June 13, 1967 **C. H. WARD** **3,325,764**

COLLECTOR HEAD

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2 Sheets-Sheet 1

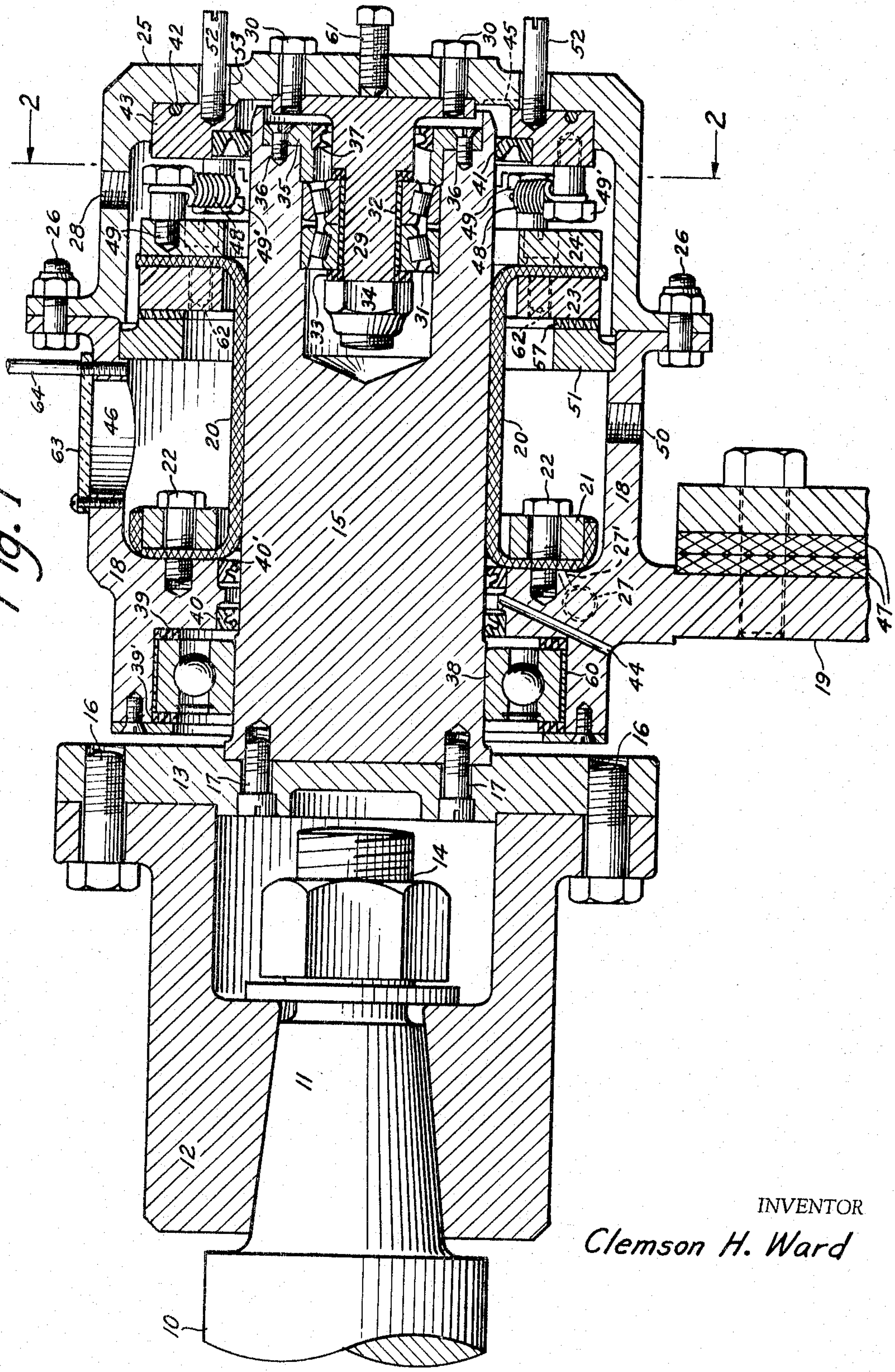

Fig. 1

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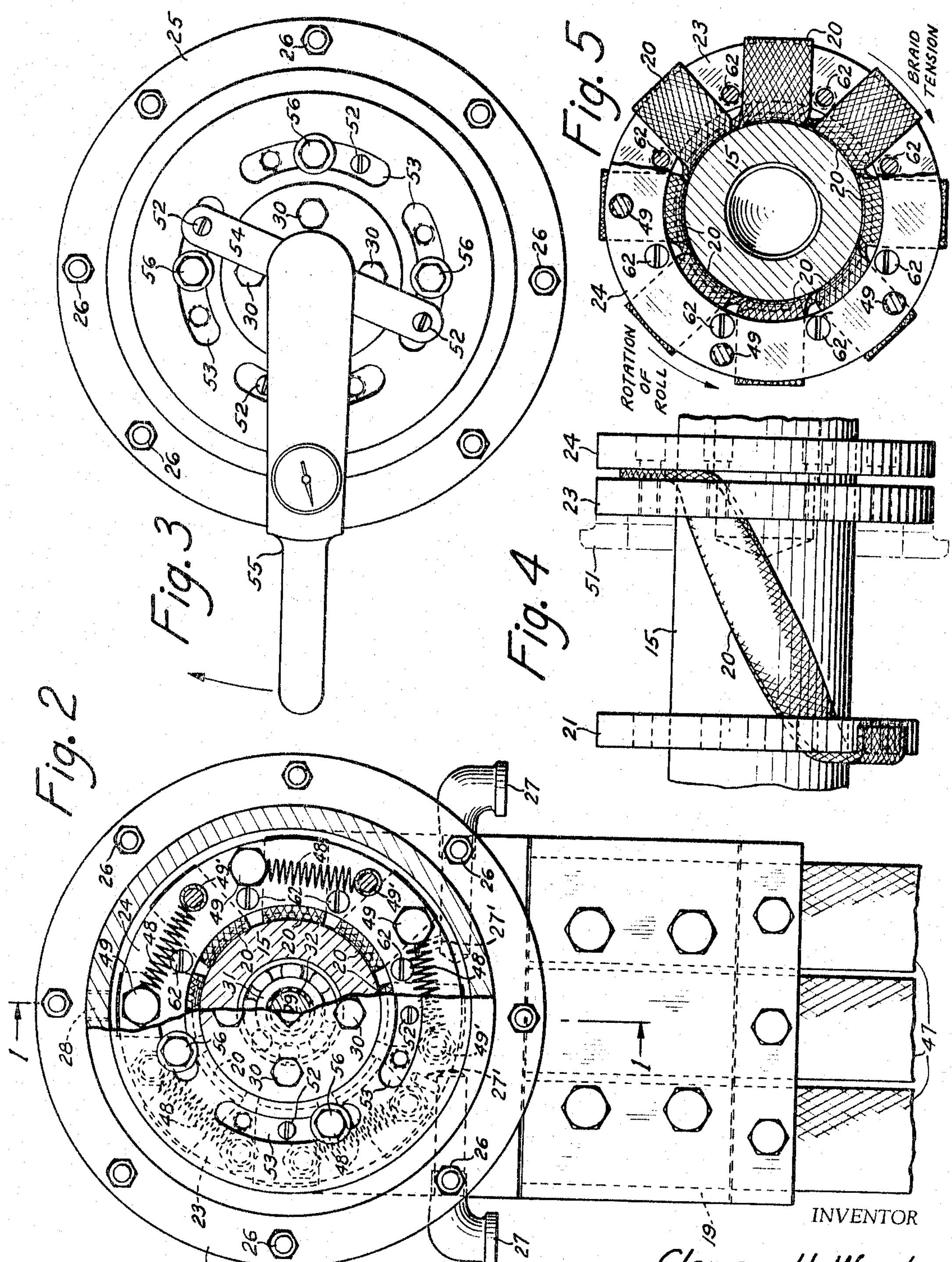

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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COLLECTOR HEAD

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This invention relates to a collector head assembly, and more particularly to an assembly adapted for use in the continuous electrolyzing of metal strip.

In electrolyzing metal strip, and especially in the electrolytic deposition of a non-ferrous coating on steel strip, the strip may pass through an electrolytic plating cell in either a horizontal or vertical direction. An electrode, connected to a source of electric current, is disposed in the electrolyte in the plating cell in close proximity to the path of the strip through the electrolyte. A rotatable contact roll engages the strip outside the cell, and the roll is connected to the opposite pole of the electric source to complete the electric circuit through a portion of the strip.

In the horizontal type of plating, there are generally a plurality of plating cells, with the moving strip normally contacting a contact roll at the exit end of each cell. Commonly, the strip passes between two rolls, with a metal, usually steel, contact roll at the top, and a backing roll, covered with some non-conductive substance such as rubber, bearing on the strip immediately below the contact roll.

In the vertical or skein type of plating cell, wherein the strip may engage a contact roll outside the cell after each vertical pass around an electrode disposed vertically in the plating bath, virtually the same type of roll structure is used as in the horizontal type of operation, except that, in the vertical type, the emerging strip is usually carried out of the plating bath on a driven contact roll, and is forced into intimate contact therewith by a rubber-coated wringer roll placed above the contact roll.

The contact rolls, which are generally made in the form of a hollow cylinder, may vary in diameter, depending on the type of operation, from possibly 3 inches to 15 inches or more. In a modern, high speed tinplating line of the horizontal type, the roll will have a diameter of about 10 inches, and a length sufficient to take care of at least a 36 inch-wide strip. Each end of the roll has a reduced-diameter portion to form a journal which fits within a journal bearing.

Heretofore, it has been the practice to collect current from the contact roll by means of a reduced end portion of the roll. This reduced end portion extends beyond the journaled portion of the roll, and thus provides ready access for the collector head assembly, of which the brushes are a part.

Brushes provided relatively satisfactory operation for tin lines operating at speeds of from 500 to 600 feet per minute. However, with present day lines operating at speeds of up to 1500 feet or more per minute, a serious torque problem develops through the use of the brush type current collector. Even at the slower speeds of around 500 to 600 feet per minute, at which speed some tin lines are still operated, the amount of torque drag resulting from the use of brushes is considerable. Power losses increase with increased speed, and at 1500 feet per minute power loss from drag torque is such that synchronization of roll speed to strip becomes a problem.

An object of this invention is to provide a collector head which generates a minimum of torque on an electroplating contact roll.

Another object is to provide a liquid cooled collector head which can be readily removed or replaced when not in operation.

A further object is to provide means for maintaining

the correct tension on the contact elements of a collector head, and for changing such tension as necessary.

Another object is to provide a collector head which is self-supporting, and which follows any change in contact roll alignment.

With these objects in mind, I have developed a lightweight, liquid-cooled collector head having braid-type contact portions, in which the tension on the contact portions can be adjusted without removal of the head, and the whole assembly can be removed from its operating position, or replaced therein, with a minimum of delay.

In the drawings:

FIG. 1 is a vertical section of the complete assembly taken along the line **1—1** of FIG. 2.

FIG. 2 is an end view of the assembly, part of which is in section taken along the line **2—2** of FIG. 1.

FIG. 3 is an end view showing tensioning means.

FIG. 4 is a plan view of a contact drum and one contact braid.

FIG. 5 is an end view of the tension rings, braid and contact drum.

The improved collector head includes a contact plate, which is made integral with part of the collector head housing. Within the housing, and attached at one end to the contact plate, is a series of elongated electrically conducting contact members of soft material arranged longitudinally around the periphery of an electrically conducting, rotating drum. The opposite ends of these elongated contact members are fastened to rotatable tensioning discs, or rings. The drum is connected both mechanically and electrically to the end portion of a contact roll, or other electrically conducting, rotating element. The housing is of closed construction so as to permit containment and circulation of cooling liquid in the vicinity of the contact members and the contact drum. At the free end of the drum, there is located spring-mounted means for adjusting tension on the tensioning rings. The rings, in turn, supply tension to the contact members.

The improvement of this invention will be readily understood by reference to the drawings. Referring particularly to FIG. 1, steel contact roll **10** has a tapered, reduced end portion **11** in metal-to-metal fit with, and bolted at **14** to, brass roll flange **12**. Flange **12** is in turn attached to brass collector head flange **13** by means of six bolts indicated at **16**. An aluminum bronze contact drum **15** is secured to flange **13** by means of six bolts indicated at **17**.

In the structure just described, good conductivity is obtained for the passage of electrical current from the contact roll through successive joints to the contact drum. However, because of the relatively small contact area between drum **15** and flange **13**, conductivity may be enhanced if the contact portions of drum and flange are tinned and sweated together.

As an alternative to joining the parts by sweating, conductivity between drum **15** and flange **13** could also be enhanced by constructing the drum and flange in one piece.

The brass collector head casing **18** is an integral part of contact plate **19**. Actual removal of current from drum **15** is performed by a series of eight strips **20** which can be, for example, 1⅛ inch wide, 5/32 inch thick, and of a soft electrically conductive material of copper contact braid having a contact length of, for example, about four inches. One end of each braid is secured physically and electrically to brass contact plate **19** by means of brass clamping ring **21** and bolts **22**. The other end of each braid is secured between two tensioning rings **23** and **24**, the two rings being held together by stainless steel cap screw **62**. The braids are arrayed longitudinally, and in spaced relation, around the periphery of contact drum **15**.

Current removed from the drum by means of the braid passes through the contact plate to bus bars, not shown, whence it travels through the generators, anodes, electrolyte and strip, as will be understood, to contact roll **10** to complete the circuit.

The installation of the braid, as described, will normally place the braid strip in a line parallel with the center line of drum **15**, and in close contact with the surface of said drum throughout the length of the exposed section of the braid. The braid is thus depicted in FIGURE 1.

The braids must be placed under sufficient wrapping tension to ensure good contact between braid and drum. Tension is maintained by a constant rotative force applied to brass tension rings **23** and **24** by five tension springs **48**. The torque applied to rings **23** and **24** causes spiral wrapping of the braid around the drum, and is supplied in a direction counter to the operational rotation of the drum. The spring load is set to about 75 to 100 inch pounds, in a manner which will be described.

Alternatively, the braids may be prestressed in a spiral configuration so that when they are attached to rings **23** and **24** and to ring **21**, they will have already assumed the approximate contour in which they are used in operation. Inserting the braids in a direction away from the axis of the drum, in a prestressed condition, will improve wear of both drum and braid.

Completing the collector head housing is a brass casing cap **25**, joined to casing **18** by bolts indicated at **26**. By this union, the housing provides a closed container, except for water inlets and outlets described below, for the circulation of cooling water about drum **15** and braids **20**.

Contact drum **15**, which, in this example, rotates in a counter-clockwise direction in concert with contact roll **10**, has a cylindrical opening at the free end in which it supports a steel shaft **29**. The shaft is attached to casing cap **25** by bolts **30**. Bearing support for shaft **29** within drum **15** is provided by roller bearing housing **31**. An insulating Bakelite bushing **32** is inserted between shaft **29** and bearing **31**, while Bakelite washers **33** prevent lateral movement of the bearing, the complete bearing assembly being secured to the shaft by steel retaining nut **34**. A brass seal and bearing retainer ring **35**, secured to drum **15** at **36**, carries a rubber seal **37** to prevent water from entering ball race housing **31**.

Ball bearing housing **38** provides additional support for the collector head casing, housing **38** being retained in place between casing section **18** and drum **15** by Bakelite bushing **39** and **39'**, as well as Bakelite insulating bushing **60**. Rubber seals **40'** and **41** are provided to retain cooling water within the collector head housing proper. Seals **40** and **37** also confine lubricating grease within the area occupied by the bearings.

Referring now to FIG. 2, inlets **27** and outlet **28** provide for the circulation of cooling water about the elements of the collector head, the water entering the housing at inlet nozzle **27'**. Water within the housing will be made to circulate about the exposed sides of the braids and exposed areas of the outside drum surface. Water acts as both coolant and lubricant, and as such increases the useful life of both the braids and the drum. The casing being provided with seals **40'** and **41**, forms a water-tight compartment for the lubrication and cooling of braids and drum. Further to prevent leakage of water from the casing, O ring gasket **42** is located between spring tension and sealing ring **43** and casing section **25**.

Additional means are provided to prevent leakage of water into the bearing areas by inclusion of drain slots **44** and **45**.

An inspection hole **46**, fitted with a transparent cover **63**, is located at the top of the housing in casing section **18**. An air vent **64** is also located at the top of casing section **18**.

It will be seen that the entire collector head housing assembly comprising contact plate **19**, casing sections **18** and **25**, and all structures attached thereto, are supported on drum **15** by tightly fitting bearing housings **31** and **38**. The assembly is held stationary by means of heavy wire connections **47** attached to contact plate **19**. The self-supporting feature of the collector head is important, in that this feature permits the head to accommodate to any change in alignment of the contact roll, the head thus being in constant alignment with said roll.

Casing cap **25** is provided with a threaded stud **61** for the purpose of pushing the cap away from the assembly, when it is desired to remove the cap therefrom.

Proper tension on braids **20** is maintained through the agency of a spring-mounted system which controls the degree of rotation of braid tension rings **23** and **24**. With the right end of each braid **20**, as shown in FIG. 1, secured between rings **23** and **24**, the rings are urged simultaneously in a clockwise direction, and counter to the direction of rotation of drum **15**. Freedom of movement of the rings is provided by Teflon thrust pad **57**. Thrust pad **57** bears against bearing spacer sleeve **51**, which in turn is seated in casing section **18**. The degree of rotation of the rings is limited by the braid tension required to maintain a satisfactory electrical contact between braid and drum.

A series of five bronze wire springs **48** is located between tension ring **24** and brass spring tension and sealing ring **43**. Referring to the uppermost spring **48** in FIG. 1, one end of spring **48** is attached to bolt **49**, the bolt in turn being secured to ring **24**. The other end of spring **48** is attached to bolt **49'** which is in turn secured to ring **43**. When clockwise rotational motion is applied to ring **43** by external force, as will be described, tension is applied to each of the springs **48**. The load applied to the spring moves ring **24**, along with its companion ring **23**, in the same rotational direction as ring **43**. As previously mentioned, braid tension for the apparatus described in this example is maintained by applying a load of between about 75 and 100 inch pounds to the springs **48**.

Spanner-engaging pins **52**, secured to ring **43**, extend through slots **53** located in casing cap **25**, as shown in FIGURES 2 and 3. By applying the spanner **54** of a torque wrench **55** to two diametrically opposed engaging pins **52**, as shown in FIG. 3, ring **43** may be rotated to subject springs **48** to sufficient tension to in turn rotate tension rings **23** and **24**. When the proper tension has been applied to the braids, lock nut **56**, operating in slot **53**, is tightened, so that the desired load can be maintained on the braids indefinitely.

As the right end of braid **20** in FIG. 1 is gripped between tension rings **23** and **24**, any rotation of the rings extends the braid, and tends to pull it in a line diagonal to the axis of drum **15**. The course taken by the extended braid, in relation to the drum axis, is shown in FIG. 4. The diagonal pull put on the braid by rotation of drums **23** and **24** will produce torsion in the braid, although the braid tends to assume substantially the contour of the contact drum against which it is held.

The helical direction taken by the braid and the manner by which the braid is held in position by the tension rings, is clearly shown in FIGS. 4 and 5. A plug fits into a drilled one inch hole **50** at the bottom of casing **18**. When the plug is removed, the opening acts as a drain slot. By backwashing with water through outlet **28**, the interior of the assembly can be washed to remove fine particles of copper-bearing powder dislodged from the braids and drum. Washing results in a sludge at the bottom of the casing, which sludge can be removed through the drain slot.

The collector head of the example is designed to operate at 4500 amperes. By increasing the size of the head a corresponding increase in current capacity can be obtained. Ordinarily, in a tinplating line, a collector head will be located at each end of the contact roll.

Obvious substitutions can be made in the choice of materials for the various parts of the apparatus described. For the most effective operation, however, all parts of the assembly which aid in the transfer of current should be made of a material of high electrical conductivity such as copper or the various brasses and bronzes. Silver-plated copper surfaces, such as those of braid wires, may be found advantageous in overcoming reduced conductivity due to surface corrosion.

The copper braid may be any commercial braid made from copper or copper-bearing wire of small diameter. Preferably, the braid should be made from wires having a diameter of approximately 0.010 inch, to produce optimum flexibility and wear in conjunction with a contact drum of convenient size, e.g. about 3 inches in diameter. The most desirable braid wire diameter will be dependent to some extent on the diameter of the contact drum.

The contact drum, which, in the examples given, has a diameter of about 3 inches, and length of 10 inches, may be made from a bronze alloy of the nature of beryllium bronze or aluminum bronze, or from any highly electrically conductive metal having a surface hardness sufficient to withstand the wear to which it is subjected. Mill tests have shown that an aluminum bronze drum—in one instance a drum having a composition of approximately 7.5% aluminum, 2% silicon and the remainder copper—will have a drum wear life of about three to four times that of a drum made from beryllium bronze. Aside from improved wear of the drum itself, when an aluminum bronze drum has been used for a period of 600 hours, only a scattered few wires of the contact braid are cut during the life of the drum. When beryllium bronze has been used as the drum material, neraly half of the contact braid wires have been cut through when in use for a much shorter operating period.

The reason for the great improvement with the aluminum bronze material is not clear, but it is believed that it may be due to formation on the drum surface of a protective aluminum oxide film which is electrically conductive, as well as wear-resistant and non-galling when running against copper braid wires.

The apparatus described herein comprises a lightweight assembly, which can be readily removed or replaced when contact roll changes are necessary, or when replacement parts to the assembly itself are required. Damage to parts during removal or replacement of the assembly is substantially completely obviated. Moreover, the assembly provides a self-supporting device of high electrical efficiency and low drag torque.

The invention is not limited to electroplating, but can be applied to any electrical operation where current is collected from a rotating conductive member of cylindrical configuration.

I claim:

1. In a liquid cooled current collecting device, the combination which comprises a contact drum secured at one end to a rotary contact member, a housing enclosing said drum, a contact plate attached to said housing and a plurality of pliable contact sections secured at one end to said contact plate and aligned in a helical configuration around the periphery of, and in contact with, said drum, a rotatable ring mounted in said housing and securing the other end of said contact sections, means to maintain torque on said ring, and means for changing the degree of torque on said ring.

2. In a liquid cooled current collecting device, the combination which comprises a contact drum secured at one end to a rotary contact member, a housing enclosing said drum, a contact plate attached to said housing and a plurality of pliable contact sections secured at one end to said contact plate and aligned in a helical configuration around the periphery of, and in contact with, said drum, dual rotatable rings mounted in said housing and securing the other end of said contact sections, means to maintain torque on said rings, and means for changing the degree of torque on said rings.

3. In a liquid cooled current collecting device, the combination which comprises a metal contact drum secured at one end to a rotary contact member, a metal housing enclosing said drum and supported on said drum, a metal contact plate attached to said housing and a plurality of pliable metal contact sections secured at one end to said contact plate and aligned in a helical configuration around the periphery of, and in contact with, said drum, a rotatable ring mounted in said housing and securing the other end of said contact sections, means to maintain torque on said ring, and means for changing the degree of torque on said ring.

4. In a liquid cooled current collecting device, the combination which comprises a metal contact drum secured at one end to a rotary contact member, a metal housing enclosing said drum and supported on said drum, a metal contact plate attached to said housing and a plurality of pliable metal contact sections secured at one end to said contact plate and aligned in a helical configuration around the periphery of and in contact with, said drum, dual rotatable rings mounted in said housing and securing the other end of said contact sections, means to maintain torque on said rings, and means for changing the degree of torque on said rings.

5. In a liquid cooled current collecting device, the combination which comprises a metal contact drum secured at one end to a rotary contact member, a metal housing enclosing said drum and supported on said drum, a metal contact plate attached to said housing and a plurality of metallic braids secured at one end to said contact plate and aligned in a helical configuration around the periphery of, and in contact with, said drum, a rotatable ring mounted in said housing and securing the other end of said contact sections, means to maintain torque on said ring, and means for changing the degree or torque on said ring.

6. In a liquid cooled current collecting device, the combination which comprises a bronze contact drum secured at one end to a rotary contact member, a housing enclosing said drum, a contact plate attached to said housing and a plurality of pliable contact sections secured at one end to said contact plate and aligned in a helical configuration around the periphery of, and in contact with, said drum, a rotatable ring mounted in said housing and securing the other end of said contact sections, a plurality of springs for supplying torque to said ring, a combination rotatable spring tension and liquid sealing ring for supplying tension to said springs, and means for securing said spring tension ring in fixed position.

7. In a liquid cooled device for collecting current from a rotatable contact roll, the combination which comprises an aluminum bronze contact drum secured at one end to said roll, a brass housing enclosing said drum and supported thereon, a brass contact plate attached to said housing and a plurality of copper wire braid contact sections secured at one end to said contact plate and aligned in a helical configuration around the periphery of, and in contact with, said drum, dual brass rotatable tension rings mounted in said housing and securing the other end of said contact sections, a plurality of bronze wire springs for supplying torque to said rings, a combination rotatable brass spring tension and liquid sealing ring for supplying tension to said springs and means for securing said spring tension ring in fixed position.

8. In a liquid cooled current collecting device, the combination which comprises a metal contact drum secured at one end to a rotary contact member, a metal housing enclosing said drum and supported on said drum, a metal contact plate attached to said housing and a plurality of pliable metal contact sections secured at one end to said contact plate and aligned in a helical configuration around and in contact with said drum, dual rotatable rings mounted in said housing and securing the other end of said contact sections, restraining means to prevent axial movement of said rings toward said contact plate, and means for applying a variable and controlled torque on said rings sufficient to cause a spiral wrapping of said contact sections about the periphery of said drum.

9. A current collecting device comprising a contact drum adapted to be secured at one end to a rotary contact member, a contact plate disposed around one end of said drum, a rotatable ring disposed about the opposite end of said drum, a plurality of pliable metal contact sections secured at one end to said contact plate and secured at the other end to said ring, and means for rotating said ring a distance sufficient to wrap said contact sections in a helical configuration at least partially around the periphery of said drum and in contact with said drum.

10. A current collecting device comprising a contact drum adapted to be secured at one end to a rotary contact member, a contact plate disposed around said drum at the end nearest said contact member, and in bearing relation therewith, a rotatable ring disposed about the opposite end of said drum in relation to said contact member and in bearing relation with said drum, a plurality of pliable metal contact sections secured at one end to said contact plate and secured at the other end to said ring and means for rotating said ring a distance sufficient to wrap said contact sections in a helical configuration at least partially around the periphery of said drum and in contact with said drum.

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