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ELECTROHYDRAULIC METAL FORMING SYSTEM AND METHOD

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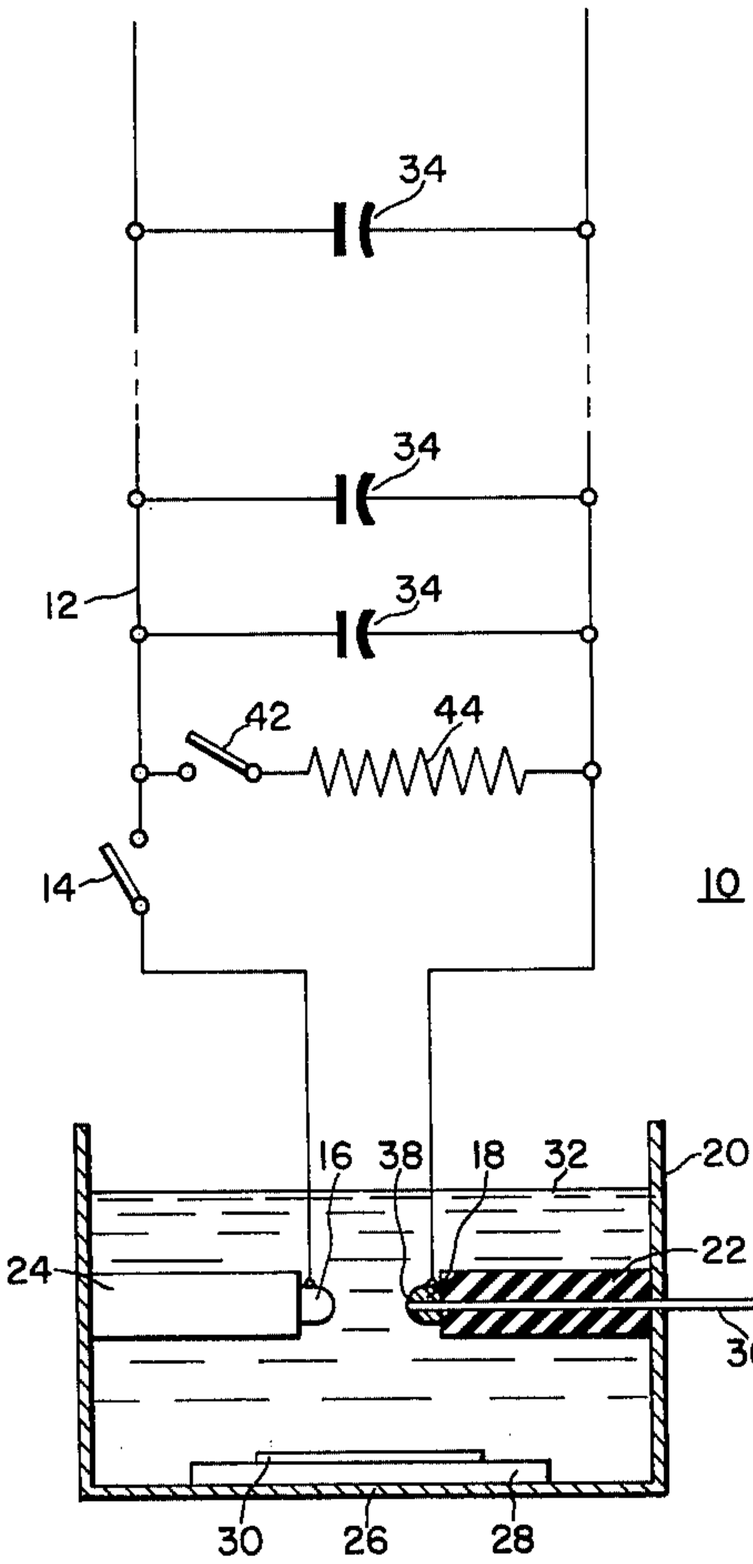

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ELECTROHYDRAULIC METAL FORMING SYSTEM AND METHOD

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The present invention relates to electrohydraulic metal forming systems and methods, and more particularly to such systems and methods in which an arc discharge induces a hydraulic pressure front for metal forming action.

In electrohydraulic metal forming, the metal piece to be formed is fixed on a die or similar object and this combination is then disposed in a liquid filled container.

Energy storage means such as a capacitor bank are then operated to produce an arc discharge between a pair of electrodes which are also submerged in the liquid in a suitable location. Hydraulic pressure generated by the arc discharge impinges on the metal piece and produces the desired metal forming action.

One of the problems encountered in electrohydraulic metal forming systems is that ordinarily the liquid in which the system arc electrodes are disposed has relatively high dielectric strength and thus prevents or substantially impedes the striking of an arc. One manner in which this problem can be countered is through the introduction of a fuse member between the submerged arc electrodes so that interelectrode current can be readily initiated through the fuse member and further so that an arc discharge continues the interelectrode current flow instantaneously after fuse blowing from overheating. The fuse thus initially provides a highly conductive path between the electrodes so that excessive voltage is not required to establish an arc in the normally high dielectric medium or liquid.

It is important, however, that an electrohydraulic metal forming system not only be able to produce a hydraulic metal forming arc, but that it be able to do so efficiently in terms of operating advantages. Hence, in most cases metal forming apparatus has good utility only if it is efficiently susceptible to repetitive operations and, if a hydraulic metal forming system such as the described system requires cumbersome or time consuming action such as replacing a fuse in order to prepare the system for a new or repeat arc strike, it is not as efficient as it desirably should be.

Thus, in accordance with the broad principles of the present invention, there is provided an electrohydraulic metal forming system which efficiently provides for repetitive metal forming operations and which comprises for this purpose energy storage means, or a bank of capacitors, connected by switching means to a pair of arc electrodes submerged in a relatively high dielectric liquid. Arc striking is enabled through controlled disposition of a pressure released relatively low dielectric medium between the submerged electrodes. The invention also encompasses method steps directed to efficient electrohydraulic metal forming. Such steps include applying an electric potential across arc electrodes submerged in a relatively high dielectric liquid and disposing in the space between the arc electrodes a relatively low dielectric medium so as to enable an arc to be struck.

It is, therefore, an object of the invention to provide a novel electrohydraulic metal forming system which efficiently provides for repetitive metal forming operations.

It is another object of the invention to provide a novel electrohydraulic metal forming system which efficiently provides for the disposition of a relatively low dielectric medium between arc electrodes submerged in a relatively high dielectric liquid so as to enable an arc to be struck between the electrodes.

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A further object of the invention is to provide a novel electrohydraulic metal forming method which efficiently provides for repetitive metal forming operations.

These and other objects of the invention will become more apparent upon consideration of the following detailed description along with the attached drawing, in which:

The single figure shows a schematic view of an electrohydraulic metal forming system constructed and operable in accordance with the principles of the invention.

More specifically, there is shown in the drawing an electrohydraulic metal forming system **10** comprising an energy storage source **12** connected by switching means **14** to spaced electrodes **16** and **18** which in turn are suitably disposed and supported in a container **20**. In this example, horizontal beams **22** and **24** attached to the two side walls of the container **20** are employed to support the electrodes **16** and **18** with the desired spacing therebetween.

Disposed on bottom wall **26** of the container **20** is a die **28** or the like. A sheet **30** of metal having suitable thickness and contour is in turn disposed and preferably suitably fixed on the die **28** so as to be formable against the die **28** upon the imposition of a hydraulic pressure front thereagainst. Thus, the container **20** holds a given volume of liquid **32** (such as water) which is the medium through which the pressure front can be advanced. Such hydraulic pressure is caused by an arc discharge between the electrodes **16** and **18** and can carry enough energy to produce the desired metal forming action against the die **28**.

In order to provide the energy necessary to initiate and sustain an arc discharge capable of producing the peak hydraulic pressure front required for metal forming, the energy storage source **12** includes one or more capacitors **34** but preferably a bank of capacitors **34** which are energized from a suitable power source (not shown). While the capacitors **34** are being charged to the desired energy level, the switching means **14** are disposed in an open position. Upon completion of the capacitor charging operation, the switching means **14** can be closed so as to apply the developed capacitor potential across the electrodes **16** and **18**.

On the other hand, in some applications, the switching means **14** can be closed while the capacitors **34** are being charged so that the potential across the electrodes **16** and **18** rises generally in conformity with the development of potential across the capacitors **34**. In any event, once peak voltage or potential is applied across electrodes **16** and **18**, the relatively high dielectric strength of the liquid **32** normally prevents or substantially impedes the striking of an arc between the electrodes **16** and **18**.

When it is desired to strike an arc, the liquid in the space between the electrodes **16** and **18** is substantially displaced by a relatively low dielectric strength medium or gas (such as air) which is transported through suitable means such as a conduit **36** from a pressurized source (not shown). The conduit **36** can extend through the container **20** and supporting beam **22** with an exit end portion **38** thereof extending through the electrode **18**. However, the conduit **36** or similar transport channel can be disposed structurally in any suitable manner so long as the exit end portion thereof is effective in disposing the low dielectric medium in the space between the electrodes **16** and **18**.

In order to control the flow of pressurized air or other medium to the space between the electrodes **16** and **18**, suitable valve means such as an ordinary electromagnetically operated valve **40** can be connected to the conduit **36** for controlling the flow through the latter member.

Thus, once the necessary peak potential is applied across the electrodes **16** and **18**, the valve **40** can be actuated to release under suitable pressure or to introduce the air or other low dielectric medium into the space between the electrodes **16** and **18**. With rapid ionization of the low dielectric strength medium between the electrodes **16** and **18** under the influence of the potential thereacross, an arc is struck between the electrodes **16** and **18** and the ensuing hydraulic pressure front which advances to the metal sheet **30** is effective in producing the desired metal forming action.

The switching means **14** can then be reopened, the valve means **40** can be closed to terminate the flow through the conduit **36** and switching means **42** can be closed to discharge the remaining charge on the capacitors **34** through discharge resistor **44** if it is desired to terminate the operation of the equipment. On the other hand, the capacitors **34** can be recharged and a new metal forming operation on a new metal sheet can be readily performed again in the manner previously described. Metal forming operations can thus be efficiently and readily repeated on a continuing basis.

The foregoing description has been set forth only to point out the principles of the invention. Accordingly, it is desired that the invention be not limited by the embodiment described, but, rather, that it be accorded an interpretation consistent with the scope and spirit of its broad principles.

What is claimed is:

1. An electrohydraulic metal forming system comprising energy storage means, means for connecting said energy storage means to a pair of spaced electrodes disposed in a container, said electrodes being submerged in a liquid of relatively high dielectric strength in the container, and means for introducing a gas of relatively low dielectric strength between said electrodes to initiate a discharge therebetween.

2. An electrohydraulic metal forming system comprising energy storage means, means for connecting said energy storage means to a pair of spaced electrodes disposed in a container, said electrodes being submerged in a liquid of relatively high dielectric strength in the container, a suitably supported conduit having its outlet end disposed for introducing in the space between said electrodes a medium having a lower dielectric strength than said liquid, said lower dielectric strength medium being transportable under pressure through said conduit, and means for controlling the flow of said low dielectric medium through said conduit.

3. An electrohydraulic metal forming system comprising a bank of capacitors energizable from a suitable source of power, said capacitor bank connected to a pair of electrodes through switching means, means for supporting said electrodes in suitably spaced relation in a container, said container holding a relatively high dielectric liquid in which said electrodes are submerged, a suitably supported conduit having its outlet end disposed for introducing in the space between said electrodes a relatively lower dielectric medium than said liquid transportable under pressure through said conduit, and means for controlling the flow of said low dielectric medium through said conduit.

4. An electrohydraulic metal forming system comprising a bank of capacitors energizable from a suitable source of power, said capacitor bank connected to a pair of electrodes through switching means, means for supporting said electrodes in suitably spaced relation in a container, said container holding a relatively high dielectric liquid in which said electrodes are submerged, a suitably supported conduit having its outlet end extending through one of said electrodes so as to be disposed for introducing in the space between said electrodes a relatively low dielectric gas transportable under pressure through said conduit, and valve means for controlling the flow of said low dielectric gas through said conduit.

5. An electrohydraulic metal forming system comprising an energy storage source energizable from a suitable source of power, said energy storage source connected through switching means to a pair of electrodes, means for supporting said electrodes in suitably spaced relation in a container, said container holding a relatively high dielectric liquid in which said electrodes are submerged, a suitably supported conduit having its outlet end extending through one of said electrodes so as to be disposed for introducing in the space between said electrodes a relatively low dielectric medium transportable under pressure through said conduit, and means for controlling the flow of said low dielectric medium through said conduit.

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