Ain Shams University
Faculty of Engineering

INVESTIGATION
OF
A MODIFIED DUAL CONVERTER

A THESIS

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بسم الله الرحمن الرحيم

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master in Electrical Engineering.

The work included in this thesis was carried out by the author in the Department of Electrical Power and Machines, Ain Shams University, from 12/11/1984 to

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

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SUMMARY

In this thesis, a simple dual converter is presented. The converter comprises two anti-parallel connected three-phase bridge rectifiers, operate in the rectification mode. Braking is brought about by load conditions and not through regeneration to AC supply unlike the case of conventional dual converters. In this case three-phase fully-or half-controlled bridges can be used. The control is simple since no zero current, no zero speed detection nor inversion procedure are needed in the proposed converter. While the first bridge is supplying the motor in the positive direction, at the proper instant a command signal is initiated to block the firing signals to that bridge causing motor to decelerate under load and friction torques. After elapse of a pre-set adjustable time, through electronic timer, firing signals are applied to the second bridge rectifier. The reverse current supplied in this case will depend on the back emf of the running motor and the rate of dc voltage application. A reverse torque will be produced bringing motor to a rapid stop and then accelerates it in the negative direction. Control circuits operate both bridges under current limit conditions to protect both motor and converter from excessive currents during acceleration and reversal process.

The system can be tuned to perform the required oscillatory motion by adjusting both the position of limit switches along the track of motion in both directions, and the dead zone timing adjusted by the electronic timer.

A model for the proposed converter was used to feed a dc 220-Volt, 13-Amp., separately excited motor loaded by a friction disc. A storage osciloscope was used to obtain oscillograms for the drive voltage, current and speed during the whole duty cycle of motion. Three main variables were considered during tests and those are motor speed, load torque and dead zone timing.

The proposed dual converter is intended for relatively small-size drives with small moment of inertia so that regeneration of stored energy back to the AC supply is not necessary. The presented converter has the advantages of; simple control system, there is no possibility of inversion failure, and low cost. All the advantages of half-controlled bridges can be gained in the proposed converter including simple firing circuits, high power factor and less number of thyristor elements leading to even lower cost, unless fully-controlled bridges are needed for lower harmonic contents because of easy filteration of fully-controlled bridges.

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CHAPTER 1

INTRODUCTION TO DIRECT-CURRENT ADJUSTABLE SPEED DRIVES

1.1 General

Almost all power utilized by industry is brought into the plant through an electrical a.c. distribution system. This is invariably a three-phase, 50 Hz system.

Since power is normally distributed at constant frequency and constant voltage, and since d.c. adjustable speed systems require direct current and adjustable voltage, a fully controllable power conversion unit is of main importance.

A motor-gen utilizing an a.c. motor to drive a dc generator, with control of the generator field, has provided this function as shown in figure 1.1. In this type of units, rectification from a.c. to d.c. is performed by the commutator of the d.c. generator, by electromechanical means. The voltage magnitude is controlled by manipulation of the generator field excitation.

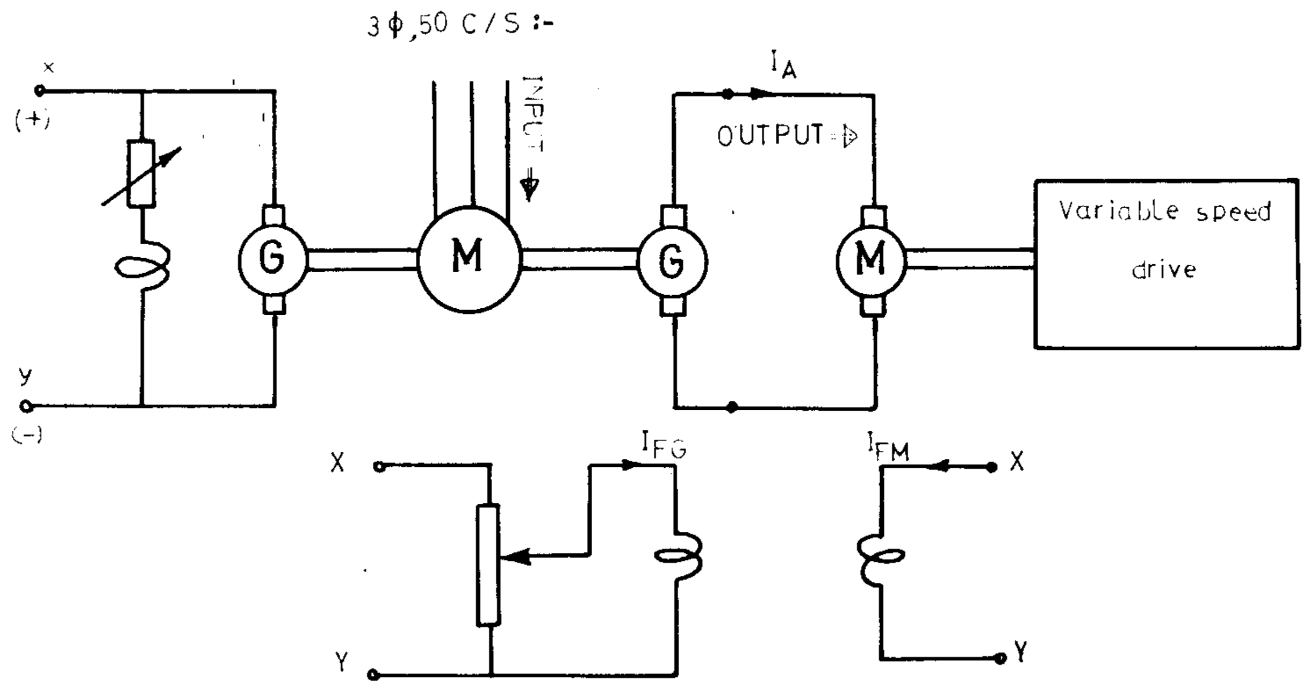

Fig. 1·1 Ward-Leonard speed control system.

Conversion of a.c. to d.c. can also be accomplished by static rectifier devices which allow current to flow in one direction, but not in the opposite direction. The magnitude of the dc voltage may then be controlled by gating the portion of each cycle so that current is allowed to flow. The gating function can be performed by a firing signal as in thyristors. Power conversion of this type is completely static, and no electromechanical devices are required between the power source and the terminal of the drive motor.

The thyristor drive has the following advantages:

1. The time response is faster.
2. Minimal maintenance is required.
3. No resistors are needed and the power losses in the thyristors are negligible, hence operating efficiency is high, above 95%.
4. Small size, less weight, and packaging flexibility results in reduced space requirement, lower initial cost, and lower installation and operating costs.

The thyristor drive has the following disadvantages:

1. The converter output has higher ripple content, the addition of a reactor in the armature circuit may be required to smooth out the ripple current.

2. Under certain operating conditions, the power factor of the a.c. supply is low.
3. Distortion of the a.c. supply voltage may be produced due to the switching action of thyristors.
4. Complex control circuitry is required to achieve regeneration.

1.2 Main Features of the Thyristor Drives

A gate triggering processor receives external inputs such as actual speed, actual current, actual torque, etc. These inputs are picked off the power circuit by means of suitable transducers. In addition, the processor can be set for any desired motor speed and torque. The actual values are compared with the desired values, and the processor automatically generates gate pulses to bring them as close together as possible. Limit setting are also incorporated so that the motor never operates beyond acceptable values of current, voltage, and speed.

It is also possible to control the speed of the motor to virtually any desired accuracy, by means of appropriate closed-loop control circuits. If the required accuracy is not too high, it may be sufficient