

[54] **METHOD OF DRYING BATTERY PLATES**
[75] Inventor: **Charles H. McAlpine**, Coloma,
Mich.
[73] Assignee: **Mac Engineering & Equipment Co.,
Inc.**, Benton Harbor, Mich.
[22] Filed: **Jan. 24, 1974**
[21] Appl. No.: **436,107**
[62] Division of Ser. No. 359,859, May 14, 1973, Pat.
No. 3,813,214.

[52] **U.S. Cl.**..... **34/17, 136/33, 34/28,**
136/27
[51] **Int. Cl.**..... **F26b 7/00**
[58] **Field of Search**..... **34/17, 18, 28, 36, 219,**
34/216, 222, 218, 236, 105, 14, 224, 225;
432/8, 11, 14, 31, 133, 152, 153, 144-150,
176, 234; 136/27, 33; 141/89, 85

[56] **References Cited**

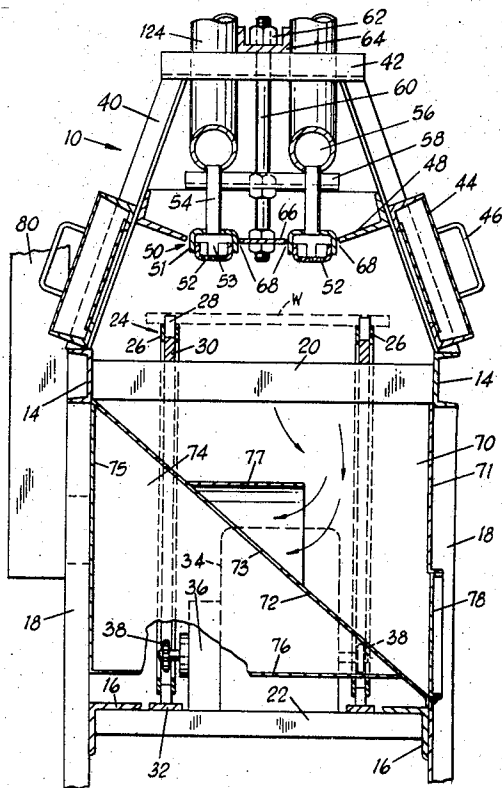
UNITED STATES PATENTS			
2,062,193	11/1936	Smith et al.	136/33
2,130,246	9/1938	Olcott et al.	136/33
2,149,813	3/1939	Lindstrom	136/33
2,220,004	10/1940	Smith et al.	136/33
2,295,474	9/1942	Horn	432/234
2,300,627	11/1942	Merson	136/33
2,300,628	11/1942	Merson	34/224

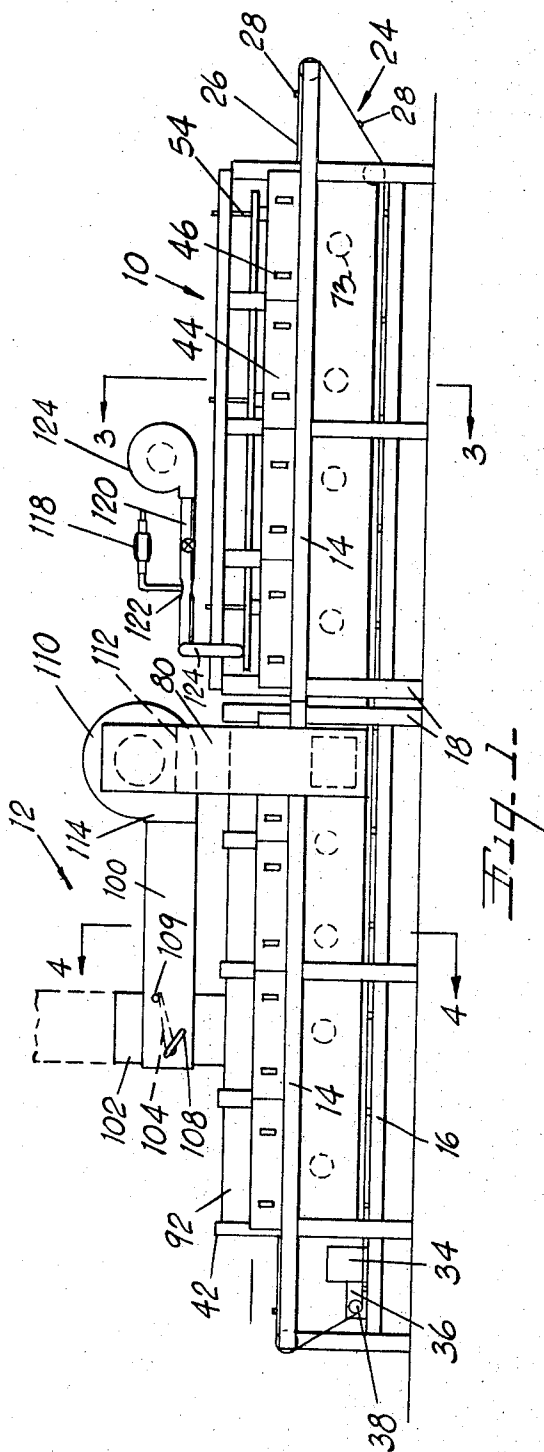
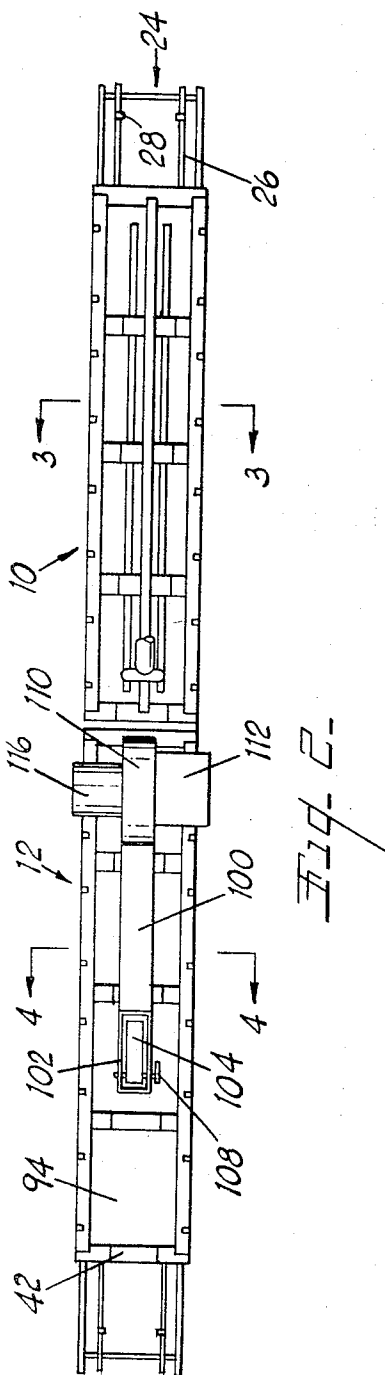
2,656,399	10/1953	Hindall et al.	34/222
2,780,453	2/1957	Coffman et al.	432/234
2,981,776	4/1961	Dunn, Jr. et al.	136/37
3,067,273	12/1962	Duddy	136/27
3,328,893	7/1967	Schilling	136/33

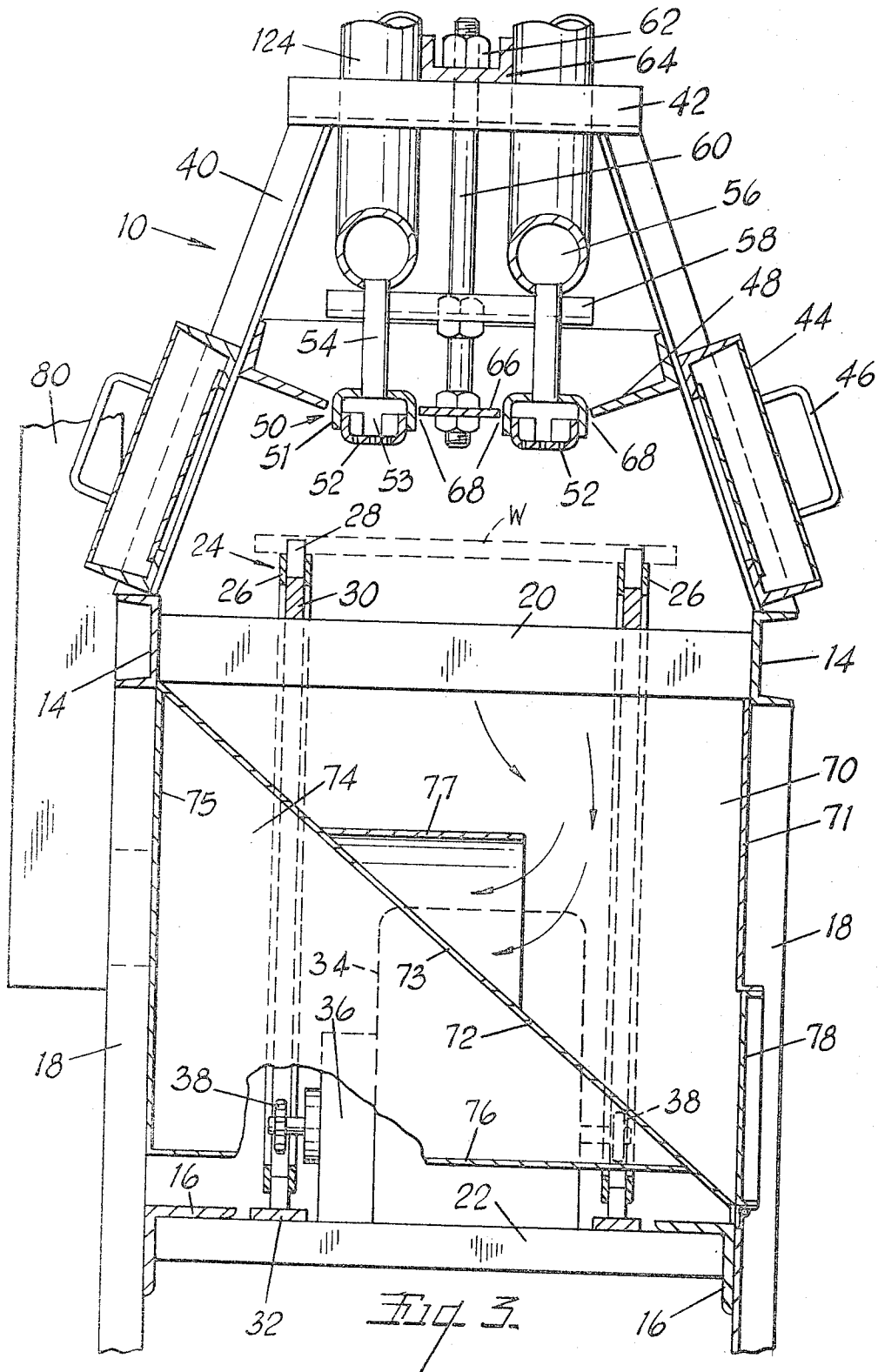
Primary Examiner—John J. Camby
Assistant Examiner—Henry C. Yuen
Attorney, Agent, or Firm—Austin A. Webb

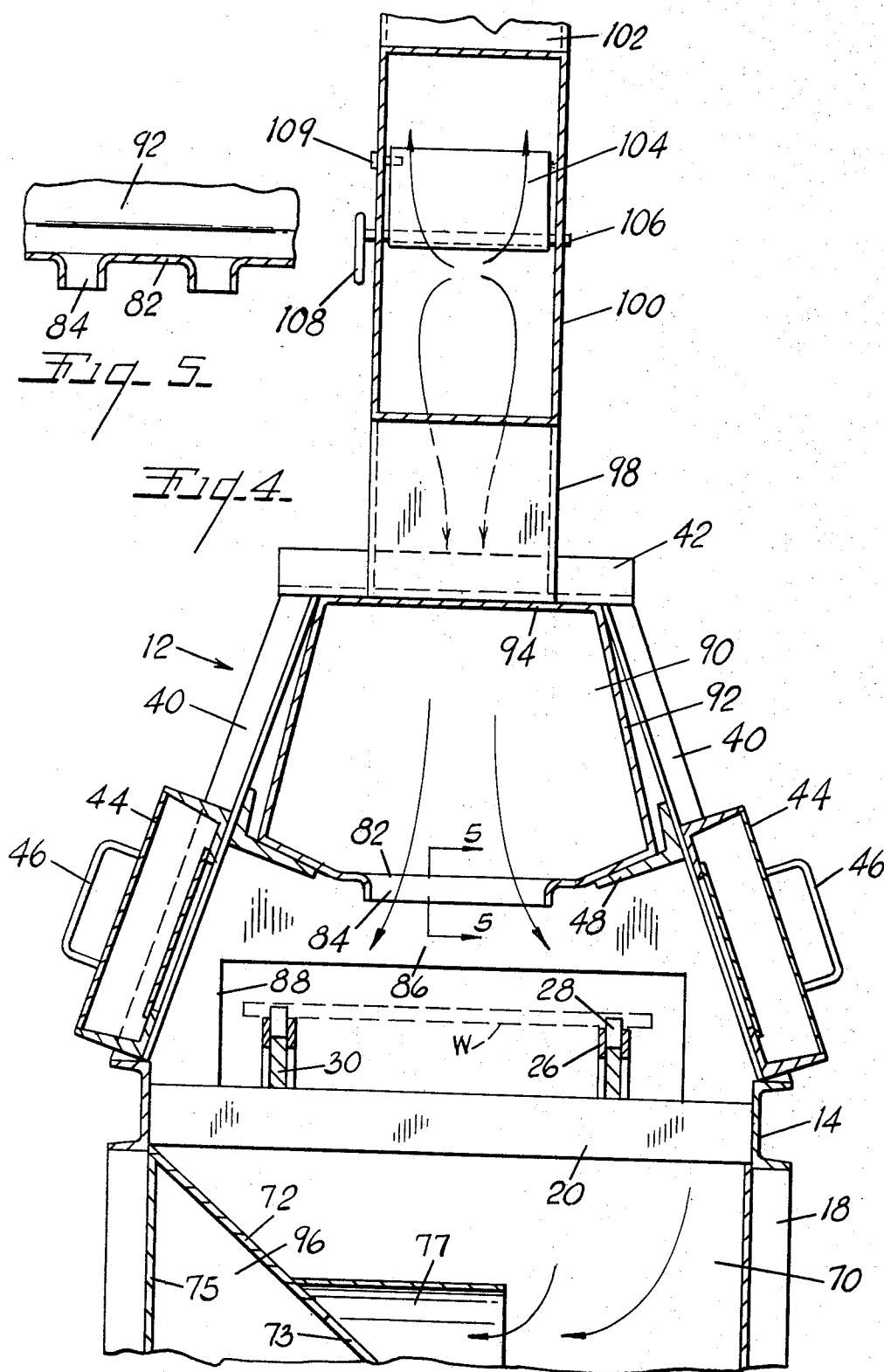
[57] **ABSTRACT**
Newly pasted plates with wet lead oxide and sulphuric acid pellets pressed in grids thereof are cured by subjecting one horizontal surface to a high temperature radiant heat source at about 1,500° F. for 10 to 20 seconds while further subjecting the one surface to a current of air at ambient temperature and at a rate of 2,000 CFM. The plates are thus heated to a surface temperature of about 350° F. on the one side and are then immediately subjected to a tempering air current against the hot side at about 250° F. and about 2,000 CFM for about ten to twenty seconds. The pellets at this time have a moisture content of about 9 percent and are sufficiently dry to be handled and stacked without sticking together.

7 Claims, 5 Drawing Figures









METHOD OF DRYING BATTERY PLATES

RELATED APPLICATIONS

This application is a divisional application covering 5 claims divided from a copending application, Ser. No. 359,859, filed May 14, 1973, now Pat. No. 3,813,214, issued May 28, 1974, in response to a requirement for restriction made in such copending application

OUTLINE OF INVENTION

The pasting of plates for lead-acid batteries by pressing and drying pellets of lead oxide and sulphuric acid in lead grid plates is a generally old practice. The problem solved by this invention is the slow drying or curing of the wet paste of the pellets, and advantageous result of the invention is rapid drying without causing the surface of the pellets to craze or develop objectionable cracks, and to cure the paste to a sufficiently dry state to permit the plates to be handled and stacked face to face without adhering to each other. Prior apparatus and methods for performing this operation have first subjected the wet plates to moderately heated air at a temperature of around 125°F., followed by heating to a higher temperature by subjecting the plates to an air current at about 350°F. Both of the heating steps maintain a high humidity and high concentration of CO₂ gas as disclosed in the patent to Lindstrom, No. 2,149,813.

Another prior system simultaneously subjects both sides of the wet plates to the high heat of closely adjacent gas burners for a sufficiently long period of time to reduce the water content of the paste to from 11 to 9 percent by weight as shown in the patent to Rose, U.S. Pat. No. 2,068,434. In the Hindall U.S. Pat. No. 2,656,399 the wet plates pass through four successive zones of 290°F, 350°F., and two of 400°F. during an eight minute curing cycle.

The present invention first subjects the top surface 40 only of a wet battery plate to the combined high radiant and convection heat of a heat source with air circulated over both the source and the plate. A gas burner with attached mantle as a radiant heat source is a practical heat source as disclosed, but electric heating elements with air circulating thereover could be substituted. The temperature of the burner which is the source of the radiant energy is of the order of 1,500°F., and combined with the effect of the air circulation as will be described raises the plates to around 350°F. in ten to 15 seconds. The plates with the top surface thus heated are immediately subjected to a blast of tempering air at about 250°F. for another ten to fifteen seconds. The plates emerging from the second or tempering section of the oven have a desirable moisture content of about 9 percent and a temperature of from 110°F. to 130°F. The lead paste is dry enough to permit stacking of the plates without sticking, and the plates can be handled and stored for further curing and drying at ambient temperatures.

DESCRIPTION

The drawings, of which there are three sheets, illustrate a practical and preferred form of the oven for performing the method.

FIG. 1 is a side elevational view of the oven.

FIG. 2 is a top plan view.

FIG. 3 is a vertical transverse cross sectional view taken along the plane of the lines 3—3 in FIGS. 1 and 2.

FIG. 4 is a vertical transverse cross sectional view taken along the plane of the lines 4—4 in FIGS. 1 and 2.

FIG. 5 is a fragmentary vertical longitudinal cross sectional view taken along the plane of the lines 5—5 in FIG. 4.

10 The oven consists of a heating section 10 and a tempering section 12. As a matter of convenience in handling, these may be constructed separately, and joined at about the middle of the oven at assembly. The main structural framework consists of longitudinally extending upper rails 14 of channel shaped cross section and lower rails 16 of angle shaped cross section. The rails are supported on legs 18 and connected by cross bars 20 and 22. The framework can of course be varied, and the description of channels and angles is given only for ease of identification.

A conveyor indicated generally at 24 has an upper reach supported on the upper cross bars 20 and moving to the left in FIGS. 1 and 2. The lower reach is supported on the lower cross bars 22. The conveyor consists of suitable chain loops 26 which carry spaced work advancing blocks 28. Upright rails 30 support the blocks along the upper reach of the conveyor and plates 32 support the blocks along the lower reach of the conveyor. Driving means in the form of a motor 34 and gear box 36 drive sprockets 38 for driving the conveyor.

The supporting framework, conveyor and drive means are conventionally illustrated as a wide variety of structures can be used.

35 The enclosures over the upper reach of the conveyor are supported by a series of somewhat A-shaped frames having inclined legs 40 of T-shaped cross section and upper cross bars 42 of channel shaped section. A series of hollow, double walled doors 44 rest against T bars 40 and the side rails 14. The doors have handles 46 and are removable for inspection. Angle bars 48 extend longitudinally between the bars 40 mid-way of their height.

The upper wall of the enclosure in the heating section 10 (See FIG. 3) consists of two aligned series of sectional gas burners 50. The burners consist of downwardly facing rectangular metal castings 51 closed on the bottom by perforated ceramic cups or mantles 52. Aligned end apertures 53 permit consecutive ignition from one end of the series of burners to the other. The burners are old so are not disclosed in greater detail. The sections extend substantially the full length of the heating section. Each burner section is suspended by a supply nipple 54 from one of two supply pipes 56. The pipes are in turn supported on cross bars 58 hanging on bolts 60 suspended by nuts 62 from a longitudinal channel 64. A filler plate 66 supported by nuts on the lower ends of the bolts occupies space where a third series of burners may be installed if desired. It will be noted that narrow air passages 68 are left between the burners and the side rails 50 and the spacer filler plate. The gas fuel is burned almost completely within the burners and heats the ceramic cups 52 to an infrared heat which radiates to the work. Air drawn through the leakage passages as will be described cools the upper metal burner parts and prolongs their life while being heated itself.

Hot gases and air from the burners are drawn downwardly around and between the work pieces into a collecting chamber 70. The chamber is generally triangular in cross section and is formed by an upright rear wall 71 and an inclined wall 72. At spaced intervals along its length, the wall 72 has large holes 73 opening therethrough to a suction duct 74 formed along the lower side of the framework by a front plate 75 and a bottom plate 76 disposed above the lower reach of the conveyor. V-shaped hoods 77 prevent material from dropping through the holes and clean out doors 78 in the back wall permit removal of material which may flake off of the work plates. The duct 74 communicates with an upwardly extending suction duct 80 which will be described in greater detail presently.

The construction of the tempering section 12 of the oven appears most clearly in FIG. 4. The structural supporting elements are duplicate extensions of the parts in the heating section and are identified by the same numbers. The top closure of the oven consists of a plate 82 supported on the longitudinal angle bars 48. The plate has a series of transversely extending downwardly flanged nozzles 84 formed therethrough to direct air against the tops of the work pieces W. An end plate 86 closes the rear end of the oven except for an opening 88 to pass the conveyor and the work. The plate 82 forms the bottom of a plenum or delivery chamber 90 having side walls 92 and a top wall 94.

Below the conveyor, the tempering section has a collecting chamber 70 similar to that in the heating section, and holes 73 extend forwardly to a duct 96. The duct 96 is an extension of the duct 74 and also communicates with the bottom of the suction duct 80.

Opening to the top of the delivery chamber 90 is a supply duct 98. A blower outlet duct 100 extends horizontally over the tempering section and opens into the side of the duct 98. Duct 98 extends upwardly as an exhaust duct 102, and a damper 104 pivoted in the intersection of the two ducts as at 106 serves to divide the flow of air in the blower duct 100, directing part to the outlet and part to the delivery chamber 90. A control for regulating or adjusting the proportion of exhausted air to recirculated air is indicated conventionally by the handle 108. A stop 109 prevents complete closure of the outlet or exhaust duct 102, so a vent for purging the oven is always open.

A blower 110 appearing in FIGS. 1 and 2 has its intake side connected by a short cross duct 112 to the upper end of suction duct 80. The outlet 114 of the blower discharges into the duct 100 to complete the air circulating passages. A motor for driving the blower is conventionally indicated at 116.

The fuel supply to the burners is old but is described briefly to show its relation to the remainder of the oven. A regulator 118 delivers gas at zero pressure which is drawn off through pipe 120 by a venturi 122 into which combustion air is blown by blower 124 at a variable rate. The blower thus controls the rate of burning. Manifold pipes 124 deliver the fuel to the distribution pipes 56.

Operation

The work pieces W are placed on the inlet end of the conveyor in a wet molded semi-plastic condition. With the burners 52 in operation, the ceramic cups develop a temperature approaching 1,500°F. and radiate on the work. Quantitatively, for most battery plates it is desir-

able to burn fuel at a rate of about 300,000 B.T.U. per hour. This develops a bulb temperature along the tops of the plates of about 350°F. The conveyor operates at between 50 and 100 feet per minute, with 75 feet per minute being preferred. As a result, in a heating section about ten feet long, the plates are subjected to this intense heat for ten to 15 seconds before passing into the tempering section 12 of the oven. The still hot gases are mixed with air leaking through the openings 68 and the end of the oven drawn from underneath the work plates through the passages 70, 73 and 74 to the duct 80, where they are mixed with cooler gases from the duct 96. The blower 110 moves the mixture to the regulating damper 104, and a fraction of the mixture is delivered through the chamber 90 and ports 84 against the tops of the superheated plates.

The capacity of the blower in the example illustrated is about 4,000 cubic feet per minute, about half of which is heated by passing over the burners and around the work, with the result that the plates are subjected to a tempering flow of air at about 250° F. The setting of the damper 104 acts as a control for the temperature of the tempering air, with about one-third or less of the air being exhausted and two-thirds or more being recirculated at a temperature of 250° F. or more.

The action in the tempering section of the oven is cooling and air drying. The semi-plastic plates entering the section are hot on the top surface, cooler on the bottom, and still cooler in their interiors. As the water in the lead oxide paste of the plates is driven off by heat, the tempering air actually cools or takes away excess heat from the outer surfaces of the plates, while heat flow inwardly from the heated surface plus exothermic heat progressively evaporates water from the interior mass of the plates. The chemical solidifying and drying of the mass thus takes place without disruptive boiling off of the water and without objectionable crazing or development of fine cracks in the lead sulphate pellets of the grid plates. When the plates are delivered from the left end of the oven they are sufficiently hardened to be handled, and are dry enough to be stacked for final curing, and hardening without becoming stuck together. The metallic lead content of the paste is reduced to about 15 percent when leaving the oven, which further reduces to less than 5 percent after 24 hours air curing, as is common practice.

While gas fired radiant heaters have been disclosed, electric resistance heaters, with similarly spaced and downwardly or inwardly directed elements could be substituted.

What is claimed as new is:

1. The method of drying wet paste pellets in lead battery plates which comprises the steps of:
 - a) advancing said plates successively in generally coplanar relation, subjecting one side only of the plates and the pellets therein while being so advanced to a source of radiant energy at over 1,000°F. for a sufficient period of time to raise the ambient temperature at said one side of the plates to about 350°F.,
 - b) and next subjecting said one side of the plates so heated to a blast of tempering air at between 100°F., and 325°F. for a sufficient period of time to reduce the surface temperature of said one sides of the plates to below 150°F.
2. The method as defined in claim 1 in which air at ambient temperature is drawn around said heat source

5

and over the plates being heated at a rate of about 2,000 cubic feet per minute.

3. The method as defined in claim 2 in which said plates are subjected to heat for between 10 and 15 seconds,

and are then subjected to said air blast for at least the same period of time.

4. The method as defined in claim 2 in which the air blasted against said plates consists of a mixture of heated air drawn from around said heat source and said plates while being heated and approximately an equal volume of recirculated air drawn from around the plates being cooled.

6

5. The method as defined in claim 4 in which part of the mixture of air drawn from around said plates is exhausted without being recirculated to the plates being cooled.

5 6. The method as defined in claim 5 in which the amount of said air mixture exhausted from the system is between 35 percent and 15 percent of the air drawn over said plates.

10 7. The method as defined in claim 1 in which the temperature of the blast of air directed against the tops of said plates after the plates have been heated is about 250° F.

* * * * *

15

20

25

30

35

40

45

50

55

60

65