Method of and device for the spark erosion of hardmetal objects.

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Proprietor: N.V. Philips' Gloeilampenfabrieken
Groenewoudseweg 1
NL-5621 BA Eindhoven (NL)

Inventor: de Beurs, Hans
c/o INT. OCTROOIBUREAU B.V., Prof.
Holstlaan 6
NL-5656 AA Eindhoven (NL)
Inventor: Rekers, Antonius Theodorus
c/o INT. OCTROOIBUREAU B.V., Prof.
Holstlaan 6
NL-5656 AA Eindhoven (NL)

Representative: Weening, Cornelis et al
INTERNATIONAAL OCTROOIBUREAU B.V.
Prof. Holstlaan 6
NL-5656 AA Eindhoven (NL)

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Description

The invention relates to a method of machining a hardmetal object by means of spark erosion in an aqueous solution, utilizing measures which counteract corrosion of said object. The invention also relates to a spark-erosion device comprising a work vessel and a sparking wire electrode which is led through said work vessel.

Using the spark-erosion technique, hardmetal objects having a complicated or a simple configuration can be rapidly and accurately manufactured. For this purpose, a spark-erosion device is used which comprises a metal sparking wire electrode. In the spark-erosion process, said wire electrode is usually kept at a negative, pulsed, electric voltage of maximally several hundreds of volts relative to the object to be machined. Said wire electrode can be used to cut the hardmetal, because under the influence of electric discharges particles are removed from the hardmetal. Hardmetal objects are to be understood to mean, in particular, objects of sintered metallic carbides and borides which also comprise up to several tens of percents by weight of metals as binders. A well known and advantageously used example thereof is sintered WC comprising 10% by weight of Co.

Spark erosion takes place under a liquid in a work vessel. At present, demineralized water is preferably used for this purpose. Said liquid has a desired, high electric resistance of at least 5.10^8 Ohm.cm. Organic compounds increasing the discharge stabilization and/or reducing the wear of the wire electrode, may be dissolved in said demineralized water. Spark erosion of hardmetal objects in aqueous solutions has disadvantages. From European Patent Specification No. 176.224, it is known that corrosion of the faces which are cut in the object in the spark-erosion process may occur. In EP 176.224, a special bipolar pulse frequency of the voltage on the sparking wire electrode is proposed to alleviate this corrosion problem. Applicants have established that this measure is insufficient. The use of a bipolar pulse frequency does not provide a complete protection against corrosion of the hardmetal object.

It is an object of the invention to provide, inter alia, a method for the spark erosion of a hardmetal object in an aqueous solution, in which method hardly any or no corrosion at all takes place. A further object of the invention is to provide a spark-erosion device for machining hardmetal objects under conditions such that hardly any or no corrosion of the hardmetal takes place.

These and other objects of the invention are achieved by a method of the type mentioned in the opening paragraph, which is characterized in that during the spark-erosion process the object is cathodically protected by means of a protective electrode which is present in the solution and which is electrically connected to the object via an external power source.

The invention is also based on an improved insight in the corrosion processes which play a role in the spark erosion of hardmetal objects in aqueous solutions. Applicants have established that, in fact, two different corrosion processes are involved.

One of said corrosion processes is caused by the fact that the hardmetal to be machined is at a time-averaged positive electric potential relative to the wire electrode. This type of corrosion is often termed galvanic corrosion. It causes the faces cut in the object to be attacked. This type of corrosion can be reduced by adapting the pulse shape of the spark potential between the sparking electrode and the object to be machined.

The other corrosion process is caused by the surprisingly high corrosion current which hardmetal objects bring about in demineralized water. Said corrosion current is caused by the dissolution of the binder of the hardmetal. In the case of hardmetal on the basis of WC comprising Co as a binder, Co dissolves in the form of Co²⁺, which is a result of which the hardmetal is negatively polarized relative to the aqueous solution. The dissolution of the binder particles causes the surface of the hardmetal to be weakened, so that the machining can readily take place when the hardmetal is subjected to a mechanical load. Said machining may take place, in particular, when the machined hardmetal object is used as a stamping or punching tool.

Unlike the former corrosion process, the latter corrosion process does not only take place at the cut faces but throughout the surface of the hardmetal object in so far as it is present in the aqueous solution. It has been proved that oxygen present in the aqueous solution considerably accelerates the corrosion process. The necessary flushing operation by means of water brings about a relatively high oxygen content in the aqueous solution. Further, it has been found that the latter corrosion process is accelerated due to the negative polarization of the wire electrode. This causes the magnitude of the negative polarization of the hardmetal object to be reduced relative to the aqueous solution during the spark-erosion process. This brings about a higher corrosion current.

The above-mentioned recognition has led to the method according to the invention. By virtue of the cathodic protection by means of an external power source and a protective electrode, the magnitude of the negative polarization of the hardmetal object is increased relative to the aqueous solution during the spark-erosion process. As a result thereof, the corrosion current and, hence, the corrosion of the hardmetal are substantially reduced. Said corrosion reduction takes place throughout the surface of the hardmetal.

As the protective electrode is polarized relative to the hardmetal object, a protective current is created in the aqueous solution, said protective current being
opposite to the corrosion current. To attain sufficient
protection against corrosion, the protective current
must at least be equal to the corrosion current. Prefer-
ably, the protective current is a few times higher
than the corrosion current.

Further it has been found that cathodic protec-
tion by means of a standard sacrificial anode, for ex-
ample a Zn-electrode, without external power source
does not lead to satisfactory results. An acceptable
protection against corrosion can be attained by using
a standard rod-shaped Pt-electrode which is electro-
cally connected to the hardmetal object through an
external power source.

A preferred embodiment of the method according
to the invention is characterized in that the protective
electrode is plate-shaped and is held substantially
parallel to a surface to be protected of the hardmetal
object during the spark-erosion process, and in that
the protective electrode is kept at a positive voltage
relative to the object.

It has been found that in this manner a much bet-
ter protection against corrosion can be realised than
by using a rod-shaped, standard Pt-electrode. When
said Pt-electrode is used, a uniform density of the
protective current throughout the surface of the hard-
metal cannot be attained. Due to this, the magnitude of the polarization of the hardmetal relative to the
aqueous solution is not the same everywhere. This
leads to an increased corrosion. When a plate-
shaped, protective electrode is used a uniform cur-
cent density on the surface to be protected of the
hardmetal object can be realised.

Another preferred embodiment of the method ac-
cording to the invention is characterized in that the
object is arranged between two plate-shaped protec-
tive electrodes, and in that the protective electrodes
are kept at a positive voltage relative to the object dur-
ing the spark-erosion operation. In general, the hard-
metal objects are manufactured from a plate-shaped
member. The use of two plate-shaped protective elec-
trodes which are held parallel to the two main surfa-
ces of such a plate-shaped, hardmetal body results in
a two-sided protection against corrosion during the
spark-erosion process.

A further embodiment of the method according to
the invention is characterized in that the protective vol-
tage is 10-100 V. At said voltage, the protective cur-
cent in demineralized water appears to be approxi-
mately 200 μA/cm². This is a number of times higher
than the corrosion current of hardmetal (WC compris-
ing Co as a binder) in demineralized water, which is
20-50 μA/cm². Under said conditions, an excellent
protection against corrosion is obtained.

The invention also relates to a spark-erosion de-
vice comprising a work vessel and a sparking wire
electrode which is led through said work vessel. Ac-
cording to the invention, said device is characterized
in that the work vessel contains one or two electrically
conducting protective electrodes, and in that said
electrode(s) is (are) provided with at least an electric-
connection which can be connected to a hardmetal
object to be machined via an external power source.

A preferred embodiment of the spark-erosion de-
vice is characterized in that one surface of the elec-
trode(s) is electrically conducting and the other sur-
face is electrically insulated. During the spark-
erosion operation, the electrically insulated surface
of the electrode(s) must be facing away from the object
to be machined. It has been found, that it is desirable
to insulate one of the surfaces of each electrode in or-
der to preclude the derangement of the spark gener-
ator as well as the occurrence of leakage currents to
other conducting parts, such as the guide guides and
clamping tools, in the work vessel. The electrically
congducting surface may consist of a layer of electro-
cally conducting material, such as Au or graphite. The
electrically conducting surface preferably consists of
Pt.

A further preferred embodiment of the spark-
erosion device according to the invention is charac-
terized in that the electrode(s) is(are) provided with a
through-hole for the sparking wire electrode, in which
hole an electrically insulating wire envelope is fixed.
Thus, during the spark-erosion process said wire en-
volve, through which the sparking wire electrode
runs, is present between the protective electrode(s)
and the object to be machined. Said wire envelope
may comprise, for example, a synthetic resin sleeve
which is clamped at one end in the aperture of the
electrode. The use of said sleeve results in a consid-
erably improved liquid flow around the sparking elec-
trode at the location where the spark-erosion opera-
tion takes place. By virtue thereof, an improved dis-
charge of the material sparked-off in said operation
is obtained, so that fewer material particles get be-
tween the protective electrode(s) and the machined
object. Thanks to this, the homogeneous, electric
current distribution between the electrode(s) and the
object can be better maintained, so that the protective
current density over the surface to be protected of
the object cannot become too small. Another impor-
tant advantage of the presence of the wire envelope
relates to the protection of the object from galvanic
corrosion. The part of the sparking electrode located
between the object and the electrode(s) could be sub-
ject to said corrosion. Said part of the sparking
electrode is at an average negative voltage of a few
tens of volts relative to the object.

The invention will be explained in greater detail by
means of an exemplary embodiment and with refer-
ence to the accompanying drawing, in which
the Figure shows that part of a spark-erosion
device according to the invention, in which the spark-
erosion process takes place.

The Figure is a diagrammatic, sectional view of

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the part of the spark-erosion device where the actual spark-erosion process takes place. Said part comprises a work vessel 1 which is filled with demineralized water 2. Said work vessel contains two parallel, electrically conducting plates 3, 4 between which there is arranged a hardmetal object 5 to be machined. Said hardmetal object consists of WC comprising Co as a binder. Preferably, the plates 3, 4 largely consist of a synthetic resin carrier 6, 7 which is provided with an electrically conducting layer 8, 9 of Pt at the surface facing the object to be machined. It is alternatively possible to use a carrier 6, 7 of steel plate. In the latter case, the surface of the plates facing away from the object must be provided with an electrically insulating lacquer layer 10, 11. Both plates are connected to the hardmetal object with electrically conducting wires 13 via a d.c. voltage source 12 (diagrammatically shown). During the spark-erosion process the electric voltage was 10-100 V. By virtue thereof, a protective current was attained which was several times higher than the corrosion current. The plates 3, 4 are provided with a through-hole 14, 15. An electrically insulating wire envelope 19, 20 in the form of a sleeve may be provided in the apertures 14, 15, said wire envelope, through which the sparking wire electrode runs, extending between the protective electrode and the object. During the spark-erosion process rinsing water flows through said wire envelopes. Said rinsing water entrains the spark-off material. An electric, pulsed voltage of 200-220 V relative to the hardmetal to be machined is applied to the plates 3, 4 during the spark-erosion process. The sparking wire electrode is led through the work vessel via pulley guide members 17, 18. Plates 3, 4 and object 5 are fixed (not shown) to the wall of the work vessel in known manner via an electrically insulated clamping tool. During spark erosion, the hardmetal object moves relative to the protective electrodes and the sparking wire electrode.

By means of the above device, the formation of corrosion on hardmetal during spark erosion can be effectively precluded. This will be made clear by means of the following experiments.

A hardmetal object of WC comprising Co as a binder was machined in a spark-erosion process in demineralized water without cathodic protection for 24 hours. In said case, the plates 3, 4 and the external power source 12 were absent. Microscopic examination (enlargement 500 x) showed that the surface of the hardmetal was attacked by corrosion to a depth of 20-50 μm. The experiment was repeated with cathodic protection under otherwise identical conditions. In this case, the spark-erosion device shown in the drawing was used. In a visual, microscopic examination (enlargement 500 x) carried out after a 24 hour sparkerosion process, no signs of corrosion were found on the surface of the hardmetal object.

Claims

1. A method of machining a hardmetal object by means of spark erosion in an aqueous solution, utilizing measures which counteract corrosion of said object, characterized in that during the spark-erosion process the object is cathodically protected by means of a protective electrode which is present in the solution and which is electrically connected to the object via an external power source.

2. A method as claimed in Claim 1, characterized in that the protective electrode is plate-shaped and is held substantially parallel to a surface to be protected of the hardmetal object during the spark-erosion process, and in that the protective electrode is kept at a positive voltage relative to the object.

3. A method as claimed in Claim 1, characterized in that the object is arranged between two plate-shaped protective electrodes and in that the protective electrodes are kept at a positive voltage relative to the object.

4. A method as claimed in Claim 2 or 3, characterized in that the positive voltage is 10-100 V.

5. A spark-erosion device comprising a work vessel and a sparking wire electrode which is led through the work vessel, characterized in that the work vessel contains one or two plate-shaped, electrically conducting protective electrodes, and in that said electrode(s) is (are) provided with at least an electrical connection which can be connected to a hardmetal object to be machined via an external power source.

6. A spark-erosion device as claimed in Claim 5, characterized in that the electrode(s) is (are) provided with a through-hole for the sparking wire electrode, in which hole an electrically insulating wire envelope is fixed.

7. A device as claimed in Claim 5 or 6, characterized in that one surface of the electrode(s) is electrically conducting and the other surface is electrically insulated.

8. A device as claimed in Claim 7, characterized in that the electrically conducting surface of the electrode(s) consists of Pt.

Patentansprüche

1. Verfahren zum Bearbeiten eines Hartmetallog-

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Schutzelektrode plattenförmig ist, bei der Funkenerosionsbehandlung sich nahezu parallel zu einer zu schützenden Oberfläche des Hartmetallegenstandes erstreckt und gegenüber dem Gegenstand auf einer positiven Spannung gehalten wird.

3. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der Gegenstand zwischen zwei plattenförmige Schutzelektroden gebracht wird, die auf einer gegenüber dem Gegenstand positiven Spannung gehalten werden.

4. Verfahren nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß die positive Spannung 10 - 100 V beträgt.

5. Funkenerosionsvorrichtung mit einem Behandlungsgäsfäß und einer Funkendrahtelektrode, die durch das Behandlungsgäsfäß hindurchgeführt wird, dadurch gekennzeichnet, daß das Behandlungsgäsfäß eine oder zwei elektrisch leitende Schutzelektrode(n) aufweist, die mit mindestens einem elektrischen Anschluß versehen sind, der über eine externe Stromquelle an einen zu bearbeitenden Hartmetallegenstand anschließbar ist.

6. Funkenerosionsvorrichtung nach Anspruch 5, dadurch gekennzeichnet, daß die Elektrode(n) mit einer hindurchgehenden Elektrode versehen ist, wobei in dieser Öffnung eine elektrisch isolierende Drahthülle vorgesehen ist.

7. Vorrichtung nach Anspruch 5 oder 6, dadurch gekennzeichnet, daß eine Oberfläche der Elektrode(n) elektrisch leitend und die andere Oberfläche elektrisch isoliert ist.

8. Vorrichtung nach Anspruch 7, dadurch gekennzeichnet, daß die elektrisch leitende Oberfläche der Elektrode(n) aus Pt besteht.

Revendications

1. Procédé pour usiner par étincelage un objet en métal dur dans une solution aqueuse en prenant des mesures pour contrécarrer une corrosion du dit objet, caractérisé en ce que pendant le procédé d'étincelage l'objet est protégé cathodiquement par une électrode protectrice présente dans la solution et reliée électriquement à l'objet par l'intermédiaire d'une source de puissance extérieure.

2. Procédé selon la revendication 1, caractérisé en ce que l'électrode protectrice est en forme de plaque et qu'elle est maintenue sensiblement parallèlement à la surface à protéger de l'objet en métal dur pendant le processus d'étincelage, et en ce que l'électrode protectrice est maintenue à une tension positive par rapport à l'objet.

3. Procédé selon la revendication 1, caractérisé en ce que l'objet est disposé entre deux électrodes protectrices en forme de plaque et en ce que les électrodes protectrices sont maintenues à une tension positive par rapport à l'objet.

4. Procédé selon la revendication 2 ou 3, caractérisé en ce que la tension positive est comprise entre 10 et 100 V.

5. Dispositif d'étincelage comportant un récipient d'usinage et une électrode d'étincelage filiforme s'étendant à travers le dit récipient d'usinage, caractérisé en ce que le récipient d'usinage contient une ou plusieurs électrodes protectrices électriquement conductrices présentant la forme d'une plaque, et en ce que ladite (lesdites) électrode(s) est (sont) munie(s) au moins d'une connexion électrique pouvant être reliée à un objet en métal dur à usiner par l'intermédiaire d'une source de puissance extérieure.

6. Dispositif d'étincelage selon la revendication 5, caractérisé en ce que l'électrode (les électrodes) présente(nt) une ouverture percée pour l'électrode filiforme, dans laquelle est fixée une enveloppe de fil électriquement isolant.

7. Dispositif selon la revendication 5 ou 6, caractérisé en ce que l'une des surfaces de l'électrode (des électrodes) est électriquement conductrice et en ce que l'autre surface est isolée électriquement.

8. Dispositif selon la revendication 7, caractérisé en ce que la surface électriquement conductrice de l'électrode (des électrodes) est en Pt.