm in texture to withstand considerable pressure. This last property is perhaps the most important of all from a practical standpoint, as without it coke is practically useless for metallurgical purposes, and coke which does not possess this property cannot fairly be termed "metallurgical" coke. The very natural supposition that the fusibility or infusibility of any variety of coal, and therefore its value for making coke, must always stand in fixed ratio to its proportional composition is not at all borne out by practice. The property of fusing or not fusing finally depends on the presence or absence of certain carbon compounds, of which intimate knowledge has not yet been attained. The analysis of a particular variety of coal will not afford any certain indication as to whether or not it will produce a good article of coke. Actual trial furnishes the only reliable test. Some coals which furnish a first-class article of coke contain less than half the proportion of volatile combustible matter which other coals contain that will not produce matallurgical coke at all. Neither the proportion of fixed carbon in a coal nor the proportion of volatile matter in a coal gives any certain indication of its coking qualities. Many coals, however, which would naturally be expected from their chemical analysis to furnish good coke will when subjected to the coking process frit together to a slight extent and produce a very inferior article of coke. The fact, however, that they do produce an infe-

rior coke and that their chemical analysis would indicate that they ought to be classed among coking-coals has given rise to long and expensive experiments, for the reason that the users of the coal thought that there must be something wrong in the conditions under which it was attempted to coke these coals. I myself have made long and expensive experiments upon these coals and have finally discovered a process by which almost all the coals which contain enough volatile combustible matter to be classed among coking-coals can be made to yield at a small expense a first-class article of coke.

I do not pretend, of course, that this process is applicable to anthracite coals and there are some bituminous or sembituminous coals which either from the fact that they contain a small proportion of volatile combustible matter or for some other reason will not yield a good quality of coke; but my process is applicable to the vast majority of all those bituminous and semibituminous coals and lignites which have hitherto been considered non-cokable.

My process is especially applicable to the non-anthracitic coals which occur in the middle west and far west of the United States. The majority of these coals occur in the cretaceous formation as distinguished from the carboniferous formation, the coals occurring in the latter being sometimes called "true coals." These soft coals from the carboniferous formation usually present but comparatively little difficulty in coking. Such is not the case, however, with the bituminous or semibituminous coals which occur in the cretaceous formation, and it is to this kind of coals that my process is particularly applicable.

In the accompanying drawings, which illustrate an apparatus adapted to carry out my process, Figures 1, 2, 3, and 4 are side elevations, partly in section, of my apparatus. These sheets are to be read consecutively. Fig. 5 is a cross-section of the tar-tank, and Fig. 6 is a cross-section of the oven structure.

a represents a building or bin into which the coal as brought from the mines is discharged and stored. *b* is a crusher located underneath said bin and is intended to crush the coal into small fragments—about the size of rice-grains, for example.

c is an elevator which delivers the crushed coal into the moistening-chamber *d*, which is made of iron and of a size to hold about eighty tons. This moistening-chamber *d* is provided with a steam-jacket *e*, and into the top of the chamber *d* a hot-water pipe *f* through a rose or sprinkler *g* delivers boiling-hot water in a spray into the chamber.

I have found by experiment that although it is not strictly necessary to moisten the coal, yet the moistening considerably increases the quantity of the coke, and I have also found that the use of boiling-hot water increases the quality of the coke produced in a very marked degree. If no water is used, the tar which is mixed with the coal subsequently seems to roll the coal into small lumps, and in these lumps are to be found pieces of coal not moistened at all by the tar. This stream of hot water entering the chamber *d* is so regulated that about four per cent., by weight, of water is added to the coal—enough to thoroughly moisten the coal—so that if left to itself no appreciable amount of water would drain off the coal.

k represents a waste-pipe located in the bottom of the chamber *d* for the purpose of draining off the excess of water, and *l* represents a shelf arranged over said waste-pipe to prevent clogging.

h represents a tar-tank into which the tar obtained from the coke-ovens (which are of the by-product variety) is dumped. To keep the tar in this tank in a liquid condition, it is provided with a steam-jacket *i* and an internal coil of steam-pipe *j*.

m represents a scale on the outside of the tank, *n* a float-valve in said tank, and *o* a pointer adapted to travel over the scale, the pointer and float-valve being connected by a rope *p*, passing over the pulleys *q*. It is convenient to make this tank of such a size that the movement of the index over the scale of the space of one foot will deliver enough tar to treat, say, five tons of coal, which is the ordinary charge for a bee-hive oven, and it may be arranged that the index will ring a bell after it has traveled over one division of the scale.

r represents a delivery-pipe for the tar, which pipe is provided with a hand-valve *s*. This pipe delivers into a mixer *t*, to which the coal is delivered from the chamber *d* on the withdrawal of the sliding valve *u*. The mixer *t* is large enough to take in one charge—that is to say, five tons of coal—and the mixer itself consists of a drum provided with a hinged cover and with internal projections or spear-heads *v*, mounted on a central shaft *w*, which shaft is provided with stirring-arms *x*, the drum and shaft being revolved in different directions by means of power applied to the pulley *y* and the rope-pulley *z*.

The amount of tar to be mixed with a charge of coal varies, of course, with the particular coal under treatment. No definite rule can be laid down; but for the coals obtained from this vicinity with which I have been experimenting ten per cent., by weight, of tar is about the right quantity.

One curious fact that has developed in the course of my experiments is that notwithstanding the coal under treatment contains within itself enough tar and other volatile substances to apparently cause the fixed carbon in the coal to agglutinate together and form a good article of coke, these volatile substances, including the tar, will not produce the desired result. For example, I took one lot of coal, weighing about five tons, and

attempted to coke it by itself. The experiment failed utterly as far as the coking was concerned, the result being a loose pulverulent mass; but about fifteen per cent. of tar was obtained. This tar was then mixed with another charge of five tons of coal taken from the same seam, and the result was a fine article of coke and about twenty per cent. of tar, showing that the coal had in itself more than enough tar to cause the fixed carbon to agglutinate together and form coke.

After the moistened coal and tar have been thoroughly mixed together they are carried by the elevator 1 into the storage-chamber 2, from which chamber they are either delivered into cars 3 or a spiral conveyer 4 is made, if desired, by means of which they are conveyed to the ovens 5, which are of the usual type. These ovens are shown in Fig. 3 and also in cross-section in Fig. 6. They are provided with the usual dampers 7 for the admission of air, and they discharge into a jacketed hydraulic main 8.

9 indicates a pipe connecting the several ovens with the hydraulic main, and each of these pipes is provided with a valve 10.

All the volatile constituents resulting from the coking operation go into the hydraulic main 8 and thence into condenser 11.

12 represents a valve-pipe connected to the lower part of the hydraulic main and leading into the main tar-chamber 13. The pipes in the condenser deliver into the usual tank 14, provided with partitions 15, which tank is connected by an overflow-pipe 16 with the main tar-tank 13. A pipe 17, provided with a valve 18, also connects the tanks 13 and 14. The tar, ammoniacal liquor, &c., are nearly all deposited in the tank 14. The gas after passing through a scrubber is delivered into the gasometer. This scrubber consists of two upright columns 19 and 20, closed at the bottom by screens 21 and filled with lime or coke or a mixture of the two. A valve-pipe 22 delivers hot water to the top of these columns 19 and 20. A suction-fan 23 draws the gas up through the column 19 and down through the column 20 and delivers it into the gasometer 24, from which a delivery-pipe conducts the gas to any desired point for consumption, and more especially to the boilers 26 and 27, by means of pipes 28 and 29.

Many varieties of soft coal and lignites will furnish enough gas to develop all the power required in the whole process.

30 represents a steam-pipe connected with the boilers, which furnishes the steam required for heating the chamber *d* and tank *h* for driving the tar and water pumps, as well as the elevators, crushers, mixers, and conveyers, and is connected with the pump 31, which draws hot water through the pipe 32 from one or both of the boilers. This pipe 32 connects with the pipe 33, and by means of the valves 34 and 35 it may also be used to pump cold water into the boilers.

36 is a subsidiary hot-water pipe connected to the pump 31 and delivers hot water into the pipe 22.

37 represents the main hot-water-delivery pipe, which delivers hot water to the chamber *d*.

38 represents a tar-pump supplied with steam from the pipe 30 by the pipe 39. It draws the tar from the tank 13 by means of the pipe 40 and forces the tar through the pipe 41 into the tank *h*.

The operation is obvious from the description. The coal is received from the railway-train, is crushed, moistened with boiling-hot water, mixed with a certain per cent. of coal-tar, which percentage is determined by previous experiment upon the particular coal in question, and delivered into the coke-ovens, where it is subjected to the coking operation, the volatile by-products passing into the hydraulic main. The gas after being purified is led into a gasometer, from whence it is drawn as desired to be used as a fuel, and the tar is dumped back again and mixed with a sufficient charge of coal. Thus the whole operation is continuous, the tar from one charge being drawn back to moisten the next succeeding charge, &c. I have found by experiment that a very large number of coals hitherto considered non-cokable could be successfully and cheaply coked by my process.

While I have described my invention and the apparatus I have used in carrying it out, I wish it to be distinctly understood that it could be carried out by many different forms of apparatus and that I do not limit myself to any particular apparatus or to the exact details described.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The continuous process of making metallurgical coke, which consists in pulverizing bituminous or semibituminous coal, mixing it with about four per cent. of water and about ten per cent. of coal-tar, charging the coking-ovens with said mixture, and distilling it, substantially as described.

2. The continuous process of making metallurgical coke, which consists in pulverizing bituminous or semibituminous coal, mixing it with about four per cent. of boiling-hot water, mixing the moistened mass with about ten per cent. of coal-tar, charging the coking-ovens with said mixture, distilling it, and returning the heavy portion of the distillate containing tar, pitch and similar substances (mixed with a fresh charge of coal moistened with hot water) into the coking-ovens during the coking operation, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

JOSEPH HEMINGWAY.

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T. B. HORTEN.