Feb. 14, 1933.

N. H. HILLER

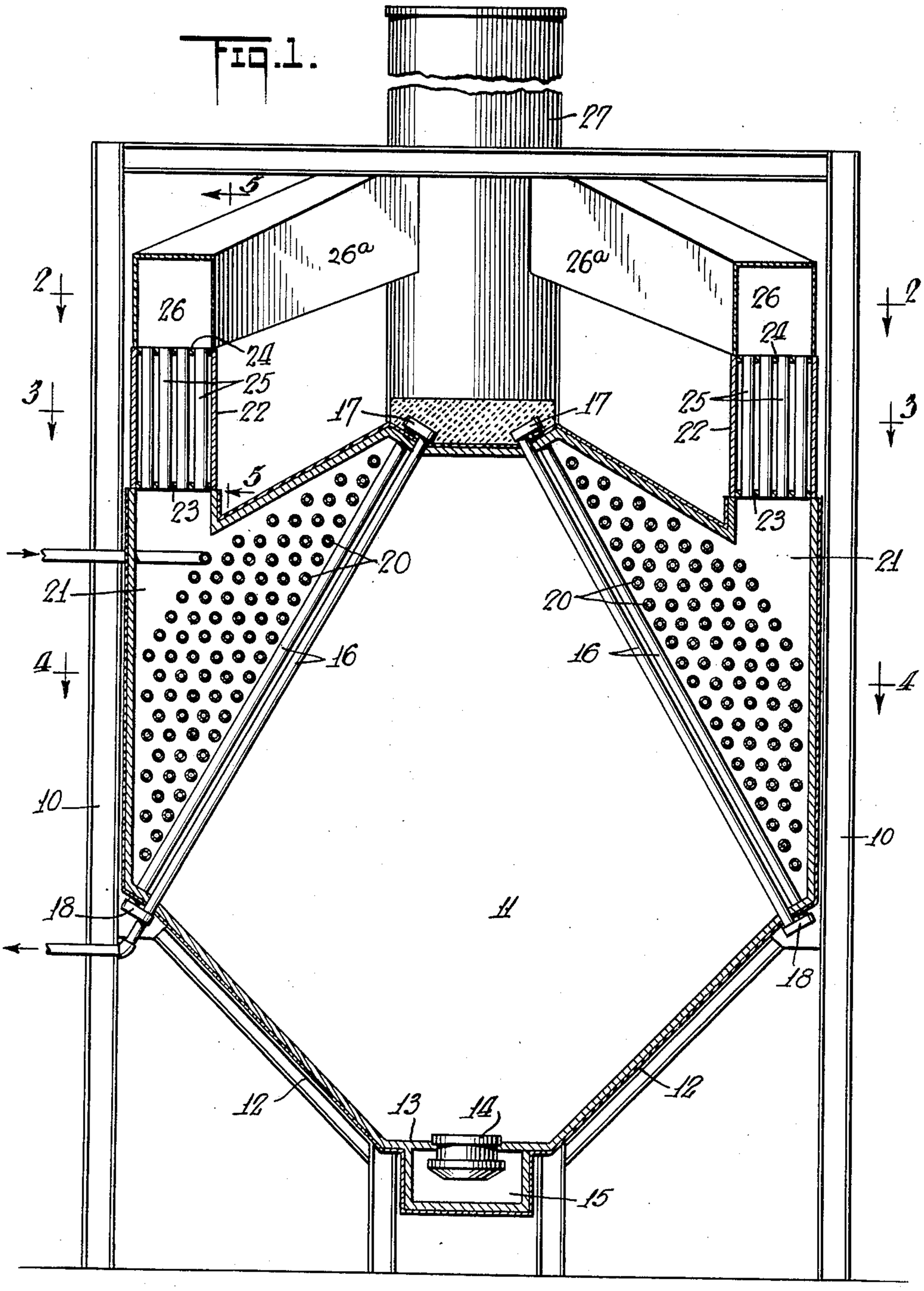
1,897,758

LIQUID HEATER

Filed May 7, 1930

3 Sheets-Sheet 1

Fig. 1.



INVENTOR
Nicolai H. Hiller
BY
Dann Fairbank Hirsch & Fretz
ATTORNEYS

Feb. 14, 1933. N. H. HILLER 1,897,758

LIQUID HEATER

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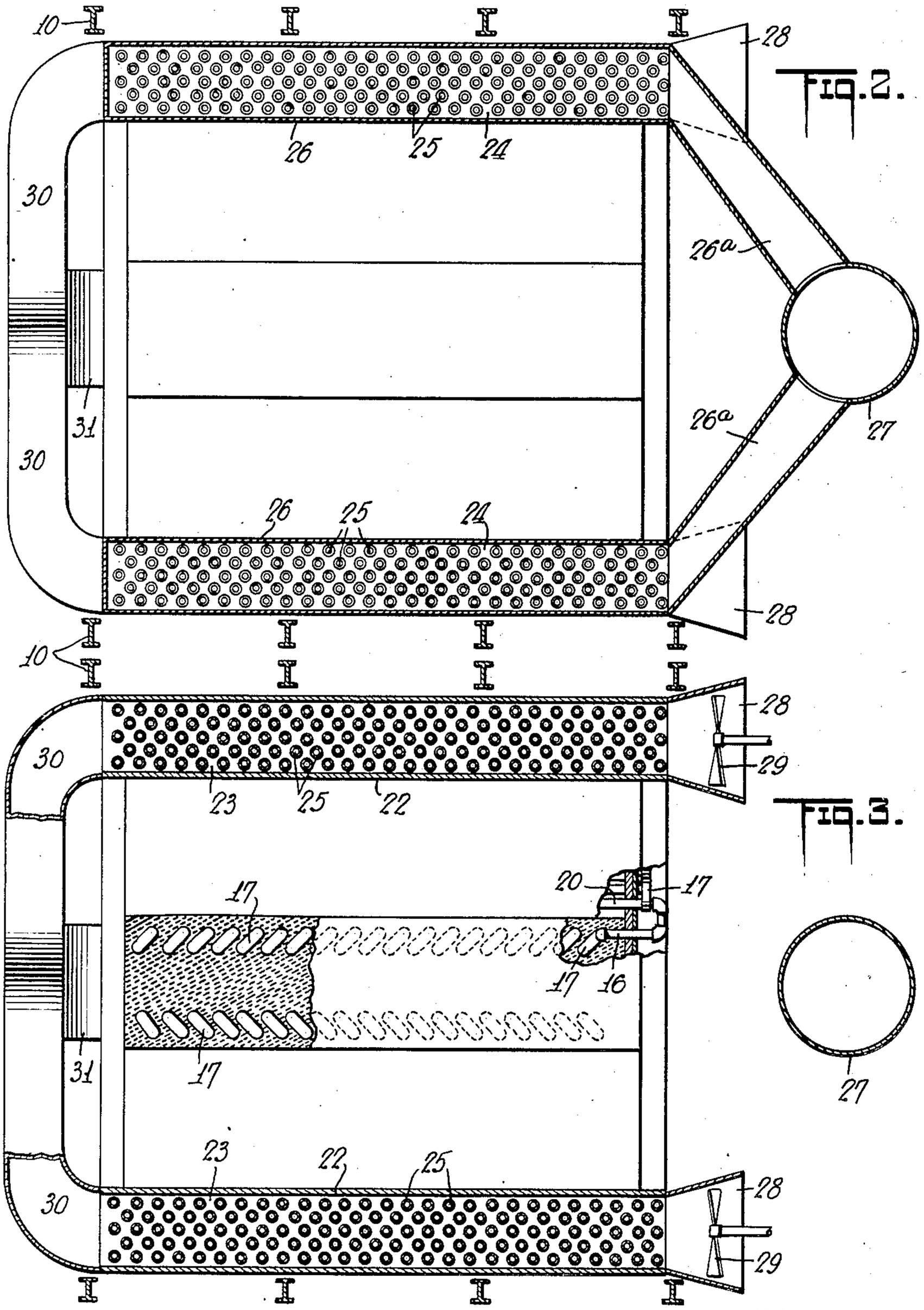

FIG. 2.

FIG. 3.

INVENTOR
Nicolai H. Hiller
BY
Dewey Fountaine Hirsch & Fraser
ATTORNEYS

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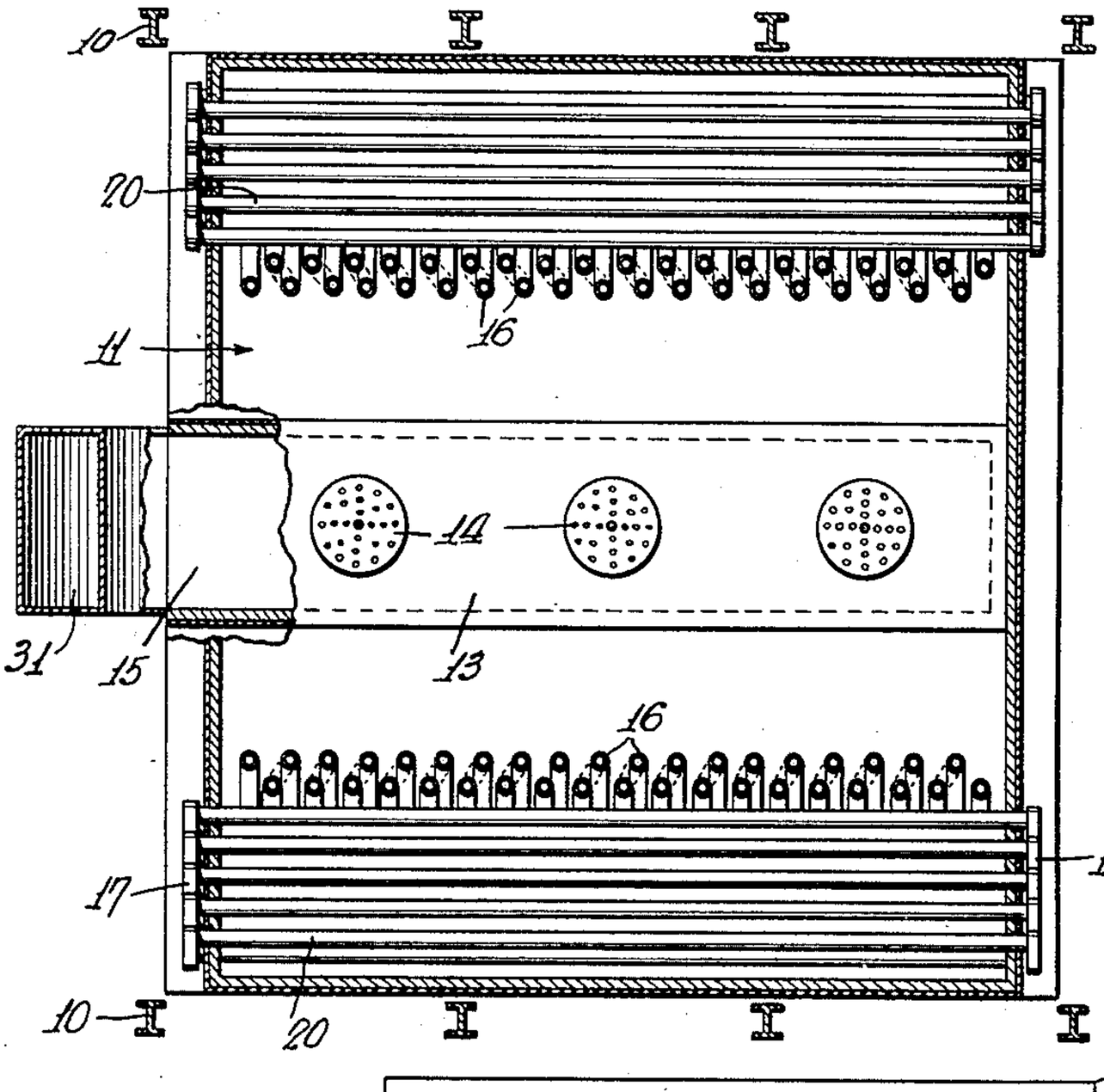
Fig. 4.



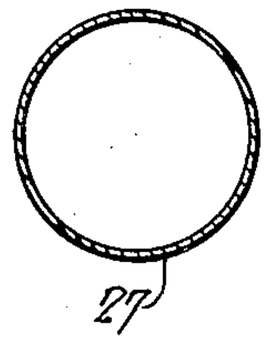


Fig. 5.

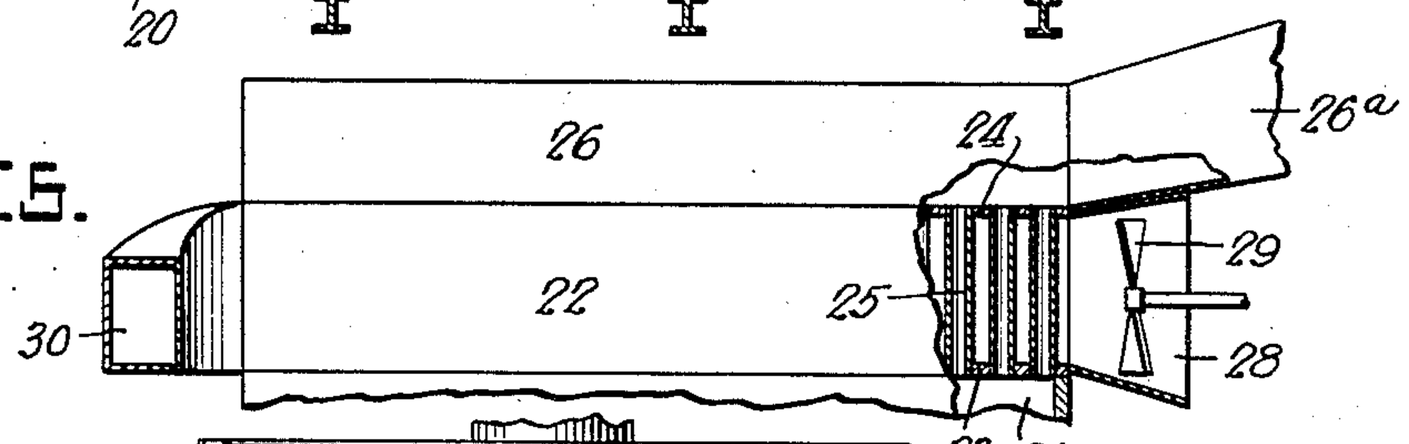
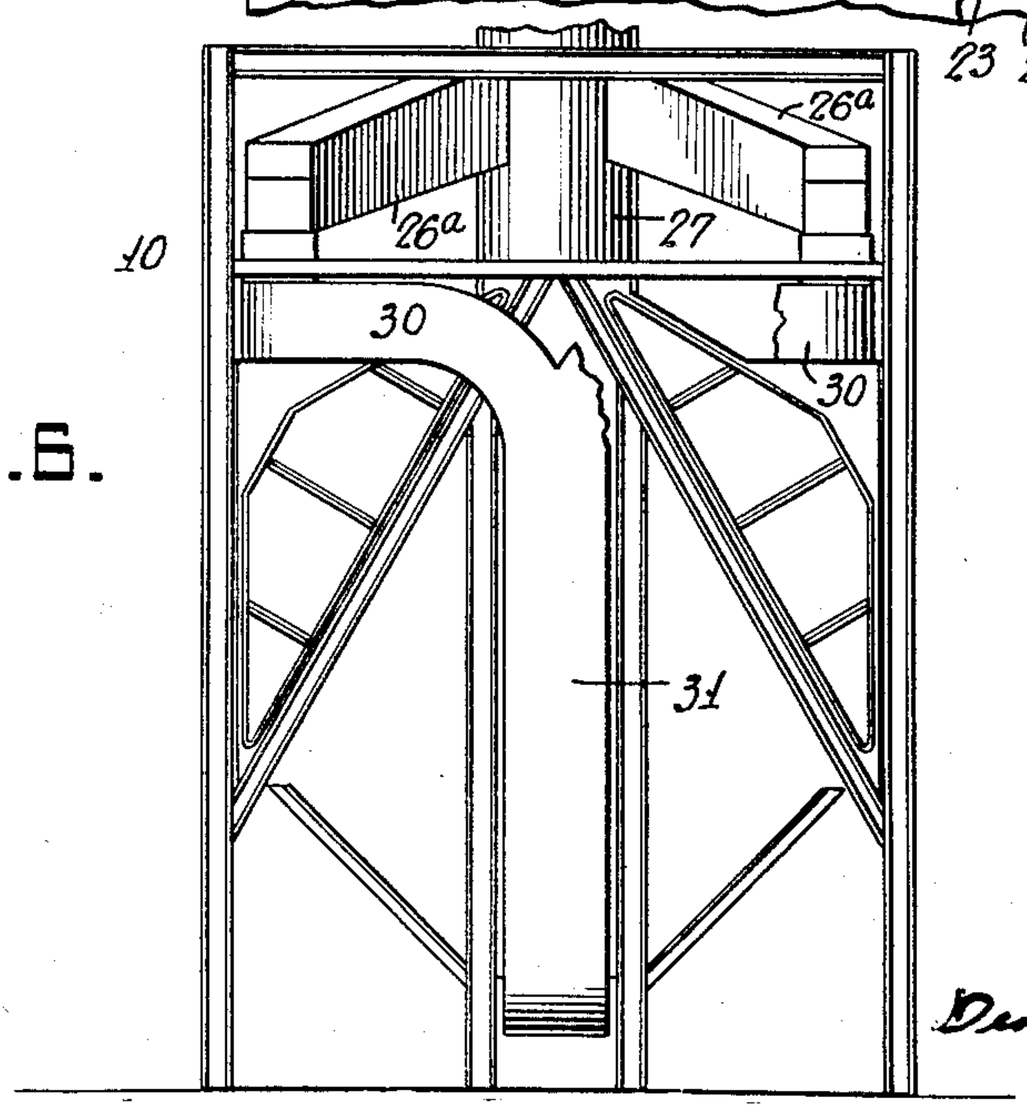


Fig. 6.



INVENTOR
Nicolai H. Hiller
BY
Dean Tarbox Hirsch & Foster
ATTORNEYS

Patented Feb. 14, 1933

1,897,758

UNITED STATES PATENT OFFICE

NICOLAI H. HILLER, OF CARBONDALE, PENNSYLVANIA

LIQUID HEATER

Application filed May 7, 1930. Serial No. 450,411.

This invention relates to a heat transferring unit, and more particularly to a furnace which is adapted to heat such liquids as water, oil and the like.

The present invention is particularly adapted to heaters used in the art of refining or cracking, and provides a furnace therefor having a new and improved arrangement of oil tubes whereby the transition of the hot combustion gases from the radiant section of the oil tubes to the convection section is accompanied with material deflections in the path of said gases.

The invention also provides a novel improved furnace construction whereby the hot gases of combustion are made to lead a circuitous path between the tubes without the necessity of baffles.

The invention still further provides means for so arranging the radiant tubes so as to render them easily accessible for cleaning or replacement. These radiant tubes, it should be noted are subjected to the greatest amount of heat, and are the ones most susceptible to heat injuries and the like.

The invention still further provides a novel furnace construction for dispersing the flame in the furnace so that the oil tubes may absorb the maximum heat from the flame itself.

The invention also contemplates means for progressively constricting the passage of the combustion gases as they pass in contact with the heated tubes, so that the cooling of these gases and the consequent decrease of their volume will be counter-balanced sufficiently to effect substantial constancy in the velocity of these gases.

The invention further contemplates means for preheating the air leading into the combustion chamber of the furnace by contacting this air with the flue pipes of the system.

The invention also consists in certain new and important features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the appended claims, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof.

Fig. 1 shows a vertical longitudinal section through a furnace embodying the present invention.

Figs. 2, 3, 4, and 5 are transverse sections taken on line 2—2, 3—3, 4—4 and 5—5 respectively, of Fig. 1, and

Fig. 6 is a front elevation of a furnace having parts broken away.

Like reference characters denote like parts in the several figures of the drawings.

In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

In the specific exemplification of the present invention shown in the accompanying drawings, a suitable frame structure 10 is provided upon which is built the setting of the furnace. This furnace is provided with a combustion chamber 11 having side walls 12 preferably inclined at angles of about 45° and connected at the bottom by a floor 13. Extending through the floor 13 are a plurality of suitable burners 14, the combustion supporting air for which is supplied by an air tunnel 15.

Extending along each side of the combustion chamber 11, and converging upwardly at a preferable angle of 60° with the horizontal is a pair of rows of radiant tubes 16 arranged in stagger relationship and constituting the radiant heating sections of the furnace. These tubes 16 derive a great deal of their heat by radiation from the flame of the burners 14, and if desired the furnace walls may be constructed of refractory brick-work which may be heated to incandescence to increase this radiant factor.

The ends of the tubes 16 extend beyond the furnace walls and are joined by suitable bends 17 and 18 or the like so as to provide a series connected between the individual

tubes of the radiant section. The bends 17 may be protected against heat losses by refractory material such as cinders 18 or by a plurality of removably mounted juxtaposed tiles. By extending the ends of the tubes 16 beyond the furnace walls, these bends are rendered easily accessible so that they may be removed for cleaning or replacement of the tubes.

Horizontally extending on the outer sides of these radiant tubes 16 are a plurality of tubes 20 constituting the convection sections of the fluid circulating system. These tubes are confined in a convection chamber 21, the walls of which are formed to effect a constriction in the passage of combustion gases as they pass through the tubes, so that irrespective of the cooling of these gases and the consequent decrease in volume thereof, their velocities will be maintained substantially constant. All of these convection tubes 20 are connected in series by return bends, and they are also connected in series with the radiant tubes 16 so that the oil is led into the lowest convection section of the tubes 20 and passed out through the last of the series of radiant tubes 16. The furnace may be built and the radiant tubes 16 so inclined that all of the tubes 16 and 20 are of the same length thereby obviating the necessity of carrying more than one length tube in stock.

Extending along each side of the furnace setting is an air conduit 22, the top and bottom of which are provided with crown plates 23 and 24. These plates 23 and 24 have passing therethrough flue pipes 25 leading into a conduit 26, the back end of which is connected to a chimney stack 27 by flues 26ª. The flue pipes 25 permit the flue gases from the chamber 21 to pass therethrough and into the conduit 26, where they are passed out through the flues 26ª and the chimney stack 27.

The back portion of each air conduit 22 is open to the atmosphere through a flared portion 28 which is provided with a fan 29, or there may be one fan with a bifurcated duct connected to each of the flue pipes 25. The front portion of each air conduit 22 is connected to a conduit 30 which is disposed along the front portion of the furnace and which lead to a conduit 31 connected to the air tunnel 15.

It should be noted that the heater is divided into two similar parts so that two separate primary flows of oil through the two sides may be provided at the same time. If desired, however, a single primary flow of oil might be split into two paths through the two sides of the heater and joined together again after passing through the heater.

The burner 14 should preferably be of the type which produces a fantail shaped flame so that said flame substantially conforms with the shape of the furnace. This permits the absorption by the radiant tubes 16 of a material amount of heat from the flame itself. However, regardless of the type of burner used, it is obvious that the inclined side walls 12 aid in the dispersion of flames towards the radiant tubes effecting thereby a corresponding increase in the transfer of heat from the flame itself.

Although oil burners are a suitable means for effecting combustion, it is obvious that the present invention is adapted to any type of fuel. Either gas, oil or coal dust may be burned in suitably designed burners with the necessary changes in furnace design.

Instead of dividing the heater into two main heating sections, i. e., radiant and convection sections, it may be desirable in accordance with the temperature of the incoming fluid to be heated to divide the heater into three main heating sections, constituted by a low rate or secondary section, a primary or high rate convection section and a radiant section. Under these conditions, the oil would first go through the low rate convection section, then into the high rate convection section and finally through the radiant section. This high rate convection section may consist of another series of inclined tubes disposed behind the radiant tubes 16 in stagger relationship therewith. These high convection tubes would then receive heat by radiation as well as by contact with the very hot combustion gases.

In certain refining processes, the incoming flow of oil in the heater would be at such a temperature that it might be desirable to omit the high rate of convection sections.

It should be noted that the oil tubes are so arranged and the furnace so constructed as to obviate the necessity of baffles. Also by crossing the path of the hot gases, by transversely disposed tubes 19, after their passage through the radiant tubes 16, this path is caused to be broken up into a more circuitous route, thereby effecting a more intimate contact between the hot gases and the convection tubes.

Although the invention has been described with particular adaptation to the art of oil refining or cracking, it is obvious that it can be used in any heat transfer unit such as a superheater, boiler or the like without departing from the spirit of the invention.

While certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the forms and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

I claim:

1. A heat transferring furnace including two series of oppositely disposed inclined and upwardly converging sets of serially interconnected tubes, and two series of serially interconnected horizontal tubes disposed at the outer sides of said first mentioned tubes and directly connected in series with said first mentioned tubes, all of said tubes being of substantially the same length.

2. A furnace for heating fluids, including a combustion chamber, a pair of convection chambers, each having a pair of walls converging in the direction of the flow of the gases, so as to form a chamber substantially triangular in vertical cross-section, and having an outlet for the gases of combustion at the apex thereof, whereby the velocity of the gases passing through said convection chambers will be maintained substantially constant, a burner disposed in the lowermost portion of said combustion chamber, said combustion chamber having side walls diverging upwardly from points closely adjacent to opposite sides of said burner, said burner giving an upwardly extending flame having a fan shaped vertical cross-section, whereby the sides of said flame impinges on said side walls and is dispersed thereby, said flame being unobstructed in a vertical direction, a first set of tubes comprising two separate series of serially interconnected straight tubes, the two series of tubes converging upwardly, so as to gradually decrease the width of the combustion chamber towards the top, and serving to separate said combustion chamber from said convection chambers, a second set of tubes comprising two separate series of serially interconnected straight tubes of substantial equal length, extending transversely of the tubes of the first set in the rear thereof, and interconnected serially with the corresponding adjacent series of said first set, and having the inner row thereof extending substantially the full length of the tubes of the corresponding series of tubes of said first set, said second set of tubes being disposed in said convection chambers, so that the converging walls of said chambers are disposed adjacent to said last mentioned tubes, whereby the gases will be in contact with said tubes, while under the influence of the constriction of the convection chambers formed by said converging walls.

3. A furnace for heating fluids, including a combustion chamber having a bottom wall, a burner in said bottom wall, said combustion chamber having side walls diverging upwardly from points adjacent to opposite sides of said burner, a first set of tubes comprising two separate series of straight tubes extending longitudinally upward, and coverging towards the top of the combustion chamber from points adjacent to the top of said side walls, a pair of substantially triangular convection chambers, each having a pair of side walls converging in the direction of flow of the gases from the ends of the tubes of said first set, and having an outlet for the gases of combustion at the apex thereof, a second set of tubes comprising two separate series of straight tubes of equal length, disposed in said convection chambers, whereby the gases will be in contact with said tubes while under the influence of the constriction of the convection chambers caused by said converging walls, the tubes of the first and second series of each set being serially connected.

4. A furnace for heating fluids, including a combustion chamber, a source of heat in said combustion chamber, a first set of serially interconnected tubes extending substantially towards the top of said chamber, and bounding at least a portion of the sides of said combustion chamber, a convection chamber progressively constricted in the direction of flow of said gases from the ends of the tubes of said first series of tubes, a second set of serially interconnected straight tubes disposed in said convection chamber so that the gases of combustion will be in contact with said tubes while under the influence of the constriction of said convection chamber, said second set of tubes being transversely disposed with respect to said first set of tubes, and directly connected serially thereto, said second set of tubes having the row thereof which is disposed adjacent to said first set of tubes extending substantially the full length of said first set of tubes.

5. A heat transfer furnace including a combustion chamber, a convection chamber having converging side walls to gradually decrease the area for gas flow therethrough, the larger end of said convection chamber being in open communication with said combustion chamber, a first set of serially interconnected straight tubes disposed across the inlet to the convection chamber from said combustion chamber, and a second set of serially interconnected straight tubes disposed in said convection chamber in the rear of said first set of tubes and adjacent thereto, the two sets of tubes being disposed transversely with respect to each other and connected in series, all of the tubes of both sets being of substantially the same length.

6. A heat transfer furnace including a combustion chamber, a convection chamber having converging side walls to gradually decrease the area for gas flow therethrough, the larger end of said convection chamber being in open communication with said combustion chamber, a first set of serially interconnected straight tubes disposed across the inlet to the convection chamber from said combustion chamber, and a second set of

serially interconnected straight tubes disposed in said convection chamber in the rear of said first set of tubes and adjacent thereto, and including a plurality of rows of tubes, said rows having gradually decreasing numbers of tubes in the direction of gas flow, the two sets of tubes being disposed transversely with respect to each other and connected in series, all of the tubes of both sets being of substantially the same length.

7. A heat transfer furnace including two series of oppositely disposed, inclined, and upwardly converging sets of tubes, two series of horizontally disposed tubes at the outer sides of said first mentioned tubes, all of said tubes being of substantially the same length, and removable means connecting the tubes of each set in series and connecting the sets in series, whereby any tube may be removed independently of the others, and all of the tubes of both sets are interchangeable.

8. A heat transfer furnace including a combustion chamber, a convection chamber having side walls converging in the direction away from said combustion chamber to gradually decrease the area for gas flow therethrough, a first set of straight tubes disposed across the inlet to said convection chamber at the wider end thereof, a second set of straight tubes disposed in the rear of said first set of tubes and in said convection chamber, all of the tubes of both sets being of substantially the same length, and detachable means connecting the tubes of each set in series and connecting said sets in series, whereby any tube may be removed independently of the others and replaced by a tube of predetermined length.

9. A furnace for heating liquids including a combustion chamber having a bottom wall provided with a burner and side walls extending upwardly from said bottom wall and diverging from adjacent to said burner, a pair of convection chambers opening into said combustion chamber on opposite sides thereof and above said side walls, each of said convection chambers being substantially triangular in vertical cross-section and including a pair of walls converging in the direction of flow of gases from said combustion chamber and having an outlet at the apex thereof for the gases of combustion, and a set of serially connected, substantially horizontal tubes disposed in each of said convection chambers, the rows of tubes of said sets nearest to said combustion chamber being disposed in planes that converge upwardly from adjacent to the upper edges of said side walls toward the upper end of said combustion chamber.

10. A furnace for heating liquids including a combustion chamber having a bottom wall provided with a burner and side walls extending upwardly from said bottom wall and diverging from adjacent to said burner, a pair of convection chambers opening into said combustion chamber on opposite sides thereof and above said side walls, each of said convection chambers being substantially triangular in vertical cross-section and including a pair of walls converging in the direction of flow of gases from said combustion chamber and having an outlet at the apex thereof for the gases of combustion, and a set of substantially horizontal tubes all of substantially the same length and disposed in each of said convection chambers, said tubes being arranged in a plurality of substantially parallel rows, the rows of tubes of said sets nearest to said combustion chamber being disposed in planes that converge upwardly from adjacent to the upper edges of said side walls toward the upper end of said combustion chamber, and the tubes of the several rows being serially connected to provide counterflow in respect to the outflowing gases.

Signed at New York in the county of New York and State of New York, this 5th day of May, A. D. 1930.

NICOLAI H. HILLER.