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CURRENT TRANSFER DEVICE FOR HIGH-SPEED ROTARY SHAFTS

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2 SHEETS—SHEET 1

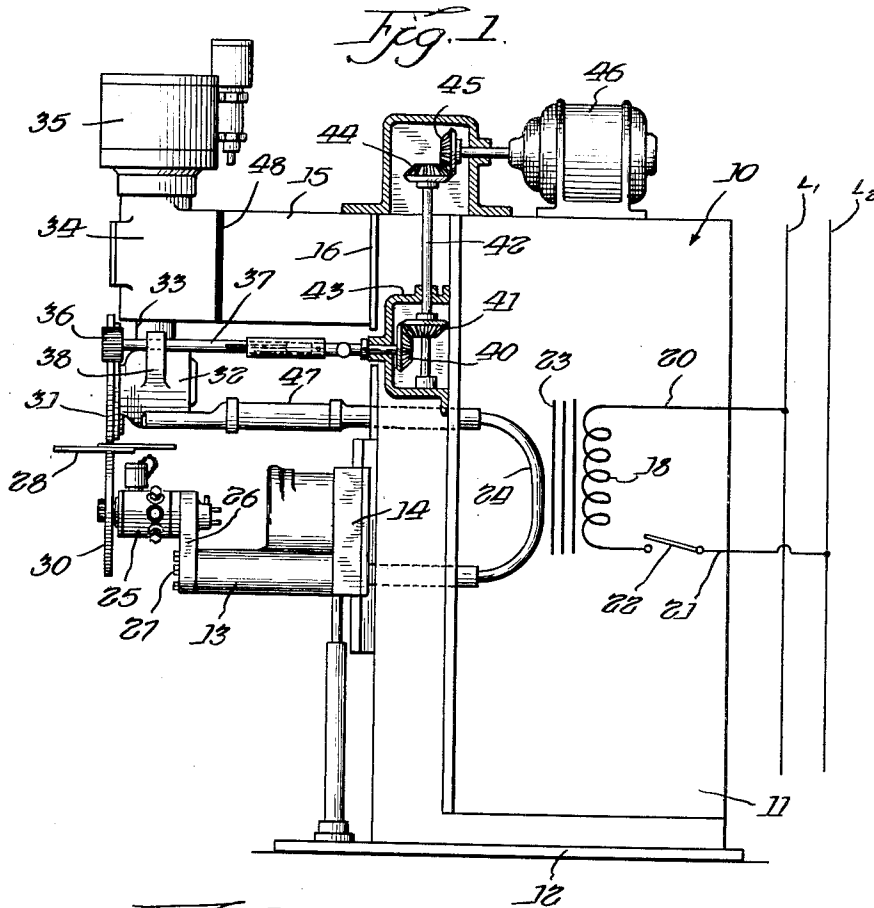


*Fig. 4.*

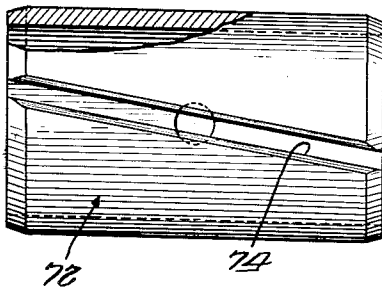
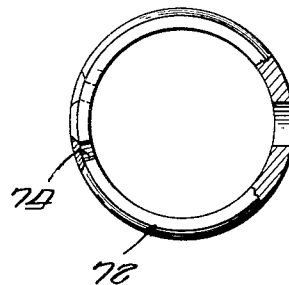


*Fig. 5.*



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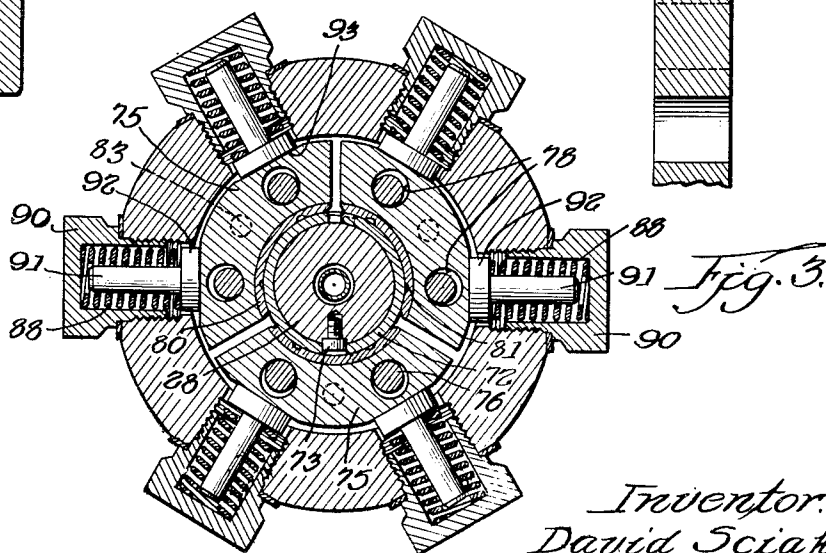
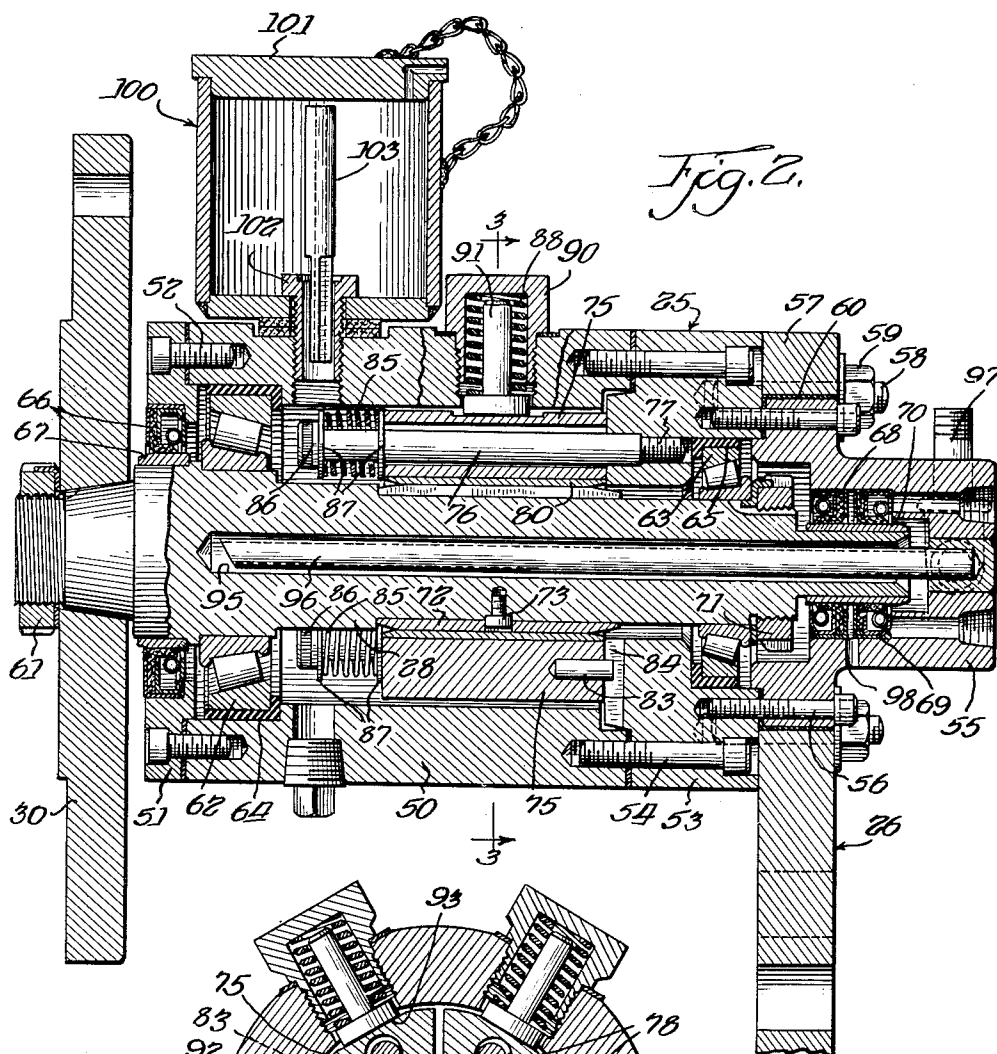
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2 SHEETS—SHEET 2



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## UNITED STATES PATENT OFFICE

2,636,066

## CURRENT TRANSFER DEVICE FOR HIGH-SPEED ROTARY SHAFTS

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7 Claims. (Cl. 173—324)

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The invention relates to electrical apparatus and has reference in particular to current conducting means for high speed rotary shafts such as employed in welding machines where it is necessary to provide a conductive path for high amperage current from a stationary member to a rotary shaft operating at high speeds.

In seam welding machines the wheel-shaped electrode rotates in a bearing and the current is conducted from the bearing to the wheel shaft. The same bearing has to take the radial load applied to the shaft as the wheel is forced under pressure into contact with the workpiece. This radial pressure produces a contact between the shaft and the bearing and enables the current to pass from one part to the other. However, the contact surface between the shaft and bearing is only a linear contact and this results in a high concentration of the current on an extremely narrow contact surface. The resulting heat losses accelerate the wear of the bearing and shaft already caused by radial pressure. Eventually the contact conditions deteriorate and the guiding of the shaft in the bearing becomes inaccurate. Frequent renewal of the shaft and bearing is required in order to maintain the bearing in proper working condition.

In my Patent No. 2,529,634, granted November 14, 1950, and entitled Sliding Contact System for Conducting Electric Current I have disclosed and claimed a sliding contact system incorporating special features of design for conducting current from a stationary member to a rotating shaft in a manner to eliminate detrimental current losses while permitting free rotation of the shaft. The design has been utilized in carrying high current in the neighborhood of 150,000 amperes from the stationary member to the rotating conductor which, however, has had a low speed of rotation, approximately five revolutions per minute. In the device of said application current is conducted from the stationary member through the medium of silver contacts which pass the current to a rotating shaft of high conductivity copper alloy whose surface is harder than the silver of the contacts. Usually a thin shell of the high conductivity hard copper alloy is shrunk onto the copper shaft which conducts the high amperage current to the moving work. Extreme care must be taken to insure that good contact is obtained between the sleeve and the shaft.

An object of the present invention is to provide an electrical contact system incorporating improved constructional features which will adapt the same for transferring high amperage cur-

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rents to a high speed rotary shaft having speeds in excess of 125 revolutions per minute.

Another object is to provide an improved device for transferring high currents from a stationary member to a high speed rotating member and which will eliminate detrimental current losses and provide large contact areas between relatively moving parts so as to reduce the electrical resistance and facilitate transfer of the current.

Instead of the sleeve having a shrunk fit on the shaft the present invention provides a longitudinally split sleeve and which has a loose mounting on the rotary shaft with means being provided to hold the split sleeve to the shaft and to insure rotation of the sleeve with the shaft. The sleeve is split in order to allow the sleeve to breathe whereby to take up any change in size due to the difference in rate of expansion and contraction between the sleeve and shaft.

A further object is to provide a device as described which will employ current conducting segments in combination with the longitudinally split sleeve for transferring current from a stationary housing member to a rotating shaft journaled thereby, and wherein the segments have sliding contact with the sleeve and are so resiliently mounted that the floating condition of the segments permits them to follow any surface irregularity and to also compensate for the normal play which may exist in the roller or ball bearings.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings which illustrate an embodiment of the invention and wherein like reference characters are used to designate like parts—

Figure 1 is an elevational view of a resistance welding machine of the seam welding type which embodies the improvements of the invention;

Figure 2 is a sectional view of the driven wheel assembly of the seam welder of Figure 1 illustrating the improved electrical contact system of the invention for conducting current from the stationary supporting member to the shaft of the rotating electrode wheel;

Figure 3 is a transverse sectional view taken substantially along line 3—3 of Figure 2;

Figure 4 is an elevational view, parts being shown in section, of the split sleeve; and

Figure 5 is an end elevational view of the split sleeve as shown in Figure 4.

Referring to the drawings, which show one industrial application of the present invention, the resistance welding machine of the seam welder type is designated generally by numeral 10 and consists of a frame 11, a bottom supporting plate 12, a lower electrode arm or supporting member 13 fixed to the frame as at 14, and an upper arm 15, likewise fixed to the frame as at 16. Resistance welding machines are supplied with electric current from an alternating current source such as indicated by the leads L<sub>1</sub>, L<sub>2</sub>, and to which is electrically connected the primary winding 18 of the machine by the conductors 20 and 21. In order that the current supply from the alternating current source to the primary winding may be interrupted by the operator some form of switch means is interposed in the primary circuit such as the switch 22 in conductor 21. The primary winding 18 constitutes one element of the welding transformer which includes an iron core 23 of high permeability and a secondary winding 24 comprising one or more turns of a copper bar of considerable thickness.

The lower arm 13 supports a housing 25 by means of the member 26 suitably bolted to arm 13 by the bolts 27. The housing 25 journals a shaft 28, better shown in Figure 2, to which is suitably secured the lower electrode wheel 30, the journalling means for the shaft and the manner of conducting current from housing 25 to the shaft and thus to the wheel being clearly shown in Figure 2. The upper electrode wheel 31 is adapted to contact a workpiece such as 28 interposed between the electrode wheels 30 and 31, as shown in Figure 1, the said upper electrode wheel being suitably journaled by member 32 secured to plunger 33 and mounted for vertical movement with said plunger by means of the head 34. The head 34 forms part of the upper stationary arm 15 and said head includes the pressure chamber 35 which mounts a piston, not shown, for reciprocating movement to effect up and down movement of plunger 33, the member 32 and also the upper electrode wheel 31. Said wheel 31 may be suitably driven as by the driving wheel 36 fixed to shaft 37 and journaled by the arm 38 integral with member 32. At the opposite end of shaft 37 the pinion 40 is keyed thereto and said pinion meshes with pinion 41 keyed to the vertical shaft 42 suitably supported for rotation by bracket 43. By means of pinion 44 on shaft 42, which meshes with pinion 45 driven by the electric motor 46, power is supplied to the driving wheel 36 for effecting rotation of the upper electrode wheel 31. The structure allows for movement of member 32 in a vertical direction, which movement is necessarily limited since it is only required that the electrode wheels be spaced apart a short distance to allow the location of a workpiece between the same. High amperage current is conducted to member 32 by the conductor 47 which is suitably secured to member 32 and extends rearwardly of the same to electrically connect with one terminal of the secondary circuit 24. The other terminal of the secondary circuit is electrically connected to the lower stationary arm or member 13 and from said arm the circuit is completed through 26, housing 25 and shaft 28 to the electrode wheels. The head 34 is suitably insulated from arm 15 by the insulating strip 48.

Referring more particularly to Figure 2, the housing 25 constitutes an assembly of several annular members including annular member 50 to which is secured the face plate 51 by means of the securing bolts 52. The second annular mem-

ber is designated by numeral 53 and said member is suitably secured to 50 by means of bolts 54. An end cap or end closure 55 is bolted to member 53 by bolts 56 and the assembled housing 25 is suitably supported by member 26 which provides an annulus 57 at its upper end, the same having encircling relation with the end cap 55 and being bolted to member 53 by the threaded bolts 58 to which are threaded the nuts 59. It is contemplated that a gasket of insulating material or the like, identified by numeral 60, will be interposed between the end cap 55 and the annulus 57 whereby to assist in insulating the end cap from member 26, which member carries the high amperage currents to the housing 25. For this purpose good electrical contact should exist between member 26 and member 53 and said contact is insured by the securing bolts 58 and nuts 59.

The members 50, 53, face plate 51, and the end cap 55, are maintained in assembled relation by the secured relation which they have with each other to form the tubular housing 25 within which is journaled shaft 28, the reduced end of which projects beyond face plate 51. Said projecting end receives the electrode wheel 30, the same being suitably held to the shaft by securing nut 61. The shaft is journaled by means of bearing assemblies of the roller bearing type, assembly 62 having location within member 50 and assembly 63 having location within member 53. It is necessary to insulate the bearing assemblies from their supporting members so that they will not conduct current. Accordingly, it will be seen that assembly 62 is insulated from member 50 by means of the insulation 64. In a somewhat similar manner assembly 63 is insulated from member 53 by the insulation 65. At the forward end of shaft 28, adjacent the electrode wheel 30, an oil seal 66 is provided, the same being mounted in the face plate 51, and bearing against a seal sleeve 67 on shaft 28. At the rear end of shaft 28, which is located within the end cap 55, and which end is accordingly reduced in diameter, a pair of oil seals 68 and 69 are provided, the same being mounted by the end cap 55 and having coaction with the seal sleeve 70. Also at its rear end the shaft 28 is threaded for receiving nut 71, which is suitably threaded thereto, whereby to retain the shaft in journaled relation by the bearing assemblies 62 and 63 within housing 25.

The intermediate section of shaft 25 is provided with a sleeve 72 of hard metal of low conductivity, such as steel, and which is loosely mounted on shaft 28, being held to the shaft, however, by means of the screws 73 so that the sleeve rotates with the shaft. The sleeve 72 is split longitudinally, thereby providing the slot 74 which extends from end to end of the sleeve and at an angle to the longitudinal axis. The reason for the split in the sleeve is to allow for differential expansion and contraction of the sleeve and shaft material. The shaft 28 is preferably formed of copper, whereas, the sleeve 72 must necessarily be of somewhat harder material such as steel in order to secure the desired toughness and wearing qualities. Since said materials have somewhat different rates of expansion and contraction it is not feasible to shrink-fit the sleeve on the copper shaft. The loose fit provided by the split in the sleeve permits the sleeve to breathe.

Since the sleeve and the shaft 28 between the bearing assemblies is spaced from the housing 25, flow of electric current from the housing to the shaft can only take place through means provided

therefor and which consist in a plurality of segments 75, as best shown in Figure 3. The segments encircle sleeve 72 and in accordance with the invention said segments are resiliently biased in two directions at right angles to each other, one direction being radial so as to maintain the segments in contact with sleeve 72, and the other direction being axial to maintain the segments in contact with the contact face provided by member 53. The segments are supported in a floating manner by means of a plurality of pins 76 which are threadedly secured as at 77 to member 53 so as to extend in a forward direction from the smooth contact face provided by member 53 and in a direction parallel to the longitudinal axis of shaft 28. Each segment is provided with a pair of longitudinally extending openings 78 and the pins 76 extend through the openings which are somewhat larger than the pins to provide for a floating movement of the segments, whereby they are able to take up any surface irregularity in the sleeve and to also compensate for normal wear of the parts and normal play which may exist in the bearing assemblies.

The segments may be formed entirely of silver in order to insure good conductivity in the transfer of the high amperage currents from member 53 to shaft 28, or, as disclosed in the drawings, the segments may be of copper having a thin facing of silver on their interior surface, such as indicated by 80. It may be desirable to provide the silver facings 80 with oil grooves such as indicated by numeral 81. Guiding members for each segment are provided by means of a pin 83 fixed to the segment and projecting from the rear end thereof for coaction in slot 84, which extends in a radial direction in the contact face provided by member 53.

The pins 76 receive coil springs 85 which have telescoping relation therewith and which are held on the pins by the capped end 86. A washer 87 is located at each end of a spring 85 and it will be seen that the coil spring assembly is positioned on the pins 76 in a manner to resiliently force the segments in an axial direction whereby to maintain the segments in good electrical contact with the contact face of member 53. Other coil springs 88, each retained within a spring retaining cap 90, are provided for the purpose of resiliently biasing the segments in a radial direction. A pin 91 is associated with each coil spring and said pin at its end adjacent the segment is provided with a head 92 which directly contacts the segment, for which purpose the segment is provided with a flattened section such as indicated by numeral 93. The action of the radial coil springs 88 is to press the heads 92 of their pins against the segments and since the pressure is in a radial direction the segments are resiliently forced in a radial direction to maintain pressure contact between the segments and the sleeve 72.

From the foregoing, it will be seen that the axial and radial pressures exerted on the lower electrode wheel 30 will be taken up by shaft 28 which is suitably guided and journaled by the bearing assemblies 62 and 63. The segments 75 undergo no reaction due to these pressures exerted on the wheel. The segments are at all times maintained in pressure contact with housing 25 and with the sleeve 72, constituting part of shaft 28, so as to provide a path of high conductivity for transferring the high amperage currents from the housing to the shaft and which operate efficiently, notwithstanding the high rotary speeds contemplated for shaft 28. It is possible for shaft

28 to rotate at speeds in excess of 125 revolutions per minute and high amperage current will be efficiently conducted to the shaft without any noticeable detrimental effect on the condition of the surfaces even after many thousand revolutions of the shaft. It will be noted that the segments are spaced with respect to each other to provide recesses therebetween and which recesses are parallel to the axis of the shaft. Said recesses act in a manner to collect any metal particles which may result from operation, and in this manner the small metallic particles are prevented from galling the shaft or the segments so as to avoid excessive wear which would otherwise take place.

It is desirable to cool the rotating shaft and to also maintain the parts of the present contact system immersed in oil. For cooling the shaft the same is provided with a central bore indicated by numeral 95 extending longitudinally thereof and into which projects the liquid conducting pipe 96. Cooling liquid is supplied to the pipe 96 by means of the exteriorly located threaded nipple 97 and it is contemplated that a suitable discharge opening will be provided in the end cap 55 for draining the liquid accumulating within the end cap. The opening 98 functions as a drain for the cooling liquid such as may collect between the oil seals 68 and 69. The numeral 100 indicates an oil reservoir having a cover 101, the reservoir being suitably secured by the nipple 102 which has threaded engagement with member 50 to provide a passage to the interior of the member so that oil contained by the reservoir may be supplied to the moving parts housed by the housing 25. Numeral 103 designates a breathing tube for the oil reservoir since it is contemplated that the reservoir will be maintained approximately full so as to maintain the parts of the present contact device completely immersed in the oil, such as castor oil or similar lubricant.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings, as various other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. A current conducting device for high speed rotary shafts, the combination with a current conducting member and a shaft journaled by said member for rotation, a sleeve of low conductivity hard material loosely mounted on the shaft but held so as to rotate with the shaft, said sleeve being split from end to end at a slight angle to the longitudinal axis whereby to permit differential expansion and contraction of the sleeve and shaft material, a plurality of segments of highly conductive metal interposed between the member and sleeve and having contact with each, means applying pressure to the segments in two directions to maintain a pressure contact of the segments with both the member and the sleeve, and other means completing an electric circuit including said member, the segments, sleeve and shaft.

2. A current conducting device for high speed rotary shafts, the combination with a current conducting member and a shaft journaled by said member for rotation, a sleeve of conductive metal mounted on the shaft intermediate its ends, said sleeve having a helical slot longitudinally thereof to allow differential expansion and

contraction of the sleeve and shaft material, means holding the sleeve to the shaft so that the sleeve rotates with the shaft, a plurality of segments of highly conductive metal interposed between the member and the sleeve and having smooth surfaces disposed at right angles to each other for contact with smooth surfaces provided by the member and sleeve respectively, means applying pressure to the elements individually to maintain the contacting surfaces in engagement, and other means completing an electric circuit through the member, the segments, the sleeve and shaft.

3. A current conducting device for high speed rotary shafts, the combination with a current conducting member and a shaft journaled by said member for rotation, a sleeve of conductive metal mounted on the shaft intermediate its ends, said sleeve having a helical slot longitudinally thereof to allow differential expansion and contraction of the sleeve and shaft material, means holding the sleeve to the shaft so that the sleeve rotates with the shaft, a plurality of segments of conductive metal in surrounding relation with the sleeve and having smooth surfaces disposed at right angles to each other for contact with smooth surfaces provided by the member and sleeve, respectively, coil springs applying pressure to the segments in an axial direction and other coil springs applying pressure to the segments in a radial direction to maintain the contacting surfaces in engagement, and means completing an electric circuit through the segments and the sleeve.

4. In a resistance welding machine, in combination, a current conducting member, a shaft journaled by the member and having an electrode wheel secured thereto, said member providing a contact face intermediate the length of the member and disposed normal to the axis of the shaft, a longitudinally split sleeve loosely mounted on the shaft adjacent the location of said contact face, means fixed to the shaft and located in the slot provided by the longitudinally split sleeve for effecting rotation of the sleeve with the shaft, a plurality of segments of conductive metal disposed in surrounding relation with the sleeve and adapted to contact the sleeve and also said face, coil springs individually applying pressure to the segments in an axial direction to maintain the segments in contact with the face, and other coil springs individually applying pressure to the segments in a radial direction to maintain the same in contact with the sleeve.

5. A resistance welding machine as defined by claim 4, wherein the split in the sleeve is at an angle to the longitudinal axis to facilitate lubrication of the moving parts and the sliding contact of the segments with the sleeve, and additionally including ball bearing assemblies at the respective ends of the shaft for journaling the shaft, and means insulating the bearing assemblies to prevent flow of current through the same.

6. A resistance welding machine as defined by claim 4, wherein the sleeve is loosely mounted on the shaft to permit differential expansion and contraction of the sleeve and shaft material, and additionally including a plurality of pins disposed in spaced relation around the shaft and supporting and positioning the segments, said pins preventing rotation of the segments with the shaft, and said pins supporting the axial coil springs which have telescoping relation with the pins.

7. In a resistance welding machine, in combination, a current conducting member, a shaft journaled by the member at its respective ends by bearing assemblies but being spaced from the member between the bearing assemblies, said member providing a smooth surfaced contact face disposed normal to the axis of the shaft and located between the bearing assemblies, a longitudinally split sleeve loosely mounted on the shaft but held so as to rotate with the shaft and disposed adjacent the contact face, a plurality of segments in surrounding relation with the sleeve and adapted to contact the sleeve and said face, a plurality of pins fixed to the member and extending in an axial direction from the contact face of the member, said pins supporting the segments respectively in a manner permitting limited floating movement of each segment independently of the other segments, coil springs individually applying pressure to the segments in a radial direction to maintain the same in contact with the sleeve, and other coil springs supported by the pins and individually applying pressure to the segments in an axial direction to maintain the same in contact with the contact face.

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