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TYPE TSD-1000 WELDING TRANSFORMER WITH REMOTE CONTROL OF WELDING CURRENT

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/A digest/

The method of high-speed welding under a layer of flux is being more and more widely used in the most diverse branches of industry. Due to the fact that it is possible to use very large currents, this method ensures high productivity in welding operations.

To feed the arc in high-speed automatic welding installations, a heavy-duty welding transformer is required as well as a regulator, permitting the regulation of welding current directly from the control box of the automatic apparatus. With this in view, the "Elektrik" Plant, in 1948, designed and started series production of welding transformers with remote control for a nominal welding current of 1,000 amperes.

The ordinary welding transformers made by the "Elektrik" Plant for manual arc welding (Types STE-24 and STE-34 for 350 and 500 amperes) are made in two sections. In contrast to this, the Type TSD-1000 transformer is made in one section. The basic part (transformer) and the device which regulates the welding current (reactor) are made on a common magnetic circuit according to a scheme suggested by Academician V. P. Nikitin (first proposed in 1925, patent No 3140).

The principle of this scheme is that the transformer and reactor portions have a common yoke in which the magnetic fluxes are in opposition due to the orientation of the windings. As a result of this, the dimensions of the yoke not only need not be increased but can even be reduced as the resultant flux under load will be considerably less in the yoke than in the remaining portions of the magnetic circuit. However, in view of the fact that, when the transformer is on no-load, there will be no magnetic flux in the yoke from the

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reactor, it should be designed to take all the magnetic flux which passes through it under no-load conditions. This type of magnetic circuit makes it possible to reduce the expenditure of transformer steel, the weight and the dimensions of the transformer, and to improve operational qualities by decreasing the losses in the magnetic circuit.

Construction of the Transformer

The transformer consists of the following basic members: (1) the magnetic circuit (core), (2) the transformer winding (primary and secondary), (3) the reactor winding, (4) the mechanism for lifting and lowering the movable portion of the reactor, (5) the interlocking and current indicating mechanism, and (6) the stand in which the above basic elements are mounted.

Magnetic Circuit

The magnetic system consists of two basic parts, the lower fixed part (on which the primary and secondary transformers are mounted underneath and the reactor windings on top), and the upper movable section. Both the fixed and movable sections of the magnetic circuit consist of sheets of transformer steel, mark E4A, 0.5 millimeter thick.

The movable reactor block slides along guide bars in such a way that a gap in the core of the reactor can be varied, thereby regulating the inductive reactance of the secondary circuit of the transformer. This creates a falling characteristic and a variation of the welding current in the required limits.

Transformer Windings

The primary and secondary transformer windings are not connected with each other electrically. The primary winding is designed to be connected to a single-phase 220 or 380-volt supply, but transformers are also made for 500 volts on special order. The secondary winding is made of uninsulated copper wire.

The windings are in the form of two cylindrical coils, each of which consists of two layers of primary winding and one layer of secondary winding. Wooden separators are placed between the layers, thus forming air passages and increasing the cooling surface. The secondary windings of both coils are connected in parallel. The primary windings are connected in series for 380 volts and in parallel for 220 volts. In this way, a secondary no-load voltage of 65 volts is assured in both cases. Due to the fact that the operation of heavy-duty automatic apparatus frequently causes a considerable voltage drop in the supply current, which in turn drops the secondary voltage, provision is made for sectioning the primary winding by tapping the corresponding turns and leading them out to a terminal board. When this step arrangement is used, the secondary voltage on no-load will be 75 volts for normal supply voltages.

The reactor winding consists of two coils made of bare copper bus bars connected in series and insulated with asbestos inserts.

Mechanism for Raising and Lowering the Movable Block of the Reactor

As was pointed out above, the regulation of the welding current is accomplished by altering the air gap in the middle part of the reactor core. A three-phase electric motor (0.25 kilowatts, 1,420 rpm,) is used to drive the mechanism which varies the reactor gap. Lifting and lowering the movable block is accomplished through this mechanism (belt-driven) by reversing the electric motor which is controlled by means of two magnetic starters, one for each direction of rotation. An interlock is provided to avoid the possibility of short circuits in case both buttons were pushed simultaneously.

Interlocking and Current Indicating Mechanisms

Special cam mechanisms switch off the electric motor automatically when the moving block reaches one of the extreme positions. The distance between the extreme positions of the magnetic circuit is about 80 millimeters. The shaft of the interlocking mechanism makes one incomplete turn through the whole range of regulation of the welding current.

Corresponding positions of the cams on the shafts are fixed by means of set screws. Each position of the camshaft of this mechanism corresponds to a definite position of the movable reactor block and consequently, to a definite value of welding current. This makes it possible to use the mechanism to indicate current by means of a graduated disk mounted on the free end of the shaft.

The welding current depends not only on the gap in the magnetic circuit of the reactor, but also on the voltage at the terminals of the secondary transformer winding and on the load resistance. Therefore, strictly speaking, the graduated readings are correct only when nominal voltage is applied to the terminals of the transformer with an ohmic load resistance in the secondary circuit corresponding to a voltage drop of 35 volts, which is considered to be an average value for automatic arc welding under a layer of flux.

Accurate regulation of welding current can be done from the ammeter mounted directly on the control panel of the automatic apparatus.

Stand

The transformer and all the mechanisms are mounted on a rigid welded frame in an enclosed stand with double doors providing access to the interior. The whole unit rests on a base with four wheels which enable the transformer to be moved as required under operational conditions.

The main terminal boards are located inside the stand, on the lower side. One of them is designed to connect the terminals of the secondary welding circuit and the other, for connecting to the line. In addition to these boards, there is another terminal board mounted inside. Its left three terminals are for connecting up the three-phase line to the electric motor; the right three terminals connected the two starting buttons for the remote control of welding current.

On the front panel of the stand there is a window revealing the current indicating mechanism. Alongside this window there are two starting buttons for welding-current control. Thus, in addition to remote control of welding current, it is possible to regulate it directly at the transformer from the current indicating scale. This is necessary when operating automatic machines since remote control is carried out on the basis of an ammeter with the arc already struck. Preliminary setting of the current must be done from the indicator.

Technical Data

As noted previously, the transformer is built for a 220 or 380-volt 50-cycle single-phase power supply and is designed to operate on repeated short-time duty alternated with intervals of rest. For a nominal welding current of 1,000 amperes, the switching duration factor is taken as 0.55. For currents less than 1,000 amperes, the factor can be increased, while with currents above 1,000 amperes, it should be correspondingly reduced.

The control of welding current is accomplished smoothly in the range from 400 to 1,200 amperes. The upper limit can be attained with a secondary voltage of 75 volts. The duration factor at this limit should not exceed 40 percent. The primary transformer current is approximately 310 amperes at 220 volts and 180 amperes at 380 volts. The efficiency of the transformer is about 85 percent, while the power factor is approximately 0.5.

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