July 27, 1943. W. E. CRAWFORD 2,325,481

ELECTRIC FORMING APPARATUS

Filed Dec. 10, 1942

FIG. 1.

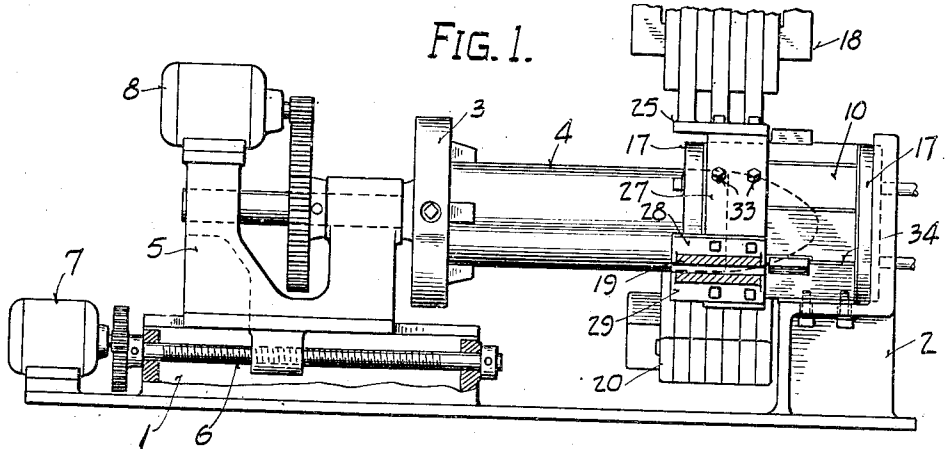


FIG. 2.

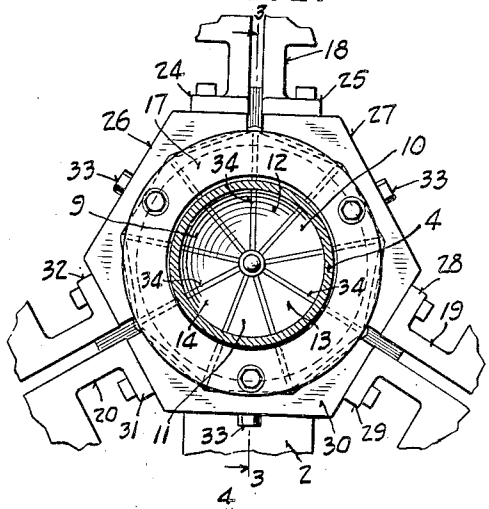


FIG. 4.

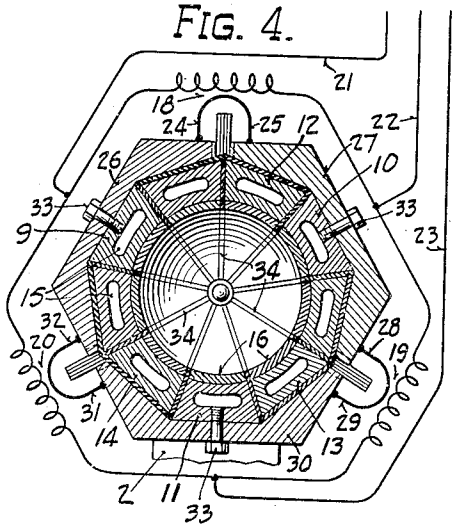
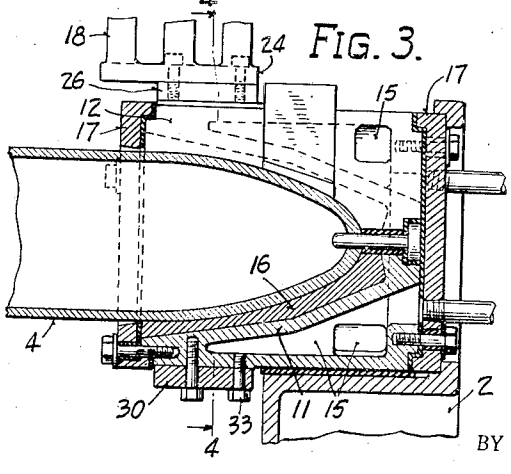


FIG. 3.



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ELECTRIC FORMING APPARATUS

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Application December 10, 1942, Serial No. 468,525

8 Claims. (Cl. 219—3)

This invention relates to electric forming apparatus and is applicable to the forming of cylindrical objects into symmetrical shapes such as the flanging or closing of tubes and the reduction in diameter or upsetting of tubes and rods.

The invention more particularly relates to electric forming machines in which a cylindrical object is pushed into a confining die made up of segments constituting electrodes for applying heating current to the article in the region of forming, the die and article being relatively rotated during the process.

The principal object of the invention is to provide a more efficient apparatus having a greater path of current flow through the article being heated and which can be readily adjusted for different article sizes and shapes.

Another object is to greatly increase the speed of forging and the consequent production from a single machine.

Other objects and advantages will appear in the following description of a preferred embodiment of the invention illustrated in the accompanying drawing.

In the drawing:

Figure 1 is a side elevation of the machine;

Fig. 2 is a forward end elevation of the forming dies showing the electrical connections;

Fig. 3 is a longitudinal section through the dies, taken on line 3—3 of Fig. 2; and

Fig. 4 is a transverse section through the dies, taken on line 4—4 of Fig. 3.

The machine comprises in general two spaced upright standards 1 and 2 carrying the operative parts of the machine. Standard 1 supports the chuck 3 for gripping the rear end of the tubular blank 4 and rotating and feeding the blank or other article being formed. For this purpose the chuck 3 is rotatably mounted in a frame 5 which is slidable toward and away from the standard 2 under suitable driving power such as the screws 6 rotated by motor 7. A second motor 8 on the frame 5 is connected to rotate the chuck 3 as the latter is fed forward.

The standard 2 supports the forming dies and transformers. The forming dies preferably comprise six separate segments arranged in a circle and having complementary inner faces for engaging and forming the blank 4. Three segments 9, 10 and 11 constitute electrodes for applying heating current to the pipe 4 and the remaining three intermediate segments 12, 13 and 14 are of substantial width for separating the electrode segments to provide a long current path through the article between the latter.

The die segments 9 to 14, inclusive, are constructed of copper and preferably have water cooling passages 15 therein and also die inserts 16 of special alloy material to provide for wear of the die surfaces as set forth in the copending application of John M. Floyd, Serial No. 395,804, filed May 29, 1941, for Dies for electrical forging machines, and assigned to a common assignee herewith.

The die segments are secured together by end rings 17 in a manner similar to that set forth in the copending application of the present inventor, Serial No. 396,668, filed June 5, 1941, for Electric heating and forming apparatus.

The transformers 18, 19 and 20 are disposed radially outwardly from the respective die segments 12, 13 and 14. The primaries of the several transformers are preferably connected between the separate leads 21, 22 and 23 of a source of three-phase alternating current to provide a different phase for each transformer.

The secondary of transformer 18 has its leads 24 and 25 connected to the electrodes 9 and 10 through separate circumferentially extending bus bars 26 and 27, respectively. The secondary of the transformer 19 has its leads 28 and 29 connected to the electrodes 10 and 11 through the separate circumferentially extending bus bars 27 and 30, respectively. Likewise, the secondary of the transformer 20 has its leads 31 and 32 connected to the electrodes 11 and 9 through the bus bars 30 and 26, respectively. In this construction each electrode has a separate bus bar for supplying current to it; electrode 9 having bus bar 26; electrode 10 having bus bar 27; and electrode 11 having bus bar 30. The bus bars are secured to their respective electrodes by bolts 33 and extend in opposite directions circumferentially from their electrodes so that the secondary leads of each transformer are parallel and close together.

The transformer connections to the electrodes are at the forward or open end of the die to provide for maximum heating current at the location where the blank 4 first engages the die. The die segments 12, 13 and 14 are completely insulated from the bus bars and electrodes and are not expected to carry current, although, due to their contact with the blank 4, it is possible that they carry some current which otherwise would pass through the blank only. However, by reason of the insulation between the intermediate die segments 12, 13 and 14 and their respective adjacent electrodes, the entire current is forced to pass through the blank 4 on either

side of each electrode. This provides at least two regions where each of the heating currents have to pass through the blank. In addition to this, it is preferable to make each of the intermediate die segments in two or more parts separated by insulation 34, for instance. This gives an additional gap where the heating current must flow beneath the insulation and through the blank 4. To further minimize the flow of current through the die faces at the insulated section, these faces may be slightly flattened as described in the application of Sven Westin et al., Serial No. 458,216, filed September 14, 1942, for Electric forming.

The several insulations 34 are located preferably midway between the pairs of electrodes and radially in line with the space between the respective pairs of secondary leads of the transformers. The insulation 34 may be cut out to the rear of the bus bars to provide space for the insertion of laminated magnet core material for choking current flow longitudinally of the electrodes, as more particularly set forth in application, Serial No. 396,668, above referred to.

The intermediate die sections 12, 13 and 14, beneath the bus bars should be constructed of non-magnetic highly-conductive metal such as copper, since this will reduce the amount of flux traversing the loop between the leads by reason of the opposing flux set up by eddy currents.

The segments 9 to 14, inclusive, may have the same shape and size and be interchangeable. However, in some instances the electrodes 9, 10 and 11 may be pointed toward the rear and the intermediate segments may extend back with substantially uniform width, and in other instances the electrodes 9, 10 and 11 may have substantially parallel sides and the intermediate segments 12, 13 and 14 may be pointed toward the rear.

The number of electrodes and transformers may be varied, the lowest number being one transformer and two electrodes. It is also desirable in some instances to have the die surface of the electrodes extend radially inward slightly farther than do the die surfaces of the intermediate sections to provide for greater contact pressure between the electrodes and blank.

Various embodiments of the invention may be employed within the scope of the accompanying claims.

The invention is claimed as follows:

1. In an electric forming apparatus, a die providing a die cavity for receiving and forming an article, said die comprising a plurality of circumferentially spaced segments at least two of which constitute electrodes and are substantially spaced apart with at least one intermediate segment insulated therefrom, and means to supply electric current to said electrodes for heating the article as it enters said die.

2. In an electric forming apparatus, a die comprising a plurality of spaced die segments arranged in a circle to provide a die cavity for receiving and forming an article, said die segments being insulated from one another, and means supplying electric current to a plurality of said segments with intermediate insulated segments therebetween.

3. In an electric forming apparatus, a die comprising a plurality of spaced die segments of non-magnetic electrically-conductive material arranged in a circle to provide a die cavity for receiving and forming an article, said die segments being insulated from one another, and means supplying electric current to a plurality of said segments with intermediate insulated segments therebetween.

4. In an apparatus of the class described, circumferentially-spaced electrodes separated by intermediate die sections insulated therefrom to provide for a long heating current path through the article being formed.

5. In an apparatus of the class described, circumferentially-spaced electrodes separated by intermediate die sections insulated therefrom to provide for a long heating current path through the article being formed, said intermediate segments being of electrically conductive non-magnetic material.

6. In an apparatus of the class described, circumferentially-spaced electrode segments separated by intermediate die segments insulated therefrom to provide for a long heating current path through the article being formed, said electrode segments being connected to the separate phase leads of a multiphase alternating current source.

7. In an apparatus of the class described, a pair of electrode die members separated by an intermediate die member insulated therefrom and providing a complementary die surface contacting with the article being formed, and a transformer for supplying heating current to the article and having its secondary connected through leads to the respective electrodes, said transformer being disposed adjacent said intermediate member and having its secondary leads following closely the contour of said member and insulated therefrom.

8. In an apparatus of the class described, a pair of electrode die members separated by an intermediate die member insulated therefrom and providing a complementary die surface contacting with the article being formed, and a transformer for supplying heating current to the article and having its secondary connected through leads to the respective electrodes, said intermediate member being of electrically-conductive non-magnetic material and being divided into a plurality of insulated parts transverse to the direction of current flow through the article in contact therewith.

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