No. 737,487. PATENTED AUG. 25, 1903.

E. RIVEROLL.

SMELTING FURNACE.

APPLICATION FILED MAR. 9, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. II.

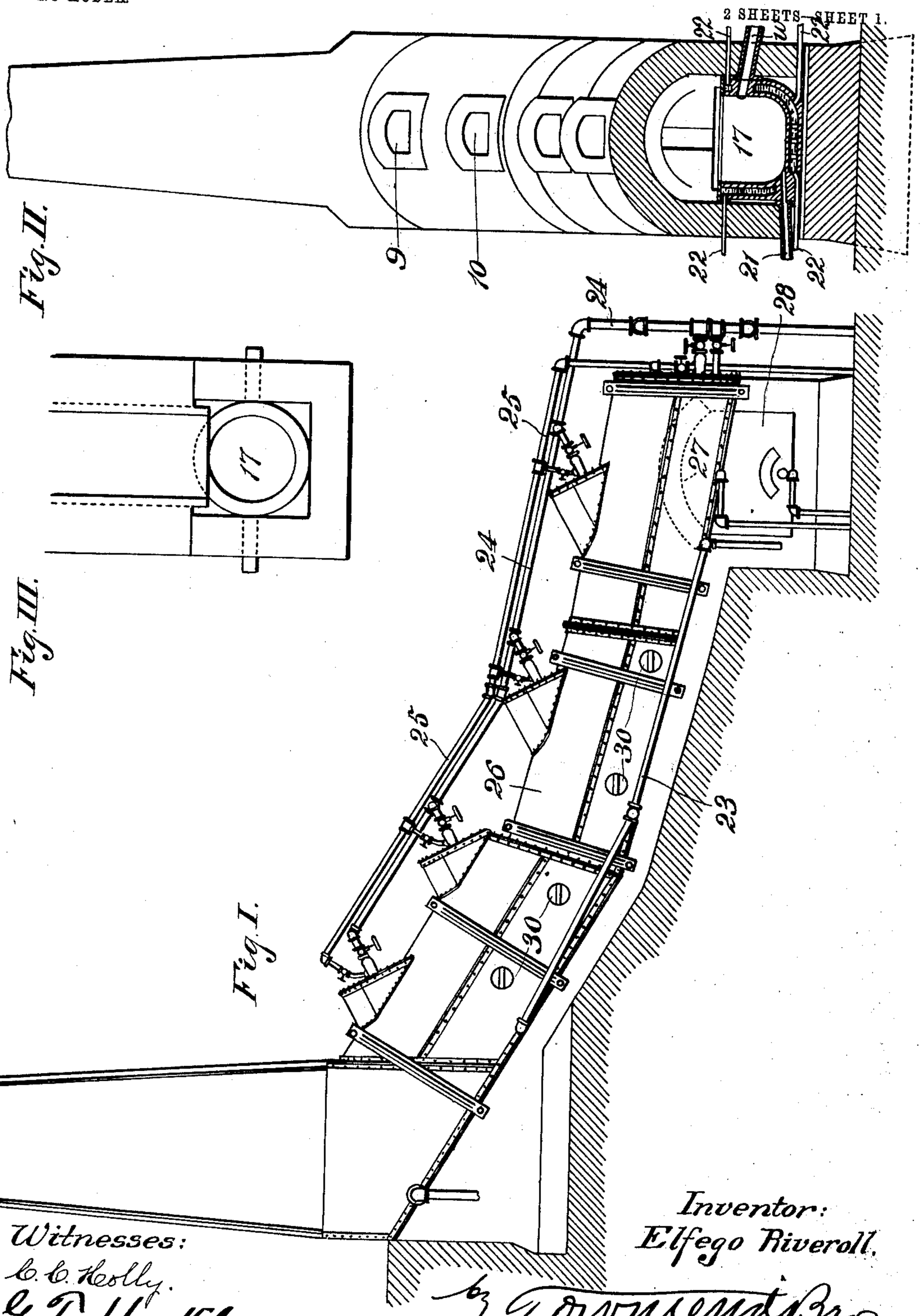

Fig. III.

Fig. I.

Witnesses:
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G. T. Hackley

Inventor:
Elfego Riveroll,
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Atty's

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. V.

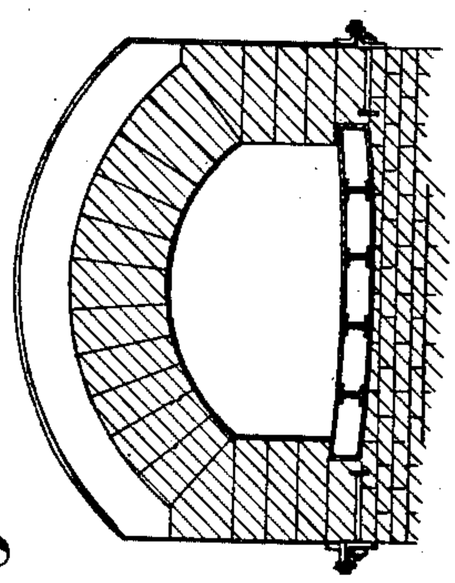


Fig. IV.

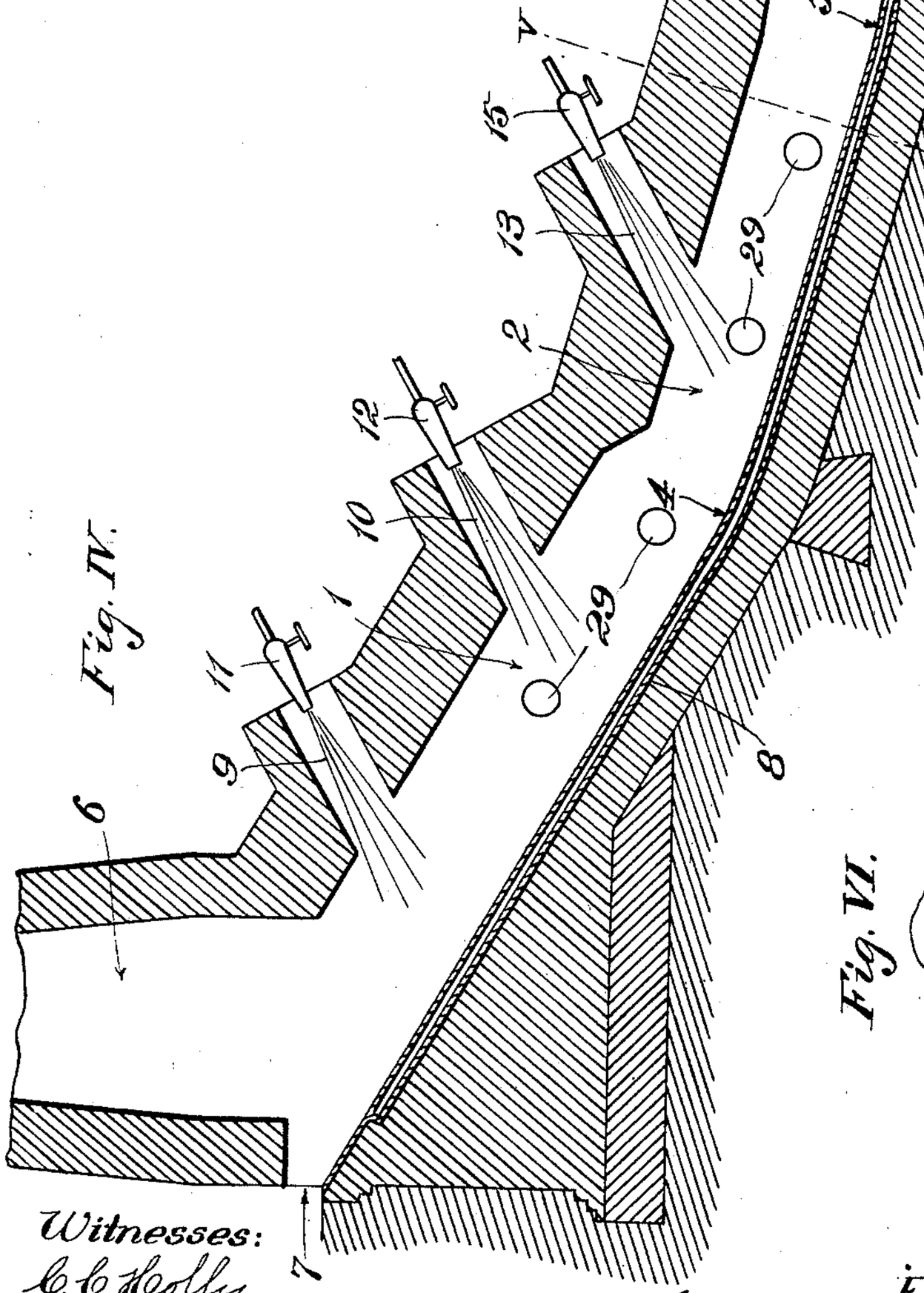
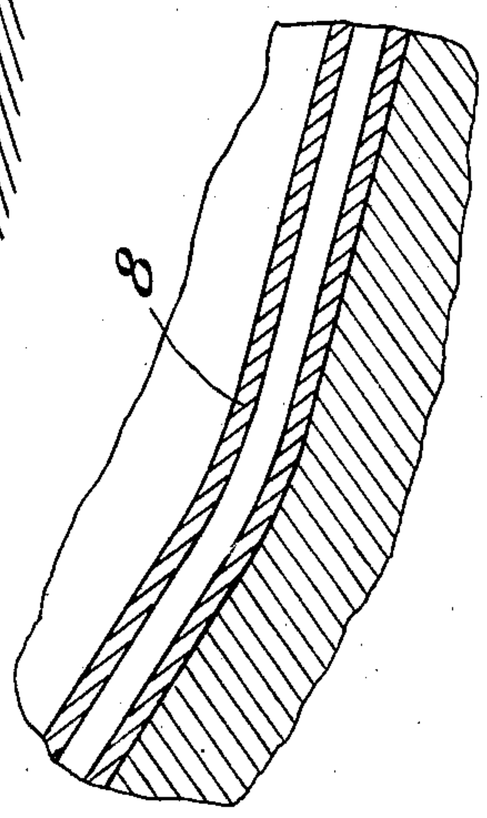


Fig. VI.



Witnesses:
C. C. Holly.
G. J. Hackley

Inventor:
Elfego Riveroll.
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No. 737,487. Patented August 25, 1903.

UNITED STATES PATENT OFFICE.

ELFEGO RIVEROLL, OF LOS ANGELES, CALIFORNIA.

SMELTING-FURNACE.

SPECIFICATION forming part of Letters Patent No. 737,487, dated August 25, 1903.

Application filed March 9, 1903. Serial No. 146,993. (No model.)

To all whom it may concern:

Be it known that I, ELFEGO RIVEROLL, a citizen of Mexico, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Smelting-Furnace, of which the following is a specification.

My invention relates to a smelting-furnace in which a smelting heat is produced by means of liquid fuel, such as crude petroleum, and the furnace while especially constructed with the object in view of smelting iron ore may be used also in the smelting of other ores.

Numerous attempts have been made heretofore to smelt iron ore by using liquid fuel, such as crude oil; but such attempts have been failures in a commercial way, as in no case more than one hundred and fifty pounds of the charge has been reduced at any one time, and, moreover, coke or charcoal has had to be introduced to the extent of ten per cent., or thereabout, in order to bring about the necessary chemical reaction.

Chief among the difficulties of smelting iron ore by using liquid fuel was the difficulty of getting rid of the oxygen in the iron ores and the difficulty of securing proper application of the heat to the entire charge of the ore being reduced.

One object of the present invention is to provide a furnace in which iron ore may be successfully smelted by means of liquid-fuel burners using crude oil and without using coke or charcoal.

Another object is to construct a furnace through which the ore is fed by gravity past a number of liquid-fuel burners and the liquid product is finally discharged into a receiver.

Another object is to subject the ore to a gradually-increasing temperature in its passage through the furnace, so that the ore is gradually reduced to the desired liquid state, the purer metal sinking to the bottom and the slag floating to the top.

Another object is to so construct a furnace that the ore will not pack up inside the furnace or clog around the burners, but in which the ore will be well spread out and the entire surface of the ore-body be exposed to the heat from the burners. The flames from the burners impinge directly against the ore, and a white heat is produced wherever the flame from the burners strike the ore, and carbon dioxid is formed throughout the entire combustion-chamber.

By constructing the furnace on inclined ground the cost of heavy foundations is avoided, and by introducing the heat from the burners at various points along the body of the furnace a perfect control of the heat is secured, and the amount at various points along the furnace can be regulated as desired to suit the character of ore and the various stages through which the ore must pass in its travel through the furnace.

Referring to the drawings, Figure I is a side elevation of the furnace. Fig. II is a front elevation of the furnace. Fig. III is a plan view of the crucible with its surrounding adjacent walls, the upper part of the lower end of the furnace being removed. Fig. IV is a longitudinal vertical section through the furnace. Fig. V is a sectional view on line V V, Fig. IV. Fig. VI is an enlarged longitudinal vertical sectional view of a portion of the furnace at a curve in the bottom.

The furnace comprises, essentially, an inclined chamber, in this embodiment consisting of three contiguous sections 1, 2, and 3 of varying inclinations. The section 1 has the greatest inclination, the section 2 has a less inclination, while the section 3 has the least inclination. The chamber 1 is the largest and longest section and the roof is highest, while the chamber 2 is shorter and has a lower roof, the section 3 being the shortest of the three sections. The junctions of the three sections are gradually curved, as at 4 and 5.

The upper end of the furnace is provided with a chimney 6, the lower part of which is provided with a charging-door 7, through which the ore is fed to the upper chamber. The floor of the furnace is provided with a water-jacket 8, which extends through the three sections.

The roof of the section 1 is provided with one or more combustion-chambers. In this embodiment two are provided, 9 and 10, which are arranged at an incline from the horizontal and also at an angle to the axis of the section 1.

11 and 12 designate oil-burners for the respective combustion-chambers 9 and 10.

13 and 14 are combustion-chambers for the sections 2 and 3, respectively, which are both arranged at an incline to the horizontal and also at an angle to the respective sections with which they connect.

15 and 16 are oil-burners for the respective combustion-chambers 13 and 14.

17 is a water-jacketed crucible in a well 18, arranged at the lower end of the furnace. The crucible may rest upon the rails 19. The crucible is provided with a slag-spout 20.

21 is a spout through which the metal may be drawn from the bottom of the crucible.

22 designates water-pipes communicating with the water-jacket 17.

23 is a water-pipe which conveys water to the water-jacket 18.

24 is a pipe with which the burners are connected.

25 is a steam-pipe which supplies steam to the burners.

The outside of the furnace is preferably provided with a steel jacket 26.

The floor of the lower end of section 3 preferably extends over the edge of the crucible 17, as shown in Fig. III.

As shown in Fig. I, the side of the furnace is arched, as at 27, and the brickwork 28 below the arches 27 may be removed when it is desired to run the crucible out of the furnace.

The ore is fed to the upper end of the furnace and slides down gradually through the sections, and the flames from the oil-burners strike directly against the oncoming ore, the direction of the flame being opposed to the direction of the ore travel, which secures the economical and efficient application of heat. The direction of the products of combustion is toward the upper end of the furnace, and the monoxid in traveling toward the chimney through the furnace passes through the entire body of the ore and frees the ore of oxygen, and that part of the ore which is liquefied flows down the inclined floor of the furnace into the crucible 17. The first section of the furnace is larger than the other two sections and will contain more ore. As the burners are located above the ore, a free space is formed between the ore and the burners, which makes it impossible for the ore to collect and pack around the burners and clog the action of the same, as in the case with a cupola or upright style smelter. As the smelting proceeds the metal continues to flow into the crucible, the purer metal sinking to the bottom and being periodically drawn from the spout 21, while the slag floats to the top of the crucible and passes therefrom through the spout 20.

The floor of the first section may have an incline, preferably, of about six inches to the foot, while the second section may have an inclination about four inches to the foot, and the third and last section has an inclination of about two inches to the foot. The object of providing the different inclinations along the bottom is to insure that the ore will be steadily fed from the section 1 to the lower sections 2 and 3. The inclination of the lower sections is less in order to hold the charge, as the entire charge, or nearly so, when in those sections is in a liquid state and passes therethrough more readily than when in solid form. If the inclination of the bottom were constant throughout, the lower end of the furnace would be exhausted as fast as the ore is reduced and the metal would flow off faster than the ore could be fed from the top. The ore readily travels by gravity down the six-inch grade, and by the time it has reached the second section it has been roasted. During its travel through the second section with four-inch grade the roasted ore comes within the smelting zone and all or nearly all of the ore is reduced to a liquid state, the reduced ore flowing through the second and third sections into the crucible. The third section with the two-inch grade serves to stop any chunks of ore which might pass through the second section without becoming fully smelted, and the two-inch grade is such that the ore will not travel down it by gravity, but must be reduced before flowing down into the crucible.

I regard this invention as new in that the chamber is inclined and that combustion-chambers are disposed along the inclined chamber and communicating therewith and that the burners in the combustion-chambers are directed downwardly.

Furnaces for roasting ores have been invented showing inclined chambers into which hot air is fanned from a fireplace; but they were not smelters, being unprovided with means for producing carbon dioxid throughout the inclined chamber and changing the carbon dioxid. Such a furnace is shown in the patent granted to Thompson November 22, 1881, No. 250,015. Furnaces have also been invented with an inclined chamber for feeding ore to a level melting-chamber, as shown in the patent granted to Siemens March 15, 1892, No. 470,712; but the smelting is not performed in the inclined chamber, the latter being merely a feeding and roasting chamber. No furnace, to my knowledge, has ever been invented or constructed with means for successfully smelting iron ore in an inclined chamber by using liquid fuel heretofore.

One furnace which I have built was forty feet in length, two feet in the clear inside, and with floor-pitches of six, four, and two inches, respectively. In a test run the iron ore showed by analysis metallic iron 56.7, silica and alumina 13.3, sulfur 1.4. The analysis of the limestone flux was lime 52.5, silica 6.3 The specific gravity of the oil used in the burners was 20.5. Two barrels of oil were used on an average in reducing each ton of the charge. After smelting the resultant slag consisted of forty-five per cent. silica and

alumina, fifty per cent. lime, and five per cent. iron and other elements.

While I have shown and described the furnace as an iron-smelter, it should be understood that it may be used in the smelting of other ores.

It should be understood that I do not limit myself to the particular construction herein shown and described, as many changes might be made therein without departing from the spirit of the invention. For instance, the sections might be more or less and of different pitches than specified, the burners might be more or less, and liquid fuels other than crude petroleum might be used.

The inclined chamber is provided along each side wall with a series of poke-holes 29, which are plugged and are capped by removable plates 30. If by any possibility the charge becomes frozen or clogged, the poke-holes provide a means of access to the interior.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. In a smelting-furnace, an inclined chamber, combustion-chambers disposed along the inclined chambers and communicating therewith, and burners in the combustion-chambers and directed downwardly.

2. In a smelting-furnace, an inclined chamber having a floor of varying pitch, combustion-chambers disposed along the inclined chamber communicating with the inclined chamber, and liquid-fuel burners discharging through the combustion-chambers, toward the floor of the inclined chamber.

3. In a smelting-furnace, an inclined chamber having a floor of varying pitch, liquid-fuel burners disposed along the chamber and directed toward the floor of said chamber, one section of the chamber being relatively larger in cross-section than another section.

4. In a smelting-furnace, an inclined chamber having a floor of varying pitch, liquid-fuel burners disposed along the chamber and directed toward the floor, the upper section of the chamber having a higher roof than the other.

5. In a smelting-furnace, an inclined chamber having a floor of varying pitch, one section of the chamber being larger in cross-section than another section, a combustion-chamber communicating with the larger section, and a combustion-chamber communicating with a smaller section, and liquid-fuel burners in the combustion-chambers directed toward the floor.

6. In a smelting-furnace, an inclined chamber, a plurality of combustion-chambers in the roof of the inclined chamber, and liquid-fuel burners therein.

7. In a smelting-furnace, an inclined chamber the upper section of which has a pitch steeper than a lower section and liquid-fuel burners near the roof of the chamber and directed in a general direction the resultant of toward the floor and toward the upper end of the chamber.

8. In a smelting-furnace, an inclined chamber the upper section of which is larger and has a steeper pitch than a lower section, and liquid-fuel burners near the roof of the chamber and directed toward the floor.

9. In a smelting-furnace, an inclined chamber the upper section of which is larger and has a steeper pitch than a lower section, a plurality of combustion-chambers on the roof communicating with the inclined chamber and distributed along the same, and oil-burners in the respective combustion-chambers.

10. In a smelting-furnace, an inclined chamber the upper section of which is larger, longer and of steeper pitch than a lower section, a plurality of combustion-chambers on the roof communicating with the inclined chamber and distributed along the same, and oil-burners in the respective combustion-chambers.

11. In a smelting-furnace, an inclined chamber the upper section of which is larger and has a steeper pitch than a lower section, a plurality of combustion-chambers on the roof communicating with the inclined chamber and distributed along the same, and oil-burners in the respective combustion-chambers, said combustion-chambers being inclined to the respective sections of the inclined chamber with which they communicate.

12. In a smelting-furnace, an inclined chamber the upper section of which is larger, longer and has a steeper pitch than a lower section, a plurality of combustion-chambers on the roof communicating with the inclined chamber and distributed along the same, and oil-burners in the respective combustion-chambers, said combustion-chambers being inclined to the respective sections of the inclined chamber with which they communicate.

13. In a smelting-furnace, an inclined chamber having a floor of varying pitch, liquid-fuel burners disposed along the inclined chamber and directed toward the floor, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

14. In a smelting-furnace, an inclined chamber, combustion-chambers disposed along the inclined chamber communicating therewith, and burners in the combustion-chambers, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

15. In a smelting-furnace, an inclined chamber having a floor of varying pitch and liquid-fuel burners disposed along the chamber and directed downwardly, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

16. In a smelting-furnace, an inclined chamber having a floor of varying pitch, and liquid-fuel burners disposed along the chamber considerably above the floor and directed downwardly, a well at the lower end of the inclined

chamber, and communicating therewith, and a crucible in the well.

17. In a smelting-furnace, an inclined chamber having a floor of varying pitch, combustion-chambers disposed along the inclined chamber communicating with the inclined chamber, and liquid-fuel burners discharging through the combustion-chambers, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

18. In a smelting-furnace, an inclined chamber having a floor of varying pitch, liquid-fuel burners disposed along the chamber and directed toward the floor of the chamber, one section of the chamber being relatively larger in cross-section, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

19. In a smelting-furnace, an inclined chamber having a floor of varying pitch, liquid-fuel burners disposed along the chamber and directed toward the floor of the chamber, the upper section of the chamber having a higher roof than the other, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

20. In a smelting-furnace, an inclined chamber having a floor of varying pitch, one section of the chamber being larger in cross-section than another section, a combustion-chamber communicating with the larger section, and a combustion-chamber communicating with a smaller section, and liquid-fuel burners in the combustion-chambers directed toward the floor, a well in the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

21. In a smelting-furnace, an inclined chamber, a plurality of combustion-chambers in the roof of the inclined chamber, and liquid-fuel burners therein, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

22. In a smelting-furnace, an inclined chamber the upper section of which has a pitch steeper than a lower section and liquid-fuel burners near the roof of the chamber and disposed along the chamber and directed in a general direction the resultant of toward the floor and toward the upper end of the chamber, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

23. In a smelting-furnace, an inclined chamber the upper section of which is larger and has a steeper pitch than a lower section, and liquid-fuel burners near the roof of the chamber and disposed along the chamber and directed toward the floor, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

24. In a smelting-furnace, an inclined chamber the upper section of which is larger, longer and of a steeper pitch than a lower section, and liquid-fuel burners near the roof of the chamber and disposed along the chamber and directed toward the floor, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

25. In a smelting-furnace, an inclined chamber the upper section of which is larger and has a steeper pitch than a lower section, a plurality of combustion-chambers on the roof communicating with the inclined chamber and distributed along the same, and oil-burners in the respective combustion-chambers, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

26. In a smelting-furnace, an inclined chamber the upper section of which is larger, longer and has a steeper pitch than a lower section, a plurality of combustion-chambers on the roof communicating with the inclined chamber and distributed along the same, and oil-burners in the respective combustion-chambers, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

27. In a smelting-furnace, an inclined chamber the upper section of which is larger and has a steeper pitch than a lower section, a plurality of combustion-chambers on the roof communicating with the inclined chamber and distributed along the same, and oil-burners in the respective combustion-chambers, said combustion-chambers being inclined to the respective sections of the inclined chamber with which they communicate, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well.

28. In a smelting-furnace, an inclined chamber the upper section of which is larger, longer and has a steeper pitch than a lower section, a plurality of combustion-chambers on the roof communicating with the inclined chamber and distributed along the same, and oil-burners in the respective combustion-chambers, said combustion-chambers being inclined to the respective sections of the inclined chamber with which they communicate, a well at the lower end of the inclined chamber therewith, and communicating therewith, and a crucible in the well.

29. In a smelting-furnace, an inclined chamber having a floor of varying pitch, liquid-fuel burners disposed along the line of the inclined chamber and directed toward the floor, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well, and a liquid-fuel burner in the end wall directed across the crucible toward the discharge-mouth of the inclined chamber.

30. In a smelting-furnace, an inclined chamber having a floor of varying pitch and liquid-fuel burners disposed along the chamber and directed downwardly, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well, and a liquid-fuel burner in the end wall directed across the crucible toward the discharge-mouth of the inclined chamber.

31. In a smelting-furnace, an inclined chamber having a floor of varying pitch, combustion-chambers communicating with the inclined chamber, and liquid-fuel burners discharging through the combustion-chambers, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well, and a liquid-fuel burner in the end wall directed across the crucible toward the discharge-mouth of the inclined chamber.

32. In a smelting-furnace, an inclined chamber having a floor of varying pitch and liquid-fuel burners disposed along the chamber and directed downwardly, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well and a water-jacket along the floor.

33. In a smelting-furnace, an inclined chamber having a floor of varying pitch and liquid-fuel burners disposed along the chamber and directed downwardly, a well at the lower end of the inclined chamber, and communicating therewith, and a crucible in the well, a chimney at the upper end of the inclined chamber and communicating therewith.

34. In a smelting-furnace, an inclined chamber having a floor of varying pitch, injector-burners disposed along the chamber and directed downwardly, a well at the lower end of the inclined chamber and communicating therewith, and a crucible in the well.

35. In a smelting-furnace, an inclined chamber, a plurality of combustion-chambers in the roof of the inclined chamber and injector-burners therein.

36. In a smelting-furnace, an inclined chamber, an upper section of which has a pitch sufficient to feed ore by gravity and a lower section of which has a pitch sufficient to retard and stop the ore, and injector-burners disposed along the inclined chamber.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, at Los Angeles, in the county of Los Angeles and State of California, this 2d day of March, 1903.

ELFEGO RIVEROLL.

Witnesses:
GEORGE T. HACKLEY,
TILLIE E. ADAM.