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Voltage and Current Controlled Welding Transformer With Load Series Motor

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Abstract— The aim of proposed paper is to present a simplified model of welding transformer which can used for different current and voltages. Special attention is paid to the study of magnetic behavior of transformer and choke. A simplified model allows to use easily different types of fluxes which required different current and voltages for welding. This project provides the detailed sequence of operations necessary to determine the different values of current at specified voltage of welding transformer from numerically simulated open circuit experiments.

Keywords— voltage and current controlled tappings,load series motor.

1. INTRODUCTION

A welding transformer is a step down transformer with open circuit voltage of about 70 volts and having negative voltage characteristics can be used for welding work. To get the negative voltage characteristics transformer is step down transformer ,secondary winding turns are less than primary winding turns and a choke are used that is an inductive reactance is concern with secondary circuit. Another definition is a step down transformer having choke with taps or movable core in between primary control the arc current and to give it stability comprises a welding transformer. Welding transformer are used in AC machines with low voltage, high amperage current in the secondary winding. A combination of primary and secondary taps on the welding transformer is commonly used to provide a macro adjustment of the welding current, as well as adjustment of secondary voltage. Transformer ratings for AC machines are expressed in KVA (kilovolt-amperes) for a specified duty cycle. This duty cycle rating is a thermal rating and indicates the amount of energy that the transformer can deliver for a stated percentage of a specific time period, usually one minute, without exceeding its temperature rating. The RMS short current secondary current specification indicates the maximum current that can be obtained from the transformer. Since heating is a function of the welding current, this parameter gives an indication of the materials that can be welded.

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2. PROBLEM FORMATION WITH CONVENTIONAL WELDING TRANSFORMER

Electric arc welding is done by short circuiting two high current electrodes and withdrawing them. For generating the arc we need a huge amount of current. It was observed that different O.C. voltages are required to strike and to maintain the arc for different types of electrodes. The current range required for different works is a very wide one. It is difficult for operator to weld different material from same welding transformer as current requirement is different. If same transformer is used for all materials, welding will be free improper and lot of difficulties will be overcome by the operator. A number of welding transformers are required for different material which will increase cost for purchasing and also it required large space. Hence it is possible to design a welding transformer for an electric arc welding for different values of currents and voltages. This modified welding transformer will overcome the problem encountered by conventional welding transformer.

A. The aim and objectives of this project are

- To provide highly efficient variable voltage and current transformer having no moving parts and operable to smoothly vary the transformer output over a wide range of values.
- To design and build an electric arc welding machine that operates on two phase as well as three phase AC supply at constant frequency (50 Hz). This reduces the requirement of number of welding transformers because it can operate on any type of welding electrodes. To have an electric arc welding machine that is more efficient which produce neat welding.
- To eliminate the necessity of using expensive welding transformer.

- To provide transformer and control apparatus formed is to reduce the bulk of the equipment normally employed in electric arc welding in system.

3.VOLTAGE AND CURRENT CONTROLLED WELDING TRANSFORMER

A. CONSTRUCTION

1. Winding

It was observed that different O.C. voltages are required to strike and to maintain the arc for different types of electrodes. For ordinary- general purpose welding rods used for mild steel work the O.C. voltage required to strike and maintain the arc is between 40 to 60 volts, for cast iron rods it is from 60 to 80 volts and for stainless steel rods it is from 80 to 100 volts. The current range required for different works is a very wide one.

The simplified model of welding transformer is shown in fig 3.1. There are two primary coils, named as 1)Main Primary and 2) Sub Primary. The main primary coil is housed.on one limb of core and sub primary along with secondary on the other limb of a two limbed core. The main secondary coil has taps to change the O.C. secondary voltage.

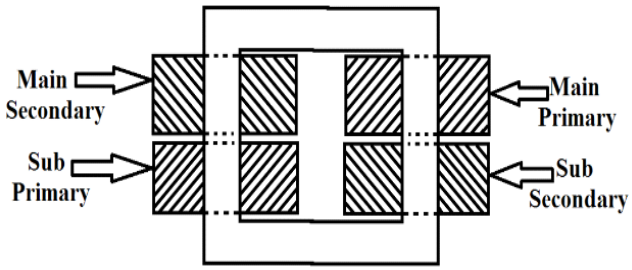

Fig.1 Construction of winding transformer

When the sub primary is completely out of circuit the minimum current is obtainable for welding because of high reluctance of magnetic circuit and/or mutual inductance between the two circuits / coils. (Primary and Secondary).

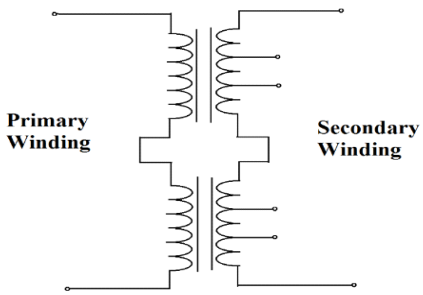

Fig.2 Circuit connection

Instead of only one secondary coil – two secondary coils named as main secondary and sub-secondary are used for Low and High range of currents as well as voltages. The sub-secondary and sub-primary coils are placed at the bottom. Main primary and main secondary coils placed on them respectively. From fig.1 and fig .2 two primary coils and two secondary coils with tapings, different ranges of currents as well as voltages are obtained as per our requirement for better welding. The gauge used for primary and secondary windings are 10gauge and 3 gauge respectively.

2 Choke

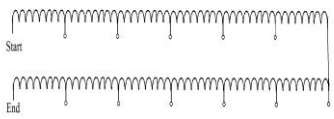

Fig. 3 Choke with tappings

The main function of choke is to limit the current flowing through circuit. Choke is pure inductive reactance. Around a magnetic core, few turns of thick conductor suitable for appropriate current range are wound as shown in fig.3.3

Taps are provided to get a suitable fixed current range. This is connected in series with secondary. Different taps are used for different size of electrodes, used for different works. When all the turns are in circuit minimum current is obtainable and when this choke is not in circuit, maximum current is available. The gauge used for choke winding is 3 gauge. There are 11 taps to the choke, sometimes two sets of taps are provided to the choke and with permutation and combination many ranges can be obtained. Table 1. Is showing different sizes of electrodes used for welding and their current ranges?

Table 1 Welding current range of electrodes.

Sr. No.	Size of Electrode		Current range Amps.
1	1.5 mm.	16 SWG	25-45
2	2.0 mm.	14 SWG	40-70
3	2.5 mm.	12 SWG	60-90
4	3.15 mm.	10 SWG	80-140
5	4.0 mm.	8 SWG	140-180
6	5.0 mm.	6 SWG	180-240
7	6.30 mm.	4 SWG	240-300

B. Specifications

Current Rating	= 200 Amp
O.C. Voltage	= 50 to 100 Volts
No Load Current	= 1.6 to 2.1 Amps
Type of cooling	= Air natural
Efficiency	= 95 %
General Duty Cycle	= 60%

4. RESULTS

Transformer is tested for 45 V and 8 SWG, the results are shown in table no.2

Table 2. Different current ratings for 45V

Sr. No.	Welding Current (Ampere)	Arc Voltage (volts)	KW Rating	Arc Resistance (Ω)	Cos Ø
1	50	22	1.1	0.44	0.48
2	60	22.4	1.34	0.37	0.49
3	80	23.2	1.85	0.29	0.51
4	90	23.6	2.12	0.26	0.52
5	100	24	2.4	0.24	0.53
6	110	24.4	2.68	0.22	0.54
7	180	27.2	4.89	0.15	0.60

Transformer is tested for 75 V and 10 SWG, the results are shown in table no.3

Table 3. Different current for 75V

Sr. No.	Welding Current (Ampere)	Arc Voltage (volts)	KW Rating	Arc Resistance (Ω)	Cos Ø
1	90	23.6	2.12	0.35	0.31
2	110	24.4	2.68	0.22	0.32
3	130	25.2	3.27	0.19	0.33
4	160	26.4	4.22	0.16	0.35
5	180	27.2	4.89	0.15	0.36
6	290	31.6	9.16	0.10	0.42

5. LOAD SERIES MOTOR

A better substitute for an exhaust fan in forced air cooled welding transformer. The forced air cooled welding transformer are provided with a small fractional H.P. single phase motor of capacitor type or shaded pole type to work as an exhaust fan to cool down the windings. The load series motor known as kanchan motor is a single phase motor connected in series with load. It is a current controlled shaded pole motor, designed to run if connected in series with load and speed of motor is proportional with load current i.e arc current. This special motor is very suitable for forced air cooled welding transformer. This motor can easily replace the ordinary exhaust fan.

5.1 Construction

Its construction and working is similar with standard shaded pole motor. The stator poles are made of laminated steel pieces, each pole piece comes with a slot cut into its pole face. Single or multistranded wire shading coil is placed in slot of these motor. (see fig no. 4)

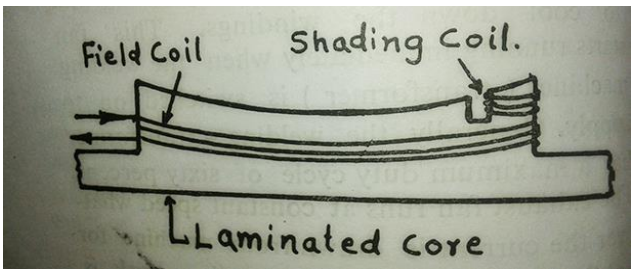

Fig 4 winding of load series motor

The main field windings are wound around the reminder of each pole pieces. It forms a closed loop circuit and the rotor is of squirrel cage type. The field winding few turns of thick conductor capable of carrying the full load current of the load equipment.

5.2 Operation

When the work is started the field windings are energised and magnetic field is set up between the pole and rotor.

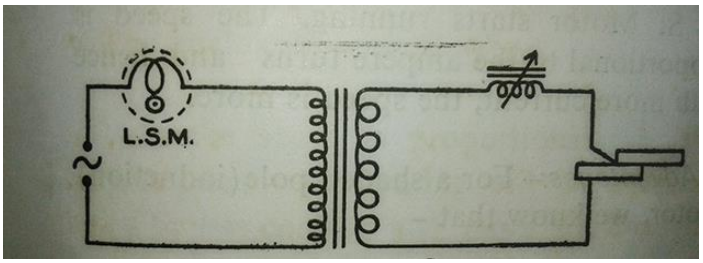

Fig 4 connection of load series motor with welding transformer

A portion of the magnetic field is also linked with shading coil which lies in the path of the magnetic field. Due to shading coil lines of flux which it links, slightly out of phase with reminder of the flux lines coming from the pole pieces. There is a two phase magnetic field similar to a two phase voltage at every pole piece. Because of the squirrel cage rotor with high resistance the slip is large and thus speed is not constant and very over a wide range by changing the load current. When there is no load on secondary i.e when no welding work is going on, the no load current flow through the windings of motor hence the motor does not run due to negligible load current. When the welding work is started more current is drawn from the supply then motor will start running. The speed is proportional to the ampere turns and hence with more current, the speed is more.

6. CONCLUSION

A welding transformer 35KVA, 2 phase, 50 Hz, step down is designed and manufactured for different current ranges. This is suitable for various electrodes required for welding of different metals. Joints are welded using this transformer are electrically and mechanically carry sounds. Designed transformer is having duty cycle of 60% for continuous operation. If we compare the voltage and current control welding transformer with ordinary welding transformer for same application found that the cost of machine is nearly one-fourth of ordinary machine because one voltage and current control welding transformer is equal to four ordinary transformer of different voltages. Therefore cost saving is more

7. REFERENCES

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