Dec. 27, 1966 O. VON MOSSIN 3,295,091

LIQUID CONTACT ARRANGEMENT BETWEEN RELATIVELY ROTATABLE CONDUCTORS

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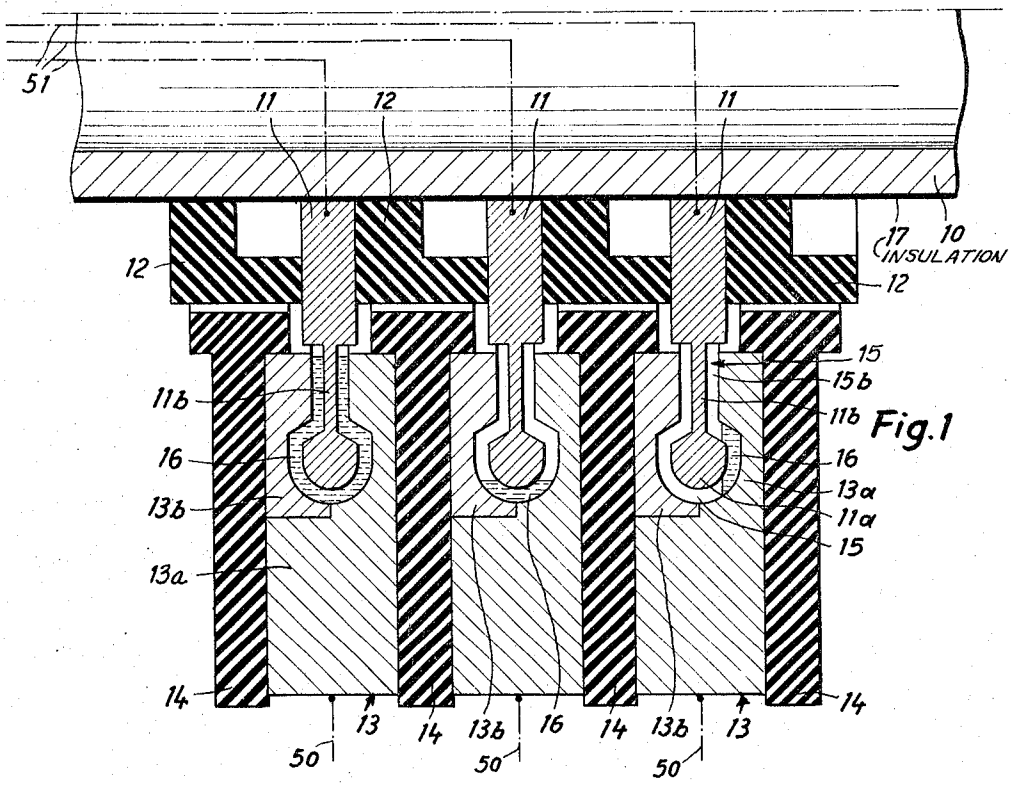

Fig.1

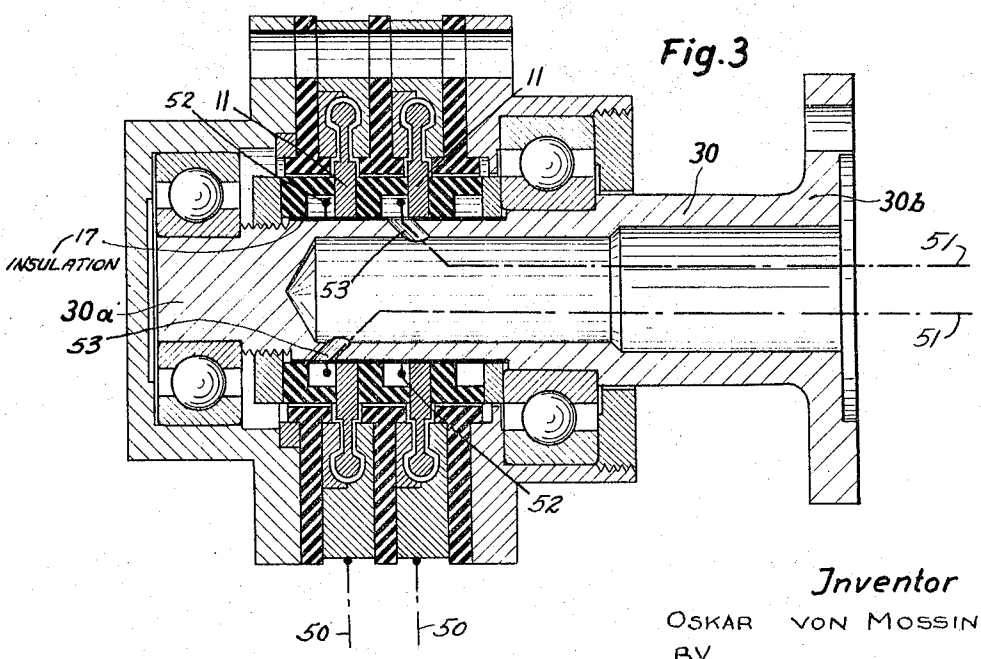

Fig.3

Inventor

OSKAR VON MOSSIN

BY

Kenyon & Kenyon

ATTORNEYS

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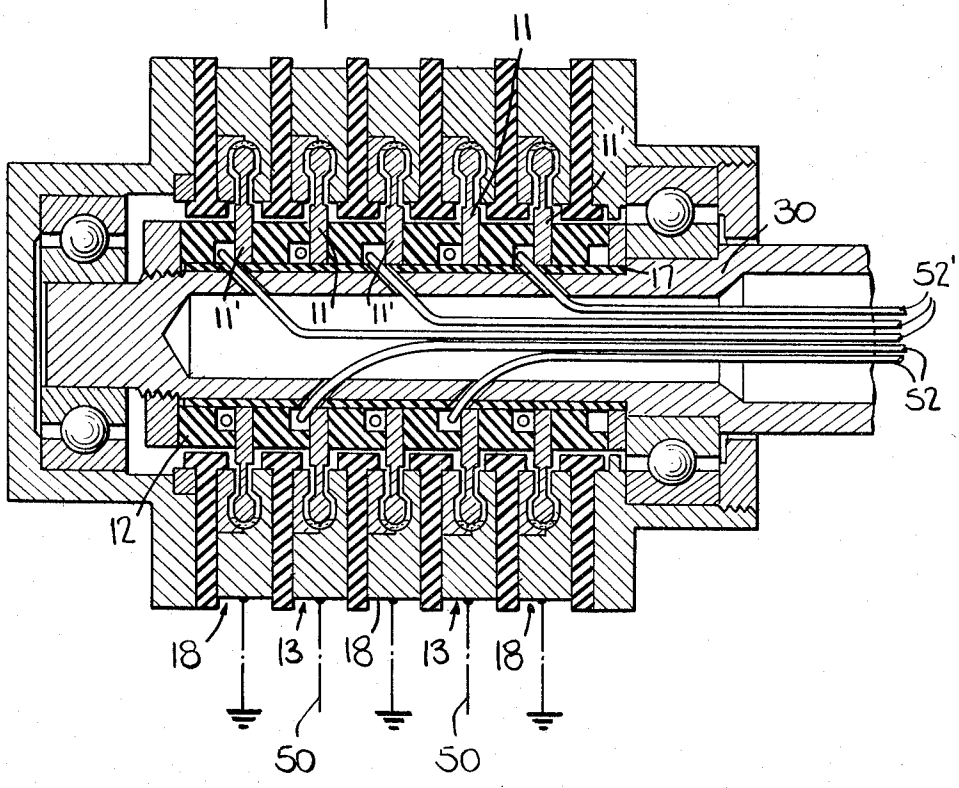
Fig. 1A.



INVENTOR.
OSKAR VON MOSSIN

BY
Kenyon & Kenyon
ATTORNEYS

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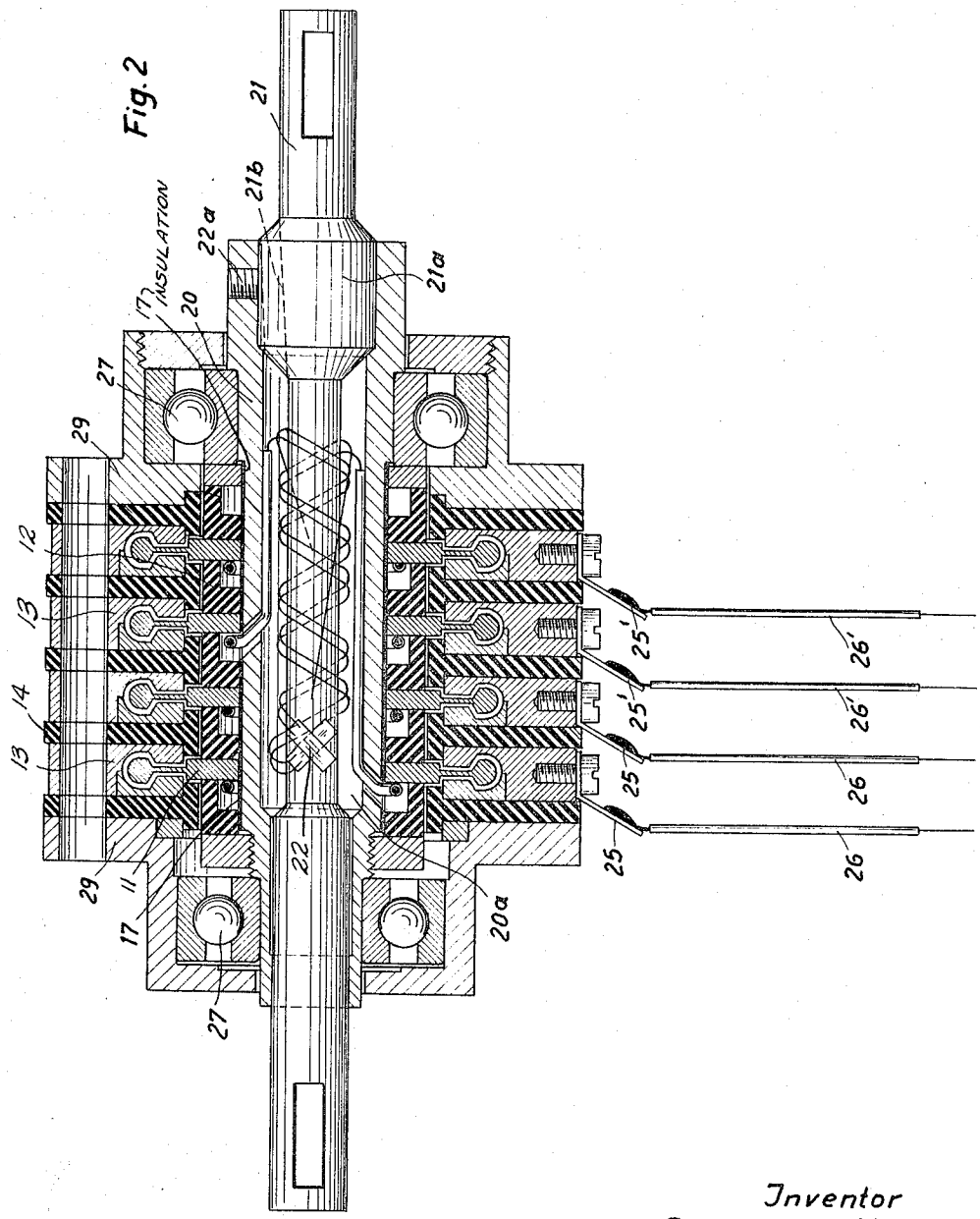
Fig. 2



Inventor
OSKAR VON MOSSIN
BY
Kenyon & Kenyon
ATTORNEYS

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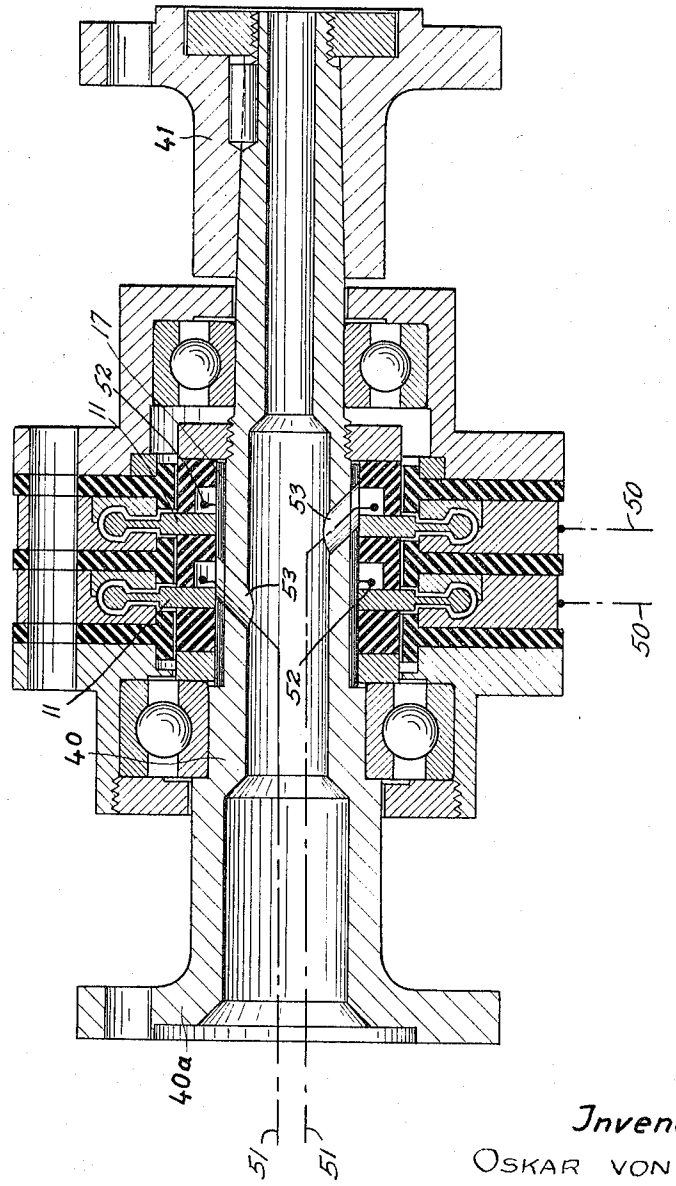
Fig. 4



Inventor
OSKAR VON MOSSIN
BY
Kenyon & Kenyon
ATTORNEYS

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LIQUID CONTACT ARRANGEMENT BETWEEN RELATIVELY ROTATABLE CONDUCTORS

Oskar von Mossin, 3 Kennedy-Damm, Dusseldorf, Germany

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4 Claims. (Cl. 339—5)

The invention relates to a contact arrangement for transmitting electric currents between relatively rotatable conductors, in which electric conductive discs, insulated from each other, dip into a liquid electric conductor accommodated in annular chambers.

Contact arrangements of the above-mentioned type are known in which the chambers for accommodating the liquid electric conductor are located in a housing of an electric insulating material. On this housing, terminals are mounted each of which projects with one end into its respective chamber and is thereby in electric contact with the liquid electric conductor. In these contact arrangements the capacitance between the individual contact elements assumes different values because the ring formed by the liquid electric conductive material changes according to the position of the arrangement and the speed of rotation. In many cases this is undesirable, especially when the contact arrangement is to be used for transmitting high-frequency measuring currents. In addition the known contact arrangements can as a rule only be used when their axis is horizontal.

The object of the invention is primarily to produce a contact arrangement of the type mentioned at the outset, in which the disadvantages of the known arrangements are avoided.

For this purpose the chambers containing the liquid conductor (contact chambers) each have a substantially closed electric conductive screening.

At the same time the contact chambers themselves may be of electric conducting material.

In this manner it is possible, according to the invention, to keep the capacitance between the individual contact elements constant independently of the distribution of the liquid electric conductor in the contact chambers.

The annular contact chambers are preferably of such cross-section that each chamber receives and contains the liquid electric conductor independently of the axial position of the arrangement when the arrangement is at a standstill. This enables the contact arrangement to be used in any position.

At the same time the cross-section of the contact chambers can be enlarged at the periphery and narrowed towards the axis. The cross-section of the contact discs is also enlarged within the cross-sectional enlargement of the contact chambers.

It is advisable to make the peripheral edge of the contact discs of substantially semicircular shape in outward direction and the periphery of the chambers surrounding this edge correspondingly hollow or concave. This ensures the smoothest possible flow of the contact medium even at high speeds of rotation.

It is also advantageous to arrange rotatable screening discs between the current transmitting contact points. This prevents inductive influences between the measuring circuits.

The part of the arrangement carrying the contact discs

is preferably constructed as a hollow shaft. This hollow shaft may be slip-on or flanged. In the latter case it has a flange at one or both ends.

Several embodiments of the invention are illustrated by way of example in the accompanying drawings, in which

FIG. 1 is a diagrammatic longitudinal section showing half the contact arrangement, and

FIG. 2 a longitudinal section of a contact arrangement with a hollow shaft to be slipped on to a measuring shaft, while

FIGS. 1*a*, 3 and 4 show further embodiments of the invention.

In FIG. 1 a hollow shaft designated by **10** is provided with an electrically insulating coating **17**. Contact discs **11** are mounted on this shaft and separated from each other by spacers **12** of insulating material. The cross-section of contact disc portion **11***b* is reduced while the cross-section of portion **11***a* is again enlarged.

Metal discs **13** are separated by spacers **14** of an electric insulating material and have a close leak-proof fit in the device. After insertion of the respective contact discs **11**, metal discs **13** may, for example, be screwed into place in a leak-proof manner. The metal discs **13** are composed of parts **13***a* and **13***b* and contain contact chambers, indicated generally by reference numeral **15**, which have an annular part **15***b* of narrowed cross-section and an outer part **15***a* of widened cross-section. These chambers contain a liquid electric conductor **16** such as mercury or gallium, into which the contact discs **11** dip, with the result that the electric contact is established between the contact discs and the annular discs **13** containing the contact chambers. Any good conductive liquid which retains its liquid state in the temperature range coming into question can be used as contact medium. Mercury or gallium is preferably used as the contact medium. The chemical composition of the medium should be such that both when standing idle and also in the case of slow and high speed rotation, any chemical change in the contact material is as far as possible avoided for a long period. The conductive liquid **16** may be filled into the contact chambers **15** by means of bore-holes (not shown) in discs **13**. The bore-holes preferably have inside threads and are plugged upon insertion of the conductive liquid by means of threaded screws which prevent leakage of the fluid back through the bore-holes.

Measuring current is tapped for example at terminals **50**, indicated in broken lines, while the leads for the current to be measured are designated by **51**. They are located in the hollow shaft **10** and extend to the contact discs **11**.

As is shown in FIGS. 1–4, the cross-section of chambers **15** shown therein is bottle-like, with the neck portion of the bottle toward the hollow shaft and the interior edges of the neck portions substantially parallel to one another. As is shown in FIG. 1, chambers **15** are so dimensioned that the liquid electric conductor does not flow out of the chambers even when the arrangement is at a standstill, irrespective of the arrangement's axial position. Thus, when the device is at a stand-still, the liquid **16** accumulates in the lowest portion of the chamber. The liquid **16** in the chamber at the left side of FIG. 1 illustrates the level of the liquid when the arrangement is at a stand-still and the device is horizontal. The liquid conductor **16** in the chamber at the right side of FIG. 1 illustrates the level of the liquid when the device

is vertical and rotating rather than at a stand-still; and the liquid conductor **16** in the chamber at the center of FIG. 1 illustrates the level of the liquid when the device is horizontal and rotating. It will be noted that in each case the liquid conductor **16** is in contact both with its respective contact disc **11** and also with its respective conductive disc **13**.

The contact discs **11** are rounded at their outer end and the contact chambers are correspondingly hollow or concave. Owing to this rounding, smooth flow of the contact medium is ensured, even in the case of higher speeds of rotation. The narrow part **11***b* of the contact discs and the narrowed gap of the contact chambers prevent the contact medium from flowing out from the contact chambers both when the contact arrangement is in vertical position and when it is subjected to tremors and vibration.

The arrangement can be used for transmitting currents of any kind. It is particularly suitable for transmitting electric measuring currents of high frequency which are liable to be influenced by different capacitive values between the contact elements. As in the case of the subject matter of the invention the outer shape of the screenings between the contact chambers always remains the same, the capacities also remain constant.

If inductive influencing between the measuring currents is also to be eliminated, additional elements **18** are provided which are grounded and arranged, for example, between each two current-conducting contact elements as shown in FIG. 1*a*. In FIG. 1*a*, grounded, rotatable shielding discs **18**, of a conductive material, are shown on either side of conductive discs **13** which have terminals **50**, shown in broken lines, for tapping current from the discs. Leads **52** are electrically connected to the contact discs **11** which extend within discs **13**, and leads **52'** are electrically connected to the contact discs **11'** which extend within the grounded discs **18**. Except for the addition of grounded elements **18** between the conducting contact discs **11**, the arrangement of FIG. 1*a* generally corresponds to that of FIG. 3. For example, it includes an insulation coating **17** and spacers **12** as in the arrangement of FIG. 3, and a hollow shaft **30'**.

FIG. 2 shows an embodiment of the contact arrangement with four contact points for transmitting measuring currents influenced by two elongation measuring strips or strain gauges **22** which serve to measure the torque transmitted by shaft **21**. As is shown in FIG. 2, the contact for one of the strain gauge leads is electrically connected to the first contact disc **11** from the left of FIG. 2, and the contact for the other of the strain gauge leads is electrically connected to the third contact disc **11** from the left of FIG. 2. Other contacts are provided in a corresponding manner for the second and fourth contact discs **11** from the left. The hollow shaft designated by reference numeral **20** carries contact discs **11** which are separated from each other by insulating spacers **12**. The contact chambers are defined by conductive discs designated by reference numeral **13**. They are separated from each other by insulating spacers **14**. The hollow shaft **20** is provided with a coating **17** of insulating synthetic resin. **29** are end caps which accommodate the ball bearings **27** with the aid of which the outer part of the arrangement is mounted on the hollow shaft **20**.

Reference numerals **25** and **25'** respectively designate the terminals connected to the contact chambers to which the leads **26** and **26'** are connected. These leads **26** and **26'** serve, for example for feeding and conducting high frequency strain gauge measuring currents. One of the two strain gauges shown in FIG. 2 is shown in circuit with elements **25** and **26**, and the other is shown in circuit with elements **25'** and **26'**.

In the hollow shaft **20**, a measuring or testing shaft **21** is arranged, the fluctuations in torque of which are to be measured, for example, with the aid of the elongation strips **22**. The hollow shaft has a part **20***a* with enlarged internal diameter in which the testing shaft **21** provided with a collar **21***a* is inserted. This collar **21***a* may be provided with a bore **21***b* if the measuring point is located outside the hollow shaft **20**. Reference numeral **22***a* designates a screw-threaded bore for a grub screw by means of which the measuring shaft **22** is connected with the hollow shaft **20**.

In the embodiment illustrated in FIG. 3, the contact discs are arranged on a hollow shaft **30**, the end **30***a* of which is mounted on the housing containing the contact chambers, whereas the other end of the hollow shaft is constructed as a flange **30***b* to which some rotating part can be rigidly connected. Reference numerals **50** designate the terminals and leads, shown in broken lines, for tapping the testing current, and reference numerals **51** designate the leads for the current to be measured in the torque tube. The openings from the inside of the torque tube past insulation **17** to contact discs **11** are designated by reference numeral **53**, and the electrical connectors at the contact discs are designated with reference numeral **52**.

The contact arrangement is built up like a box of bricks, that is, more or fewer contact elements can be arranged side-by-side so that a large number of currents can be transmitted, for example, measuring values for power, torque, work, output, speed, acceleration, temperature, hydrogen ion concentration, and so forth. All other conceivable signals of electronic circuits can also be transmitted, for example, signals of radar installations or television plants, also in the case of different carrier frequencies.

The number of contact elements arranged in series in a contact arrangement cannot be increased indiscriminately on account of the relatively narrow permissible length tolerances. This disadvantage can be overcome by arranging several self-contained contact arrangements in series. For this purpose the hollow shaft **40** as shown in FIG. 4 is provided with a flange at each end. The flange **40***a* can, for example be connected with a rotary measuring shaft and the flange **41** with another contact arrangement.

What I claim is:

1. A contact device for the transmission of electrical currents between relatively rotatable conductors comprising:

(1) a plurality of electrically conductive, mutually insulated members each of which forms an annular chamber,

(2) an electrically conductive liquid within the chambers,

(3) a plurality of electrically conductive, mutually insulated disc-like members, at least a portion of each of said disc-like members entering a chamber and contacting said liquid therewithin,

each chamber having a portion opposite to the side of the chamber through which a disc-like member enters which is wider than the portion of the chamber adjacent to the side of entry of said disc-like member, and

each disc-like member having

(a) an edge portion which is within a chamber and is wider than said portion of the chamber adjacent to the side of entry of said disc-like member, and

(b) a portion outside of any of the chambers which is wider than and overlies a said portion of the chambers adjacent to the side of entry of said disc-like member.

2. A contact device according to claim **1** wherein a portion of the periphery of said edge portions of said disc-like members is substantially semicircular in cross-section and wherein a portion of the inner periphery of the chambers is concave and substantially semicircular in cross-section.

3. A contact device according to claim **1** wherein the chambers are bottle-like in cross-section and each have a

neck portion with sides substantially parallel to one another, and an outside portion which is proportioned such that a portion of said electrically conductive liquid remains within the chambers when the contact device is stationary, irrespective of the attitude of the chambers.

4. A contact device according to claim 1 further characterized by a rotatable screening disc between each pair of adjacent disc-like members.

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EDWARD C. ALLEN, *Primary Examiner.*

ALFRED S. TRASK, *Examiner.*