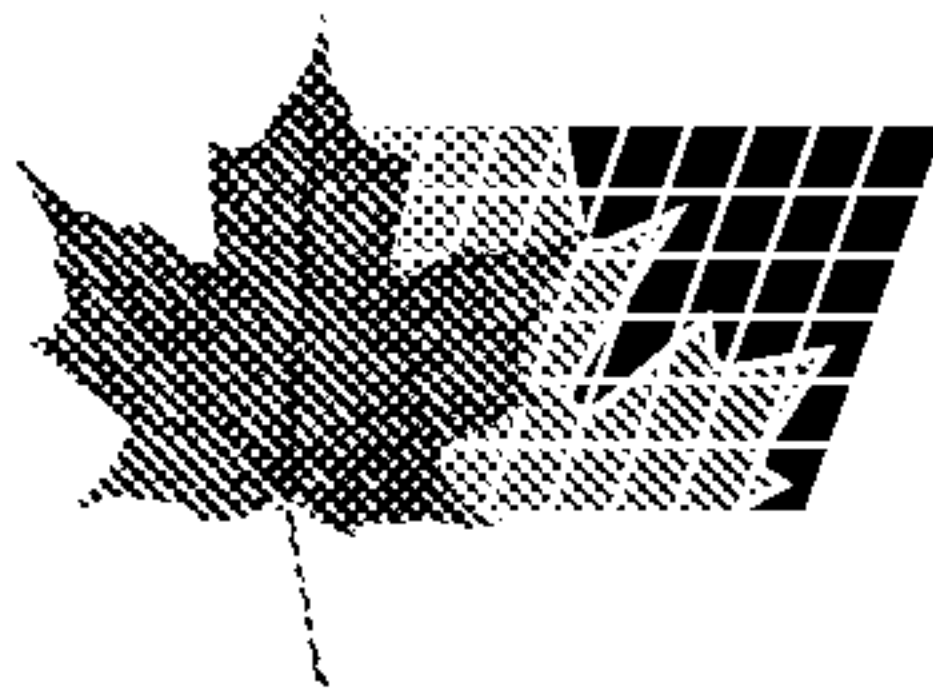




(72) TOTH, LASZLO, HU

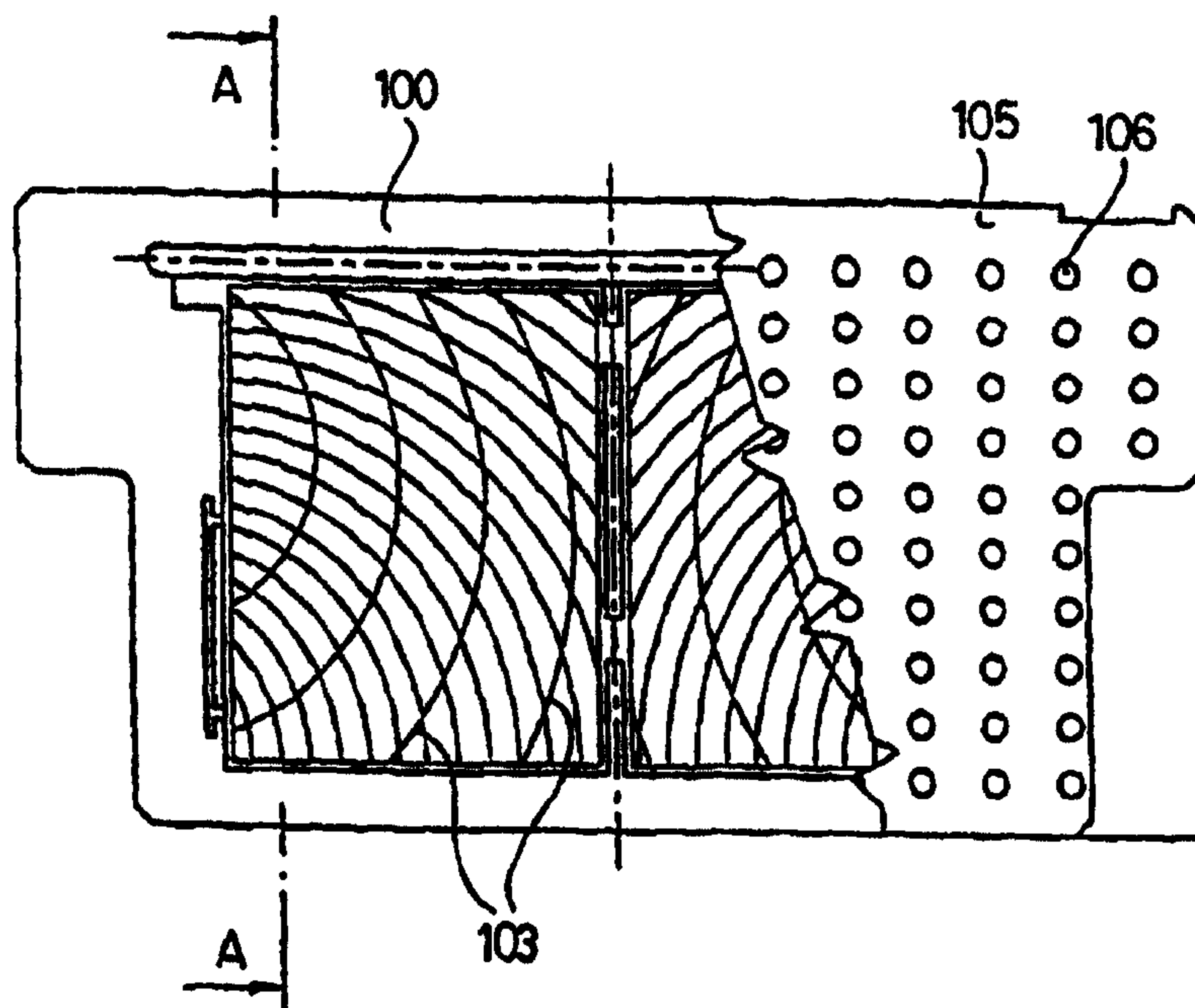
(72) SAROSI, GYORGY, HU

(71) AKKU BOTOND FEJLESZTO ES GYARTO KORLATOLT
FELELOSSEGU TARSAGAG, HU

(51) Int.Cl.⁶ B22D 25/04, H01M 4/84, B22D 13/00

(54) CASSETTE A CHARGEUR FORMATEUR DE MOULE,
PROCEDE DE FABRICATION DE GRILLES DE PLOMB POUR
BATTERIES ET EQUIPEMENT CORRESPONDANT

(54) DIE-FORMING MAGAZINE CASSETTE, METHOD FOR
MANUFACTURING BATTERY LEAD GRIDS USING SAID
MAGAZINE CASSETTES, AND EQUIPMENT
ACCOMPLISHING SAID METHOD



(57) The invention relates to a die-forming magazine cassette for producing grids of lead-acid batteries. The essence of the invention lies in that said cassette comprising die-forming plates (100) consisting of two aluminium sheets (101, 102) arranged on the two sides of a ferromagnetic plate (105) provided with through openings (106) filled up with the material of said aluminium sheets (101, 102) when pressed onto said ferromagnetic plate (105), the outer surface of said aluminium sheets (101, 102) being provided with grooves (103, 104) corresponding to the web of the lead grid, so that said grooves (103, 104) arranged on the two sides of the die-forming plates (100) are displaced with respect to each other and turned face-to-face constitute a magazine cassette, where the grooves (103, 104) are filled up with the material of the battery grid. The invention relates further to a process for producing grids of lead-acid batteries made by die-forming magazine, which are heated by induction heating. The invention relates further to an equipment for producing the grid structure of lead batteries by means of a manufacturing equipment operating on the centrifugal principle. The essence of the equipment lies in that the equipment being designed to operate in continuous mode.

PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

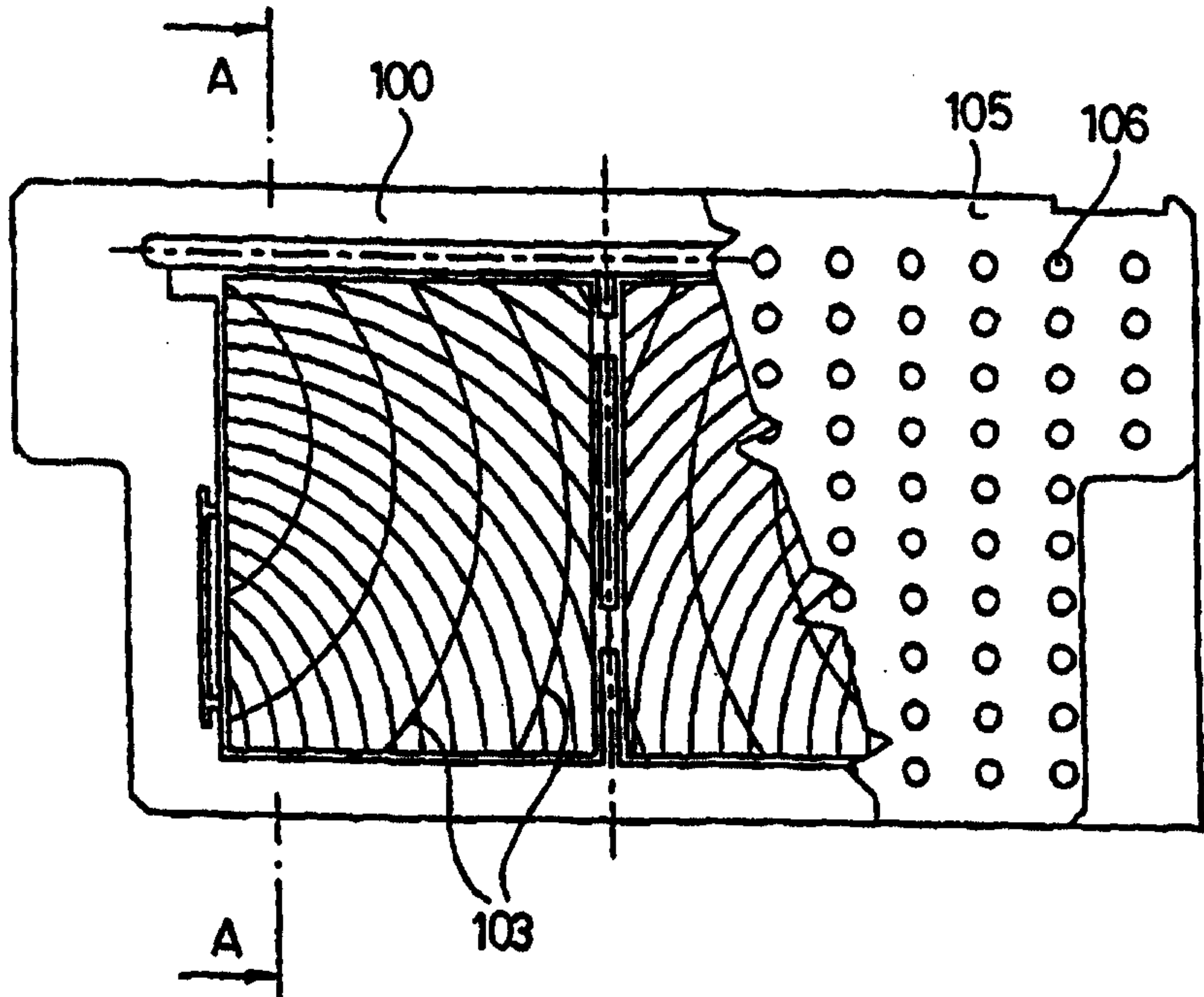
(51) International Patent Classification ⁶ : B22D 25/04, 13/00, H01M 4/84	A1	(11) International Publication Number: WO 00/05016 (43) International Publication Date: 3 February 2000 (03.02.00)
(21) International Application Number: PCT/HU98/00070 (22) International Filing Date: 24 July 1998 (24.07.98) (71)(72) Applicant and Inventor: TÓTH, László [HU/HU]; Bakáts tér 3, H-1092 Budapest (HU). (74) Agent: DANUBIA PATENT AND TRADEMARK ATTORNEYS; Bajcsy-Zsilinszky út 16, H-1051 Budapest (HU).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>

(54) Title: DIE-FORMING MAGAZINE CASSETTE, METHOD FOR MANUFACTURING BATTERY LEAD GRIDS USING SAID MAGAZINE CASSETTES, AND EQUIPMENT ACCOMPLISHING SAID METHOD

(57) Abstract

The invention relates to a die-forming magazine cassette for producing grids of lead-acid batteries. The essence of the invention lies in that said cassette comprising die-forming plates (100) consisting of two aluminium sheets (101, 102) arranged on the two sides of a ferromagnetic plate (105) provided with through openings (106) filled up with the material of said aluminium sheets (101, 102) when pressed onto said ferromagnetic plate (105), the outer surface of said aluminium sheets (101, 102) being provided with grooves (103, 104) corresponding to the web of the lead grid, so that said grooves (103, 104) arranged on the two sides of the die-forming plates (100) are displaced with respect to each other and turned face-to-face constitute a magazine cassette, where the grooves (103, 104) are filled up with the material of the battery grid. The invention relates

further to a process for producing grids of lead-acid batteries made by die-forming magazine, which are heated by induction heating. The invention relates further to an equipment for producing the grid structure of lead batteries by means of a manufacturing equipment operating on the centrifugal principle. The essence of the equipment lies in that the equipment being designed to operate in continuous mode.



WO 00/05016

PCT/HU98/00070

1

Die-forming magazine cassette, method for manufacturing battery lead grids using said magazine cassettes, and equipment accomplishing said method

Technical Field

5 The invention relates to a die-forming magazine cassette by means of which lead grids of storage batteries can be produced. Further the invention relates to a method for manufacturing said lead grids by using die-forming magazine cassettes complying with the invention, as well as an equipment for accomplishing said manufacturing method.

10 Background Art

As is known from latest turnover data of the World, approximately 300 million medium-size (55 Ah) starter batteries are being manufactured per year. The main constructional units of lead-acid batteries are lead grids produced by smelting, and every 1 million batteries require approximately 5000 tons of lead to be processed.
15 Considering this figure it can be seen that yearly 1,5 million tons of lead have to be processed in the course of manufacturing said vehicle batteries.

In the past 75 years lead grids have been produced with practically unchanged technology, the overwhelming majority of lead grids being manufactured by gravitational casting. Of course, during said long period of items different kinds of casting equipment have been developed that have through steadily reached ever
20 improving technical levels, the manufacturing times have basically remained unchanged. The technical parameters of the products prepared by gravitational casting, however, continue to be restricted, due to the inevitable physical laws governing the method used.

25 In the course of processing said huge quantities of lead alloys by the known method, several ten thousands of traditional lead-grid casting equipment have been put in operation, representing just as many sources of environmental pollution increasing the amount of lead released into the atmosphere.

Drawback of the gravitational casting method used at present is that, depending
30 on the technical level of the actual equipment used, about twice, three or four times larger quantities of lead have to be smelted than the overall mass of the end products, i.e. that of the grid material built into the batteries, owing to the allowances resulting from the applied technology.

A further deficiency of gravitational casting lies in its extremely low efficiency and also the high metal losses due to oxidation associated with remelting of casting allowance, and also the harmful impacts on the environments are further increased.

5 The number of batteries manufactured being very high, the labour force absorbed by that branch of industry is also very large. The reduction of labour would be very advantageous with special regard to the risks imposed on public health.

Another known method of shaping up the grid structure of lead batteries is the continuous casting practised since several decades and developed by Wirtz Co. In the
10 course of this technology calcium-lead sheets are stretch-rolled to size and torn, then are expanded, and in a separate technological step are formed to their final shape. This procedure is more complicated than the gravitational casting technology mentioned before, and special technical knowledge is required to perform it properly. The method is costly and the equipment accomplishing the technology can only be
15 operated in a centralised way, since the installation of such a manufacturing equipment would exceed the capabilities of individual battery producing firms.

Grids produced by the latter technology provide though very good quality products, but their properties are disputable, since the plaster retaining capability of grids-expanded this way is less satisfactory and, at the same time, the production cost
20 of grids resulting from the complicated manufacturing technology is extremely high. As a result of these two deficiencies the method has failed to find wider application.

According to the method disclosed in Patent Specification HU 210034, the grid structure of batteries is shaped in cassettes arranged into stacks of thin laminated bundles. The cassettes are accommodated on a carrier table rotating along a central
25 axis. The metal melt required to form the grid is forwarded gravitationally from the crucible arranged in the axis of rotation into the magazine cassette placed radial on the carrier table. The equipment described here can produce lead grids satisfying all demands, but that production technology cannot be operated in continuous mode or only in very uneconomically, because of the following reasons:

30 • axial inflow of melt requires heating of the casting head to a very elevated temperature, because the rate of acceleration of the fed-in melt being slow until it reaches the inlet openings of magazine cassettes, the melt is compelled to perform

a rotating movement until being discharged from the casting head, causing on the one hand considerable heat loss and on the other hand under the effect of turbulence, it unnecessarily absorbs air, impairing thereby the quality of the product,

- 5 • temperature of the die-forming magazine cassettes must be kept above the eutectic point of the metal melt, since otherwise the melt at the inlet solidifies and cannot be cast,

- the constructional arrangement is such - and this is clearly apparent from Figure 3 of the mentioned specification - that the magazine cassettes cannot be treated thermally in the proper way. Heating of elements made of aluminium to the desired temperature can basically be made in two ways:

- 10 a/ Through heat transfer by conduction. This way of heat transfer, however, is very slow, and fails to ensure uniform heat distribution within the stack, since the parts used in the method to facilitate detachment of the mould set as thermal insulation between the sheets. The method itself is extremely time and energy consumptive and requires interposition of some temperature equalizing means.

- 15 b/ Heating may take place by radiating heat in a heating tunnel or furnace, but the heating-up of sheet layers is very difficult even in this way because a considerable proportion of heat rays are reflected by the aluminium surface.

- 20 c/ Heating may be take place in die-forming magazine cassettes overheated in a forced way where the melt is heated as governed by hydraulic laws. Slightest leaks of magazine cassettes will cause the melt to escape under the effect of centrifugal force. A further drawback of overheated magazine cassettes is their very low recooling rate, since the cassettes cannot be handled before sufficient solidification of lead grids enclosed by the die-forming plates has taken place.

25 With the methods described under items a/ to c/ the system cannot substantially be controlled or in a very limited way only, by varying the rotational speed, therefore no optimization can be performed by changing the basic parameters.

In the equipment disclosed in Patent Specification HU 210034 the die-forming magazine cassettes are made of semi-hard aluminium sheets, the aluminium metal being alloyed. Drawback of alloyed aluminium is that

- 30 • formation of the required profiles in etched plates is complicated, and the removal of the workpiece from the die-forming plate is cumbersome, partly, following from the preceding and partly, due to the copper employed as alloying component in the die-

forming plates, the latter have to be heated up beyond 400 °C in the course of the manufacturing process, at this temperature level, the die-forming plates get wetted with the lead alloys, so that form separators are to be employed in order to permit
5 undamaged removal of workpieces.

- heating-up of magazine cassettes and form separators of considerable mass to the required temperature i.e. to the mentioned level above 400°C is both circumstantial and time consuming. With contact heat transfer the heat gradient steadily increases while proceeding toward the inside of the cassettes, since the material of form
10 separators act also as perfect thermal insulators. With indirect heat transfer this phenomenon still persists, worsened by the reflection of a considerable proportion of heat rays from the surface of aluminium sheets as already referred to before.

Summing up the above factors, the heating-up process of aluminium cassettes is extremely time consuming. In order to keep the heated-up cassettes at equal
15 temperature, they have to be heated to a temperature considerably exceeding the level required by the employed technology; and they have to be adjusted to a final temperature level in a properly controlled recooling system. The problem can not be solved by heating up with the die-forming plates taken apart either. This ensures though a faster heat transfer, but the die-forming plates cannot be assembled in their
20 distorted state.

Considering that in the process of centrifugal casting the basic main unit is the die-forming magazine cassette itself, if designing the latter to have a shape better adapted to the given application and with improved parameters, whereby the majority of the aforementioned deficiencies can be eliminated.

25 Disclosure of the Invention

With the present invention the aim of proposing a die-forming magazine cassette has been set that it can be heated more easily than those used so far. At the same time the new magazine cassettes will be properly shape-retaining, that can be applied also in combination with centrifugal casting equipment and, in addition,
30 savings in material consumption can also be attained.

The proposal offered by the invention has been arrived at on the basis of the recognition that the magazine cassettes are made up of two different metals forming a laminated metal plate, where the material of its lateral sides is aluminium, just as in known designs, but the core of the plate consists of a ferromagnetic, magnetizable

material. The importance of using a ferromagnetic material lies with the heating of the magazine cassette, permitting the cassette to be heated by way of induction.

The invention is thus a die-forming magazine cassette for producing grids of
5 lead-acid storage batteries. The essence of the invention lies in that said cassette comprising die-forming plates consisting of two aluminium sheets arranged on the two sides of a ferromagnetic plate provided with through-going openings filled up with the material of said aluminium sheets when pressed onto said ferromagnetic plate. The
10 outer surface of said aluminium sheets being provided with grooves corresponds to the web of the lead grid, so that said grooves arranged on the two sides of the die-forming sheets are displaced with respect to-each other and turned face-to-face constituting a magazine cassette, where the grooves are filled up with the material of the battery grid.

It is advantageous if the grooves are made arched-shape and the material of
15 the ferromagnetic plate being A38.11 grade steel, and the material of the aluminium sheets being Al 90.99.

Further subject of the invention is equipment for producing the grid structure of lead batteries by means of equipment operating on the centrifugal principle. The essence of the apparatus lies in that the equipment being designed to operate in
20 continuous mode and to comprise a rotary -receiving table ith four working positions, in which the magazine cassettes are located in a rotary rim wheel, the table being built up of a receiving station, a casting station, a braking station and a station performing the exchange of magazine cassettes, and the ready cassettes are expediently led through a cooling equipment to the a mechanism emptying the cassettes and
25 discharging the final products, where the outlet end of said mechanism is connected to an equipment assembling the cassettes and preparing them for casting, to which an induction-type heating device is attached, the outlet of which being provided with an element forwarding the preheated magazine cassettes to the rotary-receiving table.

30 Further subject of the invention is a method where the grids of lead-acid batteries are produced by using a magazine cassette, and further, a equipment for accomplishing said method.

Brief Description of the Drawings

In the following, the invention will be described in detail with reference to the attached drawings showing embodiments as examples, where

- 5 Figure 1 shows the front view of the die-forming plate of the die-forming magazine cassette of the invention;
- Figure 2 shows a sectional view taken along line A-A of Figure 1;
- Figure 3 shows the simplified drawing of the equipment using die-forming magazine cassettes built-up of the die-forming plates of the invention.

10 Best Mode for Carrying out the Invention

Thus, in Figure 1 the front view of the laminated die-forming plate 100 complying with the invention is shown, two such plates being placed opposed to each other to constitute a die-forming magazine cassette. In Figure 2 the section along line A-A of Figure 1 is shown, where the arrangement of layers of the die-forming plate 100
15 can be clearly observed.

The laminated die-forming plate 100 incorporates two aluminium sheets 101 and 102, with an expediently selected ferromagnetic plate 105 placed between them, constituting the core of the lamination. The composite, laminated arrangement of plates is built up so that a ferromagnetic plate 105 provided with suitable through-
20 openings 106, e.g. with expediently bored holes, is taken, the material of which can be steel, in the embodiment shown as example an A 3811 grade steel. To the two sides of the 105 ferromagnetic plate provided with openings 106 the two aluminium sheets 101 and 102 are applied by rolling, the material of said two aluminium sheets 101, 102 being in that case a very high grade Al 99.9 pure aluminium. In one step of
25 rolling, the material of the aluminium sheets 101 and 102 simply fill out the openings 106 of the ferromagnetic plate 105, when pressed into them. So that through openings 106 virtually a rivet joint develops between the soft-aluminium aluminium sheets 101 and 102 located on the two sides. On the outer side of aluminium sheets 101 and 102, grooves 103 and 104 are provided corresponding to the web of lead grids. Used
30 in storage batteries, in such a way that on the two sides of the die-forming plates 100, i.e. in the aluminium sheets 101 and 102, said grooves 103 and 104 are displaced with respect to each other, in the shown case along arched lines. Two die-forming plates 100 located opposite to each other commonly constitute a single magazine cassette,

i.e. a single casting pair, where the grooves 103 and 104 are those, which are filled up with the material that will form the battery grid.

The die-forming plates 100 shaped in this way can well be used for manufacturing lead grids in the course of centrifugal casting. In the surface of the die-forming plate 100 the grooves 103 and 104, i.e. the pattern corresponding to the lead grids may be obtained e.g. by rolling. So occurrence of undercuts and machining distortions can be avoided, so that these will not obstruct the lifting-out of grids shaped up between the die-forming plates 100 either.

The aluminium plates 101 and 102 of the die-forming plate 100, as mentioned further above, are made of high-grade aluminium, e.g. Al 99.9, that can be anodized and/or provided with a PTFE coating. Thereby it can be ensured that a liquid flowing at high velocity between the die-forming plates 100 arranged opposite to each other will not cause any wearing. The flowing metal melt between the die-forming plates 100 is provided also with sufficient thermal insulation in the course of flow, further also the wetting of surfaces of the die-forming plates 100 by the streaming melt is eliminated. So that no metallic adherence of the grid developing between the die-forming plates 100 can take place to the surface of said plates.

Since the die-forming plate 100 is designed to have a laminated structure, i.e. there is a ferromagnetic plate 105 interposed between the two outer aluminium sheets 101 and 102, forming inner iron cores, the die-forming plates 100 can optimally be heated up. This uniform heating-up can be made in an induction furnace of expediently selected frequency at an almost any selected energy density. Advantage of the die-forming plates 100 is that the heating-up process can be regulated and kept under at will by means of the ferromagnetic plate 105, independently of the heat-conduction properties of the aluminium sheets 101 and 102 built into the die-forming magazine cassette. Beyond all, the mechanical strength of the aluminium sheets 101 and 102 is increased by properly chosen perforated ferromagnetic plate 105.

Our experience has shown that the die-forming magazine cassettes constructed with the use of the die-forming plates 100 complying with the invention can very well be used in the centrifugal casting equipment.

Casting equipment employing die-forming magazine cassettes of the invention is illustrated in some detail in Figure 3.

In that equipment a separately rotatable four- or six-position rotary rim wheel 1 provided with die-forming plates 100 and axially displaced inlet openings is mounted into a four- or six-position rotating-receiving table 107, having thus four work positions
5 marked by numbers I, II, III, IV. by Figure 2.

The rotating-receiving table 107 is rotated in the case of the example shown by a rubber-wheel friction drive, but the drive may be a single-purpose rim-drive and/or a ratchet-pawl work cylinder. Within given and pre-selected cycle the four-position rotating-receiving table 107 is angularly displaced counter-clockwise by 90° when
10 passing from one phase to the next one. In each working position, the following operations are performed.

In position I, the drive assumes the required rpm. in function of temperature and viscosity of the entering melt, as well as depending on the heating-up of magazine cassettes. In that position acceleration of the rotary rim wheel 1 and checking of
15 casting parameters take place.

In position II, i.e. in casting position, the mouthpiece 109 of the lead dosing station 108 is turned over the centre of rotation of the casting ring of rotary run wheel 1 rotating with the required rpm., so as to ensure axially displaced admission of molten lead into the cassette. Lead is fed by suitable feed pump not shown in the figure.

20 The required amount of molten lead determined in the function of the quantity of the products is poured into the magazine cassette composed of the die-forming plates 100 shown in Figure 1 in 15 to 20 seconds. In the next step the mouthpiece 109 of feed pump automatically returns into its basic position.

In position III the rotary rim wheel 1 entering at the assumed rpm is braked and
25 brought to standstill under forceful cooling.

In position IV the filled rotary rim wheel 1 is removed and replaced by another rotary rim wheel 1 ready to perform a new casting. This new rotary rim wheel 1 entering in braked condition comes linked up with a hydraulically operated rotary lifting equipment 4. The left-hand side arm of this hydraulic rotary lifting equipment 4 lifts the
30 magazine cassettes already prepared to perform casting. I.e. the cassettes are heated up to the required casting temperature, whereas the right-hand side arm of the rotary rim wheel 1 lifts in single operation the already cast rotary rim wheel 1, then angularly displaces the arms counter-clockwise by 90°. In that position the left-hand-side lifts in the rotary rim wheel 1 prepared for casting, while the right-hand side rotating arm

leads the rotary rim wheel 1 containing the already cast magazine cassettes over a roller conveyor 6. Also this series of operations is performed within a period of 1 minute. Thus lifting-off of magazine cassettes by pairs is performed by hydraulic rotary
5 lifting equipment 4 in the following sequence: the two magazine cassettes of rotary rim wheel 1 is in positioned state, the hydraulic rotary lifting equipment 4 is in lifting working position, and the hydraulic rotary lifting equipment 4 is transporting the ready magazine cassettes by means of the roller conveyor 6 towards a cooling tunnel 7. With the embodiment shown as an example the magazine cassettes are led through a
10 counter-flow cooling tunnel 7 at a velocity of 1 m/min. From here the magazine cassettes are carried a sloping roller path to a dismantling position 9, then from here toward an emptying mechanism 10, where the cassettes are emptied, and the final products, i.e. the lead grids of the battery are taken off and dispatched. The next working positions an assembling station 11, where the cassettes are assembled,
15 prepared for casting, and where their clamping is performed. The magazine cassettes prepared for casting are led through a induction-type pre-heater 12, then through a induction-type equalizing heating element 13 and, finally, said cassettes appear at the outlet end of said element.

In the arrangement proposed by the invention the heating of magazine
20 cassettes and their filling up with lead takes place in a closed system and in continuous mode of operation, so that the contamination of environment is totally eliminated. The magazine cassette, designed in compliance with the invention and consisting of die-forming plates 100 shown in Figure 1, is heated up to the required temperature level in a uniform way ensuring throughout identical end temperature by
25 employing a ferromagnetic plate 105 between two aluminium sheets 101 and 102 compressed by the latter, said ferromagnetic plate 105 being heated while passing through the induction furnace 12, and aluminium sheets 101 and 102 are also heated up to a temperature required for casting of the lead.

CLAIMS

1. Die-forming magazine cassette for producing grids of lead-acid batteries, **characterized by** said cassette comprising die-forming plates (100) consisting of two aluminium sheets (101, 102) arranged on the two sides of a ferromagnetic plate (105) provided with through openings (106) filled up with the material of said aluminium sheets (101, 102) when pressed onto said ferromagnetic plate (105), the outer surface of said aluminium sheets (101, 102) being provided with grooves (103, 104) corresponding to the web of the lead grid, so that said grooves (103, 104) arranged on the two sides of the die-forming plates (100) are displaced with respect to-each other and turned face-to-face constitute a magazine cassette, where the grooves (103, 104) are filled up with the material of the battery grid.

2. Die-forming magazine cassette as in Claim 1 **characterized by** the arched shape of grooves (103, 104).

3. Magazine cassette as in Claim 1 **characterized by** the material of the ferromagnetic plate (105) being A 38.11 grade steel.

4. Magazine cassette as in Claim 1 **characterized by** the material of the two outer aluminium sheets (101, 102) being Al 99,9.

5. Process for producing grids of lead-acid batteries made by die-forming magazine of claims 1-4 **characterized by** the die-forming magazine are heated to the temperature needed to casting lead-grid by induction heating in an induction furnace having predetermined frequency.

6. Equipment for producing the grid structure of lead batteries by means of an manufacturing equipment operating on the centrifugal principle, **characterized by** the equipment being designed to operate in continuous mode and to comprise a rotary -receiving table (107) with four working positions, in which the magazine cassettes are located in a rotary rim wheel (4), the table (107) being built up of a receiving station, a casting station, a braking station and a station performing the exchange of magazine cassettes, and the ready cassettes are expediently led through a cooling equipment to the a mechanism (10) emptying the cassettes and discharging the final products, where the outlet end of said mechanism (10) is connected to an equipment assembling the cassettes and preparing them for casting, to which an induction-type heating device is attached, the outlet of which

being provided with an element forwarding the preheated magazine cassettes to the rotary-receiving table (107).

5 7. Equipment of Claim 6 **characterized by** being connected with a ceramic-lined casting head to keep the temperature of fed-in molten metal above eutectic level.

8. Equipment as in Claim 6 or 7, **characterized by** the outer surface of the die-forming plates (100), being provided with a heat-insulating layer, e.g. anodic oxidation layer and/or PTFE coating.

1/2

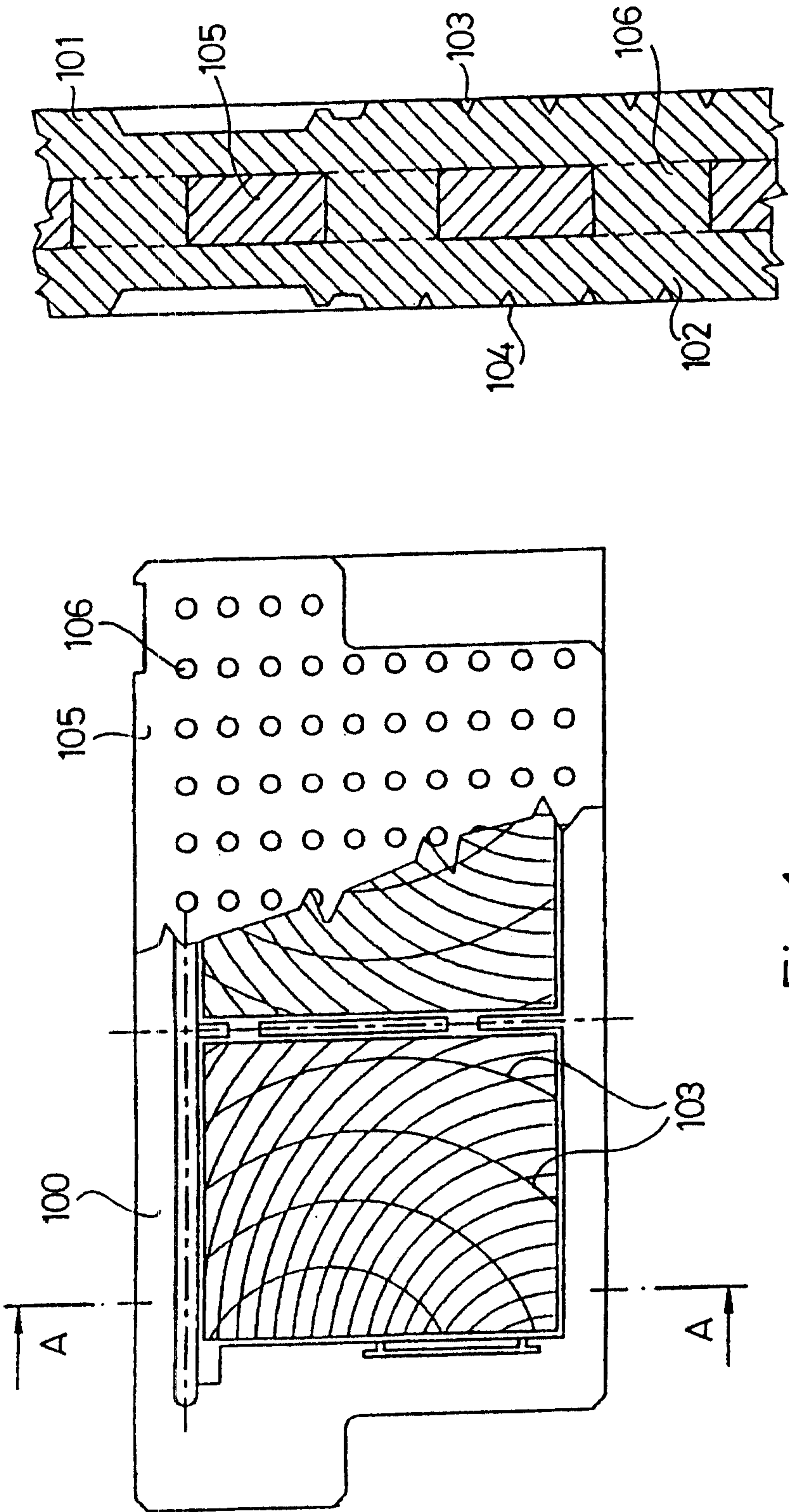


Fig.1

Fig.2

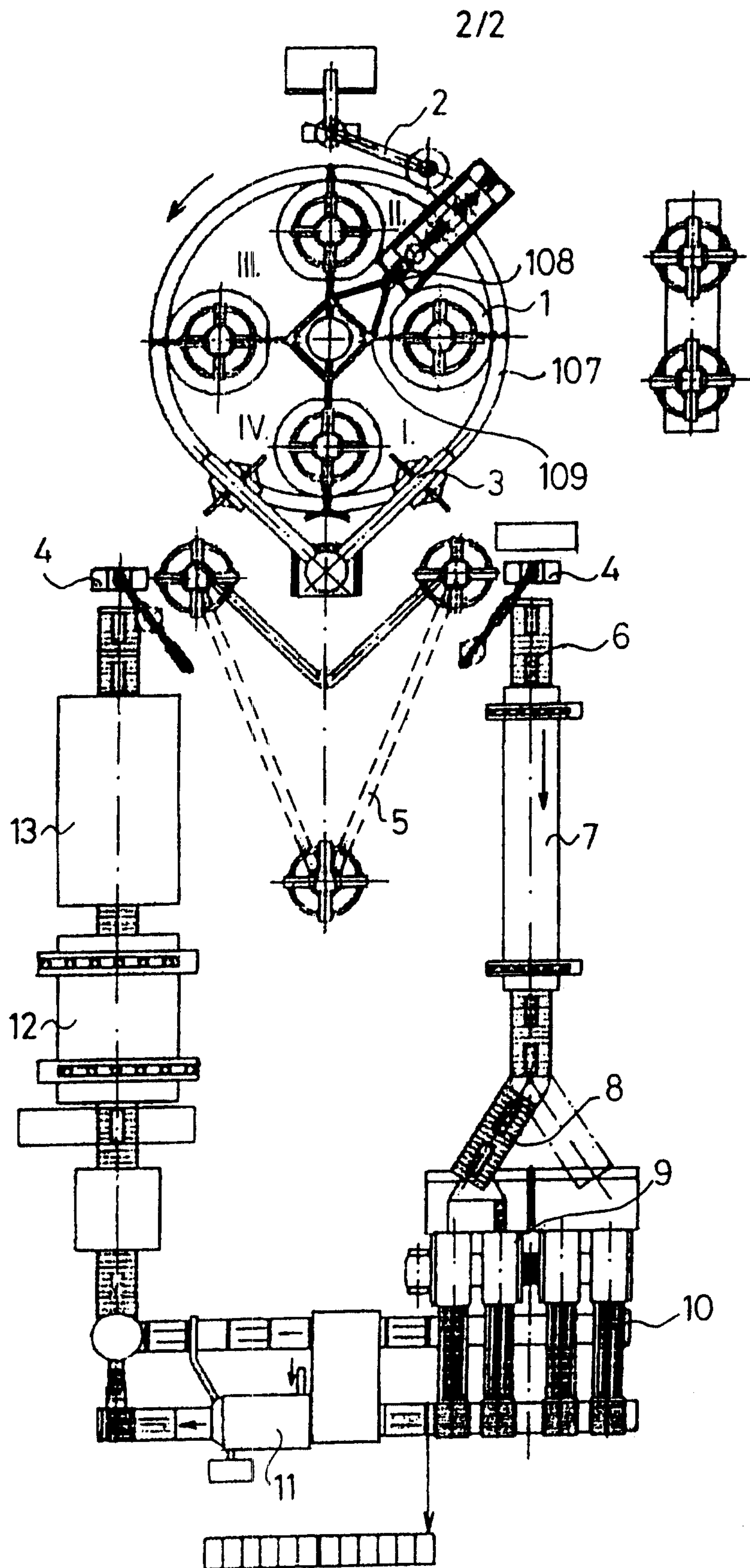


Fig.3

