Materials of Conferences

A THYRISTOR CONVERTER WITH METERING CAPACITORS IN A POWER CIRCUIT

Magazinnik L.T.
Ulyanovsk State Technical University
Ulyanovsk, Russia

Thyristor converters with metering capacitors in a power circuit were widely used in electrical installations demanding a continuity of energy metering when a load was changed [1]. Transistor capacitor converters of half-bridge and bridge types are used usually in installations under 10-15 kilowatts in power. If a power of installation was greater [2] then thyristor capacitor converter was more preferable. Ion nitriding furnaces, arc metal spraying pistols, and such like can served as examples of such loads.

Thyristor-capacitor converters for dc loads are executed of bridge circuit and for ac loads are executed of half-bridge circuit.

Unreliability of an overload protection was the general disadvantage of aforementioned thyristor capacitor converters when a thyristor commutation was failure. A pulse-width selector [2] was part of a protection circuit of common devices that accounted for a lag post triggering of protection and operable reliability of protection was reduced.

The proposed protection system [3] is shown in figure 1 and it are comprised of the three-winding transformer. The first winding of this transformer is connected between the side and the thyristor bridge common anode. The second winding was connected between a cathode one of thyristor bridges and an anode another thyristor bridge so that the midpoint of the second winding formed one of leads of the alternating current thyristor bridge diagonal. The second winding has twice number of loops than the first winding. It has an opposite connection with the first winding. And the third winding of the mentioned transformer is connected with the turn-off pulse former; output of it is connected with the driving point of the thyristor circuit-breaker.

That makes to exclude the comparator and, above all, the pulse-width selector from circuits of type devices. That permits to provide a performance and a high reliability of the protection system. Indeed, the preventive type of the protection system was provided in the proposed device, i.e. a current was not increased practically when the thyristor bridge commutation was break off.

The vital difference of the proposed solution consists in the following. A load current flowed, for example, through the first winding 12 and the half-winding of the second winding 13, i.e. through opposite connection windings having an equal number of loops and formative a bifilar when the thyristor bridge operated normally. Thus sum of ampere-turns is vanishing. Accordingly, inductance of these windings is vanishing too. An analogous picture was occurred when the diagonal of thyristors 3 and 4 was activated. The resistance can be neglected, i.e. the proposed device operates analogous type devices on an operation mode. The current induced by the supply U_n must flowed through the first winding 12 and through the whole second winding 13 of the three-winding transformer 11 when a disruption of commutation was occurred, for example, when an activations of thyristors 1, 3 were occurred synchronous. This current had not surpassed the magnetizing current until the three-winding transformer is saturating, i.e. the short circuit being closed practically. Characteristics of the three-winding transformer choose sufficiently that its saturation time would equal the interrupting time of the thyristor circuit-breaker. A disconnect signal enter to this circuit-breaker 7 through the pulse former 15 from the third winding 14 in emergency state. An analogous picture would occurred too when thyristors 2 and 4 had been connected. In this case the magnetizing current flowing through the first winding 12 of the three-winding transformer 11 only. Note that since an interrupting time of the thyristor circuit-breaker 7 is less (tens of microseconds) that three-winding transformer gabarits are less too and connection of this with the power circuit of the thyristor capacitor converter is not a disadvantage. The demagnetizing of the three-winding transformer 11 would occurred when every disconnection of thyristor circuit-breaker was occurred. I.e. the three-winding transformer 11 is used according to total hysteresis curve and the proposed protection system is in ertialess and is restricted the current to a trifling load.

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AN OPTIMIZATION OF HALF-BRIDGE INVERTERS WITH A TRANSFORMER LOAD

Magazinnik L.T.
Ulyanovsk State Technical University
Ulyanovsk, Russia

Half-bridge inverters with transformer loads in an alternating current (ac) diagonal are widely used in various electrical installations. Classic variant of such inverters is corresponded the half-bridge of two transistors shunted by two reverse diodes and the half-bridge of two capacitors in-series. A load of the ac diagonal is usually a transformer and the direct current (dc) diagonal is connected to the power source. Main advantages of such inverters are simplicity of the circuit and a default of the constant component in the ac diagonal. The replacement of transistors by thyristors in the half-bridge has own deficiencies: a thyristor half-bridge inverter is operable in restricted load range and his regulation is probable by pulse-frequency method only. Using of the additional switching unit permitting to perform the recharge of the metering capacitor is part of that unit are one of removal variants of that's disadvantages. Thus a half-bridge inverter control is realized over a wide load range by the instrumentality of the standard time-proportional control system closed on a load current. The hardware form of a realization of the described control system is given in [1] and the up-to-date form microcontroller-based is given in [2]. But a range extension of regulation of an inverter load is attended by definite problems: 1) the preliminary recharge circuit of metering capacitor contains the circuit composed of thyristors, inductances and the metering capacitor in-series, that increased additional energy losses; 2) transformer windings voltage amplitude and load voltage were vary from zero to supply voltage when the control process is occurred. When voltage amplitude is reduced that an ionization is complicated and an arc excitation is complicated if, for example, electrical arc was a load [3]; 3) the circuit of the additional switching unit is more difficult.

The solution permitting to eliminate above-listed disadvantages is proposed in [4]. The new respective circuit of the thyristor half-bridge inverter is shown on figure 1.

The device contains the thyristor half-bridge inverter compressed of capacitors 1, 2, thyristors 3, 4, and the additional switching unit. This unit is corresponded the additional thyristor half-bridge inverter compressed of thyristors 7, 8 and capacitors 5, 6 which capacities are far less than capacities of capacitors 1, 2. The dc diagonal of this additional inverter is connected in-parallel with the thyristor half-bridge inverter 1, 2, 3, 4. The primary winding of the transformer 9 is connected with the ac diagonal of the half-bridge inverter 1, 2, 3, 4. And the secondary winding of this transformer is connected to the direct current load 13, which is connected in-parallel with the current sensor 14. In addition, the transformer 9 contains the additional winding 15 that is connected to the ac diagonal of the additional thyristor half-bridge inverter 5, 6, 7, 8 and having the number of loops are less than the number of loops of the primary winding 10. The control system is corresponded the standard system of a pulse-frequency regulation. This system consists of the surge injector unit 16 connected with the one of outputs of pulse-length modulator 17. In addition, the feedback controller is compressed of standard system of a pulse length regulation and the mentioned standard system is closed on a load current by an output signal of the current sensor 14 connected with one of outputs of the feedback controller 18. The secondary input of this controller is connected with the signal of source current U_3 and the output of this controller 18 is connected with the secondary input of the pulse-length modulator 17. The output of the mentioned surge injector unit 16 is connected with respective driving points of thyristors 3, 4 and the output of the pulse-length modulator is connected with respective driving points of thyristors 7, 8 included in the additional thyristor half-bridge inverter 5, 6, 7, 8.

The new device permits to exclude the circuit of a preliminary recharge of the metering capacitor together the metering capacitor. Capacitors of the thyristor half-bridge inverter are performed the duties of the metering capacitor thus losses were decreased and circuit was more simplify. In addition, voltage amplitude of the load was not changed and was some more than voltage supply when half-period average voltage of the load was changed in the mentioned device. That made considerably easier the “firing” and the arc stability if arc space was a device load.

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