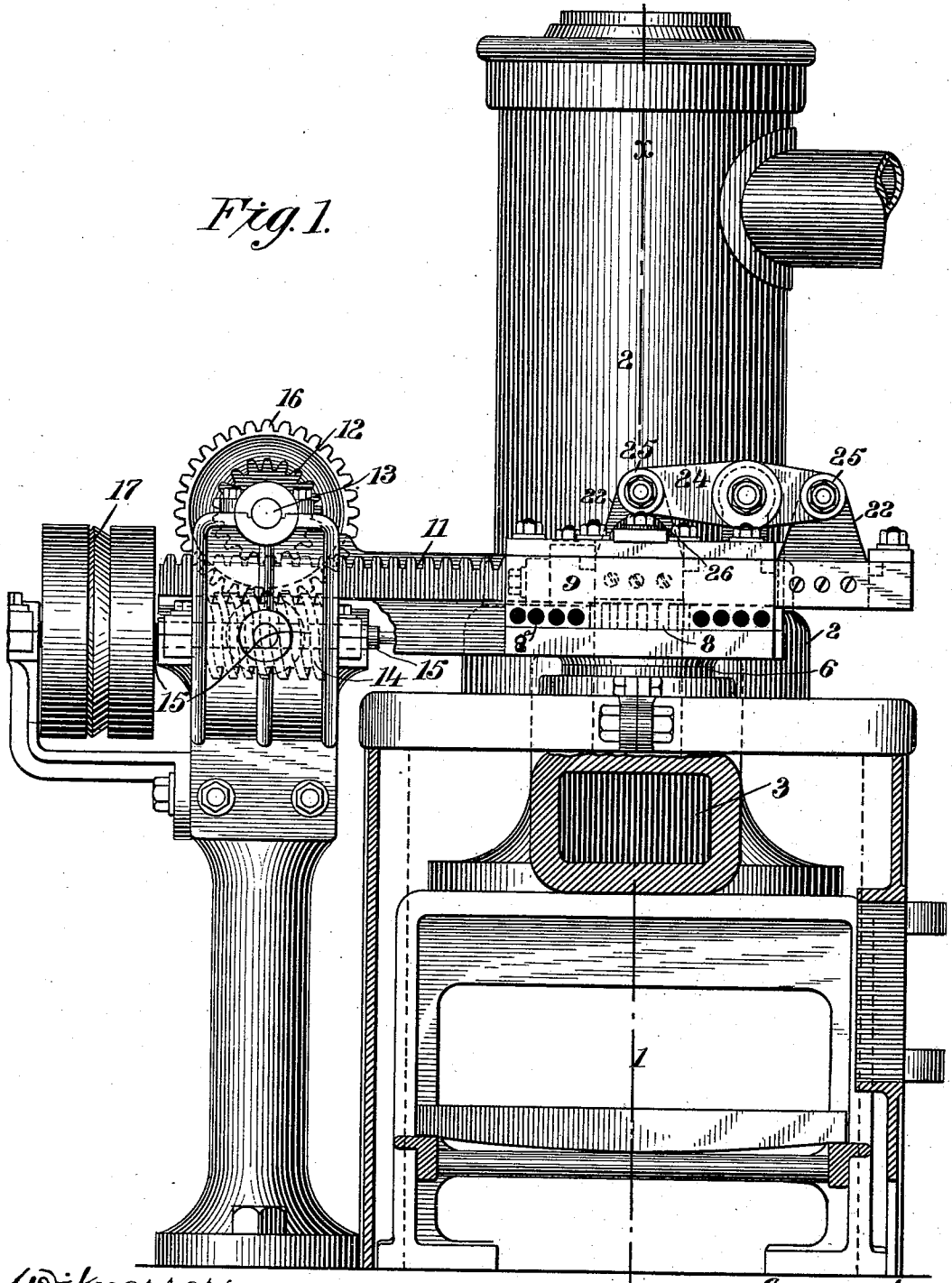
(No Model.) 4 Sheets—Sheet 1

A. F. MADDEN.

MACHINE FOR CASTING GRIDS FOR SECONDARY BATTERIES.

No. 471,527. Patented Mar. 22, 1892.

Fig. 1.



Witnesses
Wm. J. Tanner
N. D. Sheldon Jr.

Inventor
Albert Franklin Madden
by his attorney A. N. Hubbard

(No Model.) 4 Sheets—Sheet 2.

A. F. MADDEN.

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Fig. 3.

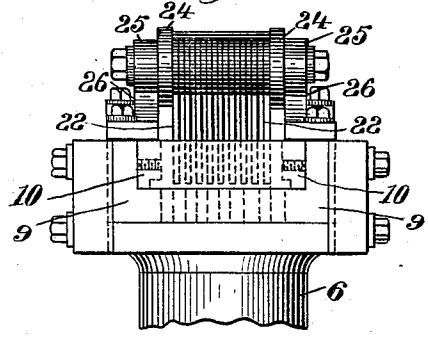

Fig. 2.

Witnesses
Wm. J. Danner
H. J. Sheehan Jr.

Inventor
Albert Franklin Madden
by his attorney A. H. Hubbard

(No Model.) 4 Sheets—Sheet 3.

A. F. MADDEN.

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Fig. 4.

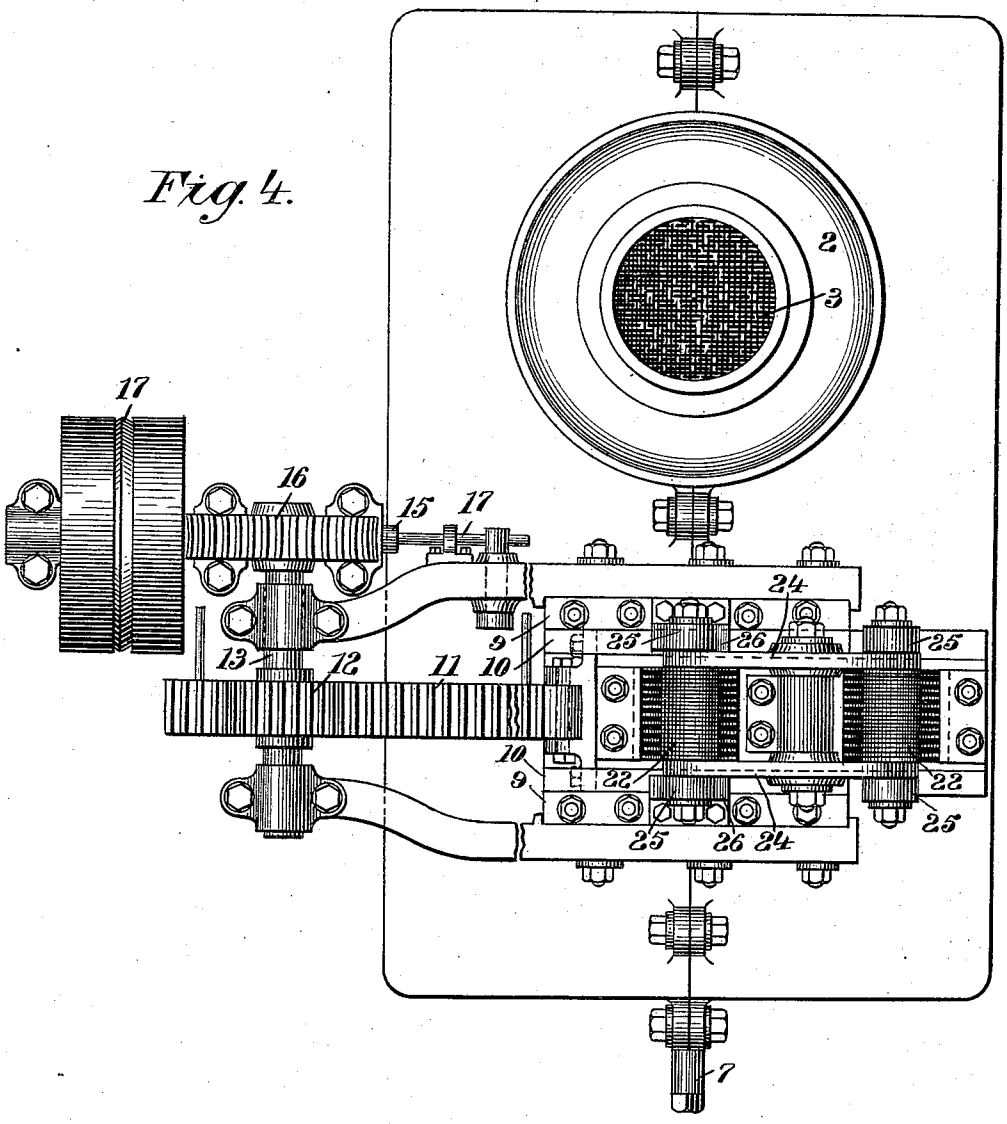
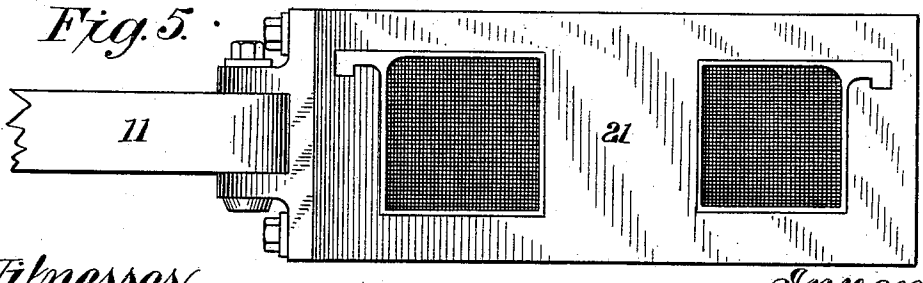


Fig. 5.



Witnesses
Wm. F. Tanner
N. S. Shelton

Inventor
Albert Franklin Madden
by his attorney A. N. Hubbard

(No Model.) 4 Sheets—Sheet 4.

A. F. MADDEN.

MACHINE FOR CASTING GRIDS FOR SECONDARY BATTERIES.

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Fig. 6.

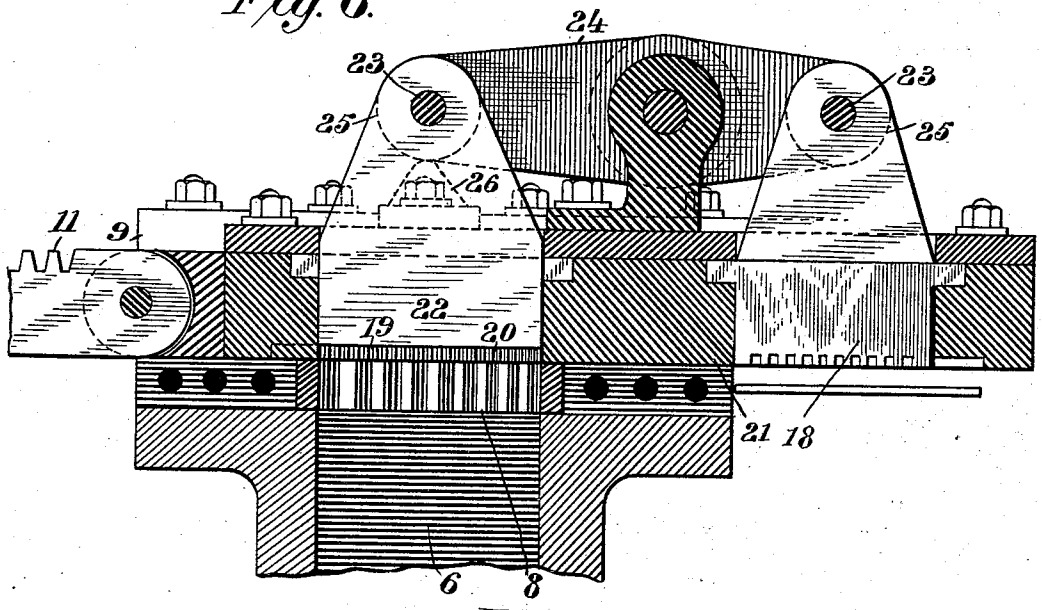


Fig. 10.

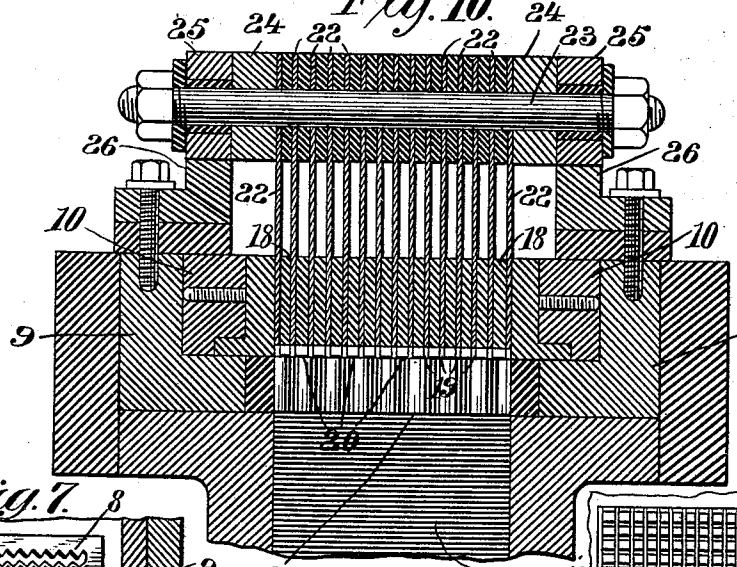


Fig. 7.

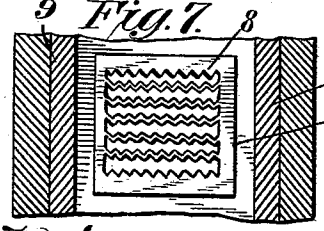


Fig. 9.

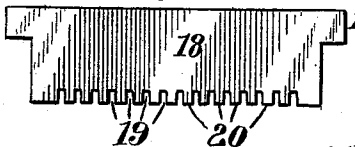
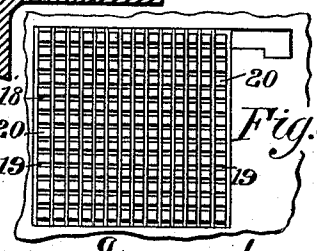


Fig. 8.



Witnesses
Wm. J. Tanner
H. S. Shelton Jr.

Inventor
Albert Franklin Madden
by his attorney
A. H. Hubbard

UNITED STATES PATENT OFFICE.

ALBERT FRANKLIN MADDEN, OF NEWARK, NEW JERSEY, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO JOHN M. PENDLETON, OF NEW BRIGHTON, NEW YORK.

MACHINE FOR CASTING GRIDS FOR SECONDARY BATTERIES.

SPECIFICATION forming part of Letters Patent No. 471,527, dated March 22, 1892.

Application filed February 16, 1889. Renewed July 24, 1890. Serial No. 359,731. (No model.)

To all whom it may concern:

Be it known that I, ALBERT FRANKLIN MADDEN, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Machines for Casting Grids for Secondary Batteries; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to certain new and useful improvements in machines for casting from lead or a suitable alloy grids such as are used to form the electrodes of secondary batteries.

The objects of my invention are to provide a machine capable of producing grids exceedingly compact, solid, and homogeneous in their structure, which shall be free from such imperfections as honey-comb and sprues, which shall contain the greatest possible number of perforations and the thinnest possible partitions between said perforations, in which the metal of the partitions shall be hard and compact, and in which the side walls of the perforations shall each be parallel with each and each at right angles to the surface of the plate; and with these ends in view my invention consists in the details of construction and combinations of co-operating elements, which will hereinafter be fully described, and then recited in the claims.

Prior to my invention these grids have been produced in either of two ways, by casting or by pressure from sheet metal. In the former method a divided chill with abutting teeth or projections corresponding to the perforations of the grid has been employed and the molten metal run into this chill. Such a casting is, however, very difficult to produce, owing to the thin space of large area into which the metal has to flow—say, for instance, thirty-six square inches with a thickness of but three thirty-seconds of an inch. It therefore follows that many obviously imperfect grids are thus formed and that many more apparently good become, after a little while, worthless from lack of homogeneity. Furthermore, if the teeth of the two parts of the chill do not abut perfectly together fins are formed within the perforations and these fins must subsequently be removed. In the latter method above referred to—namely, by stamping or pressure—the partitions in the grid are limited in their thinness because the pressure of the die must be so great that a very thin partition is left with its metal crushed and divided, and the cutting-edges of the die form a fin upon the under side of the grid. Furthermore, it is necessary in making grids by this process to compress the margin or edge of the grid all around prior to operating upon the central area and to hold it so compressed during such stamping, for otherwise the metal may spread or slough out at the sides. This more tightly-compressed rim or edge is disadvantageous to the perfect operation of the plate which is made from the grid, since it interferes with the perfectly equal expansion which must be afforded to the plate to prevent the latter from warping or buckling when in action in the battery.

In a properly-constructed secondary battery the positive and negative grids are of the same surface area, but of different thicknesses, and I propose in the machine herein described to cast both kinds of plates, the alternate plates being respectively thick and thin, thereby making an equal number of each kind in the operation of the machine for a given time.

In order that those skilled in the art to which my invention appertains may more fully understand the construction of my machine and the manner in which the cast grids are produced by means thereof, I will describe the same in detail, reference being had to the accompanying drawings, which form a part of this specification, and in which—

Figure 1 is a front elevation, partly in section; Fig. 2, a vertical section upon the line *x x* of Fig. 1; Fig. 3, a detail end elevation of the carriage and the support for the same; Fig. 4, a plan view of the machine; Fig. 5, a detail plan view showing the general appearance of the under side of the molds; Fig. 6, a detail longitudinal section through the carriage; Fig. 7, a transverse section on line *y y* of Fig. 2; Fig. 8, a plan view showing a small mold adapted to cast plates with few and large perforations, so that the construction

and arrangement of mold-bars and ejectors may be understood; Fig. 9, a side elevation of one of the mold-bars; Fig. 10, a vertical section at right angles to Fig. 6.

In the drawings, 1 is a furnace, which may be of any preferred construction and which is provided with a stack 2, through which the products of combustion may escape. This stack is of considerable diameter and within it is arranged a crucible 3, which is exposed to the fire at its lower end and which from its height forms, when filled with the molten metal, a column, from which pressure for injection may be derived, as will be hereinafter set forth. The crucible and the walls of the furnace may be of iron, since the heat required to raise lead to the melting-point is relatively low; but the parts exposed to the severest heat—such as the crucible and the furnace-linings—are preferably made of fireclay or other highly-refractory substance.

4 is an outlet closed by means of a screw-threaded plug 5. This outlet is merely for convenience in drawing off the contents of the crucible for cleaning or repairing the latter. The crucible is, as may be seen by reference to the principal sectional view, extended outward somewhat in L shape at its lower end, and 6 is a short vertical chamber communicating with the crucible by a hole 6^a, which latter may be wholly closed or partially closed to any degree desired by means of a screw-threaded tapered plug 7. At the top of the short column or chamber 6 is a series of zigzag bars 8, which form a grating across the same and which as to their upper edges are finished with square sharp corners. The purpose of these bars will be presently explained. In the top of the short column, at either side of the grating, are formed openings 8^a, preferably extending through the casting. These afford a circulation of air, which tends to keep the top of column over which the freshly-made casting slides comparatively cool, whereby a chill is imparted to the lead. If found desirable to still further cool the column for chilling, as above set forth, streams of water may be caused to circulate through the openings by means of suitable pipes connected therewith. In the same horizontal plane with the top of the bars last referred to are the ways 9, upon which a carriage 10 is mounted and adapted to slide. This carriage has secured thereon a rack 11, which extends outwardly therefrom, and said rack is operated in both directions by means of a pinion 12, mounted on a short transverse shaft 13. This shaft is rotated by a spiral pinion 14 on the pulley-shaft 15 and meshes with a worm-wheel 16 upon said shaft 13, and the pulley-shaft has any suitable clutch and reversing mechanism 17, whereby the proper movements may be imparted to the carriage backward and forward for the purpose hereinafter explained.

I have not thought it necessary to enter upon any detailed description of the particular construction and arrangement of the shafts, clutches, and reversing mechanism illustrated in the drawings, for while that shown is well fitted to operate the machine it forms no essential part of my invention.

In the bottom of the carriage and lying in a plane immediately above the grating heretofore referred to are the molds in which the plates are cast. There are two of these and they are constructed as follows: Each mold consists of a number of bars 18, which have cut across their exposed edges a series of notches 19. (See Figs. 8 and 9.) The edge of each bar is so arranged that the width and depth of the notches are the width and thickness of a partition in the grid to be made, and those projecting parts 20 between the notches are square upon the face and of exactly the size of the perforations to be made in the grid to be produced. A series of these bars of the proper length are firmly set in what I have termed for convenience the "mold-plate" 21, which forms the lower surface of the carriage, and which has cut therein the shape of the rim and lug of the grid. (See Fig. 5.) The said bars are so set that their projecting faces are just flush with the face of the mold-plate, and they are spaced each bar from the next to exactly the width of the transverse notches, which, as hereinbefore set forth, are of a width equal to the thickness of the partition desired to be made in the grid. In these spaces between the bars are arranged a series of ejector-plates 22, which fit the spaces closely and which extend upward to the top of the carriage and are all secured together and to a shaft 23, mounted upon rocking levers 24.

It is intended in this machine to cast two plates, one positive and one negative, and these are preferably of different thicknesses. Therefore I provide two sets of mold-bars, having their edges notched to different depths corresponding to the different thicknesess of the plates, and two sets of ejectors mounted upon the ends of the rocking levers, so that movement applied to one set of ejectors will operate the other set in the opposite direction between the mold-bars. The cams 26 are adapted to raise each set of ejector-plates upward for the filling operation just to the top of the notches in the bars, and at the same time the other set of ejectors is depressed to throw out the plate last made. The movement which these ejectors have between the mold-bars is about equal to the thickness of the grid to be cast, and is shown in Fig. 6, where the left-hand ejectors are shown as raised the thickness of the grid above the face of the mold-bars and the right-hand ejectors are shown as depressed, so as to be flush with the face of the mold-bars. It is necessary that the limit of upward movement of each set of ejectors shall be flush with the bottom of the notches in the bars. The downward movement is not essential to be accurately limited

to the face of the mold-bars, since any downward movement that will throw out the finished grid will be sufficient.

25 are rollers secured on the rocking levers, and said rollers are adapted as the carriage slides to ride up on the lifting-cams. These cams 26 are stationary upon the frame or bed on which the carriage moves and serve by engagement with the rollers upon the ends of the ejector-supporting shafts to raise the ejectors at certain specified times. The movement of the carriage is just sufficient to allow each mold to be brought perfectly over the grating which is at the upper end of the chamber, and the time at which the ejectors are so raised by the cams is at the moment when the mold is fully and exactly over the said chamber.

The operation of my invention is as follows: It will be readily understood that the height of the column of lead in the crucible and the connection of the latter with the chamber will cause a pressure at the upper end of said chamber, and that if the grate were left uncovered the metal would spurt upward so long as a difference in height between the column and chamber subsisted. This pressure is utilized in securing the proper filling of the molds. The mold-plate at the bottom of the carriage is in contact with the top surface of the bars which form the grating, and so closely fits thereon that the melted metal in the chamber cannot find exit except into the molds when the latter are in position. When one mold (say the positive, as seen at Fig. 6) is brought over the grating by moving the carriage along its ways, said mold is as to all parts thereof, except the transverse notches in the mold-bars and the rim and lug, closed, because the ejectors are at their downward limit of movement, with their faces flush with the faces of the mold-bars. As soon as the mold is fully over the grating the cams raise the levers, (see dotted lines at left hand of Fig. 6,) and this withdraws the ejectors a distance equal to the thickness of the plate. Then the whole mold is open and the metal under pressure rushes upward through the grating and fills each and every part of the mold. Then the carriage is moved along and the lead which is in the mold is cut off by the edges of the grate-bars from the mass of lead in the chamber. In so doing the grate-bars also wipe off and surface the lower side of the casting. The plurality of cutting-bars is employed in preference to one or two, so that the cutting off of the whole surface of the grid may be as nearly simultaneous as possible and before it has time to cool unevenly. As the mold that has been filled passes from over the grating, the blank middle surface of the mold-plate comes over it and stops any outflow of metal, and as that passes from over the grating the other mold comes over said grating. When the other mold is moved within the field of the molten metal, the ejectors therein are down, leaving open only, as heretofore set forth, the rim and tang and the notches in the edges of the mold-bars. When it comes fully over the grating and the ejectors are lifted by the cams, it follows that the ejectors upon the other end of the levers are pushed downward, and this downward movement presses out the grid previously cast and which meanwhile has become sufficiently cool to remain set in shape. The distance between the molds is sufficient to have each clear the top of the carriage support or base when the other is over the grating, Figs. 1 and 6. As these grids are alternately ejected at each side of the machine, they may be removed in any desired manner; but in practice I prefer to have them received upon traveling belts or other suitable conveyers, so that they may have ample opportunity to cool before being handled. When in operation, the machine is, by reason of the reversing mechanism attached thereto, substantially automatic, making one grid and depositing the one last cast at each movement of the carriage. Moreover, it produces in any given time an equal number of positive and negative grids and deposits the positives all on one side the machine and the negatives all on the other side the machine.

In the formation of grids by means of this machine the whole area of the mold is exposed to the molten metal and the filling of all parts thereof is practically simultaneous. Furthermore, this filling is effected under the pressure derived from the column in the crucible, which is sufficient to cause the metal of the casting to be very homogeneous and free from honey-comb or blow-holes. The pressure of the column may be retained substantially constant by occasional additions of fresh lead, and the pressure may also be varied somewhat by means of the screw-threaded plug, which is adapted to fit the hole between the chamber and the crucible.

The molds which are herein shown are in some features of their construction like the dies which are shown and described in certain Letters Patent of the United States No. 391,542, granted to me the 23d day of October, 1888; but the action of the mold in this machine is obviously different from the action of the die in said patent.

Instead of the crucible so shaped as to inject the metal by means of the column of metal therein contained, other means, as a pump, for forcing it into the molds could be employed instead; but I prefer the column by reason of its simplicity and the certainty of its action.

I claim—

1. In a machine of the character described, the combination, with the crucible, of the chamber communicating with the crucible, the mold at the top of the chamber and adapted to be moved across the latter, and the grate-bars arranged at the upper end of the cham-

ber and having their upper faces contiguous to the bottom face of the mold-plate, substantially as set forth.

2. The combination, with the crucible and chamber, of the carriage arranged upon the ways at the top of the latter, a pair of molds arranged in the lower face of said carriage, the bars for surfacing the contents of the mold, and means for imparting to the carriage a movement in both directions, whereby the molds may be alternately brought within the field of the injected lead and taken out of it for removal of the grid, substantially as set forth.

3. The combination, with the crucible and means for injecting the metal, of the carriage having molds in the lower surface thereof conformed to the shape of the grid, movable ejectors projecting downward to the surface of each mold, levers at the top of the carriage, to which the ejectors are secured, and a cam for the operation of the levers, whereby the ejectors are raised and lowered and the molds alternately opened and closed, substantially as set forth.

4. The combination, with the lead-containing chamber and the means for applying the proper injecting-pressure thereunto, of the sliding carriage above the top of the chamber, the mold-plate on the bottom of the carriage, the molds in said plate, the blank spaces between said molds, the grate-bars abutting against the face of the mold-plate, and means for moving the carriage relatively to the grate-bars and chamber, substantially as set forth.

5. The combination, with the chamber and means for imparting pressure to the metal therein, of the carriage having the mold-plate upon the bottom thereof, the mold-bars set in said mold-plate, the ejectors arranged between said mold-bars, means for moving the carriage, and further means for actuating the ejectors between the mold-bars, substantially as set forth.

6. The combination, with the carriage and the mold-plate at the bottom thereof, of the mold-bars secured in said plate and flush with its lower surface, the ejectors interposed between the mold-bars, the levers pivoted to a standard on the carriage and connected at either end to the ejectors, means for operating the carriage, and a cam for lifting the levers and ejectors, substantially as specified.

7. The combination, with the chamber and the means for applying pressure to the metal therein, of the carriage, the molds in the bottom thereof, means for actuating said carriage across the top of the chamber, and the grate-bars arranged at the top of the chamber and adapted to surface the metal in the mold and to sever the same from the mass contained in the chamber, substantially as set forth.

8. The combination, with the chamber and the means whereby pressure is applied to the metal therein, of the carriage, the two molds of different depths arranged in the bottom thereof, the ejectors movable between the mold-bars of each mold, and means for imparting simultaneous but unequal and opposite movement to the said ejectors, substantially as shown and set forth.

9. The combination, with the chamber and the means for imparting pressure to the metal within the same, of the carriage mounted above the chamber, the molds located in the bottom of the carriage, the ejectors and means for simultaneously operating the same in different directions and to different degrees, a rack extending outwardly from the carriage, a pinion meshing with and adapted to move said rack, and a clutch and shifting mechanism for reversing the rotation of the pinion, whereby the backward and forward movements are imparted to the carriage, substantially as set forth.

10. The combination, in a machine of the character described with the crucible and the chamber, the latter having ways at its top, of the carriage provided with molds and arranged in said ways, the casing of said chamber having a series of openings for cooling, whereby a chill is afforded at each side of the chamber, substantially as set forth.

11. In a machine of the character described, the combination, with the vertical crucible, of a vertically-disposed chamber connected near its bottom with said crucible, a carriage having therein two molds of relatively large surface area located above the chamber, means for reciprocating said carriage, whereby its molds alternately enter the field of injection, chills located one at each side the chamber in the path of movement of the filled mold, and the grate-bars whereby the casting is severed and surfaced, substantially as specified.

12. In a machine of the character described, the combination, with the crucible and the vertical chamber connected therewith, of a reciprocatory mold-carriage provided with a mold corresponding substantially in surface area to the area of the chamber and shallow relative to its area, the ejectors in said mold, and the surfacing grate-bars between the chamber and the mold, all combined, as described, whereby the mold is filled in all parts simultaneously by the ingress of a large quantity of the casting metal as distinguished from a gradual filling, as by pouring.

13. In a machine of the character described, the combination, with the jacketed crucible L-shaped in its interior, of the vertical chamber connected at its bottom end with the L-shaped portion of the crucible, a furnace extending beneath both the crucible and the chamber and the mold-carriage, and means for reciprocating the same, mounted upon the top of the chamber, substantially as set forth.

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

ALBERT FRANKLIN MADDEN.

Witnesses:

THOMAS C. VERNON,

N. T. BRYAN.