No. 884,181. PATENTED APR. 7, 1908.

A. W. MACHLET.

CASE HARDENING.

APPLICATION FILED DEC. 20, 1905.

2 SHEETS—SHEET 1.

Fig. 4.

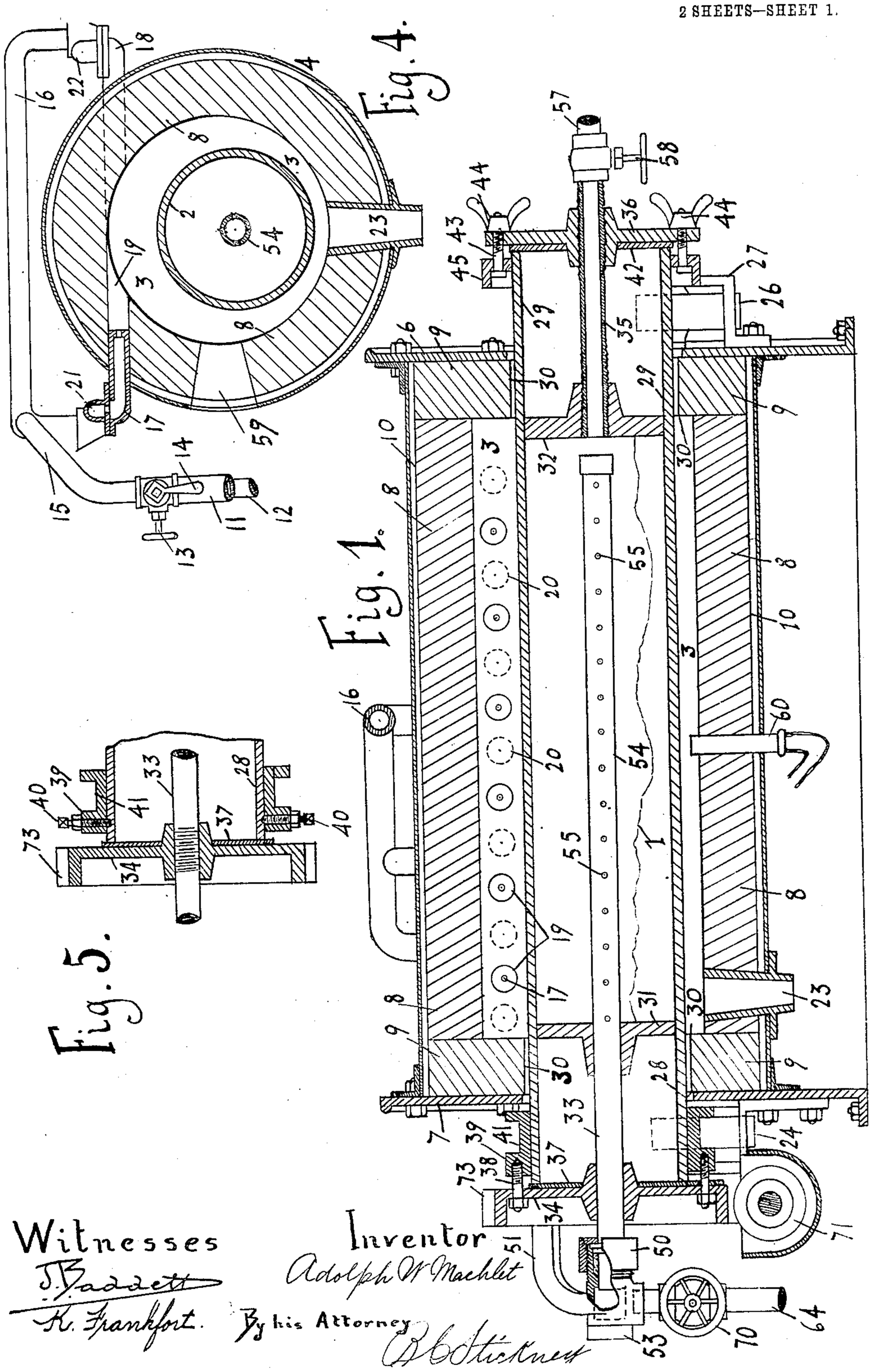

Fig. 1.

Fig. 5.

Witnesses

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2 SHEETS—SHEET 2.

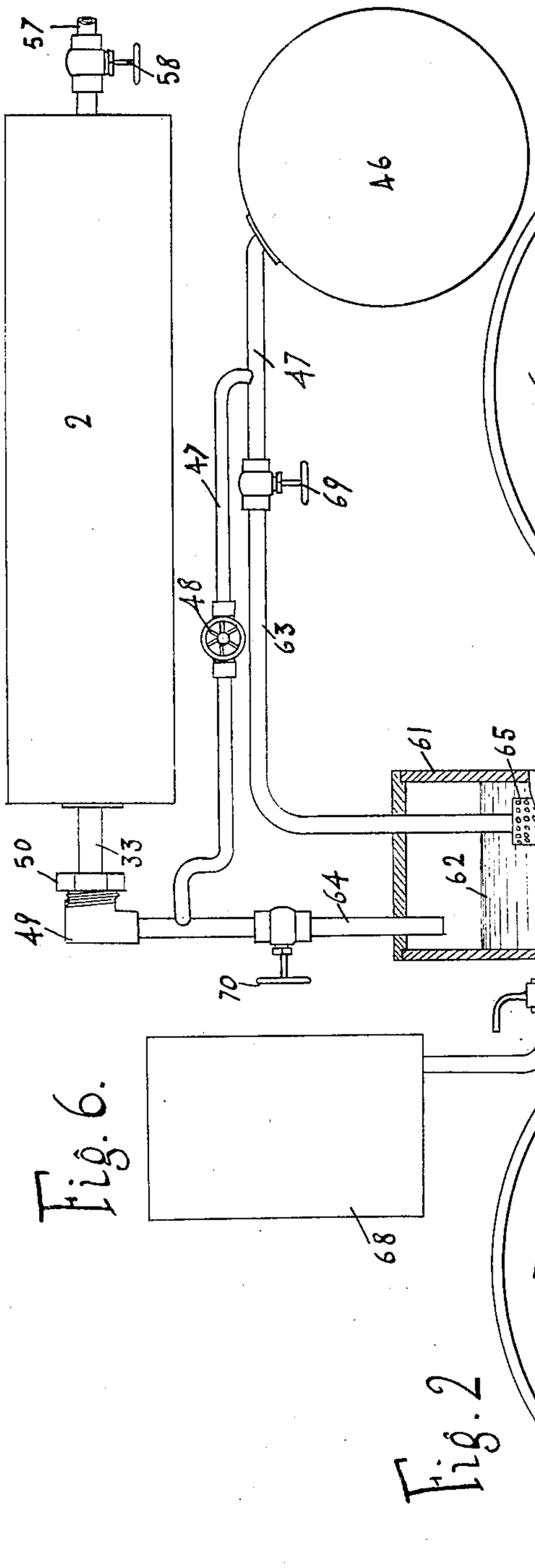

Fig. 6.

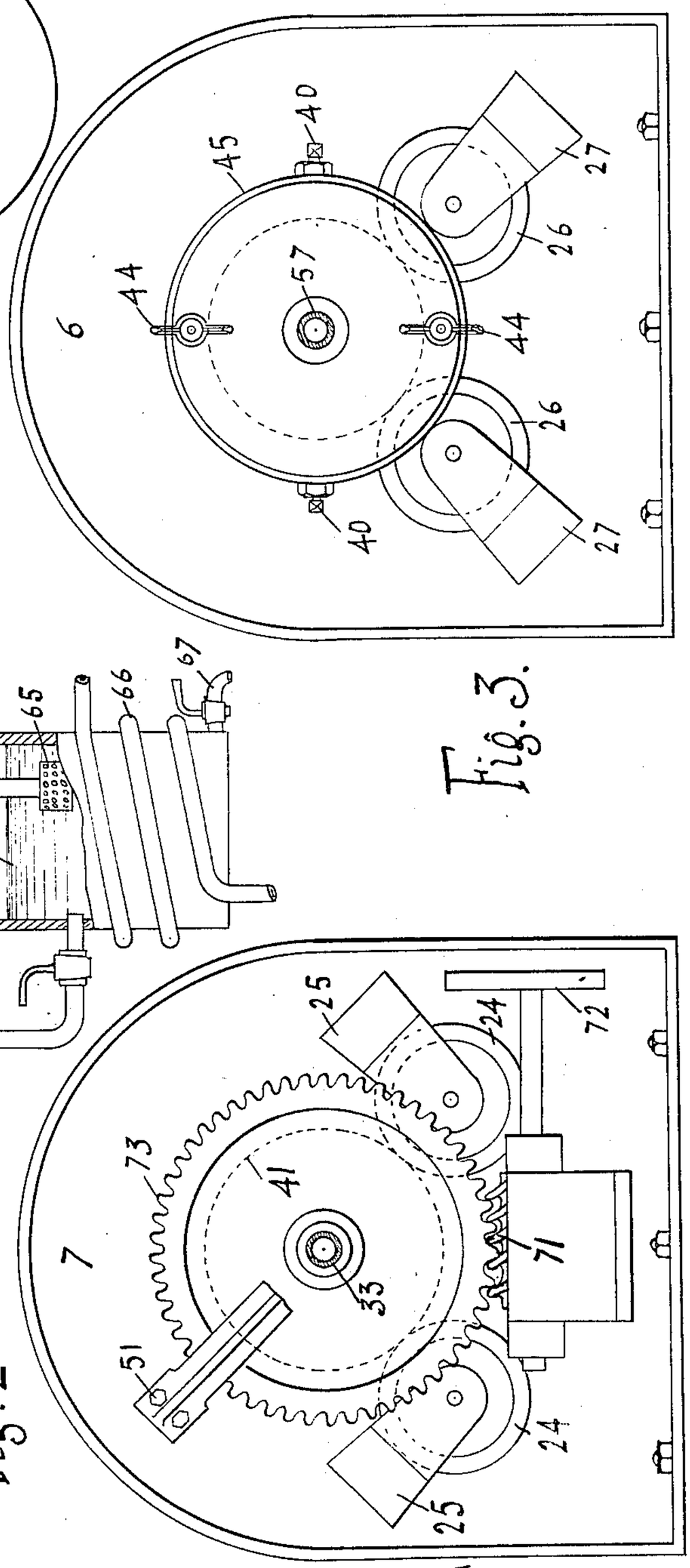

Fig. 3.

Fig. 2.

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CASE-HARDENING.

No. 884,181. Specification of Letters Patent. Patented April 7, 1908.

Application filed December 20, 1905. Serial No. 292,626.

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, 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. 255,355, filed April 13th, 1905, Patent No. 847,588.

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 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 con-

structed. 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 unformly 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 jet or sprayer 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; 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. Ammonia gas may be otherwise mingled with the carburizing gas in some cases. 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. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in placing the articles in a metal retort, closing the retort, supplying carburizing gas mixed with ammonia to the retort, applying heat uniformly to the exterior of the retort, maintaining the heat of the articles uniform while causing fresh carburizing gas mixed with ammonia to circulate constantly through the retort, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are cemented to the predetermined depth; the proportion of ammonia being sufficient to prevent deposit of free carbon.

2. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in confining the articles in a closed metal retort maintained at a uniform heat throughout during the carburizing operation, mixing carburizing gas with ammonia by passing one through the other and passing the mixture through the heated retort containing the articles to carburize the same, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the predetermined depth; the ammonia forming a sufficient proportion of the compound gas to prevent deposit of free carbon.

3. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in confining the articles in a closed metal retort maintained at a uniform heat throughout during the carburizing operation, agitating them while so confined, passing carburizing gas first through ammonia water and then through the retort to carburize the articles therein, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the depth predetermined.

4. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in passing carburizing gas mixed with a diluting gas over the articles while the latter are maintained at a uniform heat, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the depth predetermined; the proportion of diluting gas being sufficient to prevent the deposit of free carbon.

5. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in confining the articles in a closed metal retort maintained at a uniform heat throughout during the carburizing operation, mixing carburizing gas with more than its own bulk of ammonia by passing one through the other and passing the mixture slowly through the heated retort containing the articles to carburize the same, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the predetermined depth.

6. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness,

consisting in confining the articles in a closed metal retort maintained at a uniform heat throughout during the carburizing operation, passing carburizing gas through the heated retort containing the articles to carburize the same, the carburizing gas being first thinned to such a high degree that no deposit of carbon forms upon the articles, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the predetermined depth.

7. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in placing the articles in a metal retort, closing the retort, applying heat uniformly to the exterior of the retort, maintaining the heat of the articles uniform while causing fresh carburizing gas mixed with ammonia to circulate constantly through the retort, simultaneously agitating the articles, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are cemented to the predetermined depth; the proportion of ammonia being sufficient to prevent deposit of free carbon.

8. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in confining the articles in a closed metal retort maintained at a uniform heat throughout during the carburizing operation, mixing carburizing gas with more than its bulk of ammonia and passing the mixture through the heated retort containing the articles to carburize the same, agitating the articles during their cementation, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the predetermined depth.

9. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in passing carburizing gas thinned with more than its own bulk of inert gas over the articles while the latter are maintained at a uniform heat, and agitated, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the depth predetermined.

10. The process of case-hardening steel or iron articles, consisting in passing carburizing gas through ammonia water, adding carburizing gas to the mixture, and passing the resulting mixture slowly over the articles for a predetermined period while they are maintained at a uniform heat and agitated.

11. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in passing carburizing gas thinned with more than its own bulk of neutral gas over the articles while the latter are maintained at a uniform heat, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the depth predetermined.

12. The process of case-hardening in bulk with uniformity low-carbon steel articles to form upon each thereof a thin shell of a uniform and exact predetermined thickness, consisting in passing carburizing gas mixed with more than its own bulk of ammonia over the articles while the latter are maintained at a uniform heat, and arresting the cementation at the expiration of a predetermined interval of such length that the articles are carburized to the depth predetermined.

13. The process of case-hardening steel or iron articles, consisting in heating them uniformly, and simultaneously agitating them and subjecting them to a current of carburizing gas which is thinned by ammonia.

14. The process of case-hardening steel or iron articles, consisting in heating them uniformly, and simultaneously agitating them and subjecting them to a current of carburizing gas which is thinned by ammonia to such an extent that less than half the gas in the current consists of carbon.

15. The process of case-hardening steel or iron articles consisting in heating them uniformly and simultaneously both agitating them and subjecting them to a current of carburizing gas mixed with a diluting gas, the bulk of the latter being greater than that of the carburizing gas.

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Witnesses:
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