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ELECTRICAL MEASUREMENTS AND THEIR INDUSTRIAL APPLICATIONS

AN IMPROVED VARIAC® SPEED CONTROL

Also IN THIS ISSUE

● **THE ⅓ H.P. VARIAC SPEED CONTROLS,** TYPES 1700-AL and AH, have given an excellent account of themselves in a large number of applications since their introduction two years ago[1]. The combination of the Variac with a rectifier and choke has many advantages as a source of adjustable armature voltage for operating d-c shunt or compound wound motors over a wide speed range. The resistance of the armature voltage source can be made low, usually less than half the armature resistance of the motor, so that good regulation is obtained, essentially the regulation of the motor itself. The armature current is essentially ripple-free, so that torque pulsations are negligible and no derating of the motor is required. The controls are of compact single-unit construction, providing reversal and dynamic braking without auxiliary equipment.

One factor which has limited the acceptance of these controls has been that a tube rectifier is employed. The use of tubes, however rugged

[1]For a description of these controls, see W. N. Tuttle, "Variac Motor Speed Controls," *General Radio Experimenter*, Vol. 23, April, 1949, pp. 1-8.

Figure 1. New Type 1700-B Variac Speed Control installed on toroidal winding machine.

Figure 2. Panel view of the Type 1700-B Variac Speed Control.

they may be, is always a reminder to the customer that additional maintenance problems may be involved. Tube life records leave him unconvinced. (Actually we know of no tube failure whatever in the case of the TYPE 1700 Controls, either in equipment installed or in the course of our original experimental work.) A tube rectifier requires the use of some sort of time delay mechanism to insure proper warm-up before load is applied. This is not a handicap in shop equipment for which the power unit can be turned on at the beginning of each working day, but is a definite limitation in the case of equipment subject to occasional use, and is a reminder to the user that electronic equipment, supposedly subject to failure, is involved.

A new ½ h.p. control, TYPE 1700-B, is now offered, which is the same in size and in general appearance as the TYPE 1700-A design but in which a selenium rectifier is substituted for the tube rectifier with considerable simplification in construction. Figure 1 shows the new control operating a toroidal winding machine. The selenium rectifier requires no time delay device, no center-tapped step-up transformer, and no filament supply. The saving in these components results in a substantial reduction in cost without sacrifice in performance and with the advantage of instant starting.

The photograph, Figure 3, of the interior of the new control shows the simplicity of the design. At the upper corners of the cabinets are the field-supply transformer and the choke. The combination overload breaker and field switch is beside the Variac. The start-stop-reverse switch and the dynamic braking resistor are at opposite sides. The armature rectifier stacks are in the bottom corners with the field rectifier and Jones plug between them. As with the earlier TYPE 1700-AH and AL Controls, all components are mounted on the lid. The plug and jack arrangement simplifies installation and makes it possible to remove the unit without disturbing the wiring.

RECTIFIER LIFE

The new design has been made possible largely by improvement in available selenium rectifiers. Motor control equipment is frequently subject to operation in high ambient temperatures. To protect a rectifier from failure due to excess plate temperature, substantial derating has been necessary even when high ambient conditions were expected only occasionally. This has made both the bulk and the cost of suitable rectifiers almost prohibitive. Rectifiers recently announced not only require fewer plates for a given voltage but also are capable of withstanding sustained overloads or long periods of high ambient temperature without failure. Maximum rectifier life of 40,000 to 50,000 hours still requires derating to limit the maximum plate temperature, but occasional operation at higher-than-normal temperatures now costs only a moderate decrease in life instead of possible immediate breakdown. With the new rectifiers, it is estimated on the basis of manufacturer's tests that a life of at least 15,000 hours will be obtained on continuous duty with the control box in an ambient temperature of 40°C. This means that for ordinary applications, where operation is usually at lower temperatures, almost indefinite life is to be expected. Even where operation under extreme conditions is the rule rather than the exception, several years of rectifier life should still be obtained.

FEATURES

The TYPE 1700-B Control has several new features worth noting in addition to those of instant starting and freedom from tube replacement. The field supply is isolated by a transformer from the armature circuit. This means that standard compound-wound motors having five leads can be reversed by means of the switch on the control. In the TYPE 1700-A design, a straight shunt motor connection is required for reversing service. Operating the field supply from a separate transformer instead of from a tap on the Variac makes it possible to open the Variac input connection whenever the motor is stopped and still have field excitation available for dynamic braking. Elimination of the Variac no-load loss during standby periods results

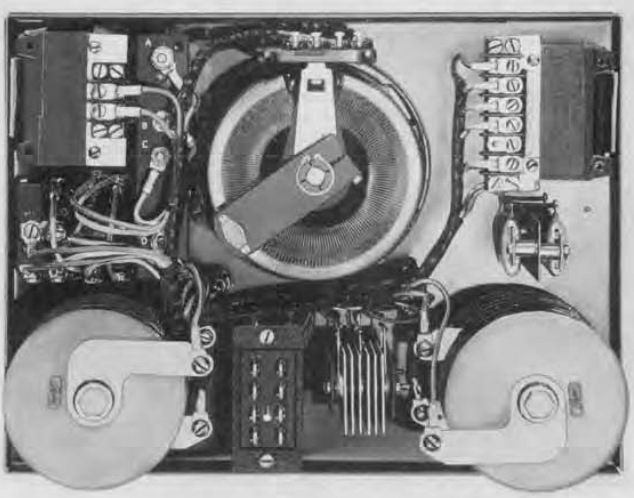


Figure 3. Interior view of the control showing simple construction resulting from use of selenium rectifiers.

in cooler operation of the control. Since there is no tube and no warm-up problem, the motor may be started or stopped by a switch in the a-c circuit, although the dynamic braking is not operative when this is done. Microswitches can be employed conveniently for limit switches in many applications because it is not necessary to interrupt the direct current in the armature circuit.

PERFORMANCE

Performance curves for the new control operating with a compound-wound motor are given in Figure 3. The regulation at base speed is about 24 per cent. With the series field disconnected, about 18 per cent regulation is obtained, but with appreciable reduction in starting torque. For most applications the compound connection is preferred because of the improved starting characteristics, although this consideration is not so important with ⅓ h.p. motors as with those of higher rating. Since the r.p.m. rise in speed between full load and no load is roughly the same at all speeds, the percentage regulation varies inversely as the speed setting. Even at the lower speed settings, however, the regulation has proved entirely satisfactory in a wide range of applications. Experience had proved that it is only the exceptional application which requires that speed be very closely held against load variations. For all ordinary applications, the inherently good regulation characteristics of the shunt motor, as provided by the TYPE 1700 Controls, are all that can be desired.

ONE MODEL ONLY — 115 VOLTS

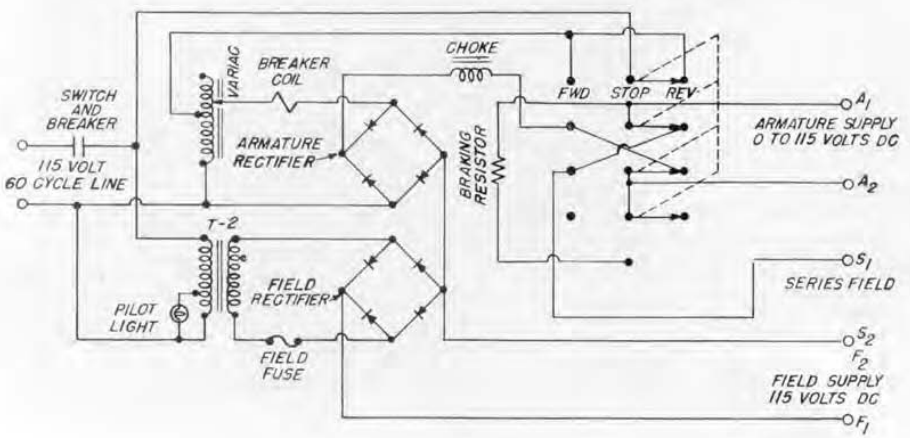
The TYPE 1700-B Control is available only for operation at 105-125 volts, 60 cycles. An equivalent 230-volt design is not practicable because the kva rating of the Variac is less at the higher voltage and because a more bulky and more expensive selenium rectifier would be required. Where 230-volt operation is required and the warm-up time delay is not a disadvantage, the TYPE 1700-AH Control is recommended. Where the instant-starting feature is desired with 230-volt operation, the TYPE 1700-B Control can be used with a 230-115-volt autotransformer of 600 va rating.

SUMMARY

To summarize,

(1) The new Variac control is simple and easy for shop electricians to understand.

Figure 4. Schematic circuit of the Type 1700-B Variac Speed Control.



(2) It is a rugged, long-life control that is essentially maintenance free.

(3) It is instant-starting, and adjustable speed is obtained without the complications inherent in the thyratron arrangements.

(4) It has a very large short-period overload capacity and is outstanding in its ability to start heavy loads quickly.

(5) The very low ripple in the armature circuit means that there are no torque pulsations and that standard motors can be used at their full rating.

This combination of characteristics makes these controls adaptable to a wide range of applications.

— W. N. TUTTLE

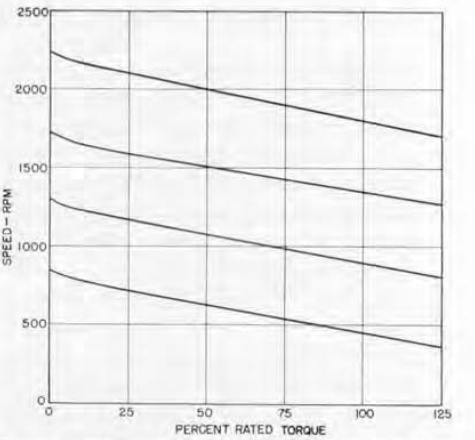


Figure 5. Speed-Torque curves of Type 1700-B Variac Speed Control operating a G.E. type BC Compound-Wound Motor rated ⅓ h.p., 1725 rpm, 115 v, 3.0 a input.

SPECIFICATIONS

Supply Frequency: 60 cycles

A-C Input Voltage: 105-125

D-C Output Armature Voltage: 0-115

Continuous D-C Output Armature Current: 3.0 a

D-C Output Field Voltage: 115, 75

Maximum D-C Output Field Current: 0.4 a

Input Power: Stand-By, 38 watts
Full Load, 560 watts

Speed Range: Motor rated speed down to zero at constant torque.

Motor: 115-v D-C shunt or compound motor of ⅛ h.p. rating, or other motors operating within the continuous armature current rating of 3.0 amperes, may be used with the control. A motor with a commutating pole is preferable because improved commutation is obtained over the speed range. We can supply the motor listed below. Motors of other manufacture can be used equally well.

Overload Protection: A time-delay magnetic circuit breaker permits heavy starting currents of short duration, but protects the control and motor in event of a stall. Breaker will open between 3.5 and 4.35 amperes armature current on sustained overload, but will permit a starting current inrush of 12 amperes for 3 seconds.

Reversal and Dynamic Braking: A manually operated start-stop-reverse switch and a dynamic braking resistor are included in the control. Strong braking action is obtained in the stop position.

Mounting and Wiring: Holes are provided in the back of the box for mounting on a wall or bracket. Mounting must be vertical and must permit free access of air through the bottom of the cabinet. Two holes for BX or conduit wiring are located in the center of the bottom of the box.

Domensions: Box, $9\frac{5}{16}$ x $12\frac{3}{8}$ x $4\frac{5}{8}$ inches; dimensions over knobs and louvers, $9\frac{5}{16}$ x $12\frac{3}{4}$ x 6 inches.

Net Weight: $23\frac{1}{2}$ pounds, GE motor 30 pounds.

Type		*Code Word*	*Price*
1700-B	**Variac Speed Control,* 115 v, 60 cycles**	AFOOT	**$165.00**
BC46AB29	**GE ⅓ h.p. Semi-enclosed 1750 rpm motor, 115 v, dc, for use with Type 1700-B**	MOTOR†	**45.79**

*To order speed control with motor, use compound code word, AFOOTMOTOR.
†U.S. Patent No. 2,009,013.

TYPE 71-A VARIAC® TRANSFORMER

A source of low voltage, a-c power is a necessity in any electrical laboratory or experimental shop. A convenient, adjustable source, readily adaptable to many uses, can quickly pay for itself with time savings alone. A continuously adjustable transformer of the Variac type, but with a completely isolated secondary winding, provides such a source.

The 71-A Variac Transformer has been developed to meet these requirements. It is a ready-to-use, enclosed package with attached cord and plug for 115-volt, 60 cycle input, and a pair of versatile TYPE 938 Binding Posts to deliver 0 to 16 volts output.

The transformer is rated for 5 amperes continuous duty, with a conservative 50°C. internal temperature rise and an output regulation drop of less than 3 volts at full setting.

The basic unit is composed of two layer-wound primary coils on opposite legs of a conventional stack of L-type laminations plus two single-layer secondary coils wound over each of the primaries. The insulation between coils and to the core will withstand a 1250-volt breakdown test. The secondaries are tapped by a unique arrangement of two standard Variac brushes on a single aluminum radiator, which permits direct connections of the coils to both line and load without slip rings.

The simple, rugged enclosure is largely made up of two heavy aluminum U pieces, which are held so as to provide a ¼-inch mounting slot at the bottom and a guiding track for the slider carrying radiator and brushes at the top. This slider assembly is the only moving part.

The mounting slot permits securing the unit to a wall, out of working space,

or into a device as a permanent component.

The slider track is calibrated in open-circuit voltage for ready reference.

The limited voltage range makes this transformer particularly safe for experimental work, the isolated secondary permits its use in floating circuits, and the continuous adjustment is convenient in compensating for voltage fluctuation or in determining performance over a voltage range.

We have found this device extremely useful for controlling the small low-voltage soldering irons used in miniature work, as a filament supply on breadboard models, as an intensity control for microscope lamps, and in many other applications.

— H. M. WILSON

SPECIFICATIONS

Input Voltage: 115 volts
Output Current: 5 amperes maximum
Output Voltage: 0-16 volts open circuit
0-13 volts at 5 amp.
No-Load Loss: Less than 5 watts
Dimensions: (Length) 5½ x (width) 3⅝ x (height) 3¼ inches, overall.
Net Weight: 4 pounds.

Type		*Code Word*	*Price*
71-A	Variac Transformer*	POPPY	$18.50

*U. S. Patent No. 2,009,013.

MISCELLANY

PAPERS — By W. R. Thurston, of General Radio's New York Office: "U-H-F Measuring Equipment," at the April 11 Meeting of the Lancaster Subsection, I.R.E., at Lancaster, Pa.

— By Frederick Ireland, of General Radio's Los Angeles Office: "Impedance Measurement Techniques at Frequencies between 50 and 1000 Mc," at the April Meeting of the Los Angeles Section, I.R.E.

— By William R. Saylor, of the Sales Engineering Department, Cambridge Office: "Some Recent Developments in the Instrument Field," at the March 27 Meeting of the Technical Group on Instruments and Measurements, Boston Section, A.I.E.E.

— By Donald B. Sinclair, Chief Engineer, and Arnold P. G. Peterson, Engineer: "A Single-Ended Push-Pull Amplifier," at the 1951 I.R.E. National Convention, New York, March 22.

— By Donald B. Sinclair, Chief Engineer: "Considerations in the Design of a Line of Inexpensive Test Equipment," at the New England Radio Engineering Meeting, Boston, April 21.

HONORS — At their 109th National Meeting, in New York on January 31, 1951, the American Meteorological Society gave its award for "outstanding services to the Society by an individual" to Henry S. Shaw of Westbrook, Maine. Mr. Shaw, now retired, was formerly Chairman of the Board of the General Radio Company.

RECENT VISITORS from ABROAD

From Sweden:

Tord Bohlin, Chief Development Engineer, A. B. Refa, Stockholm; B. G. Lindbeck, Chief, Measuring and Physical Department, SKF Laboratories, Gothenburg.

From Switzerland:

Robert Goldschmidt, Head, Research and Development Department, Cableries et Trefileries de Cossonay S. A., Cossonay; Gustave Guanella, Head, H-F Research Department, and Rene Kunzli, Assistant to Chief of H-F Construction Department, Brown-Boveri and Co. A.G., Baden.

From South Africa:

Dr. J. C. R. Heydenrych, National Physical Laboratory, South African Council for Scientific and Industrial Research, Pretoria.

From India:

S. K. Chatterjee, Lecturer, Department of Electrical Communication, Indian Institute of Science, Bangalore, India.

From Australia:

John A. Paton, Managing Director, and B. F. Israel, Sales Manager, Transmission Products Pty., Ltd., North Sydney.

From Japan:

M. Tomota, Director and Chief Engineer, Yokogama Electric Works, Ltd., Tokyo; Toshifusa Sakamoto, Department of Electrical Engineering, First Faculty of Engineering, University of Tokyo; and Dr. Takashi Isobe, Professor, Department of Electrical Measurements, Faculty of Engineering, University of Tokyo.

APPARATUS FOR NOISE MEASUREMENT

An excellent summary of the important characteristics of noise-measuring equipment is contained in a paper by Dr. Leo L. Beranek, entitled "Apparatus for Noise Measurement." Originally prepared for the National Noise Abatement Council, this paper has also been presented before medical and industrial hygiene groups. The general requirements for a sound-level meter are reviewed, and the characteristics of six types of microphones and six types of analyzers are discussed. Calibrating devices, vibration pickups, and recorders are also considered. The paper is directed to those responsible for the purchase and use of noise-measuring equipment in factories, law-enforcement agencies, business offices, medical clinics, and other organizations outside the engineering field. Copies are available on request to the *General Radio Experimenter*.

CREDIT — Author of the article in the April issue, entitled "A Dynamic Microphone for the Sound-Level Meter," was Ervin E. Gross, of our Development Engineering Group.

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