Relaxation Oscillations of a Motor-Generator Combination

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When the generator that is driven at constant speed by a motor (a prime mover) is connected to a separately excited d–c motor (no load), if the circuit parameters are adjusted properly, it is found that the rotation of the motor reverses periodically and the angular velocity of rotation excutes relaxation oscillations.

Introduction; In order to explain the action of the motor relaxation oscillations, we will first discuss the oscillatory motion in quality. Voltage of a generator is proportional to the strength of a magnetic field of it because the motor-generator is driven at constant speed by the prime mover. In the case, generated voltage balances the sum of three quantities, the drop of the effective inductance, the resistive drop of the circuit, and the counterelectromotive force of the separately excited motor. Considering the moment of inertia of the rotating parts of the motor, its kinetic energy of rotation is in proportion to the square of the angular velocity ω, accordingly the change ratio of the velocity of the rotating parts of the motor with respect to time depends on the moment of inertia and rotating force of the motor, the latter is proportioned to the armature current of the motor(as load)since the exciting current is kept constant. Now in Fig. 1 when we close the switch S, the voltage and the current of the d-c series generator will build up if the effective resistance of the circuit will be below the critical value, at the same time the rotating velocity of the motor(no load)increases and

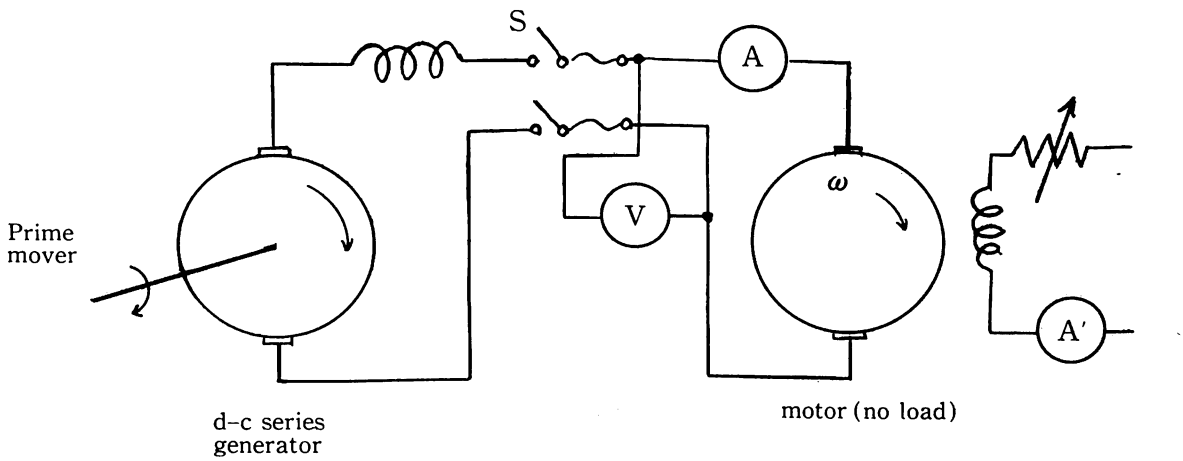

Fig. 1 Experimental Circuit

the counterelectromotive force nearly rises proportionally, as before stated. Finally the E.M.F. in the circuit becomes the difference between the voltage of the generator and the motors. Thus after the current arrived at a certain value, the generated E.M.F. goes down in accordance with the current diminution. As the velocity of the motor(no load)is sustained constantly by the gained momentum meanwhile, the counter E.M.F. predominates over the generated E.M.F. of the series generator. And the circuit current flows inversly,in consequence separately excited motor becomes a generator in a moment, which makes the d-c series generator to a motor that will revolve against the rotation of the prime mover. But it will put a quick end since no load motor has no rotating power except itself. By reason of the circuit current flow becomes conversely, the residual magnetism of the series generator is also reversed, the voltage of the series generator begins to build up again as soon as no load motor stops, however the polarity of the generator is opposite to one of the first instant.

So the motor increases the velocity to the opposite direction again, at last the counter E.M.F. is superior to the generator, consequently the motor comes to stop again, the entire cycle of the change is reiterated, namely motor-generator combination shows a kind of oscillatory phenomenon.

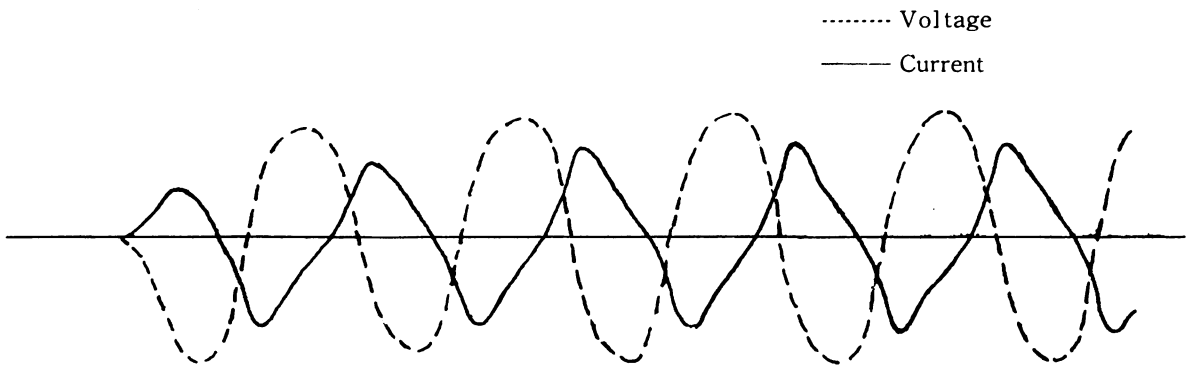

Fig. 2 Waveshapes

Experiments: Experimental results is shown in Fig.2. As see from the results, the oscillatory component of the current is almost triangular wave, and voltage wave form is approximately sine wave. More some phase difference between current and voltage is observed from Fig. 2.

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References

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