

J. A. HERRICK.
GAS MUFFLE.

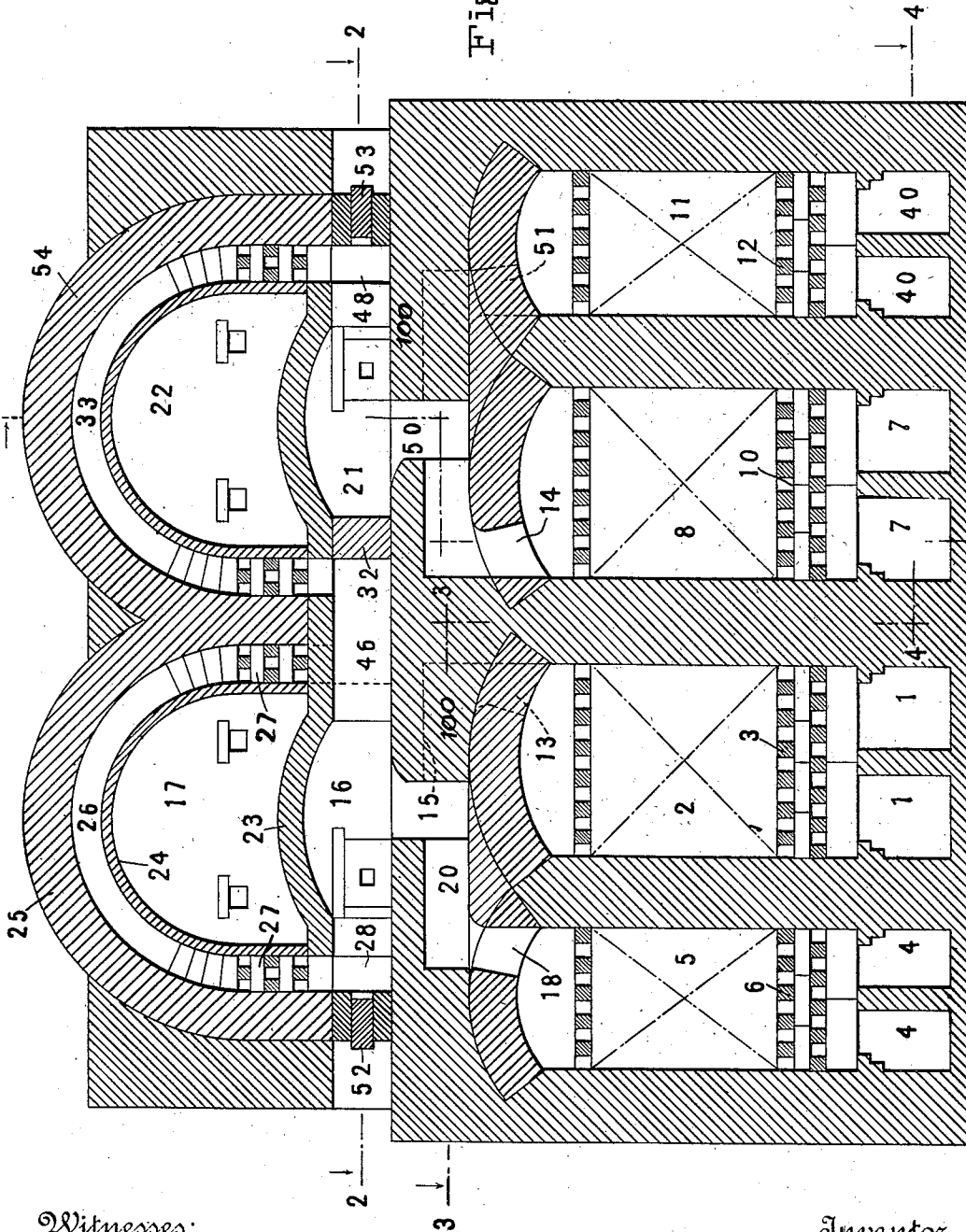
APPLICATION FILED JULY 28, 1909.

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5 SHEETS-SHEET 1.

1,057,832.

Fig- 1-



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5 SHEETS—SHEET 2.

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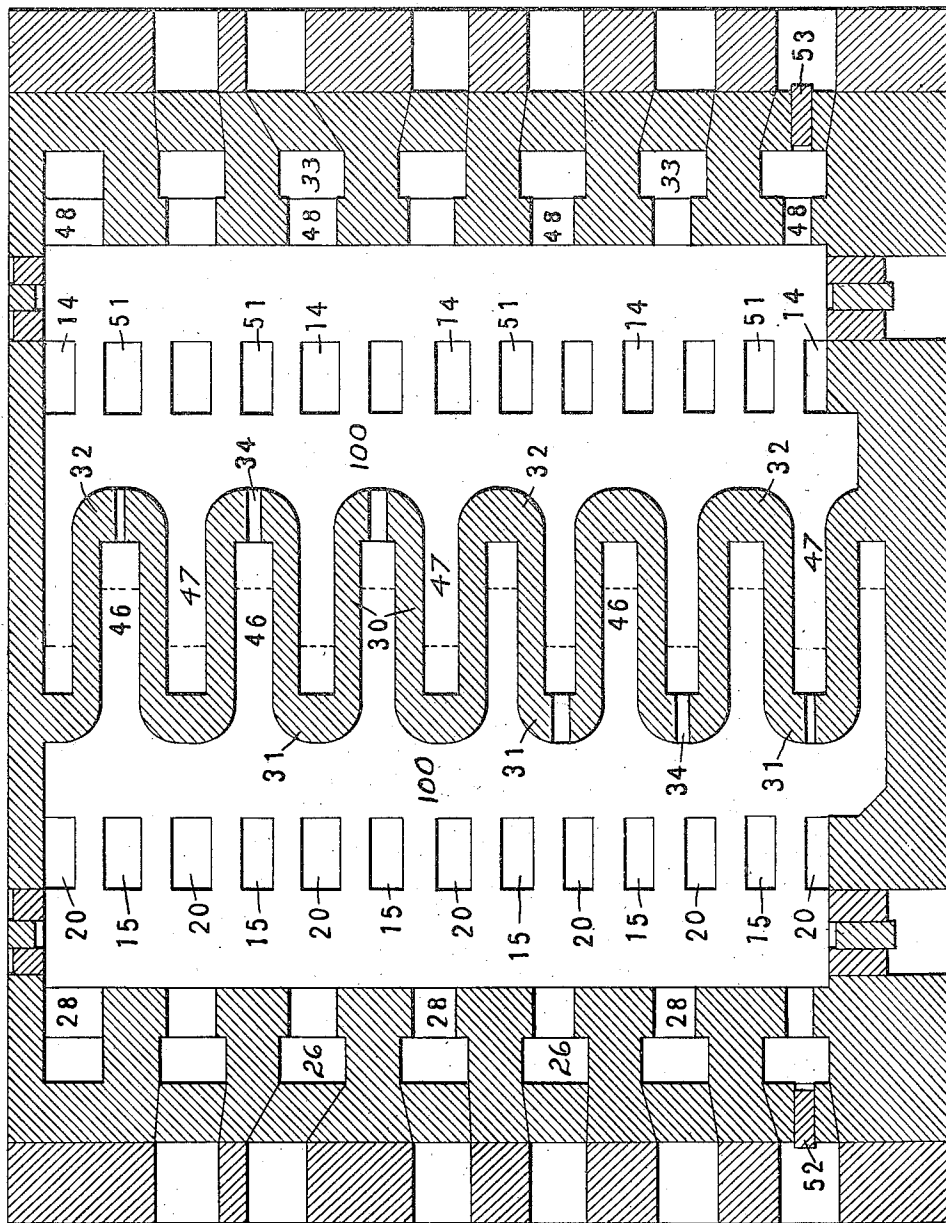


FIG-2-

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5 SHEETS—SHEET 3.

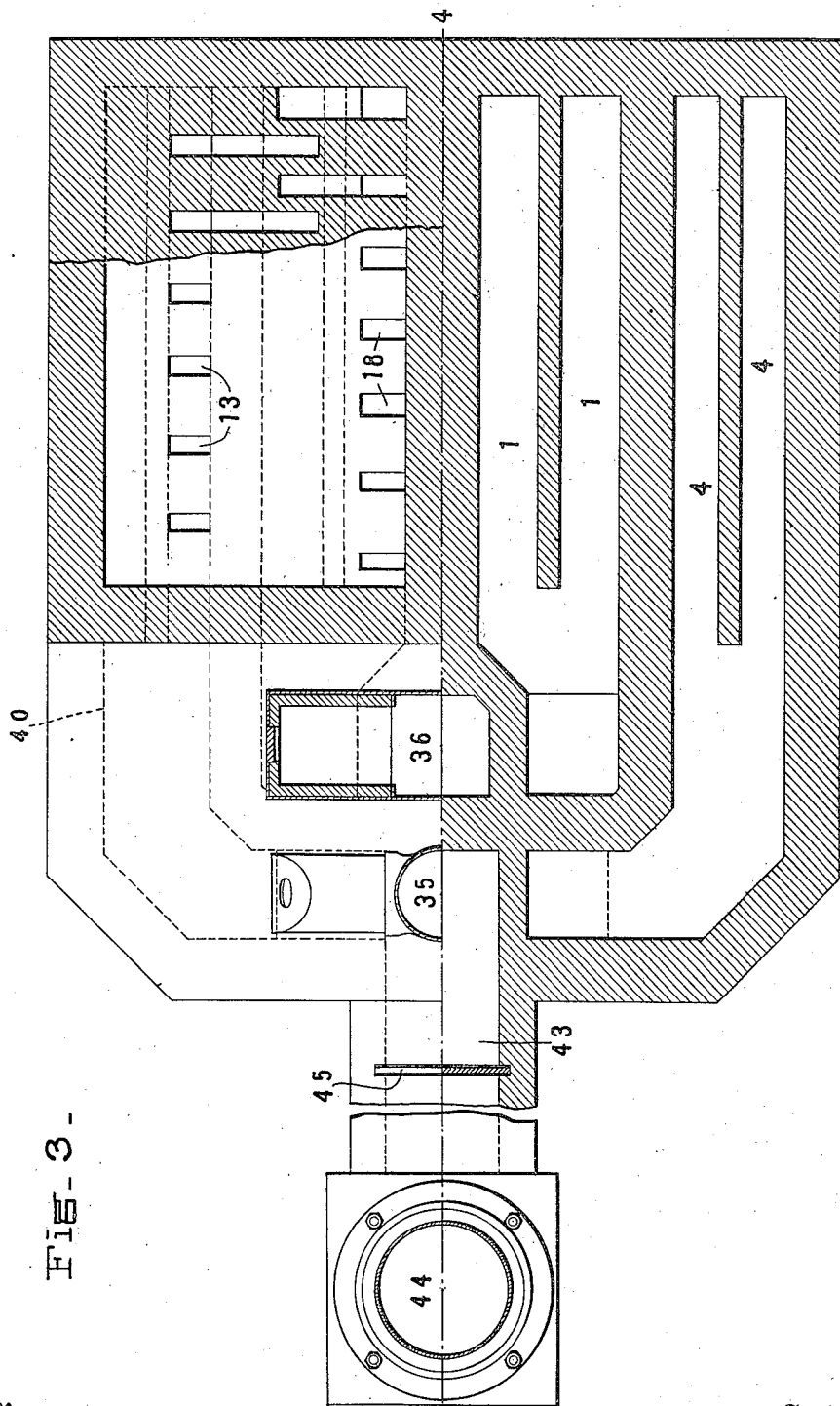


FIG-3-

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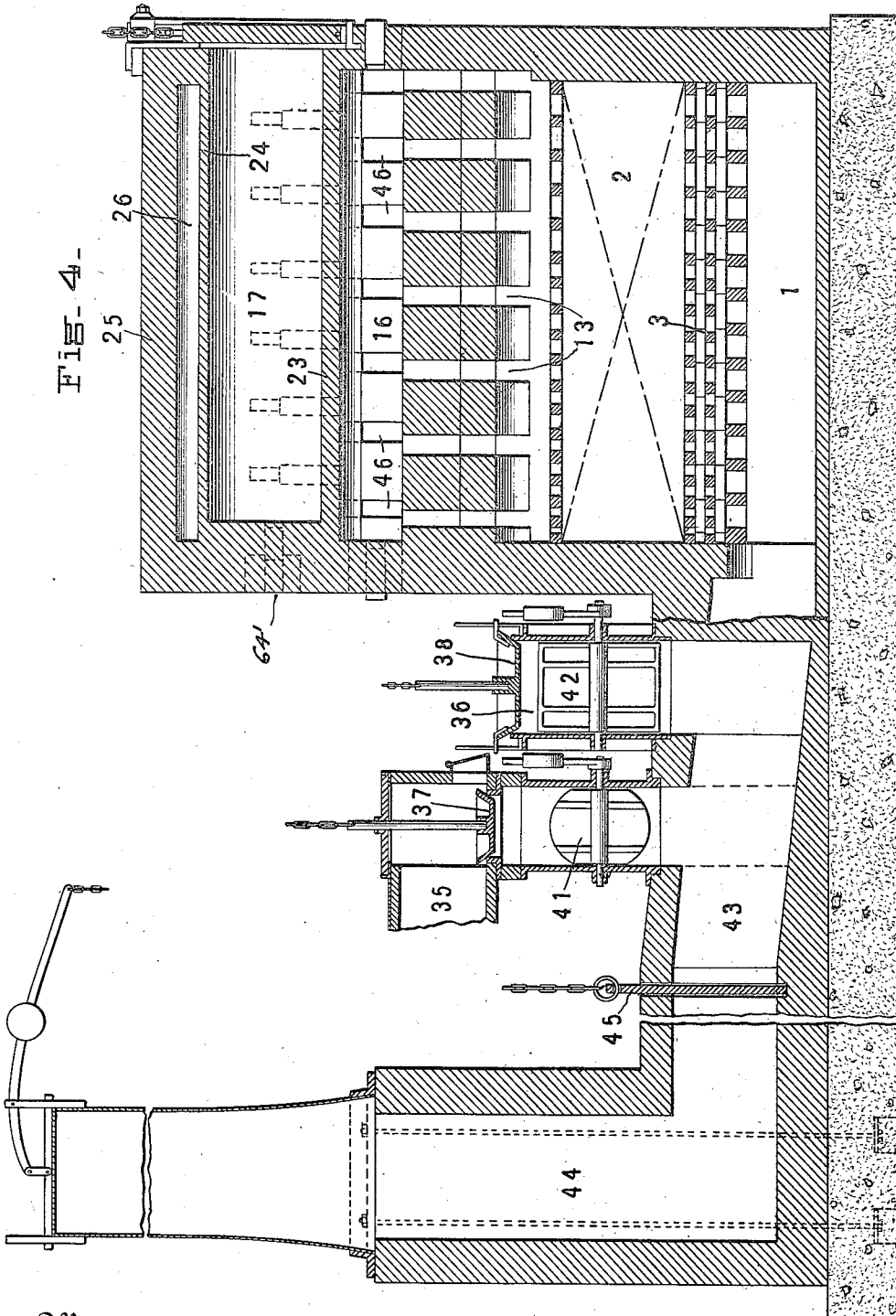
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5 SHEETS-SHEET 4.

1,057,832.



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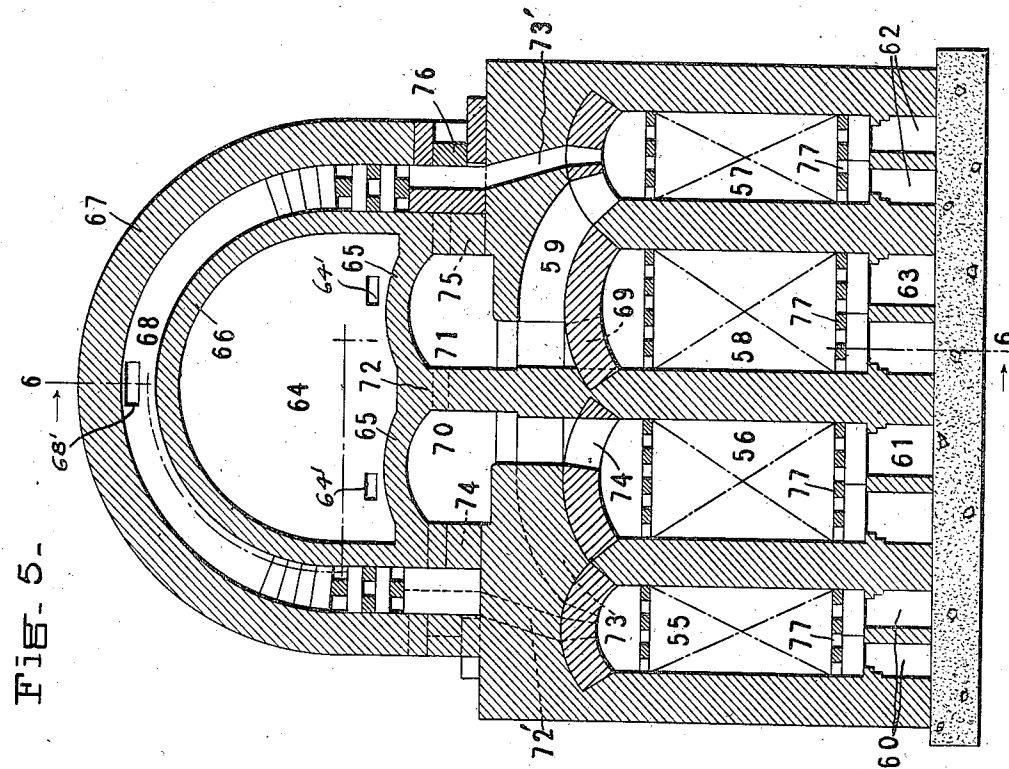
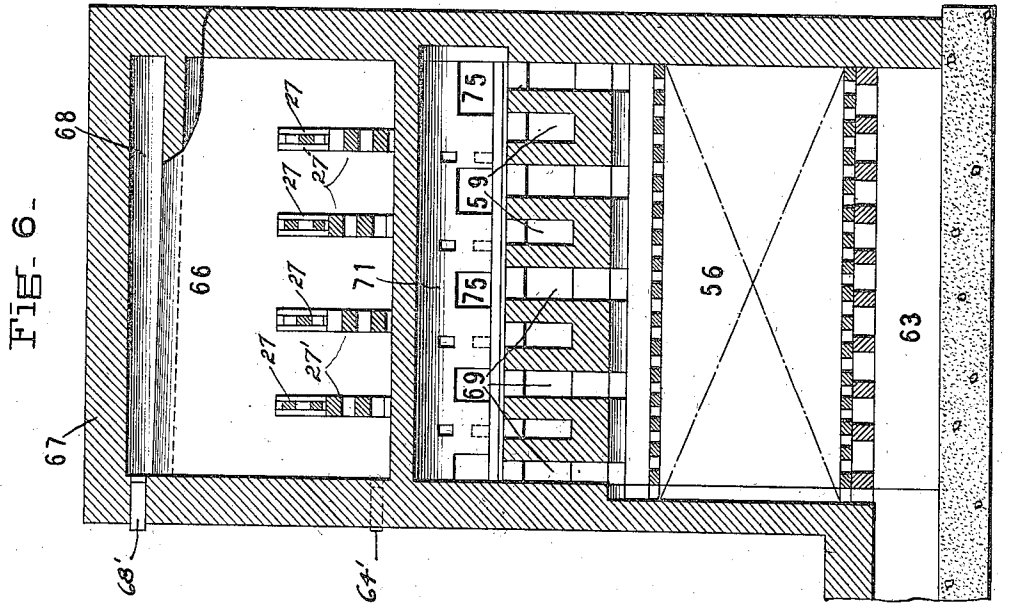
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5 SHEETS—SHEET 5.

1,057,832.



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UNITED STATES PATENT OFFICE.

JAMES A. HERRICK, OF NEW YORK, N. Y.

GAS-MUFFLE.

1,057,832.

Specification of Letters Patent.

Patented Apr. 1, 1913.

Application filed July 28, 1909. Serial No. 510,094.

To all whom it may concern:

Be it known that I, JAMES A. HERRICK, residing at New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Gas-Muffles, of which the following is a specification.

This invention relates to improvements in that class of furnaces known as "muffles," and one of the objects thereof is to provide new and improved apparatus of the above character designed to provide increased heat efficiency, and economy in fuel consumption.

Another object of the invention is to provide apparatus employing gaseous fuel of such construction as will provide for uniform heat within the muffle.

Another object is to provide apparatus of this character which will take up a greater quantity of the heat generated by the burning gases than has been done in similar apparatus and which will absorb, for purposes of regeneration, a greater quantity of the heat present in the products of combustion.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements and arrangement of parts, which will be exemplified in the construction hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings wherein is illustrated several of various possible embodiments of the invention: Figure 1 is a vertical, sectional view taken through the center of the preferred embodiment of my improved muffle; Fig. 2 is a horizontal sectional view taken substantially on the line 2—2 of Fig. 1; Fig. 3 is a similar view taken partly on the line 3—3 of Fig. 1 and partly on line 4—4 of Fig. 1; Fig. 4 is a vertical sectional view taken substantially on line 4—4 of Fig. 3; Fig. 5 is a vertical sectional view of a different embodiment of the invention; Fig. 6 is a vertical sectional view on line 6—6 of Fig. 5 in the direction of the arrow.

Similar reference characters refer to similar parts throughout the various figures of the drawings.

Referring now to the drawings, and particularly to the embodiment illustrated in

Figs. 1 to 4 inclusive 1 indicates air passage ways which extend lengthwise of the apparatus and 2 is an air regenerative chamber which is preferably filled with spaced blocks or checkers 3, as shown. 4 indicates gas passage ways which extend lengthwise of the apparatus and 5 is a gas regenerative chamber which is also filled with checkers 6.

7 indicates air passage ways similar to those shown at 1 above which is arranged an air regenerative chamber 8 containing checkers 10. Gas passage ways 40 similar to those shown at 4 are adapted to deliver gas to the gas regenerative chamber 11 which is also filled with checkers 12. Chambers 2 and 5 constitute one pair of air and gas regenerative chambers, and chambers 8 and 11 constitute a second pair of air and gas regenerative chambers.

Inasmuch as the apparatus now to be described is duplex but one side thereof may be specifically described in order to impart a clear understanding of the invention. The air after passing through the regenerative chamber 2 is discharged through a port 13 shown in dotted lines, (a similar port 14 being shown in full lines leading from chamber 8,) and flues 15 to a combustion or firing chamber 16 which extends underneath a muffle 17. The gas from the chamber 5 is discharged through the port 18 and flues 20 into chamber 16, the gas and air flues leading into chamber 16 being arranged in alternation as shown in Fig. 2. It will be understood that the gas and air from the regenerative chambers 8 and 11 are similarly discharged into a combustion chamber 21 which extends longitudinally of the second muffle 22. Muffle 17 which extends longitudinally of the apparatus is provided with an arched floor 23 and an arched dome 24 above which, and spaced therefrom is a wall 25, the space provided between the muffle and the inner surface of said wall constituting a flame space 26.

Spaced blocks or "kickers" 27 may be interposed between the muffle and the inner surface of wall 25, as shown, such construction aiding in holding the walls of the muffles in place and providing for a free passage way for the flame. These blocks 27 are arranged in the form of independent horizontally spaced piers 27', which extend upwardly to the spring of the muffle arch, and divide the flame space into a series of spaces

graduated in size from end to end of the muffle, there being a flame port into the space between each pair of piers, said flame ports being graduated as to size in correspondence with the graduated spaces between the piers into which they open. Furthermore I prefer that these piers shall be of openwork construction, for viewing and ventilating purposes, and to allow of expansion. The reason for graduating the size of the spaces between piers is in order that more flame may be directed toward the door end of the muffle, where the spaces are largest, than to the back end, where the spaces are smaller. Ports as at 28 are provided between chamber 16 and the flame space 26 through which flames may pass about the muffle.

Arranged midway between muffles 17 and 22 is a wall 30, said wall comprising a plurality of alternately arranged U-shaped portions 31 and 32 clearly shown in Fig. 2 of the drawings, the construction being such that alternate U-shaped portions 31 and 32 are disposed respectively beneath the flame spaces 26 and 33 of muffles 17 and 22. It will be seen that this construction not only permits the passage of flame from one flame space to the other but also permits the direct passage of flames from the combustion chamber 16 of muffle 17 to the flame space 33 of muffle 22 and vice versa. If desired, small openings as at 34 may be provided in this wall to permit of the passage of a small quantity of the flame directly from one combustion chamber to the other.

Referring now to Fig. 4 of the drawings 35 indicates a conduit adapted to deliver gas to the apparatus and 36 indicates a similar conduit through which air may be delivered; the passage of the gas and air through said conduits being controlled as by means of valves 37 and 38. The conduit 37 communicates with the gas passage ways 4 and 40 respectively which extend underneath the gas regenerative chambers around either side of the apparatus and the air conduit 36 similarly communicates with the air passage ways 1 and 7. The direction of flow of gas and air may be controlled as by means of valves 41 and 42 shown in Fig. 4. These valves are adapted to deflect the gas and air to one side of the apparatus to the exclusion of the other, and at the same time open the air and gas passage ways upon the side of the apparatus from which the air and gas is excluded, to a flue 43 which leads to a stack 44. It will be seen therefore that when gas and air enter through one side of the apparatus the opposite side thereof is open to the flue and stack so that the products of combustion may be discharged there-through as will be hereinafter more fully explained. A valve as at 45 may be provided in flue 43.

Having thus described the construction of this embodiment of my invention the operation thereof may now be understood. The valves 41 and 42 being properly positioned, the gas and air pass through the passage ways 4 and 1 to the regenerative chambers 5 and 2 and then pass upward through said regenerative chambers between checkers 6 and 3 which will be heated, as will be hereinafter described and which will give up a part of said heat to said ingoing gas and air. The gas and air will then be delivered as by means of the ports 18 and 13 and flues 20 and 15 to the combustion chamber 16, through the apertured partition 100 which separates the regenerative chambers from the combustion chambers. The gas and air mixing at this point, burst into flame just above ports or flues 20 and 15, and at this point, it may be noted that these flues have a greater cross-sectional area at the front or door end of the muffle, than at the rear and decrease regularly in cross-sectional area from front to rear of the apparatus. This construction provides for a greater amount of flame at the front part of the apparatus. The ports 28 which lead from the combustion chamber 16 to the flame space 26 are similarly constructed so that a greater portion of the flame will pass about the front end of the muffle. This construction is desirable for the reason that, owing to the fact that the front or door of the muffle is opened frequently for the insertion and removal of the material to be treated, it is necessary to supply a greater amount of heat through the front portion of the muffle. For the same reason the flame space 26 is preferably of greater cross-sectional area at the front end of the muffle than it is at the rear end; and the openings in the checker-work are also preferably somewhat larger at the front end than at the rear end of the air and gas regenerative chambers.

The flame in the combustion chamber 16 divides, one part passing to the outside through ports 28 around the lower corner of the muffle up the side and over the top thereof, filling the entire space between the same and the surface of the outside walls. This flame passes entirely around the first muffle from left to right, and then drops down through the flues 46 formed by the U-shaped portions 31 and 32 of wall 30 into chamber 21, which, when the flame is passing in this direction through the apparatus, may be termed a "gathering chamber." The other part of the flames pass between the legs of the U-shaped members thence through flues 47 and upward about the second muffle 22 whence they return through ports 48 to the chamber 21. From chamber 21 the flames pass down through the flues 50 and ports 14 and 51 into the regenerative chambers 8 and 11 whence they pass through the passage

ways 7 and 40 to the stack. The products of combustion passing through the regenerative chambers 8 and 11 come into contact with the checkers and heat the latter, so that when the direction of flow of gas and air through the apparatus is reversed, said gas and air will be heated before ignition. This last described operation of reversing the flow of gas and air through the apparatus may be accomplished as has been above described by means of the valves 41 and 42 which deflect same through the passage ways upon the opposite side of the apparatus.

Suitable blocks as at 52 and 53 may be slidably mounted in lateral openings provided in walls 25 and 54. These blocks may be slid in and out to vary the size of the passage ways 28 and 48 through which the flames pass from the combustion chambers to the flame spaces about the muffles, in order that the amount of flame required to properly heat any portion of the muffle may be regulated.

When the apparatus has been in operation for some time the rear portion of the muffle will be very much hotter than the front portion, on account of the door and the pull of the stack. In order to relieve this condition I may provide valve-controlled openings in the rear wall of the apparatus, so that communication may be established between the atmosphere and the flame chamber and also between atmosphere and the interior of the muffle, when desired.

Referring to the embodiment of my invention shown in Figs. 5 and 6 of the drawing, 55 denotes a gas regenerative chamber and 56 an air regenerative chamber corresponding chambers 57 and 58 being provided upon the right hand side of the apparatus. Air and gas are delivered to the regenerative chambers 55 and 56 as by means of passage ways 60 and 61; similar passage ways 62 and 63 being provided to deliver gas to the other side of the apparatus. Suitable valve mechanism (not shown) is provided for delivering air and gas to regenerative chambers at one side of the apparatus and for allowing the products of combustion to pass to the stack; the direction of flow of the gas through the apparatus being determined by the position of the valves. Mounted above the regenerative chambers is the muffle 64 having the arched floor 65 and the arched dome 66 about which is positioned an exterior permanent wall 67 leaving a space 68 between the muffle and wall which provides a flame space. Suitably spaced bricks or "kickers" are employed for supporting the lateral walls of the muffle. Extending longitudinally underneath muffle 64 is a pair of chambers 70 and 71 respectively, separated by a wall 72 which, if desired, may be provided with apertures as shown in dotted lines. Passage ways 73 and 74 lead

from regenerative chambers 55 and 56 to chamber 70 and similar passage ways 59 and 69 lead from the regenerative chambers 57 and 58 to chamber 71. The series of mouths of the two series of passage ways upon two sides of the apparatus which lead from the regenerative chambers to the chambers 70 and 71 are preferably arranged in alternation. 72¹ and 73¹ are auxiliary gas conduits leading direct from the gas regenerative chamber to the flame space 68. Leading from chambers 70 and 71 to the flame space 68 are lateral passage ways 74 and 75, said passage ways allowing flame to pass upward about the dome of the muffle to the flame space 68. The exterior wall of the apparatus may be provided with suitable apertures at any desired point in which may be mounted slidable blocks as at 76. These blocks when slid inwardly or outwardly are adapted for varying the size of the various flues. In the operation of this embodiment of my invention the gas and air passing upward through the regenerative chambers 55 and 56 mix in the chamber 70 where they are ignited. The flame then passes through passage way 74, thence upward about the dome of the muffle through the flame space 68, then downward about the muffle, part thereof then passing through passage way 59 into the chamber 57, and part thereof passing downward through the passage way 69 into the gas regenerative chamber 58. Thus it will be seen that some of the flame entering chamber 57 may pass downward into air regenerative chamber 58 and some through passage ways 59 and 73 into the gas regenerative chamber 57. These chambers, as in the first above described embodiment, are filled with checkers 77 which operate to absorb the heat present in the products of combustion, so that when the direction of flow of air and gas through the apparatus is reversed such heat will be used in preheating such gas and air, the discharging products of combustion operating to replenish the heat in the checkers located in the other pair of regenerative chambers. It will be obvious that some of the gas will pass upward through either of the tubes 73 to meet the flame passing through the lateral openings 74 and 75 which lead from the chambers 70 and 71 to the flame space 68. For relieving an overheated condition of the back of the muffle, I may provide suitable valve-controlled passages in the back wall of the apparatus, as indicated at 68', whereby communication may be established between the back of the flame space 68 and atmosphere. And similarly, to cool the back of the muffle itself when desired, I may provide similar passages 64', to establish communication between the back of the muffle and atmosphere.

Accordingly it will be seen that I have provided constructions well adapted among

others to maintain all the ends and objects pointed out in an entirely simple yet efficient manner.

The various regenerative chambers and the passage ways leading therefrom to the chambers underneath the muffles and the flame spaces which surround them are so arranged that the muffles are subjected to such heat as will maintain a uniform heating of the interior thereof.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense. It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention, which as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In apparatus of the class described, a muffle having a surrounding flame-space, a combustion chamber communicating with said flame-space, regenerative chambers communicating with said combustion chamber for delivering heated air and gas thereto, and an apertured partition between said regenerative chambers and the combustion chamber.

2. In apparatus of the class described, a pair of muffles, a wall about each of said muffles and spaced therefrom, a chamber underneath each of said muffles, a wall separating said chambers and provided with flame passage ways, and a pair of regenerative chambers located beneath each of said first mentioned chambers.

3. In apparatus of the class described, a pair of muffles, a wall about each of said muffles and spaced therefrom, a chamber underneath each of said muffles, a wall separating said muffles and provided with flame passage ways, an air and a gas regenerative chamber arranged beneath each of said first mentioned chambers, and partitions provided with gas and air passage ways positioned between said regenerative chambers and said first mentioned chambers.

4. In apparatus of the class described, a pair of muffles, a wall about each of said muffles and spaced therefrom, a chamber underneath each of said muffles, a wall separating said chambers, said wall providing passage ways from the space surrounding one muffle to that surrounding the other, and an air and a gas regenerative chamber arranged beneath each of said chambers, each

of said last mentioned chambers being provided with a series of ports, the ports of the two series being arranged in alternate relation.

5. In apparatus of the class described, a pair of muffles, a wall positioned about each of said muffles and spaced therefrom, a chamber underneath each of said muffles, a wall separating said chambers, said wall being so formed as to provide passage ways between the spaces formed between the muffles and said first mentioned walls, an air and a gas regenerative chamber arranged beneath each of said first mentioned chambers, each of said last mentioned chambers being provided with a series of ports, the ports of said two series being arranged in alternate relation, and a passage way common to said ports for conducting a mixture of air and gas to said first mentioned chambers.

6. In apparatus of the class described, a pair of muffles, a wall about each of said muffles and spaced therefrom, a combustion chamber beneath each said muffles, a wall separating said chambers and so formed as to connect the spaces formed between the same and said muffles, and a gas and an air regenerative chamber disposed beneath each of said first mentioned chambers.

7. In apparatus of the class described, a pair of muffles, a gas and an air regenerative chamber located beneath each of said muffles, a wall provided with gas and air ports located above each of said regenerative chambers, means for directing a flame first about one of said muffles and then about the other, and means for introducing air and gas into one pair of regenerative chambers and for allowing the products of combustion to be discharged from the other pair of regenerative chambers, said means being adapted to reverse the direction of flow of air and gas and the discharge of the products of combustion through said apparatus.

8. In apparatus of the class described, a pair of muffles arranged side by side, a wall surrounding said muffles and spaced therefrom, a series of ports arranged along the side of each muffle through which the flame may pass first horizontally and then upwardly about the muffles, one portion of the flame passing about one muffle and the other portion thereof about the other muffle, a pair of regenerative chambers for delivering a mixture of gas and air to one of said chambers, and a second pair of chambers through which products of combustion may pass.

9. In apparatus of the class described, a pair of gas fired muffles, each of which is provided with a combustion chamber below the same, walls surrounding said muffles and spaced therefrom to provide flame spaces. flues connecting the said chambers, flues connecting the spaces above the muffles, means

for introducing a mixture of gas and air into one of said chambers and for withdrawing the products of combustion from the other of said chambers, means for causing the flame to divide so that part thereof will pass about one muffle and part about the other muffle, and means for reversing the direction of said flow of flame about said muffles.

10. In apparatus of the class described, a pair of muffles each of which has a surrounding flame space and a firing or collecting chamber disposed beneath the same, a pair of chambers arranged below each of said first mentioned chambers, one pair of said last mentioned chambers being adapted to deliver a mixture of gas and air to one of said first mentioned chambers and the other pair of said mentioned chambers being adapted to receive the products of combustion from the other of said first mentioned chambers and to store the heat remaining in said products of combustion.

11. In apparatus of the class described, a pair of muffles each of which is provided with a combustion chamber beneath the same and a surrounding flame space, passage ways connecting said flame spaces, passage ways connecting said chambers, a pair of chambers disposed beneath each of said first mentioned chambers and connected therewith by means of passage ways, each pair of last mentioned chambers comprising a gas regenerative chamber and an air regenerative chamber, means for introducing air and gas into one pair of said last mentioned chambers, and means whereby passage of gas, air and products of combustion through said apparatus may be reversed, each pair of said last mentioned chambers being provided with means for absorbing heat present in the products of combustion and for delivering said heat to the ingoing gas and air.

12. In apparatus of the class described, a muffle, a wall positioned about the same to provide a flame space, a chamber underneath said muffle and extending the entire length thereof, an air regenerative chamber located beneath said muffle, a gas regenerative chamber located beneath said muffle, each of said last mentioned chambers being provided with a series of flues and the flues of said series being arranged in alternate relation, and a series of flues terminating in the bottom of said first mentioned chamber which connects the same with the flues leading from the air and gas regenerative chambers.

13. In apparatus of the class described, a muffle, a wall about said muffle and spaced therefrom providing a flame space, blocks interposed between said muffle and said wall, a chamber arranged beneath said muffle and extending longitudinally thereof,

passage ways connecting said chamber with said flame space, a gas and an air regenerative chamber located beneath said muffle, each of said chambers having a series of ports leading therefrom to said first mentioned chamber, said ports being arranged in alternate relation.

14. In apparatus of the class described, a pair of muffles each of which is provided with a surrounding flame space, passage ways connecting said flame spaces, a chamber arranged underneath each of said muffles and extending longitudinally thereof, a pair of chambers arranged beneath each of said first mentioned chambers, one chamber of each of said first mentioned pair of chambers comprising a gas regenerative chamber and the other chamber of each pair an air regenerative chamber, alternately arranged passage ways connecting the chambers of each pair to one of said first mentioned chambers, and means whereby gas and air may be introduced into said apparatus through one pair of regenerative chambers and the products of combustion discharged through the other pair thereof.

15. In apparatus of the class described, a pair of muffles each of which is provided with a surrounding flame space, passage ways connecting said flame space, a chamber arranged underneath each of said muffles and extending longitudinally thereof, a pair of chambers arranged beneath each of said first mentioned chambers, one chamber of each of said first mentioned pair of chambers comprising a gas regenerative chamber and the other chamber of each pair an air regenerative chamber, alternately arranged passage ways connecting the chambers of each pair to one of said first mentioned chambers, means whereby gas and air may be introduced into said apparatus through one pair of regenerative chambers and the products of combustion discharged through the other pair thereof, and means in each of said last mentioned chambers for absorbing the heat present in the products of combustion.

16. In apparatus of the class described, a pair of muffles, each of which is provided with a surrounding flame space and a longitudinally extending combustion chamber arranged beneath the same, passage ways connecting the flame space of each of said muffles and for connecting the combustion chamber of each muffle with its flame space, a pair of regenerative chambers located beneath each of said muffles, means whereby a mixture of gas and air may be introduced into the apparatus through one pair of regenerative chambers and the products of combustion discharged through the other thereof, means in each of said regenerative chambers for absorbing the heat present in the products of combustion, and means

whereby the direction of flow of gas and air and the discharging of the products of combustion through the same apparatus may be reversed.

5 17. In apparatus of the class described, a muffle provided with a surrounding flame space, a chamber arranged underneath said muffle and extending longitudinally there-
10 of, passage ways connecting said chamber with said flame space, said passage ways uniformly decreasing in cross-sectional area from the front to the rear of the muffle, gas and air regenerative chambers arranged under-
15 neath said first mentioned chamber, and passage ways connecting said regenerative chambers with said first mentioned cham-
bers, said passage ways uniformly decreas-
ing in cross-sectional area from the front
to the rear of said muffle.

20 18. In apparatus of the class described, a muffle provided with a surrounding flame space and having a longitudinally extend-
ing combustion or firing chamber arranged
beneath the same, a series of passage ways
25 connecting said chamber with said flame space, said passage ways increasing in cross-
sectional area from the rear to the front of
the muffle, a pair of regenerative chambers
arranged underneath said muffle, each cham-
30 ber being connected with said first men-
tioned chamber by a series of passage ways
which are arranged in alternation and which
decrease in cross-sectional area from the front
to the rear of the apparatus, and means in
35 each of said last mentioned chambers for
absorbing heat from the products of com-
bustion and for giving off said heat to the
ingoing gas or air.

19. In apparatus of the kind described, a
40 muffle, and a wall positioned about the same
to provide a flame space substantially co-
extensive with the muffle, the cross-sectional
area of the flame space being greater at one
end than at the other.

45 20. In apparatus of the class described, a muffle, a wall positioned about the same to
provide a flame space substantially co-ex-
tensive with the muffle, the cross-sectional
area of the flame space being greater at one
50 end than at the other, a combustion cham-
ber below the muffle and opening into the
flame space, and a chamber opening into
said combustion chamber by way of a row
of ports, the port at one end of the row be-
55 ing larger than the port at the other end.

21. In apparatus of the class described, a
muffle, a wall positioned about the same to
provide a flame space substantially co-exten-
sive with the muffle, the cross-sectional area
60 of the flame space being greater at one end
than at the other, a combustion chamber be-
low the muffle and opening into the flame
space, and a chamber opening into said com-
bustion chamber by way of a row of ports,

the port at one end of the row being larger 65
than the port at the other end, said last
named chamber being filled with checker-
work, the openings whereof at one end of
the chamber are larger than those at the
other end. 70

22. In apparatus of the kind described, a
longitudinally extending muffle having a
surrounding flame space and a longitudi-
nally extending combustion chamber be-
neath and in alinement therewith, a row of 75
passageways along the length of the com-
bustion chamber and connecting the same
with the flame space, and means for varying
the size of each one of said row of passage-
ways, whereby the amount of flame required 80
to properly heat any portion of the muffle
may be regulated.

23. In apparatus of the kind described, a
closed muffle having a surrounding wall
spaced therefrom to provide a flame-space 85
about the muffle and extending from front
to rear thereof, there being a valved open-
ing connecting the rear of the flame-space
with the outer air.

24. In apparatus of the kind described, a 90
closed muffle having a surrounding wall
spaced therefrom to provide a flame space
about the muffle and extending from front
to rear thereof, there being a valved opening
in the rear wall of the muffle to the outer air. 95

25. In apparatus of the kind described,
a closed muffle having a surrounding wall
spaced therefrom to provide a flame space
transversely about the muffle and extending
from front to rear thereof, the rear end of 100
the flame space being defined by a wall
which is an extension of the rear wall of
the muffle, said wall having a valve-con-
trolled opening into the rear of the flame
space, and a valve-controlled opening into 105
the rear of the muffle.

26. In apparatus of the kind described,
a muffle having an arched top, a wall posi-
tioned about the muffle to provide a flame
space, and independent horizontally spaced 110
piers between the muffle and the surround-
ing wall, each pier extending substantially
up to the spring of the muffle arch whereby
vertically unobstructed passages are formed
between adjacent piers. 115

27. In apparatus of the kind described,
a muffle having an arched top, a wall posi-
tioned about the muffle to provide a flame
space, and independent horizontally spaced 120
piers between the muffle and the surround-
ing wall, each pier extending substantially
up to the spring of the muffle arch whereby
vertically unobstructed passages are formed
between adjacent piers, said piers being of
openwork construction. 125

28. In apparatus of the kind described,
a muffle having an arched top, a wall posi-
tioned about the muffle to provide a flame

space, and horizontally spaced piers between the muffle and the surrounding wall, each pier extending substantially up to the spring of the muffle arch, said piers providing graduated spaces between them from end to end of the muffle.

29. In apparatus of the kind described, a muffle having an arched top, a wall positioned about the muffle to provide a flame space, and independent horizontally spaced piers between the muffle and the surrounding wall, each pier extending substantially up to the spring of the muffle arch whereby vertically unobstructed passages are formed between adjacent piers, there being a flame port into the space between each pair of piers.

30. In apparatus of the kind described, a muffle having an arched top, a wall positioned about the muffle to provide a flame space, and horizontally spaced piers between the muffle and the surrounding wall, each pier extending substantially up to the spring of the muffle arch, there being a flame port into the space between each pair of

piers, said flame ports being graduated as to size from end to end of the muffle.

31. In apparatus of the class described, a muffle structure having a surrounding flame-space, a plurality of combustion chambers communicating with said flame-space at different points, a regenerative chamber for each of said combustion chambers, and an apertured partition between each regenerative chamber and the corresponding combustion chamber.

32. In apparatus of the class described, a muffle having a surrounding flame-space, a combustion chamber communicating with said flame-space, a regenerative chamber communicating with said combustion chamber, and an apertured partition between said regenerative chamber and the combustion chamber.

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

JAMES A. HERRICK.

Witnesses:

ADELE HONIGSBERG,
BLANCHE W. COULDOK.