Feb. 13, 1962 J. J. RILEY 3,021,497

LOW LOSS ANTI-FRICTION CURRENT TRANSFER MEANS FOR ROTATING DEVICES

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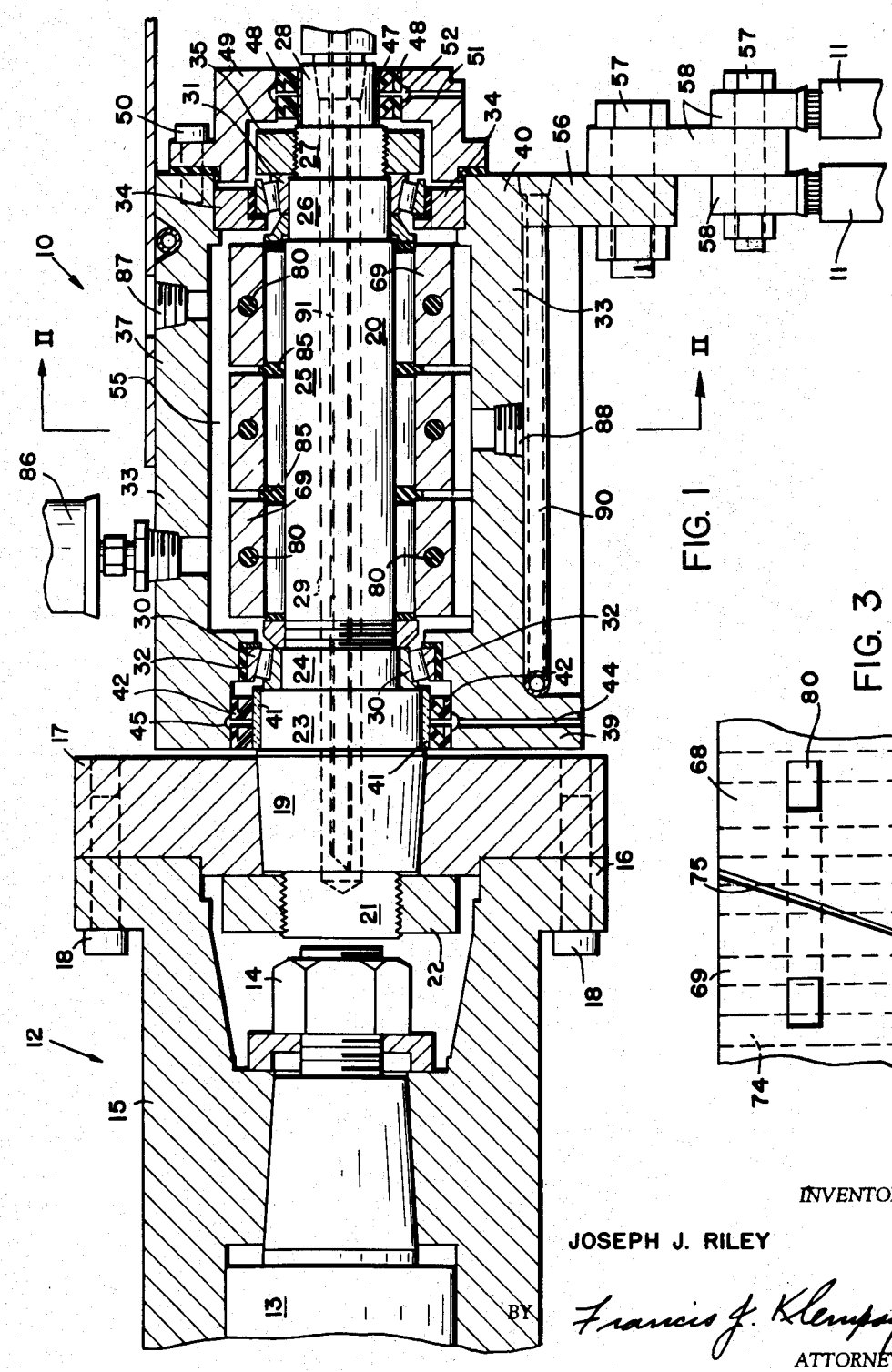


FIG. 1

FIG. 3

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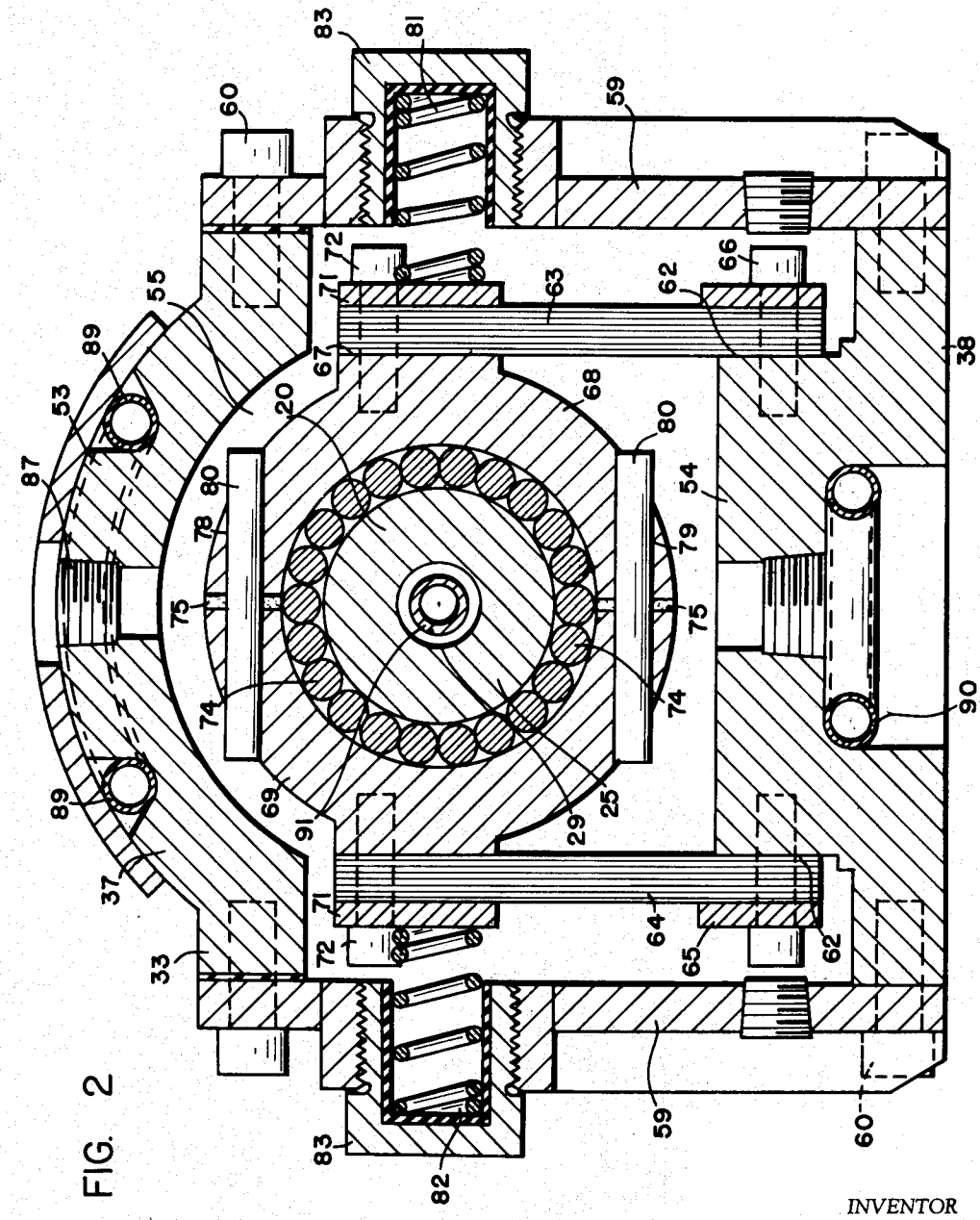


FIG. 2

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LOW LOSS ANTI-FRICTION CURRENT TRANSFER MEANS FOR ROTATING DEVICES

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11 Claims. (Cl. 339—5)

The present invention relates generally to means for transferring very heavy electrical currents, in the order of hundreds of thousands of amperes, between two relatively movable current conducting devices in an improved manner. More particularly, the present invention is directed to apparatus for use in electric resistance welding, continuous strip electro-plating and the like wherein extremely large electrical currents are transferred from a stationary current conducting member to a rotating current conducting spindle with the minimum of potential drop.

In the prior patent to Melvin M. Seeloff, No. 2,726,371, which is assigned to the assignee of the present invention, there is shown apparatus of the type generally contemplated by the present invention. In this patent a current conductive spindle is provided with an even diametered contact portion whose periphery is engaged by a plurality of elongated current conductive anti-friction rollers. The rollers are encased by a current collector shoe and the shoe is resiliently urged toward the spindle along one longitudinal plane to insure physical contact between the current collector shoe, the anti-friction rollers and the current conductive spindle. Although apparatus constructed in accordance with the teachings of the above mentioned patent has been widely and successfully employed, it has been found that the main transfer of current takes place on the side at which the current collector shoe is resiliently urged into engagement with the anti-friction rollers. Thus, at any instant of time, most of the electrical current is flowing through only one or a small number of the anti-friction rollers. Although the above is not objectionable when low duty cycles and/or relatively low currents are involved, such current transfer apparatus is not entirely acceptable when extremely heavy currents and/or heavy duty cycles are contemplated.

It is an object of the present invention to provide current transfer means for rotating devices which is of a highly compact nature and a simplified overall construction but yet which is adapted to transfer extremely heavy electrical currents with a minimum of potential loss or resistance drop in an improved manner.

More specifically, it is an object of the present invention to provide low loss anti-friction current transfer means wherein anti-friction rollers are employed for transferring currents between relatively movable parts and wherein the current is more evenly distributed between these anti-friction rollers. As will be hereinafter more fully apparent, the current conductive spindle is surrounded by a plurality of anti-friction rollers which are in turn surrounded by relatively stationary current conductive roller cage halves. Each of the roller cage halves is individually and resiliently urged into pressure engagement with the anti-friction rollers and the current conductive spindle. In this manner, the current carrying capacity of the apparatus herein disclosed is substantially greater than that of similar prior art devices.

Still another object of the invention is to provide low loss anti-friction current transfer means for rotating devices embodying a pair of roller cage halves wherein the slits or openings between the halves do not interfere in any manner with the relative rolling movement of the current conductive anti-friction rollers. The longitudinal

axes of the anti-friction rollers extend in one plane while the slits or openings between the roller cage halves extend in a second plane which is slightly angled with respect to the first mentioned plane. Thus, the anti-friction rollers are adapted to ride freely past the openings or slits between the roller cage halves.

A further object of the invention is to provide current transfer means for rotating devices of the character above described which embodies improved means for keeping the roller cage halves in alignment. The roller cage halves are maintained in concentric aligned relation by a pair of aligning pins whereby these roller cage halves can slide transversely with respect to the longitudinal axis of the current conductive spindle. This arrangement allows each of the roller cage halves to be individually and resiliently urged into engagement with the anti-friction rollers and the current conductive spindle but yet insures alignment between these halves and the spindle.

Specifically, the invention seeks to provide apparatus for the purpose indicated with inexpensive and utilitarian construction. Practical and durable electrical apparatus capable of extensive periods of maintenance-free use under severe operating conditions is provided.

The above, as well as other objects and advantages of the invention, will become more apparent upon consideration of the following specification and accompanying drawing wherein there is disclosed a preferred embodiment constructed in accordance with the teachings of the invention.

In the drawing:

FIGURE 1 is an axial sectional view of the low loss anti-friction current transfer means for rotating devices constructed in accordance with the teachings of the present invention;

FIGURE 2 is an end sectional view along the section line II—II of FIGURE 1; and

FIGURE 3 is an enlarged fragmentary plan view showing specifically the slit or opening between a pair of the roller cage halves employed in the current transfer means.

Referring now to the drawing, there is shown current transfer means, generally designed by the reference numeral **10**, which is adapted to transfer extremely heavy electrical currents from a stationary supply source, such as conductors **11**, to a rotating device generally indicated at **12**. The rotating device **12** is shown to comprise an electro-plating roll **13** which is mounted on one of its ends by a nut **14** in rigid relation with respect to a rotating current conductive roll carrier **15**. The roll carrier **15** has an annular flange **16** at the rear end thereof which is abutted against and rigidly attached to an annular current conductive member **17** by a plurality of circumferentially spaced bolts **18**. The annular current conductive member **17** has a tapering axial opening therein which receives an enlarged tapering portion **19** of a longitudinally extending current conductive spindle **20**. The extreme forward end portion **21** of the spindle **20** is of reduced diameter and threadably received thereon is a large lock nut **22**. The arrangement is such that the tapering portion **19** of the spindle **20** may be drawn into tight frictional contact with the opening in the annular member **17** upon proper manipulation of the lock nut **22**. The above apparatus—including the annular member **17**, the roll carrier **15** and the electro-plating roll **13**—are rotatable with the spindle **20**. Also, any current transferred to the spindle **20**, in a manner to be later described, will be conducted to the electro-plating roll **13**.

The electro-plating roll **13** is employed in the electro-plating of metal strip, but it should be clearly understood from the outset that the current transfer means **10** is adapted to transfer heavy duty electrical currents to rotating devices other than electro-plating rolls. For ex-

ample, the electro-plating roll 13, roll carrier 15 and annular member 17 may be replaced with a current conductive welding electrode wheel or similar device, if desired.

The current conductive spindle 20, in addition to the threaded forward end portion 21 and the enlarged tapering portion 19, comprises a forward sealing portion 23, a forward bearing portion 24, an elongated and even diametered electrical contact portion 25, a rear bearing portion 26, a rear threaded portion 27 and a rear sealing portion 28. The various portions of the spindle 20 are of different diameters and this spindle 20 is preferably machined to the shape shown from a highly conductive material such as copper or one of its alloys. The spindle 20 is bored throughout an appreciable portion of its length at 29 to provide a means for cooling the same as will be further described.

The spindle 20 is journaled at longitudinally spaced points on opposite sides of the electrical contact portion 25 by the forward and rear bearing assemblies 30 and 31, respectively. The inner race of the forward bearing assembly 30 is rigidly mounted on the forward bearing mounting portion 24 of the spindle while the outer race of this bearing assembly is insulated from but rigidly mounted in an annular flange 32 in the forward wall of a current conductive stationary housing 33. The inner race of the rear bearing assembly 31 is mounted on the rear bearing portion 26 of the spindle 20 while its associated outer race is insulated and mounted from an annular member 34 which in turn is rigidly received within the rear wall of the housing 33. The bearing assemblies 30 and 31 are of the anti-friction thrust type whereby, upon proper tightening of a large nut 35 threadedly received on a rear threaded portion 27 of the spindle 20, the spindle 20 is journaled for anti-frictional rotation. As set forth above, the outer races of the bearing assemblies 30 and 31 are insulated from the housing 33 and the annular member 34 whereby current cannot flow across these bearing assemblies from the housing 33 to the spindle 20.

The current conductive housing 33 is of a generally open sided rectangular box-like shape that defines a top wall 37, a bottom wall 38, FIG. 2, a front wall 39 and a rear wall 40. The front and rear walls 39 and 40 are suitably apertured to journal the spindle 20 in the manner above described.

Press-fitted or otherwise rigidly attached to the forward sealing portion 23 of the spindle is an elongated sleeve 41 of sapphire or other extremely hard wear resistant non-conducting material. Mounted within the axial bore of the front wall 39 and disposed forwardly of the forward bearing assembly 30 are a pair of generally V-shaped annular sealing gaskets 42. Each of the sealing gaskets 42 is formed from a resilient material, such as nylon or one of the plastics, for example, and is so dimensioned that the flanges thereof resiliently bear against and effect a seal between the sleeve 41 and the annular side wall of the bore within the front wall 39 of the housing 33. A suitable radially extending slot 44 and a circumferentially extending groove 45 are provided to allow lubrication of the gaskets 42 and sleeve 41.

A similar arrangement is employed for sealing the rear end of the spindle 20 wherein a highly wear resistant and non-conducting sleeve 47 is fitted on the rear sealing portion 28 and the spindle and a pair of V-shaped annular gaskets 48 are mounted within an axial opening in an annular rear cover cap 49. The annular rear cover cap 49 is insulated from and bolted to the rear wall 40 of the housing 33 by means of bolts 50. The rear cover cap 49 is provided with a radially extending slot 51 and an annular groove 52 to allow lubrication of the sleeve 47 and gaskets 48.

The sealing means above described are similar to those shown and described in the copending application of Melvin M. Seeloff, Ser. No. 760,470, filed September 11, 1958, now Patent No. 2,983,891, which is assigned to the assignee of the present invention. Such sealing means are characterized by their good fluid sealing capabilities without imparting an appreciable drag or friction on the spindle 20 which is adapted to be rotated at high speeds. Further, the use of the wear resistant and non-conducting sleeves allows the same to be used continuously without interferring in any manner with the current flow in the spindle. The housing 33 is adapted to be filled with a lubricant and the gaskets 42 and 48 are so disposed that the same are effectively self-sealing.

The top wall 37 of the housing 33 is rounded at 53 throughout its length while the bottom wall 38 of the housing has a vertically extending generally U-shaped projection 54 therein. The top and bottom walls define a relatively large cavity 55 which surrounds the electrical contact portion 25 of the spindle 20 and is adapted to receive the means for transferring the very large electrical currents to the spindle. The rear end of the bottom wall 38 of the housing has a downwardly depending flange 56 which may be silver plated and is adapted to be electrically connected with the conductors 11 by means of bolts 57 and current connectors 58. Heavy duty electrical currents are transferred from the current conductors 11 to the housing 33. The open sides of the housing 33 are closed by the side walls 59 which are insulated from and bolted to the top and bottom walls of the housing by the bolts 60.

Received within the cavity 55 is the means for transferring heavy duty electrical currents to the contact portion 25 of the spindle 20 and this means comprises three identical assemblies disposed axially along the contact portion 25. To avoid unnecessary repetition in the specification only one of these assemblies will be described in detail although like reference numerals designate similar parts throughout the various views of the drawing.

Referring in particular to FIGURE 2 of the drawing, the U-shaped vertically extending portion 54 of the bottom wall 38 defines a pair of transversely spaced and vertically extending surfaces 62 against which are rigidly clamped one set of ends of laminated or braided thick flexible current conductors 63 and 64 by means of plates 65 and bolts 66. The other set of ends of the thick flexible conductors 63 and 64 are clamped against vertical surfaces 67 of the roller cage halves 68 and 69, respectively, by means of plates 71 and bolts 72. It should thus be apparent that the large currents in the housing 33 are adapted to be conducted to the roller cage halves 68 and 69 by the thick flexible conductors 63 and 64 and that the roller cage halves may move with respect to the housing 33. Each of the roller cage halves is generally semi-circular in cross section and, when these halves are assembled, they surround the electrical contact portion 25 of the spindle 20 in spaced relation thereto. Disposed between the roller cage halves 68 and 69 are a plurality of axially extending cylindrical current conductive rollers 74 which are adapted to have rolling contact with the outer periphery of the contact portion 25 of the spindle 20 and with the inner surfaces of the roller cage halves 68 and 69. The rollers 74 provide the actual means for transferring the heavy duty electrical currents to the rotating spindle in an anti-friction manner whereby minimum losses occur during such transfer.

The roller cage halves 68 and 69 are so disposed that there are slits or openings 75 between the adjacent end faces thereof. As is clearly shown in FIGURE 3 of the drawing, the openings 75 extend along a line which is angled acutely or disposed diagonally with respect to the longitudinal axis of the spindle 20 and the longitudinal axes of the anti-friction rollers 74. It is preferred that the roller cage halves 68 and 69 be machined or otherwise formed as an integral part and then split along a diagonal line to provide the angled openings 75. The angled openings 75 are important in the accomplishment

of the objects of the invention in that the disposition thereof is such that they do not interfere with the anti-friction rolling movement of the rollers **74**. As the spindle **20** rotates at a high speed the rollers **74** will also revolve thereabout and the diagonal disposition of the openings **75** prevent any of these rollers from hanging up and prevents the openings from otherwise interfering with the desired operation of the rollers. It will be noted that only a small portion of any one roller will be disposed beneath an opening **75** at any given instance of time.

The top and bottom portions of the roller cage halves **68** and **69** are transversely bored at **78** and **79** adjacent to the openings **75** and intermediate the ends thereof. Received within the bores **78** **79** in spanning relation with respect to the openings **75** are aligning pins **80** which are preferably formed from "diamondite" or some other material exhibiting good insulating properties and extreme hardness. Alternately, the aligning pins **80** may be formed from steel and insulated from the bearing cage halves by suitable insulating means as will be apparent to those skilled in the art. The aligning pins **80** are loosely received within the bores **78** and **79** whereby the roller cage halves **68** and **69** are adapted to be held in alignment with respect to the spindle **20** and with respect to each other.

The plates **71** clamping the upper set of ends of the thick flexible conductors **63** and **64** to the roller cage halves extend downwardly to provide bearing surfaces for the ends of the compression springs **81** and **82**. Each of the compression springs **81** and **82** is received in and insulated from a cup-like housing **83** that is removably secured in one of the side walls **59**. The arrangement is such that each of the roller cage halves is positively and resiliently urged into pressure engagement with the rollers **74** and the contact portion **25** of the spindle **20**. Since each of the roller cage halves **68** and **69** is urged into engagement with the anti-friction rollers **74** by its associated compression spring the heavy duty currents are adapted to flow into the spindle **20** at two diametrically opposed and circumferentially spaced areas through at least two of the rollers **74**. This effectively doubles the current capacity of the current transferring means when compared to the apparatus shown in the above mentioned prior Seeloff Patent No. 2,726,371.

To further increase the current transferring capacity of the apparatus a plurality of the above described assemblies can be installed in axially spaced relation along the contact portion **25** of the spindle **20**. For example, as shown in FIGURE 1, three such assemblies may be employed with adjacent assemblies separated by insulating spacers **85**. It should be understood that any number of such assemblies may be employed as is dictated by the capacity of the transfer means required for any given installation.

All of the assemblies and the forward and rear bearing assemblies **30** and **31** are completely immersed in a bath of light weight lubricant, such as castor oil, for example, which contributes to the free running nature of the apparatus and is operative to act as a heat transfer agent. To this end there is provided a transparent reservoir **86** and an air vent plug **87** in the top wall **37** of the housing **33** while a drain plug **88** is included in the bottom wall **38**.

To effect cooling of the lubricant and the various component parts of the apparatus, a U-shaped conduit **89** is embedded in the top wall **37** of the housing while a U-shaped conduit **90** is brazed, soldered or otherwise attached to the bottom wall **38** of the housing. These conduits are connected to suitable coolant supply means, not shown, whereby coolant is circulated therethrough to conduct the heat away from the lubricant and the housing. Received centrally within the central bore **29** of the spindle **20** is a tube **91** which, in combination with the bore **29**, defines a pair of circular and circumferentially spaced coolant passageways. These coolant passageways are in communication with a rotary fluid coupling not particularly shown, whereby coolant may be circulated through the interior of the spindle **20**.

It should be apparaent that I have accomplished the objects initially set forth by providing apparatus capable of transferring extremely heavy electrical currents between two relatively movable members. Of particular importance is the provision of a split roller cage with each roller cage half being resiliently urged into engagement with the anti-friction rollers and the contact portion of the spindle whereby the flow of current takes place at two areas. The roller cage is split along a diagonal line and each half is loosely and slidably received on transversely extending aligning pins. The openings or slits between the roller cage halves do not interfere with the rolling movement of the rollers but yet the aligning pins always insure that the roller cage halves are aligned with respect to the rollers and the spindle. The apparatus is further characterized by its capability of transferring extremely heavy electrical currents at low potential loss while yet being of extremely simplified construction and being adapted to operate at very high speeds with a minimum of wear.

Although I have shown and described a preferred embodiment of the invention it should be understood that many changes may be made therein. Accordingly, reference should be had to the following appended claims in determining the true scope and intent of the invention.

I claim:

1. In a rotary current transfer device for transferring extremely heavy electrical currents to a rotating spindle and having a current conductive housing and, spaced bearing means mounted in said housing, for journaling said spindle; said spindle having a contact portion intermediate said bearing means; and means to transfer current from said housing to said contact portion of said spindle comprising a plurality of elongated current conductive anti-friction rollers positioned about said contact portion in electrical contact therewith, a pair of current conductive roller cage halves positioned about and encircling said contact portion and said rollers, spring means acting on each of said roller cage halves for urging said roller cage halves towards said contact portion of said spindle and into contact with said rollers, conductor means connecting each of said roller cage halves with said housing, and means to align said roller cage halves with respect to each other.

2. Apparatus according to claim 1 further characterized in that said means to align said roller cage halves with respect to each other comprises an aligning member extending transversely with respect to the axis of said spindle, said roller cage halves having aligned transversely extending bores therein to receive said aligning member whereby said roller cage halves are slidably mounted on said aligning member.

3. Apparatus according to claim 1 further characterized in that each of said roller cage halves has a flat surface on the outer periphery thereof, said conductor means comprising a bundle of laminated flexible current conductors, a pair of clamping plates, each of said conductors having one set of ends thereof clamped against said flat surface on the outer periphery of one of said roller cage halves by one of said clamping plates, said spring means comprising a pair of compression springs, and said springs engaging and bearing against said clamping plates.

4. Apparatus according to claim 1 further characterized in that the adjacent edges of said roller cage halves are angled with respect to the axes of said rollers and said spindle, said angled adjacent edges of said roller cage halves defining a pair of diagonally extending slots whereby said rollers have free rolling movement with respect to said slots.

5. Apparatus according to claim 4 further characterized in that said means to align said roller cage halves com-

prises a pair of aligning members spanning said diagonally extending slots, said roller cage halves being bored to receive said aligning members, and said roller cage halves being slidably mounted on said aligning members.

6. A rotary current transfer device for carrying heavy duty electrical currents comprising a current conductive housing, a current conductive spindle, means journaling said spindle in said housing, said spindle having a contact portion, a plurality of elongated current conductive antifriction rollers encircling said contact portion, a plurality of circumferentially positioned and circumferentially spaced current conductive roller cage portions encircling said spindle and said rollers, means for transferring current from said housing to said roller cage portions, and spring means engaging each of said roller cage portions intermediate the ends thereof for radially urging the same into electrical contact with said rollers and towards said spindle.

7. Apparatus according to claim 6 further characterized in that the spaces between the adjacent ones of said roller cage portions define a plurality of slots, and said slots being angled slightly with respect to the longitudinal axes of said rollers.

8. Apparatus according to claim 6 further comprising means for aligning said roller cage portions transversely with respect to the longitudinal axis of said spindle, said last mentioned means comprising aligning pins spanning the spaces between the adjacent ones of said roller cage portions, and said roller cage portions being slidably mounted on said aligning pins for relative transverse movement.

9. A rotary current transfer device for carrying heavy duty electrical currents which comprises a current conductive housing, said housing having a top wall, a bottom wall and front and rear end walls, bearing means mounted in said front and rear end walls, a current conductive spindle, said bearing means journaling said spindle, said spindle having a contact portion intermediate said bearing means, a plurality of elongated current conductive rollers engaging and encircling said contact portion, a pair of current conductive roller cage halves encircling said spindle and said rollers, a pair of side plates attached to said housing, means for transferring electrical current from said housing to said roller cage halves, and spring means extending between said side plates and said roller cage halves for urging the latter into contact with said rollers and towards said spindle.

10. A device for transferring high amperage electrical currents to rotary apparatus comprising a current conductive housing, a current conductive spindle, bearing means in said housing and journaling said spindle at spaced points, said spindle having a contact portion extending principally between said bearing assemblies, current transferring means disposed within said housing for transferring current from said housing to said spindle, said current transferring means comprising a plurality of axially aligned assemblies, each of said assemblies comprising a plurality of elongated current conductive rollers and a plurality of circumferentially spaced and circumferentially extending current conductive roller cage portions, and spring means for urging each of said roller cage portions into engagement with said rollers and towards said spindle.

11. Apparatus according to claim 10 further comprising means separating each of said assemblies, and said last mentioned means comprising a ring of insulating material encircling said contact portion of said spindle.

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