

The present invention relates to a device for handling electrodes in an electroerosion machine, which comprises a trough receiving the liquid dielectric and the work-piece to be machined, which trough is mounted to be adjustable in the X- and Y-direction with respect to the sleeve.

Electroerosion machines of this type are used increasingly and their method of operation, which is assumed to be known, plays no essential part in the scope of the invention. However, in the connection according to the invention, it is significant that the electrodes of such a machine have to be changed more frequently during operation.

Namely, in some machining operations on one and the same work-piece, it is necessary, in the course of machining, to exchange the electrode used by the electroerosion machine, several times, particularly if the control of the machine takes place automatically and is thus capable of carrying out a plurality of machining operations taking place in succession, on one and the same work-piece. So as not to disturb or interrupt this machining process, which takes place automatically, automatically operating electrode changing devices have been created, which can possibly also be controlled by the machine programme, as has become basically known for example from DE-OS 28 37 719.

Since the electroerosive machining is a machining process proceeding relatively slowly, there is an increasing endeavour to automate this process, furthermore for example from DE-OS 35 33 001, electrode changing devices have become known, in which an electrode magazine constructed in the manner of a chain and rotating endlessly is provided. A gripping arm has the task of engaging a selected electrode and inserting it in the machining device, or removing it from the machining device and returning it to the magazine. In order that upon removal from the magazine, the

correct electrode is picked up, or in order that when deposited in the magazine, the electrode once more adopts its predetermined position, a revolving magazine of this type must be driven until the selected electrode or the predetermined storage position is located in the region of the gripping arm.

The drawback of such electrode changing devices is on the one hand the large space requirement, the long access time and the high price, in particular if a large number of electrodes are stored in the magazine and should be ready for possible access. In order to avoid these drawbacks, for example in EP-A-0 132 599 A1, it has also been proposed to construct the tool magazine with a plurality of substantially disc-shaped electrode supports, able to rotate about a first shaft, along the periphery of which supports the electrodes are located and to provide a transportation arm, which is able to tilt about a second shaft located at a distance therefrom, in order to engage the electrodes, remove them from the magazine and insert them in the machining device or vice versa.

Such a device has a substantially shorter access time and a reduced space requirement, but is always still rather expensive, so that it is economical solely with a large number of required electrode locations.

However, in numerous applications, there is no requirement to keep dozens or even hundreds of electrodes ready for access, but it would suffice if a few electrodes could be changed automatically; the creation of an automatic electrode changer of the aforementioned types would thus be uneconomical.

In the publication JP-A 55 58931, a device for handling electrodes in an electroerosion machine has been proposed, which comprises a trough receiving the dielectric and

the work-piece to be machined, which trough is mounted to be adjustable in the X- and Y-direction with respect to the sleeve, an electrode support arrangement with a plurality of electrode supports being located within the trough and the electrode supports projecting from the side wall of the trough towards the inside of the trough in a region into which the sleeve can be brought by X- or Y-adjustment of the trough. However, this arrangement requires a relatively large amount of space within the trough, so that the usable space of the trough is greatly restricted.

It is therefore the object of the present invention to provide a handling device of the aforementioned type, which allows the automatic changing of a few electrodes, which takes up hardly any additional space and which has a simple and robust construction, thus can be produced economically. This object is achieved according to the invention by the features of Patent Claim 1.

If the trough is enlarged only slightly, there can be located inside the trough, close to one side wall, depending on the size of the electrodes, six to eight thereof. Due to the swivelling construction of the electrode supports, it is ensured that the latter can be located in a region of the trough in which the sleeve is able to slide, in order to be picked up automatically by the chuck of the sleeve.

Developments of the object of the invention and preferred embodiments thereof are described in the dependent Patent Claims 2 to 9.

One embodiment of the device according to the invention will be described in detail hereafter with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic front view of a known electro-erosion machine, on which the device according to the invention can be used;

Figure 2 is a cutaway view of one side wall of the trough from inside, with the device in the inoperative position;

Figure 3 is a cutaway view of the trough from above, part of the device being shown in broken line in the operative position;

Figure 4 is a section through a trough wall with the device in the inoperative position; and

Figure 5 is a section similar to Figure 4, but with the device in the operative position.

In Figure 1, an electroerosion machine designated generally by the reference numeral 1 is illustrated in a diagrammatic view from the front. The erosion machine comprises a base 3, on which a table 4 able to slide in the X- and Y-direction is mounted. The table 4 supports a trough 5 open at its upper side, which serves for receiving the liquid necessary for the erosion process. Also located on the base 3 is an upright 6, which supports the machine head 7. A sleeve 8 is received in the machine head 7 in the Z-direction, i.e. to be vertically adjustable and possibly able to rotate. The sleeve 8 is provided with a chuck 9 for receiving a machining tool 10, shown only diagrammatically, namely an erosion electrode. Located in the trough 5 is a work-piece holder 11, which receives a work-piece 12 to be machined.

The more accurate construction and method of operation of such an erosion machine is known to a man skilled in the art and does not need to be described here in detail.

In the embodiment illustrated in Figures 2 to 5, it is now provided that the trough 5 is provided on its

front side with a door-like front wall 14, which is pivotally attached for example by means of hinges 15 to the trough 5. Located on the inside of the front wall 14 is an upper transverse support 16 and a lower transverse support 17, between which two guide columns 18 extend. Furthermore a frame is provided, consisting of an upper cross-bar 19, a lower cross-bar 20 and respectively a connecting bar 21 on the left-hand side and on the right-hand side. The frame is mounted to be vertically adjustable along the guide columns 18. Provided for adjusting the frame are for example pneumatic drive cylinders 22 located on both sides thereof, which cylinders are supported at the lower end on the lower transverse support 17 and which at the top are connected to extensions of the upper cross-bar 19 of the frame projecting beyond the lateral connecting bars 21.

Two pairs of swivel arms are mounted on the frame: the first pair of swivel arms comprises an outer arm 23 and an inner arm 24, and the second pair of swivel arms comprises an outer arm 25 and an inner arm 26. Seen in lateral projection (see Figure 2), the swivel arms 23-26 have an approximately Z-shaped construction, in which case one outer leg respectively of each swivel arm 23-26 is mounted to swivel respectively about a shaft 27, which extend between the upper cross-bar 19 and the lower cross-bar 20 of the frame. The two other outer legs of the first pair of swivel arms 23, 24 support a bearing block 28 and the two other outer legs of the second pair of swivel arms support a bearing block 29, the connection between the respective outer legs and associated bearing block likewise being articulated. As a whole this produces a parallelogram-like linkage arrangement for the parallel displacement of the bearing blocks 28 and 29.

The two bearing blocks 28 and 29 each support a transverse beam 30 or 31, to each of which four electrode supports

32 are attached in this example. As can be seen from Figures 3 to 5, the latter have a tongue-like construction and project perpendicularly from the transverse beams 30 or 31, in the direction of the inside of the trough 5. At their free end they are provided with a slot-like opening 33, which serves to receive the shaft 34 of an electrode 10 (Figures 4 and 5).

An electrode support arrangement is formed by the frame, formed from the cross-bars 19, 20 and 21, by the four swivel arms 23, 24, 25 and 26, by the bearing blocks 28 and 29, by the transverse beams 30 and 31 as well as by the electrode supports 32, which electrode support arrangement is on the one hand adjustable in the vertical position under the action of the drive cylinder 22 and on the other hand can be swung out from an inoperative position into an operative position. The swinging movement in this case takes place under the action of for example pneumatic drive cylinders 35, which are supported at one end on the connecting bars 21 and which at the other end are pivotally connected to the swivel arms 24 or 26.

Due to the afore-described members, an electrode support arrangement is formed, which comprises two support units able to swing out independently of each other: a first unit 36, formed from one half of the frame, the first pair of swivel arms 23, 24, the bearing block 28, the transverse beam 30 and four electrode supports 32 (on the left in Figures 2 and 3), and a second unit 37, formed from the other half of the frame, the second pair of swivel arms 25, 26, the bearing block 29, the transverse beam 31 and four electrode supports 32 (on the right in Figures 2 and 3). The two units 36 and 37 are arranged in a centrosymmetrical manner with respect to the central axis A of the front wall 14 of the trough 5. The arrangement is in this case such that each unit 36 or 37 may adopt two positions:

- An inoperative position (shown in full line in Figure 3 or according to the illustration in Figure 4), in which the swivel arms 23, 24 or 25, 26 are tilted towards the frame 19, 20, 21, so that the transverse beams 30 or 31 and with them the electrode supports 32 lie as close as possible to the front wall 14, each unit 36 or 37 solely taking up space on the respectively associated half of the front wall 14, on both sides of the central axis A.
- An operative position (shown in broken line in Figure 3 or according to the illustration in Figure 5), in which the swivel arms 23, 24 or 25, 26 are swung out towards the interior of the trough 5, so that the transverse beams 30 or 31 and with them the electrode supports 32 lie in a substantially central position within the trough 5 so that respectively two of the electrode supports 32 are located on the left and on the right of the central axis A.

This can be achieved due to the fact that the pivot points (axis of the shafts 27) of the first and second pairs of arms 23, 24 or 25, 26 lie relatively close to the central axis A, that the swivel arms 23-26, seen in their horizontal projection, are bent so that the respective two swivel axes of the swivel arms are staggered with respect to each other by the width of the cross-bars 16 or 19 and that the arms 23 or 25 are pivoted on the respectively outer end of the transverse beams 30 or 31, remote from each other, whereas the arms 24 or 26 are respectively pivotally attached in the centre of the transverse beams 30 or 31.

As can be seen, only one of the two support units 36 and 37 should and can be tilted from the inoperative position into the operative position, since at the time of a changing operation, the chuck 9 of the sleeve 8 gains

access solely to one electrode 10 held in the electrode supports 32.

The method of operation of the device is as follows:

It is assumed that all the electrode supports 32 are each equipped with an electrode 10 and that both support units 36 and 37 are in the swung-in inoperative position shown in full line in Figure 3. This situation is also illustrated in Figure 4. The erosion process is now intended to begin and the sleeve 8 must be equipped with an electrode. Starting from the assumption that the electrode required first is located in the support unit 36, the swivel arms 23 and 24 are swung under the action of the drive cylinder 35 from their inoperative position into the operative position shown in broken line in Figure 3. Due to this the four electrodes located in the electrode supports 32 of the first unit 36 are located in a substantially central position within the trough 5. The trough 5 is now displaced in the X- and/or Y-direction by drive means which are known per se and are not shown, until the central axis B of the chuck 9 of the sleeve 8 coincides with the central axis C of the electrode 10. Then the entire frame 19, 20, 21 can be moved upwards under the action of the drive cylinder 22, until the shaft 34 of the electrode 10 enters the chuck 9 and the electrode is held on the sleeve 8. By displacing the trough 5 in the direction Y_1 (Figure 5) the shaft 34 is released from the electrode support 32, the frame 19, 20, 21 can once more be lowered and the swivel arms 23, 24 can be tilted back again into the inoperative position.

Now the erosion process may begin by means of the first electrode 10 just clamped. The support units 36 and 37 which have been swung back, do not hinder this, since the stored electrodes 10 in the electrode supports 32 lie very close to the front wall 14 (Figure 4).

When the first stage of the erosion machining by means of the first electrode is terminated, the first support unit 36 is once more swung out and raised and finally by moving the trough 5 in the X- and Y_2 -direction is brought into such a position that the respective electrode support 32 has engaged the electrode 10 clamped in the sleeve 8, by the shaft 34. There then follows lowering of the frame 19, 20, 21 or raising of the sleeve 8, a displacement of the trough 5 in the X-direction, until the central axis C of the next electrode 10 required aligns with the central axis B of the sleeve 8 and renewed raising of the frame 19, 20, 21 or lowering of the sleeve 8, in order to insert this next electrode 10. Finally, the trough 5 is moved back in the previously described manner in the Y_1 -direction, the frame is lowered if necessary and the swivel arms 23, 24 are swung back, in order that the following erosion step may take place.

This process is repeated in a similar manner, covering a plurality of electrodes, until the erosive machining of the work-piece 12 is terminated. If, in the example, all four electrodes 10 in the first support unit 26 have been used, the second support unit 37 is naturally then swung in. Due to the construction and arrangement of the swivel arms 23, 24 or 25, 26, the respective transverse beam 30 or 31 with the associated electrode supports 32 is located in both cases at the same, central position within the trough 5, which minimises the displacements necessary and considerably simplifies the control of the machine. In the interests of optimizing the sequences of movement, it is thus recommended to provide the electrodes in an appropriate arrangement in the electrode supports 32, for example the first four required electrodes in the unit 36 and the next four required electrodes in the unit 37.

As already mentioned, the insertion of an electrode 10 in the chuck of the sleeve 8, after completed positioning in the X- and Y-direction, may take place either by raising the frame 19, 20, 21 or by lowering the sleeve 8 or, however, by both movements simultaneously.

If work-pieces with significant vertical dimensions are to be machined, as shown in broken line in Figure 5 by the reference numeral 12', in contrast to the previously described sequence of operations, first of all a raising of the frame 19, 20, 21 is necessary before the swivel arms 23, 24 or 25, 26 can be swung out. The insertion of the electrode 10 in the chuck 9 of the sleeve 8 takes place in this case exclusively by lowering the sleeve 8, after the X-Y-positioning is terminated.

The aforescribed device may naturally be modified in various ways within the scope of the invention. Thus, for example, the transverse beams 30 or 31 may be attached releasably and exchangeably to the bearing blocks 28, 29, in order to pick up optionally a group of four electrode supports 32 lying relatively far apart for comparatively large electrodes 10 (as shown in the drawings) or a group of perhaps five or six electrode supports 32 lying closer to each other for smaller electrodes. Also the construction and arrangement of the frame 19, 20, 21 and of the swivel arms 23, 24, 25, 26 can be different, provided that the tilting movement of the electrode supports required according to the invention from an inoperative position close to the trough wall into an operative position in an approximately central position within the trough can be carried out.

In any case, with the device proposed according to the invention, a handling device for electrodes is created, which has a very simple construction, is robust and uncomplicated and economical to produce. It may be thoroughly

satisfactory for numerous applications in which there is no requirement to keep a large number of electrodes ready for access, but in which only a few electrodes have to be changed. Since most commercially available electro-erosion machines are equipped with a trough, whereof the front wall can be swung out in the manner of a door, the construction of the proposed device, in which the entire electrode support arrangement is anchored on the front wall, is straight away suitable for equipping existing machines. Since the required sequences of movement within the device are very simple (tilting of the arms and vertical adjustment of the frame), a fully automated change of electrode can be integrated very simply in an existing machine programme with the assistance of the device according to the invention.

Claims

1. Device for handling electrodes (10) in an electroerosion machine (1), which comprises a trough (5) receiving the liquid dielectric and the work-piece (12) to be processed, which trough (5) is mounted to be adjustable in the X- and Y-direction with respect to the sleeve (8), an electrode support arrangement (36, 37) with a plurality of electrode supports (32) being disposed inside the trough (5), characterised in that the electrode support arrangement comprises a frame (19, 20, 21), which is mounted to be vertically adjustable on one of the side walls (14) of the trough (5) and on which at least two swivel arms (23, 24 or 25, 26) are attached, which jointly at their free ends support a plurality of electrode supports (32), so that the electrode supports (32) can be swung from a retracted inoperative position close to one side wall (14) of the trough (5) into an operating position, in which they project from the side wall (14) of the trough (5) towards the inside of the trough into a region in which the sleeve (8) can be brought by X- and/or Y-displacement of the trough (5).
2. Device according to Patent Claim 1, characterised in that the electrode support arrangement (36, 37) is adjustable in the Z-direction.
3. Device according to Patent Claim 2, characterised in that pivotally attached to the free ends of the two swivel arms (23, 24 or 25, 26) is a transverse beam (30 or 31), on the upper side of which is disposed a plurality of substantially fork-like electrode supports (32) projecting from the transverse beam.
4. Device according to Patent Claim 3, characterised in that the transverse beam (30 or 31) with the electrode supports (32) is exchangeably attached to the swivel arms (23, 24 or 25, 26).



5. Device according to one of the preceding Patent Claims, characterised in that disposed on the frame (19, 20, 21) in a centrosymmetrical manner are two pairs of swivel arms (23, 24 and 25, 26) each with a plurality of electrode supports (32).

6. Device according to Patent Claim 5, characterised in that the pivoting of the swivel arms (23, 24 or 25, 26) on the frame (19, 20, 21) and on the electrode supports (32) takes place so that the latter can be tilted into a substantially central position within the trough (5).

7. Device according to Patent Claim 6, characterised in that the swivel arms (23, 24 or 25, 26) are bent.

8. Device according to one of the preceding Patent Claims, characterised in that the electrode support arrangement (36, 37) is located on the front wall (14) of the trough (5), which can be hinged in the manner of a door.

9. Device according to one of the preceding Patent Claims, characterised in that pneumatic or similar drive cylinders (35 or 22) are provided for tilting the swivel arms (23, 24 or 25, 26) and for the vertical adjustment of the frame (19, 20, 21).

