

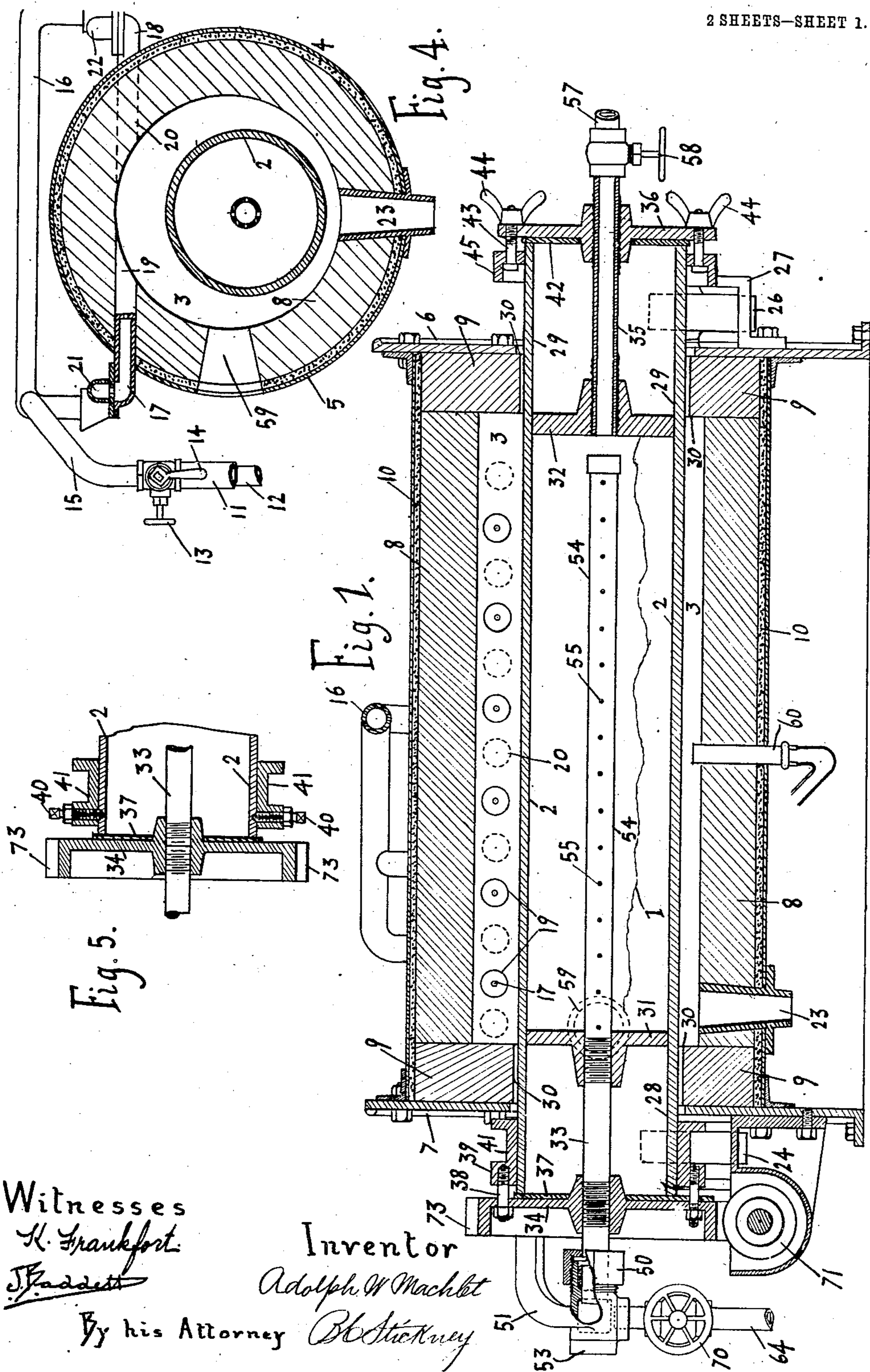
No. 884,180.

PATENTED APR. 7, 1908.

A. W. MACHLET.  
CASE HARDENING APPARATUS.

APPLICATION FILED DEC. 19, 1905.

2 SHEETS—SHEET 1.



Witnesses  
H. Frankfort.  
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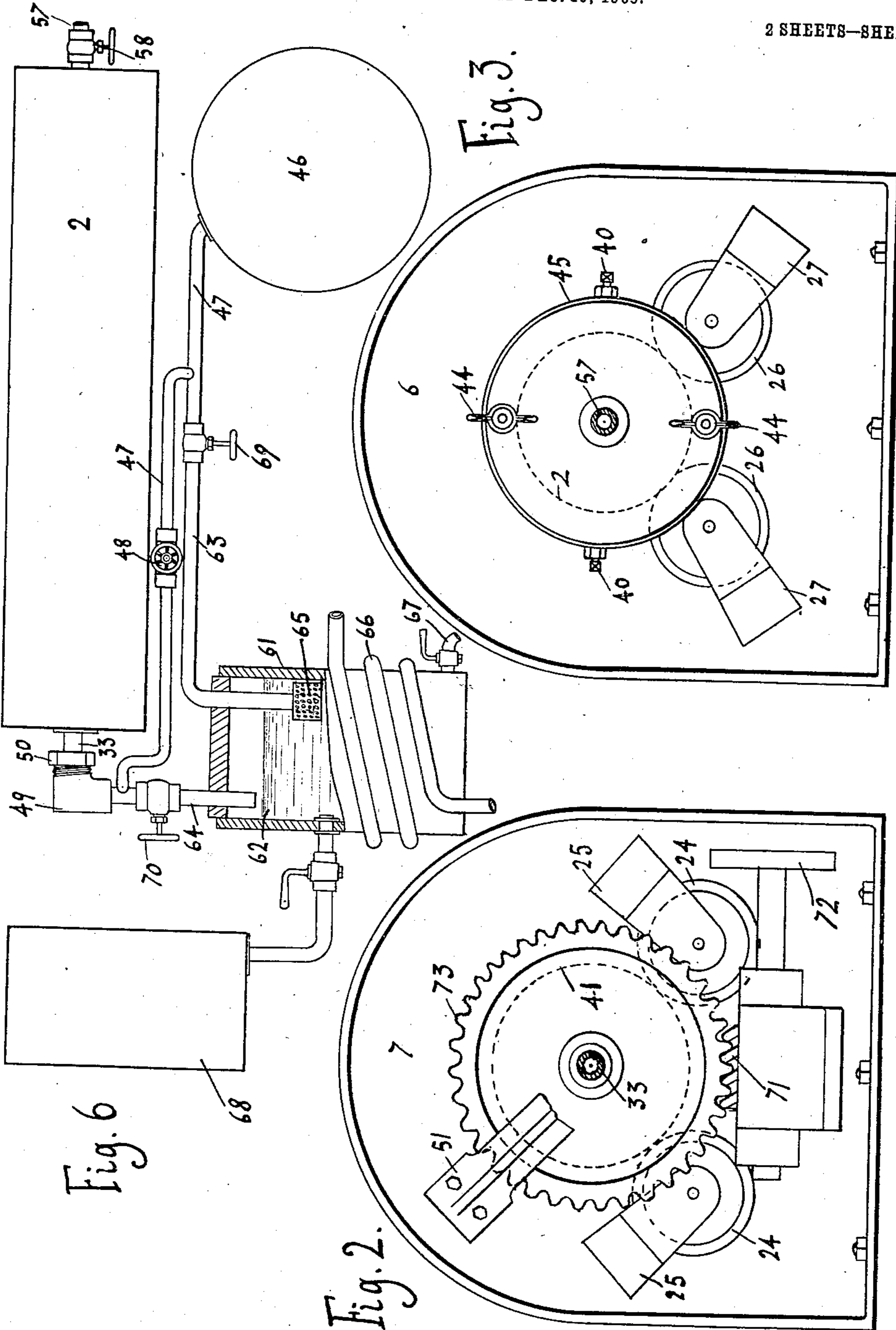
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# UNITED STATES PATENT OFFICE.

ADOLPH W. MACHLET, OF ELIZABETH, NEW JERSEY.

## CASE-HARDENING APPARATUS.

No. 884,180.

Specification of Letters Patent.

Patented April 7, 1908.

Application filed December 19, 1905. Serial No. 292,515.

*To all whom it may concern:*

Be it known that I, ADOLPH W. MACHLET, a citizen of the United States, residing in Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Case-Hardening Apparatus, of which the following is a specification.

This invention relates to the case-hardening of steel and iron articles, particularly small articles in bulk, by subjecting the articles when heated to a bath or current of carburizing gas.

The features of the invention disclosed herein are in the nature of improvements upon the invention set forth in my pending application, No. 244,244 filed Feb. 4th, 1905, Patent No. 822,460.

When illuminating gas, which is rich in carbon, is employed as a case-hardening agent, a large part of the carbon in the gas is deposited upon the articles and upon the walls of the retort. This is not only a waste of material, but it is also apparent that the deposit of surplus carbon upon the surface of the articles prevents proper access of the gas to the articles, thus delaying the completion of the process, and hence making it necessary to maintain the heat for undue length of time, besides which the articles are not cemented evenly, there being a greater depth of cementation upon other portions of each article than upon the portion which receives the deposit of surplus carbon upon the surface.

One of the objects of my invention is to avoid this difficulty, and not only reduce the amount of carburizing gas consumed and prevent deposit of surplus carbon, but also to decrease the time required for cementing the articles to a given depth, and thereby reduce the expense for maintaining the heat of the retort. I also aim to render the case-hardening even in depth and hardness all over the articles, particularly where an extremely thin case is desired.

Another object of the invention is to prolong the life of the retort and also to reduce the expense of renewing the same when worn out. In place of a cast-iron retort, having one or more partitions cast therein and flanges cast thereon for various purposes, I form a retort which consists of a section of tubing, which is usually made of soft steel

and can readily be purchased in this form, although it may be made of wrought iron. Upon this tubing I secure suitable collars, flanges and covers, and within the tubing I insert partitions which are preferably rigidly attached to the covers, so as to be movable therewith; the space between the partitions in the retort being wholly within the flame chamber in the furnace.

I aim to reduce materially the cost of case-hardening articles, to insure that the case-hardening operation shall produce a shell of uniform thickness all over the article, regardless of the shape, to regulate or gage exactly the depth of cementation, and to make it practicable to case-harden small articles cheaply and rapidly in bulk and with uniformity. After cementation is completed, the articles may be tempered in the manner described in my said application.

I heat the articles to a point above redness, but below the melting point in an atmosphere of carburizing gas, preferably above atmospheric pressure. I preferably effect gentle agitation of the articles during the cementation, so as to expose all portions of the articles to the action of the gas. The heat may be from about 1500 to about 1800 degrees Fahrenheit. The progress of the cementation may be known or predetermined and may be arrested at any point, the thickness of the shell being determined in advance even to a thousandth part of an inch.

The illuminating or carburizing gas I cause to pass through ammonia water before entering the retort. By this means, a very large proportion of ammonia is taken up by the carburizing gas. Preferably much less than half of the bulk of the gas entering the retort consists of carbon. In this way, the deposit of surplus carbon upon the surface or exterior of the articles is avoided, or at least reduced to such an extent as to be negligible, the process is much hastened, and a uniform shell of higher quality than heretofore is produced.

In the accompanying drawings, Figure 1 represents a sectional elevation taken from end to end of one form of an apparatus constructed for case-hardening and tempering articles according to my invention. Fig. 2 is an elevation of the left-hand end and Fig. 3 an elevation of the right-hand end of the carburizing apparatus seen at Fig. 1. Fig. 4 is a vertical cross-section taken near the left-

hand end of the furnace at Fig. 1. Fig. 5 is a sectional plan illustrating the means of attaching the flange to the end of the tubing which forms the retort. Fig. 6 is a diagram illustrating the connections to the retort.

The steel or iron articles to be case-hardened, represented by a dotted line 1, are deposited in bulk within a retort 2, preferably in the form of a barrel or elongated cylinder, and mounted wholly within a flame chamber 3 of a furnace 4, the latter comprising a cylindrical or other body 5 having heads 6 and 7. The furnace is provided throughout with a refractory lining, the cylindrical portion thereof which lines the body being indicated at 8, and that portion which lines the heads of the furnace being indicated at 9; all of said lining being usually set in plaster of paris seen at 10. The space inclosed by said refractory lining, forms said flame chamber. Any suitable fuel may be consumed in the furnace; and it may be otherwise constructed. Preferably a mixture of hydrocarbon fuel with air is used, the air being admitted through a pipe 11, and the fuel, such as ordinary illuminating or heating gas, being admitted through a pipe 12; the supply of air and fuel being regulated by valves 13, 14. The air and fuel become mixed within the pipes 15, 16, and the mixture is admitted to burners 17, 18, inserted in horizontal openings 19, 20, formed in the opposite walls of the furnace near the top of the flame chamber. The burners point alternately in opposite directions, as seen at Fig. 4, so as to direct the flames across the top and down around both sides of the retort, and form two sets, extending along the top of the flame chamber above said retort. Two feed pipes 21, 22, extending along the furnace connect the burners in the sets; said pipes being supplied by the pipe 16, which extends across the top of the furnace. The gas flames are directed upon and over the retort and play down around the same and escape through an outlet 23 formed in the bottom of the furnace at the end of the retort, whereby even heating of the latter is assured. The supports of said retort are mounted upon the exterior of the furnace heads, and consist of a pair of rolls 24 carried upon brackets 25, fixed upon the left-hand head 7, and a pair of rolls 26 mounted upon brackets 27 fixed upon the right-hand head 6. The retort consists of a section of wrought iron or soft steel tubing, which is readily purchasable in this form, and comprises the main chamber, in which the articles 1 are placed, and extensions 28 and 29 projecting from the ends of the furnace, the extension 28 revolubly mounted upon the rolls 24, and the extension 29 upon the rolls 26. Said extensions project through openings 30 formed in the refractory lining 9 and through similar openings in the heads of the furnace.

Inserted in the retort are two partitions 31, 32, the former rigidly connected by a central inlet pipe 33 to a cover 34, and the latter similarly connected by an outlet pipe 35, to a cover 36; the latter being movable together with the partition 32, so as to permit the retort to be charged and discharged. The cover 34, which is provided with an asbestos or other packing 37, is secured by bolts 38 to a flange or wheel 39, which is detachably secured by set screws 40, Fig. 5, and is provided with an annular recess 41, which forms a tread to run upon the rolls 24; the flanged walls of said recess serving to prevent endwise displacement of the retort.

The cover 36, which is provided with an asbestos packing 42, is secured by bolts 43 and wing nuts 44 to a collar 45, which is detachably secured upon the retort by bolts 40 in the same manner as seen at Fig. 5. The space between the partitions 31, 32 is wholly within the flame chamber of the furnace, and hence the articles in said space are uniformly heated. The tubing is inexpensive, and far more durable than a retort formed with cast-iron; while when worn out, it may be readily separated from its flanges, covers and partitions, and a new one inserted upon which the same attachments may be employed.

The carburizing gas may be a pure hydrocarbon, although I have found in practice that good results are obtained by the use of ordinary city gas.

The gas which is used for cementation may be supplied under pressure in any suitable way, but for the sake of illustration, I have shown a gas receiver or tank 46, which contains gas preferably under pressure. In some cases the pressure may be just a little higher than atmospheric pressure; or it may vary from just sufficient to charge the retort, to the highest that may be found practicable. This receiver is connected to the retort by means of a pipe 47, provided with a valve 48, and a pipe or elbow 49, the latter being in line with the axis of retort 2. A gland is shown at 50 to accommodate the rotation of the retort, since the pipe 49 remains stationary. A yoke or bracket 51 is fixed upon the head 7 of the furnace to support the gland 50, into which pipe 49 is threaded. The latter is provided with a cap 53, which may be removed to give access to the interior of the pipe and gland for cleaning. Threaded into the end of the retort, is a spray pipe 54, having numerous apertures 55 for directing the gas in small jets into the retort; said sprayer 54 being connected by the pipe 33 to the gland 50. The sprayer 54 may extend for nearly the entire length of the retort, so as to insure that articles throughout the retort shall be acted upon by gas of uniform quality.

In operation, the retort is charged with articles and the gas in the furnace is ignited and the retort heated thereby, until the

articles are above red heat. Then the carburizing gas is admitted into the retort through the pipe 33 and the air escapes through a vent 57, having an adjustable valve 58; said vent remaining slightly opened throughout the operation, and the gas escaping therefrom igniting and constantly burning. By means of the valve 58, the duration of the stay of the gas in the retort may be regulated.

The furnace may be provided with a sight hole 59 and a pyrometer 60, whereby the operator may determine precisely when the articles have retained the required heat for cementation.

In a receptacle 61, Fig. 6, I place water 62 which is charged with ammonia; and by means of a pipe 63 I lead the gas from the holder 46 through the ammonia water, whereby the gas becomes charged with ammonia and passes from the receptacle 61 through a pipe 64 and the gland 50 and inlet 33 to the retort 2. The pipe 63 terminates in a spray 65 below the surface of the ammonia water, so as to insure a thorough charging of the gas with the ammonia. The receptacle 61 may be heated by placing the same in a vessel of hot water or by surrounding the same with a heating coil 66 or otherwise, in order to keep the temperature of the ammonia sufficiently high for mixing well with the gas; or a temperature of about 190 degrees Fahrenheit being preferable. The spent ammonia water may be drawn off through an outlet 67, and the receptacle refilled from a tank 68.

The valve 48 may be kept closed, so that the gas from the gas-holder 46 may be passed through the ammonia water, whereby the carburizing gas is thinned to an extreme degree, the bulk of the ammonia entering the retort being much greater than the bulk of the carburizing gas. If however, a larger proportion of the latter is desired, the valve 48 may be opened a little, so as to permit some gas to pass from the holder 46 directly to the retort 2, while other gas passes through the ammonia water into the retort. Valves 69, 70, may be provided upon the pipes 63 and 64 to facilitate the control of the gas and ammonia. By this means, but little, if any more carburizing gas is admitted to the retort than is taken up by the iron or steel articles therein, so that deposit of excess carbon upon said articles or upon the walls of the retort is avoided.

Rotation of the retort during the carburizing operation is effected by means of a worm 71 operated by a pulley 72, and meshing with a worm wheel 73 formed upon the cover 34; whereby the articles are gently agitated, and all portions thereof exposed with substantial uniformity to the action of the gas in the retort.

Variations may be resorted to within the

scope of my invention, and portions of my improvements may be used without others.

Having thus described my invention, I claim:

1. A furnace containing a revoluble retort, said retort provided at its ends with covers, and partitions within said retort, one partition attached to each cover so as to be movable therewith, and means for passing iron-carburizing gas through said retort.

2. A furnace containing a revoluble retort, said retort closed at one end and provided at the other end with a movable cover, a partition within said retort and rigidly attached to said cover, and means for passing iron-carburizing gas through said retort during its rotation.

3. A furnace containing a revoluble retort, said retort closed at one end and provided at the other end with a movable cover, a partition within said retort and attached to said cover, and means for passing iron-carburizing gas through said retort during its rotation; means being provided for clamping said cover, and a packing being provided between said cover and the end of said retort.

4. A furnace containing a revoluble retort, said retort provided at its ends with covers, and partitions within said retort, one partition attached to each cover so as to be movable therewith, and means for passing iron-carburizing gas through said retort; means being provided for clamping each of said covers, and packings being provided between said covers and the ends of said retort.

5. A furnace containing a revoluble retort, the ends of said retort projecting from the furnace and being supported upon rolls, one end of said retort being closed, the other end having a movable cover provided with a packing; and partitions within said retort at such points that the space between the partitions is wholly within the flame chamber of the furnace; one of said partitions being connected to said cover so as to be movable therewith, and means for passing iron-carburizing gas through said retort.

6. A furnace containing a revoluble retort, the ends of said retort projecting from the furnace and being supported upon rolls, each end of said retort provided with a movable cover and a packing, partitions within said retort at such points that the space between them is wholly within the flame chamber of the furnace; said partitions being connected one to each of said covers so as to be movable therewith; and means for passing iron-carburizing gas through said retort during the rotation thereof.

7. A case-hardening apparatus comprising a furnace containing a retort closed at one end, a movable cover for the other end of said retort, a removable partition within said retort, and an open pipe securing said

partition to said cover, and means for passing a current of iron-carburizing gas through said retort.

8. A case-hardening apparatus comprising  
5 a furnace containing a retort having a movable cover at each end, removable partitions within said retort, open pipes securing said partitions to said covers, and means for causing a current of iron-carburizing gas to flow  
10 through said pipes.

9. A case-hardening apparatus comprising a furnace containing a retort closed at one end, and provided with an inlet, a movable cover secured to the other end of the furnace  
15 and provided with a packing, a partition within the retort, and a vent pipe connecting said partition to said cover.

10. A case-hardening apparatus comprising a furnace containing a retort having covers at its ends and partitions between its ends, and inlet and outlet pipes connecting said partitions to said covers.

11. A case-hardening apparatus comprising a furnace containing a retort having covers at its ends, partitions between its ends,  
25 an inlet pipe connecting one of said covers to one of said partitions, and a vent pipe connecting the other of said covers to the other of said partitions.

12. A furnace containing a retort and provided with rolls upon which the retort revolves, said retort having covers, partitions at such points within the retort that the space within them is entirely within the  
35 flame-chamber of the furnace, an inlet pipe securing one of said partitions to one of said covers, a gland for said inlet pipe, and a vent pipe securing the other of said partitions to the other of said covers.

13. A furnace containing a retort, said retort provided at its ends with movable covers, and partitions within said retort, said partitions attached to said covers, and a space between said partitions lying wholly  
45 within the flame chamber of the furnace, and the ends of said retort projecting from the furnace and being revolubly supported upon the exterior of the furnace.

14. A furnace containing a retort, the latter having movable covers at its ends, said ends projecting from the furnace, and partitions within the retort and connected to said covers to be removable therewith, the space between said partitions being wholly within  
55 the flame chamber of the furnace, and means for supplying carburizing gas to and venting it from said retort.

15. A furnace containing a retort, means being provided upon the exterior of the furnace for revolubly supporting the retort, partitions within the retort at such points that the space between the partitions is wholly within the flame chamber of the furnace, a cover at one end of the retort and rigidly connected to one of said partitions, a packing  
65

for said cover, and means for passing a current of iron-carburizing gas through said retort during the revolution thereof.

16. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace, and consisting of a section of tubing of soft steel or wrought iron, rolls supporting said retort for revolution, covers detachably connected to the ends of said retort, partitions applied to the interior of said retort, and means for passing a current of iron-carburizing gas through said retort.

17. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace, and consisting of a section of tubing of soft steel or wrought iron, rolls upon which one end of the retort is supported, a tire detachably secured upon the other end of said retort, rolls upon which said tire runs, said tire having a flange to prevent endwise displacement of the retort, a cover detachably connected to said flange, gearing connected to said cover, a collar detachably secured upon the other end of said retort, a removable cover connected to said collar, and partitions within said retort and connected to said covers.

18. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace and consisting of a section of tubing, covers detachably connected to the ends of said retort, detachable partitions within said retort, and means for passing a current of iron-carburizing gas through said retort.

19. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace and consisting of a section of tubing, covers detachably connected to the ends of said retort, detachable partitions within said retort, and means for passing a current of iron-carburizing gas through said retort; and means exterior to said furnace for revolubly supporting said retort.

20. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace and consisting of a section of tubing, covers detachably connected to the ends of said retort, rolls upon which the retort is revolubly supported, detachable means for preventing endwise movement of the retort, means for passing a current of iron-carburizing gas through the retort during its revolution.

21. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace and consisting of a section of tubing, covers detachably connected to the ends of said retort, rolls upon which the retort is revolubly mounted, partitions within the retort, one of said partitions rigidly connected to one of the covers, means detachably connected to the retort for effect-

ing revolution thereof, and means for admitting iron-carburizing gas to and venting it from the retort.

22. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace and consisting of a section of tubing, covers detachably connected to the ends of said retort, rolls upon which the retort is revolubly mounted, partitions within the retort, one of said partitions rigidly connected to one of the covers, means detachably connected to the retort for effecting revolution thereof, and means for admitting iron-carburizing gas to and venting it from the retort; one of said covers having a gear provided thereon, and means for driving said gear.

23. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace and consisting of a section of tubing, a cover detachably connected to one end of said retort, a gear provided upon said cover, means for driving said gear, a partition within said retort, an inlet pipe rigidly connecting said partition to said cover, a gland connected to said inlet pipe, means revolubly supporting said retort, a cover for the other end of said retort, and a partition connected to the last-mentioned cover by means of an outlet pipe.

24. In a case-hardening apparatus, the combination with a furnace, of a retort extending through the furnace and consisting of a section of tubing, a flange detachably secured upon said section, a cover detachably connected to said flange and having a gear, means for driving said gear, rolls upon which said retort is revolubly mounted, said flange being constructed to coöperate with some of said rolls to prevent endwise displacement of the retort, a partition within said retort and rigidly connected to said cover, a detachable collar upon the other end of said retort, a cover connected to said collar, a partition within said retort and connected to the last-mentioned cover, and regulatable means for passing a current of iron-carburizing gas through said retort during the revolution thereof.

25. In a case-hardening apparatus comprising a closed retort formed of metal and provided with means to permit restricted venting of vitiated gas during the carburizing operation, and also having means for causing the retort to heat quickly and uniformly throughout to a degree suitable for carburizing steel articles therein, and for maintaining a substantially even temperature of the retort throughout the carburizing operation, the combination with means connected to the retort for furnishing thereto a supply of fresh carburizing-gas during the carburizing operation, of means also connected to the retort for supplying thereto simultaneously with the carburizing-gas a plenum

of suitable gas for diluting the carburizing gas, and means to agitate the articles during the carburizing operation.

26. In a case-hardening apparatus comprising a closed retort formed of metal and provided with means to permit restricted venting of vitiated gas during the carburizing operation, and also having means for causing the retort to heat quickly and uniformly throughout to a degree suitable for carburizing steel articles therein, and for maintaining a substantially even temperature of the retort throughout the carburizing operation, the combination with means connected to the retort for furnishing thereto a supply of fresh carburizing-gas during the carburizing operation, of means connected to said gas-supplying means for mixing the carburizing-gas, before it enters the retort, with a plenum of suitable gas for diluting the carburizing-gas, and means to agitate the articles during the carburizing operation.

27. In a case-hardening apparatus comprising a closed retort formed of metal and provided with means to permit restricted venting of vitiated gas during the carburizing operation, and also having means for causing the retort to heat quickly and uniformly throughout to a degree suitable for carburizing steel articles therein, and for maintaining a substantially even temperature of the retort throughout the carburizing operation, the combination with means connected to the retort for furnishing thereto a supply of fresh carburizing-gas during the carburizing operation, of means connected to said gas-supplying means for mixing the carburizing gas, before it enters the retort, with a plenum of ammonia and means to agitate the articles during the carburizing operation.

28. In a case-hardening apparatus comprising a closed retort formed of metal and provided with means to permit restricted venting of vitiated gas during the carburizing operation, and also having means for causing the retort to heat quickly and uniformly throughout to a degree suitable for carburizing steel articles therein, and for maintaining a substantially even temperature of the retort throughout the carburizing operation, the combination with means connected to the retort for furnishing thereto a supply of fresh carburizing-gas during the carburizing operation, of means connected to said gas-supplying means for mixing the gas before it enters the retort, with a plenum of ammonia, and means for heating the ammonia to a sufficient degree to enable it to mix properly with the carburizing gas.

29. In a case-hardening apparatus comprising a closed retort formed of metal and provided with means to permit restricted venting of vitiated gas during the carburizing operation, and also having means for causing the retort to heat quickly and uni-

formly throughout to a degree suitable for carburizing steel articles therein, and for maintaining a substantially even temperature of the retort throughout the carburizing operation, the combination with means connected to the retort for furnishing thereto a supply of fresh carburizing gas during the carburizing operation, of a receptacle for ammonia water connected to said gas supply; means being provided to cause the gas to pass through the water before entering the retort; and means to agitate the articles during the carburizing operation.

30. In a case-hardening apparatus comprising a closed retort formed of metal and provided with means to permit restricted venting of vitiated gas during the carburizing operation, and also having means for causing the retort to heat quickly and uniformly throughout to a degree suitable for carburizing steel articles therein, and for maintaining a substantially even temperature of the retort throughout the carburizing operation, the combination with means connected to the retort for furnishing thereto a supply of fresh carburizing gas during the carburizing operation, of a receptacle for ammonia water connected to said gas supply; means being provided to cause the gas to pass through the water before entering the retort; and means for heating said receptacle; and means to agitate the articles during the carburizing operation.

31. In a case-hardening apparatus comprising a closed retort formed of metal and provided with means to permit restricted venting of vitiated gas during the carburizing operation, and also provided with means for maintaining the retort throughout the carburizing operation at a substantially even temperature suitable for carburizing, the combination with means for effecting slow rotation of the retort during the carburizing operation, of means connected with the re-

tort for supplying thereto carburizing gas during the rotation of the retort, and means also connected with the retort for supplying thereto simultaneously with the carburizing gas a plenum of suitable diluting gas.

32. In a case-hardening apparatus comprising a closed retort formed of metal and provided with means to permit restricted venting of vitiated gas during the carburizing operation, and also having means for causing the retort to heat quickly and uniformly throughout to a degree suitable for carburizing steel articles therein, and for maintaining a substantially even temperature of the retort throughout the carburizing operation, the combination with means connected to the retort for furnishing thereto a supply of fresh carburizing-gas during the carburizing operation, of a spray pipe within the retort to receive the fresh carburizing gas and extending throughout the retort to distribute the gas with substantial evenness to the articles filling the retort, and means for rotating the retort during the carburizing operation.

33. In combination, a furnace having a flame chamber, a retort in the form of a barrel having ends, hollow supports extending from said ends and projecting from the furnace, and revolubly mounted exteriorly of the furnace, one of said ends being in the form of a removable cover, a pipe extending through the other of said ends and terminating outside of the barrel in a gland, by which carburizing gas is supplied to the barrel during its rotation, and a spray pipe forming a continuation of said pipe and extending therefrom within the barrel substantially the entire length of the barrel.

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Witnesses:

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