

[72] Inventor **Jurgen Schulz**
Berlin, Germany
 [21] Appl. No. **707,208**
 [22] Filed **Feb. 21, 1968**
 [45] Patented **Aug. 10, 1971**
 [73] Assignee **Accumulatorenfabrik Sonnenschein**
G.m.b.H.
Budingen am Oberhessen, Germany

2,542,503	2/1951	Galloway.....	228/58 X
1,745,886	2/1930	Bissell et al.	219/9.5
2,569,150	9/1951	Brennan	164/103 X
2,261,412	11/1941	Reeve.....	29/155.55
2,858,586	11/1958	Brennan	164/251 X
2,735,148	2/1956	Shannon et al.	164/105 X

Primary Examiner—J. Spencer Overholser
 Assistant Examiner—V. K. Rising
 Attorney—B. Edward Shlesinger

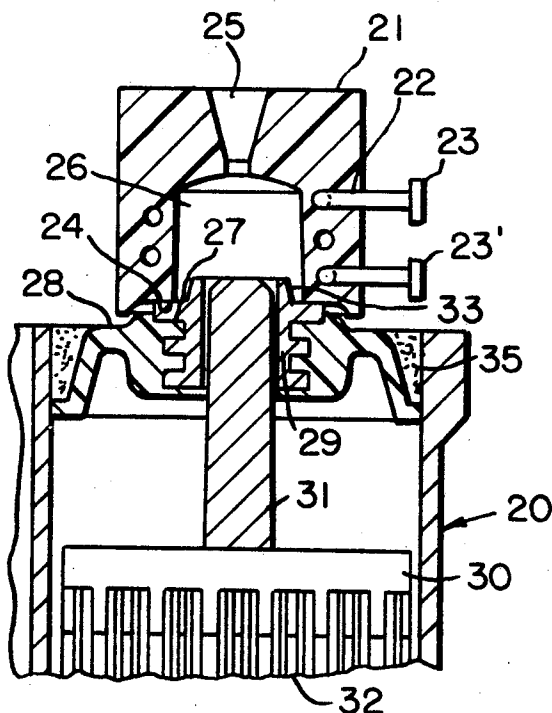
[54] **PROCESS FOR BONDING POLE CONNECTIONS AND THE LIKE TO BATTERY POSTS AND THE LIKE**
3 Claims, 18 Drawing Figs.

[52] U.S. Cl. **164/109,**
164/DIG. 2, 249/134, 164/105, 164/138, 164/51,
164/251, 164/338, 164/333, 164/334, 249/78,
249/90, 249/97, 249/105, 249/94, 249/85
 [51] Int. Cl. **B22d 19/00**
 [50] Field of Search **136/176;**
228/58; 164/332, 103, 251, 51, 105, 333, 334,
DIG. 2, 108, 109; 219/10.43, 10.41, 10.69, 2, 9,
10.69 X; 249/85, 94

[56] **References Cited**
UNITED STATES PATENTS

2,454,053 11/1948 Galloway..... 228/58 X

ABSTRACT: Metal parts of a storage battery as, for instance, terminal posts, plates, etc. are connected together by inserting them into a mold, and either before or during pouring of molten metal (lead) into the mold, generating a high frequency current in the mold to strip any oxide film from the parts. During pouring this current will create a turbulence in the molten metal to aid in film-stripping. The molten metal fuses to the metal parts. After the mold has been filled it can be cooled to harden the cast bonding metal onto the metal parts that are to be connected. A copper tubular conductor mounted in the mold acts both as an electrical current conductor and as a conveyor for the coolant.



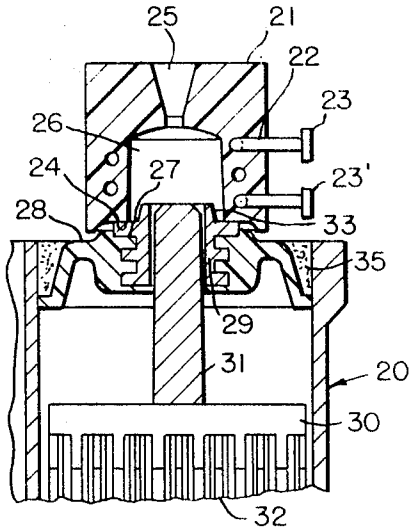


FIG. 1

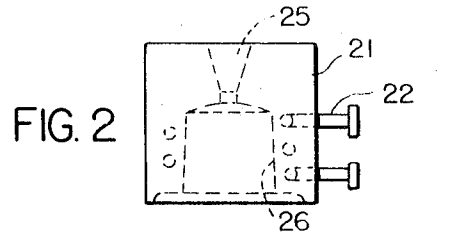


FIG. 2

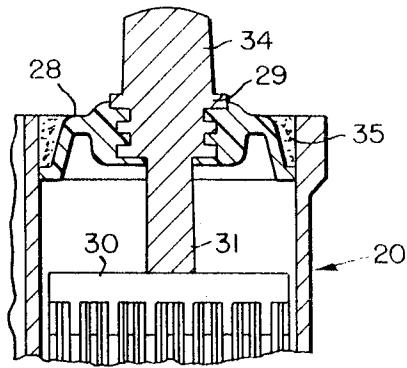


FIG. 3

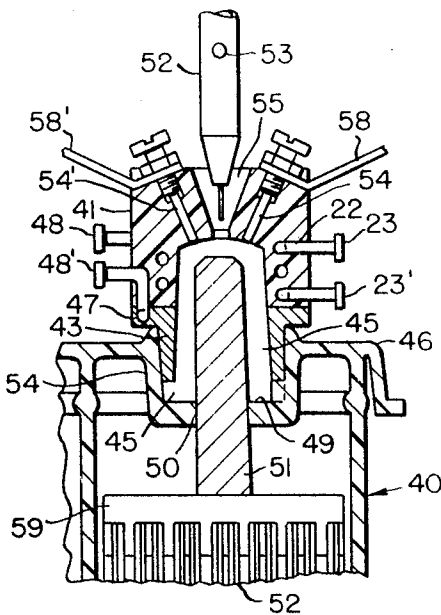


FIG. 4

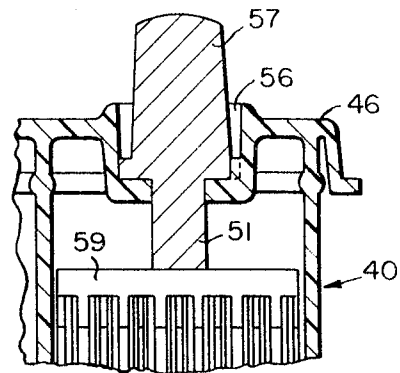


FIG. 5

INVENTOR
JÜRGEN SCHULZ

BY

R. Schlenker
ATTORNEY

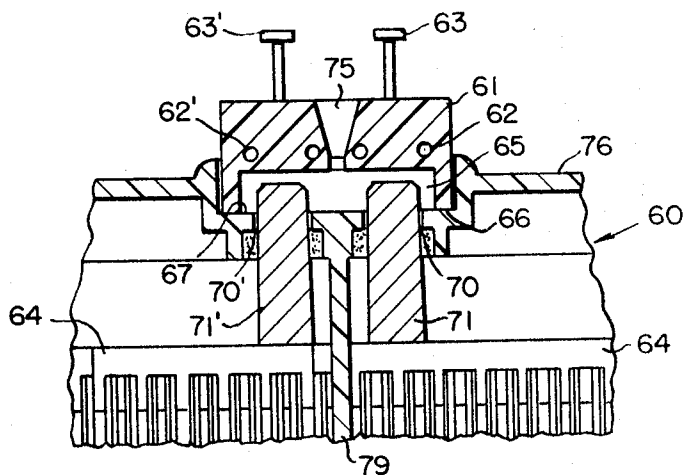


FIG. 6

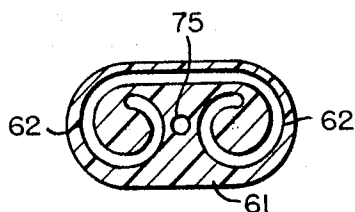


FIG. 7

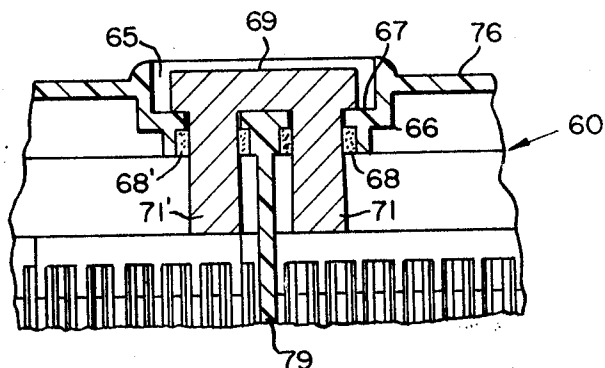


FIG. 8

INVENTOR
JÜRGEN SCHULZ

BY *J. Schulzinger*
ATTORNEY

FIG. 9

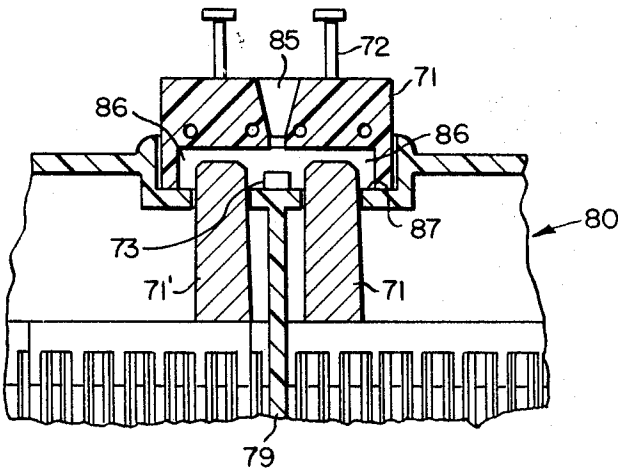


FIG. 10

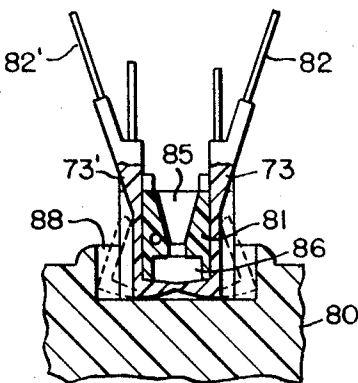
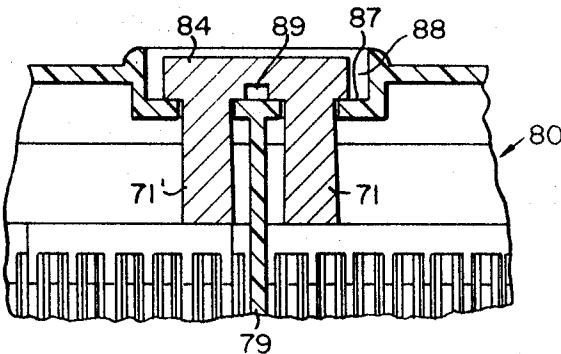


FIG. 11

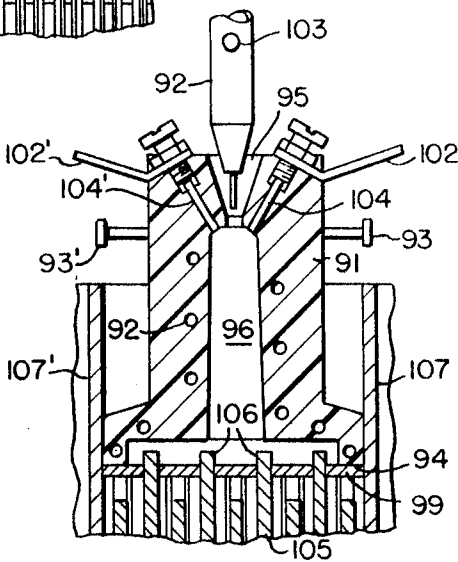


FIG. 12

INVENTOR
JÜRGEN SCHULZ

BY *B. Eschenberger*
ATTORNEY

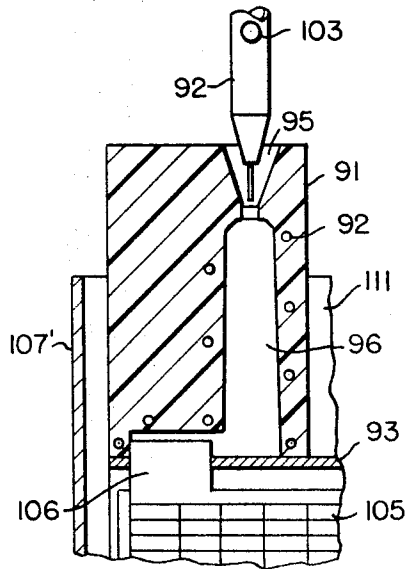


FIG. 13

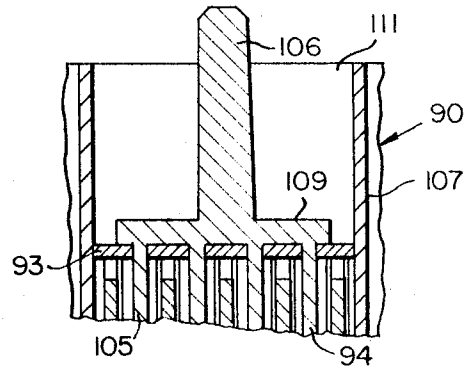


FIG. 14

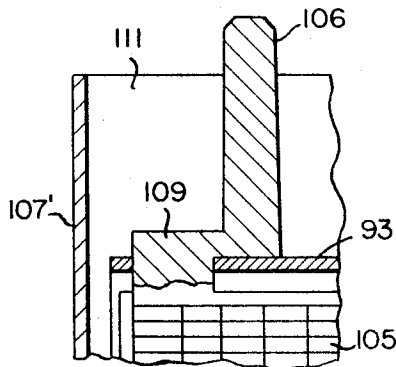


FIG. 15

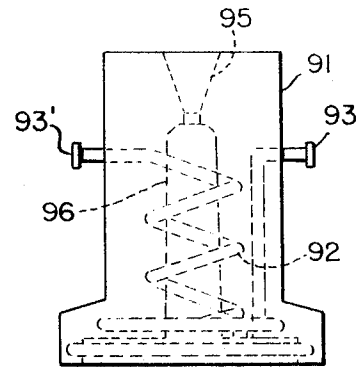


FIG. 17

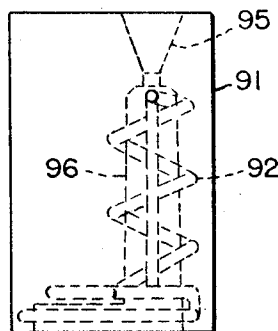


FIG. 16

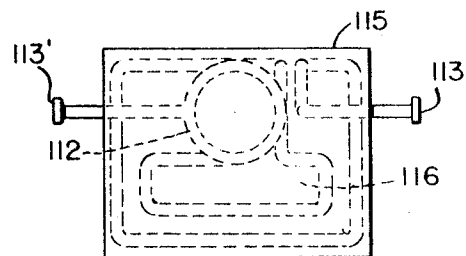


FIG. 18

INVENTOR
JÜRGEN SCHULZ

BY

B. Schaefer

ATTORNEY

PROCESS FOR BONDING POLE CONNECTIONS AND THE LIKE TO BATTERY POSTS AND THE LIKE

This invention relates to a process and to apparatus for bonding metallic parts to metallic construction elements especially of accumulators or batteries by flowing metallic bonding material into a mold, while heating the construction elements inductively and then cooling the mold to chill and stiffen the bonding material.

Processes of this kind, by which, for example, pole bridging cell binders and pole connections can be cast on elements of accumulators, are already known. It has been found, however, in some of these prior processes, that because the metallic parts which are to be connected are covered with a thin oxide film, it is difficult or impossible to flow molten metal over such parts and fuse the metal and the parts to one another. This has been the drawback particularly, for example, with prior attempts to cast metal connections on the hard lead used for accumulators or batteries. To avoid this disadvantage the oxide film must be broken up and at least partially washed away.

This same drawback limits the applicability of another known process where resort is had to a flux containing a strong reducing substance in order to remove the oxide film. This process is not adapted for casting cell binders or connecting poles on lead battery terminals.

It has already been suggested, also, that the oxide film be removed during the casting process with the help of a strong gas flame. This process is adapted however only for the production of pole binders for starter batteries. It is not suited to the casting of pole bridges especially when a great number of accumulator plates are to be cast to a corresponding long bridge.

In a further process of this type, which is described in German Pat. No. 820037, the group of accumulator plates is introduced from above into a mold lying thereunder which is shaped corresponding to the pole bridge to be molded and is heated from below inductively by means of a high frequency current. Thereby the tips of the accumulator plates are melted through contact with the heated mold before the pouring of the molten metal stream into the mold. In this process likewise the oxide film remains on the molten metal and hinders the flow of the metals together and thereby the desired fusing. Also this process is on this account unsuited for the bonding of cell connections and connected poles.

The purpose of the present invention is to obviate the above-named disadvantages and to provide a process and corresponding apparatus able to achieve firm connections between the construction elements for example of accumulators and cast metal parts and with relatively small use of energy. The solution of this problem consists in projecting the construction elements or parts to be bonded with the metal parts into the mold therefrom to generate heat directly by means of induction.

The process of the invention proceeds from the fact that by direct transmission of high frequency energy to an easily meltable metal as for example hard lead, with the help of a high frequency current flowing through a conductor loop the upper surface of the metal can be melted whereby through the vortex field generated a vigorous motion of the flowing particles is evoked. On the basis of this vigorous motion the oxide film present on the upper surface is shattered and washed away so that the molten metal entering by the casting process can be bound readily with the melting upper surfaces. It is especially advantageous that the intensity of the upper surface movement, and thereby the force working on the oxide layer, can be controlled through choice of suitable frequencies, current densities, field strength, and action time. The named quantities can be controlled so that the melting metal fuses on the upper surface layers, while the metal lying beneath these layers remains stable and a fast bond between the on cast metal and the metal on which it is to be cast exists so that their production requires only relatively small amounts of energy.

The inductive heating of the construction elements or parts can take place either before or during the pouring of the molten metal into the mold.

It also has been established that the molten metal should be directly inductively heated during the casting. When the mold is cooled continuously during the molding process this will avoid premature hardening on the cold mold wall and incomplete filling of the mold while the direct inductive heating of the molten metal takes place in the layers which are in immediate contact with the mold wall. Since the molding process takes place relatively quickly this additional heat supply needs only be maintained for a short time. Thereby the mold need not necessarily be made out of heat stable material, for example ceramic, but can be made of organic materials, for example phenol resin impregnated paper, vulcanized rubber, pressed or molded or other suitable artificial materials which possess a sufficiently small breakage factor and do not heat too strongly in a high frequency field. The metal melting can take place in the mold in case of necessity also advantageously under pressure.

A special advantage of the process of the invention is that each casting proceeding, as, for example, the casting of the pole bridges on the current terminals, the casting of the cell connections, and the casting of the connecting poles can be carried out by use of the individual parts used in the erection of the accumulator, such as the housing, the cell covers, etc. Thereby an easier and simpler assembly of the accumulators, for example, on an automatically operating assembly conveyor is possible. Where nonmetallic construction parts are used, these can be provided in advantageous manner with the bridging for the reception of the construction elements to be bonded metallically with the metal parts, as well as possess dense surfaces for molding the molds. Preferably these non-metallic construction parts remain on the accumulator during progress of the molding process.

Further advantages and individual features of the inventive subject matter will be apparent from the following description in connection with the drawings in which exemplary embodiments are schematically illustrated.

In the drawings:

FIG. 1 shows fragmentarily in section a battery cell and a mold in molding position for molding the round post of the cell;

FIG. 2 is an elevational view of the mold showing how the conductor tube is wound in the wall of the mold of FIG. 1;

FIG. 3 is a fragmentary sectional view, similar to FIG. 1 but showing the mold removed and the part cast on the post;

FIG. 4 is a fragmentary sectional view, similar to FIG. 1, but illustrating another embodiment of mold for the round pole in casting position;

FIG. 5 is a fragmentary sectional view, similar to FIG. 3, and showing the round pole cast from the mold of FIG. 4;

FIG. 6 is a fragmentary cross section similar to FIGS. 1 and 4, of adjacent cells with their binding posts and showing a suitable mold in casting position for casting the cell binders;

FIG. 7 is a section taken transversely through the mold of FIG. 6 and showing the conductors for this mold;

FIG. 8 is a fragmentary section, similar to FIG. 6 but with the mold removed and showing the cell binder cast on the adjacent cell posts;

FIG. 9 is a fragmentary section showing another embodiment of a suitable mold in position for casting cell binders on the binding posts of neighboring cells;

FIG. 10 is a fragmentary sectional view, similar to FIG. 8, and showing the cell binder cast with the mold of FIG. 9;

FIG. 11 is a fragmentary section showing a laterally foldable grip for carrying a battery case, and a mold for casting the same;

FIG. 12 is a fragmentary section showing a cell and a suitable mold for molding the pole bridge on the terminal on the cell plate;

FIG. 13 is a fragmentary sectional view in a plane perpendicular to the plane of the section of FIG. 12;

FIGS. 14 and 15 are fragmentary views at right angles to one another, showing the finished plate assemblies of a cell; and

FIGS. 16, 17 and 18 are diagrammatic views illustrating various arrangements and structures of conductors in the wall of a mold.

The mold 21 shown in FIG. 1 for molding the round posts 31 of a battery or accumulator 20 is made from a poured or pressed resin, for example, "Araldit" or "Teflon" (tetrafluoroethylene) in which there is embedded a conductor 22 made of copper tubing and having terminals 23, 23' extending laterally out of the mold. The arrangement of the conductor 22 in the mold is illustrated schematically in FIG. 2; the conductor is so wound in the cylindrical mold that the copper tube lies close to the wall surface of the mold cavity 26.

The mold 21 has at its upper end a fill funnel 25 through which molten metal can be poured into the mold cavity 26. The base of the mold has a vulcanized rubber cover 28 in which a lead bushing or socket 29 is vulcanized. The bushing or socket 29 is provided at its end contiguous to the mold with a collar 33 extending into the mold cavity 26. The end post 31 carried by the bridge 30 of a battery cell plate 32 is adapted to project into the socket 29 during the molding thereon of a head by the process of the present invention.

In use, the bottom surface 24 of mold 21 is placed tightly against the surface 27 on the vulcanized rubber cover 28. When the casting operation is completed, the collar 33 of the lead socket and the end post 31 are to be connected with the ground pole 34 shown in FIG. 3 as a finished casting. Therefore, the upper surface of the collar 33, which extends into the mold, and the face of the post 31 are first heated in an inductive manner by high frequency current through the conductor 22 so strongly that the upper surface of the collar 33, the lead socket 29, and the upper face of the post 31 are fused together. Through the electrical field of the conductor 22, moreover, there is produced in the molten metal a strong motion of the parts of the fluid which removes and sweeps away the previous oxide film on the post. Thereupon the mold cavity 26 is filled completely through the filling opening 25 with molten metal as a result of which the round post 31 is fused to the construction elements 29 and 34. The current to conductor 22 may then be turned off, and instead coolant may be supplied to it to chill the mold and its contents. Since no oxide film any longer exists on the upper surfaces of the construction elements there is attained a very tight bond between the construction elements and the ground pole 34.

The mold 41 illustrated in FIG. 4 is designed especially for the molding of round posts 51 for accumulators 40 having plastic housings. As with the embodiment illustrated in FIG. 1, the conductor 22 is embedded in a mold body of heat-stable cast or pressed plastic, and consists of a thin-walled copper tube having terminals 23, 23' for conducting the high frequency current and coolant. The arrangement and construction of the conductor 22 corresponds to the embodiment in FIG. 2.

The mold 41 fits on a metal ring 43 concentric to the post 51 which projects into a recess 45 of the plastic battery cover 46. The metal ring 43, made preferably of aluminum, is provided with an independent cooling system 47 whose supply and exhaust connections 48, 48' extend out of the mold body 41. The mold cavity of mold 41 is closed at its bottom when the mold is in casting position, by the bottom 49 of the recess 45 and by the post 51 extending into the mold cavity through the opening 50 in the bottom 49. The post 51 is carried by a bridge of a set of battery plates 59.

In the upper portion of the mold 41 there is a fill opening 55 into which the lead conduit 52 may be projected to conduct the molten metal into the mold. A valve 53 of suitable construction may be provided in conduit 52 to control the flow of molten metal therethrough. The head of the mold is provided with two contact pins 54, 54' which are connected by conductors 58, 58' to a nonillustrated electrical governing apparatus which, upon the bridging of the contact pins by the molten metal rising in the mold to a predetermined level, will inter-

rupt supply of the molten metal and of the high frequency current.

After the removal of the mold 41 and its concentric metal positioning ring 43 there remains the cast round post 57 shown in FIG. 5 which is now integral with the post 51 and sets in the recess 45 in the plastic cover 46. The small space 56 provided about the post serves for the reception of a sealing material.

The mold 61 illustrated in section in FIG. 6 is adapted for molding cell connections on the binding posts of adjacent cells 64 of an accumulator or battery 60. 79 is the partition wall between cells. The mold shown consists again of a heat-fast plastic in which a conductor 62 is embedded. The connection terminals 63, 63' serve for carrying the high frequency energy and the coolant to the hollow induction conductors so that the mold can be held at a desired temperature, for example, ambient temperature. The position of the conductor 62 within the mold body 61 is shown in FIG. 7 where the mold is shown in horizontal section.

The mold 61 sits with its lower contact surface 66 on the bottom 67 of the tub-shaped recess 65 in the plastic cell cover 66. When the mold is in position, the mold cavity is closed by the bottom 67 of the recess 65 and the upper surfaces of two binding posts 71, 71', which extend through openings 70, 70' in the bottom 67 into the mold cavity. The molten metal is conveyed into the mold cavity through fill opening 75. The flow is controlled as was described in connection with the modification illustrated in FIG. 4 by a nonillustrated control valve.

FIG. 8 shows the apparatus of FIG. 6 after removal of the mold 61. The connector 69 molded onto the binding posts 71, 71' lies flush and tight on the bottom 67 of the trough-formed recess 65. The binding posts 71, 71' in this embodiment are tightened against the cell interior by rubber gaskets 68, 68'. The tub-shaped recess 65 can be filled above the binders and in the space around the connector 69 with a soldering material.

An embodiment like that shown in FIG. 6 is illustrated in FIGS. 9 to 11. 80 designates the accumulator or battery; 79 the cell divider; 71, 71' denote the cell posts to be connected; and 72 is the tubular conductor which conducts electricity or coolant to the mold. Here there are laterally extendable grips 73, 73', provided which project into the mold cavity 96 and serve to leave a space, which is shown in FIG. 10 at 89, between the binder 84, which is to be cast, and the bottom 87 of the oblong space 88. In this space there is filled, after production of binder 84, a solder which insulates the pole passage. With this arrangement, the installation of sealing rings below the cell cover as disclosed at 68, 68' in FIG. 8 is superfluous.

The arrangement of the laterally foldable grips 73, 73', indicated in FIG. 9, is more accurately shown in FIG. 11. There the grips are mounted to be laterally swingable and engage in pincerlike fashion below the mold cavity 76 when the molten metal is filled through the opening 85 into the mold 81. They may be swung, after cooling of the solder, with the help of the handles 82, 82', on the upper ends of the projections 73, 73', to the dash line positions shown, and, together with the mold 81 may be separated from the trough-shaped recess 88.

In FIGS. 12 and 13 there is illustrated a new type mold especially for molding bridges onto the current conducting lugs of like plates of a battery cell. The mold 91 shown consists again of a heat-fast pourable or pressed plastic, in which is embedded the high frequency induction conductor 92. It is provided at 93, 93' with terminals for the conduct of high frequency energy and of the cooling medium. The mold 91 sits with its contact surface 94 on a comblike strip 99 of acid-resisting, elastic material which is carried by the separators 105 of the battery plate set and simultaneously serves as a protection plate for the separators and for the starter covering plate. The comblike strip 99 is provided with openings through which the lugs 106 of battery plates 105 extend into the mold cavity 96. In the upper portion of the mold there is a filling

opening 95 into which the duct 92 is extended. A valve 103 on this duct controls flow of the molten metal into the mold cavity. At the head of the mold 91 are the two further contact pins 104, 104' which are connected by electrical conductors 102, 102' to a not-illustrated control apparatus which, upon bridging of the contact pins by the molten metal in the mold cavity, interrupts the supply of molten metal to the mold and throttles the high frequency energy or interrupts it entirely. The walls 107, 107' of a cell of an accumulator are shown before the soldering process for the plate packet.

In FIGS. 14 and 15 the set of plates 105 together with the molded post bridge 109 and the molded end pole 106 are illustrated in section as they appear after the separation of the mold 91 from the recess 111 of the cell of the battery 90.

FIGS. 16 to 18 clearly illustrate in diagrammatic manner the arrangement of the high frequency induction conductor 92 within the mold 91 of FIGS. 12 and 13. Here the conductor is wound spirally about the mold cavity 96 and tightly against the wall of the mold cavity.

The invention also encompasses the molding, for example, of square-formed pole bridges, as especially can be understood from FIG. 18. Tubular copper conductors 112 may be provided for this purpose to supply the high frequency energy or the cooling means required for maintaining a desired mold temperature. 115 is the mold; 116 is the mold cavity; and 113, 113' are the conductor terminals which may be connected selectively to a source of electrical energy or to a coolant supply.

While the invention has been described in connection with several different embodiments thereof, it will be understood that it is capable of further modification as will be apparent to those skilled in this art.

Having thus described my invention, what I claim is:

1. A process for casting a metal part onto a metallic element, which comprises projecting a portion of the element into the mold cavity of a mold, subjecting the portion of the element which projects into the mold cavity to the action of a high frequency electromagnetic field so as to melt the surface of said portion by direct induction heating, flowing molten

metal into said mold around the portion of said element, which projects into said cavity, to fill the cavity and cooling the mold to solidify the molten metal in the cavity on said element, the high frequency electromagnetic field being applied after pouring of the molten metal into the mold has been started to create a turbulence in the molten metal in the mold cavity to aid in washing away an oxide film present on said portion of said element.

2. A process for casting a metal part onto a metallic element, which comprises projecting a portion of the element into the mold cavity of a mold, subjecting the portion of the element which projects into the mold cavity to the action of a high frequency electromagnetic field so as to melt the surface of said portion by direct induction heating, flowing molten metal into said mold around the portion of said element, which projects into said cavity, to fill the cavity and cooling the mold to solidify the molten metal in the cavity on said element, said element being a post of a storage battery cell, a cover being placed over said cell having a bored metal socket molded therein, said mold being disposed, prior to the casting operation, in abutting relation to said cover and with its mold cavity extending over said socket and with said post projecting through the bore of said socket into said mold cavity.

3. A process for casting a metal part onto a metallic element, which comprises projecting a portion of the element into the mold cavity of a mold, subjecting the portion of the element which projects into the mold cavity to the action of a high frequency electromagnetic field so as to melt the surface of said portion by direct induction heating, flowing molten metal into said mold around the portion of said element, which projects into said cavity, to fill the cavity and cooling the mold to solidify the molten metal in the cavity on said element, said element being a post of a storage battery cell, and this post and the post of an adjacent cell of the battery being projected into the mold cavity which is shaped to form a bridge connecting the two posts, and both posts being projected into the mold cavity before pouring molten metal into the mold.

45

50

55

60

65

70

75