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ELECTRICAL MEASUREMENTS AND THEIR INDUSTRIAL APPLICATIONS.

FIVE NEW VARIAC® SPEED CONTROLS ROUND OUT THE LINE

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●THE ADDITION of the TYPES 1701-AM, 1703-A, 1702-M, 1704-A, and 1705-A Variac® Motor Speed Controls to the four previously announced brings to nine the models now available.

THE TYPE 1703-A control, of 1/6-hp rating, fills the gap between the 1/5-hp controls, TYPES 1701-AK and AU, and the 1/3-hp control, TYPE 1700-B.

THE TYPES 1704-A and 1705-A controls extend the line to higher ratings, 1 and 1 1/2 hp, respectively.

THE TYPE 1702-M is a new 3/4-hp control for push-button operation, which is an alternative to the TYPE 1702-A.

Figure 1. The Type 1703-A One-Sixth Horsepower Control.



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The TYPE 1701-AM control is similar to the TYPE 1701-AK of $\frac{1}{2}$ -hp rating but has only a single-speed range and has an armature-circuit fuse accessible from the front panel. Comparative specifications and prices of the entire line of controls are given in the table on page 4.

The Variac Motor Speed controls, first announced in April, 1949,¹ provide adjustable constant-speed operation of d-c motors from a-c lines. Separate rectifiers supply field and armature power and a Variac[®] adjustable transformer, ahead of the armature rectifier, makes it possible to vary the armature voltage from the rated value down to zero smoothly and with good regulation. The superior performance of armature-voltage control is thus provided by particularly simple and reliable equipment.

Advantages

This system, however, has advantages not common to other adjustable-armature-voltage systems, and it is becoming evident in the rapidly expanding field of applications that the control is basically a new device with a unique combination of characteristics. Selenium rectifiers are employed so that power conversion and control are accomplished without using either rotating machinery or electron tubes. Low-cost, simple installation, elimination of warm-up time, and long

¹W. N. Tuttle, "Variac Motor Speed Controls," *General Radio Experimenter*, Vol. 23, April, 1949, pp. 1-8.

life with very much reduced maintenance are the result. The use of selenium rectifiers rather than tubes also greatly increases the short-period overload rating. This is particularly important in starting heavy loads or in repeated starting and stopping. The rectified armature voltage is reduced by changing the amplitude of the a-c input, rather than, as in a thyatron rectifier, by cutting out part of the cycle. The result is that it is relatively easy to filter the armature supply and so to obtain very low ripple content. This reduces both motor heating and torque pulsation in the motor output.

The speed-torque characteristics of the control, providing about 15-25 per cent regulation at base speed, seem to be definitely superior to those of a very "stiff" drive for most applications. A drive with these characteristics yields enough to protect the work or tool when irregularities are encountered, but maintains constant speed under heavy load under ordinary conditions.

Applications

With the Variac Motor Speed Control, it is possible to start delicate equipment or critical processes smoothly and slowly. On toroidal winding machines handling fine wire, for example, one user reports that wire breakage has been practically eliminated. On these machines, no other control had been satisfactory.

An application where the excellent starting characteristics of the control have proved of great value has been for the spindle drives of a battery of ten winding lathes for transformer coils in our own plant. Here, in order to obtain maximum production, over-voltage starting is employed with a special low-



Figure 2. Compact Control Station for Type 1702-M Three-Quarter Horsepower Control.





inertia motor so that the spindle can be accelerated to more than 5000 rpm in about three seconds. Although the starting current peak is about seven times the full-load value, maintenance on the controls has been negligible and none whatever has been required on the motor brushes or commutators. The first installation of this group has been in operation almost five years. A similar application requiring frequent starting and stopping is on automatic condenser-winding machines.

The virtual elimination of torque pulsation, resulting from the very low ripple content of the armature current, has proved particularly valuable in precision grinding work, and the control is being used increasingly for both grinder feeds and spindles and for similar applications.

The controls have proved highly versatile, and any listing of uses can only suggest the many fields where they can be used successfully. In machining plastics and in lens lapping, the ease and smoothness of adjustment have proved very valuable. In conveyors and in process work of various kinds, the constancy of speed has proved highly satisfactory in a large number of applications. The characteristics of the controls have been found particularly suited to rewinding and take-up drives of various kinds.

Descriptions of the new controls follow with a tabulation of specifications and prices for the complete line.

The Type 1703-A One-Sixth Horsepower Control

As shown in Figure 1, this control is similar in appearance to the TYPE 1701 controls but has two and one-half times

Figure 3. Cabinet, Variac, and Control Station for Types 1704-A and 1705-A Controls Rated One and One-Half Horsepower. The shallow cabinet takes very little room on the side of a machine.

the output rating. It provides in addition two features previously available only in the larger models. These are dynamic braking and the superior starting characteristics of compound-wound motors. We have had many requests for a control of this rating, a typical application being for heavier feed drives than can be handled by the TYPE 1701 controls. A power cord and 3½-foot motor cable are included as with the TYPE 1701, and the control also requires no bottom ventilation, so can be used on a laboratory bench.

The Type 1702-M Three-Quarter Horsepower Control

This new control is offered as an alternative to the TYPE 1702-A in cases where the cabinet of the latter is too large to be mounted within convenient reach of the operator of the driven machine, or where push-button control is preferred to the mechanically-operated switch. Control relays for starting, reversing, and dynamic braking are included in the cabinet, replacing the Variac and control switch; and the Variac, push buttons, and a pilot light are mounted in a separate, compact control station, illustrated in Figure 2. This is a dust-proof enclosure, which protects the Variac fully from metal





VARIAC MOTOR SPEED CONTROLS

Type No.	1701-AK 1701-AM1	1701-AU	1703-A	1700-B	1702-M	1704-A	1705-A
Motor Horsepower Range	1/16 and less	1/16 and less	1/16 to 1/4	1/8 and 1/4	3/8 and 3/4	1	1 1/2
Power Supply: (Single phase ac)							
Full load amperes	115 1.5	115 2.2	115 4.2	115 5	115** 10	230 6.3	230 8.5
Line voltage limits	105-125 105-120	105-125 105-120	105-125	105-125 No rating	105-125 No rating	210-250 No rating	210-250
at 60 cycles							
Impedance — watts							
Full load	175	175	235	360	1150	1500	1930
Standby	None	None	30	38	85	90	90
Control Output — DC							
Armature — Amperes	0.8	0.8	1.5	3.0	6.5	4.5	6.0
Field — Volts	0-15	0-115	0-115	0-115	0-115	0-250	0-250
Field — Amperes	1.25	1.0	0.2	0.4	0.2	0.3	0.3
Speed Range	115 0 to 0	115 0 to 0	66 0 to 0	115 0 to 0	115 0 to 0	230 0 to 0	230 0 to 0
Dynamic Braking	rated	0 to rated	1.25 rated	1.15 rated	1.15 rated	1.12 rated	1.12 rated
Armature Overload Protection	None	None	Automatic in Stop Position	Automatic in Stop Position	Automatic in Stop Position	Automatic in Stop Position	Automatic in Stop Position
Control Station	On cabinet	On cabinet	On cabinet	On cabinet	On cabinet	On cabinet	On cabinet
Cabinet Dimensions — inches	5 1/2 x 6 1/2 x 4 1/2	5 1/2 x 6 1/2 x 4 1/2	7 1/2 x 7 1/2 x 4 1/2	12 1/2 x 9 1/2 x 6	13 1/2 x 15 x 6 1/2	21 x 19 1/2 x 7	21 x 19 1/2 x 7
Net Weight — pounds	6	6	9	21 1/2	41	WEEDY	WAXER
Code Word	-AK WINDY -AM WIDOW	WEARY	WEBBY	AFOOT	1705-A AMAZE 1702-M WISPY	WEEDY	WAXER
Price	\$75.00	\$75.00	\$97.50	\$170.00	\$202-A \$245.00 1702-M \$350.00	\$470.00	\$495.00
Motor Ratings: Open drip proof / Reversible, 40 c. Rise Contingent upon Horizontal, Right Base	<p>Series or Universal with Armature and Field Leads Separate</p> <p>Compound</p> <p>1/8 1/8 1/8 1/8</p> <p>1/8 1/8 1/8 1/8</p> <p>1/8 1/8 1/8 1/8</p> <p>1/8 1/8 1/8 1/8</p> <p>1/8 1/8 1/8 1/8</p> <p>1/8 1/8 1/8 1/8</p> <p>1/8 1/8 1/8 1/8</p>						
Horsepower	1/4	1/4	1/4	1/4	1/4	1/4	1/4
Speed — RPM	1725	1725	1725	1725	1725	1725	1725
Leads (brought out separately)	4	4	6	6	6	6	6
Bearings	Sleeve	Sleeve	Sleeve	Sleeve	Sleeve	Ball	Ball
General Radio Designation	MOD-5	MOD-4	MOD-11	MOD-3	MOD-6	MOD-9	MOD-10
Code Word	MOTOR*	MOTOR*	MOTOR*	MOTOR*	MOTOR*	MOTOR*	MOTOR*
Net Weight — pounds	10 1/2	3 1/2	25	30	60	75	87
Price	\$33.00	\$17.50	\$41.00	\$51.00	\$84.00	\$170.00	\$195.00

THESE MOTORS CAN BE SUPPLIED WITH VARIAC MOTOR SPEED CONTROLS

To order motor with Variac Speed Control, use compound code word, WINDYMOTOR, AMAZEMOTOR, etc. Motors are not sold separately. The Type 1701-AM is similar to the Type 1701-AK, except it has one speed range (0 to rated) and its armature base is accessible from the front panel. *Type 1702-P1 Autotransformer is available for use on 230-volt lines; weight, 20 1/4 pounds; price, \$27.50.





chips and dirt. The relay control circuit has been carefully engineered, the prototype model having been in continual use on a lathe in our Experimental Shop for almost four years. We feel confident that this control will be particularly free of relay maintenance difficulties.

The Types 1704-A and 1705-A Controls of One and One and One-Half Horsepower Rating

These larger controls are also for push-button operation, but differ from the smaller TYPE 1702-M in that a conventional push-button station is used and the Variac is mounted separately. Because of the size of the TYPE V-20 Variac, a single-unit control station is no longer feasible. With the large machines on which these controls would be used, there is usually room in the cabinet

where the Variac can be placed, making the whole installation very simple and compact.

Special Controls for Machine Manufacturers

Frequently, the user wants to combine a Variac speed control with other equipment in his own cabinet. For such applications, the basic elements of the control can be provided as a sub-assembly along with a separate Variac. For these cases, the user usually prefers to provide conventional contactors and overload protection as part of the complete control equipment for the machine or process. These sub-assemblies are not listed as standard controls but can be provided on order in most sizes if reasonable quantities are involved.

— W. N. TUTTLE

INK FLOW ON ROTATING ROLLERS

The accompanying photographs are the result of an interesting study of the physical properties of printing ink. The General Radio TYPE 1530 Microflash was used as a high-speed light source to make all of these photographs.

Attempts to correlate theoretical studies of physical properties of printing ink with actual press results observed are often unsuccessful for short, stiff inks and inks used for high-speed press operation. Mr. Lars H. Sjodahl of

the International Printing Ink Division of Interchemical Corporation has studied this problem using an inkometer and the Microflash. The inkometer allows measurement of the torque required to split an ink film of predetermined thickness. It consists essentially of two inked roll-

Figure 1. Filamentation of white offset ink with the Inkometer rollers turning at 300 feet per minute. The filaments reach a length of four-hundredths of an inch, forty times the thickness of the ink film. There is very little ink "mist."





Figure 2. Same ink at 900 feet per minute. The filaments break closer to the "nip" because elastic forces are built up more rapidly at higher speeds.



Figure 3. A head-on view of the same conditions shown in Figure 2. There are about 130 filaments per inch.



Figure 4. An ink which "flies" badly at a speed of 300 feet per minute. The filaments stretch out to one-eighth inch before breaking. Many free-floating ink particles are thrown off.

ers, the speed of which can be varied to simulate actual press condition. The Microflash allows high-speed photographs to be taken of the ink filaments that form as the ink film on the rollers separates.

Mr. Sjudahl's results indicate that previous calculations of the force necessary to break the filaments were too high, often by a factor of one hundred. These calculations had been based strictly on viscous flow equations. The lower force actually required is attributed to the effect of absorbed gases in the ink expanding as the ink moves away from the "nip" between the rollers.

These Microflash photographs show the length of the filaments under varying conditions and the ink "mist" that forms as the filaments break.

From "Ink Flow on Rotating Rollers" by Lars H. Sjudahl, First Annual Meeting of the Technical Association of the Lithographic Industry, Chicago, April 15, 1949.

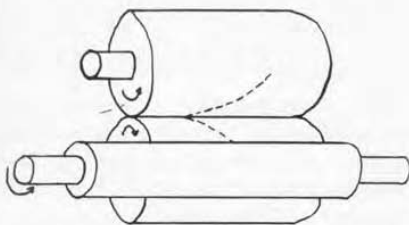


Figure 5. Sketch of Inkometer rollers showing line of focus for Figures 1, 2, and 4.

A COMPLETE ASSEMBLY FOR CAPACITANCE MEASUREMENTS

The TYPE 1610-A Capacitance Measuring Assembly equipment is a well-

integrated assembly of standard General Radio Company instruments mounted





in a bench-type relay rack, complete with all interconnections. With this equipment, accurate two- or three-terminal measurements can be made of capacitance and dissipation factor over the frequency range from 60 cycles to 100 kc. The assembly is comprised of the following instruments: TYPE 716-CR Capacitance Bridge, TYPE 716-P4R Guard Circuit, TYPE 1231 BRFA Amplifier and Null Detector and Filter, and the TYPE 1302-A Oscillator. The assembly is operated from a 115 volt, 60 cycle, a-c power line.

The Capacitance Measuring Assembly, TYPE 1610-A, has been in use at the General Radio Standardization Laboratory and government research laboratories since it was first announced in the August, 1952, *Experimenter*. In addition, leading component and wire manufacturers, aircraft manufacturers, and petroleum companies have found that the packaged convenience and accuracy of the assembly add a new step in quality control to their manufacturing processes.

The guard circuit eliminates the effects of terminal capacitance by means of a three-terminal connection to the sample and makes possible accurate measurements of the direct capacitance of components and samples that may have large terminal capacitances to ground. One example of the use of this equipment is the measurement of components over wide ranges of temperature and humidity as required by JAN specifications and many present-day commercial applications. The conditioning chamber in which the sample must be placed is often at a distance from the bridge terminals, requiring shielded leads of considerable length whose capacitance, in a simple two-terminal measurement, would be in parallel with that of the sample. With the guard circuit, the same accuracy of



measurement can be obtained under these conditions as would be obtained if a two-terminal sample were connected directly to the bridge terminals. Measurements of capacitance up to 1000 μmf are possible to $\pm 0.1\%$ or $0.8 \mu\text{mf}$,¹ whichever is the larger, and of dissipation factor to ± 0.00005 or $\pm 2\%$ for change in dissipation factor observed, when the change is less than 0.06.

For two-terminal measurements of solid dielectric samples, the Capacitance Measuring Assembly can be used with the TYPE 1690-A Dielectric Sample Holder, which is designed for use with standard ASTM two-inch discs.

For use solely in two-terminal capacitance measurements, the assembly is

¹When a worm-correction calibration for the TYPE 716-C Capacitance Bridge is used, the accuracy can be improved to $\pm 0.1\%$ or $\pm 0.2 \mu\text{mf}$, whichever is larger.





available without the guard circuit, which is replaced in the rack by a dummy panel. This assembly is the TYPE 1610-A2. Both assemblies are listed below.

Type		Code	Price
1610-A	Capacitance Measuring Assembly.....	SEDAN	\$1,930.00
1610-A2	Capacitance Measuring Assembly, less Guard Circuit.....	SABER	1,635.00
1690-A	Dielectric Sample Holder.....	LOYAL	435.00
	Worm-Correction Calibration	WORMY	50.00

U. S. Patent 2,173,427. Licensed under patents of the American Telephone and Telegraph Company and patents of the Radio Corporation of America.

MISCELLANY

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