Nov. 2, 1965 P. J. WOODING 3,215,974

ELECTRODE STUB CLAMP

Filed Jan. 22, 1963 2 Sheets-Sheet 1

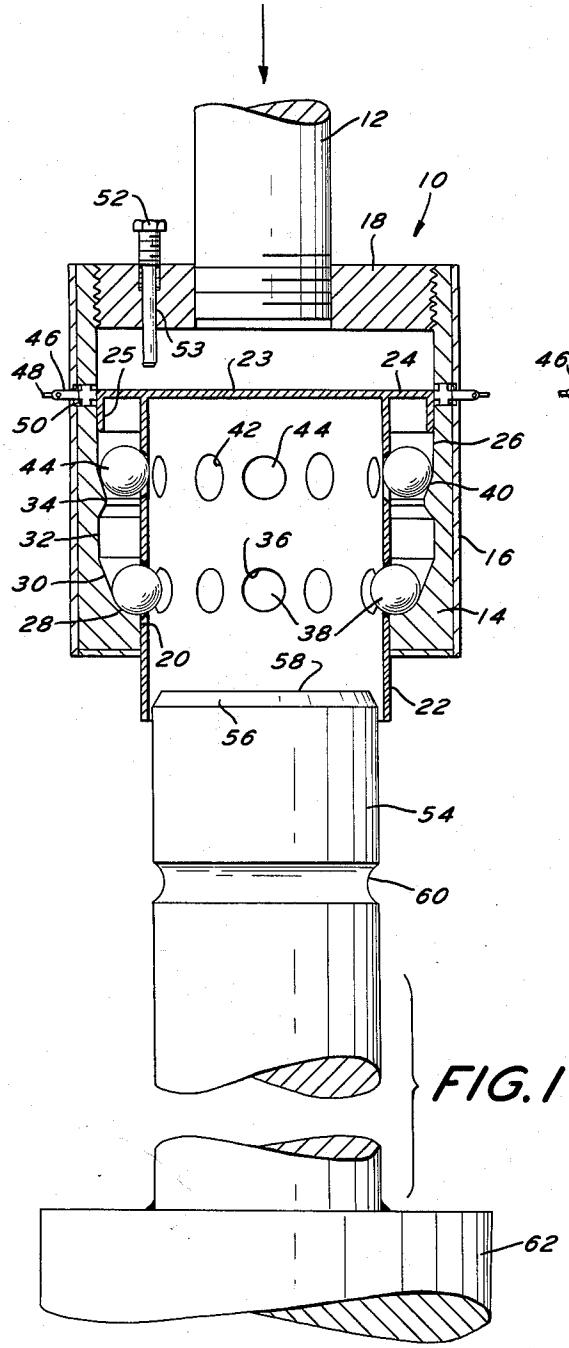


FIG. 1

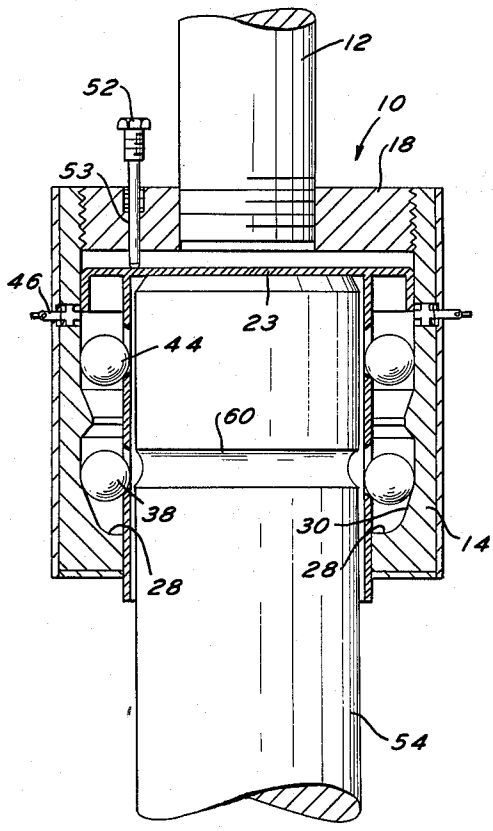


FIG. 2

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ELECTRODE STUB CLAMP

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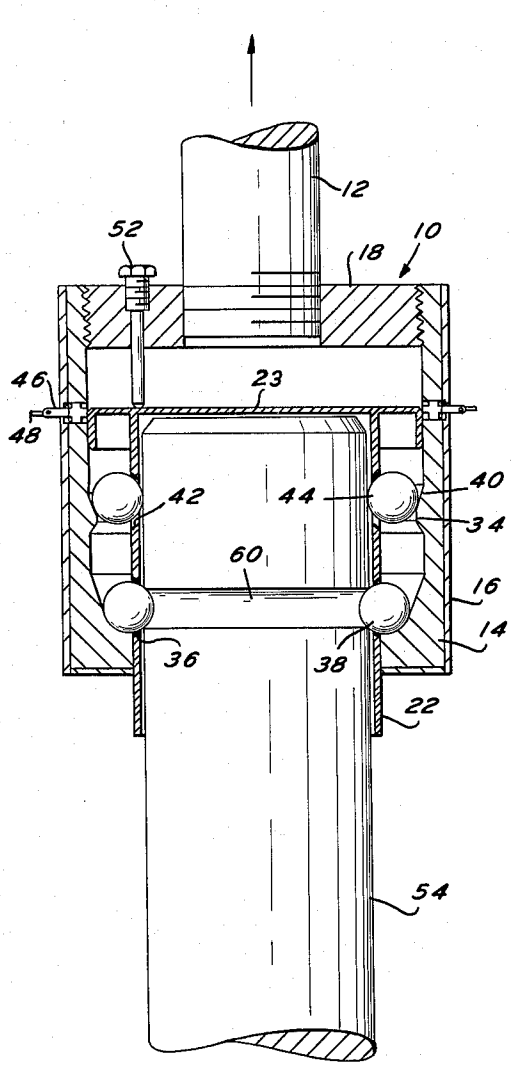


FIG. 3

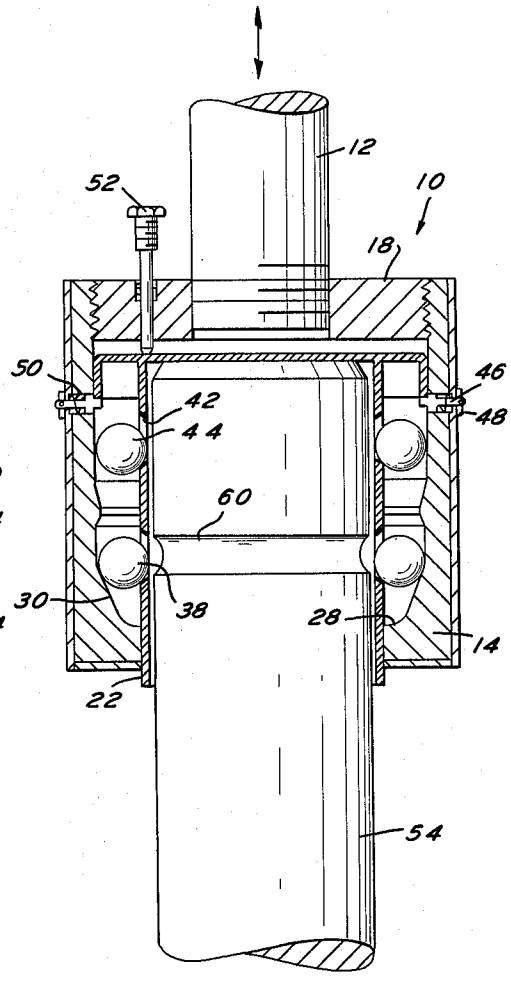


FIG. 4

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ELECTRODE STUB CLAMP

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This invention relates to releasable clamps, and more particularly, to a releasable electrode stub clamp for consumable electrodes and the like.

In order to develop the ultimate in physical properties, many alloys are consumably remelted after initial production of chemically sound electrodes by conventional air melting or vacuum induction melting techniques. These electrodes may be cast in electrode molds specially designed for the purpose or forged from cast ingots. Consumable remelting is effected by suspending the electrode in a water-cooled mold and melting it progressively by arc or resistance heating. The melting may be carried out in a vacuum, under an inert gas blanket, or in air with a layer of slag to protect the arc or create a resistance heating path.

Regardless of the means of producing the electrode, it must be supported in an upright position and so aligned that there can be no danger of arcing or other contact between the electrode and the inner surface of the water-cooled mold. The normal means of suspension is a water-cooled ram designed to carry currents of the order of many thousand amperes. For example, a furnace designed to produce a maximum electrode weighing twelve tons would have a ram designed to carry approximately 35,000 amperes.

The present invention relates to a means for releasably connecting the electrode to the water-cooled, current-carrying ram. Many different types of clamping devices have been proposed heretofore. Most of the devices proposed heretofore require lengthy periods of adjustment and/or are expensive to maintain.

The requirements of a clamp or connecting means for this purpose are that it should be effective over a wide range of electrode weights; it should be capable of carrying the furnace maximum rated current; it should connect and disconnect virtually instantaneously without the use of heavy wrenches or other tools; it should lock the electrode on the upright axis of the furnace and prevent swinging of the electrode due to electro-magnetic or other forces at the lower end of the electrode; the locking and disconnecting actions should be positive; it should include provision for welding sections of electrodes together in the furnace or related equipment by applying pressure in a downward direction without danger of electrode misalignment; it should have a relatively low initial cost; and it should have very low or minimum maintenance cost due to replacement of wearing parts.

None of the devices proposed heretofore have been entirely satisfactory. One attempt to solve the problems associated with such a clamp is illustrated in Patent No. 3,046,319. In this patent, the weight of the electrode is supported by friction developed between the inner surfaces of a ring of tilting cams and the outer surface of the electrode stub. Such cams do not prevent the electrode from swinging under the action of the electro-magnetic forces,

are subject to occasional failure due to electrodes slipping out since only friction is used to support the electrode, cannot effectively push a stub or electrode section downwards to complete a weld, have a relatively high first cost, and have a very high maintenance cost due to the fact that the wearing parts are contour-turned cams of special copper alloy.

The clamps of the present invention comply with all of the above-enumerated requirements of those engaged in the art of consumable electrode melting. The stubs which cooperate with the clamp of the present invention may be reused indefinitely and may be welded directly to the electrodes while supported by the clamp of the present invention. Hence, machining and replacements cost of stubs are very small relative to pounds of metal produced per stub.

It is an object of the present invention to provide a novel clamp adapted to be releasably engageable with an electrode stub.

It is another object of the present invention to provide an electrode stub clamp which is simple, capable of being connected or disconnected with a minimum of effort, and which prevents swinging of an electrode due to an electro-magnetic force at the lower end of the electrode.

It is another object of the present invention to provide a novel electrode stub clamp adapted to support an electrode in an upright position.

It is another object of the present invention to provide an electrode stub clamp which has a relatively low initial cost and little or no maintenance cost due to replacement of wearing parts.

It is another object of the present invention to provide an electrode stub clamp having positive locking and disconnecting actions responsive to reciprocation of the ram.

Other objects will appear hereinafter.

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIGURE 1 is a sectional view of the clamp of the present invention prior to engagement with the stub of an electrode.

FIGURE 2 is a sectional view of the clamp of the present invention illustrating a relationship between the parts of the clamp and the stub during the connecting action.

FIGURE 3 is a sectional view of the clamp of the present invention showing the relationship between the elements of the clamp and the stub when the stub is locked to the clamp.

FIGURE 4 is a sectional view of the clamp of the present invention illustrating the relationship of the elements during the action of disengaging the clamp and the stub.

Referring to the drawing in detail, wherein like numerals indicate like elements, there is shown an electrode stub clamp designated generally as **10**.

The clamp **10** is suspended at the lowermost end of a water-cooled, current-carrying ram **12**. The clamp **10** includes an annular housing **14** made from a copper alloy or other good current carrying material. The housing **14** is generally cylindrical and may be provided with a steel outer shell **16**. An annular ring **18**, made from the same material as the housing **14**, may be threadedly connected

to the uppermost end of the housing **14** and the lowermost end of the ram **12**.

The end of the housing **14** remote from the ring **18** is provided with an axial aperture **20**. A cage **22** extends through the aperture **20** into the housing **14** and is reciprocally guided by the aperture **20**. The cage **22** may be made from a material such as mild steel and is in the nature of a cylindrical sleeve. Cage **22** is provided with an end wall **23** at its uppermost end. End wall **23** is provided with a radially outwardly directed extension **24** which terminates in an axially extending lip **25**. Lip **25** is guided for reciprocation by the axially extending portion **26** of the inner surface of the housing **14**. Hereinafter, surface **26** may be referred to as an axially extending wall. Hence, it will be noted that the cage **22** is guided for reciprocation by aperture **20** and surface **26** which are at two axially spaced points along the axis of the housing **14**.

The inner surface of the housing **14** at the lowermost end thereof is irregular. Commencing at aperture **20**, the inner surface of the housing **14** includes an arcuate surface **28** merging into a tapered surface **30** which converges toward the aperture **20**. The tapered surface **30** merges into an axially extending surface **32** which, in turn, merges into a radially inwardly directed ledge **34**.

The cage **22** is provided with a first row of holes **36**. A plurality of spherical balls **38** are supported in the space between the outer surface of the cage **22** and the inner surface of the housing **14** below the rib **34**. The balls **38** are preferably made from a good electrically conductive material which may be identical with the material of the housing **14**.

A tapered surface **40**, substantially parallel to tapered surface **30**, extends between the surface **26** and the ledge **34**. The cage **22** is provided with a second row of holes **42**. A plurality of balls **44** are disposed between the outer peripheral surface of the cage **22** and the inner peripheral surface of the housing **14** above the ledge **34**. The balls **38** and **44** are of the same size and are inserted to project through one of the holes **36** and **42**, respectively, as will be made clear hereinafter.

A plurality of aligned apertures are provided in the housing **14** and shell **16** for receiving a latch member **46**. Latch member **46** may be provided with a pivotable tab **48**. Each latch member **46** is provided with a radially inwardly directed bias from a spring **50**. In FIGURES 1–3, the pivotable tab **48** engages the outer peripheral surface of the shell **16**, thereby overcoming the bias of spring **50** and retaining the latch member **46** in an inoperative disposition.

Three pins **52** are provided, each extending through a hole **53** in the ring **18**. Each pin **52** is provided with a partially threaded portion adapted to be threadedly engaged with mating threads in hole **53** for a purpose to be described hereinafter.

The clamp **10** is adapted to be releasably engaged with a stub **54**. Stub **54** is provided with an end face **58** and a beveled surface **56** extending between the surface **58** and the outer peripheral surface of the stub. The stub **54** is provided with a peripheral groove **60**. The distance between the groove **60** and end face **58** is slightly less than the distance between end wall **23** and the row of holes **36** as shown more clearly in FIGURE 2.

The end of stub **54** remote from face **58** is adapted to be welded to one end of an electrode **62** and substantially concentric therewith. For purposes of illustration, one embodiment of the present invention utilizes a stub **54** having a diameter of approximately seven inches and a length of approximately twelve inches. The stub **54** is adapted to be utilized with electrodes **62** having a diameter of up to twenty-six inches. The stub **54** is preferably made from steel. The clamp of the present invention is utilized as follows:

A stub **54**, possibly already welded to one end of the electrode **62** is position below the clamp **10** and aligned

approximately on the same axis as the ram **12**. The ram **12** and clamp **10** are then lowered over the stub **54**. The taper of surface **56** guides the stub into the cage **22**. When the surface **56** on stub **54** contacts the ring of balls **38**, further downward movement of the cage **22** is prevented until the housing **14** has moved down a sufficient distance to permit the balls **38** to roll up the tapered surface **30**.

The ram **12** and housing **14** continue to descend until cage lip **25** just clears the latch members **46**. This relationship may be readily ascertained by means of a scribe line on the cage or by the position of the lower edge of the cage with respect to the lower edge of housing **14**. Accordingly, the operating mechanism for the ram **12** is reversed, thereby causing the ram **12** to move upwardly. At this point, it should be noted that the groove **60** is above the ring of balls **38**, see FIGURE 2. As the ram **12** and housing **14** move upwardly, the balls **38** roll down the tapered surface **30** onto the arcuate surface **28** wherein they project through the holes **36** into the groove **60**. Further differential movement between the clamp **10** and the stub **54** is prevented. Hence, the stub **54** and electrode **62** will now move upwardly with the clamp **10**.

At this point, the ring of balls **44** will have moved down the tapered surface **40** and project through the holes **42** into engagement with that portion of the outer peripheral surface of the stub **54** above the groove **60**. Such engagement prevents the electrode **62** from swinging due to electrode-magnetic or other forces on the lower end of the electrode during the melting operation. Then the pins **52** may be threadedly engaged in the holes **53**. The relationship of the elements at this point is illustrated in FIGURE 3.

At the end of the melting operation, or any time when it is desired to release the electrode stub **54** from the clamp **10**, the ram **12** is lowered to permit the weight of the electrode **62** and stub **54** to be supported from below. The pins **52**, if used, will be unthreaded. Thereafter, the ram **12** will be lowered downwardly until the lip **25** of the cage **22** is above the latch members **46**. In doing so, the balls **38** and **44** will be caused to roll up their respective tapered surfaces and thereby be no longer in contact with the stub **54**. At this point, latch members **46** will be moved radially inwardly. In the illustrated embodiment this will be accomplished by flipping tabs **48** to the disposition illustrated in FIGURE 4, thereby enabling the springs **50** to move the latch members radially inwardly.

The ram **12** is now raised in an upward direction. As the ram **12** moves upwardly, the cage **22** will descend slightly until it abuts the latch members **46** and will be retained in that position as illustrated in FIGURE 4. Since the balls **38** and **44** will not project through their holes, continued upward movement of the ram **12** and clamp **10** is possible thereby leaving the electrode **62** and/or stub **54** on its supporting surface.

The advantages of the present invention include positive locking and unlocking features which are virtually automatic. The clamp exerts high radial pressure on the electrode stub **54** in proportion to the mass of the electrode **62** thereby permitting transfer of the melting currents involved which are also roughly proportional to the mass of the electrode. The clamp **10** components are simple and relatively loosely fitting and, therefore, by proper selection of materials, the clamp **10** is capable of withstanding temperatures of the order of several hundred degrees Farenheit during the melting operation.

The threaded pins **52** prevent automatic disconnection of the clamp **10** with respect to the stub **54** except when desired. Also, the pins **52** permit downward pressure to be exerted on the electrode stub **54** without misalignment for welding purposes. The wearing parts of the clamp **10** are the balls **38** and **44**. Balls **38** are preferably a tough current-carrying copper alloy, while the balls **44** may be mass-produced bronze balls.

It will be appreciated that the stub **54** may be interconnected with the clamp **10** as described above and then welded to one end of the electrode **62** by passing current through the ram **12**, clamp **10** and stub **54**, thereby striking an arc between the lowermost end of the stub and the juxtaposed end face of the electrode. When an electrode has been consumed, only a small plate-like portion will remain integral with the stub **54**. The plate-like portion will then be separated from the stub **54** by a cutting torch or the like. Thereafter, the stub **54** will be welded to a new electrode and reused in the same manner described above.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

It is claimed:

1. An electrode stub clamp comprising a housing made from a good electrically conductive material, a cage within and reciprocally guided by said housing, said cage having a portion spaced radially inwardly from the inner peripheral surface of said housing, said portion of said cage having a plurality of holes therethrough, a plurality of members between said portion of said cage and said surface of said housing for mechanically and electrically coupling a stub to said housing, each of said members being of good electrically conductive material and electrically coupled to said housing, each of said members being adapted to partially project through one of said holes, said cage and housing being open at one end for receiving an electrode stub, means adjacent the other end of said cage for abuttingly contacting an end of an electrode stub to effect movement of said cage within said housing, and means for selectively causing said members to partially project through their respective holes to effect said mechanical and electrical coupling.

2. A clamp in accordance with claim **1** including a selectively operable latch means on said housing for latching said cage in one position thereof to prevent reciprocation of the cage with respect to said housing.

3. A clamp in accordance with claim **1** wherein said members are balls having a diameter at least twice as great as the thickness of said portion of said cage.

4. A clamp in accordance with claim **1** wherein said cage is cup-shaped, said means adjacent said other end of said cage being a bottom wall of said cage, and said one end of said cage projecting through said one end of said housing in at least one position of said cage.

5. A clamp in accordance with claim **1** wherein said members are balls, and said means for selectively causing said balls to partially project through said holes including a cam surface on the inner peripheral surface of said housing, and an axially directed surface on said housing adjacent said cam surface, said axially directed surface being in guiding contact with said cage.

6. In a consumable electrode apparatus the improvement comprising an upright current-carrying ram, a housing of a good electrically conductive material having an end wall connected to one end of said ram, a cage within and reciprocally guided by said housing, said cage being open at one end and having a radially inwardly directed wall portion adjacent its other end for abutting contact with a stub, said housing having an aperture at its end opposite to said end wall, said one end of said cage being adapted to project through said aperture, said cage having a plurality of holes therethrough, members of a good electrically conductive material supported by said housing between the inner peripheral surface of said housing and the outer peripheral surface of said cage, said members being adapted to project through said holes to mechanically and electrically couple said housing to a stub, and means on said housing for selectively causing said members to project through said holes as a function of the position of said cage within said housing.

7. Apparatus in accordance with claim **6** including axially spaced guide surfaces on said housing in guiding contact with axially spaced surfaces on said cage.

8. Apparatus in accordance with claim **6** wherein said members are balls, the diameter of said balls being substantially greater than the thickness of the portion of said cage containing said holes, and said last-mentioned means including a cam surface on the inner peripheral surface of said housing adjacent said aperture.

9. Apparatus in accordance with claim **6** including a solid stub of electrically conductive material, said stub projecting axially into said cage and contacting said wall portion thereon, said stub having a peripheral groove, the distance between said groove and the portion of said stub contacting said wall portion being substantially equal to the distance between said wall portion and said holes, and said members being the sole means for mechanically and electrically connecting said stub to said housing.

10. Apparatus in accordance with claim **9** including means within said housing contacting said stub at a location between said wall portion and said groove for preventing said stub from swaying with respect to said housing.

11. An electrode stub clamp comprising a housing made from a good electrically conductive material, said housing being closed at one end and having an aperture at its other end, a cage within and reciprocally guided by said housing, said cage being closed at one end and open at its other end, the closed ends of said cage and housing being adjacent one another, said other end of said cage projecting into said other end of said housing, said cage having a plurality of holes extending therethrough on an axially directed portion thereof, and conductive means within and engaging said housing adapted to partially project radially inwardly through said holes in response to the reciprocatory disposition of said cage with respect to said housing.

12. A clamp in accordance with claim **11** including a first means on said housing for latching said cage in one position thereof to prevent reciprocation of said cage in one direction with respect to said housing, and a second means on said housing for selectively preventing reciprocation of said cage in an opposite direction.

13. A clamp in accordance with claim **12** wherein said cage has a radially outwardly directed flange at said one end, and said second means being associated with said flange to effect prevention of reciprocation of said cage in the opposite direction.

14. An electrode stub clamp comprising a cylindrical housing made from a good electrically conductive material, a cylindrical cage within and reciprocally guided by said housing at two locations along the length of said cage, a radially outwardly directed flange at one end of said cage in abutting contact with said housing and constituting one of said locations on said cage, a radially inwardly directed wall portion on said one end of said cage, the other end of said cage being open, said housing having an aperture at one end with the surface defining said aperture guiding the other end of said cage, said cage having first and second rows of holes in an axially directed surface thereof, balls between the inner peripheral surface of said housing and the outer peripheral surface of said cage, each of said balls being adapted to project through one of said holes, the balls of said first row being made of a good electrically conductive material and being electrically coupled to said housing, and means on said housing for selectively causing the balls of said first row to project through their respective holes to a greater extent than the balls of the second row for mechanically and electrically coupling said housing to an electrode stub.

15. A clamp in accordance with claim **14**, including a radially inwardly directed ledge on the inner peripheral surface of said housing, said ledge preventing balls of

said second row from commingling with balls of said first row, a cam surface on said ledge for contact by the balls of said second row, and said first and second row of holes being on opposite sides of said ledge in all reciprocatory positions of said cage.

16. A clamp in accordance with claim **14** including a solid electrode stub, said stub projecting through said other end of said cage into engagement with said wall portion, said stub having a peripheral groove, and said balls of good electrically conductive material partially projecting through their respective holes into mechanical and electrical contact with said groove on said stub.

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