Title	A measurement of response time for magnetic amplifiers
Sub Title	
Author	藤田, 廣一(Fujita, Hiroichi)
Publisher	慶應義塾大学藤原記念工学部
Publication year	1954
Jtitle	Proceedings of the Fujihara Memorial Faculty of Engineering Keio University Vol.7, No.27 (1954.) ,p.83(12)- 87(16)
JaLC DOI	
Abstract	Recently, the magnetic amplifier is used in a automatic control circuit or a computer circuit. Therefore, the response time of the magnetic amplifier has increased its importance and has been measured frequently. Unfortunately the conventional instruments which measure the response time are considerably inconvenient. For example, the electromagnetic oscillograph is used to take a photograph of the load current wave form of the magnetic amplifier and its wave form is integrated. The method described in this paper in order to measure the response time of the magnetic amplifier consists of a simple and reliable electronic device and a cycle counter.
Notes	
Genre	Departmental Bulletin Paper
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO50001004-00070027-0012

A Measurement of Response Time for Magnetic Amplifiers

(Received April 18, 1955)

Hiroichi FUJITA*

Abstract

Recently, the magnetic amplifier is used in a automatic control circuit or a computer circuit. Therefore, the response time of the magnetic amplifier has increased its importance and has been measured frequently. Unfortunately the conventional instruments which measure the response time are considerably inconvenient. For example, the electromagnetic oscillograph is used to take a photograph of the load current wave form of the magnetic amplifier and its wave form is integrated.

The method described in this paper in order to measure the response time of the magnetic amplifier consists of a simple and reliable electronic device and a cycle counter.

I. Introduction

The response time of a magnetic amplifier is defined as the time during which a change of load current or voltage reaches 63 or 95 percent of a total change. And it is represented occasionally in the number of cycles of a-c supply voltage.

When the magnetic characteristics of core materials have a rectangular B-H loop, the wave form of the output current exhibits the typical rapid rise as one core saturates at some angle, and exhibits sinusoidal form after saturation. Therefore, if we measure the response time from the peak value of output current, we can not obtain its exact value, so we must measure it from the area of the output wave form.

The device described in this paper is a simple and reliable electronic device with cycle counter and two thyratrons. One of these thyratron is used as a starting switch of a cycle counter, the other is used as to stop it, when the value of load current reaches a specified value (63% or 95% of total change).

The duration of this cycle counter operation is the response time of the magnetic amplifier. In an integrating circuit, a rectifier (1 N 34) is used as a switching circuit to discharge the condenser in every cycle.

---

* 藤田廣一， Lecturer at Keio University

II. Principle of Operation and Description of Circuit.

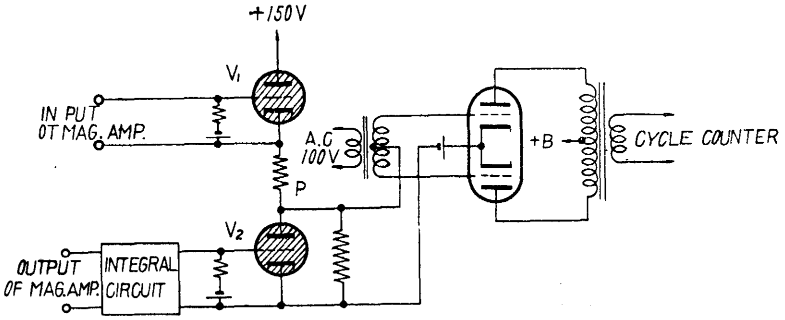


Fig. 1

In the Figure 1, two thyratrons, V_1 and V_2, are connected in series. The control d-c voltage of the magnetic amplifier is supplied to the control grid of V_1 and makes the V_1 discharge at the initial point of input unit step function. The control grid of V_2 is connected to the integrating circuit which integrates the output current wave form of the magnetic amplifier. The bias voltage of V_2 must be pre-adjusted to be discharged when the integrated wave form reaches the 95% or 63% of the final steady state value.

Then the potential of P increases rapidly at the discharge of V_1 and falls down at the discharge of V_2, so we can obtain an impulse during the response time of the magnetic amplifier. This impulse is supplied to a control grid of push-pull triodes, which are always supplied several volts of a-c 50 cycles, but are cut off by ample d-c bias voltage. Therefore, the cycle counter operates, with the signal of 50 cycles, only during the time of the impulse which appears at P.

The particular integrating circuit is shown Figure 2, the output wave form of the magnetic amplifier (a) is integrated by resistor 1 mΩ and a capacitor 0.1 μF as shown in (b). But desired wave form is shown in (c). In this circuit, the only positive wave form is supplied to the cotrol grid of 6 SN 7, as the negative wave form is passed through the rectifier 1 N 34 which is a switch for negative wave form and the integral of positive wave form starts from zero level. As the result, the wave form (d) appears across the grid of 6 SN 7.

In Figure 3, $T_1/2$ amplifies the output wave forms of the magnetic amplifier. $T'_1/2$ and T_2 amplify the integrated

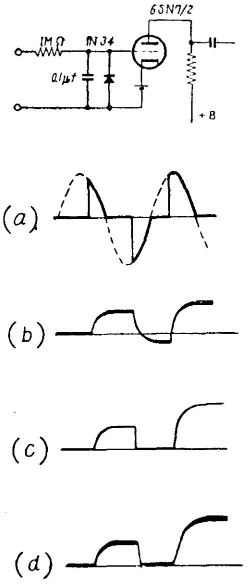


Fig. 2

positive wave form. This amplified integrated wave form is supplied to the control grid of the thyratron V_2. Variable resister VR_1 adjusts the output voltage of the

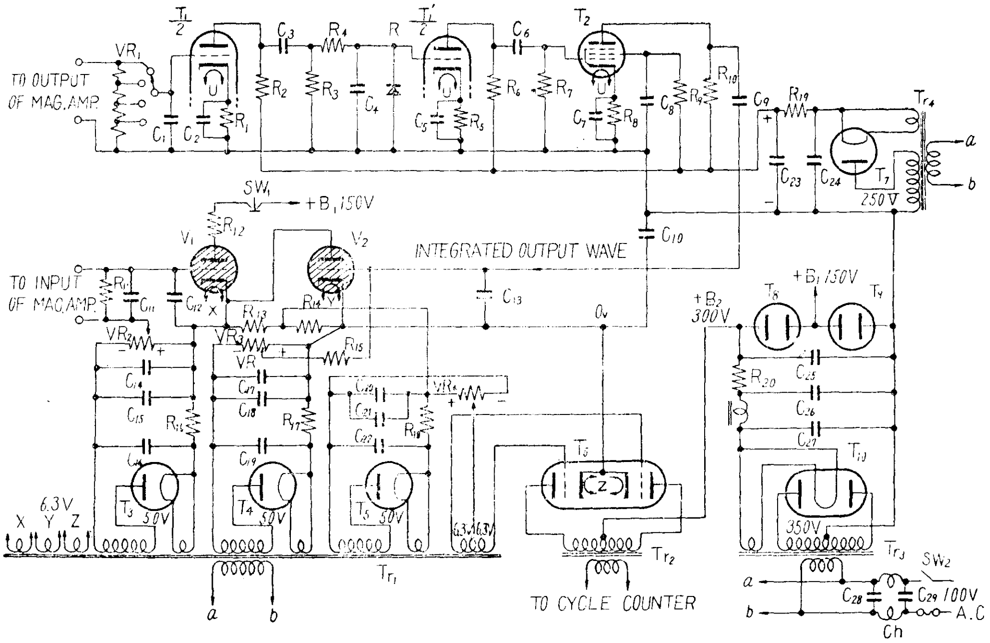


Fig. 3

R_1	2KΩ	(½W)	C_1	0.0001 μF	(1000V)	C_{20}	0.1μF (600V)
R_2	100KΩ	(〃)	C_2	10 μF	(50 V)	C_{21}	10 μF (350V)
R_3	100KΩ	(〃)	C_3	0.3 μF	(600 V)	C_{22}	10 μF (350V)
R_4	1MΩ	(〃)	C_4	0.1 μF	(1000V)	C_{23}	10 μF (350V)
R_5	2KΩ	(〃)	C_5	10 μF	(50 V)	C_{24}	10 μF (350V)
R_6	100KΩ	(〃)	C_6	0.1 μF	(600 V)	C_{25}	4 μF (500V)
R_7	1MΩ	(〃)	C_7	50 μF	(50 V)	C_{26}	4 μF (500V)
R_8	2KΩ	(〃)	C_8	1 μF	(300 V)	C_{27}	4 μF (500V)
R_9	1MΩ	(〃)	C_9	0.1 μF	(600 V)	C_{28}	0.01 μF (600V)
R_{10}	250KΩ	(〃)	C_{10}	0.1 μF	(600 V)	C_{29}	0.01 μF (600V)
R_{11}	2KΩ	(〃)	C_{11}	0.01 μF	(600 V)		
R_{12}	3KΩ	(2W)	C_{12}	0.01 μF	(600 V)	VR_1	5,10,20,40KΩ (½W)
R_{13}	5KΩ	(〃)	C_{13}	0.001 μF	(600 V)	VR_2	20KΩ+20KΩ(Vari)
R_{14}	5KΩ	(〃)	C_{14}	0.1 μF	(600 V)		+20KΩ
R_{15}	50KΩ	(½W)	C_{15}	10 μF	(350 V)	VR_3	50KΩ (½W)
R_{16}	10KΩ	(〃)	C_{16}	10 μF	(350 V)	VR_4	50KΩ (〃)
R_{17}	10KΩ	(〃)	C_{17}	0.1 μF	(600 V)	R	1N34
R_{18}	10KΩ	(〃)	C_{18}	10 μF	(350 V)		
R_{19}	3KΩ	(2W)	C_{19}	10 μF	(350 V)		

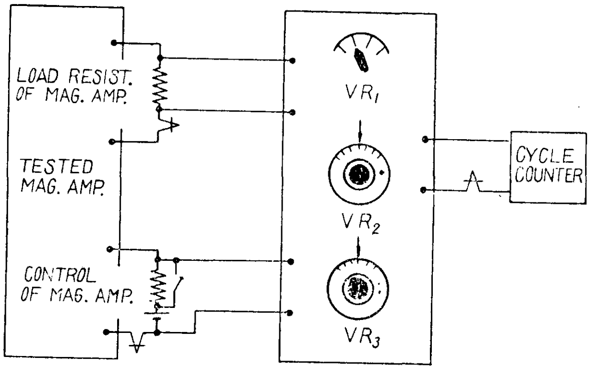
T_1	6SN7	T_9	150/60	Ch	2mH
T_2	6SJ7	T_{10}	150/60		
T_3	80BK	V_1	TY66G		
T_4	80BK	V_2	TY66G		
T_5	80BK	T_{r1}	P. 100V S. 50V,6.3V		
T_6	6N7	T_{r2}	15×2:1		
T_7	80BK	T_{r3}	P. 100V, S. 350V×2, 5V		
T_8	80	T_{r4}	P. 100V, S. 250V, 5V		

magnetic amplifier so that the amplified wave form does not distort. R_{11} is chosen lower in order to eliminate undesirable voltages such as noise voltage, abnormal peak voltage of swtching shock, etc. R_{12} limits the current of thyratron V_1 and V_2. Two resistor of R_{13} and R_{14} are connected in series and divide the anode voltage of V_2 because the thyratron V_2 needs high anode voltage (over 100 volts d-c) but the impulse voltage for T_6 does not need so high. The proper grid potential of T_6 at the operation is obtained by subtracting the voltage across R_{14} from the divided voltage by VR_4.

The impedance of the cycle couter is low. Therefore an impedance matching is done by trnsformer TR_2 whose delay time can be entirely negligible affirmed as the results of experiment. The capacitors C_1, C_{11}, C_{12}, C_{13} C_{14}, C_{17}, C_{20}, C_{28}, and C_{29} serve to by-pass any abnomal voltage in the circuit and to keep the device stable.

III. The Method of Measurement

The block diagram for the method of this measurement is shown in Figure 4. At first, we adjust VR_2 to discharge the thyratron V_1 at the initial point of unit function. Then VR_3 is adjusted to discharge the thyratron V_2 when the integrated wave form reaches the 95% or 63% of the final steady state value. After these two preparations, we supply a step voltage to control winding of a testing magnetic amplifier then the response time is indicated by the cycle counter. If we want to repeat the measurement, we set back the magnetic amplifier to the former state and break the circuit of thyratrons by SW_1 to



A VIBRATOR OF OSCILLOGRAPH

Fig. 4

stop their discharges.

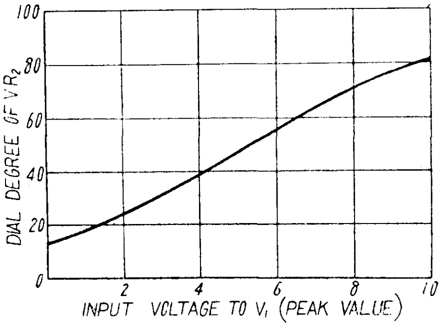


Fig. 5

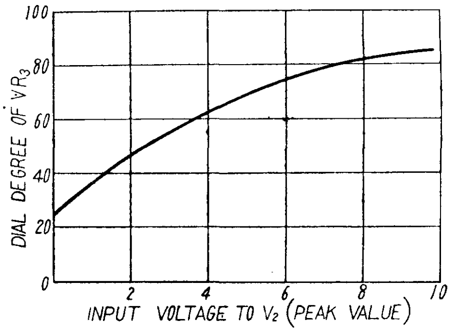


Fig. 6

The curve in Figure 5 shows the relationship between dial degree of VR_2 when V_1 discharges, and the peak value of the amplitude. Figure 6 shows the same relationship for the thyratron V_2 and VR_3. Figure 7 is the photograph taken by the electromagnetic oscillographs to assure the operation of this device.

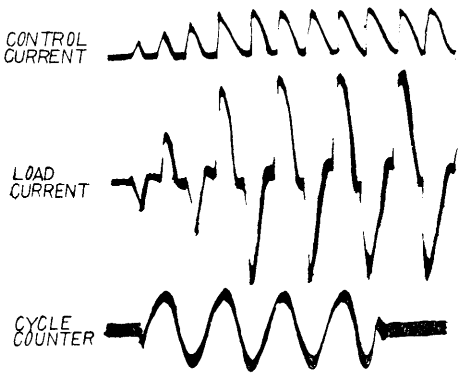


Fig. 7

IV. Note

The main error of this device depends upon the fluctuation of a-c supply voltage. If the a-c voltage fluctuates during the preset of device and measurement, the error occurs. When the a-c voltage drops down, the characteristics of this device will not be affected too much, but those of the magnetic amplifier will be affected, that is relatively, the preset final value of the device rises. consequently the response time will be measured as longer than the true response time. Therefore, great care must be taken to maintain the a-c supply voltage stable. The biggest limitation of this device is that it can not measure the response time when the load current of the magnetic amplifier falls down.

Acknowledgement

We acknolwledge our indebtedness to Mr. Nakajima and Mr. Kobayashi of Fuji Electric Co. and Mr. Kamo and Bansho, the student of Keio University.