COMMERCIAL GRADE COMPONENTS
A wide range of units for every application

U.T.C. Commercial Grade components employ rugged, drawn steel cases for units from 1” diameter to 300 VA rating... vertical mounting, permanent mold, aluminum castings for power components up to 15 KVA.

Units are conservatively designed... vacuum impregnated... sealed with special sealing compound to insure dependability under continuous commercial service.

A few of the large number of standard C.G. units are described below. In addition to catalogued units, special C.G. units are supplied to customer’s specifications.

**INPUT, INTERSTAGE, MIXING AND LOW LEVEL OUTPUT TRANSFORMERS**
(200 ohm windings are balanced and can be used for 250 ohms)

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Application</th>
<th>Primary Impedance Ohms</th>
<th>Secondary Impedance Ohms</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>131</td>
<td>1 plate to 1 grid</td>
<td>15,000</td>
<td>125,000</td>
<td>$ 9.50</td>
</tr>
<tr>
<td>132</td>
<td>1 plate to 2 grids</td>
<td>15,000</td>
<td>125,000</td>
<td>$ 9.50</td>
</tr>
<tr>
<td>133</td>
<td>2 plates to 2 grids</td>
<td>30,000</td>
<td>P to P</td>
<td>68,000 overall</td>
</tr>
<tr>
<td>134</td>
<td>Line to 1 grid hum-bucking</td>
<td>50, 200, 500</td>
<td>80,000</td>
<td>$ 12.50</td>
</tr>
<tr>
<td>135</td>
<td>Line to 2 grids hum-bucking</td>
<td>50, 200, 500</td>
<td>120,000 overall</td>
<td>$ 13.50</td>
</tr>
<tr>
<td>136</td>
<td>Line to 1 grid hum-bucking</td>
<td>50, 200, 500</td>
<td>80,000 overall</td>
<td>$ 17.50</td>
</tr>
<tr>
<td>137</td>
<td>Single plate and low impedance output or line to 1 or 2 plate hum-bucking</td>
<td>15,000, 50, 200, 80,000 overall</td>
<td>$ 13.50</td>
<td></td>
</tr>
<tr>
<td>138</td>
<td>3P KCS 50, similar tubes to AB 50’s</td>
<td>30,000</td>
<td>P to P</td>
<td>35,000 overall</td>
</tr>
<tr>
<td>139</td>
<td>3P KCS 50, similar tubes to AB 50’s</td>
<td>30,000</td>
<td>P to P</td>
<td>35,000 overall</td>
</tr>
<tr>
<td>140</td>
<td>Line to 1 grid hum-bucking</td>
<td>50, 200, 500</td>
<td>80,000 overall</td>
<td>$ 17.50</td>
</tr>
<tr>
<td>141</td>
<td>Line to 2 grids hum-bucking</td>
<td>50, 200, 500</td>
<td>120,000 overall</td>
<td>$ 13.50</td>
</tr>
<tr>
<td>142</td>
<td>Line to 1 grid hum-bucking</td>
<td>50, 200, 500</td>
<td>80,000 overall</td>
<td>$ 17.50</td>
</tr>
<tr>
<td>143</td>
<td>Line to 2 grids hum-bucking</td>
<td>50, 200, 500</td>
<td>120,000 overall</td>
<td>$ 13.50</td>
</tr>
<tr>
<td>144</td>
<td>Line to 1 grid hum-bucking</td>
<td>50, 200, 500</td>
<td>80,000 overall</td>
<td>$ 17.50</td>
</tr>
<tr>
<td>145</td>
<td>Line to 2 grids hum-bucking</td>
<td>50, 200, 500</td>
<td>120,000 overall</td>
<td>$ 13.50</td>
</tr>
<tr>
<td>146</td>
<td>Line to 1 grid hum-bucking</td>
<td>50, 200, 500</td>
<td>80,000 overall</td>
<td>$ 17.50</td>
</tr>
<tr>
<td>147</td>
<td>Line to 2 grids hum-bucking</td>
<td>50, 200, 500</td>
<td>120,000 overall</td>
<td>$ 13.50</td>
</tr>
<tr>
<td>148</td>
<td>Line to 1 grid hum-bucking</td>
<td>50, 200, 500</td>
<td>80,000 overall</td>
<td>$ 17.50</td>
</tr>
<tr>
<td>149</td>
<td>Line to 2 grids hum-bucking</td>
<td>50, 200, 500</td>
<td>120,000 overall</td>
<td>$ 13.50</td>
</tr>
</tbody>
</table>

**CG VARIMATCH OUTPUTS FOR P. A.**
Universal units designed to match any tubes within the rated output power, to line or voice coil. Output impedance 500, 200, 50, 16, 8, 5, 3, 1.5 ohms. Primary impedance 3000, 5000, 7000, 10,000, 14,000 ohms.

<table>
<thead>
<tr>
<th>Type</th>
<th>No.</th>
<th>Watts</th>
<th>Audio Class C</th>
<th>List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVP-1</td>
<td>15</td>
<td>42, 63, 45, 47, 2A3, 636, 8R6, 35L8</td>
<td>$ 9.00</td>
<td></td>
</tr>
<tr>
<td>CVP-2</td>
<td>30</td>
<td>42, 63, 2A3, 636, 8R6, 45C2</td>
<td>14.00</td>
<td></td>
</tr>
<tr>
<td>CVP-3</td>
<td>60</td>
<td>46, 50, 6H4D, 6L6, 807, 5881</td>
<td>20.00</td>
<td></td>
</tr>
<tr>
<td>CVP-4</td>
<td>125</td>
<td>800C, 807, 807, 1-600D, 810</td>
<td>25.00</td>
<td></td>
</tr>
<tr>
<td>CVP-5</td>
<td>200</td>
<td>211, 242A4, 203A, 838, 418, 719</td>
<td>30.00</td>
<td></td>
</tr>
</tbody>
</table>

**CG VARIMATCH LINE TO VOICE COIL TRANSFORMERS**
The U.T.C. VARIMATCH line to voice coil transformers will match any voice coil or group of voice coils to a 500 ohm line. More than 50 voice coil combinations can be obtained, as follows:
2, 4, 5, 6, 7, 1, 5, 2, 2, 5, 3, 3, 8, 4, 4, 5, 5, 6, 6, 2, 7, 5, 8, 9, 10, 11, 12, 14, 15, 16, 18, 20, 21, 25, 28, 30, 31, 40, 47, 50, 62, 69, 75.

**CG VARIMATCH MODULATION UNITS**
Will match any modulator tubes to any PF load.
Primary impedances from 500 to 20,000 ohms
Secondary impedances from 30,000 to 300 ohms.

<table>
<thead>
<tr>
<th>Max. Watts</th>
<th>Type No.</th>
<th>Audio Class C</th>
<th>List</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>CVM-1</td>
<td>60, 69, 6H6D, 2A3, 16, 6L6, 310</td>
<td>14.00</td>
</tr>
<tr>
<td>20</td>
<td>CVM-2</td>
<td>60, 125, 807, 807, 467, 70, 1608</td>
<td>20.00</td>
</tr>
<tr>
<td>20</td>
<td>CVM-3</td>
<td>125, 250, 900, 807, 145, 72, 90, 22, 27</td>
<td>29.00</td>
</tr>
<tr>
<td>300</td>
<td>CVM-4</td>
<td>300, 600, 50-6, 25A3, 28, 755, 25B-120</td>
<td>35.00</td>
</tr>
<tr>
<td>600</td>
<td>CVM-5</td>
<td>600, 1200, 900, 360, 204A, 100-245, 225P4, 115.00</td>
<td></td>
</tr>
</tbody>
</table>

For full details on this line, write for Catalog.

United Transformer Co.
150 VARIICK STREET, NEW YORK 13, N. Y.

*EXPORT DIVISION: 13 EAST 40TH STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"*
CAPACITOR WINDER MOTOR CONTROL
Westinghouse unit equipped with thyratron tubes facilitates handling of delicate foils during production of component parts (See page 118)  

ELECTRON TUBES—1930 to 1950
The history of electronics revolves around them, and major advances in design are noted  

UHF TELEVISION FIELD TEST, by R. F. Guy
First experimental station, erected at Bridgeport, Conn., relays New York vhf programs at uhf  

AIRPLANE FUEL GAGE, by Curtiss R. Schaefer
Weight of gasoline is measured by capacitance-type self-balancing bridge  

DEVELOPMENTS IN COMMUNICATION THEORY, by Claude E. Shannon
Clarifies relationships between information, bandwidth, channel capacity and noise  

PIN-POINTING ULTRASONIC ENERGY, by H. J. Dana and J. L. Van Meter
A system for recording on non-light-sensitive paper without contact  

TELEVISION PRODUCTION TECHNIQUES, by Ricardo Muniz
Conveyor accessories, subassembly jigs and assembly-line fixtures insure quality and cut costs  

MEASURING SMOKE DENSITY, by P. S. Dickey
Sealed-in-glass construction and unique bolometer circuit give high accuracy over long periods  

REDUCING UNWANTED MOBILE RADIATION, by D. Pinkerton and N. Shepherd
Testing techniques for discovering spurious and harmonic radiations and methods of reducing them  

CITIZENS BAND REGULATIONS, by Leo M. Conner
An interpretation of FCC rules governing 460 to 470-mc transmitter operation  

OPTAR—A NEW SYSTEM OF OPTICAL RANGING
Applications include infrared "radar", automatic camera focusing, devices for the blind  

SIMPLIFIED INTERCARRIER SOUND, by Walter J. Stroh
Application of gated beam tube reduces number of tubes and tuned circuits  

SYNTHETIC CRYSTALS, by Charles E. Green
Design and performance characteristics are discussed in detail  

EQUALIZER DESIGN CHART (Reference Sheet), by Charles Boegli
Attenuation or accentuation of base and treble in audio circuits are quickly determined

BUSINESS BRIEFS  
CROSS TALK  
TUBES AT WORK  
ELECTRON ART  
NEW PRODUCTS  
NEWS OF THE INDUSTRY  
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with new marion ruggedized instruments

The new Marion Ruggedized meters (Hermetically Sealed) now give you an exceptionally accurate and sensitive means for electrical measurement and indication — under extreme conditions of Shock, Vibration, Mechanical Stress, Strain, Weather Conditions and Climate. This whole new family of Ruggedized Panel instruments gives you new freedom of application. You can use them where you have never before dared use “delicate instruments.” What’s more, they meet the dimensional requirements of JAN I-6 and are completely interchangeable with existing standard JAN 2½” and 3½” types.

When you need ruggedized meters for rugged applications; when you need special meters for special applications; when you need better meters for any application . . . call on Marion — the name that means the most in meters.

Send for your free copy of our booklet on the New Marion Ruggedized Instruments today. Marion Electrical Instrument Company, Manchester, New Hampshire.

MARION MEANS THE MOST IN METERS

Canadian Representative: Astral Electric Company, 44 Dunforth Road, Toronto, Ontario, Canada
Export Division: 458 Broadway, New York 13, U.S.A., Cables Morhanex
Phonic Motors
and
Timing Devices

In many branches of scientific work the need arises for a motor capable of a very high standard of constancy of speed. The frequency of the mains electricity supply is not normally controlled to better than one or two per cent., so that a mains-operated synchronous motor may be inadequate, and centrifugal governors, as used on gramophone motors, may not provide a sufficiently precise control. In such cases a phonic motor driven by an alternating current supply of high frequency stability may be employed. It is not perhaps generally realized that in their modern form such motors may be used to give quite a large torque, and are able to maintain synchronous despite the sudden imposition of relatively large inertia loads. Under steady-state conditions, "hunting" is almost entirely eliminated, and the constancy of rotational speed is almost entirely dependent on the frequency stability of the alternating current supply.

A precision quartz crystal controlled frequency of 100 kc/s may attain a frequency stability of the order of one part in 10^13. This frequency is then divided electronically to 1,000 c/s by means of regenerative dividers or locked multivibrators. In order to facilitate comparisons with time signals, or to use the frequency standard as a clock, it is necessary to derive a still lower frequency—preferably one cycle per second. Electronic division in the range 1,000 to 1 cycle per second, with high phase stability, is difficult, and the simplest and most reliable method is to drive a phonic motor from the 1,000 c/s source, and to fit mechanical contacts to suitably geared driven shafts. An added advantage is that by employing further gearing, more widely spaced signals may be obtained. Thus signals spaced at intervals of one sidereal second, or any other specified interval, may be obtained from an oscillator with a fundamental frequency of 100 kilocycles per mean time second. By means of a simple mechanical device, controlled changes in phase of the timing of the contacts are also possible.

MOTOR TORQUE

Designed for use at frequencies from 50 c/s - 2000 c/s.
Phonic Motors of this type form the nucleus around which are built the timing devices illustrated on this page.

The Timing Device Type D-I99-A provides an impulse of 1/10 second duration once every second when the motor is supplied with power at a frequency of 1,000 c/s.

The Timing Device Type D-I93-A provides an impulse of 1/10 second duration 61 times per minute end, in addition, an Impulse of 1/second duration once per minute. A worm and wheel adjustment allows phasing correction.

Muirhead & Co. Ltd.
Precision Electrical Instrument Makers
Beckenham, Kent, England

Telegrams and Cables: MUIRHEADS ELMERS-END
20 years ago, IRC advertised resistors for television!

And right now, while we produce for today’s requirements, electronics 1970 is on our drawing boards. 25 years young this year, IRC combines a quarter-century of specialized engineering with free, fresh thinking on new resistance problems. Result of this concentration: — A unique variety of high-quality, lower-cost resistance products, plus unbiased recommendations.

TELEVISION IN 1930
Advertising resistors for television 20 years ago was not nearly so advanced as IRC’s present planning for the future.
important

LESS THAN 3% change from original value due to aging has been proven for MV High Voltage Resistors. The resistance coating of Type MV's is stabilized at high temperature. Application of this filament coating in helical turns on a ceramic tube gives a conducting path of long effective length and permits the use of up to 100,000 volts for the MV R resistor. For high voltages where high resistance and power are required Type MV's are available in a wide range of values, sizes and terminals, all described in Bulletin G-1. Use the coupon to get your copy.

AGING IS NO PROBLEM
with Advanced BT Resistors. Filaments are pre-cured and stabilized, practically eliminating any possibility of resistance change through aging. Engineered to meet JAN-R-11 specifications for fixed composition resistors, IRC BT's have established their superiority in all important characteristics. Let us prove it to you... check the coupon for 12 page technical data Bulletin B-1. 21 characteristic charts compare IRC performance to rigid JAN specifications.

AFTER 10,000 CYCLES
of rotation IRC's new Q Control shows less than 10% change in resistance for values below 1 megohm, and not over 15% change for values of 1 megohm and above. Noise level after the same rigorous tests remains well within the industry standard for new controls. Investigate the many advantages of this modern size 15/16" diameter control. Complete mechanization in manufacture assures you of absolute uniformity and a dependable source of supply. Coupon brings you full details on Bulletin A-4.
Top Products in Every Line
Cut Costs and Build Sales
with AMERICAN PHILLIPS SCREWS

HOW THEY CUT COSTS: From vacuum cleaners to vending machines; from trucks to office appliances and suntan lamps... manufacturers use American Phillips Screws to speed up production, stop spoilage, and cut unit-costs. For these modern fastenings banish fumbling, crooked driving and scarred surfaces... cut assembly time as much as 50%.

HOW THEY BUILD SALES: On any product, the crossed-recess of American Phillips Screws is a "green light" to buyers who stop and look for an outward index of inward quality. They know that smooth-headed American Phillips Screws protect product-performance by staying tight and resisting vibration. Does your product have these two American Phillips advantages of cost-reduction and sales-promotion? No reason why it shouldn't... for American Phillips Screws always cost least to use. Write for proof.

AMERICAN SCREW COMPANY, Main Offices: Providence 1, R. I.
Plants at Willimantic, Conn., and Norristown, Pa.

AMERICAN PHILLIPS Screws

ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

April, 1950 — ELECTRONICS
Look to the Specialist
in Tube Production
... for Better Tubes
... for Technical Progress

Example...

ADVANCED VACUUM TECHNIQUES

Two electron tubes may look exactly alike, their ratings and operating characteristics may be similar, but their processing in manufacture can—and does—result in a fundamental difference between them. For it is the things you can’t see in a tube, the intangibles—which are as important as the physical structure itself—that ultimately determine the tubes’ true worth. It is the ability of the manufacturer to understand the problems involved and to effectively solve them through the application of all the skills at his disposal—skills which can only be gained through specialization and long years of experience.

Machlett Laboratories has these skills—acquired in over half a century of electron tube experience.

Its’ unique series of vacuum techniques—the essential elements in electron tube manufacture—is an outstanding example of the importance of the “unseen” in tube performance and life. Machlett standards—based on long experience—require more than the conventional “pumping” or “exhaust” procedure. High voltage exhaust, rigorous pre-exhaust vacuum firing and the extreme in sanitary techniques are standard practice on all Machlett tubes. In many instances final seals are made by Machlett’s unique method of R.F. brazing—thus eliminating the usual flame-formed glass to glass seal and so providing greater freedom from contamination of internal structures and misalignment of electrodes.

These “plus” features are not necessary to the production of average—or even good—tubes. They are essential, however, to producing the best the art now makes possible.

This is just one example of Machlett’s ability, one of the many advantages you gain from Machlett’s long experience devoted solely to the manufacture of the highest quality electron tubes.

If you are contemplating the installation of new equipment or replacing your present tubes, it will pay you to...

"Look to the Tube Specialist"

For information regarding available tube types, consult your local Graybar representative or write direct to Machlett Laboratories, Inc., Springdale, Conn.
Because of its amazingly high load-input ratio, the No. 5000 relay operates at 115 volts 60 cycles on only 0.007 ampere—a fraction of the current consumed by any other type of mercury relay! With this low amperage operating the coil, the contacts will handle 5 amperes at the same voltage! And tests indicate the No. 5000's life to be over 30 million operations!

Designed especially for sensitive thermo-regulation, it is ideally suited for use in electronic tube circuits where the output of the tube is limited. It can be used as a pilot relay operating from a very sensitive thermo-regulator—serves equally well for high and low temperature control—and functions perfectly with either mercury-and-glass or bi-metal regulators.

For full information on this sensational relay, write The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.
SUBJECT: ZERO TEMPERATURE COEFFICIENT CAPACITORS

PROBLEM: Relatively large capacitances (.01 to .5 Mfd.) were required for a 400 cycle resonant filter, for operation from \(-60^\circ C\) to \(+75^\circ C\).

SOLUTION: Plasticon AS Capacitors have a positive temperature coefficient of 1000 parts per million per degree Centigrade. Plasticon LS Capacitors are negative 1000 ppm/°C. By combining matched capacitor elements of each type in a single container, temperature coefficients from plus 1000 ppm to minus 100 ppm/°C can be supplied.

A .25 mfd capacitor for 440 VAC, 400 cycle operation Type (AL) SC254-44X measures \(1\frac{3}{4}''\) x \(1''\) x \(2\frac{1}{8}''\) high. Type (AL) Capacitors can be furnished from 330 VAC and higher; from .01 mfd. and up.

What is YOUR engineering problem? Your inquiries will receive immediate attention.

We manufacture a standard line of Plasticon Capacitors, Pulse Forming Networks and High Voltage Power Supplies. Write for our catalog.
MITCHELL-RAND announces....

1766EX CAPACITOR END FILLER

FOR SEALING OIL, WAX AND ELECTROLYTIC PAPER TUBE CAPACITORS

it's new • it's better • it's low cost

Once again Mitchell-Rand demonstrates the effectiveness and value of its research and development. It produces 1766EX, a resin base thermoplastic having high cold flow, solid adhesion, inflexible oil resistance, absolute sealing and low-cost characteristics, all superior to any like product now available. 1766EX is the product long required by manufacturers of paper tube capacitors that must be guaranteed for operating temperatures to 105°C.

Yes, once again Mitchell-Rand gives point to its repute as "Headquarters for Everything in Electrical Insulation".

1766EX adds another to Mitchell-Rand's more than 3500 compound and wax formulas that resist high voltage breakdown, salt spray atmosphere, humidity, cracking or flaking, acids and alkalies, with excellent flexibility and adhesive qualities, high cold flow and good thermal conductivity. Its waxes that penetrate fibre, floss, bakelite, paper and cloth and with low viscosity, high surface tension and good electrical characteristics. Mitchell-Rand has the compound or wax to meet your specific requirements and should the need arise for a special formula to meet a particular condition, then Mitchell-Rand will create the compound embodying every quality required.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLD FLOW (M-R)</td>
<td>250/255 F</td>
</tr>
<tr>
<td>S.P. (B&amp;R)</td>
<td>255/260 F</td>
</tr>
<tr>
<td>POURING TEMPERATURE</td>
<td>350/400 F</td>
</tr>
<tr>
<td>COLOR</td>
<td>Brown</td>
</tr>
<tr>
<td>ADHESION</td>
<td>Good</td>
</tr>
<tr>
<td>PENETRATION 77/100/5</td>
<td>0</td>
</tr>
<tr>
<td>CHLORIDE CONTENT</td>
<td>*Negative</td>
</tr>
<tr>
<td>SPECIFIC GRAVITY</td>
<td>1.59</td>
</tr>
<tr>
<td>FLASH POINT</td>
<td>490 F</td>
</tr>
<tr>
<td>MINERAL OIL RESISTANCE</td>
<td>Good</td>
</tr>
</tbody>
</table>

The high cold flow temperature of 1766EX permits its use for paper tube capacitors which are guaranteed for operating temperatures up to 105°C. Employing the standard container specified for the standard M-R Cold Flow test (2" in diameter by 1/4" high, filled to depth of 1") 1766EX will resist cold flow at 115°C for more than 24 hours.

APPLICATION CHARACTERISTICS:

Sealing of capacitors with 1766EX is facilitated by the low pouring viscosity and good bubble release which this seal exhibits. The relatively sharp melting point and special filler combination of 1766EX permit easy pinhole repair. These properties make 1766EX particularly well suited for sealing electrolytic units.

MITCHELL-RAND INSULATION CO. Inc.

51 MURRAY STREET • Cortlandt 7-9264 • NEW YORK 7, N.Y.

A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH • INSULATING PAPERS AND TWINES • CABLE FILLING AND POTHEAD COMPOUNDS • FRICITION TAPE AND SPLICE • TRANSFORMER COMPOUNDS • FIBERGLAS SATURATED SLEEVING • ASBESTOS SLEEVING AND TAPE • VARNISHED CAMBRIC CLOTH AND TAPE • MICA PLATE, TAPE, PAPER, CLOTH, TUBING • FIBERGLAS BRAIDED SLEEVING • COTTON TAPES, WEBBINGS AND SLEEVINGS • IMPREGNATED YARN TUBING • INSULATED VARNISHES OF ALL TYPES • EXTRUDED PLASTIC TUBING
Centralab's Special Electronic Component Parts Design

Service May Solve a Problem for You

How many times have your design engineers been called upon to develop new equipment only to be faced with a new bug — or special problem of one variety or another? Everything about the new gadget seems but you need a special part to lick the special problem. To Centralab Engineers these queer bugs and special problems are as welcome as a Rolls Royce to a burlesque queen.

They look on these problems as their own and from their bag of 30 years of electronic experience — they always come up with an answer. Take a look over the next two pages. See for yourself some of these "Specials" in ceramics, switches and capacitors that CRL has developed to meet special needs during the past few years. Maybe you'll see one that can help — or you'll know where to go with your next special problem.

Centralab — DEVELOPMENTS THAT CAN HELP YOU
Define your problem—bring it to Centralab

If you have an unusual electronic or ceramic part design and fabrication problem — bring it to Centralab. It may very well happen that with a combination of standard CRL parts — or a slight modification thereof — we can help you solve it. If special requirements warrant — we can design a completely new unit and produce it for you. All we need is your exact requirements as to purpose, size, capacity, voltage and resistance. Write Dept. "E" outlining your problem. No obligation. Centralab Division, Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisconsin.

1 A solenoid operated selector switch.
2 Automatic selector switch for automobile radio.
3 Combination control and selector switches.
4 Front and rear view—push button type tone switch.
5 Left — dual TV Trimmer. Right — TV trimmer combined with ceramic coil form.
6 5000V dual disc ceramic capacitor. Actual size, slightly larger than a nickel.
7 Special tubular ceramic capacitor — 2200 MMF ± 1%.
8 Control with offset shaft and operating gears.
9 Front and rear view — Centralab's miniature (smaller than a dime!) Dual Model 1 Control.
Special Electronic Parts?

10 Examples of special "printed circuit" parts. Left — a fixed value capacitor. Right — an inductance coil.

11 Front and rear view — special type by-pass capacitor.

12 Special ceramic coil form and trimmer assembly.

13 Steatite ceramic coil form with bonded metal end.

14 Centralab Steatite ceramic used in special forms — coils etc.

15 CRL. Steatite used as part of diffusion system in hot water heater.

16 Special feed-thru by-pass capacitor.

17 Special 5-10 KV hi-voltage capacitor.

18 Metallized ceramic rods for rotor sections in hi-voltage variable transmitter capacitors, and resonant lines.

19 Special antenna loading variometer.
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They're factual!

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Centralab Printed Electronic Circuits
42-6 - COUPLATE - P. E. C. interstage coupling plate.
42-22 - VERTICAL INTEGRATOR - for TV application.
42-24 - CERAMIC PLATE COMPONENTS - for use in low-power miniature electronic equipment.
42-27 - MODEL 2 COUPLATE - for small or portable set applications.
999 - PENTODE COUPLATE - specialized P. E. C. coupling plate.
42-9 - FILPEC - Printed Electronic Circuit filter.

Centralab Capacitors
42-3 - BC TUBULAR HI-KAPS - capacitors for use where temperature compensation is unimportant.
42-4 - BC DISC HI-KAPS - miniature ceramic BC capacitors.
42-10 - HI-VO-KAPS - high voltage capacitors for TV applications.
695 - CERAMIC TRIMMERS - CRL trimmer catalog.
981 - HI-VO-KAPS - capacitors for TV application. For jobbers.

Centralab Switches
953 - SLIDE SWITCH - applies to AM and FM switching circuits.
970 - LEVER SWITCH - shows indexing combinations.
995 - ROTARY SWITCH - schematic application diagrams.
722 - SWITCH CATALOG - facts on CRL's complete line of switches.

Centralab Controls
42-18 - TC CAPACITORS - temperature compensating capacitors.
814 - CAPACITORS - high-voltage capacitors.
975 - FT HI-KAPS - feed-thru capacitors.

Centralab Ceramics
967 - CERAMIC CAPACITOR DIELECTRIC MATERIALS.
720 - CERAMIC CATALOG - CRL steatite, ceramic products.

Look to CENTRALAB in 1950! First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. For complete information on all CRL products, get in touch with your Centralab Representative. Or write direct.

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Division of Globe-Union Inc.
900 East Keefe Avenue, Milwaukee, Wisconsin

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O1 B1
ANOTHER HYTRON FIRST YOU’LL BE BUYING SOON

NEW HYTRON
12 BH7
does more for less

- Ideal Sweep Amplifier
- Higher-Perveance Twin Triode
- Designed for TV
- Permits Lower-Cost TV Sets
- Another Hytron TV First

AND NOW THE HYTRON
16TP4 Another Hytron 16-inch rectangular picture tube. Follows closely on heels of original Hytron rectangular tube, the 16RP4. Write for Bulletin E-150 for complete data. Watch also for early announcements of new Hytron 11-inch and 19-inch rectangular tubes.

MODERN LOW-COST 16-IN. DESIGN
A Hytron contribution to lower TV costs. All-Hytron: 1X2, 6BQ6GT, 6U4GT, 12BH7, 16TP4 or 16RP4. For application and circuit details, write for Bulletin E-151.

Here’s another Hytron original you’ll be buying soon. New 12BH7 twin triode is enthusiastically hailed as tops for sweep circuits by leading makers of TV sets. One half 12BH7 sweeps wide-angle 16-inch picture tube at 14 kilovolts. One section alone matches performance of: Paralleled 6SN7GT. Or equivalent single triode. Or triode-connected beam pentode. Other half of 12BH7 is free for other uses—such as blocking oscillator.

How does Hytron do it? Higher perveance (lower tube loss)? Yes. Also the Hytron 12BH7 is: designed for TV. Rated for TV. Tested for TV. Again a Hytron TV first. Again a Hytron contribution to lower-cost TV for the mass market. Watch for the 12BH7. Write for Bulletin E-149.
Inquiries are invited concerning single pads and turrets having other characteristics.

- VSWR less than 1.2 at all frequencies to 3000 mc.
- Turret Attenuator* featuring "Pull—Turn—Push" action with 0, 10, 20, 30, 40, 50 DB steps.
- Accuracy ± .5 DB, no correction charts necessary.
- 50 ohm coaxial circuit. Type N connectors.

STODDART AIRCRAFT RADIO CO.
6644 SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA
Hillside 9294
60 CYCLES ON THE NOSE!

THE BRUSH MODEL BL 809 Regulated Frequency Power Supply furnishes moderate power at 60 cycles that is completely unaffected by the frequency of the primary power source. It will govern the operation of fractional horsepower synchronous motors at fixed speed or set the characteristics of controls where accurate frequency is essential. No adjustments are needed for any loading from zero to full capacity of 60 watts.

Designed for continuous, unattended operation, the Brush Regulated Frequency Power Supply acquires frequency stability from a temperature-compensated tuning fork. Frequency accuracy is one part in 100,000. For example, under normal conditions it will operate a synchronous electrical clock system with a time accuracy of less than one minute per month—despite variations in input frequency.

This Regulated Frequency Power Supply is engineered throughout for safe, dependable operation and is housed in a weatherproof, baked enamel, steel case, fitted with sturdy handles for easy portability. Write for complete information and specifications.

THE Brush DEVELOPMENT COMPANY
3405 Perkins Ave., Cleveland 14, Ohio, U. S. A.

(Models are also available for stabilization of frequencies other than 60 cycles)

Put it in writing with a

BRUSH RECORDING ANALYZER

ELECTRONICS — April, 1950

17
NEW! MIDGET, HIGH-TEMPERATURE
PULSE-FORMING NETWORKS

Here's a new, extremely compact and lightweight capacitor pulse-forming network that will operate at temperatures up to 120° C! With a volume of 6 cubic inches, it's just about one third the size of a conventional network with the same rating (6E2-5-2000-50-P2T).

The life expectancy of this 6-kv unit ranges from 3.5 hours at 80° C ambient to 1 hour at 110° C. A second new network twice this size has a life of about 330 hours at 100° C—9 hours at 120° C. If you want more data on these new units, write Capacitor Sales Division, General Electric Company, Pittsfield, Mass.

DELAY LINES—BY THE FOOT

These G-E delay lines provide a means for delaying signals with a bandwidth up to 2-megacycles for any time interval from .25 to 10.00 microseconds. They are available in bulk form in lengths up to 100 feet—delay equals approximately ½ microsecond per foot. Characteristic impedances of 1100 and 400 ohms per foot are available. Since the line is very flexible, it may be bent into 4-inch diameter coils.

Ordering line in bulk form makes it possible for you to cut it to the exact length required for your particular application. For complete ratings and specifications, see Bulletin GEC-459.
If your requirements call for compact selenium stacks for operation in cramped quarters, these new, highervoltage G-E selenium cells may be your answer. Their 18-volt d-c output means you can design stacks which are about 25% smaller than possible with 12-volt cells. The improved aging characteristics of these cells is made possible by a new G-E evaporation process which deposits selenium on aluminum with greater uniformity. Stacks are available with rated outputs of 18 to 126 d-c volts at 0.15 to 1.20 amperes with inputs of 23 to 180 a-c volts. See Bulletin GEA-5280.

This new G-E flow interlock provides sure protection against overheating in water-cooled components such as tubes, transformers, and dynamos. Its function is to open the electrical circuit when water flow is lower than a preset minimum and close it when flow is above this point.

Adjustment can be made to actuate the electrical contact for any flow between 1 gallon per minute and 4 gallons per minute. The cut-in, cut-out differential of the unit is 0.2 gpm. The electrical circuit is rated at 10 amperes at 125 volts a-c, 5 amperes at 250 volts a-c and 3 amperes at 460 volts a-c. Maximum water-line pressure rating is 125 pounds per square inch. The unit is bronze with standard 3/8-inch fittings and is easy to install and adjust. For further description see Bulletin GEC-411.

This new G-E battery-operated electronic voltmeter combines the portability of an ordinary low-sensitivity multimeter with the high sensitivity and versatility of a line-voltage-operated vacuum-tube voltmeter.

Its weight is only 4 pounds (with batteries), its size—3"x6"x8", but it measures a-c and d-c voltage in 7 ranges from 0-1 to 0-1000 volts, d-c current in 4 ranges from 0-1 to 0-1000 milliamperes, resistance in 5 ranges from 100 ohms to 10 megohms, mid-scale value.

D-c input impedance is 11 megohms on all ranges. A-c input impedance is 0.5 megohm shunted with 20 mmf on all ranges. Frequency response is flat within 5 per cent up to 15,000 cycles on all up to and including the 0-100-volt range. More data in Bulletin GEC-622.

G-E time meters, with dependable Telechron® motor drive, are especially useful in recording the operating time of radio transmitters or other electronic devices so that tubes may be replaced before they fail. They record operating time in hours, tenths of hours, or minutes, and are supplied for 11-, 115-, 230-, or 460-volt operation. The case is of molded textolite to harmonize with other G-E 3/8-inch instruments mounted on the same panel. You'll find more description along with dimensions and pricing information in Bulletin GEC-472.

GLOBAR Type BNR Resistors Display Unusual NON-LINEAR Voltage-Resistance Characteristics

Unretouched photographs of oscilloscope screen above show the effect obtained by connecting a GLOBAR type BNR resistor in series with a fixed resistor across a 115 volt 60 cycle supply.

Wave Form of Applied Voltage.

Wave Form of Current Flowing in Circuit.

Typical successful applications of BNR Ceramic Resistors include:

1. Oil burner ignition transformers to prevent high voltage feed back into line.
2. Small motors to prevent arcing of governor contact points.
3. Stabilizing rectifier circuits by limiting peak voltages.
5. Protection of solenoid valves in direct current circuits.

Bulletin GR-2 contains useful engineering data on GLOBAR Type BNR Ceramic Resistors. Copies will be supplied immediately upon request. Write Dept. V-40, The Carborundum Company, GLOBAR Division, Niagara Falls, N.Y.

GLOBAR Ceramic Resistors

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company
It is Our Privilege
to serve the Leaders

THIS FREE BOOK — fully illustrated, with performance charts and application data — will help any radio engineer or electronics manufacturer to step up quality, while saving real money. Kindly address your request to Dept. 16.

ANTARA® PRODUCTS

G A & F® Carbonyl
Manufacturers of

CARBONYL IRON POWDER CORES

( THE CORE IS THE HEART OF THE CIRCUIT )

Aladdin Radio Industries, Inc.
Chicago, Illinois

Henry L. Crowley & Company, Inc.
West Orange, New Jersey

Delco Radio Division
General Motors Corporation
Kokomo, Indiana

Lenkurt Electric Co., Inc.
San Carlos, California

Magnetic Core Corporation
Ossining, New York

National Moldite Company
Hillside, New Jersey

Powdered Metal Products Corporation
of America
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Pyroferric Company
New York, New York

Radio Cores, Inc.
Oak Lawn, Illinois

RCA Victor Division
Radio Corporation of America
Camden, New Jersey

Speer Resistor Corporation
St. Marys, Pennsylvania

Stackpole Carbon Company
St. Marys, Pennsylvania

Iron Powders...
Another Rauland "First"!

NEW "Indicator Gun" CR TUBE

Assures perfect ion trap magnet adjustment instantly...

positively

is a fool-proof solution to the problem of ion trap magnet adjustment...a development which Rauland is happy to offer for the benefit of both set makers and service men.

The new Rauland "Indicator Gun"—patent pending—gives a brilliant visible signal easily seen from the rear of the set while magnet adjustment is being made. A bright green glow within the Anode Tube signals when adjustment is incorrect—dims as correct adjustment is approached—disappears when adjustment is correct.

All guesswork is eliminated—risk of screen damage through incorrect magnet adjustment is ended—and adjustment time is reduced to seconds. Assemblers or service men know that magnet adjustment is right—know that any remaining picture defect is in other controls.

The Rauland "Indicator Gun" adds nothing to the price of Rauland picture tubes. First production is in the 12LP4-A with Luxide Screen—available now!

THE RAULAND CORPORATION

Perfection Through Research

4245 N. KNOX AVENUE • CHICAGO 41, ILLINOIS
can you put your Finger on the TROUBLE?

If you can, a SORENSEN Electronically controlled, magnetic amplifier regulating circuit can solve it!

Sorensen's new line of Electronic AC Voltage Regulators is the most accurate and most economical line of Electronic Voltage Regulators on the market today. Standard specifications offer Accuracy to within ±0.1% and Distortion as low as 2%. Load range from zero to full load. All models are temperature Compensated and can be supplied hermetically sealed or fostered. And the Sorensen line uses less tubes than other electronic type regulators.

Sorensen Engineers are always at your service to solve unusual problems and give you the benefits of years of experience. Describe your needs and let a Sorensen Engineer suggest a solution. It will save you time and money to try Sorensen first.

TYPICAL AC REGULATORS

Model 5000-2S—high power
Input 95 to 130; distortion 3%;
load 0-5000 VA;
Accuracy ±0.1% against line
or load; 50-60 cycles

Model 3000S—medium power
Input 95 to 130; distortion 3%;
load 0-3000 VA
Accuracy ±0.1% against line
or load; 50-60 cycles

Model 500S—low power
Input 95 to 130; distortion 3%;
load 0-500 VA;
Accuracy ±0.1% against line
or load; 50-60 cycles

CATALOG A1049 DESCRIBES COMPLETE LINE
you name it...PRESTO has it!

The variety of PRESTO equipment is one reason engineers all over the nation look to PRESTO for the solution to every recording problem. Pioneer in sound recording, PRESTO excels in the production of precision tape recorders, power, peak limiting and recording amplifiers and flawless recording discs. For the greatest selection of the greatest equipment...PRESTO is a name to remember.
the core is stronger, and has higher resistance to vibrations and shock.

The resistance wire—made to H.H. specifications especially adapted to these resistors—is more uniformly wound so that failures under stress are eliminated.

The special alloy terminals are more securely fastened to the ceramic body by spot-welding—highly resistant to corrosion.

All wire connections are protected by a positive, non-corrosive bonding.

and...

New—blue-gray enamel coating—crazeless, thermo-shock-proof gives greater protection throughout the most rugged service—longer life under extremes of humidity, salt water and severest atmospheric conditions. And by withstanding higher heat these resistors afford a greater safety factor.

The fixed, the ferrule and the flat types are especially designed for and manufactured in accordance with JAN-R-26A specifications.
APPLICATIONS UNLIMITED
for the SOLA Constant Voltage PRINCIPLE

TYPE CV — STANDARD: Wide range of capacities and voltages, regulation ±1% or less with a total primary variation of 30%, ideal for use with electronic equipment where close voltage regulation is required. BULLETIN DCV-102.

TYPE CV — PLATE AND FILAMENT SUPPLY: A single, compact source of filament and plate supply voltages, regulated to within ±3% or less with line voltage variations of 100-130 volts. BULLETIN DCVE-138.

TYPE CVH — HARMONIC FILTER: Incorporates harmonic neutralizing circuits, ±1% regulated voltage, less than 3% harmonic distortion. BULLETIN DCVH-136.

TYPE CVA — FOR TELEVISION RECEIVERS: Voltage regulation of home TV Receivers at moderate price, ±3% or less. BULLETIN DCVA-135.

The SOLA Electric Company has consistently set the standards in the voltage regulating field. SOLA built the first Static-Magnetic Regulator which could be economically applied to industrial and commercial equipment. SOLA Transformers have always delivered the highest standard of performance in the voltage regulating industry.

SOLA TRANSFORMERS

SOLA Constant Voltage Transformers and Constant Voltage Transformers are manufactured under one or more of the following U. S. Patents: 2,143,746; 2,212,198; 2,146,621.

ENDURANCE ELECTRIC CO., Concord West, N. S. W., Australia
UCCOA RADIO S.A., Buenos Aires, Argentina

April, 1950 — ELECTRONICS
Jensen

Model H-510

COAXIAL 2-WAY SPEAKER

For thrilling life-like reproduction . . . For truly satisfying listening pleasure . . . For a host of history-making features that mean higher performance . . . new flexibility and convenience—be sure to hear and see the Jensen H-510. You'll know why wise listeners tell us it's the best at any price!

*The Genuine Jensen Wide-Range Series includes a distinguished group of new coaxial and single-unit speakers—a complete range of sizes, ratings and prices. Ask for Data Sheet 152.

"Best . . . at any Price!"

JENSEN MANUFACTURING COMPANY

DIVISION OF THE MUTER COMPANY

6607 South Laramie Avenue, Chicago 38, Illinois • In Canada: Copper Wire Products, Ltd., 351 Carlaw, Toronto

ELECTRONICS — April, 1950

29
**Akra-Ohm** PRECISION resistors

Designed to meet JAN-R-93 specifications

As experienced specialists in precision wire-wound resistors, Shallcross is in close touch with the latest requirements for military cases. Thirteen types listed in Bulletin 23 are designed to meet JAN characteristics 'B'. Four types are designed to meet JAN characteristics 'A'.

**PRECISION POWER and FIBER GLASS INSULATED RESISTORS**

Practically any Shallcross Akra-Ohm resistor including miniature types can be supplied with fiber-glass insulated wire and special impregnation which increases power rating from 2 to 4 times while still assuring high stability and close accuracy. Other precision power types include single layer inductively wound 3 to 10-watt resistors.

**HIGH STABILITY RESISTORS**

...Matched pairs or sets

Numerous Shallcross Akra-Ohm resistors can be supplied with guaranteed tolerance to 0.01% and stability to 0.003%. Matched pairs or sets are available to extremely close tolerances.

SHALLCROSS MANUFACTURING
A complete assortment of types, sizes, styles, ranges and mounting facilities for military or industrial uses including electronic measuring and computing equipment.

Keeping fully abreast of modern advancements in precise electronic circuitry, Shallcross Akra-Ohm wire-wound resistors are prime requisites. Many hermetically-sealed and other special types are available. Write for Shallcross Akra-Ohm Engineering Bulletin R3 for complete electrical and mechanical characteristics plus helpful precision resistor selection data.
Now!...a Recording
ALPHATRON* Vacuum Gauge

for permanent, accurate records of pressures from 1 micron to 10mm.

Answer to a long-felt need, this new recording Alphatron offers you accurate, reliable records in a most important high vacuum range. At will, you can record slow or rapid changes in total pressure between 0 and .1mm. . . . between 0 and 1mm. . . . and between 0 and 10mm. If desired, the upper scale can be factory-set for 0-20mm. without loss of linearity.

This new instrument is designed to have the versatility and accuracy you want. For additional technical information on the Alphatron principle of operation . . . on other features of this recording combination write today.

QUICK FACTS ON THE RECORDING ALPHATRON*

- Accurate vacuum measurements by alpha particle ionization method.
- Records in three important ranges: 0-.1mm, 0-1mm, 0-10mm. Upper range can be factory-set for 0-20mm.
- Optional control of an external circuit.
- Continuous linear response to total pressure on each range.
- Available with either strip or circular chart recorders.
- Full-scale sweeps of 24, 12, 4.5 seconds.
- Gives continuous recordings of either slowly or rapidly changing pressures.
- Available in straight front for panel mounting.

*REG. U.S. PAT. OFF.
OHMITE
High-Current, Rotary
TAP SWITCHES

The Most COMPLETE LINE
of its Type on the Market

Compact - Dependable

Equipment manufacturers know that when they require high-current, non-shorting rotary tap switches, they can usually find the right type and size in the Ohmite line. Ohmite high-current tap switches are particularly designed for a-c use. Illustrated are five sizes of high-amperage, multi-point selectors. They are extremely compact, providing up to 12 tap terminals. Capacities range from 10 to 100 amperes a-c. In addition to the models shown, Ohmite tap switches are available in open-type models, for both shorting and non-shorting applications. Ohmite is also prepared to supply open-type tap switches with special features—such as special angles between taps, and capacities up to 25 contact points. All Ohmite switches can be mounted in tandem for multiple-pole operation.

Be Right with -

OHMITE

25th Anniversary
1925-1950

RHEOSTATS • RESISTORS • TAP SWITCHES
1. **CERAMIC CONSTRUCTION** provides perfect insulation, unaffected by arcing. Contacts and mechanism are entirely enclosed and protected (except for Model 111).

2. **EXTREMELY COMPACT**, yet have many high-current taps, perfectly insulated. Terminals are convenient for wiring. Back-of-panel mounting.

3. **SILVER-TO-SILVER CONTACTS**, for high electrical conductivity. Have low surface resistance, and eliminate contact maintenance.

4. **SELF-CLEANING ROTOR CONTACT**. Slightly rounded, assuring perfect seating and producing slight rubbing motion with every operation.

5. **"SLOW-BREAK" MECHANISM**, incorporating a positive cam-and-roller. Provides "slow-break, quick-make" action, particularly suited to alternating current. Minimizes sparking, extends contact life.

6. **"DEAD" SWITCH SHAFT**. Completely insulated from the load by a high-strength driving hub which will withstand a 2000-volt test.

**AVAILABLE IN TANDEM MOUNTINGS**

Have many applications, including simultaneous control of separate circuits. Extended shafts, with universal coupling for single-knob control of two or three switches.
ANOTHER DUMONT FIRST!

The New
Du Mont-Holmes
SUPERSPEED
Projector

Sets new standards of performance, utility and economy for TV station operation. Provides a means of film pickup that approaches the contrast and clarity characteristic of studio productions.

DIRECT FILM PROJECTOR
Used with a Du Mont Special Image-Orthicon film pickup to give studio clarity to movies and teletranscriptions.

BACKGROUND PROJECTOR
Brings dramatic moving sets and backgrounds into any studio. Eliminates costly and cumbersome sets and backdrops.

For information on the Superspeed Projector or other Du Mont Telecasting Equipment write, phone, or visit.

ALLEN B. DU MONT LABORATORIES, INC., TELEVISION TRANSMITTER DIVISION, CLIFTON, N. J.

Electronics — April, 1950
The unique electrical, mechanical, physical and chemical properties of Stackpole carbon, graphite and carbon-graphite products solve countless problems of friction, temperature, arcing, corrosion, shaft sealing, voltage regulating and others. So broad is the line of standard Stackpole products, so extensive the facilities for "specials" that it is practical to list only a few of them here. Let Stackpole engineers recommend and quote on your next requirements.
TWO EVERY WEEK!

First of low frequency radio transmitters for the C.A.A.'s Omnirange System

Designed! Produced! Tested! Shipped! Accepted!

Prototype Designed
and built by Bunnell entirely from C.A.A. requirement specifications

Rigid Production Testing
procedures devised and put in operation by Bunnell development and methods engineers

J. H. BUNNELL & Co.
81 Prospect Street, Brooklyn, N.Y., Dept. 15
Research, Design and Development Engineering, Manufacturing

Type TLG Omnirange Transmitter — The transmitter, core of the Omnirange System, consists of L.V. Power Supply and Exciter, 4 KW Power Amplifier, Modulator, 10 KW Power Amplifier, H.V. Power Supply and Control Center, Transformer and accessory equipment.

Electronics — April, 1950
NEW Miniature Telephone Type Relay

NEW LK RELAY

MOUNTING: End mounting for back of panel or under-chassis wiring. Interchangeable with standard "Strowger" type mounting.

COIL POWER: From 40 milliamps to 7 watts D.C.

CONTACTS: Standard 2 amperes, special up to 5 amperes. 2 amperes up to 6 P.D.T. 5 amperes contacts (low voltage) up to 4 P.D.T. Special 20 ampere power contacts S.P.S.T., normally open, paralleled.

DIMENSIONS: 1½" HIGH, 2½" LONG, 1½" WIDE

These are the dimensions for the 6 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

Can be furnished hermetically sealed with solder terminals.

PLUG-IN MOUNTING—SPECIAL.

SK RELAY

MOUNTING: Front of panel mounting and wiring.

COIL POWER: From 100 milliamps to 4.5 watts D.C.

CONTACTS: Same as "LK".

DIMENSIONS: 1½" HIGH, 1¼" LONG, 3½" WIDE

These are the dimensions for the 6 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

CAN ALSO BE FURNISHED HERMETICALLY SEALED WITH SOLDER TERMINALS.

PLUG-IN—SPECIAL.

SK, HERMETICALLY SEALED

ALLIED CONTROL CO. INC. 2 EAST END AVE., NEW YORK 21, N. Y.

40 April, 1950 — ELECTRONICS
Erie General Purpose Ceramicons became favorites in the industry when TV sets were still a negligible part of total output. The qualities which recommended them for by-passing and coupling applications which were not frequency determining in radio receiving sets, become even more important in television assembly.

Erie "GP" Ceramicons are rugged and compact. Tubular form and phenolic insulation provide extra sturdiness that withstands rough handling both in installation and in service.

General Purpose Ceramic Condensers are economical because, by limiting them to definite capacity values, they can be manufactured in quantity without sacrifice of quality.

They are made in insulated and non-insulated styles, in popular capacity values up to 10,000 MMF. Write for detailed information and samples.
DEFLECTION YOKE SWEEPS
70° WITH HIGH EFFICIENCY!

Requires only 20 watts of horizontal input power from 260-volt supply!

A 70° tube is tough to sweep—and to do it correctly takes a lot of power, particularly at 13-14 kv. Most yokes today lose efficiency when required to sweep wide-angle tubes.

Now an improved General Electric Deflection Yoke, ready for delivery to manufacturers, licks the problem from the inside out. G-E engineers at Electronics Park found that the key to more sensitivity and greater efficiency was in the design and position of the yoke windings. To get a wire pattern that would assure a high degree of uniformity of the magnetic field, they designed an improved machine that winds coils with knife-sharp precision and without distortion. This process now helps turn out yokes that provide accurately-shaped, straight-sided pictures.

For applications requiring high efficiency, the new yoke is available with ferrite core. The complete G-E line of television components also includes ion traps, focus coils, horizontal sweep transformers, size and linearity controls. General Electric engineers will be glad to consult with you on the applications of these components to your designs. Wire or write: General Electric Company, Parts Section, Electronics Park, Syracuse, New York.

You can put your confidence in—

GENERAL ELECTRIC

April, 1950 — ELECTRONICS
Whether your job is large or small, intricate or routine, we take pride in doing the finest job in the entire field of sheet metal housings. And when Karp is called in, your costs are cut down — down!

25 years of know-how go into every "simple" job, as well as into each "complex" project. For the finest of equipment and facilities are all yours, all the time . . . to produce and deliver on time! Karp makes no parts or items of its own, to delay or disrupt your production schedules.

And remember, the facilities of Karp's 70,000 square foot plant belong to you!
Make it a point to call on us for an estimate of your next job. Your inquiries and personal visits are always welcome. An illustrated data book is yours for the asking.
VERSATILE
Multi-channel --
telegraph Al or
telephone A3.

RUGGED
Components
conservatively
rated. Completely
tropicalized.

STABLE
High stability (.003%) under
normal operating
conditions.

Model 446 transmitter operates on 4
crystal-controlled frequencies (plus 2
closely spaced frequencies) in the band
2.5-13.5 Mcs (1.6-2.5 Mcs available).
Operates on one frequency at a time;
channeling time 2 seconds. Carrier
power 350 watts, Al or A3 AM. Sta-
bility .003% using CR-7 (or HC-6U)
crystals. Operates in ambient 0° to +
15° C using mercury rectifiers; -35°
to +45° C using gas filled rectifiers.
Power supply, 200-250 volts, 50/60
cycles, single phase. Conservatively
rated, sturdily constructed. Complete
technical data on request.

Here's the ideal general-purpose high-
frequency transmitter! Model 446...
4-channel, 6-frequency, medium power,
high stability. Suitable for point-to-
point or ground-to-air communication.
Can be remotely located from
operating position. Co-axial fitting to
accept frequency shift signals.

Consultants, designers and manufacturers of standard or special
electronic, meteorological and communications equipment.

AER - Q - COM
AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

DEALERS: Equipeletra Ltda., Caixa Postal 1925, Rio de Janeiro,
Brasil * Henry Newman Jr., Apartado Aereo 138, Barranquilla,
Colombia * Radelec, Reconquista 46, Buenos Aires, Argentina
NO DOUBT you’ve experienced it—the real pleasure in grasping a problem, wrestling with it a bit, and then coming up with a solution. The unusual electrical insulation part shown above is a good example. It illustrates the kind of problem that could arise in your plant—and wind up in our “Imagination Department.”

To make the part, the Manufacturer wanted plenty of structural strength, dielectric strength, light weight, and resistance to moisture, heat, and corrosion—all wrapped up in a material that was easy to machine. Continental-Diamond studied the problem, used a little imagination, and came up with two different plastics—Laminated Dilecto Tubing for the threaded section, and Celoron for the molded, macerated ring.

It’s a good example of imagination at work—but it’s a better example of how you, too, can depend upon C-D to engineer the right plastic for your needs. For C-D has no “axe to grind.” We can recommend from five basic plastics subdivided into a remarkably wide range of grades and combinations of grades to meet your requirements. For complete engineering help or fast delivery of any grade, call your nearest C-D office, any time.

CELORON (Molded High-Strength Plastic)
MICABOND (Bonded Mica Splittings)
DIAMOND FIBRE (Vulcanized Fibre)
VULC OID (Resin Impregnated Fibre)
DILECTO (Laminated Thermosetting Plastic)
This Atomic Age calls for huge capacitor banks in atom-smashing installations. Typical is the betatron installation at the University of Illinois, Urbana, Ill., with a capacitor bank totaling 12,960 mfd's. made up of 648 units each rated at 20 mfd's. 6000 volts D.C. Sufficient energy is stored in this capacitor bank to lift a 3000 lb. car 57 ft.!

Aerovox engineering and experience were important factors in the special design and processing required for the manufacture of these capacitors. Such skill is applied to all Aerovox production, regardless of type or size. Every design is given individualized attention. Because of outstanding experience with oil-filled capacitors, together with production facilities difficult to duplicate elsewhere, Aerovox is meeting the rigid requirements of atom-smashing installations.

Likewise for other high-voltage needs such as deep-penetration X-ray, radio transmitting, high-voltage testing, carrier-current coupling, and electronic laboratory equipment, Aerovox offers the widest choice of tried-tested-proven capacitors backed by application engineering second to none.

Try Aerovox first! Our engineers will gladly share their high-voltage capacitance “know-how” with you in solving your particular problem.

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AERVOX CORPORATION, NEW BEDFORD, MASS., U.S.A.

SALES OFFICES IN ALL PRINCIPAL CITIES • EXPORT: 13 E. 40th ST., NEW YORK 16, N. Y.

Cable: 'ARLAB' • In Canada: AERVOX CANADA LTD., HAMILTON, ONT.

Aerovox Series '26 oil-filled stack-mounting capacitors. One or more units can be conveniently banked in series or parallel. Voltage ratings up to 150,000 D.C. Max. per unit.

Aerovox Series '20 steel-case oil-filled capacitors. Voltage ratings up to 50,000 D.C.W. Also dual units of 25,000 v. (12,500-12,500) for voltage doubler circuits.

April, 1950 — ELECTRONICS
In thousands of successful applications of low pressure processing, Kinney Vacuum Pumps are setting the pace for speed and economy. Fast pump down means fast processing time—and that's why Kinney Pumps are so often picked for the job. In one case they are creating the low absolute pressure required in a gigantic synchro-cyclotron . . . in another, they are helping to turn out a steady stream of peanut-sized electronic tubes. Whether it's "one of a kind" or "mass production", Kinney Pumps have the stamina and rugged dependability to meet the toughest service conditions in every field . . . pharmaceutical or food, metallurgical or optical, electrical or electronic.

Single Stage Models are available in eight sizes: capacities from 13 to 702 cu. ft. per min. — for pressures to 10 microns Hg. abs. Compound Kinney Vacuum Pumps are furnished in three sizes — capacities 5, 15, and 46 cu. ft. per min. — for test pressures to 0.5 micron Hg. abs. Send for Bulletin V45 — the complete story on Kinney Vacuum Pumps, Oil Separators, and other Vacuum Pumping Accessories.


Making old things better
Making new things possible

KINNEY Vacuum Pumps
Look at it for use in limited spaces... and you'll pick the Honeywell Mercury Switch.

The amount of space it occupies is often a mighty important thing to consider when you select a mercury switch.

The "mighty midget," pictured above in actual size, is the tiniest mercury switch in the Honeywell line. It is doing a giant job... affording positive on-off action for as many as 50 million cycles, in such products as coin vender machines, record players and sign flashers.

Honeywell Mercury Switches are compact... are adaptable to unusual mountings. They operate at low angles... have no moving parts... are sealed against dust, gas and corrosion.

The complete line is at your command... affording greater latitude in product design, with improved performance and trouble-free operation. Write for a copy of new Catalog #1343 for down-to-earth information... or call in your local Honeywell engineer for a detailed discussion of a particular application.

MINNEAPOLIS-HONEYWELL REGULATOR CO.
BROWN INSTRUMENTS DIVISION
4428 Wayne Avenue, Philadelphia 44, Pa.

 Offices in 27 principal cities of the United States, Canada and throughout the world.

For positive action, low angularity, longer life, wide selection, specify Honeywell Mercury Switches.

MINNEAPOLIS-HONEYWELL
FOR POSITIVE ACTION
ANNOUNCING

EIMAC TUBE TYPE

2C39A*

PLANAR CONSTRUCTION
HIGH-MU TRIODE

The new Eimac 2C39A triode is the culmination of over five years of research and application engineering. It is the outgrowth of earlier types 2C38 and 2C39.

Its high performance standards make it the standout triode for VHF and UHF CW service, pulse service and aircraft navigational systems.

As a power amplifier, oscillator, or frequency multiplier, this small high-mu triode exhibits excellent characteristics from low frequencies to above 2500 megacycles.

Let us send you complete data and application notes on the new Eimac 2C39A triode... then consider the advantages it offers in the design of compact, moderate power-output equipment.

*Conforms with newly issued JAN specifications.

EITEL-McCULLOUGH, INC.
San Bruno, California
Export Agents: Frazer & Hansen, 301 Clay St., San Francisco, California

Another Engineering Achievement by Eimac
The controlling unit of these frequency standards is a bi-metallic fork, temperature-compensated and hermetically sealed against humidity and variations in barometric pressure. When combined with related equipment, accurate speed and time controls are afforded by mechanical, electrical, acoustical or optical means.

Instruments of our manufacture are used extensively by industry and government departments on such precision work as bomb sights and fire control. Whatever your frequency problems may be, our engineers are ready to cooperate.

When requesting further details, please specify the Type Numbers on which information is desired.

FOR USE IN SUCH FIELDS AS

AVIATION
ASTRONOMY
BALLISTICS
HIGH-SPEED PHOTOGRAPHY
VISCOSITY MEASUREMENT
NUCLEAR PHYSICS
TELEMETERING
RADIATION COUNTING
FLUID FLOW
CHEMICAL REACTION
NAVIGATION
SCHOOL LABORATORIES
INDUSTRIAL RESEARCH LABS.
ACCURATE SPEED CONTROL

TYPE 2001-2. BASIC UNIT
Frequencies, 200 to 1500 cycles. Dividers and Multipliers available for lower and higher frequencies. Miniaturized and JAN construction. Output, 6 volts.

TYPE 2005. UTILITY UNIT
consists of Type 2001-2 and booster to provide 10 watts at 110 V at 60 cyc. Input, 50-100 cyc.

TYPE 2111. POWER UNIT
50 W output. 0-110 V at 60 cyc. Input, 50-100 cyc., 275 W.

TYPE 2121A. LAB. STANDARD
Outputs, 60 cycle, 0-110 Volts. 120-240 cycle impulses. Input, 50-400 cycles, 45 W.

American Time Products, Inc.
580 Fifth Avenue
New York 19, N.Y.

OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

April, 1950 — ELECTRONICS
NOW AVAILABLE
ON A MASS PRODUCTION BASIS

CORNELL-DUBILIER TINY MIKE

The TINYMIKE now makes it possible for you to get full-sized "Cornell-Dubilier performance" in an ultra-small, space-saving ceramic capacitor only 19/32" in diameter and 5/32" thick.

Application: Bypass and coupling in ultra-compact assemblies, especially for TV, FM and VHF.

Characteristics: Unusually low inductance, minimized eddy current losses, remarkable electrical ruggedness, high dielectric strength of ceramic, high insulation resistance, low power factor.

TINYMIKES are presently available in 500 volts DC working, with a guaranteed minimum capacity from 1,000 mmfd. to 5,000 mmfd., over a temperature range of +10° C to +65° C. Units available in capacities from 100 to 150 mmfd can be supplied at a tolerance of ±10% or ±20%.

Since the performance of a ceramic capacitor depends in large measure on the quality of its ceramic body, every step in the manufacture of TINYMIKES is controlled by Cornell-Dubilier engineers. This means that the same dependable quality that has made C-D's famous for over 40 years is now available in TINYMIKE ceramics.


C-D Best by Field Test!

CONSISTENTLY DEPENDABLE
CORNELL-DUBILIER
CAPACITORS — VIBRATORS
ANTENNAS — ROTATORS — CONVERTERS

ELECTRONICS — April, 1950
**Q.**

Why is “dag” Colloidal Graphite best for CRT Exterior Wall Coating?

**A.**

It’s cheaper

... Has better adhesion

... Requires no baking

... Resists scratching

"dag" Dispersion #194 is a lacquer-base dispersion of microscopically small graphite particles. It is easily applied to CRT surfaces by spraying, and dries very rapidly, enabling tubes to be handled in 2 or 3 minutes. Maximum adhesion is obtained by drying at room temperature for 24 hours, or by forced infra-red drying for ½ hour.

"dag" Dispersion #194 forms a smooth, uniform, conductive black coating on any type glass. Its adhesive properties are so good that it will resist scratching by a thumb nail or soaking in water.

Prominent CRT manufacturers have found "dag" colloidal graphite dispersions satisfactory and usually cheaper for wall coatings . . . for other electronics work, too. Let Acheson Colloids engineers show YOU how these versatile dispersions can solve many and varied electronics problems. Send the coupon NOW for more information.

---

**ACHESON COLLOIDS CORPORATION**
Port Huron, Michigan

Send me more information on:

_____ "dag" Dispersion # 194 for Exterior Wall Coating

_____ "dag" Colloidal Graphite in Electronics

Name: ________________________________

Company Name: ________________________________

Address: ________________________________

City: ___________________, Zone: _____ State: __________

---

ACHESON
COLLOIDS
CORPORATION
Port Huron, Michigan

April, 1950 — ELECTRONICS
INDUSTRIAL OSCILLOSCOPE—For tracing circuit trouble in electronic-control equipment, this scope is fast, accurate, and dependable. Ideal for checking welding machines, high wave capacitor discharge panels, variable speed motor controls. Set it down anywhere—the case is insulated . . . carry it easily—weighs only 27 pounds . . . use it in many ways—tests both AC and DC.

* Tests make-and-break of relay circuits
* Checks waveforms in Thyratron control
* Max. input voltage 550
* Sensitivity 0.15 volts dc/inch, 0.18 volts rms/ inch.

IN WELDING OPERATIONS—USE IT TO

* check "hard-starting" ignitrons
* observe voltage shapes on tube elements in timing sequence circuits
* check instantaneous regulation on high current welder supply line
* set "full heat limit adjustment"
* check relays for bounce and high resistance contactors
* check "on" and "off" time in seam welders
* check behavior of peaking transformers
* check high frequency interference switch transients caused by other equipment

INDUSTRIAL TUBE ANALYZER—Which tubes are bad? Don't guess—check them quickly, easily with this Analyzer that pays for itself in the cost of tubes you would normally scrap. Tests Thytrons and Phanatrons with ratings up to 100 amperes peak current. Can be operated by nontechnical personnel after brief instruction. Backs up the G-E Industrial Oscilloscope to boost your maintenance efficiency, cut your costs.

Wherever you are, there's a G-E office nearby. Call there for further information on the equipment you see here. Meanwhile, write us for the Electronic Test Equipment Catalog—it's free! General Electric Company, Section 440, Electronics Park, Syracuse, New York.
... the outstanding heritage of another great performer

DEFINING THE OSCILLOGRAPHIC SPECTRUM from 10 cps. to 15 megacycles

THE NEW DU MONT TYPE 294 CATHODE-RAY OSCILLOGRAPH

The Type 294 is an extremely versatile cathode-ray oscillograph combining high-voltage operation with precise high-frequency circuit design, extending its general-purpose utility to meet the specialized needs of high-speed transient study.

Stable operation of the high-gain, wide-band amplifier of the Y axis over the entire frequency range from 10 cps. to 15 megacycles includes the performance of a signal-delay line built into the Y-axis circuit to insure full display of short-duration pulses. An input pulse rise time of 0.01 µs. will be reproduced with a rise time not exceeding 0.03 µs.

Available undistorted deflection of both symmetrical signals and unidirectional pulses of either positive or negative polarity exceeds the usable vertical scan of the cathode-ray tube. A built-in high-voltage unit supplies 12 kv. accelerating potential to the Du Mont Type 5XP cathode-ray tube; rear-panel selection of a lower potential may be made for increased sensitivity and deflection.

A flexible sweep circuit provides continuously variable driven and recurrent sweeps with sweep calibration being provided by internal timing markers applied through the Z-axis amplifier.

Permanent records of phenomena studied with the Type 294 may be made with either the Du Mont Type 271-A or 314-A Oscillograph-record Camera.

GENERAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Cathode-ray Tube</th>
<th>Du Mont Type 5XP- Accelerating potential</th>
<th>12,000 volts 7,000 volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y-axis Amplifier</td>
<td>Frequency response</td>
<td>10 cps. to 15 megacycles</td>
</tr>
<tr>
<td></td>
<td>Sensitivity</td>
<td>0.15 rms volt/in. at 7 kv.</td>
</tr>
<tr>
<td></td>
<td>Rise time</td>
<td>0.20 rms volt/in. at 12 kv.</td>
</tr>
<tr>
<td></td>
<td>Signal Delay</td>
<td>0.03 µs. from 10% to 90%</td>
</tr>
<tr>
<td></td>
<td>Drive Delay</td>
<td>0.03 µs. from 10% to 90%</td>
</tr>
<tr>
<td>X-axis Amplifier</td>
<td>Frequency response</td>
<td>2 cps. to 700 kc.</td>
</tr>
<tr>
<td></td>
<td>Sensitivity</td>
<td>0.4 rms volt/in. at 7 kv.</td>
</tr>
<tr>
<td></td>
<td>Rise time</td>
<td>0.5 µs. from 10% to 90%</td>
</tr>
<tr>
<td></td>
<td>Driven Sweep Range</td>
<td>0.1 sec. to 2 µs.</td>
</tr>
<tr>
<td></td>
<td>Recurrent Sweep Range</td>
<td>10 cps. to 150 kc.</td>
</tr>
<tr>
<td>Z-axis Amplifier</td>
<td>Polarity selection</td>
<td>3 volts peak to blank trace of normal intensity</td>
</tr>
<tr>
<td>Timing-Marker Intervals</td>
<td>100 µs., 10 µs., 1 µs.</td>
<td></td>
</tr>
<tr>
<td>Trigger Generator</td>
<td>Repetition rate</td>
<td>200 to 3600 p.p.s.</td>
</tr>
<tr>
<td></td>
<td>Output amplitude</td>
<td>50 volts peak</td>
</tr>
<tr>
<td></td>
<td>Output Polarity</td>
<td>positive or negative</td>
</tr>
<tr>
<td>Physical Specifications</td>
<td>Indicator Unit</td>
<td>24½&quot; d.—15½&quot; h.—12½&quot; w.—62 lbs.</td>
</tr>
<tr>
<td></td>
<td>Power Supply</td>
<td>19½° d.—15½° h.—12½° w.—100 lbs.</td>
</tr>
</tbody>
</table>

ALLEN B. DU MONT LABORATORIES, INC., INSTRUMENT DIVISION, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY
1 SUB-MINIATURE "GUIDED MISSILES" FILTERS
For security reasons details of this development in miniaturization must be omitted. It can be told, however, that all six channels are contained in a total volume of 18 cubic inches or 3 cubic inches per channel.

2 TONE CHANNEL FILTERS
Available for either 170 or 310 cycles spacing between channels. These filters have received wide acceptance and are extremely popular among manufacturers of carrier telegraph equipment. In addition to the many standard types of tone filters we are supplying, special characteristics can readily be incorporated into designs to suit your application.

3 CRYSTAL ELEMENT CHANNEL FILTERS
These extremely sharp wide band filters employing crystals and toroidal coils, were so compact that they were substituted in Air Force equipment for ordinary I.F. transformers. Result was tremendous improvement in selectivity and signal to noise ratio. We derived great satisfaction from this achievement.

4 TELEMETERING FILTERS
Among the earliest to be employed in the improved telemetering system now in general use. Particular attention has been paid to linearity of phase shift and good transient suppression as well as high inter-channel attenuation in order to eliminate distortion in telemetering reception.

WRITE FOR TECHNICAL INFORMATION

ALL INQUIRIES WILL BE PROMPTLY HANDLED

Exclusive Manufacturers of Communications Network Components
Type 3
Maximum speed, contact pressure, and sensitivity; and minimum transit time. Originally designed as a high-speed telegraph relay, it has also been used for direct operation from barrier-layer photo cells and thermocouples, as well as for measurement and other industrial applications. Weight, 22 oz.

Type 4
Long contact travel, medium speed and sensitivity. Originally designed as a telephone impulsing relay (d-c dialing up to 100 miles, and v-f dialing on trunk circuits), it has also been used in audio-frequency teleprinter systems, etc. Also available in d.p.d.t. version, with self-synchronizing contacts. Weight, 11.8 oz.

Type 5
Miniature relay of phenomenal performance in proportion to size and weight. Primarily developed for military and aircraft uses, but is providing answers to problems in many other fields. Rugged design of exceptional thermo stability. Dimensions of relay proper same as safety-match box. Weight, 4.8 oz.
C. P. CLARE & CO., secures U.S. rights to bring you
the English-made CARPENTER POLARIZED RELAY

In recognition of a widespread need for a polarized relay capable of repeating with high accuracy feeble signal pulses of varying time duration and of maintaining this ability for long periods without attention, C. P. CLARE & CO. set out to design such a relay, to have the following characteristics:

- High sensitivity
- Low hysteresis
- Short transit time
- Complete absence of contact rebound
- Ease of adjustment
- Long operational life between adjustments
- High contact pressure
- Absence of pivots, with their almost inevitable shake and liability to wear or bind
- Immunity from the effects of mechanical vibration
- Absence of positional error
- Immunity from the effects of external fields
- Shortness of operating time — important for some applications.

A comprehensive survey of available relays, made as a prelude to this design project, disclosed that the CARPENTER POLARIZED RELAY, manufactured by Telephone Manufacturing Co. Ltd., of London, England, conforms closely to the ideal and surpasses all previously existing polarized relays.

That this superior relay might be made immediately available to its customers, C. P. CLARE & CO. have paid a high compliment to another relay manufacturer: they have arranged to be exclusive distributor of the CARPENTER POLARIZED RELAY in the United States.

Some of the remarkable features of the CARPENTER POLARIZED RELAY which make C. P. CLARE & CO. proud to sponsor it are described on these pages. More complete information is immediately available from CLARE sales engineers located in principal cities. Look in your classified telephone directory . . . or write: C. P. CLARE & CO., 4719 West Sunnyside Avenue, Chicago 30, Ill.

Write for CLARE Bulletins 110-111-112 for complete details

MAGNETIC CIRCUIT OF TYPE 5 RELAY
This schematic diagram shows the magnetic circuit of the Carpenter Type 5 Relay in one plane. Actually the axis of vibration of the armature is parallel to the axis of the signal coil. The working pole pieces (the 5 poles) of the permanent magnets and the contact mounts overlap one another on either side of the armature. The reversal circuit is reduced to its simplest possible form, having only a single air gap in which the armature is situated.
For a higher order of PRECISION in control

The characteristics of Kollsman miniature Motor-Driven Induction Generators suggest many remote indication and control applications. These light, space-saving units—precision-engineered for extreme sensitivity—combine motors of high torque/inertia ratio with generators offering linear voltage vs. speed ratios over a wide range.

These Motor-Driven Induction Generators are representative of a complete line of small Kollsman special-purpose AC motors. If those available do not meet the requirements of your particular instrumentation or control problem, Kollsman laboratories are staffed and equipped to develop a unit to your specifications. For further information, write: Kollsman Instrument Division, Square D Company, 80-64 45th Avenue, Elmhurst, N. Y.

Kollsmann Motor-Driven Induction Generators

Motor characteristics: Maximum torque at stall—smooth-running (will not "cog"), fast-reversing—operate from 2-phase source, or from single-phase source with phase-shifting condenser.

Generator characteristics: Low residual voltage—output/residual voltage ratio of 100:1 in some models—residual voltage "spread" as low as 2 millivolts—available with built-in voltage temperature compensating network—constant frequency output—amplitude directly proportional to speed.

Unit characteristics: Both rotors mounted on same shaft, assuring positive alignment—geared models, with ratios between 5:1 and 75,000:1, designed to safely transmit a maximum torque of 25 oz/in. — backlash held to a minimum.
IN MANY circuit applications, germanium diodes offer advantages over vacuum tubes in size, weight, heat reduction, and feedback control. The important factor of cost, too, is worth your attention, for diode prices are dropping steadily as manufacturing techniques improve and new diode uses are developed.

General Electric's complete line includes four types of general purpose diodes, two new television units of low shunt capacity, one UHF type, and the efficient new G-E Quad for ease of replacement.

"BEFORE YOU DESIGN, LET US HELP YOU WORK OUT A BETTER WAY!"

APPLICATION ENGINEERING SERVICE
A corps of G-E engineers, specialists in tube and diode applications, are available to help you with your circuit problems. Strategically situated in major cities, these men are at your service whenever you need them. Inquire at the G-E office nearest you, or write: General Electric Company, Electronics Park, Syracuse, New York.

SEND FOR THE NEW, COMPLETE G-E GERMANIUM DIODE HANDBOOK—packed with useful information for the electronics engineer and designer!

General Electric Company, Section 440 Electronics Park, Syracuse, New York
Please send me ______ copies of the new G-E Germanium Diode Handbook at $1.25 per copy postpaid.

☐ Bill me ☐ Check or M.O. enclosed

NAME ____________________________

ADDRESS ____________________________________________

CITY ____________________________ STATE _________
RMC DISCAPS

Exceed Guaranteed Minimum Capacity at 85°C

Capacity change between room temperature and 65°C, +18% - 0%

More than eight years of intensive engineering research and three years of successful commercial production are behind this outstanding RMC achievement.

Type B Series DISCAPS were developed to maintain capacity much nearer initial values than heretofore possible. This accomplishment, in small size condensers that have real practicability, results in a decidedly more effective by-pass at the higher frequencies encountered in TV and FM applications. Because RMC produces the complete condenser, even to the processing of the dielectric element itself, it is possible to exercise the finest quality control through every phase of manufacturing.

The Newest Development in Ceramic By-Pass Condensers

Type B Series DISCAPS are the smallest disc ceramics available, 1000 mmf. and 1500 mmf. DISCAPS are actually less than one-half the size of competitive condensers.

Improved processes of dielectric element impregnation and outer casing insulation are exclusive with DISCAPS. Their low self inductance, low power factor and moisture impervious characteristics place them in a class alone. Approval by leading makers of TV sets and tuners as well as manufacturers of specialized high frequency equipment is proof of their superiority.

SEND FOR SAMPLES AND TECHNICAL DATA

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 1708 Belmont Ave., Chicago 13, Ill.

FACTORIES AT CHICAGO, ILL., AND ATTICA, IND.
**Specifications**

**Output Voltages:**
- DC: High voltage: 0-500 volts (without switching), 200 ma. maximum load.
- DC: Bias voltage: 0-150 volts, 5 ma. maximum load.
- AC: Unregulated: 6.3 volts at 10 amps maximum load.

**Regulation:**
- High voltage: Better than \(\frac{1}{2}\%\) from no load to full load, 20 to 500 volts; or for line voltage, 105 to 125 volts.
- Bias: Better than 1% from no load to full load at maximum output voltage. Regulation of any other voltage dependent on setting of voltage control. Internal impedance may be as high as 25,000 ohms.

**Meters:**
- Current meter: 0-200 ma. (High voltage only)
- Voltmeter: 2 ranges (0-500 and 0-150 volts). Meter range may be switched to facilitate reading of high voltage output. 0-150 volt range may be switched to read bias output voltage.
- Hum: Less than 8 mv.

**Terminals:**
- Either positive or negative high voltage terminal may be grounded. Positive terminal of bias supply is permanently connected to negative high voltage terminal.

**Input Power:**
Approximately 400 watts maximum at 105-125 volts, 50/60 cycles.

**Overload Protection:**
Load and line separately fused. Fuses available on front panel.

**Mounting:**
- Relay Rack Panel. Finish: -hp- grey. Detachable end pieces with hinged handles for table use, $5.00 per pair.
- Size: 10\(\frac{1}{2}\)" x 19", 13" deep. Weight 60 lbs. Shipping weight 85 lbs.
- Price: $250.00 l.o.b. Palo Alto, California.
- Data subject to change without notice.

---

**Continuous variable plate and bias voltages.**

**High stability,**
- \(\frac{1}{2}\%\) regulation.

For laboratory, production work or industrial use, the new -hp- Model 712A is one of the most economical, convenient and broadly useful power supplies you can buy. It provides continuously variable regulated plate and bias direct current, as well as a 10 amperere, 6.3 volt alternating current for filament supply. It is a particularly useful power source for small transmitters, constant frequency oscillators, temporary set-ups or "breadboard" layouts. In nearly every application, the instrument's ease of operation and ability to meet many different power requirements saves valuable engineering time.

**Conservative Rating**
The design of -hp- Model 712A is such that tubes operate well below manufacturer's rating, even under conditions of low output voltage and high current. Transformers are conservatively rated and only oil-filled condensers are employed to insure long, trouble-free service even under extreme operating conditions.

For details and demonstration, see your local Hewlett-Packard representative or write direct to the factory.

**Hewlett-Packard Company**
2057A Page Mill Road, Palo Alto, California
Export: FRAZAR & HANSEN, Ltd., 301 Clay Street, San Francisco, Calif., U.S.A.
Offices: New York, N.Y., and Los Angeles, California

---

**hp laboratory instruments**

**For Speed and Accuracy**

- **-hp- Products:**
  - VHF and UHF Signal Generators
  - Voltage Dividers, Multipliers and Shunts
  - Electronic Frequency Meters
  - FM and TV Broadcast Monitors
  - Regulated Power Supplies
  - Audio Frequency Oscillators
  - Audio Signal Generators
  - Vacuum Tube Voltmeters
  - Frequency Standards
  - Square Wave Generators
  - Wave Analyzers
  - Distortion Analyzers
  - Amplifiers

---

**ELECTRONICS — April, 1950**
YOU CAN BE SURE... IF IT'S Westinghouse

This new portable is only one example of how you can meet all electrical measuring requirements... portable... switchboard... panel.

Here's Why...

★ The most complete line
   in the industry! Supply your instrument needs from one source.

★ Shipments in 10 days!
   We can meet practically every electrical measuring requirement 10 days from receipt of order at the factory.

★ Meets A S A standards!
   The most exacting specifications for instrument manufacture ever devised.
The First
LOW-COST PORTABLE
of its kind!

★ Magnetically shielded...
may be used anywhere—guarded against errors due to proximity of other
instruments, high current busses, magnetic fields or magnetic materials.

★ Convenient pocket-size...
small and compact—without sacrifice of performance—completely insulated
for safe use.

★ Complete variety of ratings...
in a-c, d-c and rectifier types for the full range of current and voltage
measurements.

Westinghouse has this great, new, portable instrument line ready for you now... the
first instruments in the low-priced field that are specifically designed and manufactured
to provide all of these features. Phone, write or wire your nearest Westinghouse
representative. He will have an experienced instrument specialist help you plan your
needs, whether they be portable, panel or switchboard instruments. Write for C.S. 43-100. Westinghouse Electric Corporation, 95 Orange Street, Newark, New Jersey.

Specify Westinghouse -get more for your instrument dollar!
CALIFORNIANS are always optimistic about the future of their State, and apparently it does not take long for a newcomer to acquire the habit.

Cledo Brunetti, who until recently was with the National Bureau of Standards but is now with Stanford Research Institute, said in a recent speech that because western industry does not have to worry too much about amortizing investments made long ago it is likely to adopt automatic control equipment more rapidly than industry in other sections of the country.

He also said that the west is just beginning to realize its electronics production potential, and that it will not be long before it will be manufacturing most of its own component parts.

Receiving-Type Tube failures accounted for 38.5 percent of the unscheduled equipment removals by Piedmont Airlines in 1949. Supervisor of Radio Maintenance W. D. Rollick sees some hope of improvement, however, as the type 5654 tube appears to have a figure of merit of 1,200 compared to the 50-hour life expectancy of the original commercial 6AK5 after which it was modelled.

Large Tubes of the transmitting and industrial type have had their lives extended quite materially, particularly since the war. We saw one the other day that has been upgraded by the manufacturer from 1,000 to 7,000 hours in the last five years.

Speaking Of Industrial Tubes, the trend seems to be toward metal and ceramics. There are three reasons: (1) better heat dissipation, (2) lower costs and (3) more rugged appearance.

The Amateur Market has been a disappointment to many component-part manufacturers so far this year. Possible explanations include tvi, the continued availability of surplus gear and a growing tendency to buy manufactured equipment rather than to build.

Any other reasons occur to you?

Radio-Phono-Tele Production in 1949 by RMA members was as follows:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>% Number</th>
<th>Electric Table (under $12.50 billing price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-M</td>
<td>10.39</td>
<td>1,259,488</td>
</tr>
<tr>
<td>A-M/F-M</td>
<td>25.55</td>
<td>4,096,883</td>
</tr>
<tr>
<td>F-M (including converters)</td>
<td>31</td>
<td>31,940</td>
</tr>
<tr>
<td>Console A-M</td>
<td>0.04</td>
<td>4,386</td>
</tr>
<tr>
<td>AM/F-M</td>
<td>13</td>
<td>12,271</td>
</tr>
<tr>
<td>Table-Radio-Phonos A-M</td>
<td>1.51</td>
<td>159,118</td>
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<tr>
<td>Console-Radio-Phonos A-M</td>
<td>0.83</td>
<td>84,722</td>
</tr>
<tr>
<td>A-M/F-M</td>
<td>3.68</td>
<td>369,270</td>
</tr>
</tbody>
</table>

Battery Portable A-C/D-C | 11.57 | 1,175,056
| Table | 54 | 55,000
| Console | 22.56 | 2,281,884

Auto: Television Table Models Without Radio | 14.20 | 1,442,494
Table Models With Radio | 7.81 | 795,082
Console or Consolette Without Radio | 1.75 | 175,421
Console or Consolette With Radio | 1.75 | 175,421
Phonographs | 1.79 | 181,351
With radio attachment | 2.92 | 296,967

TOTAL: 1,000,000 10,159,091

Production of radios, phonographs and television sets by months was:

<table>
<thead>
<tr>
<th>Month</th>
<th>Percent</th>
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<tbody>
<tr>
<td>January</td>
<td>5.22%</td>
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<tr>
<td>February</td>
<td>7.00</td>
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<tr>
<td>March</td>
<td>8.88</td>
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<tr>
<td>April</td>
<td>7.00</td>
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<td>May</td>
<td>6.86</td>
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<td>June</td>
<td>6.90</td>
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<td>July</td>
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<td>September</td>
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<td>October</td>
<td>10.24</td>
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<td>November</td>
<td>10.36</td>
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<tr>
<td>December</td>
<td>10.18</td>
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Popocatepetl Crash of a Mexican airliner last September kicked up sufficient fuss in the country to cause its Congress to recommend immediate modernization of navigation equipment and systems. Funds for the job will probably be voted at the present session, and much of the money will go for electronic apparatus.

An Enterprising Manufacturer in Red Bank, N. J., is offering electronic engineers cravats that are "symbolic yet conservative." You can buy an "electron-tube tie" or a "radio-circuit tie" in blue and red, brown and gold, red and gray,
The advantages of the octal type key plug-in terminal are now extended to include applications calling for as high as 20 pins. Many additional types of relays and other electrical components may now employ this simple fool-proof combination of hermetic sealing and plug-in connection. Sockets are available. All Fusite Hermetic Terminals are an interfusion of steel and inorganic glass. Write Dept. E for specifications and complete information.
BARRY Mounts

FOR ASSURED CONTROL of SHOCK and VIBRATION

Powerful and sensitive, compact and light-weight, this new RCA family of aircraft radio equipment is built to meet the communications and navigation needs of airline, feeder line, and executive aircraft, bush flyers, and sportsman pilots.

For assured protection against shock and vibration in the roughest types of flying operations, RCA provides individual mounting with BARRY Mounts.

With the AVR-21 Automatic Direction Finder, for example, Type M-112 BARRY Mounts perform satisfactorily when the unit is subjected to 10-G vibration in any of three directions, without resonance above 13 cycles.

BARRY aircraft mounting bases are also available for rack installation... in standard dimensions to government specifications... or to exact customer's specifications.

Free Catalogs give dimensions and load ratings of stock BARRY Mounts. Catalog 502 covers aircraft applications, Catalog 504 covers industrial and general-purpose mountings. WRITE TODAY to

THE BARRY CORP.

Main Office 177 Sidney St. Cambridge 39 Massachusetts

New York Rochester Philadelphia Washington Cleveland Dayton

Chicago Minneapolis St. Louis Los Angeles Toronto

April, 1950 — ELECTRONICS
In the next group of three letters the first designates the launching point of the missile, the second tells where it is going and the third, the letter M, merely means that it is a guided missile. The letter A stands for air, S means surface, and U means underwater. Then another dash.

The next letter designates the service branch by which the missile is used, A for Air Force, G for Army, and N for Navy. Dash.

The final number and letter indicates the model. A lower-case letter "a" means first modification, a lower-case "b" second modification. Thus X-UAM-N-3b would denote an experimental underwater-to-air guided missile used by the Navy, model 3 with a second modification.

If You Noticed last month that our front cover looked different it was because of that color strip down the left side. We blush to admit that we made up a beautiful and expensive set of plates that were perfect in every respect except for the fact that the picture had been turned just 90 degrees out of phase!

So we sawed up the plates and put in the color strip to take care of the altered dimensions. Wouldn't surprise us at all if we received compliments for the change of pace despite the fact that it was the result of a near miss.

In February (p 63) we noted that a new book titled "Natural History" would be printed with ink giving off the odor of pine forests, called for suggestions suitable for ELECTRONICS.

Rosamund Cruikshank of Portsmouth, N. H. suggests "Chan(n)el No. 5." Leon A. Wortman of Fairchild Recording suggests the odor of melting pitch ("Nothing makes an electronic engineer sit up and take notice faster.") Warren L. Holmen of Minneapolis thinks we might use "the odor that steals into the consciousness a short time after one unknowingly kicks the soldering iron from its stand while repairing a neighbor's console."
Outstanding Advantages of the new Mallory Spiral Inductuner:

1. A single control for easy selection and fine tuning of any television or FM channel.
2. Easily adapted to UHF converter use.
3. Excellent stability eliminates frequency drift.
4. Supplied in three- or four-section designs.
5. Far more quiet operation; permits high signal-to-noise ratio in front-end designs.
6. Free from microphonics.
7. Greater selectivity on high frequency channels.
8. Eliminates "bunching" of high-band channels.
9. Simplifies front end design and production.
10. Reduces assembly costs.

New Improvements in Mallory Inductuner* for Television Receivers

Now there are important new reasons why the Mallory Inductuner should be first choice for your TV receiver. Each one offers more convenience to the set owner, new economy for you, without any sacrifice in the performance advantages of the continuous tuning principle...

Improved Inductuner eliminates "dead zone" from continuous tuning; covers entire TV range from 54 to 216 megacycles, including FM, in only 4 revolutions!

Improved Inductuner covers entire TV spectrum in only 3 revolutions, if FM is not required!

Improved Inductuner can be channel-indexed for touch-tuning without dial watching...still provides fine-tuning adjustment!

Finally, the Improved Inductuner is available at low cost and will make important savings for you in assembly and alignment operations.

That's Value Beyond Expectation!

Write for technical details. Also inquire about the surprisingly low cost and superior performance of the suggested front-end designs which Mallory engineers have developed around the Inductuner.

Television Tuners, Special Switches, Controls and Resistors

SERVING INDUSTRY WITH

- Capacitors
- Contacts
- Controls
- Resistors
- Rectifiers
- Vibrators
- Special
- Power
- Switches
- Supplies
- Resistance Welding Materials
1930 ... Anniversaries are easiest to take if they are ignored. But ELECTRONICS is only twenty years old this issue, so let's get on with it.

When a magazine turns the corner of another decade, its editors turn their attention to their longtime friends, the charter subscribers. Five thousand such friends got copies of the first volume, in 1930. Of these, our records show 423 have never left us, even for a single issue. To these, and other long-term supporters of our efforts, we feel an accounting is due. Perhaps the new recruits will find the record worth recounting.

The charter subscriber who has renewed his subscription regularly at the one-year rate has paid $91 for the issues of this magazine to date. If he took advantage of the special charter subscriber rate, and has since renewed every three years, at the three-year rate, he got the service at the rock-bottom price of $60.

What did such a friend and supporter get for his money? He got a total of 43,700 printed pages, 15,700 of which were devoted wholly to editorial material. If he binds his volumes, text and advertising, he has a shelf-full 6 feet long. The editorial content of 20 years, reduced to 400-page volumes of standard textbook size, fills the equivalent of 80 volumes of technical information. These he got for 75 cents each. On the same basis, the advertising pages constitute 150 volumes—a truly encyclopedic commercial history of the electronic arts. Charter advertisers are still with us, too. Of the 74 charter advertisers still in business, 56 appeared in these pages in 1949.

So much for quantity. What about the quality? We feel satisfied that a good job has been done, but that's only a personal opinion. Several facts stand out. The average net paid circulation has increased from 5,092, in the six-month period ending December 1930, to 30,884 for the same period in 1949. The renewal percentage (an editor's bogey, having about the same force as the $25 of a 6AG5 has for the quality-control engineer, namely, you keep it up, or else) has followed the economic fortunes of business, but through the 20 years it has consistently bettered par for the course. It would appear, therefore, that reader acceptance is reasonably high.

One thing is certain. The field of electronics has grown rapidly, and the load on the staff has kept pace. In 1933, it took only 354 editorial pages to cover the electronic developments of that depression year. In 1946, when we were busy publishing the huge backlog of copy stored during the war, it took 1,519 pages. Last year, things having settled down to a steady roar, it took 1,247 pages.

The staff has grown in proportion. Initially three men and a girl, and for one brief period reduced by sickness to two men and no girl, the editorial staff now comprises nine editors and three attractive young ladies. The editorial turnover has not been high. One editor has been with us since the beginning, and of the 18 editors whose names have appeared on the masthead at one time or another, half are still at their desks.

That is the factual record. But no recital of facts and figures can reflect the great sense of excitement, the sense of participating in a vital and fascinating profession, in a great and burgeoning industry, that has buoyed up the staff throughout these twenty years. Memories are many: The private preview of a new art at dinner in Major Armstrong's home two days before he presented his famous paper on f-m in 1935. Being hauled up before the IRE Board of Directors for scooping the Proceedings on the orthicon in 1939. The gratified smile on Claude Shannon's face as he handed us the corrected proofs of our report on his famous theory of noise and bandwidth in communication. These memories, and a hundred others like them, mirror the past.

As for the future, our feelings are no different. We have the same feeling of excitement that comes from dealing with active men in a vital field, the same eager anticipation for the new developments to come. ... 1950
The progress of the electronic art through the past two decades has been of such magnitude it is difficult to assess in technical terms. The applications in communications, in industry, in applied science and in medicine are so various, that even to list them is a formidable task. It is simpler to cast the review in terms of the common denominator of all electronic development, the electron tube itself.

When this magazine was first published, in April 1930, electron tubes had been in existence for a quarter of a century, dating back to the Fleming diode valve in 1905. In that quarter century many of the basic types had made their appearance: the triode in 1907, tetrodes in 1927, and r-f and power pentodes in 1929. X-ray tubes were in wide use, and cathode-ray tubes were available, although not yet widely used in oscillographs. Gas-filled rectifiers were in use, and the thyratron was announced in 1928. The two-plate magnetron and the dynatron had been invented. Work was under way on the iconoscope, but it had not been publicly announced. As of 1930, there the list ended.

It is not surprising, therefore, that the complete list of tubes considered to be of interest to amateurs in 1930 comprised only 41 types. The 1930 edition of the "Radio Amateurs Handbook" contained a tabulation of 11 receiving tubes, 19 transmitting tubes, 8 rectifiers and 3 current regulators. In 1930, active tubes listed in the "RCA Tube Handbook" totalled 59: 25 receiving types, 32 transmitting types and 2 others.

Those were the good old days! The 1950 edition of the ARRL Handbook lists 1,189 types, an increment of 28 new tubes for every one listed in 1930. The active tubes in the RCA list doubled in number every five years until 1940, and have nearly doubled again since then. There are 689 types in the HB-3 catalog as of 1950. This represents in 20 years, an increase of nearly 12 times in the output of one company alone.

The cumulative record of tube development throughout the years, in all countries, is beyond estimation. But some idea of the proliferation in tube design can be derived from the listings of the 1949 "International Radio Tube Encyclopedia," which encompasses most of the tube-type designations, in nine classifications, manufactured throughout the world. The total is 10,424 tube types! An accompanying table gives the details of this prodigious record. Note that it contains 80 different types of tuning indicators, 787 cathode-ray tube types, and 4,891 receiving tubes.

Production of tubes has reached well into the billions. Well over
The history of electronics revolves around tubes. Two decades have seen the marketing of over 10,000 types, worldwide production approaching five billion units, and over thirty major advances in design.

Three billion receiving tubes have been made in the U.S.A. alone. Receiving-tube sales averaged about 50 million annually from 1930 to 1955. Since the war the rate has been 200 million or more annually. During the war even higher figures were reached. One series alone, the proximity-fuze tubes, achieved a total production of 130 million.

Technical Advances in Tubes

So much for tube types and production. Of greater interest to engineers are the technical advances revealed in new electron-tube principles.

During the past twenty years, no fewer than 34 electron tubes essentially new in principle have appeared. These represent no mere changes in envelope, basing or heater voltage; they are basic advances. First on the list is Stuart Ballantine’s variable-mu tube. Last is the electron coupler, described to readers of this journal only last month. Included in the list are the whole family of television camera tubes, from iconoscope and image dissector to image orthicon; the electron accelerators from cyclotron to betatron and synchrotron; all the electron multipliers; the electron optical tubes, electron microscope and infrared image converter; all the uhf and shf family, from klystron and resonatron to the cavity magnetron. Included also are such workhorses as the beam-power tetrode.

Along with these new ways of controlling free electrons to perform new tasks, steady progress has occurred in mechanical structure to make tubes more rugged and reliable, more efficient in the use of filament and plate power, more comprehensive in frequency range. Part of this mechanical effort has led to changes in envelopes and basing practice. Typical trend is the jargon of the bases: octal, locatal, noval, magnal, duodecal and diheptal. Some tubes have “gone small” and others are enormous, from the miniatures and subminiatures on the one hand to the recently announced 500-kilowatt triode on the other.

I—The Electron Image

Certain trends are discernible in the roster of the new tube principles and structures. In view of the present status of television, one of the most important of these trends is that based on the electron image. The basic idea of creating and storing a pattern of electrons which corresponds point for point with an optical image goes back to the suggestion of Campbell-Swinton in 1908, but a practical embodiment was not publicly described until 1933, when Zworykin gave his paper on the iconoscope before the IRE at Chicago. Concurrently, the concept of the electron image had been used by Farnsworth in the development of his image dissector, which he first described before the Franklin Institute in 1934.

At about the same time, the elec-
tric-optical research of Knoll and Ruska led to the development of the electron microscope. In 1936, the “electron telescope”, an image converter which translates directly from infrared to visible light, was announced. In 1939 came the orthicon, a low-electron-velocity version of the iconoscope, and in 1945 the image orthicon. This latter device, considered by many to be the crowning achievement of electron tube development, employs the principle of electron multiplication itself developed as late as 1934, to achieve sensitivity to light surpassing the fastest photographic film.

Last year, a new storage tube was briefly described which equals the sensitivity of the eye.

II—The Electron Group

Early tubes were designed on the basis of collecting the electron current at the plate of the tube, thus transforming the space current directly into a conduction current in the circuit attached to the plate. But, with the development of the magnetron, a wholly new means of extracting the energy from electrons was conceived. This consisted of whirling, or otherwise moving, a group of electrons past electrodes with which they did not actually make contact, and relying on the field of force surrounding the electron groups to induce current in the electrodes. This principle was put to work in the early magnetron and its modern progeny, the cavity magnetron. It has appeared in different forms in many other high-frequency tubes, including the klystron and the traveling-wave tube.

The electron-induction principle has been applied in reverse in one of the most important groups of machines in modern technology, the particle accelerators of nuclear science. Starting with the cyclotron in the early thirties, charged particles have been whirled at speeds approaching that of light, and at energies approaching a billion electron volts, in successive variations of the cyclotron principle: the f-m cyclotron, the betatron, the synchrotron and the bevatron.

So far as frequency of operation is concerned, the electron-grouping technique is clearly responsible for the extension of radio transmission and reception to the region above 1,000 mc, although triode structures have penetrated above this limit in a few cases. Part of the technique has been the inclusion within the tube envelope of one or more tuned circuits, which receive their excitation from the passing groups. The most noteworthy example of the latter class in the cavity magnetron, which has extended the radio spectrum above 30,000 mc, and has achieved peak power levels of the order of megawatts at somewhat lower frequencies.

III—Scaling Down

The urge toward higher frequencies has inspired designers to follow the obvious, but difficult, trail of reducing the size of tube structures and the spacing between elements. One of the first examples of this trend was the acorn tube, one type of which (the 6F4) is still rated as one of the best high-frequency triodes, operating up to 1,200 mc.

Just before the war, the button-stem miniature tube appeared. It was originally designed for personal portable radio receivers but was quickly appreciated as a true advance in high-frequency design. The disk-seal lighthouse tube followed, noteworthy for its integration with external cavities for tuned circuits. Still another form was the pencil triode. Subminiature tubes, initially designed for hearing aids, and later adapted to the proximity fuze, have achieved exceptional high-frequency performance, coupled with low power consumption. The proximity-fuze tubes had not only to be small but also to withstand tremendous mechanical shock, 20,000 times the acceleration of gravity in artillery applications.

IV—Transconductance Up

A similar trend has affected the design of electrode structures, particularly as related to mutual conductance. The battery triodes prior to 1930 (UV199 and WD-11) were hardly distinguished by modern standards. Each had a mutual conductance less than 500 micromhos, and the power output tubes (112A and 71A) as well as the early pentodes (77 and 78) got no higher than 1,500 micromhos. With the advent of the heater-filament power pentode, and particularly when the beam-power tetrode appeared in 1936, conductances began to rise, reaching 6,000 micromhos in the 6L6 beam tetrode.

When wideband-amplifier design became important about 1936 with the advent of the 6-mc television channel, attention was directed toward combining high transconductance with low input and output capacitance. One of the early successes was the type 1852, later renamed 6AC7, which achieved a conductance of 9,000 micromhos, with an input-output capacitance sum of 16 µµf. This type, with its remote-cutoff sister the 1853/6AB7, became the standard wideband i-f amplifier tube in early television receivers.

Came the war and radar, and the need for better tubes forced still further reduction in cathode-grid spacing and finer control-grid windings. Button-stem tube construction was adapted to assist in high-speed production and from it came the 6AK5, a pentode with 5,000 micromhos conductance and a capacitance sum of only 6.8 µµf. Putting this tube in high-speed production left many an engineer prematurely gray, but at the end of the war it was the most widely used wide-band tube. Too costly for postwar commercial television sets, it was replaced by a watered-down version known as the 6AG5.
The ultimate in the brute-force, or make-the-triole-do-it, school of design is the co-planar triode designed by the Bell Laboratories for microwave relays. This tube (BTL 1553) has a transconductance value of 5,000 micromhos, coupled with a capacitance sum of 10 µf. It will amplify at 4,000 mc, over a bandwidth of 60 to 80, with a gain of 4 to 6 db per stage. Old hands said this improbable tube was impossible to build on a production basis, but it’s being built. The grid-cathode spacing is six thousandths of an inch, the grid wires a third of a mil in diameter and wound 1,000 turns to the inch. Viewed on this scale the surface of an ordinary oxide cathode is mountaneous; to make it plane, the surface is milled off as though it were a Johannsen block.

V—Photosensitivity

The phototubes have been in many respects a family apart, but that is not to say that the photosensitive designers have been inactive. Two main avenues of improvement have been followed: extension of the spectral responses toward the blue and ultraviolet, and vast increases in overall sensitivity.

In 1930, virtually the only photosurface in wide use was the cesium-oxide-silver, or S-1 photoemitter, which displays an overwhelming preference for infrared radiation in the region of 8,000 Angstrom units. Five new surfaces now grace the handbooks (S-3, 4, 5, 8 and 9). All of these have essentially no infrared response, but have peaks in the blue region, or just over the border into the ultraviolet. Surface S-9 extends into the green region, and has a spectral distribution not markedly different from that of the eye. Taken together, these photoemitters, with various optical filters, can cover adequately the visible spectrum, and well into the infrared and ultraviolet.

As for sensitivity, use of the electron multiplier in phototubes affords an increase of the order of a million times. The 917 vacuum phototube, widely used before the war, has an average luminous sensitivity of 20 microamperes per lumen. The gas-filled phototube of similar vintage (type S68) hits about 90 microamperes per lumen. But the 924-A multiplier phototube, which dates from 1940 or thereabouts, hits an average sensitivity at full rating of 10 amperes per lumen, and an especially sensitive tube may reach 300 amperes per lumen. This tube will produce a signal just equal to the noise when the light falling on the photoemitter is 10 billionths of a lumen, i.e. it will register the light from a tallow candle at three miles. For the affluent, the 1P21 multiplier, at five times the price, goes down to half a billionth of a lumen. The catalog description of the latter tube “for applications involving very low light levels” is something of an understatement.

VI—C-R Tubes in Job Lots

This review of tube progress must obviously conclude with the class of tube responsible for more vacuum than all other types combined, the cathode-ray picture tube. Here the improvements have been various: in the electron gun focus is now maintained over a wider range of beam current, and the first anode current has been markedly reduced. The negative ions are forcibly removed from the cathode-ray by the bent-gun or the inclined-slot gun, in conjunction with ion-trap magnets. Phosphors are more efficient and considerably more uniform than before the war. Phosphor coatings are of two kinds: aluminum behind the screen to increase luminous output and to control negative ions, and “blaxide” in front to take the extra brilliance away and enhance contrast.

The evolution of the c-r tube envelope is preponderantly a post-war phenomenon, and the end seems not in sight. The super-heavy face plate has given way in the larger sizes to the metal-sided construction. The aspect ratio, in bondage for several years, seems about to be redeemed as the rectangular-faced tube makes its appearance. Not the least of the c-r tube accomplishments are the production and price figures attained. Over 3 million picture tubes were produced in 1949, and the manufacturer's price for a 16-inch tube had descended to $29.00 as of April this year, about that for a 10-inch tube in 1947. Future progress, in these as well as other types of tubes, may be hard to describe. But it can be counted on.

—D.G.F.
First experimental satellite station installed for long-term evaluation of uhf television reception. Standard transmitter, supplemented by cavity tripler and output stage, feeds slot antenna. Printed circuits used in adapter to convert standard receivers.

By RAYMOND F. GUY
Manager Radio and Allocations Engineering National Broadcasting Co., Inc. New York, N. Y.

The assignment of uhf channels to television service can be intelligently made only if certain basic facts are available in advance. The kinds of information needed are:

1. The distances at which a given field strength can be produced by a station when it utilizes practical antenna heights, transmitter powers that are economical or possible to attain and transmitting antenna gains that are optimum.

2. The service range as it is ultimately limited by noise produced in receiver input circuits, relative to the field strength. Receiver noise figures must be known and evaluated.

3. The efficiency of practical receiving antennas and associated transmission lines.

4. The effect of earth prominences, buildings and other obstructions that cause diffraction, shadows and multipath effects, depending upon height and the type of knife-edge over which the signals pass and distance.

5. The amount of signal variation from hour to hour and from season to season resulting from changes in the troposphere.

6. The distances at which the station will produce field intensities capable of causing interference to other stations on the same channel.

7. Finally, geographical and frequency assignments must be made with a view towards reducing cochannel and adjacent channel interference to tolerable levels, using practical transmitters and receivers.

Since 1946, attempts have been made to evaluate the service potential of the ultrahigh frequencies, particularly in the region between 475 and 890 mc. The results obtained by several investigators are available in the literature.

It was decided that the next step must be the construction and operation of a complete uhf television broadcast station in a representative community. Every part of the facility was custom built to insure

FIG. 1—Modified frequency control keeps sound carrier 4.5 mc above picture

FIG. 2—Tripler cavity surmounted by output cavity. Identical units are employed for the sound and picture transmitters
that the performance would be truly representative of the uhf television transmission conditions, in an area typical of those in which many uhf stations will later be operated.

The site finally purchased is located in Stratford, Connecticut, near the Stratford-Bridgeport boundary, on Success Hill, one of five hills surrounding Bridgeport on the land side and about 2.5 miles distant from the center of the city. It was chosen for its central location, altitude of 190 feet, minimum of shadow problems, relative isolation and because there were few zoning restrictions. About 350,000 people, half of whom reside in the city of Bridgeport, live within the area served.

The transmitter building is a one-and-a-half-story frame structure about 24 by 34 feet with floor area of 1,164 square feet. The basement is used by the RCA Service Co. in connection with the installation of receivers in the area.

The transmitting antenna is supported by a 210-foot fabricated tower rising to an overall height of 443 feet above sea level. At the 160-foot level is located the directional dish antenna used for pick-up programs from WNBT on Channel 4 in New York, 53 miles away. A 2,000-mc link is alternatively employed to modulate the transmitter.

Application for construction permit was filed Feb. 8, 1949 and the first transmissions with full power and modulation were made December 29, under the call letters KC2XAK. A total of 50 television receivers with uhf converters is being installed for qualitative tests and field strength measurements with mobile equipment are being made in the area.

When it became apparent some years ago that television service would have to expand into the uhf region, work was started on the development of tubes and circuits to provide satisfactory apparatus at adequate power to meet anticipated requirements. The KC2XAK transmitting plant, relatively simple in design, depending heavily upon existing commercial equipment, is suitable for commercial operation on actual program schedules. Many improvements are planned and will be employed before the termination of the tests. In particular, it should be remembered that the present operation

**Highlights of the Bridgeport Installation**

- Sound-carrier frequency control maintains intercarrier separation of 4.5 mc
- Tripler and output cavities adapt standard equipment to uhf
- Receiver-characteristic visual monitor
- Vestigial sideband filter for uhf
- Notch diplexer for feeding picture and sound signals to antenna through a single coaxial line
- Special transmission line between transmitters and antenna
- New slot-type antenna with 88 apertures, vertical beam width of 2 degrees and power gain of 17
- Special tuners with printed-circuit filter for survey with standard receivers
will be in the 529-535 mc region. Different techniques will be necessary at 900 mc.

Basically, the transmitter comprises a type TT-500B 500-watt commercial vhf unit delivering picture power at 176.75 mc and sound power at 178.25 mc, followed in each case by a tripler and power amplifier. Sound modulation is conventional. Grid modulation of the picture power amplifier is accomplished by eight parallel type 6L6 tubes operating as cathode followers. Performance conforms to standard vhf practice. The transmitter operates with a power output of 1 kw on sync signal peaks.

**Sound Carrier Frequency Control.** Because of the very small amount of deviation (25 kc) employed for frequency modulation of the sound channel at the operating frequency (534.75 mc) it is necessary to maintain the center frequency exactly in order to reduce noise. Because many receivers employ the intercarrier system, it is further necessary that the sound frequency be maintained exactly 4.5 mc higher than the picture frequency of 530.25 mc.

For these reasons, the center-frequency control of the sound transmitter depends upon a crystal reference chosen to compensate for variations of the picture transmitter crystal control circuit. The method of maintaining the required 4.5-mc difference, shown in Fig. 1, involves a slight modification of the customary commercial equipment.

As shown in the block diagram, the output frequency of the picture transmitter depends upon a crystal oscillator and a frequency multiplier of 108 times. Output from this 4,909.722-ke crystal oscillator is fed to a mixer and the 41.7 difference between this and 4,951.899 kc from the sound-channel modulated oscillator is fed to still another mixer. This mixer adds the multiplied output from the 104,167-ke difference crystal oscillator and feeds approximately 250 kc through a divider to the frequency detector. The difference between the variable signal near 20.8 kc and a 20.8-ke signal derived from the difference crystal oscillator actuates the motor control that tunes the modulated oscillator. As soon as the modulated oscillator is brought exactly to 4,951.899 kc, both inputs to the frequency detector are at the same frequency and the motor remains stationary.

Since the maximum amount of frequency deviation for 100-percent sound modulation amounts only to about 230 cycles at the modulated oscillator, and because the amount of effective deviation in the control circuits due to modulation is further reduced by mixing and dividing, sound modulation cannot significantly affect this frequency control. The separation is therefore maintained at 4.5 mc within plus or minus 450 cycles.

**Tripler and Output Cavities.** The assembled tripler and output cavities are shown in Fig. 2, with input at the bottom, output at the top. Eight type 4x150 tubes are used in parallel in each cavity, with

**FIG. 3—Detail of cavity for eight 4X150 tubes. Tuning of tripler is shown at (C) and output tuning adjustments in (D).**

**FIG. 4—Cross-section of tripler and output cavity units. Input to tripler is from the left and output from right at right. Cavities are actually mounted vertically as shown in Fig. 2.**
anodes visible at the top, beneath transparent covers. These covers serve both to protect the operators from plate potential and to build up a slight pressure that forces the cooling air downward past the grid seals. They are interlocked to avoid damage to equipment as well as to insure safety of personnel from plate potential.

In the closeup of the tripler unit (Fig. 3A) the tubes and output connection have been removed. The upper fingers seen through the tube apertures make contact with the anode, while the inner fingers connect to the screen grid. A typical cavity unit is shown disassembled in somewhat greater detail in Fig. 3B.

The grid and plate cavities are tuned by annular shorting bars connected for mechanical convenience to the rings shown in Fig. 3C and 3D. Additional individual grid-

circuit compensation is provided through the manipulation of controls to be seen in the photograph and Fig. 4. Equivalent grid circuits for both tripler and amplifier are shown in Fig. 5. The grid-cavity adjustment is shown as \( L_z \). Because each tube contributes its own input capacitance \( C \), an adjustment \( L_z \) is provided for each tripler tube (Fig. 5A). Various combinations of \( L_z \) and \( L_z \) can tune the circuit to resonance, but each combination presents a different input impedance. Thus, the input circuit can be adjusted to the 51.5-ohm cable connecting the tripler to the output of the modified driver. The r-f grid voltage on each of the eight tubes is balanced by adjustment of the eight \( L_z \) circuits.

Although the grid circuit (Fig. 5B) of the amplifier stage is essentially similar to that of the tripler, the input impedance is designed for about 100 ohms. Because of the higher operating frequency, the grid-lead inductance \( L_z \) becomes more significant and requires compensation in the form of series capacitance, \( C \). A dielectric sleeve slides between the metallic conductors to vary the capacitance in this equipment. In the amplifier, the grid is not returned to ground for modulation frequencies. Video signal is introduced to the grids through quarter-wavelength sections of transmission line (not shown).

The plate circuits of the triplers and amplifiers are identical and differ in operation only in the amount of loading coupled into the circuits. The output load impedance is matched by two quarter-wave transformers in series, one of which is variable to adjust the load on the tubes. The characteristic impedance is changed by varying the spacing between the inner and outer conductors of the coaxial transmission line section. Physically it is accomplished by rotating the outer conductor with respect to the inner conductor approximately as shown in Fig. 6.

Monitoring equipment includes required indicating instruments for the sound and picture channels as well as scope presentations of waveform and picture for the picture transmissions. Here, again, standard equipment has been adapted at moderate cost for use at uhf. The transmitter frequencies are heterodyned to 49.75 and 45.25 mc (formerly used for television channel 1).
the transmitted signals. This oscillator has a frequency stability of 2 parts per million per 30 days. Any drift is checked against a 250-kc oscillator-multiplier which in turn is checked against standard frequency transmissions from WWV.

**Receiver Type Visual Monitor.**

Modulation monitoring of the picture channel after the sideband filter is obtained with a standard demodulator. A special diode detector connected ahead of the vestigial sideband filter permits oscilloscopic observation of the envelope of the double sideband output. The vestigial sideband demodulator is a tuned r-f type receiver of low sensitivity using coaxial line circuit elements. It employs a constant resistance filter of the m-derived type. This design assures stability of the cutoff point on the receiver response curve and compares with the receiver characteristic contemplated in current standards. In addition to the video information which corresponds to the picture received at a distant point, the converter supplies a 100-percent modulation signal in the white direction. The schematic diagram is shown in Fig. 8. An absorption filter tuned to the carrier beat frequency between picture and sound carriers can be switched out for measuring square-wave response. The tuned relay shorting device supplies a reference level for measuring modulation depth and percent sync.

**Sideband Filter.**

The picture transmitter output circuits are connected to a vestigial sideband filter employing coaxial-line circuit elements as shown in Fig. 9. Although this filter is basically similar in design to vhf units, the shorter physical lengths resulting from the higher frequencies of transmission make possible a more economical design of the circuit elements.

**Notch Diplexer for Single Line.**

The picture and sound outputs are brought together in a notch filter employing coaxial line elements to combine the two outputs in one antenna feed line with very high attenuation looking backward towards the individual transmitters. Except for the smaller physical dimensions at the operating frequency, this type of circuit construction is well known and has been described in the literature. It is shown in the photograph with the vestigial sideband filter.

**Special Coaxial Line.**

Power is delivered to the antenna through a special 3½-inch diameter coaxial transmission line having a measured attenuation of 0.6 db and standing-wave ratio of better than 1.1.

For the particular experimental installation, a variation of standard beaded coaxial line was instead employed.

To minimize reflections caused by the special insulating beads that support the inner conductor from
the inside of the outer conductor, a special undercut-bead construction is employed. Figure 10 (not drawn to scale) shows how the inner conductor ends are connected by means of a plug. The annular grooves cut into the plug concentric with the axis of the transmission line to reduce transmission line discontinuities. There are three supporting insulators in a 20-foot length of line. The space between these insulators is approximately uniform.

**High Gain Slot Antenna.** Studies of propagation and coverage difficulties in the uhf region indicate that appreciable power will be needed as contrasted with that required on the higher vhf television channels. Because of the difficulty of generating power at uhf and because antenna structures are physically small, the additional power requirements are most easily realized by means of an array.

The bat-wing antenna elements of the superturnstile arrays require separate feed lines to each group of elements. Since it is desired to realize the highest practical antenna gain, the number of sections must be increased over the usual number employed at very high frequencies. The slot type antenna provides somewhat greater simplicity in the feed system and was employed in this station. A four-sided slot antenna for 500 mc has a diameter of about 10 inches which is sufficiently large to eliminate structural problems. By choosing a theoretical gain of 20, a vertical beam width of the main lobe of about 3 degrees at the half-power points results. Sufficient power is available in subsidiary lobes and nulls directed below the horizontal to fill in for local coverage overshoot by the main lobe. A horizontal pattern circular to plus or minus 1 percent is obtained with the 22 sets of four slots alternately arranged at 45-degree physical intervals about the supporting pole. This staggering was employed to obtain proper coupling between sections. The measured pattern of an antenna 40 feet long shows the vertical beam width of the main lobe is about 2 degrees at half-power points, with a power gain of better than 17.

The method of illuminating the slots is indicated in Fig. 11. The inner conductor of the coaxial feed is extended, beginning at the center of the antenna, by a section of the same diameter as the outer conductor. Adjustable probes are provided for each slot and have been individually turned in to the proper depth. Relation of the slots and probes is shown at the left. Additional probes spaced between those used to feed the slots are adjusted to eliminate the discontinuities caused by the pickup probes.

The photograph shows the antenna undergoing adjustment tests. In order to avoid the mechanical complications that would arise if
the adjustments had to be made with the antenna in the vertical position, a special surface was built under the horizontal antenna supports. Such an antenna designed for vertical use could not normally be adjusted so close to the ground because of reflected energy that would nullify that emanating directly from the radiator. For this work, a wire screen mounted in a suitable mechanical framework of wood was placed below the antenna as shown. The screen is backed up a quarter of a wavelength away, by “space cloth” having a resistance of 377 ohms per unit square. To the recumbent antenna, the space below appears much like the space with which it is otherwise surrounded. Space cloth is a fabric impregnated with graphite and a binder.

Receiving Equipment

Because the Bridgeport transmitter operates in the lower region of the uhf band, it has been possible to attain satisfactory performance using conventional tubes in both a tuner and a converter that covers the range from 500 to 700 mc. The units to be described do not represent finished commercial design, but are experimental models produced for obtaining reception data when connected respectively to the i-f amplifier or the antenna posts of conventional television receivers.  

UHF Tuner. This tuner comprises a high-pass input filter with cutoff at 500 mc, r-f amplifier, mixer-oscillator, i-f amplifier (132 to 138 mc) and fixed-tuned mixer-oscillator with low-impedance output at 21 to 27 mc. The first intermediate frequency is high enough to provide satisfactory image rejection with only two uhf tuned circuits, but is also low enough to obtain reasonable gain and noise factor with conventional tubes.

The tuning circuit diagram is given in Fig. 12. The high-pass input filter used to reduce spurious responses is shown schematically here but is illustrated in the photograph. The printed circuit is accomplished by photogravuring a 1.5-mil copper sheet bonded to a paper-base Bakelite sheet.

The 132 to 138-mc i-f amplifier, using two stages of type 6AG5 tubes with three double-tuned circuits, satisfactorily isolates the first and second oscillators. Automatic gain control is not used because the band-shape response varies markedly with varying tube transconductance.

The tuning elements illustrated in the underside of the tuner chassis comprise strips of copper foil mounted on natural paper-base Bakelite tubing with low-loss cement. Tapered copper foil is used to obtain a desirable tuning curve and proper tracking of the r-f and oscillator circuits. The oscillator element consists of a bifilar winding terminating in a split capacitor section. All three elements are tuned by means of copper or brass cores inside the Bakelite tubing.

The uhf converter (not shown) has been designed to operate into the antenna connection of a television receiver tuned to either channel 12 or 13. The high-pass filter has a cutoff at about 475 mc. An r-f tuned circuit with proper impedance matching to maintain high operating circuit Q is used between the filter and the crystal mixer.

The i-f system comprises a low-noise high-gain cascade stage followed by a conventional pentode stage.

The Stratford-Bridgeport project, under the direction of C. B. Jolliffe, co-ordinates the facilities of RCA Laboratories, RCA Victor Division and the National Broadcasting Co. The latter unit has taken responsibility for procurement of the site, construction of building and tower, installation, operation and field investigations.

Acknowledgement is made for technical details of the equipment design used herein to C. D. Kentner, T. M. Gluyas, L. J. Wolf and O. O. Fies.

Complete engineering data on the KC2XAK experimental station appear concurrently in the March 1950 issue of the RCA Review.

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April, 1950 — ELECTRONICS
Of the four components of the fuel-gage system—bridge transformer, indicator, amplifier and tank unit—only the indicator, a rebalance motor, contains moving parts.

AIRPLANE FUEL GAGE

Laboratory accuracy is provided in a rugged instrument that indicates the weight of fuel, rather than volume. Employs self-balancing bridge principle, approved for military aircraft under AN-G-31A specifications.

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During the latter part of 1942, the disadvantages of the conventional float types of gasoline gage for aircraft became apparent. This gage employed a cork or hollow metal float to measure the level of the fuel; the information was then transmitted via gears, magnets and/or relays to an indicating instrument on the pilot's or flight engineer's instrument panel. Serious errors resulted from gasoline slosh, the volumetric expansion of gasoline with an increase in temperature, changes in supply voltage and wear in mechanical linkages.

In the effort to obtain a better fuel quantity gage for both military and commercial airplanes, three new types of capacitor gages were developed. All of these make use of the dielectric constant of gasoline, which varies from 1.85 to 2.3, depending on the temperature and the constituents of the gasoline.

The first type consisted of an oscillator (around 100 kc) which supplied voltage to a capacitance bridge. One arm of this bridge was a concentric tube capacitor mounted vertically in the tank; the unbalance voltage, which was proportional to the level of the fuel, was rectified and read on a 270-degree d-c microammeter.

The second type also used an oscillator feeding a bridge with two capacitance arms, one of which again took the form of a concentric tube assembly in the fuel tank. The currents flowing through the tank unit and the reference capacitor (usually of the fixed silver-mica variety) were rectified and compared in a d-c ratiometer. An improved version of this type used an a-c ratiometer, constructed like a miniature two-phase power factor meter. This version eliminated the rectifiers and their waveform errors.

Approved Type

The third type is based upon the self-balancing bridge principle and is now the only type approved for military aircraft under AN-G-31A specifications. In common with the

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other two versions of capacitance-type gages, it indicates weight of fuel rather than volume when used with AN-F-28, AN-F-32, AN-F-34 and AN-F-48 aircraft fuels. This concept of fuel quantity measurement is quite important, for engines use fuel on a weight rather than volume basis.

**Circuit Action**

The basic bridge circuit is shown in Fig. 1. A concentric tube capacitor \( A \) is mounted vertically in a cell of the gasoline tank. When the tank is empty, and there is no gasoline in \( A \), the capacitance of \( A \) equals that of the reference capacitor \( B \) (usually 75 to 550 \( \mu \)f in typical installations). If the voltages across \( L_1 \) and \( L_2 \) are also equal, there is no unbalance voltage fed into amplifier \( C \), no movement of motor \( M \), and the arm of potentiometer \( P \) remains at the empty end of scale \( E \).

If the tank cell is half full, the impedance of \( A \) is decreased, and the increase in voltage from \( L_1 \) must be balanced out by an increase in voltage (but of the opposite phase) from \( L_2 \). This is accomplished by adding voltage from \( L_2 \), which is in phase with the voltage from \( L_1 \). This voltage is added by driving the potentiometer wiper to a position midway between \( E \) and \( F \), which rebalances the bridge.

When the tank is full, the amplifier again drives the motor to the new balance point, at \( F \).

The motor \( M \) is a miniature two-phase instrument type, with a salient-pole, high-resistance rotor which is designed to give maximum torque when stalled. The current for one phase is supplied by the amplifier, the current for the other by the same generator that supplies the primary of bridge transformer \( T \). The phase fed by the generator is known as the line phase, or reference phase, and is fed through a capacitor so that it is normally 90 degrees out of phase with the current from the amplifier.

The current from the amplifier is always in phase with the output voltage from the bridge, but the latter may be either in phase with, or 180 degrees out of phase with, the generator voltage. Hence the direction of rotation of the motor depends upon the phase angle of the current from the amplifier. Bridge, amplifier and motor are connected so that the unbalance voltage from the bridge always drives the motor and potentiometer in the direction required to rebalance the bridge.

As the balance point is approached, the amplifier output decreases; when balance is reached, the amplifier input and output are cancelled out and the motor stops. Thus the bridge is automatically balanced. Since fuel quantity determines the position of the wiper arm on the potentiometer, a pointer may be attached to the shaft carrying the wiper arm and thus indicate pounds of fuel on an appropriate circular scale.

The schematic of a commercial model is shown in Fig. 2. Refinements have been added to the basic circuit to allow for manufacturing tolerances in the values of the various components. Potentiometer \( P \) is used to calibrate the full-scale point; \( P \) is the zero or empty calibration adjustment. A 6.3-volt winding has been added to the bridge transformer to supply the heaters of the tubes in the amplifier.

Resistors \( R_1 \) and \( R_2 \) limit current in case of a shorted reference capacitor, tank unit or wiring. The reference capacitor \( C \) is represented by \( B \) in the basic circuit diagram. This is hermetically sealed in an HC-6/U crystal holder, and plugs into a socket in the bridge unit. The bridge transformer is supplied with 115-volt, 400-cycle, single-phase current; the amplifier and indicator must also be supplied from the same current source to maintain proper phase relationships in the system.

**Tank Unit**

The tank unit (A on the diagram of the basic circuit) is made of three concentric tubes of different diameters; the inner and middle tubes are insulated from each other and from the outer tube. All are assembled into a head casting which holds them rigidly together and provides a surface for mounting the entire unit in the fuel tank of the airplane. The center tube and the middle tube form the active capacitor surfaces; the outer tube is grounded and serves as electro-
static and mechanical shielding.

Both the inner and middle tubes are slotted as shown in the cutaway view of Fig. 3 and the inner tube may be rotated by means of a spur gear and quadrant located inside the head.

This arrangement provides a very accurate and ingenious means of setting the electrical capacitance of each unit to a predetermined value, and exact interchangeability is assured in spite of commercial tolerances in tube diameters and wall thicknesses. Spacing between tubes is 0.1 inch, which is adequate to prevent bridging by water.

Holes are provided at both top and bottom of the middle and outer tubes to admit gasoline and permit air to escape, and the size and number of these holes are so controlled as to virtually eliminate the effects of gasoline slosh in the tank.

Tank Circuit

The inner and middle tubes, which are the active elements as far as the gage is concerned, are both above ground electrically. This means that wiring capacitances are to ground in each case. The capacitance of the unshielded lead, which connects the middle tube to one side of the bridge transformer, is to ground, and effectively across the low impedance of one side of the bridge transformer secondary.

The capacitance of the coaxial cable, which runs from the inner tube of the tank unit to one side of the reference capacitor and thence to the amplifier grid, is also a capacitance to ground, and thus does not affect the values of the capacitances in the bridge.

However, the value of this capacitance does affect both the phase angle and the magnitude of the output voltage from the bridge, as illustrated in Fig. 4. These relationships are shown in the graph of voltage and phase angle curves of output voltage, for values of C (tank unit capacitance plus reference capacitance) and C_s (capacitance in shunt with the output of the bridge).

A total of 200 volts across the secondary of the bridge transformer has been assumed. The basic equations are:

\[ G = \tan^{-1} \left[ \frac{1}{\omega R (C_s + C)} \right] \]

\[ V_s = \frac{200 R}{R + C_s G \sqrt{R^2 + \left( \frac{1}{\omega C_s} \right)^2}} \]

The reduction in output voltage resulting from large values of C_s means a loss of sensitivity, which may usually be offset by more gain in the amplifier. The change in phase angle must be taken into account when determining the value of the motor phasing capacitor C_s so that there is a 90-degree phase relationship between the windings of the 2-phase motor. This phase angle gives maximum stalled torque in a motor of this type.

The value of C_s, that is added to the coaxial cable capacitance is usually a compromise to give a reasonable output voltage from the bridge plus the minimum phase shift when going from empty to full tank unit capacitance values.

The amplifier is designed around JAN-approved miniature tubes. A simple feedback loop between the two 12AT7 plates gives adequate stability. The filter, coupling and motor phasing capacitors are hermetically sealed in metal cases. The output transformer is also hermetically sealed. Cathode bias is used in the input stage to assure amplifier interchangeability with varying values of shunt capacitance.

The indicator comprises a precision linear potentiometer, wire-wound, which is driven by a miniature 2-phase motor through a gear train to rebalance the bridge and rotate a pointer over the face of a dial, which indicates the total weight of fuel in the tanks.

Features

This type of fuel gage has several outstanding advantages. The amplifier itself is not a part of the measuring circuit, and thus any tubes (or the entire amplifier) may be replaced without a shift in calibration or any other change in the accuracy of the gage.

Variations in specific gravity are almost entirely compensated by variations in volume, so that the net result is to read the weight of the fuel. This is important because the power that may be obtained from an engine is proportional to the weight of the fuel consumed rather than the volume.

The absence of moving parts in the tank unit means that these units will not have to be pulled out of the tanks to replace worn parts.

The use of a 2-phase rebalance motor, instead of a moving-coil instrument, provides a rugged, dependable instrument. This increased accuracy permits a larger pay load, or bomb load, to be carried, since it reduces the amount of fuel that must be carried to cover possible errors in the fuel gage reading.
Recent Developments in

Nonmathematical analysis of present-day and possible future communications systems. Author cites feasibility of a system for transmitting the English language at speaking rate over a channel with 20-to-1 signal-to-noise ratio and a bandwidth of only 2,3 cycles per second

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The newer systems of modulation, such as f-m, ppm (pulse position modulation), and pcm (pulse code modulation), have the interesting property that it is possible to exchange bandwidth for signal-to-noise ratio; that is, we can transmit the same information with a smaller transmitter power provided we are willing to use a larger bandwidth. Conversely, in pcm it is possible to use a smaller bandwidth at the expense of an increased signal power. The discovery of these systems has prompted a re-examination of the foundations of communication theory. A number of workers have contributed to this field, among them Gabor, Wiener, Tuller, Sullivan and the writer.

The basic ideas of communication theory are not new. Important pioneering work was done by Nyquist and Hartley in the 1920's and some of the roots can even be traced back to the nineteenth century physicist Boltzmann. The more recent developments, however, include factors that were ignored in earlier treatments; in particular, we now have a much better understanding of the effect of noise in the channel and of the importance of statistical properties of the messages to be transmitted.

In this paper the highlights of this recent work will be described with as little mathematics as possible. Since the subject is essentially a mathematical one, this necessitates a sacrifice of rigor; for more precise treatments the reader may consult the bibliography.

The type of communication system that has been most extensively investigated is shown in Fig. 1. It consists of an information source which produces the raw information or message to be transmitted, a transmitter which encodes or modulates this information into a form suitable for the channel, and the channel on which the encoded information or signal is transmitted to the receiving point. During transmission the signal may be perturbed by noise as indicated schematically by the noise source. The received signal goes to the receiver, which decodes or demodulates to recover the original message, and then to the final destination of the information.

It will be seen that this system is sufficiently general to include the majority of communication problems if the various elements are suitably interpreted. In television, for example, the information source is the scene being televised, the message is the output of the pick-up tube and the signal is the output of the transmitter.

A basic idea in communication theory is that information can be treated very much like a physical quantity such as mass or energy. The system in Fig. 1 is roughly analogous to a transportation system; for example, we can imagine a lumber mill producing lumber at a certain point and a conveyor system for transporting the lumber to a second point. In such a situation there are two important quantities, the rate R (in cubic feet per second) at which lumber is produced at the mill and the capacity C (cubic feet per second) of the conveyor. If R is greater than C it will certainly be impossible to transport the full output of the lumber mill. If R is less than or equal to C, it may or may not be possible, depending on whether the lumber can be packed efficiently in the conveyor. Suppose, however, that we allow ourselves a saw-mill at the source. Then the lumber can be cut up into small pieces in such a way as to fill out the available capacity of the conveyor with 100-percent efficiency. Naturally in this case we should provide a carpenter shop at the receiving point to glue the pieces back together in their original form before passing them on to the consumer.

If this analogy is sound, we should be able to set up a measure R in suitable units telling how much information is produced per second by a given information source, and a second measure C which determines the capacity of a channel for transmitting information. Furthermore, it should be possible, by using a suitable coding or modulation system, to transmit the information over the channel if and only if the rate of production R is not greater than the capacity C. That this is actually possible is a key result of recent research and we will indicate briefly how this is accomplished.

Measurement of Information

Before we can consider how information is to be measured it is necessary to clarify the precise meaning of information from the point of view of the communication engineer. In general, the messages to be transmitted have meaning. This, however, is quite irrelevant to
Communication Theory

the problem of transmitting the information. It is as difficult (more so, in fact) to transmit a series of nonsense syllables as straight English text. A little thought on the subject will convince one that the significant aspect of information from the transmission standpoint is the fact that one particular message is chosen from a set of possible messages. The thing that must be transmitted is a specification of the particular message which was chosen by the information source. If and only if such an unambiguous specification is transmitted, the original message can be reconstituted at the receiving point. Thus information in our sense must be correlated with the notion of a choice from a set of possibilities.

The simplest type of choice is a choice from two possibilities, each with probability $\frac{1}{2}$. This is the situation, for example, when one tosses a coin which is equally likely to come up heads or tails. It is convenient to use the amount of information produced by such a choice as the basic unit, called a binary digit or, more briefly, a bit. The choice involved with one bit of information can be indicated schematically as in Fig. 2A. At point $b$ we may choose either the upper or lower line with probability $\frac{1}{2}$ for each possibility. If there are $N$ possibilities, all equally likely, the amount of information is given by $\log N$. The reason for this can be seen from Fig. 2B, where we have eight possibilities each with probability $\frac{1}{8}$. The choice can be imagined to occur in three stages, each involving one bit. The first bit corresponds to a choice of either the first four or the second four of the eight possibilities, the second bit corresponds to the first or second pair of the four chosen, and the final bit determines the first or second member of the pair. It will be seen that the number of bits required is $\log_2 N$, in this case $\log_2 8$ or 3.

If the probabilities are not equal, the formula is a little more complicated. A simple case is shown in Fig. 2C. There are four possible choices with probabilities $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, and $\frac{1}{8}$. This can be broken down into a sequence of binary choices as indicated. The information produced is given by $(1 + \frac{1}{4} + \frac{1}{8})$: the 1 is from the first choice (at point $p$) which always occurs, the $\frac{1}{4}$ is from the choice at point $q$, which occurs only half the time (when the lower line is chosen at point $p$), and so on. In general, by a similar decomposition, the information, when the choices have probabilities $p_1, p_2, \ldots, p_N$, is given by:

$$H = - \left( p_1 \log_2 p_1 + p_2 \log_2 p_2 + \ldots + p_n \log_2 p_n \right) \tag{1}$$

This formula, then, gives the amount of information produced by a single choice. An information source produces a message which consists of a sequence of choices, for example, the letters of printed text or the elementary words or sounds of speech. In these cases, by an application of Eq. 1, the amount of information produced per second or per symbol can be calculated. It is interesting that this information rate for printed English text is about two bits per letter, when we consider statistical structure only out to word lengths. Long-range meaning structure may reduce this figure considerably.

**Encoding Information**

The importance of the measure of information, $H$, is that it determines the saving in transmission time that is possible, by proper encoding, due to the statistics of the message source. To illustrate this, consider a language in which there are only four letters: $A$, $B$, $C$, and $D$. Suppose these letters have the probabilities $\frac{1}{4}$, $\frac{1}{4}$, $\frac{1}{4}$, and $\frac{1}{4}$, as in Fig. 2C.

In a long text in this language, $A$ will occur half the time, $B$ one-quarter of the time, and so on. Suppose we wish to encode this language into binary digits, 0 or 1. Thus we might wish to transmit on a pulse system with two types of pulse. The most direct code is the following: $A = 00$, $B = 01$, $C = 10$, $D = 11$. This code requires two binary digits per letter of message.

By using the statistics, a better code can be constructed as follows: $A = 00$, $B = 10$, $C = 110$, $D = 111$. It is readily verified that the original message can be recovered from its encoded form. Furthermore, the number of binary digits used is smaller on the average. It will be,
in fact calculated as follows:
\[ t(1) + t(2) + t(3) + t(4) = 1 \]
where the first term is due to the letter A, which occurs half the time and is one binary digit long, and similarly for the others. It will be noted that 12 is just the value of \( H \) calculated for Fig. 2C.

The result we have verified for this special case holds generally. If the information rate of the message is \( H \) bits per letter, it is possible to encode it into binary digits using, on the average, only \( H \) binary digits per letter of text. There is no method of encoding which uses less than this amount.

**Capacity of a Channel**

Now consider the problem of defining the capacity \( C \) of a channel for transmitting information. Since the rate of production for an information source has been measured in bits per second, we would naturally like to measure \( C \) in the same units. The question then becomes "What is the maximum number of binary digits per second that can be transmitted over a given channel?"

In some cases the answer is simple. With a teletype channel there are 32 possible symbols. Each symbol therefore represents 5 bits, provided the possible symbols are used with equal probability. If we can send \( n \) symbols per second, and the noise level is not high enough to introduce any errors during transmission, we can send \( 5n \) bits per second.

Suppose now that the channel is defined as follows: We can use for signals any functions of time \( f(t) \) which lie within a certain band of frequencies, \( W \) cycles per second wide. It is known that a function of this type can be specified by giving its values at a series of equally spaced sampling points \( 1/2W \) seconds apart as shown in Fig. 3. Thus we may say that such a function has \( 2W \) degrees of freedom, or dimensions, per second.

If there is no noise whatever on such a channel we can distinguish an infinite number of different amplitude levels for each sample. Consequently we could, in principle, transmit an infinite number of binary digits per second, and the capacity \( C \) would be infinite.

Even when there is noise, if we place no limitations on the transmitter power, the capacity will be infinite, for we may still distinguish at each sample point an unlimited number of different amplitude levels. Only when noise is present and the transmitter power is limited in some way do we obtain a finite capacity \( C \). The capacity depends, of course, on the statistical structure of the noise as well as the nature of the power limitation.

The simplest type of noise is white thermal noise or resistance noise. The probability distribution of amplitudes follows a Gaussian curve and the spectrum is flat with frequency over the band in question and may be assumed to be zero outside the band. This type of noise is completely specified by giving its mean square amplitude \( N \), which is the power it would deliver into a standard unit of resistance.

The simplest limitation on transmitter power is to assume that the average power delivered by the transmitter (or more precisely the mean square amplitude of the signal) is not greater than \( P \). If we define our channel by these three parameters \( W \), \( P \) and \( N \), the capacity \( C \) can be calculated. It turns out to be

\[
C = W \log_2 \frac{P + N}{N} \quad (2)
\]

bits per second. It is easy to see that this formula is approximately right when \( P/N \) is large. The received signal will have a power \( P + N \) and we can distinguish something of the order of \( \sqrt{P + N}/N \) different amplitudes at each sample point. The reason for this is that the range of amplitude of the received signal is proportional to \( \sqrt{P + N} \), while the noise introduces an uncertainty proportional to \( \sqrt{N} \). The amount of information that can be transmitted with one sample will therefore be \( \log_2 [(P + N)/N] \). Since there are \( 2W \) independent samples per second, the capacity is given by Eq. 2. This formula has a much deeper and more precise significance than the above argument would indicate. In fact it can be shown that it is possible, by properly choosing our signal functions, to transmit \( W \log_2 [(P + N)/N] \) bits per second with as small a frequency of errors as desired. It is not possible to transmit at any higher rate with an arbitrarily small frequency of errors. This means that the capacity is a sharply defined quantity in spite of the noise.

The formula for \( C \) applies for all values of \( P/N \). Even when \( P/N \) is very small, the average noise power being much greater than the average transmitter power, it is possible to transmit binary digits at the rate \( W \log_2 [(P + N)/N] \) with as small a frequency of errors as desired. In this case \( \log_2 (1 + P/N) \) is very nearly \( (P/N) \log_2 e \) or 1.443 \( P/N \) and we have, approximately, \( C = 1.443 PW/N \).

It should be emphasized that it is possible to transmit at a rate \( C \) over a channel only by properly encoding the information. In general
the rate $C$ cannot be actually attained but only approached as a limit by using more and more complex encoding and longer and longer delays at both transmitter and receiver. In the white noise case the best encoding turns out to be such that the transmitted signals themselves have the structure of a resistance noise of power $P$.

**Ideal and Practical Systems**

In Fig. 4 the curve is the function $C/W = \log (1 + P/N)$ plotted against $P/N$ measured in db. It represents, therefore, the channel capacity per unit of band with white noise. The circles and points corresponding to pcm and ppm systems used to send a sequence of binary digits, adjusted to give about one error in $10^6$ binary digits. In the pcm case the number adjacent to a point represents the number of amplitude levels; 3 for example is a ternary pcm system. In all cases positive and negative amplitudes are used. The ppm systems are quantized with a discrete set of possible positions for the pulse, the spacing is $1/2W$ and the number adjacent to a point is the number of possible positions for a pulse.

The series of points follows a curve of the same shape as the ideal but displaced horizontally about 8 db. This means that with more involved encoding or modulation systems a gain of 8 db in power could be achieved over the systems indicated.

Unfortunately, as one attempts to approach the ideal, the transmitter and receiver required become more complicated and the delays increase. For these reasons there will be some point where an economic balance is established between the various factors. It is possible, however, that even at the present time more complex systems would be justified.

A curious fact illustrating the general misanthropic behavior of nature is that at both extremes of $P/N$ (when we are well outside the practical range) the series of points in Fig. 4 approaches more closely the ideal curve.

The relation $C = W \log (1 + P/N)$ can be regarded as an exchange relation between the parameters $W$ and $P/N$. Keeping the channel capacity fixed we can decrease the bandwidth $W$ provided we increase $P/N$ sufficiently. Conversely, an increase in bandwidth allows a lower signal-to-noise ratio in the channel. The required $P/N$ in db is shown in Fig. 5 as a function of the band $W$. It is assumed here that as we increase the bandwidth $W$, the noise power $N$ increases proportionally, $N = W N_0$, where $N_0$ is the noise power per cycle of band. It will be noticed that if $P/N$ is large a reduction of bandwidth is very expensive in power. Halving the band roughly doubles the signal-to-noise ratio in db that is required.

One method of exchanging bandwidth for signal-to-noise ratio is shown in Fig. 6. The upper curve represents a signal function whose bandwidth is such that it can be specified by giving the samples shown. Each sample has five amplitude levels. The lower curve is obtained by combining pairs of samples from the first curve as shown. There are now 25 amplitude levels that must be distinguished but the samples occur only half as frequently; consequently the band is reduced by half, at the cost of doubling the signal-to-noise ratio in db. Operating this in reverse doubles the band but reduces the required signal-to-noise ratio.

To summarize, there are three essentially different ways in which bandwidth can be reduced in a system such as television or speech transmission. The first is the straightforward exchange of bandwidth for signal-to-noise ratio just discussed. The second method is utilization of the statistical correlation existing in the message. This capitalizes on particular properties of the information source, and can be regarded as a type of matching of the source to the channel. Finally, particular properties of the destination can be used. Thus, in speech transmission the ear is relatively insensitive to phase distortion. Consequently, phase information is not as important as amplitude information and need not be sent so accurately. This can be translated into a bandwidth saving, and in fact part of the reduction attained in the vocoder is due to this effect. In general, the exploitation of particular sensitivities or blind spotness in the destination requires a proper matching of the channel to the destination.

Many present-day communication systems are extremely inefficient in that they fail to make use of the statistical properties of the information source. To illustrate this, suppose we are interested in a system to transmit English speech (no music or other sounds) and the quality requirements on reproduction are only that it be intelligible as to meaning. Personal accents, inflections and the like can be lost in the process of transmission. In such a case we could, at least in principle, transmit by the following scheme. A device is constructed at the transmitter which prints the English text corresponding to the spoken words. This can be encoded into binary digits using, on the average, not more than two binary digits per letter or nine per word. Taking 100 words per minute as a reasonable rate of speaking, we obtain 15 bits per second as an estimate of the rate of producing information in English speech when intelligibility is the only fidelity requirement. From Fig. 4 this information could be transmitted over a channel with 2 db signal-to-noise ratio and a bandwidth of only 2.3 cps!

**BIBLIOGRAPHY**


Two watts of sound energy concentrated into an extremely fine area records on sound-sensitive paper without touching its surface. Magnetostriction oscillator, using an 805 triode, drives a nickel-alloy tube at about 20,000 ke.

**Making a Permanent Record on Paper Without Touching the Surface**

MAKING a permanent record on paper without touching the surface of the paper may be accomplished with an information-modulated light source focused onto a moving strip or disc of light-sensitive paper. Where it is inconvenient or impossible to incorporate a light-tight housing, or where the use of light-sensitive paper is undesirable, some other means for transferring the information to paper must be used.

**Ultrasonic Recording**

A special kind of sono chromotropic paper offers a convenient alternative. It is chemically treated so that portions of its surface which are subjected to high-intensity ultrasonic energy undergo a visible change. Thus, a modulated source of ultrasonic energy could, if sufficiently intense, inscribe information on such paper for a permanent record, and also meet the requirement for a recording head that does not touch the surface of the paper.

This article describes an ultrasonic generator capable of pinpointing two watts of ultrasonic energy for the purpose outlined. In use, the recorder point, which is actually the end of the vibrating element of a magnetostriction oscillator, is mounted in a fixed vertical position slightly above the special recording paper which is continuously moved for time reference.

**Generator Requirements**

An analysis of the problem indicated that a practical frequency for use in this work should lie within the general range of 10 to 30 kc. A study of all the methods of producing ultrasonic vibrations in air indicated that the magnetostriction oscillator has the best possibilities for focusing.

It was estimated that 2 watts of usable energy would be required at the point of focus in order to effect inscription. Under most favorable conditions, the power converted into sound energy is estimated to be only about 10 percent of the electrical energy delivered to the vibrating element of a magnetostriction oscillator. Furthermore, if this vibrating element is provided with a reflector or other device on the end for focusing the energy to a point, only a small part of the input energy, possibly 1 percent will be available at the point of focus. This condition would call for an oscillator having about 200 watts electrical input to the vibrating element.

First a small oscillator was built and its behavior was studied in order to work out the design of a more powerful unit. Based upon this preliminary study, the design was made for a magnetostriction oscillator using an 805 triode to drive a nickel-alloy tube at about 20 kc. The electrical circuit for this power unit is shown in the diagram. The principal elements include the tube, a plate coil, a grid coil and the vibrating element with its mounting.

Experiments disclosed that a 1-to-1 turns ratio between plate and grid coils gives the best results. When the grid turns exceed the plate turns by more than a 2-to-1 ratio, the grid current exceeds the rated capacity of the tube. After several trials, best results were obtained by using 666 turns of No. 25 gage wire wound with ⅛-inch inside diameter one inch long for each of the coils.

**The Vibrating Element**

The vibrating element consists of a thin-wall nickel alloy tube ⅛ inch in diameter and securely mounted in a rigid holder designed for the purpose. This holder grips the tube securely at its neutral point without affecting its mode of vibration. A tube was selected rather than a solid rod because of its superior heat-radiating qualities. In an oscillator of this power, heat dissipation is a serious problem, due in part to internal friction and part to...
Schematic of magnetostriction oscillator with seven operating frequencies between 10 and 20 kc.

End-reflector type vibrating element that led to the discovery of the pencil-shaped type shown in the drawing. Unmounted tube shows slits for cooling and split-collar mounting ring at center.

circulating current induced in the tube by the grid and plate coils. The heating can be reduced considerably by slitting the tube, but this in turn produces a wide band of unwanted frequencies outside the fundamental. A compromise was effected by cutting a short longitudinal slit under each coil and leaving the ends of the tube intact.

When the vibrating element in a magnetostriction oscillator is magnetized by a-c it will vibrate at twice the applied frequency. This results from the fact that the rod will contract on both the positive and the negative swings of the applied a-c. To make the rod vibrate at the applied frequency, a magnetic bias is applied and this should exceed the induced magnetic field. In this oscillator the bias is supplied by the d-c in the plate coil.

The resonant frequency of the vibrating element of a magnetostriction oscillator is determined by the equation \( F = V/(2L) \) where \( F \) is the frequency in cps, \( V \) the velocity of sound in the material in cm per second, and \( L \) the length of the tube in centimeters.

The velocity of sound in nickel varies inversely with temperature. At 32 F it is approximately 4,973 meters per second. Therefore at this temperature the length of a plain nickel-alloy vibrating element with a natural frequency of 14 kc is 17.75 cm. When a concave piston or reflector is attached to the end of the tube the loading results in a lowered frequency. This effect requires a shortening of the tube to raise the frequency to the desired range. For the aluminum reflectors used, the length of the tube is reduced to approximately 12.7 cm.

**Mounting Ring**

For mounting a rod used as a vibrating element, it is customary to pinch it firmly between the tips of three screws extending radially from a mounting ring. However, this method is not sufficient to secure a thin metal tube without deforming it or allowing it to slip. A special mounting was designed as shown in the drawing and photograph. This split brass collar grips the tube firmly and yet permits it to be shifted when the screws are loosened. The photograph shows the assembled driver unit and the vibrating element in its mounting. The shape of the reflectors on each end of the tube is essentially spherical.

Experiments with aluminum pistons in the end of the nickel tube revealed that they absorb an excessive amount of power owing to internal friction. Therefore a reflector was formed from sheet nickel and silver-soldered to the end of the tube. This metal did not absorb so much energy by heating, but tests revealed that the focused energy from this reflector was not as yet adequate for the purpose intended. However, an interesting phenomenon was observed during these experiments.

A nickel tube had been prepared with a conical point, resembling a sharpened pencil. The cone was formed separately in a die and silver-soldered to the tube. When this blunt conical point was located just above the surface of a pan of water, it was noted that when the tube was oscillating, an air blast, issuing from a crack in the seam on the side of the cone impinged upon the surface of the water in the container below.

Another tube was prepared with a No. 80 hole drilled axially in the blunt point. In this cone, the air blast issued from the hole and depressed the surface of the water below. This effect was not the result of temperature-expanded air within the tube since the tube had two slits in the side. Apparently there is a pumping action that causes the tube to expel a jet of air of considerable force, resulting in a much better focusing of energy than was accomplished by other means.

The project which led to the discovery of this unique ultrasonic recording pencil was sponsored by the Office of Naval Research in an attempt to develop new types of facsimile recording paper.
TELEVISION PRODUCTION TECHNIQUES

Ideas for cutting costs, speeding up production and improving quality of television receivers. Featured are conveyor accessories, subassembly jigs and assembly-line fixtures

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The layout of the Du Mont television receiver plant at East Paterson, New Jersey, was aimed at giving maximum value for the customer's television dollar, by improving the ratio of time usefully expended to the time expended on lifting, lugging, carrying, moving and transporting components, tubes, cabinets, subassemblies, work in process and finished goods.

To accomplish this aim, material handling by hand labor was reduced to a minimum, a central signal system was provided and the production lines were mechanized, resulting in many worthwhile production shortcuts and quality insurance procedures.

Conveyor Line Accessories

The 450,000 square feet of production floor space was laid out to give: (1) A continuous flow of materials from receiving to shipping; (2) minimum manual handling of material; (3) powered belt conveyor assembly lines; (4) monorail overhead conveyors for delivery and storage of larger components, subassemblies and chassis units in process.

Console Tilt Table. The spring-actuated table in Fig. 1 and 2 facilitates handling of heavy console television sets during final packing in shipping cartons. When incoming cabinets are unpacked, cartons are opened at the bottom. At the packing position, the carton is placed over the upright cabinet, and the filled carton is pushed off the end of the roller conveyor as in Fig. 1A. In tipping, the carton comes in contact with the roller on the tilt table; the table then tips slowly under restraint of the 100-lb spring to meet the falling carton. After the spring has returned the table to horizontal, the table is rotated 90 degrees as in Fig. 1B for sealing the flaps, then rotated another 90 degrees for tipping the carton back upright onto a skid, on an outgoing conveyor or directly on the floor as in Fig. 1C. Additional 180-degree rotation brings the table in position for the next set. With this table, one man can handle a 320-lb console.

An angle iron backstop, visible in Fig. 2, was added to the original design. As the table returns to horizontal the first time (between Fig. 1A and 1B) the carton rests against this backstop, helping the console to slide or seat itself in the carton.

Each of the gravity roller con-

FIG. 1—Details of spring-cushioned tilt table, and three steps in its use for turning console on side and back up again without damage

FIG. 2—Tilt table in roller conveyor line enables two men or even one to turn carton with 320-lb console on side for sealing of flaps. Here carton is being turned upright again after sealing
Lifting of 60-lb chassis units is eliminated and pedestrian path is provided across roller conveyor lines by using conveyor-topped trolley cars running on floor rails across each end of television receiver aging area. For straitline transfer across gap, sets are pushed across top of car. Sets can be transferred to different lines four at a time by cart, for balancing load into the 12 aging conveyors (at right), or transferred from aging lines into the final test conveyors (at left) after their 2-hour aging at rated line voltage.

**FIG. 3**—Strategic omission of rollers and use of angle-iron stops in roller conveyor speeds and simplifies turning over of table-model tv sets in cartons for sealing of flaps.

**FIG. 4**—Overhead tube conveyor dips down at end of each main assembly line to make picture tubes available exactly where needed. Conveyor also brings tube clamping strip.

**FIG. 5**—Overhead chassis conveyor moves between curved guides that hold platform steady as a chassis is slid on or off. This conveyor eliminates lifting and trucking about 40 tons a day.
veyor assembly lines has adjustable leg supports to allow for a change in work height with different cabinet models. Ball caster plates at intersections and turn-around points in the lines facilitate turning of cabinets during final assembly and inspection. Live roller conveyors parallel to final assembly lines bring cartons and cases from the cabinet unpacking area, eliminating costly manpower in handling light but extremely bulky empty cartons that are used again for outgoing sets.

**Missing-Roller Technique.** In packing a table-model television set as it comes down a roller conveyor, the carton is placed over the upright set as shown in Fig. 3, flaps are spread out, and the carton is pushed forward until the foremost flap drops into a gap formed by leaving out some of the rollers. The set itself next drops into this gap and is turned on end with its carton. The next gap in the rollers receives the forward corners of the carton and the carton makes another 90-degree turn, landing on its top for convenient sealing of flaps. Two more gaps produce two more 90-degree turns for the sealed carton, returning it to an upright position for conveyor delivery to the finished stock area.

**Conveyor Lines**

*Overhead Chassis Conveyor.* Chassis units on which an assortment of parts have been riveted in the riveting section are suspended from a hook on the overhead chassis conveyor by the last riveting operator and are delivered to the start of the main receiver assembly lines, thus avoiding aisle trucking and providing overhead delivery and storage. The conveyor is the conventional I-beam monorail chain and roller type, 736 feet long. It dips three times along its route, to supply each of the three main assembly lines.

*Main Assembly Line Conveyors.* Each of the three main assembly lines is a belt-on-roller type conveyor 18 inches wide and providing 430 feet of moving belt surface. Metal-top tables 20 feet long accommodate all mechanical assembly operations at the beginning of the lines, and similar tables 14 feet long at the ends of the lines provide facilities for tube mounting. Total length of an assembly line is thus 464 feet. All wiring operations are done on these belts progressively; through control of belt speed the movement of the chassis is made to coincide with the prearranged time cycles set by the methods section for assembly operations, reducing the operator holdups common to push-along systems and producing a saving in move time over the push-along schemes.

*Overhead Tube Conveyor.* A 584-foot-long monorail overhead conveyor with picture-tube carriers spaced four feet apart provides a safe storage capacity for 146 picture tubes in otherwise unused space near the ceiling, eliminates the need for unpacking the tubes at assembly-line positions, and eliminates the empty-carton disposal problem. Tubes are unpacked and cartons disposed of at the receiving well where the conveyor is loaded, without using trucking facilities of any kind inside the plant.

As shown in Fig. 4, tube carriers are designed to hold any size of tube from 12 to 20 inches in diameter. The conveyor dips down over each of the three main assembly lines at the picture-tube installation point. Sizes of tubes loaded are in the same ratio as total requirements of the different lines, so an operator never has to wait more than a few seconds for the desired size of tube to come along. A separate hanger over the picture tube carrier brings the corresponding clamping strip for the tube.

*Overhead Chassis Conveyors.* Two overhead conveyors of the type shown in Fig. 5 convey finished chassis units from one part of the plant to the other. One moves units from the assembly lines to the test section. The other transfers the aligned and tested units to the cabinet assembly lines. At each loading and take-off point, chassis carriers move between a metal loading table and a backstop that permits sliding a chassis on without having the carrier swing away. Each
chassis weighs approximately 60 pounds, and would be more costly to transport manually by lifting, loading, trucking and unloading.

Subassembly Jigs

Twisting Tool. Use and construction of a simple tool for twisting together the paired leads of parallel-connected resistors or capacitors are shown in Fig. 6 and 7.

Clamping Jig. The fuse clips shown in Fig. 8 are inexpensive time-saving fixtures for holding long-shaft potentiometers securely while permitting 360-degree rotation during subassembly work.

Lead-Cutting Gage. The simple stepped metal plate of Fig. 9 enables an operator to cut resistor or capacitor leads quickly and accurately to any desired length before assembly. The lead length produced is stamped alongside each notch on the 1/8-inch thick steel plate.

Lead-Cutting Machine. High-speed precutting of capacitor or resistor leads is made possible by the specially designed machine shown in Fig. 10. A counter indicates total output for each run of parts.

Assembly Line Fixture

Easel Stands. Figures 11 and 12 show a simple and sturdy stand for holding cartons of small parts alongside main assembly lines.

Chicken-Feeder Supply Boxes. Resistors, capacitors, lengths of spaghetti, precut leads and any other small components used on assembly lines are conveniently stored in the welded metal boxes shown in Fig. 13 and 14. As operators take parts from the lower opening, more drop down. Loading is conveniently from the top, and each box holds a reasonably adequate supply.

Test Bench. The simple and sturdy all-welded bench design of Fig. 15 and 16 lends itself to eco-

FIG. 9—Universal gage for precutting capacitor and resistor leads to prescribed lengths

FIG. 10—Automatic machine developed by DuMont engineers for precutting leads of components at high speed. Motor-driven chopping blades function in a manner similar to the operation of pruning shears

FIG. 11—Universal welded-metal table for holding and storing cartons of small parts

FIG. 12—Fabricating specifications for carton-holding easel. Rough edges of welds are filed or ground off and top corners are rounded off
nomical fabrication in quantity, provides maximum versatility for use at various television receiver test, alignment and repair positions and is both comfortable and convenient for technicians using it.

A powered metal-slat conveyor brings chassis units to and from test benches on either side. Conveyor height is such as to permit sliding a chassis directly onto the bench.

Picture Tube Holder. Also appearing in Fig. 16 is a standard cathode-ray tube housing developed for bench use and capable of holding either 15-inch or 19-inch tubes. The housing is steel and the face plate is Lucite. Use of a separate picture tube at repair benches simplifies working on the bottom of a chassis during trouble-shooting.

Component Test Sets

Flux Leakage Search Coil. With the setup of Fig. 17 in the component acceptance section of the plant, it is a simple matter to determine whether the stray magnetic field of a new power transformer is sufficient to modulate the picture objectionably by acting on the electron beam in the neck of the c-r tube.

An unshielded 3,000-turn pickup coil is mounted on a special jig that permits placing the coil at the exact center line occupied by the electron gun and moving it forward or backward along this line. In addition, the jig permits rotating the coil in all three dimensions to find the point of maximum pickup. The voltage picked up by the coil is measured and its waveform viewed with a cathode-ray oscilloscope used in conjunction with a voltage calibrator (on top of scope in photo).

By using on the test chassis in turn a number of transformers exhibiting known and different external field effects in receivers, it was determined that about 0.4 volt induced in the pickup coil by the external field of a power transformer may be considered just barely passable. This voltage produces about a 1/8 inch deflection of the picture. All measurements are made with the line voltage set at its upper limit of 129 volts. The search coil technique provides a means of measuring the strengths of the external field at the c.r.t. gun position irrespective of the size or shape of the transformer being considered for acceptance.

When all available transformers exceed the leakage requirement at the distance predetermined by chassis layout, copper banding may often be used around the outside of the transformer to reduce the stray fields at their source. A banded transformer appears disassembled on the bench in Fig. 17.

Cold-Cathode Lighting. Production lines are illuminated as shown in Fig. 18. Though cold-cathode lighting equipment is more expensive initially, it gives lower lamp replacement costs and provides a more uniform intensity of lighting as the tubes do not blacken with age.

Quality in Quantity

There is, of course, much more to a successful quality production job than a fine building, miles of conveyors and various production aids. Engineering prototypes of new models are reviewed by manufacturing and receiver quality control departments, who recommend changes to improve quality and simplify manufacturing operations. Samples of the components on the bill of materials are brought in and given a rigorous test against engineering specifications by the component acceptance section of the receiver quality control department. Only parts approved may be purchased.

Individual operations on the production line are planned after exhaustive motion and time studies have been made on production prototypes of the new model constructed by the manufacturing methods section from the final bill of materials and engineering drawings.

A substantial pilot run is made to reveal any deficiencies in the methods breakdown, to train personnel, and to give manufacturing, engineering and receiver quality control departments an additional opportunity to eliminate bugs in the receiver. Complete type tests are made of each unit of the pilot run by the quality control section of the receiver quality control department.

Field test runs are made on a fully equipped mobile laboratory test bus and as a result, additional minor changes may be recommended. The bus is later used to field-check pilot runs and production models. A hinged antenna mast on the roof can be raised by one man.

The cabinet engineering and receiver quality control departments...
conduct tumbling and drop tests on a few packaged telesets of each model. After careful observations of any resultant damage to the cabinet or teleset components, changes in packaging or teleset construction are recommended to correct any weaknesses which may have been revealed.

The use of any components and materials for pilot or production runs must await approval of these materials by the incoming inspection section, as must the payment of invoices to vendors. Statistical quality control techniques are used to assure high quality in a most economical manner. Representative samples are selected from each shipment in accordance with scientifically prepared sampling plans; lots which fail to pass the sampling plan are returned to the vendor or inspected 100 percent. It is estimated that the use of scientific sampling inspection has reduced incoming inspection labor between 70 and 90 percent while giving a far better control of quality than haphazard sampling.

The subassembly section of the manufacturing department prefabricates about 50 percent of the material which goes into the completed teleset. These subassemblies are subjected to a scientific sampling inspection before being passed on the main assembly lines, where they are wired and soldered into the chassis as the set moves.

At frequent intervals along the main assembly line, a checker-repair operation is done. Defects found by these checkers are immediately reflected back to the responsible line operator. At the end of each production line, there is a 100-percent inspection by the process inspection section. The results are marked on an inspection sheet, and are plotted on a control chart which is posted and published. Defects are tagged by these inspectors, repaired by manufacturing, and reinspected before being put on the overhead platform conveyor which carries the set to the test section. In addition, scientific sampling inspection is made by the product control section before completed chassis units go to test, as a check on the main line assembly and inspection positions. This data again is plotted on control charts which are posted and published.

The teleset test section utilizes standard signals, delivered from the central signal generating room via distribution amplifiers located at various strategic places on the main floor. This central room is air-conditioned, and contains over a quarter of a million dollars of special equipment designed and fabricated by the test equipment design section.

Chassis units entering test first go to the pretest subsection, where they have power applied for the first time and are checked to be sure that each stage is operative and every control functions. Errors are corrected by trouble-shooters and repairmen. From pretest, the chassis is carried on a power-driven slat conveyor to the alignment subsection. Here each is adjusted and aligned by scope, using the signals piped from central.

After alignment, the slat con-

FIG. 15—Standard test bench used throughout DuMont plant. Diagonal panel underneath stiffens entire structure and protects coaxial terminations at left side of bench.

FIG. 16—Top of bench can be either sheet metal or plywood. The combination Lucite-metal holding fixture takes both 15-inch and 19-inch tubes.
veyor delivers the chassis to the aging area where it is run for at least two hours to bring out any latent defects. From aging, the chassis moves to the final phasing position where such defects as may have developed are corrected, and a final tailoring of the alignment is given to insure optimum performance. Each day a number of production chassis units are taken after the final phasing operation to a complete type test laboratory for electrical performance measurement.

From the phasing position, the chassis moves on an overhead platform conveyor to the final cabinet assembly section. At the beginning of each cabinet assembly line, a 100-percent cabinet inspection is performed and any necessary touchup operations are made. The cabinets move on the roller conveyor to the final assembly positions, where the chassis, loudspeaker, changer and hardware are mounted on the cabinet. Each completely assembled receiver is thoroughly checked by the final acceptance inspection section of the receiver quality control department with inside audio wobblulator and video monoscope test signals. Any which fail are trouble-shot and repaired in the next line position and then reinspected. After the teleset has been improved, final cabinet inspection is made, minor cabinet scratches that may occur on the line are touched up, and the receiver is packed and is then ready for shipment to the consumer.

Each day four or five sets of each cabinet model are moved from finished stock into the life test laboratory where each one is given a complete consumer's acceptance test. Accelerated life tests are then given at 129 line volts. The receivers are automatically turned on and off each fifteen minutes for a period as long as 16 hours for some receivers and 250 hours for others of each type. After this life run, another inspection and additional electrical measurements are made. A limited number of receivers are tested on the vibration table and in the heat and humidity chambers as a double check on production. A random selection of receivers is hauled out of finished stock and examined by Dr. Du Mont in his own personal laboratory at Cedar Grove, New Jersey, each week.

The overall philosophy is that it is more economical to make something right than to fix it.

FIG. 17—Chassis fixture for measuring stray magnetic field of power transformers at neck position of picture tube as part of power transformer acceptance test.

FIG. 18—Cross-sections of main moving-bolt assembly line and stationary sub-assembly or incoming inspection lines, with critical dimensions for optimum positioning of overhead cold-cathode fluorescent lights. Lines are usually back to back on common center supports.
Measuring Smoke Density

New sealed-beam bolometer system gives high accuracy, without need for frequent cleaning and recalibration. Lenses, mirrors, lamp and bolometric light detector are sealed in glass, and windows are washed by air. Unique circuit uses null-balance a-c potentiometer.

ONE OF THE greatest obstacles to accurate measurement of smoke is the nature of smoke itself. It coats lenses and lamps of light detectors, resulting in loss of accuracy and high maintenance costs. Dust, fly ash and fog caused by condensation of water vapor in the flue gases contribute further to inaccuracy. Where samples are drawn from the stack or breeching into bypass lines, fly ash and cinders in the smoke tend to cause clogging and result in inefficient, expensive operation.

Often smoke-density measuring devices must be installed in places where high ambient temperatures are common. This creates a problem for devices having receivers which depend on filament temperatures as an indication of density. Theoretically, the filament temperature depends on the amount of radiation reaching it through a column of smoke, but if the surrounding air becomes too hot, inaccuracy will result. In addition, excessive heat may cause rapid deterioration of radiation receivers such as phototubes and self-generating photocells, resulting in frequent replacements.

Moving the smoke detector to a cooler location solves the high-temperature problem but introduces another serious one caused by lower temperatures. In cooler parts of a stack there is a great deal of condensation. Inadequately protected instruments are quickly af-

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ELECTRONICS — April, 1950
ected by the excessive moisture, and severe corrosion results due to presence of sulphur in the flue gases.

In many cases, where the light source and light-sensitive elements are attached directly to a steel smoke stack or breeching serving boiler furnaces, warping creates a serious alignment problem. Any warping or moving of the supporting breeching due to gas temperature changes will result in the light beam being deflected away from the receiving element. This leads to errors or may cause the instrument to cease functioning altogether.

Unless voltage regulators or equivalent compensators are used, phototube-operated smoke-density instruments are subject to large errors when the line voltage fluctuates to any extent. Voltage variations affect the light source and the calibrating equipment as well as the photoelectric amplifier.

Smoke Density Methods

An early method of estimating smoke density, still employed today, is the use of Ringleman charts. Cross-hatched charts having known percentages of their area left transparent are held in the line of vision to the column of smoke. The number of the chart which most nearly matches the smoke is then assigned as an index of smoke density. Naturally this method is greatly limited by sky and wind conditions as well as human errors in judgment. An overcast sky introduces errors which become worse when high winds are present to dissipate the column of smoke as it leaves the stack. The color of particles leaving the stack leads to further errors. The closer it approaches the color of the background sky, the more difficult accurate smoke detection becomes.

A device which has done much to eliminate the guesswork from smoke-density measurement is the bolometer type instrument shown in Fig. 1. It consists of a light source and light detector (bolometer), both of sealed-beam construction, mounted at opposite ends of a length of 4-inch standard pipe. The pipe is inserted across the full width of a smoke stack or duct. It has a longitudinal slot 3 inches wide in the center to provide a passage through which smoke flows. The smoke intercepts a beam of light projected from the light source toward the bolometer. At low densities of smoke the bolometer receives all the radiation from the light source. As smoke increases, the radiation received by the bolometer decreases. These changes in radiation are transmitted to a smoke-density recorder of the electronic type.

Advantages of Bolometer

One reason for the decision to use a bolometer as a smoke-density measuring device is illustrated in Fig. 2. The low efficiency of the thermal resistance-sensitive element of Fig. 2A, open to the atmosphere and without concentration of incident radiation, is obvious. In Fig. 2B the radiation has been concentrated on the sensitive element through a converging lens. Since the lens involves two open surfaces it creates a serious problem of low efficiency due to dirt and dust accumulation.

Reflection of many metals such as silver and aluminum is high in the infra-red region. Advantage may be taken of this property by using an aluminized parabolic reflector as in Fig. 2C to concentrate radiation. In smoke-density measurement, however, this arrangement with its open metallic surface is subject to corrosion by oxygen or sulphur dioxide.

In the arrangement finally adopted, shown in Fig. 2D, the radiation-sensitive element and the metallic reflector are covered with a glass lens and enclosed in a vacuum. The evacuated region not only protects the metallic surface but also increases the sensitivity of the element by eliminating heat losses due to convection and conduction.

Null Balance Circuit

A unique bolometer circuit, shown in Fig. 3, employs an a-c potentiometer which operates on the null-balance principle. The voltage drop across the bolometer receiver is balanced against a reference voltage applied to the slidewire.

To insure greater accuracy, a common source of 115-volt 60-cycle power feeds the light source, the smoke detector, and the measuring circuit. The light source, a 150-watt commercial spotlight, is connected in series with a 10-ohm resistor to reduce filament voltage and insure long life. The smoke detector and measuring circuit are supplied with a potential of 7.5 volts through the power transformer. This potential is stepped down further by the isolating transformer to supply the reference voltage across the slidewire.

The beam from the light source is focused on the bolometer filament which is responsive to the total radiation reaching it. The temperature, and thus the resistance of the filament, varies with the radiation received. The amount of light reaching the bolometer is a function of smoke density. Therefore, the temperature of the bolometer filament as well as its resistance and the voltage drop which occurs across the bolometer are likewise functions of smoke density.

The voltage drop across the bolometer is automatically balanced against the voltage drop across the upper portion of the slidewire by the action of an electronic amplifier and motor control. The motor control is always energized and drives the motor continuously, repositioning the slidewire and recorder until the balance point is reached.
The instrument can be calibrated easily for any desired range of smoke density with the null adjustment and range adjustment shown in Fig. 3. The null adjustment establishes the maximum smoke density to be measured. At this point the voltage drop across the bolometer is at its minimum and therefore the balancing voltage also must be at its low point. In other words, it is at the point where the density of smoke has become great enough to reduce radiation reaching the bolometer to a minimum. To achieve balance the null adjustment is moved until the recorder balances at a reading of 100 percent and the slidewire is at the upper end of its travel. Since 100 percent smoke is not normally achieved, the actual procedure involves turning off the lamp to simulate this condition.

**Adjustments**

The range adjustment establishes the minimum smoke density (usually a clear stack) which will be measured. At this point full radiation from the light is reaching the bolometer and the voltage drop across the bolometer is at its maximum. The balancing voltage drop must also be at its maximum, meaning that the slidewire contact will be at the lower (0 percent smoke) end of its travel. Therefore, to set the point of minimum density at 0 percent, the range adjustment is moved until the recorder balances at a reading of 0 percent smoke. This last adjustment will in no way affect the setting of the null adjustment, which has been set at 100 percent. A fixed resistor is a further adjustment for the system and its value depends upon the distance between the light source and smoke detector.

The temperature-compensating filament shown in Fig. 3 is a sealed-in-glass resistor. Both it and the bolometer are located within the smoke detector housing so that the effect of ambient temperature variations is minimized.

As is quickly revealed by this rough study of the bolometer circuit diagram, it has the distinct advantage of being simple. The light source, smoke detector and the measuring circuit all are supplied with a-c power from the same source, making variations in line voltage self-compensating. No standard cell, dry cell, galvanometer, or d-c to a-c converter are needed, assuring accuracy, stability and permanence of calibration. By eliminating the galvanometer from the circuit and replacing it with an electronic amplifier, a motion-free detecting mechanism is created.

**Maintenance**

Both the light source and the receiver are of the sealed-beam type and are not affected by corrosive gases or dust, thus insuring long life. The radiation-focusing mirror in the bolometer will remain clean and bright indefinitely. Instruments which are not hermetically sealed are apt to require frequent cleaning of condensing lenses and reflectors, but only the front glass on the bolometer and lamp here need attention.

Frequency of cleaning of the bolometer and lamp windows is lessened by air vents on each side of the stack, shown in Fig. 1. A negative pressure in the stack causes clean air to flow through spaced flanges which secure the light source and smoke detector to the pipe, thus preventing dust and fog from reaching the lenses. To make infrequent routine cleanings easier, access doors are provided on each housing.

Excessive smoke usually represents inefficient furnace operation and means that valuable fuel or product literally is being thrown out through the stack. To reduce smoke and insure maximum furnace efficiency, a smoke density recorder can be equipped with contacts to turn on air or steam jets or to sound alarms. For the convenience of operators, smoke density may be indicated on a 29-inch bold scale which encircles the circular recording chart. For permanent records a continuous 12-inch, 24-hour circular chart is usually provided, to give a complete picture of smoke conditions for each day and show the result of any action taken toward abatement.

Today, more than ever before, measurement of smoke density must be accurate and reliable. Smoke is now limited by rigid ordinances in many large communities, while others are considering more severe legislation in the interest of public health and civic improvement.

As integral parts of the communities in which they are located, industrial plants cannot afford to neglect the demands of local smoke abatement committees. Installation of reliable smoke density measuring devices like the bolometer-type instrument not only helps to achieve better community-industry relations, but also permits more economical furnace operation.
Reducing Unwanted in MOBILE

Increasing occupancy of all the mobile service bands requires elimination of spurious and harmonic radiations, often beyond limits normally imposed by FCC. Suggestions are made for improved equipment design including low-pass filtering. A new technique for measuring the strength of these frequency components is described.

PHASE or frequency-modulation transmitters, consisting of a crystal oscillator followed by a phase modulator, a series of multipliers and a power amplifier, may have spurious radiations on any frequency that is an integral product of the crystal frequency. By RMA definition, spurious radiations are any r-f emissions except harmonics of the output carrier frequency radiated by or from the transmitter, other than its specified carrier frequency and modulation products. Harmonic radiations are r-f emissions radiated by or from the transmitter on multiples of its specified carrier frequency. Figure 1A shows the spectrum of a phase-modulation transmitter typical of mobile units available in 1948. The multipliers of this transmitter were two quadruplers followed by a doubler, giving a factor of 32. For the graph shown, the output frequency was 32 mc and the crystal frequency 1 mc. Therefore, there are possible spurious radiations at every integral megacycle but most are so greatly attenuated that they are not detected.

The measurable unwanted radiations consist of a spurious group near the output frequency and also the harmonics, spaced at intervals of the crystal frequency. They are also found at odd multiples of one-half the output frequency because the doubler-driver has only a single tuned-plate circuit. The reason why there is none at 80 mc is not known. Many other spurious radiations would be present here if each quadrupler were not followed by double-tuned circuits. Similar spec-
Radiation
TRANSMITTERS

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Extra are obtained for different multiplication factors, as will later be shown.

Improving Design

Several elementary factors govern the magnitude of the spurious radiations, and the following design features should be incorporated where they are to be minimized:

1. Adequate selectivity should follow each multiplier stage.
2. The multiplication factor for each stage should be held to a minimum.
3. The total multiplication factor of the transmitter should be low.
4. The drive on each stage should not be excessive.

Likewise, where harmonics are to be minimized, the following are important:

1. Adequate selectivity should follow the power amplifier.
2. A push-pull power amplifier will yield lower even harmonics.

Needless to say, shielding is necessary in some instances to reduce undesired coupling and direct radiation.

In order to illustrate the extent of improvement in performance attributable to each of the above design features, data are given for more recent designs. Figure 1B shows the spectrum of a transmitter directly comparable to that of Fig. 1A. The improvement is obtained by reducing the multiplication factor from 32 to 24 by changing the first multiplier from a quadrupler to a tripler, by improving the Q of the double-tuned circuits of the multipliers, by inserting a double-tuned circuit between the driver and the p-a and by increasing the selectivity of the antenna tuning circuit.

Figure 1C shows the spectrum of a narrow-band 25-50-mc transmitter that is identical to the transmitter of Fig. 1B except that the multiplication has been reduced from 24 to 12. Here the multipliers have been changed from \(3 \times 3 \times 4 \times 2\) to \(2 \times 3 \times 3 \times 2\). Note that only the spurious radiations near the output frequency are affected and are improved by approximately 20 db.

Figure 1D shows an additional step in improving performance by inserting a low-pass filter in the antenna cable of the transmitter of Fig. 1C. Only those spurious radiations above 37 mc are changed because the filter has negligible attenuation below that frequency. In this case all radiations are more than 90 db below the carrier.

One additional graph, Fig. 2, shows the spectrum of a 148 to 174-mc transmitter that incorporates these desirable design features to reduce all spurious and harmonic radiations to more than 85 db below the carrier.

Using an Output Filter

The advantage of using a low-pass filter to suppress spurious and harmonic radiations at the higher frequencies rests in its negligible insertion loss, negligible effect on antenna tuning and uncritical adjustment. Several models of the GE type KY4A filter are available having design cutoff frequencies of 43, 62, 118 and 257 mc. A1 yield

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FIG. 1—Characteristics of typical transmitters for 32 mc in 1948 (A); an improved transmitter (B); spurious radiations further reduced (C); transmitter with narrow band filter (4)

FIG. 2—Spectrum of transmitter radiation with crystal frequency X equal to 6.333.3 kc and fundamental radiation at 152 mc

FIG. 3—Low-pass filter used to limit harmonics
The Interference Problem

Manufacturers serving the increasingly lucrative field of mobile radio have shown commendable awareness of interference problems in which harmonics and spurious radiations are a part.

Under the most adverse operating conditions, interference may exist if the spurious radiation has a greater intensity than 125 dbw (db below 1 watt). However, design to meet this goal would be costly. Other methods, such as geographical separation, slightly different crystal frequency or multiplication factor will probably suffice for transmitters meeting the minimum FCC requirements listed below:

<table>
<thead>
<tr>
<th>Maximum authorized plate power input to final r-f stage</th>
<th>Attenuation in db of maximum spurious or harmonic radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 watts or less</td>
<td>40</td>
</tr>
<tr>
<td>Over 3 watts; including 150 watts</td>
<td>60</td>
</tr>
<tr>
<td>Over 150 watts; including 600 watts</td>
<td>70</td>
</tr>
<tr>
<td>Over 600 watts</td>
<td>80</td>
</tr>
</tbody>
</table>

harmonic attenuation of at least 35 db for transmitters operating in their respective bands. One of these having a cutoff of 62 mc is illustrated.

These filters consist of two m-derived sections and one constant-k section. The simplified relations given on Fig. 3 may be used to calculate the values of the circuit elements for the value m = 0.8.

Conventional Measurements

Spurious radiations and harmonics are customarily determined with the transmitter loaded into its normal antenna, and the field strengths of the various frequencies measured and compared. This method has objectionable features. The results cannot be readily duplicated and do not give a figure of merit for the transmitter alone that is usable in specifying performance.

The most objectionable feature of this method is that the antenna pattern is not the same for all frequencies and thus the ratio of the spurious field strength to the carrier field strength will vary greatly with the location at which the measurements are made. Because the input impedance of the antenna varies greatly with frequency the results obtained are both a function of the antenna design and also of the length of transmission line connecting the transmitter to the antenna.

The lossy-line method currently specified for making these measurements, although simple in theory, is not satisfactory in practice. The primary difficulty results from the fact that the attenuation of lossy line rises with frequency so that it becomes difficult to detect harmonics at high frequencies. Suppose a length of RG-21/U lossy line is used to connect the transmitter to the field strength measuring equipment. This line has an attenuation of 60 db at the fundamental frequency of 32 mc; it will therefore have an attenuation of 187 db at the fifth harmonic at 160 mc. Thus, if the 60-db attenuation reduces the fundamental to 100,000 microvolts at the field strength measuring equipment and this equipment is capable of detecting a 0.3-microvolt signal at the fifth harmonic (160 mc), it will be possible to measure a 110-db difference. However, due to the 77-db correction necessary to take care of the difference in attenuation of the lossy line at the two frequencies, it is only possible to measure a 33-db difference. It is clear from this that if the fifth harmonic is only 35 db below the carrier, it will not be detected. Actually, for a satisfactory method of measurement, it must be possible to measure any spurious radiations that are not more than 100 db below the carrier level.

The limitation of the lossy-line method is shown graphically in Fig. 1A. This spectrum of transmitter radiation was measured by the method to be described, and all of those spurious radiations lying completely above the dashed line would not have been found had the lossy-line method been used.

Another problem inherent in all measurements of this type is accentuated in using lossy line. This is the problem of eliminating undesired coupling between the transmitter under test and the measuring apparatus. The voltage being measured between the inner and outer conductor of the lossy line is often small and unless adequate shielding is provided, the amount of signal obtained by undesired paths such as by direct radiation and by conduction along the outer conductor of the line may give readings that are in error by many decibels.

![Model 4KY4A4 antenna filter used to attenuate harmonics](image)

FIG. 4—Test setup for making measurements of spurious radiation

4KY4A4

April, 1950 — ELECTRONICS
The method to be described substitutes for the lossy line an attenuator that has slightly less attenuation at the higher frequencies than at the fundamental. This attenuator is so constructed that it can be mounted in the wall of a double-shielded room. Figure 4 shows how the equipment is connected for making measurements.

**Improved Measurements**

The transmitter under test is connected to the attenuator by means of a length of RG-9/U double-shielded coaxial cable and from there to a flat load or wattmeter that has a constant impedance over the range of frequencies in which measurements are being made. The attenuator construction illustrated in Fig. 5 shows that it will insert only a slight discontinuity into the line as a very short length of the center conductor is used inside the cavity of the attenuator. The secondary (coupling coil) couples to this length of the center conductor and thus a voltage is obtained proportional to the current flowing in the transmission line. The output of the attenuator is connected to the field-strength meter or receiver by a length of RG-22/U balanced, shielded transmission line.

After each measurement, the field-strength meter is calibrated by substituting the standard signal generator for the line coming from the attenuator. Since most generators now available have an unbalanced output, a matching unit is used between the signal generator and field strength meter as illustrated.

**Attenuator Adjustment**

Adjustment of the amount of attenuation provided by the attenuator is made by moving the secondary coil relative to the short input loop. The plunger of the secondary coil assembly is marked to indicate positions of the coil for approximately 6-db steps. These various positions are calibrated against frequency by means of a standard signal generator. Calibration curves for the attenuator are shown in Fig. 6, giving the attenuation between the transmitter end of the RG-9/U and the field-strength meter.

Attenuation decreases with frequency, as would be expected from the nature of the device, making it possible to detect the higher harmonics more easily than the spurious radiations near the carrier frequency.

In addition to the attenuation position marks on the plunger of the secondary coil assembly, the plunger has a mark parallel to the axis so that the proper orientation between the coplanar primary and secondary coils can be retained. To improve the impedance match to the 95-ohm balanced output, an H-pad is inserted between the secondary coil and the plunger output.

Results using the method described above have been entirely satisfactory. With only reasonable care, it has been possible for different personnel to duplicate data within 2 or 3 db, on dates that are months apart and even for spurious radiations that are more than 100 db below the carrier.
SINCE the announcement on June 1, 1949 that the FCC would license stations for operation in the citizens band the commission’s offices have been flooded with requests for more information. It is the purpose of this article to answer questions that are most often brought up.

It seems that many people long to own a radio station. They ask, “Will I be able to get a license even though I know nothing about radio?” The answer is, “Yes, if you are a citizen of the United States and 18 years of age or older.”

The next question is usually, “How do I go about getting a license?” You write to the Federal Communications Commission, Washington 25, D.C., or to any of its Engineering Field Offices, and request a copy of Form 505. At the same time, send ten cents in coin (not stamps) to the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., and request a copy of the “Rules and Regulations Governing Citizens Radio Service.”

Form 505 requires no special information so long as the equipment you are going to use has been type approved by the FCC. If the equipment has been approved then you need only fill in the information that is on the nameplate. This must include the type approval number.

Beware of transmitters offered as “suitable for use in the Citizens Band” that do not have type approval. One example of such a transmitter is the BC-645, available on the surplus market. This set is not type approved and the FCC has not to date issued a license for its use in the citizens band.

One of the reasons the BC-645 gained early popularity was that the FCC did at one time license some of these sets as Class 2 experimental transmitters in order to get some activity started on the citizens band and obtain technical data before the band was officially opened to the general public. However, all Class 2 licenses for this type of service expired November 1, 1949 and none of them will be renewed.

The next inevitable question is, “Has type approval been issued for any set?” The answer is, “Yes.” Type approval CR401 was issued to Citizens Radio Corporation of Cleveland, Ohio, for a camera-type portable set, and many pictures of this set appeared in trade journals. However, none were offered to the general public. Then, early in July, this firm sold their assets to Stewart-Warner Electric Corporation, Chicago, and this firm is making modifications and planning production. The FCC has already issued a new type approval, CR402, for a modified set. However, if the set is further changed or modified before it is released to the public an entirely new type approval will be needed.

Transmitter Requirements

Delay in the sale of manufactured sets brings up a natural question, “Will the FCC license non-type-approved transmitting equipment?” Again the answer is, “Yes, provided it meets the standards set up for equipment in this band.” To meet the standards you must file, with your application for license, information that proves that the equipment is capable of operating as set out in the regulations. If the station is to be operated at a fixed location, then the frequency band 460 to 462 mc may be used by Class A stations. A Class A station may use up to 50 watts plate power input to the radio-frequency stage supplying power to the antenna and must be capable of maintaining a frequency tolerance of 0.02 percent. The communication bandwidth may not exceed 200 kc.

If the transmitter is to be operated in the frequency band 462 to 468 mc, the plate power input must be limited to 10 watts. This frequency band is also allocated for Class B stations which are authorized to use a plate power input to the radio-frequency stage supplying power to the antenna of 10 watts and are all adjusted to operate on the frequency of 465 mc. All operations (including frequency tolerance and communication band) must be confined to within plus or minus 0.4 percent of 465 mc.

For operation in the section 468 to 470 mc the transmitter may be designed for use at fixed locations or as a mobile unit using up to 50 watts power but must have the same frequency tolerance as for units operating in the 460 to 462 mc section of the band.

Since the FCC will not usually test composite units, information must be submitted to show that the transmitter meets the specifications. However, the Commission may require that the equipment or a prototype be made available for tests. Then users of such equipment must forward it to the Commission Laboratory, Laurel, Maryland, for tests. The transportation to and from the laboratory must be at no expense to the Government and all pertinent information must be sent with the equipment.

If you want to use composite equipment you must have a second-class radiotelephone or radiotelegraph license, or better, or have the
This interpretation of FCC rules answers such questions as: "Do I have to be a technician to get a license?" "What manufactured transmitters have been given type approval?" "What must be done to obtain permission to operate homemade equipment?"

Adjustments made by the holder of such license or under the supervision of such an operator who will be responsible for the proper functioning of the station. You must also have a commercial operator's license to service sets. An amateur license is no good for this.

**Operating Rules**

The permissible communications for stations in the citizens band are set out in the regulations as follows:

"(a) Each station in the Citizens Radio Service is authorized to communicate with other stations in this service. Communications with stations licensed under other parts of the Commission's rules or with United States Government or foreign stations is prohibited." This means that, for example, an amateur owning both an amateur station and citizens band station can not use the citizens band station to work his own or another amateur station.

"(b) All communications in the Citizens Band shall be limited to the minimum practicable transmission time. You cannot give long-winded descriptions of the sights as you drive down the road.

"(c) Stations in this band may not be used for any purpose contrary to Federal, State or Local law; or to carry program material of any kind either directly or indirectly to the public through public address systems or by any other means." In other words, you cannot use your citizens radio service equipment to relay race results for rebroadcast over a p-a system outside the track, you cannot charge Mrs. Jones for relaying a message to her husband, and you cannot have little Mary sing for the neighbors.

"(d) A Citizens Radio Station used for radio control of devices or objects shall not be used where its operation involves continuous radiation of energy by the station for operational control of such apparatus." This means that if a tone-modulated signal is used to provide separate control functions for model planes, boats or other similar devices, the carrier cannot be left running. It must be started and stopped with the tone.

"(e) A Citizens Radio Station used for the purpose of communication by radio telephone shall not emit a carrier wave unless modulated for the purpose of communication, and when using telegraphy, radiation of energy shall not occur except when telegraphic signals are being transmitted, excepting for brief tests or when adjustments are being made on the transmitter." In other words, you cannot leave the carrier on while you talk on the telephone or to let the neighbors hear the brawl you are staging.

An unusual method will be used to identify stations of the citizens radio class. The registered serial number appearing on each citizens radio station license will be the call signal assigned to the station. A station must transmit its call signal at the beginning and at the end of each communication as well as once each ten minutes during communications of more than ten minutes duration. Stations being used solely for the control of devices or objects are not required to identify transmissions.

The frequencies used in this service are available on a shared basis only, which means that in areas where a number of sets are operating there may be some heavy interference. The users of the service are expected to cooperate in obtaining the most effective use of the frequencies. The transmitters must be under control of the licensee at all times. This does not mean that the wife, husband or children of a licensee cannot operate the equipment when the licensee is not physically present. In the case of other members of the family or employees of the licensee operating the equipment it must be under the control of the licensee.

**Intended Uses**

From the foregoing it will be seen that the Citizens Radio Service is designed as a private short-distance radio communication, radio signaling and radio control service with minimum licensing requirements. It definitely is not a band for experimenters and the circuits may not be changed from the circuit originally licensed without permission of the FCC. However, the FCC does not care what you do to the receiver so you can experiment all you want in that direction. No information on the receiver is required in filing for license.

At first glance the requirements look rather stiff but the transmitter described in ELECTRONICS for November, 1947, is a good starting point if you want an f-m transmitter. Another idea is to use a-m, starting with a crystal oscillator and multiplying to 460-470 using tubes of the 6J6 type as push-pull triplers or push-push doublers. Amateurs using similar equipment and high-gain arrays have worked distances in excess of 200 miles using 420 mc. Activity on the citizens band may show similar results.

When Mr. Conner's article was received the editors of ELECTRONICS relayed it posthaste to the Commission for comment.

Back it came with just a few additions and changes, which have been included here.
OPTAR—A New System of Optical Ranging

Photoelectric exploration of images formed by lens reveals location of objects over short ranges. Applications include a wide range of optical controls, including automatic camera focusing, infrared “radar”, and devices to guide the blind.

An ingenious combination of optical and electronic principles was described recently before the New York section of the IRE by H. E. Kallmann. The system, known as optar (“optical automatic ranging”), makes use of a lens, a light-chopper, and a high-sensitivity phototube to explore space for illuminated objects, much as radar explores space for reflecting objects. Unlike radar, however, the optar principle is suited for exploration over short ranges, from a few inches to a few hundred feet, depending on the focal length of the lens.

The applications include optical controls, such as an automatic focusing attachment for movie and television cameras, short-range radar detection using infrared radiation, and guidance for the blind. The latter use was the first to be developed in detail by Dr. Kallmann, who demonstrated a portable ranging device which locates the position of illuminated objects and translates their positions into audible signals.

The Optar Principle

The basic principle of the optar system is shown in Fig. 1, which illustrates the conventional action of a lens. The objects in front of the lens, \( h_1, h_2 \), occupy positions at distances \( a_1, a_2 \) from the center of the lens system. Corresponding to the objects are images \( i_1, i_2 \) at image distances \( b_1, b_2 \). So long as the objects are located further from the lens than the focal length \( f \), a separate real image is formed for each object \( h \). It is possible, therefore, by exploring the space on the image side of the lens, to locate the image and to translate the image distances into the corresponding object distances.

The translation process is illustrated in Fig. 2, in which the image distance is shown for corresponding object distances, each expressed as a multiple of the focal length. This figure reveals that the separation of the images decreases roughly in proportion to the square of the object distances. It follows that ranging by this system is most accurate at short distances, i.e., within 200 times the focal length of the lens. At greater object distances the images fall so close together (near the focus of the lens) that it is difficult to separate them.

The essential problems are: (1) to determine the position of a single image, and (2) to explore the image space systematically for all the images it contains. These problems are solved by an ingenious light-chopping technique. The process consists of moving a series of parallel opaque bars (like the teeth of a comb) across the image space of a wide aperture lens. In consequence of the motion, the light passing through the teeth is modulated at a frequency equal to the number of bars per second.
Power consumption: 90 milliwatts

In the extraordinary blind-guidance device developed by Dr. Kallmann as his first application of the optar principle, the following items are included: A wide-aperture lens, a light chopper driven by a 1350-rpm motor, a 931-A photomultiplier tube operating at 1,000 volts. The only power source is a single standard flashlight cell operating at 60 ma, good for 100 hours continuous use!

Thus far we have considered a sharply defined image of an object occupying a small part of the field of view. When an extended object is viewed, the optar device operates on the differences in the brightness of various parts of the object. No modulation whatever occurs when an area of uniform brightness occupies the whole field of view, except the random noise component of the steady photoelectric current.

The more details are present in the image analyzed by the chopper, the more likely will be the modulation components, caused by each, to cancel each other. For random distribution of object details, the extent of the mutual cancellation must be studied by statistics, complete cancellation being the most probable result. But the fact that the probability curve has a definite width, indicates that incomplete cancellation also has a definite probability. At present, optar devices utilize only the incompletely cancelled modulation signals, which are necessarily of small amplitude.

Since the modulation signals are weak, it is necessary to maximize the signal-to-noise ratio, and this brings up the question of how large a portion of the total field of view should be intercepted by the phototube. Analysis shows that the signal-to-noise ratio of the device is independent of the interception area. This follows from the fact that both the signal and noise component increase as the square root of the number of small dark and bright areas comprising the image.

**Differential System For High Precision**

The precision with which the optar system can measure distance depends on the shape of the curve shown at the bottom of Fig. 3. For precise range measurements a differential form of the system, shown in Fig. 4, may be used. In this case, two combs are used. These occupy parallel planes and are separated a small distance along the optic axis. When centered, one comb passes slightly behind the image, and the other thereafter passes an equal distance in front of the image. The two successive a-c components are effectively subtracted, by rectification and passage through a d-c meter whose polarity is reversed as the back and front combs interchange positions. Thus two curves, like that in Fig. 3, are subtracted and a differential curve, identical in principle to that of the discriminator detector, results.

When the two combs are positioned an equal distance in front of and behind the image, the net re-
sponse of the d-c meter is zero. Thus, the broad maximum measurement is replaced by a null measurement, and correspondingly high precision can be obtained. The disadvantage of the differential scheme is that the range of image position over which the device can operate is limited to the straight slope in the middle of the discriminator curve.

The differential system can be used for precise optical control, as in automatic focusing of cameras, by the circuit shown in Fig. 5. Here two disks, carrying the comb segments, are rotated by a motor through the image space. The resulting a-c components are separated into two paths, by a gating signal synchronized with the motor. The two separated a-c components, corresponding with the respective comb segments, are rectified and applied to opposed field coils of a servo motor. The motor then rotates whenever the pair of comb segments is not centered about the image plane, and the rotation may be used to control the position of the lens until the centered condition is regained. Thereafter, the motor moves to follow any change in the position of the object. This is precisely the action required for automatic focusing of motion picture or tv cameras.

The device may also be used to control machine tools in terms of the changing position of an illuminated surface or index mark.

**Optar For Guidance of the Blind**

The first device built by Dr. Kallmann on the optar principle is the guidance device illustrated in the accompanying photographs. In order to operate the device as one would use a flashlight, it must be small, both in size and in power consumption. Economy in power consumption is a prime requisite for such a guidance device. Dr. Kallmann has succeeded in reducing the power supply to a single flashlight cell, operating at a current drain of 60 ma, or a total power output of 90 milliwatts. The fact that a photomultiplier, motor and audio stage can be operated from this minute energy source is one of the noteworthy achievements of the design. Simplified mechanical and circuit schematic diagrams are shown in Fig. 6. Included in the device are the lens, a push-button which opens the lens aperture and operates the power switch simultaneously, and a motor driving a disk on the periphery of which is carried a film printed with comb segments as shown in Fig. 7. The film is fitted to the disk in spiral fashion, so that, during each revolution of the disk, the plane of the comb travels once throughout the image space of the lens.

The light passing through the comb is collected by a 931-A multiplier phototube. The ten stages are operated at 80-120 volts per stage. With increasing illumination, the current drain on the power supply causes all voltages to drop. This reduces the amplification so the output increases approximately as the logarithm of the ambient illumination. It follows that the amplitude of the modulation at the output is a measure only of image detail, but independent of ambient illumination. Therefore, no gain control is needed. The background noise, decreasing with the square root of ambient illumination, determines the minimum light requirement. The present model will operate with less than one footcandle of ambient illumination.

Any tone heard in the headphone indicates the presence of an illuminated object possessing some degree of optical contrast. The spacing of the opaque bars on the film is decreased in 8 steps, as shown in Fig. 7, and the frequency of the modulation increases correspondingly. As a result, the pitch of the tone heard indicates the range of the object, in 8 zones covering a total distance range of 1.5 to 20 feet. The shape of the curve in Fig. 2 causes the depth of each zone to become smaller, the closer the zone is to the lens. Thus, the sightless person is given more precise range on nearby objects, as required for his convenience and protection. The construction of the device is shown in the photographs. The current

![FIG. 5—Practical setup of differential ranging device, arranged to control motor and suitable for automatic camera focusing](image)

![FIG. 6—(A) Mechanical arrangement of blind-guidance device. (B) Simplified schematic. This circuit operates with 90 milliwatts of primary power](image)
model weighs two pounds and measures 3 by 4 by 5 inches. Dr. Kallmann states that a model weighing only three-quarters of a pound measuring about 1½ by 2 by 4 inches can be built.

The motor is a split-field commutator type, having a two-pole armature of alnico. It operates at 22.5 revolutions per second at 1.5 volts, 15 ma, and has very good speed regulation, as is required to provide constancy of pitch in the audible signals. Carried on the shaft of the motor is an interrupter which operates at 22.5 cps. This applies a pulsating current to a miniature power transformer which develops about 100 volts a-c across its secondary. The high-voltage power is developed by a ten-stage voltage multiplier, consisting of a stack of miniature selenium rectifiers and appropriate capacitors and resistors, as shown in Fig. 6. The first stage of this multiplier also feeds into the audio output stage, the filament of which is connected to the flashlight cell. An a-c power output of about 0.2 milliwatt is fed to the headphone. The rotating drum carrying the comb segments is driven by the motor through a 72 to 8 gear reduction, so the drum speed is 2.5 revolutions per second. The comb segments are laid out (Fig. 7) in eight 45-degree sectors. The frequency of the a-c component (the rate of passage of the bars) varies from 600 to 2,000 cps. The comb is so arranged that the highest pitch is produced in the nearest zone.

The person using the guidance device quickly learns to associate a given series of tones with a corresponding arrangement of objects in front of him. Since the device scans only in depth, it is desirable to move the instrument slowly from left to right, to distinguish the lateral edges of the objects detected.

The choice of the number of zones, the frequencies of each, and the rate at which the tone sequence repeats itself, have been chosen as compromises between precision of ranging on the one hand and flexibility of use on the other.

Figure 8 illustrates an optar device which explores the image space in the manner just described and is intended to provide an indication of distance together with power for actuating a control. In this case the comb segments are equally spaced, and a fixed "carrier" frequency is produced as each image is passed through. A low-pass filter passes the envelope of the carrier frequency only. Synchronized with the motor drive is a "range gate" generator which allows the envelope to pass only if it occurs within a given time (caused by an object at a given distance). Thus, unwanted signals, such as arise from a face in the foreground, may be excluded. The envelope passed triggers a thyratron which actuates a control and an indicator calibrated in distance. A quenching pulse causes the thyratron to cease conduction and it remains inactive until the next signal envelope passes the gate circuit. Since, in this case, the ear is not the frequency limiting factor, complete ranging may be repeated as often as a thousand times per second.—D.G.F.
Simplified Intercarrier

Reduction in number of tubes and tuned circuits is provided by application of the gated beam 6BN6 to the intercarrier sound system of a receiver. Suppression of a-m compares favorably with other f-m detectors as does suppression of ignition interference.

INTERCARRIER SOUND claims a few advantages over the conventional system in the overall operation of the receiver as well as in the initial design.

The most important benefit of the system is the oscillator stability requirement. The sound subcarrier is dependent only upon the beat between the sound and picture carriers and not the local oscillator frequency, excessive drift of which cannot be tolerated in the conventional system. The trend toward the use of 40-mc i-f makes intercarrier sound extremely attractive since 4.5-mc is far easier to handle than 40-mc, especially in the design of the discriminator or ratio detector transformers.

Keen competition in the manufacture of television receivers demands the utmost in economy and simplicity. With the development of the 6BN6 gated beam tube by Robert Adler of Zenith and its subsequent mass production by the General Electric Company, an intercarrier sound system embodying increased simplicity and economy can be realized.

In the typical intercarrier receiver, the sound and picture carriers are amplified in a common i-f amplifier. The 4.5-mc beatnote between and sound and picture carriers is detected at the second detector and usually amplified, either in the video stages or separately, before it is separated and fed into an f-m detector. Since the frequency of the beatnote varies directly as the sound carrier, the output of the f-m detector contains the audio modulation of the sound carrier. The audio signal is then fed to a conventional audio amplifier system.

The biggest design problem is to minimize the incidental amplitude modulation of the 4.5-mc beatnote. This problem arises because even the best f-m detector circuits do not suppress a-m entirely. The most important step in this direction was taught by L. W. Parker and R. B. Dome. Through the video i-f channel the bandpass must be shaped so that the level of the sound carrier is approximately 20 db below the peak picture carrier level at the second detector.

A video i-f bandpass characteristic to accomplish this desired sound-to-picture ratio is shown in Fig. 1. The 6-db bandwidth is about 3 mc. It would be desirable to have a narrow shelf in the i-f bandpass at the sound carrier so that no slope detection of the sound carrier would occur. This is indicated by the dashed-line curve. The shelf costs an extra tuned circuit, however, and it has been found unnecessary if the slope of the i-f curve is not too steep.

If the sound carrier level is 6 db below the minimum picture carrier level, the amplitude of the beatnote in a linear detector is substantially unaffected by picture carrier amplitude. However, at low levels where the detector is operating according to a square law, the beatnote amplitude varies greatly with sync and video modulation. Therefore, it is desirable to operate the detector at a high enough level so that detection is substantially linear. The detector output level varies from approximately 1.5 to 5 volts between various makes of receivers, assuming a signal strong enough to produce a picture of reasonable entertainment value. For marginal and submarginal reception, the detector level is frequently only a fraction of one volt.

Obtaining the proper sound-to-picture carrier ratio at the second detector is just the starting point in reducing the amplitude modula-
tion. Any nonlinear amplification or overload in the i-f stages or in the video stage will introduce an a-m component on the 4.5-mc beatnote. In the video i-f chain, the last stage is most likely to overload. When overload occurs, the gain of the sound carrier varies with video modulation. To reduce overload possibilities, the last transformer in a stagger-tuned i-f system should be tuned to the picture carrier side, and all the damping of the stage should be produced by the diode. In so doing, the grid swing required of the last i-f is minimized.

Another place for incidental amplitude modulation to occur is in the video amplifier stage. The video amplifier is a high-level amplifier and must operate with a large grid swing. The transconductance of the stage as a 4.5-mc amplifier will vary with video and sync modulation, especially when the grid is driven hard. This variation causes amplitude modulation of the 4.5-mc beatnote.

If the envelope of the 4.5-mc signal is observed, one would notice that indentations in the 4.5-mc envelope occur during the vertical sync pulse periods. The shape of the indentation would look exactly like the vertical blank and sync pulse.

The depth of the indentation or the percentage of downward modulation is determined by the degree of transconductance change of the video amplifier as the sync pulse drives the grid toward cutoff. For example, in some intercarrier receivers a raspy buzz is produced in the sound when the contrast control is advanced. In these receivers the contrast control is located ahead of the grid of the video amplifier and overload of the amplifier has occurred as a result of being overdriven.

**Intercarrier Buzz**

Even though all the proper precautions to minimize amplitude modulation of the 4.5-mc beatnote have been taken in the design of the intercarrier receiver, it is subject to buzzy sound due to transmitter operation. If a transmitter is 100-percent modulated during the white portions of the picture, there will be frequent intervals in which the picture carrier level at the second detector will be zero; and, hence, the 4.5-mc beatnote amplitude drops to zero. The result, of course, is 100-percent amplitude modulation of the 4.5-mc signal, causing what is termed intercarrier buzz.

With a conventional sound system, 100-percent modulation of the picture transmitter does not affect the sound. It is hoped that the broadcasters will soon realize that intercarrier type receivers are becoming a substantial portion of the total number of sets in use, and that they will govern their operation accordingly by limiting the modulation percentage of the picture carrier to 85 or 90 percent.

Figure 2 shows the schematic diagram of an intercarrier sound system of a typical receiver.

The 4.5-mc beatnote is selected from the plate of the video stage by a resonant circuit and is fed to a ratio detector driver tube. The amplified signal is fed into a conventional ratio detector circuit using a 6AL5. The audio output is fed to an amplifier stage and then to a power output stage driving the loudspeaker. The portion of the circuit enclosed by the dotted line can be replaced by one tube, the 6BN6, and two single-tuned circuits.

The circuit of Fig. 3 is used in a few commercial receivers. Here the beatnote is taken off at the second detector. The 4.5-mc signal is amplified in two driver stages to make up for the gain lost by not utilizing the video amplifier.

The signal is demodulated in the conventional ratio detector and the audio output amplified in the conventional manner. Again the portion of the circuit enclosed by
dotted lines can be replaced by a single 6BN6 tube.

Figure 4 is a block diagram of an intercarrier sound system utilizing a 6BN6 tube. For a tube to perform in this circuit arrangement, it must be a good limiter with a high limiting sensitivity, and it must be an f-m detector with sufficiently high audio output to drive a power stage directly. The 6BN6 gated beam tube fulfills the above requirements.

The schematic of Fig. 5 shows the 6BN6 in an intercarrier receiver performing the functions of a limiter and a discriminator.

The 4.5-me beatnote from the plate of the first video stage is selected by a transformer whose primary is tuned to resonance at 4.5 mc and whose secondary is untuned and closely coupled to the primary. The first video stage is safe to utilize as an extra gain stage in this circuit because it is operating as a linear amplifier. Also the maximum output of the second detector is limited by agc circuits and the contrast control is located in the second video stage. Therefore the possibility of the first video being driven into an overload condition is eliminated.

The 4.5-me signal is coupled to the grid of the triode amplifier stage through a small capacitor. This triode amplifier is not neutralized and is highly degenerative by virtue of the voltage feedback ratio determined by the grid-plate capacitance and the 10-μF coupling capacitor. Its gain is approximately six. In the plate circuit of the triode is a single-tuned step-up transformer tuned to 4.5 mc. The step-up transformer is placed in the grid circuit so that the grid has a low d-c resistance to ground as required by the 6BN6. The B+ choke has a high impedance at 4.5 mc.

The amplified 4.5-me signal is fed to the limiter grid of the 6BN6 at a level of approximately 5 volts rms. The exact level depends upon the output from the detector, the sound-to-picture amplitude ratio of the transmitted signals, the attenuation of the sound carrier in the i-f amplifier and upon the gain factor of the amplifier stages.

The gain required in the amplifier stage or stages between the detector and the limiter grid of the 6BN6 depends not only upon these factors but also upon the weakest signal or minimum detector output for which satisfactory sound is expected. For instance, assume 0.5 volt for this minimum level. With the sound carrier 20 db farther down, it has an amplitude of about 18 millivolts rms; to bring this up to the limiting level of 1 volt rms requires a gain of 55 times or 35 db.

The circuit shown in Fig. 5 provides a gain of 43 to 46 db. A number of circuit arrangements is possible. Utilizing the video stage should be done with caution, guarding against possible downward modulation. A single pentode amplifier stage between the second detector and the limiter grid might be preferred and would provide sufficient gain.

**A-M Suppression**

One of the most important characteristics of an f-m detector is its ability to suppress amplitude modulation. In this limiter-discriminator circuit using the 6BN6 the audio output is taken directly from the anode so that amplitude modulation may slip through as a result of spurious plate-bend detection. This tendency is minimized by careful adjustment of the limiter grid bias.

The plate current-grid voltage curve of the 6BN6 resembles a step-function characteristic having an upper and lower knee. If the grid is biased too highly negative, plate-bend detection occurs at the lower knee and the average plate current tends to rise with increased signal. If the grid bias is not negative enough, plate-bend detection of the reverse kind occurs at the upper knee and the average plate current drops with increased signal.

There is an optimum grid bias at which the plate current will stay constant with increased signal. This grid bias point coincides with best a-m rejection. An adjustable control rather than a fixed resistor is placed in the cathode of the 6BN6 to obtain optimum bias because of tube tolerance variations. When the circuit is properly adjusted, the a-m suppression compares favorably with other f-m detectors in commercial use, and the gated beam detector appears to have the edge in suppression of ignition interference where other circuits are burdened by time constants.

The circuit does not contain a balanced transformer that requires critical adjustment. If the signal impressed upon the limiter grid were 30 percent a-m and 30 percent f-m, modulated simultaneously, the a-m audio component appearing in the audio circuit would be at least 20 db below the f-m component. This holds true for levels of input signal above approximately 1 volt, well below normal.

As a result of the quadrature voltage developed across the tuned circuit in the second grid, f-m detection takes place and the audio information is developed across the 220,000-ohm load resistor.

**Discriminator Bandwidth**

Figure 6 shows typical discriminator response produced by the 6BN6 with a 4.5-me center frequency. The most conspicuous difference between this curve and the one for a conventional discriminator is the absence of any sharp curvature beyond the range of
normal signal deviations. The harmonic distortion for 25-kc deviation is approximately 2.5 percent.

The bandwidth of the usable portion of the discriminator curve is proportional to the bandwidth of the quadrature circuit. Higher L-C ratio in this circuit results in a broader curve. Further broadening can be obtained by damping the quadrature circuit with a resistor but this results in impaired audio output and poorer a-m suppression.

The bandwidth can be increased by a better method used in this circuit. A small resistor (680 ohms) is inserted between the anode and the bypass capacitor. The insertion of this resistor has two effects: it damps the quadrature circuit but also supplies more energy to it. As a result, the voltage across the quadrature circuit will stay constant or even rise while the bandwidth is increased. Good audio output and improved a-m suppression result.

The plate bypass capacitor provides the correct amount of de-emphasis.

The stability of the quadrature circuit is important. It should not have excessive frequency drift with temperature and humidity changes. The fixed tuning capacitor across the quadrature circuit, therefore, has a specified temperature coefficient.

Output

The audio output which can be obtained with low distortion is largely a function of the plate supply voltage. In this circuit there is 160 to 170 volts available, and with full 25-kc deviation 15 volts rms audio output is normal with approximately 2-percent distortion. With higher plate voltage and a smaller damping resistor, it is possible to obtain 20 to 25 volts rms audio output with a harmonic distortion of 3 to 5 percent for 25-kc deviation.

With this level of audio output, the usual audio amplifier stage can be omitted and the detector output fed directly into the power tube.

If the transmitting stations could be counted upon to maintain their audio modulation percentage above 30 percent of 25 kc, a 6K6 power tube could be driven to practically full output. But to take care of those times when the percentage modulation of the sound carrier is extremely low, we have chosen to use a 6AG7 power output tube because of its high power sensitivity. A 6V6 or a 25L6 would be sufficient in most cases.

Only three adjustments are necessary. The step-up transformer is tuned for maximum 4.5-me signal at the limiter grid. The quadrature circuit is tuned for maximum undistorted audio output, and the bias control in the cathode of the 6BN6 is adjusted for maximum a-m rejection.

The intercarrier sound system described has been designed for use in a receiver of highest quality with performance comparable to conventional sound type sets. For receivers where cost is a major consideration, the triode 4.5-me amplifier may be eliminated by extracting the beatnote from the video amplifier and applying the signal directly to the limiter grid of the 6BN6 through a suitable coupling transformer.

The exact amount of intercarrier gain required between the video detector and the limiter grid of the 6BN6 depends, as has been pointed out, on the sound-to-picture carrier ratio produced in the i-f channel, and on the lowest video signal level at which satisfactory sound is expected. We have found that it is not at all hard to obtain gains of 35 db at 4.5-me in a pentode video stage by using good circuitry to separate the intercarrier signal from the video frequency band. The main problem remaining in such a circuit is the necessity of avoiding a-m modulation of the 4.5-me beatnote by the video signals due to overload in the video stage. This is most easily taken care of if the maximum video level is limited by automatic gain control circuits.

The author is indebted to Robert Adler for his valuable assistance and direction in adapting the 6BN6 as the limiter-detector of an intercarrier sound system. He is also indebted to Nathan Aram for his help in the preparation of this paper.

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Synthetic Crystals at Ultrasonic Frequencies

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Synthetic crystals possess characteristics that compare favorably with quartz, particularly in the frequency range of 10 to 150 kc. Their greatest limitation, dependence of operating frequency on temperature, is often counter-balanced by their softness and ease of handling. Relatively few experimental applications require stability greater than that offered by either the ammonium dihydrogen phosphate or Rochelle salt synthetic types.

Little has been published on the handling and in-use characteristics of these valuable circuit elements. This paper is intended to present a picture of recent developments and techniques, and to acquaint the reader with the inherent limitations and advantages of synthetic crystals.

Many of the problems encountered in quartz crystal work are paralleled in dealing with synthetic crystals. In both cases, the ratio of physical length to width must be considered. To reduce the effects of width resonance and side loading, the thickness should be $\frac{1}{2}$ to $\frac{1}{4}$ the width, the larger ratio being used for the higher frequencies.

Physical Dimensions

Figure 1 is a graph for computing the physical dimensions of ADP and RS crystals for specified frequencies. The width-to-length ratios are plotted against an arbitrary $X$ that can be used in the formula $L = X/f$, where $L$ is the length of the crystal in inches, $X$ is determined from Fig. 1, and $f$ is the resonant frequency of the crystal in kc.

A synthetic crystal bar larger than that required can be reduced to the desired dimensions by sanding the ends and sides with ordinary fine sandpaper. It is advisable to polish the sanded edges with clean cloth moistened with some solvent such as benzine to insure the removal of oil, moisture and crystal dust. Water should not be used, since synthetic crystals are water soluble. A satisfactorily cleaned crystal will measure better than 10° ohms d-c resistance.

The contacts consist of a 0.0050-in. silver foil bonded with a 0.0005-in. thick joint of Bakelite cement. Electrical contact is most satisfactorily made by pressing a foil tab against the crystal foil at the node.

The attachment of the crystal to the mount is critical in determining whether the crystal will oscillate or not. It is the mounting technique that enables the high Q of the crystal to be realized.

Several types of suspension have been tried. Comparative results indicate that the type shown in the accompanying photographs not only permits the highest Q, but also affords the greatest mechanical strength. Holes are drilled through the crystal along the nodal line, which runs across the center of the crystal bar at the point of minimum mechanical motion.

If the crystal is less than $\frac{1}{2}$ inch in width, only one hole in the geometric center of the foil is required. When the width is from $\frac{1}{2}$ to $\frac{3}{4}$ inch, two holes should be spaced from $\frac{1}{4}$ to...
Properly prepared ammonium dihydrogen phosphate and Rochelle salt crystals offer certain advantages over quartz in some applications in the frequency range from 10 to 150 kc. Softness and ease of handling frequently offset their comparatively large, but predictable, dependence on temperature.

to ½ inch apart, and crystals wider than ½ inch should have three or more holes spaced ½ inch apart. Several sizes are shown in the photographs.

Synthetic crystals are soft enough that holes may be drilled through the crystal with an ordinary twist drill. Proper clearance is maintained if the hole is about 0.001 inch larger than the rod used for supporting the crystal. Nylon rods 0.025 inch in diameter have proved quite satisfactory in that they form a secure yet compliant support. A plastic tubing should be placed on the rods and mounted against the crystal to serve as a spacer between crystal and case. The rods then run through corresponding holes in the case. These holes serve both to center and support the crystals as shown in the closeup photograph. The electrical contact foil is secured by mounting it on the plastic rod between the crystal foil and the plastic spacer.

**Crystal Circuits**

Several tuned series-resonant oscillator circuits are shown in Fig. 2. From these circuits, one might expect a very good wave form. The distortion level as measured on a General Radio distortion and noise meter is below 0.3 percent and is within the error range of the measuring instrument. The disadvantage in a tuned circuit is the change of circuit constants required for each crystal.

A series-resonant circuit suitable for wide-band application is shown in Fig. 3. This circuit will oscillate with any high-Q crystal whose resonant frequency lies between 10 kc and 150 kc. By balancing the d-c properly through the two tubes, it is possible to regulate the gain in such a manner that changes in B voltage cause negligible change in frequency. By reducing the gain of the system, it is possible to reduce the mechanical motion of the crystal to the point where oscillation is just maintained. This process reduces internal heating of the crystal and is very important in maintaining constant frequency.

The simplicity of a resistance-coupled circuit, using a synthetic crystal, is illustrated in the small photograph. Ordinarily the batteries will be replaced by a power supply. From this circuit, an output voltage of 1 volt rms can be expected when a light drive is used. With heavier drives, it is possible to obtain as much as 15 volts of clean signal.

The maximum safe current that can be handled by the crystal is limited to the maximum elongation possible before rupture. This current I can be calculated for any bar expander since $I = \frac{e b V Y}{c}$ where $e$ is the piezo-stress constant, $b$ the breadth of the crystal expressed in centimeters, $V$ the phase velocity of sound, $Y$ the breaking strain in the direction of elongation, and $I$ is expressed in electrostatic units.

<table>
<thead>
<tr>
<th>Crystal</th>
<th>I (ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-cut quartz</td>
<td>24 b</td>
</tr>
<tr>
<td>Y-cut RS</td>
<td>3.5 b</td>
</tr>
<tr>
<td>Z-cut ADP</td>
<td>10 b</td>
</tr>
</tbody>
</table>

The preceding tabulation gives a comparison of current between several crystals in terms of the width of the crystal. Again the thickness is not a factor in determining crystal parameters.

**Frequency Stability**

Experimental information on Rochelle salt and ammonium dihydro-
gen phosphate crystals indicates temperature is the greatest influencing factor in frequency stability. Variation in frequency with respect to temperature is linear in the range 25°C to 35°C. On the basis of the experimental figures and curve fitting, a formula was derived to permit the determination of change in frequency with change in temperature for both types in the range 10 to 150 kc. Results for both ADP and RS crystals are represented satisfactorily by

\[ F = (0.0236 f_0 + 1.8)^2 \]

where \( F \) is the change in frequency in cycles per degree centigrade, and \( f_0 \) is the resonant frequency in kilocycles. The data indicate one can expect a frequency stability within ±1 cycle when the temperature is maintained within 0.1°C in the range below 50 kc. The greatest instability occurs at 150 kc where the resonances might be expected to change about 3½ cycles per 0.1°C change in temperature.

The next important factor limiting stability is the oscillator to which the crystal is attached. Experimental data have shown that when the circuit in Fig. 3 is balanced for dc, it is possible to change the B voltage over a range of 2 to 1 with a corresponding change in frequency of less than one cycle per second. Change in filament voltage of 16 percent will cause a frequency shift of about one cycle per second on a high frequency crystal.

From the information given here, it is possible to predict any frequency in the range 10 kc to 150 kc within ±10 cycles at 24°C.

**Typical Example**

Suppose, for example, that we wish to design an ammonium dihydrogen phosphate crystal for a 30,000-cps oscillator, and we choose a width-to-length ratio of ¼. Interpolating on Fig. 1, for \( W/L = 0.333 \), we find \( X = 63.27 \). Then \( L = X/f_0 = 63.27/30(\text{kc}) = 2.109 \) inches, and \( W = L/3 = 2.109/3 = 0.703 \) inch.

To determine the temperature stability we use the formula, \( F = (0.0236 f_0 + 1.8)^2 = 7.1 \) cycles per deg C.

An error of 0.01 in reading \( X \) will shift the resonance 4 cycles and an error of 0.001 in cutting the crystal to length can shift the resonance as much as 15 cycles. When the crystal is cut to the dimension calculated, its resonance at 24°C can be expected to lie between 29,990 and 30,010, and have a stability within 7½ cycles per degree temperature change.

Final adjustment is made by sanding and testing each crystal. Removing material from the end raises the frequency and cutting on the sides lowers the resonant frequency.

It is also important that the crystal have a high Q since the resonant frequency shifts as the crystal is loaded. A Q of 6,000 can be obtained when cemented foils are used and a Q of 15,000 is possible when evaporated foils are used. Evacuating the crystal holder thereby unloading the crystal will permit easily a Q of 30,000.

The electrical power required to drive these crystals is very small, and it is recommended to keep this as low as practical for the reasons mentioned above. A good high-Q crystal will require about 80 microamperes at 200 millivolts or about 1.6 microwatts of crystal power.

When comparing synthetic crystals with quartz in the 10 to 150 kc range, each has its advantages depending upon the requirements of the problem. Aside from the softness and ease of handling advantages, synthetic crystals offer very favorable Q's in this range, with stability which is often more than sufficient. As to cost, Rochelle salt crystals cost from $1.00 to $1.50 each, and ammonium dihydrogen phosphate from $2.00 to $2.50 each. Gold plated foils will add about $1.00 to the price of each crystal.

**Bibliography**

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Equalizer Design Chart

Bass and treble attenuation or accentuation of two types of R-C equalizers for audio-frequency circuits are easily determined from the graph. Curves sketched from the chart resemble those computed laboriously point by point.

By CHARLES P. BOEGLI
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Four uses of the graph are demonstrated by the examples. The entire range of characteristics is related to the quantity \( a \), which is defined for each type of equalizer in Fig. 1 and 2.

An equalizer is to provide a treble drop of 3 db per octave beginning at 1,000 cps, operates from a source resistance of 33,000 ohms.

**Solution.** For 3 db per octave, \( a = 0.33 \). \( R(1 - a) = 33,000 \) whence \( R = 49,300 \) and \( a R = 16,300 \). From the graph, \( f'/f = 1.72 \) so that \( f' = 1,720 \) cps. At this frequency \( X_c = \frac{49,300}{1,000} = 9,000 \) ohms, or \( C = 0.0019 \mu F \). The high-frequency turnover is 1000/0.111 = 9,000 cps and the high-frequency level is down 9.6 db.

Find characteristics of equalizer consisting of series resistance of 48,000 ohms followed by shunt of 18,000 ohms and a 0.001 \( \mu F \) capacitor in series.

**Solution.** Total \( R = 66,000 \) ohms. At \( f' \), \( X_c = 66,000 \) ohms, or \( f' = 2,400 \) cps; \( a = 0.273 \) for which the graph shows a treble attenuation of 3.4 db per octave with \( f'/f = 1.63 \); \( f = 1,470 \) cps. Other data from the graph are the high-frequency turnover (14,200 cps) and the high-frequency level (down 11.3 db).

An equalizer for treble accentuation of 4 db per octave beginning at 5,000 cps is terminated by a 100,000-ohm grid resistor.

**Solution.** For 4 db per octave, \( a = 0.20 \). \( R/(1 - a) = 100,000 \) whence \( R = 80,000 \) ohms and \( R/a = 400,000 \) ohms; \( f = 5,000 \) cps so \( f' = 7,450 \) cps and \( f' = 37,250 \) cps. Capacitor \( C \) has a reactance of 80,000 ohms at 37,250 cps; \( C = 53 \mu F \).

Find the characteristics of an equalizer consisting of a series impedance of a 250-\( \mu F \) capacitor paralleled by 1.5-megohms, this series impedance being followed by a shunt resistance of 222,000 ohms. This equalizer has been recommended for use with crystal pickups for commercial constant-velocity pressings.

**Solution.** Parallel resistance \( R \) is 193,000 ohms; \( f' \) is then 3,250 cps. Furthermore, \( 193,000/(1 - a) = 222,000 \) whence \( 1 - a \) = 0.87 and \( a = 0.13 \). The equalizer provides 4.7 db per octave treble boost with \( f' \) at 422 cps and \( f \) (the turnover frequency) at 315 cps. The low-frequency drop is 17.7 db.

As attenuation in db per octave decreases, the frequency range over which the equalizer is effective narrows.
Elkonite* Contacts

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ELECTRONICS — April, 1950

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Navy Exhibits at IRE Engineering Show

LATEST unclassified electronic equipment comprised the exhibit of the U. S. Navy prepared for the IRE winter meeting and shown to the press a few days before the show. Such gear is the joint responsibility of three bureaus of the Navy, the Bureau of Ships, Bureau of Aeronautics and the Bureau of Ordnance.

One of the toughest problems in modern radar design is how to keep the wave fronts accurately focused by the antenna. A secondary problem is how to make the radar waves visible for study. To help solve these problems, an electronically driven ripple tank was exhibited by the Naval Research Laboratory.

Water ripples are used for the qualitative and semi-quantitative study of phase fronts near two-dimensional models of antenna structures. Electronically driven probe-vibrators are used to excite the water surface of a glass ripple tank. Synchronously chopped light is directed through the tank to a ground-glass screen where the phase front shadow patterns appear stationary. Thus, it is possible to view the changes in phase-front patterns brought about by changes in feed point position and in reflector configuration, as well as by changes of as much as several hundred percent in exciting frequency.

The Naval Ordnance Laboratory displayed a new type of magnetic material called orthonol. This material, developed by Naval Observatory Laboratory, is used for making coils for a magnetic amplifier on display.

The magnetic servo amplifier contains only coils wound on orthonol and metallic rectifiers. For purposes of demonstration it points a toy gun mount at a submarine whenever it exposes itself at the surface of a table simulating water. When the submarine surfaces, an impulse is supplied to the magnetic servo amplifier. The amplifier magnetically magnifies this impulse one-million times (power) and this output signal aims the gun at the surfaced submarine. The power output of the magnetic amplifier is 20 watts.

A telegraph test set was shown which is used for testing telegraph equipment and telegraph communications circuits. Its precision is such that any differential in the received and transmitted signals provides an indication of the quality and character of the equipment or circuit under test. The gear consists of a photoelectric signal generator, a recorder and a power supply for the recorder.

The signal generator originates precise square waves which are applied to the telegraph equipment or communications circuit under test. The recorder simultaneously receives the telegraph signal from the equipment or circuit under test. The test signal generated is repetitive in character, each repetitive
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Good fast work can only be done with the best materials. Kester Plastic Rosin-Core Solder and the more active Kester “Resin-Five” Core Solder, made only from newly mined grade A Tin and Virgin Lead, are formulated especially for TV, radio, and electrical work. Kester Solders flow better... handle easier ... faster to use.

Free Technical Manual—Send for your copy of “SOLDER and Soldering Technique.”

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cycle consisting of a minimum of 30 bauds, each of which can be made to represent either a marking or spacing condition at the will of the operator by operation of toggle switches on the control panel. The cycle is made to repeat itself at the rate at which lines are scanned on the recorder.

Wind-Tunnel Strain Gage

Many tests in supersonic wind tunnels at the Naval Ordnance Laboratory require the measurement of the aerodynamic forces and moments on a model subjected to the wind-tunnel air flow. It is desirable that the transducer have rapid response and give a force reading in a second or two after the tunnel has been turned on.

Because some of the NOL tunnels are of the intermittent type, a short blowing time allows more runs to be made per hour, leading to a greater tunnel efficiency. The intermittent feature lends itself well to the use of strain gages as sensitive elements since a zero reading can be obtained before and after the force measurement has been made, and within a few seconds of it.

The equipment on exhibit has been designed to be used with internal strain-gage balances. It consists essentially of a balancing and calibrating circuit, an amplifier, an output circuit, an oscillator, and a cathode-ray null indicator. Commercially available units are used wherever possible. Two channels are provided in a single console, but a number of consoles may be connected together when additional channels are required.

The oscillator frequency may be set at either 400 or 2,000 cycles per second, and the voltage applied to the strain-gage bridge may be adjusted between 1 and 5 volts. The smallest measurable strain is approximately 0.1 microinch per inch when used with four active gages in a full bridge circuit.

The latest development in Navy teletypewriter equipment is an electronic time-division multiplex telegraph terminal consisting of two sets, a telegraph transmitting unit, and a telegraph receiving unit.

The teletype transmitting unit accepts on-off d-c start-stop signals from local transmitting circuits, converts them to multiplex signals and applies these in sequential order, channel-by-channel, to the telegraph circuit. The signals are then delivered to the distant receiving group which accepts similar multiplex signals and converts them to start-stop signals and then transmits the start-stop signals in their original on-off d-c form to the proper local receiving circuit.

The set is capable of supplying a maximum of four channels from any one telegraph circuit at a speed of either 60 or 75 wpm. The transmitting and receiving groups, cycling at identical rates of speed, operate in synchronism at all times and are held in synchronism by a crystal-controlled oscillator.

This equipment has many features which make it highly desirable for Navy use. Once the transmitter and receiver have been synchronized they will remain so from one to one and one-half hours with the telegraph circuit disconnected. If either the receiving or transmitting circuit is inadvertently broken, there is both a visual and an audible warning signal.

The Naval Air Development Center at Johnsville, Pennsylvania, exhibited several subminiature assemblies. One of these is an eight-stage video amplifier having a bandwidth of 2.5 megacycles. The voltage gain of the amplifier is approximately 50,000 and the output is a 30-volt pulse 2 microseconds wide, with a rise time of about 0.15 microsecond.

Also exhibited by the Navy were the latest in ultra-high-frequency transmitting and receiving equipment; a tilting table to demonstrate the action of radar antenna stabilization under actual operation; one of the standard fleet-installed ppi units for remote presentation of information received on various shipboard radars; a setup of microwave oscillators and horn antennas like that in a shooting gallery to show the reflection of the waves from certain types of dielectric radomes; an infrared telephone transmitter and receiver and a radar beacon circuit that adds only four pounds to the normal radar equipment of a fighter aircraft.

Tachometer for Small Motors

BY LORNE B. SARGENT, JR.,
Aluminum Research Lab
Aluminum Co. of America
New Kensington, Pa.

AND WAYNE WEBB
Department of Physics
The Pennsylvania State College
State College, Pa.

For high-pressure viscosity measurements it was necessary to design and to construct a tachometer for measuring the rotational speed (continued on p 134)
The mistaken young man who quit the patent office...

Back in the 1880's, a young man quit the patent office. It was a perfectly good job except for one thing: There wasn't any future in it. You could, as he explained, walk through the place and see for yourself that just about every possible thing had been invented.

He was, of course, just as wrong then as he would be today almost seventy years later. In a world where nothing is impossible and many things are still unknown, progress is limited largely by lack of imagination.

In electronics alone, a "normal" quarter of a century's development has been crowded into the past half dozen years. And patent requirements of this single industry probably equal the total work of the patent office when this mistaken young fellow resigned.

Sprague Telecaps*, the first truly practical phenolic molded paper tubulars, introduced a new era in trouble-free small capacitor performance, whether under "normal" or exceptionally difficult operating or "shelf" conditions.

*T.M. registered

Sprague Subminiature Paper Capacitors, hermetically sealed in metal cases with glass-to-metal solder-seal terminals, are designed to be as good as, and often better than, larger units.
THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

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Clocking Meteors by C-W Radar

BY OSWALD G. VILLARD, JR.
Department of Electrical Engineering
Stanford University, California

A continuous-wave radar technique for measuring meteor speeds has been developed at Stanford University, California. A c-w transmitter located on the campus radiates a signal directed vertically upward. Reflections from ionization columns created by the passage of meteors through the E region of the ionosphere are received on standard communications receivers located in a shielded valley about 4 miles away.

Overloading of the receivers by the local transmitter is prevented by a ground-wave cancellation system in which a strong signal from the transmitter is picked up in a directive antenna located outside the valley, attenuated, shifted in phase, and fed to the receivers through a coaxial cable. This reference signal is substantially free of superimposed meteoric reflections because it is picked up in an antenna having very low sensitivity to signals arriving at vertical angles appreciably above the horizontal. Ground-wave leakage at the receiving site can be reduced by 20 decibels with good stability by this means.

In practice, a small amount of ground wave is allowed to leak through in order to beat with meteor-reflected signals. These reflections are Doppler-shifted in frequency due to the speed of the meteor relative to the observer. Owing to the beat with the ground wave, meteors announce themselves by audible whistles of descending pitch, not unlike the whine of a falling bomb. A recording of the whistle, together with a measurement of the slant range to the ion column when it crosses the perpendicular with respect to the observer when the whistle falls to zero pitch yields the speed of the meteor to a high degree of accuracy. Meteor showers provide a means for checking the accuracy of radio detection methods, since shower meteors travel at virtually a constant speed which is known to a high degree of precision in the case of the major annual showers.

It has been found that the ion columns form at a rate equal to the speed of the meteors, and not at a lower rate, as had been suspected. This conclusion has been confirmed at radio frequencies as low as 6 megacycles, and suggests that at least part of the mechanism by which columns are formed is akin to radiation—perhaps ultraviolet light—emanating from the tiny (pea-sized) meteoric particles themselves.

The continuous-wave radio speed-measuring technique is vastly more sensitive than the photographic methods previously available to astronomers. During a typical

Receiving station for continuous-wave meteor clocking setup developed at Stanford University. Receiver overloading is prevented by a ground-wave cancellation system
The Type 202-D Signal Generator, developed to meet the specialized requirements of engineers working with telemetering receivers and other associated equipment, will be welcomed by many who have long needed a precise and reliable instrument for rapidly evaluating overall system performance.

**SPECIFICATIONS:**

**RF RANGE:** 175-250 megacycles in one range, accurate to ± 0.5%. Main frequency dial also calibrated in 24 equal divisions for use with vernier frequency dial.

**VERNIER FREQUENCY DIAL:** This dial is divided into approximately 100 equal scale divisions and is coupled to the main frequency dial by a 24:1 gear train. The approximate frequency change per vernier division is 3.5 kc.

**FREQUENCY MODULATION (DEVIATION):** The FM deviation is continuously variable from zero to 240 kc. The modulation meter is calibrated in three FM ranges: (1) 0-24 kc., (2) 0-80 kc., and (3) 0-240 kc. deviation.

**AMPLITUDE MODULATION:** Utilizing the internal audio oscillator, amplitude modulation may be obtained over the range of 0-50% with meter calibration points of 30% and 50%. By means of an external audio oscillator, the RF carrier may be amplitude modulated to substantially 100%. A front panel jack is provided which permits direct connection of an external modulating voltage source to the final stage for pulse and square wave modulation. Under these conditions the rise time of the modulated carrier is less than 0.25 microseconds and the decay time less than 0.8 microseconds.

**MODULATION CONTROLS:** Separate potentiometers are provided for continuous control of FM and AM levels.

**MODULATING OSCILLATOR:** The internal AF oscillator may be switched to provide either frequency or amplitude modulation.

**Price and Delivery Information:** Furnished upon request.
night, on which a visual observer might see perhaps 100 meteors, 500 to 1,000 meteor speeds may be obtained with a radiated power of the order of one kilowatt. A shower may be expected to increase this number several-fold. Estimated to be 10,000 times as sensitive as the best astronomical cameras available in the past, and considerably more sensitive (owing to bandwidth and average power considerations) than radio speed-measuring techniques depending on pulsed transmissions, the continuous-wave method makes possible study of the speed characteristics of swarms of meteors too small to register on a photographic plate.

The results of a large-scale investigation using this method, now being carried out by the National Research Council in Canada, should settle a question long current in astronomical circles, whether certain of the meteors originate outside our solar system, and thus might be expected to provide a clue to the makeup of other solar systems. Visual observations made in the past, admittedly less accurate than electronic measurements, seemed to support such a conclusion. The radio method will provide the answer for meteors down to the 8th or 9th visual magnitudes.

**BIBLIOGRAPHY**


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**Strip Chart Recording with An Autoscaler**

**BY S. W. LICHTMAN, E. T. BYRAM AND H. FRIEDMAN**

**U. S. Naval Research Laboratory**

**Washington, D. C.**

**GEIGER COUNTERS** are usually employed in combination with counting circuits which register either the number of counts accumulated in a given time or the time required to accumulate a predetermined count, or with rate meter circuits which present the integrated counting rate continuously as a meter deflection. The latter method has the advantage that it can be used with strip-chart recording. Depending on the counting rate and its rate of variation, experience has shown that it is ordinarily preferable to use either one or the other type of counting.

The method of count interval recording described here is an attempt to combine the desirable features of both the direct counting method and the rate meter strip chart type of recording. It also provides a simple means of obtaining reciprocal, logarithmic, or other compressed scales to cover a wide range of counting rates.

**Count Interval System**

The method consists of controlling the current through a recording meter by means of a synchronous motor-driven potentiometer.

The running time of the motor is controlled by a scaling circuit arranged to stop automatically after a predetermined count. The motor begins to drive the potentiometer at the inception of counting and runs for the duration of the counting interval. When the specified count is reached, the potentiometer is restored rapidly to its zero position. A relay then restarts the scaling circuit and initiates a new counting interval.

If the recording meter measures the voltage output of the potentiometer, the envelope of the end points varies inversely as the counting rate, as in Fig. 1. Alternatively, if the meter is inserted in series with the variable resistor element and a constant source of voltage, the envelope of the end points traced will vary directly with the counting rate. Either a linear or a compressed deflection versus time is obtained by selecting a linear potentiometer or one with a suitable taper, such as a logarithmic potentiometer.

One type of clock-driven potentiometer assembly is shown in the photograph of Fig. 2. It comprises a synchronous clock motor with a spiral restoring spring, geared to the control potentiometer. Also shown in the photograph is a snap-switch mounted directly above the gearing. The switch is normally opened, but is closed momentarily at the end of the fly-back period by means of a cam attached to the drive shaft, thereby restarting the scaling circuit. The particular unit of Fig. 2 produced a full rotation in

---

(Continued on page 184)
Control Panel for Plastic Injection Molding Machine
Showing Position of Circuit Breakers

1 DEPENDABLE—Because Heinemann Magnetic Circuit Breakers act on the magnetic principle—the overload itself makes a magnetic field around the trip unit which INSTANTLY opens the breaker. NO WAITING for thermal units to heat. No damage can be done.

2 FLEXIBLE—Because a Time-Delay Unit, pre-calibrated at the factory to meet YOUR specifications, prevents the breaker from tripping on minor overload or starting surge. These circuit breakers are available with any one of three different inverse time delays.

Handle is plainly marked in "ON" and "OFF" position.
Breakers are listed by Underwriters Laboratory

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TRENTON, NEW JERSEY
NEW PRODUCTS

EDITED by WILLIAM P. O'BRIEN


Voltage Regulator

ACME ELECTRIC CORP., Coba, N. Y., has developed the Voltrol for testing electrical and electronic components and finished products on ranges between 70 and 130 volts. The unit is basically a specially constructed transformer with windings that are individually tapped at each turn. Regulation is accurate to 0.4-volt adjustment and output voltage is practically independent of the load. Size of the unit is 10½ in. × 6½ in. × 6½ in. Weight is 15½ lb.

Smaller Paper Tubulars

AEROVOX CORP., New Bedford, Mass., have introduced type P85 miniature paper tubular capacitors. The paper section is Aerolene-impregnated and the capacitor is sealed with Duranite. The new units can be used at 212 F without drips. Dielectric strength is maintained at elevated temperatures.

Speed Measuring Device

KAY ELECTRIC CO., Pine Brook, N. J. The Rotalyzer measures average rotational speed of a shaft and indicates variations in speed vs time. A high-frequency magnetic disc and pickup are employed on the shaft to be measured. The equipment, as supplied, includes the necessary pickup devices, a cabinet containing the electronic amplifier and analyzer elements and an oscilloscope. Standard speed range of the Rotalyzer is 900 to 7,200 rpm. Accuracy of 0.1 percent is available over the speed range.

Self-Excited Chopper

STEVENS-ARNOLD INC., 22 Elkins St., South Boston, Mass., has developed a self-excited chopper which will operate from d-c. It offers modulation and demodulation in the one unit. Nominal ratings are 10 volts, 0.001 ampere d-c, but these may be exceeded, on an intermittent basis, as required in servomechanism applications. The chopper is particularly well suited for use in aircraft where there is a d-c as well as an a-c power source to choose from.

High-Voltage Probe

ELECTRONICS INSTRUMENT CO., 276 Newport St., Brooklyn, N. Y. Model HVP-1 high-voltage probe for television servicing measures up to 30,000 volts. It uses a special helical film, steatite rod type, removable multiplier resistor. The probe
HE COULDN'T GET ALONG WITHOUT RAYTHEON SUBMINIATURE TUBES CAN YOU?

Today, nobody would dream of designing walkie-talkies or weather balloon equipment or hearing aids without SUBMINIATURE TUBES.

Stop and think! Aren't the qualities that make Subminiatures invaluable for these exacting jobs exactly what the doctor ordered for your equipment?

RAYTHEON Flat Press Subminiatures are the exception that proves the rule. They're the "small boy" that does a man's work. Rugged, long lasting, more dependable and efficient than their larger tube counterparts, they increase product acceptance. They fit standard sockets or can be soldered or welded into the circuit. Over 300 Raytheon Distributors stock them and are conveniently available to serve you. Raytheon Subminiatures are standard the world over — more in use than all other makes combined.

---

This chart gives you a glance the characteristics of representative Raytheon Subminiature Tubes.

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Remarks</th>
<th>Maximum Diameter Inches</th>
<th>Maximum Length Inches</th>
<th>Thermal Dr. (H.P.)</th>
<th>Full Cond. (max. Volts)</th>
<th>Power Output (Watt)</th>
<th>Typical Operating Conditions (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK5720/CK5724C</td>
<td>Characteristic of 6AK5</td>
<td>0.400</td>
<td>1.5</td>
<td>6.3</td>
<td>200</td>
<td>3500</td>
<td>120</td>
</tr>
<tr>
<td>CK5720/CK5724C</td>
<td>Tube, UHF Out line, 10 mw at 500 Hz</td>
<td>0.400</td>
<td>1.5</td>
<td>6.3</td>
<td>200</td>
<td>3500</td>
<td>120</td>
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<tr>
<td>CK5720/CK5724C</td>
<td>Diode, equivalent to 6AK5</td>
<td>0.315</td>
<td>1.5</td>
<td>6.3</td>
<td>150</td>
<td>1000</td>
<td>120</td>
</tr>
<tr>
<td>CK5774/CK5776C</td>
<td>Trade, High Vo.</td>
<td>0.400</td>
<td>1.5</td>
<td>6.3</td>
<td>200</td>
<td>3500</td>
<td>250</td>
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<tr>
<td>CK5784</td>
<td>Characteristics of 6AS6</td>
<td>0.400</td>
<td>1.5</td>
<td>6.3</td>
<td>200</td>
<td>3500</td>
<td>120</td>
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<tr>
<td>CK5820</td>
<td>Similar to 6AS6</td>
<td>0.300</td>
<td>0.6</td>
<td>6.3</td>
<td>150</td>
<td>117ac</td>
<td>3.0</td>
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<table>
<thead>
<tr>
<th>Specific Types</th>
<th>Remarks</th>
<th>Maximum Diameter Inches</th>
<th>Maximum Length Inches</th>
<th>Thermal Dr. (H.P.)</th>
<th>Full Cond. (max. Volts)</th>
<th>Power Output (Watt)</th>
<th>Typical Operating Conditions (Volts)</th>
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<tr>
<td>1A4X</td>
<td>Shielded RF Power — High Line</td>
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<td>4.0</td>
<td>1.0</td>
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<td>100</td>
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<td>CK574A</td>
<td>100 Ohm 125vatt-electrolytic tube, 1/2 25vatt.</td>
<td>0.285</td>
<td>0.4</td>
<td>4.0</td>
<td>1.0</td>
<td>1.3</td>
<td>100</td>
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<td>CK574A</td>
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<td>1.0</td>
<td>1.3</td>
<td>100</td>
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<tr>
<td>CK574A</td>
<td>Tube, High frequency output</td>
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<td>0.4</td>
<td>4.0</td>
<td>1.0</td>
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<td>CK5762</td>
<td>Output Power</td>
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<td>4.0</td>
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<td>Output Power</td>
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<td>1.0</td>
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<td>Trade, UHF Oscillator for radio use</td>
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<td>1.3</td>
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<td>100</td>
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<td>CK5784</td>
<td>Tube, UHF Oscillator for radio use</td>
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<td>1.0</td>
<td>1.3</td>
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<tr>
<td>CK5784</td>
<td>Electrical Trade Max. grid current 50 ma.</td>
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<td>1.3</td>
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<tr>
<td>CK5784</td>
<td>High voltage rectifier</td>
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<td>0.4</td>
<td>4.0</td>
<td>1.0</td>
<td>1.3</td>
<td>100</td>
</tr>
</tbody>
</table>

Raytheon MANUFACTURING COMPANY
SPECIAL TUBE SECTION
Newton 58, Massachusetts
SUBMINIATURE TUBES
GERMANIUM DIODES and TRIODES
RADIATION COUNTER TUBES
RUGGED, LONG LIFE TUBES

ELECTRONICS — April, 1950
matches most 20,000-ohm-per-volt meters as well as most vtm's now in use.

Small Volt-Ohmmeter
SIMPSON ELECTRIC Co., 5200-18 W. Kinzie St., Chicago, Ill. Model 303 vacuum-tube volt-ohmmeter for television servicing is only 120 cubic inches in size. Its d-c input resistance is 10 megohms for all ranges. The unit has five d-c and five a-c voltage ranges, five resistance ranges, three a-f voltage ranges, decibles from -20 to +63 in five ranges, a zero center galvanometer for f-m discriminator alignment and other galvanometer applications, and an r-f voltage range with 20 volts maximum and flat frequency measurements between 20 kc and 100 mc.

Portable Oscilloscope
ALLEN B. DU MONT LABORATORIES, INC., 1000 Main Ave., Clifton, N. J. Type 292 three-inch c-r oscilloscope weighs only 21 pounds. Input signals of 0.4 rms volt and 0.56 rms volt will produce one-inch deflection on vertical and horizontal axes, respectively. The instrument's gas-tetrode linear time-base generator provides recurrent sweep frequencies from 8 to 30,000 cps, synchronized with either the vertical amplifier or some external source.

Rectangular Picture Tube
HYTRON RADIO & ELECTRONICS CORP., Salem, Mass. Type 16RP4 is a direct-view all-glass, 16-in. picture tube with a rectangular screen. It takes approximately the same cabinet space as a round 12-inch picture tube. The picture, with standard 3 by 4 aspect ratio, has a usable screen area of 138.7 sq in. A neutral gray face increases the contrast ratio.

Magnetic Amplifier
TRANS-SONICS, INC., Bedford Airport, Bedford, Mass. Type 63-1 magnetic amplifier is intended for use in measurements and control and, when used with thermocouples or strain gage pickups, makes possible the recording of temperature, pressure and accelerations on standard recording millimeters. Gain is constant to ± % percent with a ± 10-percent change in line voltage, and zero drift over a period of several weeks is less than ± 50 µv referred to the input terminals. Power line is 117 volts, 60 cycles. Maximum output current is 300 ma.

Ionization Gage Control Circuit
DISTILLATION PRODUCTS INDUSTRYS, Ridge Road West, Rochester 3, N. Y. The DPA-38 ionization gage control circuit was designed for measuring the highest vacua attainable. It is particularly useful in determining the difficult ranges below 10⁻⁸ mm Hg. The lowest scale division represents 2 × 10⁻¹⁰ mm Hg. The new circuit features a direct-reading scale where the negative exponent of the number of milli-
Here are two unbeatable VHF power tube combinations for mobile transmitter designs where high efficiency and extreme compactness are paramount requirements. All four of these RCA-developed tubes have high power gain and may therefore be operated at relatively low plate voltage to provide large power output with small driving power.

The RCA-5763 miniature type beam power tube is very suitable as an output stage of low-power mobile transmitters and as a doubler or tripler in higher-power units. It can be operated with full input up to 175 Mc. The RCA-2E26 is intended primarily for use in the driver stages or the output stage of emergency mobile or FM transmitters. It can be operated with full input up to 125 Mc. and will provide an output of about 13 watts at 160 Mc.

The RCA-5618 power pentode and the RCA-2E24 beam power tube are quick-heating types with low filament drain, and are particularly suitable for mobile and emergency-communications transmitters where the operating power supply must be kept small. Both types are designed for intermittent operation. The RCA-5618 is superior as a doubler or tripler; the RCA-2E24, as the final amplifier in low-power FM transmitters.

Already proved in thousands of installations, these RCA tubes can be depended upon for their quality, ruggedness, and superior performance.

RCA Application Engineers are ready to work with you in applying any of these or other RCA tube types to your specific designs. For further information write RCA, Commercial Engineering, Section D42R, Harrison, New Jersey.

RCA Laboratories, Princeton, N. J.
The Fountainhead of Modern Tube Development is RCA
A JET pilot-trainer recently delivered to the U.S. Air Force by Link Aviation Corp. simulates new problems introduced in actual flight by increased aircraft speeds and improved electronic aids to air navigation.

The unit combining flight, engine and navigation problems is self-contained for both pilot and instructor, but can be separated into four sections for transportation or movement through standard doorways.

Besides standard communications and navigation simulators, the new trainer includes GCA, ILS, omni-range, offset course computer and similar facilities just coming into use under the ANDB interim program (see ELECTRONICS, p 66, Feb. 1950).

The instructor checks every aspect of flight from engine starting to landing, with a system of colored lights indicating the success or failure of pilot reaction. He can at any point throw in problems such as fuel-tank puncture, lightning flashes (with accompanying static), inoperative wing flaps or turbulence. If the pilot becomes too hopelessly confused, the instructor can press the "angelic switch" (pilot failure override) and thus clear the board entirely of all troubles which might possibly arise in flight.

The trainer is essentially electronic, even to the solution of aero-dynamic equations upon which the flight is based. Twenty-four computers comprising servo systems and amplifiers present to the pilot even the different feeling of controls with varying airspeed.

IRE Convention 1950

CREDITED as the world's largest international engineering body, The Institute of Radio Engineers held its thirty-ninth annual conference in New York at the Hotel Commodore and Grand Central Palace March 6-9, 1950.

During the four-day engineering convention and show, 18,100 members and guests attended from all parts of the United States and some thirty other countries. A total of 169 papers was presented at thirty-six special technical sessions on topics ranging from theory to the finished products in radio broadcasting, television, computing machines, sound recording, circuit theory; uhf transmitter and receiver design and operation.

The accompanying radio show in Grand Central Palace consisted of 253 separate exhibits on three floors. The exhibits included complete radio and television stations in full operation—from electronic pickup to monitoring studio kinescope to subminiature components.

The convention opened March 6 in the Commodore's grand ballroom when the meeting was addressed by Dr. Ralph Bown of the Bell Telephone Laboratories, a past-president of IRE.

On Tuesday, Raymond F. Guy, new IRE president, was the guest of honor at a luncheon. The roster of speakers included Major-Gen. F. L. Ankenbrandt, director of communications, Department of the Air Force, and Sir Robert Watson-Watt of England, the new IRE vice-president. Stuart Bailey, the outgoing IRE president, was toastmaster.

The annual dinner was held at the hotel on Wednesday with H. B. Richmond, chairman of the board of the General Radio Co., Cambridge, Mass., as speaker, and D. G. Fink, editor of ELECTRONICS, as toastmaster. The Institute's annual awards for merit in the radio-elec-
1. It gives you faster printing intermediates. Now you can speed up quantity print production...save time and money...with new Kodagraph Autopositive Film! What's more, you, or your local blueprinter, can expose this amazing reproduction material in high-intensity blueprint or direct-process machines...or in a vacuum frame; develop it in standard photographic solutions. You get positive intermediates directly...and the job can be done quickly, economically...under ordinary light.

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3. It simplifies revision, reference. Both sides of Kodagraph Autopositive Film are matte-surfaced...can be written on with pencil or pen. And since the base is highly translucent, details can be read from either side without use of an illuminator.

4. It even reproduces illustrations and text on opaque stock—giving you sharp, fast-printing "masters" which will produce sparkling direct-process prints. An economical short cut you'll appreciate in preparing data sheets, instruction manuals, and parts lists.

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tronic field were presented at the dinner. The awards include the 1950 Medal of Honor to Prof. F. E. Ter-
man, dean of the school of engineering of Stanford University; the Browder J. Thompson Memorial Prize to J. F. Hull and A. W. Ran-
dalls of the U. S. Army Signal Corps civilian staff; the Editor's Award to E. J. Barlow, of the Sperry Gyro-
scope Co. research laboratories; the Morris Liebmann Memorial Prize to O. H. Schade, research engineer of the RCA Victor Division, and the Harry Diamond Memorial Award to A. V. Haeff, consultant with the Na-
al Research Laboratory, Washing-
ton, D. C.

Thirty fellowship awards of the IRE were presented at the annual dinner. Simon Ramo responded for the group.

New Radio Propagation Laboratory

APPROVAL has been given for the development of a new 210-acre site at Boulder, Colorado, for a National Bureau of Standards radio propagation laboratory. Actual con-
struction work on the $4,500,000 project will begin during the summer of 1951. When the laboratory is completed it will employ a re-
search staff of about 300 people, most of whom will be transferred from the present staff in Washing-
ton.

The radio division of the Bureau is the central Federal group for the coordination of research on the propagation of radio waves. It is also responsible for development and maintenance of the national primary standards of electric quantities at frequencies above 10 kc. Comprehensive basic and applied research programs are adminis-
tered by the radio division in radio physics and the associated geophysical phenomena of the atmosphere. Extensive laboratory investigations are being conducted on the proper-
ties of matter at radio and micro-
wave frequencies, as well as on ways of making more precise measurements in the r-f region. In addition to its research function, the laboratory renders many advisory and consulting services to other agencies of the government.

Selection of Boulder, Colorado, as the site for the new laboratory was based on the following reasons: (1) It is uncongested by electrical and radio facilities; (2) it is near enough to a large city for equip-
ment and service needs; (3) techni-
cal factors call for moderate climate and diversity of terrain; (4) it is near a major university and also close to a major center of air and rail traffic.

National Tele System Committee Formed

To ATTAIN industry-wide agree-
ment on technical developments needed for the expansion of tele-
vision to all sections of the country and to establish basic standards which will bring color television to reality, the RCA has created the National Television System Committee. (Plans for formation of the unit were announced in ELECTRON-
ICS, February 1950, p 130).

Chairman of the group is W.R.G. Baker, vice-president of GE and di-
rector of the RCA engineering de-
partment. Vice-chairmen are Don-
ald G. Fink, editor of ELECTRONICS, and David B. Smith, vice-president

Communications Policy Board

PRESIDENT TRUMAN recently named a temporary Communications Policy Board, consisting of five members, to study and to make recommenda-
tions to him on the policies and practices which should be followed by the government in this field in order best to meet the broad re-
quirements of the public interest. Chairman of the Board is Irvin L. Stewart of the U. of West Virginia. Other members are Lee A. Du-

The Board's function is to study the present and potential use of radio and wire communications

(Continued on page 255)
PUT BETTER PICTURES ON YOUR TV SCREENS...
BY PUTTING
SYLVANIA GERMANIUM DIODES
IN YOUR SETS!

Here are 5 television receiver applications especially suited to utilize
to the full the inherent advantages of these unique circuit components

Designers of television receivers can substantially improve set performance through the use of Sylvania Germanium Diodes. Outstanding features of these elements in TV set design are freedom from hum, high efficiency, low capacity, no contact potential and exceptional linearity. Of course, in TV receivers as in all other applications, Sylvania's Germanium Diodes offer the advantages of small size and ease of mounting.

Find out just how and why Sylvania Germanium Diodes make television receivers better. Mail coupon for Electronic Engineering News Letter #8, which gives detailed circuit information on the 5 applications shown in the block diagram above.

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ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES;
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Gentlemen:
Please send me your Engineering News Letter #8,
"Applications of Sylvania Germanium Diodes in Television Receivers."

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Company
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City State

ELECTRONICS — April, 1950

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NEW BOOKS

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Electronic Time Measurements .............................. 132
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Practical Spectroscopy

While the radio engineer has been pushing his techniques to shorter wavelengths, the spectroscopist has been pushing his methods to longer ones. These two technologies are meeting in the service of science in the far infrared region where wavelengths are in the order of a millimeter.

This comprehensive volume, written by a physicist, a chemist and a biophysicist, presents the wide variety of techniques used by spectroscopists for both scientific and industrial work. The twenty chapters into which the book is divided provide readers with an introduction to the general techniques of the subject, a review of instruments, their adjustment and care, light sources, photographic techniques, the atomic and molecular origins of spectra, qualitative and quantitative spectrographic analysis, and the special methods necessary for the infrared and ultraviolet regions.

Electronic Time Measurements

This volume, as in all of the Radiation Laboratory Series, shows the results of the great effort put forth by a group of extremely competent men. In combination with Volume 19, "Waveforms," it will be an invaluable tool in the hands of the circuit design engineer. As its name

(Continued on p 256)

BACKTALK

This Department is Operated as an Open Forum Where Readers may Discuss Problems of the Electronics Industry or Comment Upon Articles which ELECTRONICS has published

Please Pass the Salary
DEAR SIRS:
The item on salaries in January Crosstalk contained interesting and (very likely) accurate information with respect to the earnings of various types of engineers, but it contained also an implication of the type that was long ago responsible for two old saws, "Figures don't lie, but liars figure" and "There are three degrees of prevaricators: liars, damn liars, and statisticians." (Pardon the language; and please do not infer that the editorial writer is aptly encompassed by either of the quotations.)

The passage at the end of the second paragraph of the article almost comes right out and says that electrical engineers can expect, after thirty-seven years, to experience declining earnings, else why the remark that they "are due for a rude shock"? It should be pointed out that perhaps the men who had enjoyed above-average earnings would have retired by the time they worked thirty-seven years, leaving the field to those whose earnings had been below average. It might even be found that the "per-individual" earnings in all brackets increased indefinitely up to the point at which each individual left his professional duties by retiring or otherwise. This would be in no way inconsistent with the statistics quoted in your article, and I for one hope that this is the actual situation.

The article, in any event, was interesting and thought-provoking.

WILLIAM C. SCHUMACHER
Brooklyn, New York

VHF from Incandescent Lamps
DEAR SIRS:
In your December 1949 "Tubes at Work" I was interested to see an article called "TV Interference from Incandescent Lamps."

My earliest encounter with vhf radiation of this type took place about twenty years ago when I was amateur 9BBH operating a mobile 5 meter station around the streets of Cedar Rapids, Iowa. It was noticed one day that a high-pitched tone was received at a certain street intersection. This tone came in on the superregenerative receiver only occasionally and was finally traced to the operation of street cars. Finally it was determined that a trolley-operated light signal (used to indicate to another street car several blocks away that the block was occupied) was the cause. Closer examination showed that the

(Continued on p 258)

April, 1950 — ELECTRONICS
The Redskin of course...

SANGAMO'S NEW MOLDED PAPER TUBULAR CAN HELP SOLVE YOUR PRODUCTION LINE PROBLEMS!

The Sangamo Redskin has the "How" it takes to tie into production lines. The strong, tough plastic casing stands rough handling and the especially designed, flexible leads are troublefree...they resist breakage and they can't pull out. It is used extensively by television manufacturers because it gives dependable long life operation at 85° C. The thermo-setting plastic case is molded under low pressure assuring elements undamaged in fabrication, longer life, greater dependability, and the absence of "hot spots."

A trial of these better molded tubulars will convince you. See your Jobber, or write for Catalog No. 800, which gives full information on the Redskin and the rest of the Sangamo Tribe.

NEVER FLINCHES IN THE PINCHES!

WATER TEST
For surpasses any existing specification requirement.

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Excellent operation under high temperature conditions.

PULL TEST
Leads resist breaking or pulling out. Takes rough handling.

LIFE TEST
Long life even under most severe operating conditions.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

In Canada: Sangamo Electric Company Limited, Leaside, Ont.

ELECTRONICS — April, 1950
Because of space limitations, an ordinary generator-type tachometer could not be used. The necessity of knowing the angular velocity of this varying motor at any instant made it inconvenient to use a revolution counter. The additional criterion of physically small, low-friction contacts on the motor shaft had to be considered also. The problem was that of devising an accurate tachometer which could be operated by small electrical contacts on the motor shaft and at the same time present a negligible load to the motor. Electrical means had to be employed because the motor in question was located inside a high-pressure steel bomb.

The solution was found in a square-wave generator-frequency meter circuit. The essential components of the instrument are shown schematically in Fig. 1. A d-c current is chopped into square waves by means of the rotor A which is mounted on the motor shaft and which contains a nonconductor E acting as a current interrupter. This square wave is then fed to capacitor B which becomes charged. During the period when the current is interrupted, the capacitor discharges through resistance C and causes ammeter D to indicate a current flow. The relation of the magnitude of the current indicated by the meter to the rate of interruption of the current in resistance C is a function of the capacitance and the potential applied to resistance C.

Several changes were necessary in this simple circuit in order that reproducible and consistent results...
Announcing 6 MORE MINIATURE COMPONENTS ahead of demand for smaller, lighter, more accurate instrumentation units

**ARMA 03 SYNCHROS**

Here are the new Synchro Units Arma manufactures specifically to meet the demand for compact servo-mechanisms in modern instrumentation.

They are designated as Arma's 03 Group and require 24 volt 400 cycle excitation.

<table>
<thead>
<tr>
<th>Type</th>
<th>Deg. No.</th>
<th>Freq</th>
<th>Voltage Input</th>
<th>Amp.</th>
<th>Watts</th>
<th>Static Accuracy</th>
<th>Rotor Friction (in.)</th>
<th>Static Friction (in.)</th>
<th>Weight (lbs.)</th>
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<td>715646</td>
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<td>24</td>
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<td>0.025</td>
<td>±15'</td>
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<td>757042</td>
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<td>0.1</td>
<td>1/4</td>
</tr>
</tbody>
</table>

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   Plates, washers, mounting studs—all aluminum! Same coefficient of expansion under all operating conditions.

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   No need to stock a variety of mounting hardware. Single-end stud with simple nut and washer permits mounting anywhere in any position.

3. **RUGGED CONSTRUCTION**
   Improved mechanical design, using a one-piece mounting stud, provides a sturdy mechanical assembly that will withstand stress and shock.

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Federal opened the way to smaller, lighter weight TV receivers. Now Federal goes further ... provides still further weight saving for receivers of all sizes ... meets all major TV power requirements ... with new stacks to operate with the higher rated capacitors used in latest TV design. Write today for full information. Address Dept. F-713.

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There is a Transcoid unit designed to meet the requirements of your particular application.

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ELECTRONIC INSTRUMENT CO., INC.
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April, 1950 — ELECTRONICS
New Potter & Brumfield MT (Miniature Telephone) hermetically sealed assembly saves more than ½ of chassis mounting space. Available with windings from a fraction of an ohm to 22,000 ohms for operation up to 230 volts, AC or DC.

Note features of the exclusive new P & B development listed on this page. Write for full information on your particular needs! Progressive P & B engineering service is available to solve every relay problem. New catalog free on request.

THE CLOSURE

Potter & Brumfield "M" type enclosure (illustrated) was especially developed for the MT relay. . . will accommodate the MT with maximum contact stack and can be fitted with all headers except standard octal plug. . . . All P & B enclosures for hermetically sealed relays are deep drawn steel, cadmium plated and painted as specified. Headers are glass insulated with high thermal shock resistance and minimum leakage resistance of 10,000 megohms at 50% humidity. . . . Up to 14 hot-tin-dipped solder terminals and plug-in connectors for 9 pin standard miniature or 14 pin special. . . . P & B "K" type enclosure 1 ½" x 1 13/32" x 2 1/8"—(not illustrated), will take any "MT" or P & B "KR" series with any header including standard octal plug. The "K" can be provided with three ½" mounting studs centered on 1 ½" x 1 13/32" dimensions. . . . Hermetically sealed relays are diced at high temperature and sealed in one atmosphere of nitrogen, which eliminates oxidation and reduces contact arcing. Leakage test by immersion in pure water at 200°F.

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Ballantine Model 300
SENSITIVE ELECTRONIC VOLTMETER
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- Range switching in decade steps—easy to use—only ONE scale to read.
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- Precision Shunt Resistors convert Model 300 Voltmeter to very sensitive direct-reading milliammeter. Write for complete data.

PRICE ................ $200.00

In addition to the Model 300 Voltmeter, Ballantine Laboratories also manufacture Battery Operated Electronic Voltmeters, R. F. Electronic Voltmeters, Peak to Peak Electronic Voltmeters, and the following accessories—Decades Amplifiers, Multipliers, Precision Shunt Resistors, etc.

Fig. 2—Charging voltage is obtained from a d-c line

The complete circuit of the tachometer is shown in Fig. 2. Thus additional capacitors were installed in order to smooth the action of the microammeter pointer. More capacitors were installed in addition to a suitable switching arrangement so that several speed ranges could be used. A rectifier tube and choke provide a more pure square wave. A voltage regulator tube was used to advantage in eliminating normal fluctuations of the line current.

The motor shaft was fitted with ten equally sized and equally spaced interrupters made of plastic. These were so designed that the conducting segments of the rotor were of the same size as the interrupters, thus providing equal on and off time per revolution. The spring contact on the rotor was made of steel music wire with a silver soldered copper tip which contacted the brass rotor. Placing the spring contact in a peripheral groove cut in the rotor improved the dependability of the operation.

Calibration

To obtain the proper scale coverage on the microammeter with various motors to be used with this circuit, the bank of capacitors was provided. The relation between these capacitors and the frequency of current interruption is given in Fig. 3. This curve can also be represented by the following equation;

\[ \log C = 0.8248 - \log S \]

where \( C \) = capacitance in microfarads and \( S \) = frequency in cycles per second. Thus if any motor having a rotational frequency within the range given on Fig. 3 were used, the cor-
RESISTS MOISTURE, MECHANICAL RUPTURE . . . HAS HIGH DIELECTRIC STRENGTH . . .

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Materials for potting, dipping or impreg-
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- Radar
- Fire Control
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April, 1950 — ELECTRONICS
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**MICROSEN**

D.C. AMPLIFIER

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<th>Field of Measurement</th>
<th>Input Element</th>
<th>Output Instrument</th>
<th>Application</th>
<th>Design Advantages</th>
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In each of the above applications, the Recorder could be replaced with a suitable milliammeter indicator, or the output can be used to actuate automatic control relays or signal devices. Inquiries for modification within the useful scope of the Microsen D.C. Amplifier are invited. If possible, such inquiries should contain complete application specifications.

**MICROSEN**

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ELECTRONICS — April, 1950
Development of stabilized, high permeability cores of various types and grades, has greatly increased the applications of toroid coils in the low frequency range from 500 cycles to 200 KC. B&W toroids feature high inductance and high Q within a minimum of space and confined electrical field. These features assure the highest performance in many types of filters or networks.

Over fifteen years background in coil design and manufacture, plus the latest toroidal coil winding equipment, provides a combination that makes it possible for B&W to meet your most exacting requirements. B&W Toroidal Coils are available in open types, shielded, potted or hermetically sealed units in addition to complete filters or networks for specific applications. Our Engineering Department is ready to assist you with your problems in the application of toroids.

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ON THE HIGHWAYS

Telechron Timing Motors
Help Reduce Driving Hazards

The careless driver is not solely to blame for the daily accident headlines. The driver whose vision or reactions are poor is another grave threat to safety on the nation's highways.

To keep the traffic accident rate to a minimum, the American Automobile Association has since 1936 conducted an intensive program of driver testing and training. Numerous testing devices — for color vision, finger reaction, foot reaction, etc. — are employed, not only to rate a driver's ability but to impress on him the necessity for "defensive driving" to guard against the other fellow's faults.

And since the appliances used to test human reactions must be accurate to a split-second, they are actuated by Telechron Timing Motors. Instantly, constantly synchronous, these famous motors respond with accurate, dependable performance — every time!

How's YOUR Timing?

If the control or recording of variables is your problem, very likely a standard Telechron Motor is your answer. A Telechron application engineer, backed by the broadest experience in the field, can help you decide that. For greatest savings in time and money, consult him as early as possible in your planning. Meanwhile, send the coupon for quick facts. TELECHRON INC. A General Electric Affiliate.

ALL TELECHRON TIMING MOTORS ARE

INSTANTLY...CONSTANTLY SYNCHRONOUS

TELECHRON INC.
40 Union Street
Ashland, Massachusetts

Please send me information on sizes and types of Telechron Synchronous Motors. My possible application is:

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It's easy to fit all TV circuits with GRACOIL TELEVISION Transformers

* Order these Gracoil TV Transformers and get identical physical and electrical duplicates of original units used in all popular receivers. Used and endorsed by leading TV set manufacturers. Dependable. Trouble-free. We invite your inquiry. Write.

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INFORMATION

French Chamber of Commerce of the United States
630 Fifth Ave.-New York 20, N.Y.

April, 1950 — ELECTRONICS
Redesign with Truarc Rings helps save $5.70 per unit for Wayne Home Equipment Company, Inc., Fort Wayne, Ind. It gives them a more compact product, eliminates a separate bearing pedestal and a skilled-labor grinding operation. It facilitates use of maintenance-free mechanical seal instead of old type stuffing box.

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins, there's a Truarc Ring that does a better job of holding parts together.

Truarc Rings are precision engineered. Quick and easy to assemble, disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

See the Truarc Exhibit, Booth #1135, at the A.S.T.E. Show.

REDESIGN TRIMS LENGTH 5 1/4 INCHES, CUTS UNIT COST $5.70

Redesign with 5 Truarc Rings gives these big savings

- Cuts length 5 1/4 inches
- Cuts total labor 15.3%
- Eliminates skilled-labor grinding operation
- Saves 38.3% materials
- Allows use of stock-size shaft, smaller bearings
- Eliminates separate bearing pedestal

TOTAL UNIT SAVING . . . $5.70
New DC
SOLENOID CONTACTORS
save installation time

Unit construction —
Fit standard AC mounting

Now, with this modern, compact solenoid-type contactor... you'll no longer have the nuisance of drilling special holes for each component and furnishing special insulation.

Ward Leonard's new Size 1, 2 and 3 DC Solenoid Contactors are unit-insulated — and have metal base plates which fit AC contactor dimensions.

Same accessibility of wiring as AC contactors... silver-to-silver contacts... components interchangeable with AC contactors.

Write for new Bulletin 1950. WARD LEONARD ELECTRIC CO., 31 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

FIG. 5—Result of calibration run of tachometer

for the other motors was considerably less. In every case the curve drawn through the points was determined by application of the principle of least squares to the experimental data. The equations for the curves are all of the form \( I = I_o + AR \) where \( R = \) revolutions per minute, \( I_o = \) leak current of 6H6 tube, \( A = \) slope of curve and \( I = \) current flow. The constants for this equation which apply to the various motors are found in the following table.

<table>
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<th>Current-Speed Equation Constants</th>
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<td>10 rpm</td>
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<td>200</td>
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<td>700</td>
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Since the data obtained in the calibration run of the 10-rpm motor are the least consistent, the errors involved are the greatest. Calculations based on the thirty-three measurements shown in Fig. 5 indicate that for this series of measurements the most probable error in the current readings is 3.1 microamperes, or less than one percent. Acknowledgment is made to the Aluminum Company of America for financial assistance.

One-Kilowatt Ultrasonic Generator

The principle of magnetostriction is employed in a low-frequency generator for ultrasonic applications developed by Mullar Electronic Products Ltd. of Britain.

The generator consists of a driving oscillator, power amplifier and low-voltage d-c power supply, together with necessary monitoring and check meters, and the transducer unit composed of a stack of...
NEW... JAN COMPONENT STANDARDS BRING DEPENDABILITY
All components meet the latest JAN (Joint Army-Navy) specifications. This means maximum resistance to wear, corrosion, humidity, fungus, temperature, and time. Thus, equipment failure is minimized and maintenance and replacement costs are reduced to the absolute minimum.

Temperature—equipment operates dependably from -55°C to +75°C (-67°F to +167°F).
Humidity—equipment performs normally at 100% humidity with condensation.
Altitude—equipment operates at full power at altitudes up to 10,000 feet (3,048 meters), and withstands shipping altitudes up to 30,000 feet (9,144 meters).

NEW... UNIT CONSTRUCTION PROVIDES OPERATING FLEXIBILITY
A flexible, multifrequency station can be formed from a combination of 96D and 96-200C Transmitters, one or two 50H Modulators and a 36D Rectifier. This provides for either simultaneous transmission on several frequencies or the selection of an individual frequency best suited to your particular communication problem.

NEW... FRONT CONTROLS PROVIDE ADJUSTMENT CONVENIENCE
All controls are located on the front of the transmitter: all R. F. stages and antenna tuning, under and overload and tone-keying adjustments, selection switch for external frequency shift excitation, rotary meter switch, exciter output control.

NEW... DRAWER-TYPE CONSTRUCTION MEANS EASY MAINTENANCE
Ball bearing, drawer-type construction permits the transmitter to be quickly withdrawn from cabinet. All components are instantly accessible... no components are hidden or buried.

Write Today
for complete information and specifications.

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Write for your copy of Technical Bulletin No. 50 showing RADIAL (Conrad, extra light, and full race), Angular Contact, Self Aligning and Pivot Bearings 1/8" to 1/2" O.D.

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5 MAIN STREET • PETERBOROUGH, NEW HAMPSHIRE

The GROUND Miniature Bearing

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<th>Portable Precision for the Field Engineer!</th>
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<td>RADIO INTERFERENCE AND FIELD INTENSITY METER</td>
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- A portable unit that you can DEPEND upon!
- Measures FIELD INTENSITIES of radio signals and r.f. disturbances using either a rod antenna or a rotatable loop antenna.
- CONTINUOUS RANGE 150 kc to 25 mc.
- ONE MICROVOLT SENSITIVITY as a two-terminal voltmeter; 2 microvolts-per-meter using rod antenna.
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WIND more COILS faster
WITH YOUR PRESENT COIL-WINDING MACHINE!

- USE PAMARCO Wire DeReeling Tensions for PERFECT COILS

Installation of these inexpensive PAMARCO tensions lowers winding costs because each machine will accommodate more coils at higher winding speeds. In addition to increased production, PAMARCO tensions raise production quality. Free-running action practically eliminates wire breakage and shorted turns. Simple thumb screw setting quickly adjusts for any wire gauge. No tools or special skill are needed for operation. For complete data call or write.

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April, 1950 — ELECTRONICS
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105°C
PERFORMANCE
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★ RESISTS DEFORMATION
★ MEETS JAN C76 LOW TEMPERATURE REQUIREMENTS
★ RESISTS SHRINK-BACK WHEN SOLDERED
★ and More Megohms!

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A tough, horn-like material with high dielectric and mechanical strength. Excellent machinability and forming qualities, great resistance to wear and abrasion, long life, light weight. Sheets, Rods, Tubes, Special Shapes.

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National Research and Engineering Service are available to you, without obligation—to help you solve your specific development problem. Write us—

TUBES AT WORK

(continued)
nickel laminations wound with a common coil for excitation and polarization. The amplifier drives the transducer and delivers a maximum output of 1 kilowatt over a frequency range of 10 kc to 25 kc.

The magnetostriction transducer is composed of a stack of nickel laminations somewhat resembling a transformer core. The insulation of this unit is such that the complete transducer may be immersed in conductive liquids without fear of damage or electrical shock. In practice the transducer can quite easily be clamped against the side of the treatment bath. Alternatively it can be fitted in a pipe junction, thus enabling the liquid to be treated as it flows over the actuating face. With simple cooling arrangements, a loading of about 5 watts per square centimeter can normally be used.

The maximum dimensional change, and therefore the maximum transfer of electric to ultrasonic energy, is obtained when the magnetostriction element is excited at its natural frequency. For this reason it is necessary to provide different transducers if the frequency of excitation is changed. The transducers at present available cover the standard frequencies 15, 20 and 25 kc.

The generator is rack-mounted for ease of service, and the controls are simplified for operation by semi-skilled labor. Continuous operation is possible at peak power over the frequency range.

Since the velocity of sound in nickel varies with the temperature and the magnetic field—and this in turn affects the natural frequency...
- and every single one is Individually Tested!

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**Better 4 Ways**
- Precision
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You are invited to write now for a copy of the brand new **Hi-Q** Datalog just off the press.

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Save time and trouble. Use this catalog's complete listing and descriptions to find exactly the battery you need for any conceivable purpose.
No "breakdown" even after roughest handling, with this new insulation

What does insulation breakdown cost you? . . . In customers "soured" on your product? In salesmen explaining, instead of selling your line? In excessive maintenance?

BH "649" Fiberglas Tubing and Sleeving is proof that insulation can be toughened against abrasion. Even after rough handling and severe bending, BH "649" retains its rated dielectric strength.

BH "649" stays supple after baking 12 hours at 300°F. No flowing, softening or blistering after 15 minutes at 425°F. Basic Fiberglas braid (1200°F) unaffected by aging.

You get this superior Fiberglas insulation at the price of ordinary cotton-base or rayon-base insulation. Often a less expensive grade of insulation can be used since there is little or no loss of dielectric strength in assembly or product use.

BH "649" is made in Grades A-1, B-1, C-1 and C-2—in all sizes from No. 24 to % " inclusive. Samples furnished gladly on request.

Bentley, Harris Manufacturing Co., Conshohocken, Pa.

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Send samples, pamphlets and prices on other BH Products as follows:

☐ BH non-fraying Fiberglas Sleeving
☐ Cotton or Rayon-base Sleeving and Tubing

you get MORE PERFORMANCE for LESS MONEY with the NEW Browning OSCILLOSYNCHROSCOPE

For only $485.00

this new five-inch Browning 'scope gives you the basic laboratory equipment for pulse work — in a single, compact unit with:

- Triggered sweep rate continuously variable from 1.0 to 25,000 microseconds per inch.
- Sawtooth sweep rate 10 cycles to 100 KC.
- Sweep calibration (triggered and sawtooth) in microseconds per screen division accurate to ±10%.
- Vertical amplifier flat within 3 db. from 5 cycles to 5 megacycles.
- Sensitivity 0.075 volts RMS per inch.
- Horizontal amplifier d.c. to 500 KC, sensitivity 2 volts per inch.
- Self-calibrating on both X and Y axis.
- Readily portable . . . weighs but 50 pounds.

PLUS THESE ELECTRICAL AND MECHANICAL FEATURES

- SUP1 cathode-ray tube operates at accelerating potential of 2600 volts
- Sweep starting time is approximately 0.1 microsecond
- Sweep may be triggered or synchronized by positive or negative sine-wave or pulse signals of 0.5 volts (external) or 0.75 inches deflection (from vertical amplifier)
- Three-step attenuator — 100:1, 10:1, and 1:1, plus continuous adjustability over entire range
- Peak-to-peak vertical calibration voltages of 0-2-20-200 at accuracy of ±10%.
- Cathode connection, brought out to front panel, allows external blanking and marker connection
- All deflection plates are available for direct connection
- Steel cabinet finished in black wrinkle
- Steel panel finished in black leatherette
- Copper-plated steel chassis with lacquer finish
- Controls grouped by function for operating convenience
- Free-view screen has graduated X- and Y-axis scales
- Size: 10” wide, 14½” high, 16½” deep
- Instrument draws 180 volt-amperes at 115 volts 60 cycles.

NET PRICE, F.O.B. Winchester, Mass.............$485.00

FREE BULLETIN gives further data on this new, low-cost, versatile oscillosynchroscope. Ask for data sheet ON-54E.

TUBES AT WORK (continued)

Driver stages and power supply of the generator. The tray mounted on the transducer is used for emulsification.

of the transducer — it is sometimes necessary to make a small adjustment to the generator frequency. For this reason a variable-frequency source of power is provided.

The transducer employed in the Mullard equipment offers scope for work in the metallurgical field in the mixing of powdered and molten metals in alloy production. It is possible that the equipment could also be used for speeding up the process of solidification in molten tin and aluminum, and for the tinning of aluminum and similar metals.

Emulsification of a number of liquids and the precipitation or dispersion of particles in suspension are further possibilities of ultrasonics receiving attention. A certain amount of success is reported in cleansing and washing applications, especially with cotton and rayon waste. It is not only possible to produce a much higher degree of cleansing, but it is also possible to reduce the time of treatment.

Simple Deviation Limiter

By Virgil M. Brittain
Portland, Oregon

To LIMIT the frequency deviation produced by a phase-modulated transmitter, it is necessary to limit the slope of the audio-frequency wave applied to the phase modulator.

A method of slope limiting which
YOU CAN BE SURE... IF IT'S

Westinghouse

No Program Interruptions

How KDKA MAKES SURE with Selenium Rectifiers

You, too, can have a power rectifier that is good for the life of your transmitter. Gone forever will be those costly program interruptions caused by the sudden necessity of replacing power tubes.

Since Selenium stacks were installed at KDKA, power rectifiers are no longer critical components. In addition to many years of service, these Selenium rectifiers provide other benefits. No warm-up period or filament power required ... ability to withstand relatively high inverse surges ... takes temporary or prolonged overloads without damage.

Why not be assured of stable operation of your power rectifier ... of program continuity at full signal strength. Your nearby Westinghouse representative will tell you how to get the job-proved Rectox. Ask him for a copy of DB-19-025 or write Westinghouse Electric Corporation, Post Office Box 868, Pittsburgh 30, Pa. J-21568

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Vacuum - impregnated, HIPERSIL core, open or cased transformers to meet exacting electrical requirements in any given case size. Special design skills, premium materials, painstaking manufacture of custom units. If you have a transformer problem, consult us immediately.

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Look for the orange package . . . the universally popular solder for use in electrical applications where bonding must be secure and free from corrosion.

The flux is in the solder . . . all you need is heat! Federated Rosin Core Solder is available in 1, 5, and 20-pound sizes.

Federated makes every commercial solder . . .

Asarco Body Filler Metal, acid-core, solid wire, spray-gun, and bar . . . purity and composition guaranteed by the world’s leading supplier of solder.
Astatic engineers have accomplished— in their tiny new “AC” Series Crystal Cartridges—a mechanical drive system with a new low in inertia. It's the primary source of a new degree of smoothness of response. You will also note new tracking excellence and low needle talk—also partially due to the drive system. Overall excellence of frequency response is particularly superior in the high frequencies. If you have not already done so, by all means check the perfection of sound reproduction which these advanced little cartridges are capable of delivering.

“AC” Series Cartridges weigh approximately five grams and are about 5/16” thick x 1/2” high x 1-1/2” long, not including pins. They are available in double needle turnover or single needle models, the latter in choice of three-mil stylus tip for 78 RPM, one-mil for 33-1/3 or 45, or with special Astatic All-Groove tip for all record types. Astatic’s exclusive Type “C” Taper-Lock Needle, easily changeable without tools, is used throughout. Housings are of molded Bakelite, with metal mounting brackets (fit standard 1/2” mounting center) and needle guards. Write for complete specifications.

Changing the Type “C” Taper-Lock Needle

Placing thumbnail against stub at rear of needle (A), simply push in direction of arrow to remove. To insert, fold card, on which new needle comes, along scored line; place narrow end of needle shank in wide end of metal cartridge groove (B) and pull card in direction of arrow.

Astatic Crystal Devices manufactured under Brush Development Co. patents
Choice of the Elite!

- After comprehensive examinations and tests, the most outstanding men in airline operations and communications have almost without exception specified the Collins 51R aircraft receiver for navigational use of the omnidirectional range.

By their choice, nearly all major United States airlines have installed or soon will install this efficient, trustworthy receiver and accessory instrumentation, to take full advantage of the new VHF radio facilities with which most of America's airways are now equipped.

The Collins 51R equipment and its companion VHF airborne transmitter, the Collins 17L, are also providing up-to-the-minute navigation and communications in an increasing number of private and business planes. Write us today for descriptive bulletins.

**COLLINS 51R SPECIFIED FOR:**

- American Airlines
- Capital Airlines
- Chicago and Southern Air Lines
- Colonial Airlines
- Continental Air Lines
- Eastern Air Lines
- National Airlines
- Northwest Airlines
- Pan American World Airways System
- Robinson Airlines
- Transcontinental & Western Air
- United Air Lines

**IN AVIATION RADIO, IT'S...**

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street  2700 West Olive Avenue
NEW YORK 18  BURBANK
Large or Small
SQUARE, ROUND OR RECTANGULAR
PAPER TUBES
FOR COIL WINDING

Inside Perimeters from .592" to 19"
With specialized experience and automatic
equipment, PARAMOUNT produces a
wide range of spiral wound paper tubes
to meet every need . . . from 1/2" to 30' long,
from .592" to 19" inside perimeter, includ-
ing many odd sizes of square and rectan-
gular tubes. Used by leading manufacturers.
Hi-Dielectric, Hi-Strength. Kraft, Fish
Paper, Red Rope, or any combination,
wound on automatic machines. Tolerances
plus or minus .002". Made to your speci-
fications or engineered for YOU.

Paramount PAPER TUBE CORP.
616 LAFAYETTE ST., FORT WAYNE 2, IND.
Manufacturers of Paper Tubing for the Electrical Industry

---

HEATHKIT
BUILD YOUR OWN
TEST EQUIPMENT

HEATHKIT AUDIO GEN KIT...$34.50
HEATHKIT TELEVISION GENERATOR KIT...$39.50
HEATHKIT TEST EQUIPMENT
HEATHKIT SIGNAL CHECKER KIT...$29.50
HEATHKIT TRACER KIT...$19.50
HEATHKIT BATTERY ELIMINATOR KIT...$22.50
HEATHKIT OSCILLOSCOPE KIT...$39.50
HEATHKIT ELECTRONIC SWITCH KIT...$34.50
HEATHKIT VACUUM TUBE VOM KIT...$24.50
HEATHKIT R.F. SIGNAL GEN KIT...$19.50
HEATHKIT IMPEDANCE BRIDGE SET...$69.50
HEATHKIT HANDITESTER KIT...$13.50
HEATHKIT CONDENSER CHECKER KIT...$19.50
HEATHKIT NEW...

HEATH COMPANY
BENTON HARBOR, 14
MICHIGAN

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Speer CARBON COMPANY
ST. MARYS, PENNA.

Frequency drift from short wave
and FM transmitters, diathermy and
electronic heating machines can be
reduced with graphite anode osc-
cillators.

And when tubes are equipped with
non-warping Speer graphite anodes,
frequency drift reaches a new low —
stability of inter-electrode capaci-
tances is assured — warping in other
tube elements is inhibited.

In other vacuum tubes — power, rec-
tifier and modulator, Speer graphite
anodes impart these characteristics
which cannot be obtained through
the use of any other type anode. Try
graphite anode tubes in your equip-
ment and you'll see why the current
trend is to graphite.

Look for graphite anodes when
you're looking for better tubes.

April, 1950 — ELECTRONICS
Blaw-Knox is building
MORE RINGSIDE SEATS
for the fast-growing TV audience

Not complete stations, of course, but those outward and visible signs of top video transmission efficiency—Blaw-Knox Antenna Towers...Electronic Engineers know what they want, and know what suppliers can best meet their requirements. For the design, fabrication and erection of their antenna support, Blaw-Knox comes to mind first because it "came to radio" first.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2077 FARMERS BANK BUILDING • PITTSBURGH 22, PA.
TWO NEW WAVEGUIDE-OUTPUT REFLEX KLYSTRONS

Varian engineered to tune over the frequency range from 8,100 to 17,500 megacycles. These tubes are designed for transmitter service, for use as local oscillators and bench oscillators as a power source for measurements. The tubes are small, light and sturdily built. Flanges with mica windows bolt directly to the waveguide with a lapped surface to avoid reflections and leakage. Special grid techniques increase efficiency, reduce microphonics. A single screw tuner covers the entire broad tuning range.

Electrical Characteristics

<table>
<thead>
<tr>
<th></th>
<th>X-13</th>
<th>X-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam Voltage</td>
<td>500 volts, max</td>
<td>600 volts, max</td>
</tr>
<tr>
<td>Beam Current</td>
<td>60 ma, max</td>
<td>60 ma, max</td>
</tr>
<tr>
<td>Heater Current</td>
<td>6.3 volts</td>
<td>6.3 volts</td>
</tr>
<tr>
<td>Reflector Voltage</td>
<td>11.1 amp</td>
<td>11.1 amp</td>
</tr>
<tr>
<td>Tuning Range</td>
<td>8,100-12,400 mc min</td>
<td>12,400-17,500 mc min</td>
</tr>
<tr>
<td>Power Output</td>
<td>100 milliwatts, min with transformer</td>
<td>10 to 100 milliwatts</td>
</tr>
</tbody>
</table>

Mechanical Specifications

<table>
<thead>
<tr>
<th></th>
<th>X-13</th>
<th>X-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode</td>
<td>Oxide coated, unipotential</td>
<td>Oxide coated, unipotential</td>
</tr>
<tr>
<td>Clearance dimensions</td>
<td>3½ x 2½ x 2½ in.</td>
<td>3½ x 2½ x 2½ in.</td>
</tr>
<tr>
<td>Weight</td>
<td>6 ounces</td>
<td>5 ounces</td>
</tr>
<tr>
<td>Output Flange</td>
<td>Mates with standard flange for 1 x ½ x 0.050 in. waveguide</td>
<td>Mates with standard flange for 0.702 x 0.301 x 0.040 in. waveguide</td>
</tr>
<tr>
<td>Cooling</td>
<td>Forced air cooling required for beam power inputs exceeding 10 watts</td>
<td>Forced air cooling required for beam power inputs exceeding 10 watts</td>
</tr>
<tr>
<td>Mounting position</td>
<td>Any</td>
<td>Any</td>
</tr>
</tbody>
</table>

Typical Operation

<table>
<thead>
<tr>
<th></th>
<th>X-13</th>
<th>X-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>10,000 mc</td>
<td>16,000 mc</td>
</tr>
<tr>
<td>Beam Voltage</td>
<td>400 volts</td>
<td>600 volts</td>
</tr>
<tr>
<td>Beam Current</td>
<td>48 ma</td>
<td>50 ma</td>
</tr>
<tr>
<td>Reflector Voltage</td>
<td>200 volts</td>
<td>280 volts</td>
</tr>
<tr>
<td>Power Output</td>
<td>230 milliwatts</td>
<td>25 milliwatts</td>
</tr>
<tr>
<td>Load VSWR</td>
<td>Less than 1.1</td>
<td></td>
</tr>
<tr>
<td>Modulation</td>
<td>30 mc</td>
<td>50 mc</td>
</tr>
<tr>
<td>Bandwidth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>Less than 0.25 mc per degree C</td>
<td></td>
</tr>
</tbody>
</table>

Not illustrated, X-21 klystron. Five-watt two-cavity oscillator. Weight approximately 4½ ounces. Specifications upon request.

Company Simulates Flight

Flight characteristics and control equipment of an aircraft can be checked prior to its construction on a calculator known as the flight simulator. With it, MIT engineers will be able to set up an electrical model of any aircraft which is in an advanced stage of design and then apply an actual autopilot to fly this nonexistent, theoretical craft.

The autopilot then has exactly the same problem that it would have in the actual flight of the missile or airplane, were the prototype built. Thus the simulator flight...
HERE WAS THE PROBLEM:
How to obtain a strong, rigid assembly for conductors supporting the filaments of sealed beam automobile headlights and, at the same time, make a perfect seal between the conductors and the glass housing of the lamp, so that gas sealed within the lamp might not escape.

AND HERE'S THE SOLUTION:
The back wall of the lamp, cast from Pyrex-like glass, has three holes through which the conductors can be passed. The area around these holes is heated until the glass is near-molten. Over each hole, on the rear side of the lamp, is then placed a "thimble"—made of specially produced D.H alloy. These thimbles are pressed into the molten glass, which, upon cooling, holds them firmly in position. The conductors are then passed through the holes in the glass wall, and their free ends soldered to the base of each thimble respectively. Lugs soldered to the thimbles, outside, provide terminals for mounting the lamp in a socket. In this manner, a strong, stable, gas-tight assembly is obtained.

Westinghouse discussed its needs with Driver-Harris. Could the necessary type of thimble stock be obtained, and supplied in strip form, .009" thick, with negligible tolerances? The answer is found on all Westinghouse sealed beam headlights today. Driver-Harris not only produces an alloy with precisely the properties needed, but advanced D-H rolling techniques meet the exacting dimensional requirements specified.

SPECIAL ALLOYS FOR SPECIAL PURPOSES is an important phase of our business. If you have been unable to find the alloy you need, tell us about it. Our 50 years of development and manufacturing experience are at your service.

The part played by the metal thimbles in solving the problem is vitally important:

1. It is imperative that the thimbles be composed of a metal alloy with a coefficient of expansion closely approaching that of glass at all temperatures up to the melting point of glass. Any appreciable difference in the rates of expansion would result in the glass being fractured.
2. The thimble stock must be initially and entirely gas-free—to avoid the possibility of bubbles or strains being formed in the glass at the seal.
3. The stock must be held to extremely close tolerances when manufactured—to meet the requirements of meticulous, high-speed presses and dies specially developed to produce the thimbles.
EMC Model 500

**THE RIGHT MOTOR AT THE RIGHT PRICE**

**EMC AND CYCLOHM FRACTIONAL H.P. MOTORS**

Model 500 is a brilliant, seasoned performer used extensively by leading manufacturers of home movie projectors, vending machines, portable tools, radar and electronic equipment, railroad signal lights, laboratory stirrers... wherever a fractional h.p. motor of proved dependability is needed at low cost.

For complete information about EMC model 500 or any of the famous EMC universal, shunt wound, or shaded pole motors and Cyclohm induction motors, write for handy reference literature and specification sheets. All EMC and Cyclohm motors can be furnished with gear units, 12 models, hundreds of ratios. EMC and Cyclohm fractional h.p. motors are made by fractional h.p. specialists...your guarantee of the right motor at the right price.

**HOWARD INDUSTRIES, INC. DEPT. EB, RACINE, WIS.**

**DIVISIONS:** EMC — ELECTRIC MOTOR CORP. CYCLOHM — CYCLOHM MOTOR CORP.

---

**VSWR and RF WATTMETER**

**SPECIFICATIONS**
- **Frequency Range:** 50 to over 1000 MCs
- **Connectors:** Standard connectors supplied are type N to accept UG-7/U attached to RG-1/U and RG-9/U cable. The instrument is supplied on request, with UHF type connectors to accept RG-1/U attached to RG-8/U and RG-9/U cable.
- **Adapters are available for attaching to 1/2 inch 51.5 ohms coaxial line.**

**MM 560 SERIES**

Provides instant assurance of proper functioning of entire RF portion of transmitter, antenna, and transmission line.

This new MicroMatch reads directly the incident power, reflected power, net power to load, and VSWR of the load. Complete $97.00

**M. G. JONES ELECTRONICS CO. BRISTOL, CONNECTICUT**

---

**F-M RADAR SYSTEMS**

Here is an overall treatment of frequency radar that covers essential theory, useful techniques and practical uses of this new and important phase of radar technology. Reflecting the findings of a broad research and development program initiated by RCA, this book puts at your fingertips a wealth of timely data designed to broaden your understanding of the principles and possibilities of F-M radar.

Just Published

466 pages, 6 x 9
156 illustrations, $4.00

By David G. Luck

Research Engineer, RCA, Laboratories Division

The author takes up and develops the general principles of distance and speed determinations by f-m radar. Some of the radio portions of an f-m radar system are then considered, including directive antennas for transmission and reception, oscillators for generating the radio frequency power transmitted, frequency modulators controlling these oscillators, etc. Indicating or control devices suitable for converting f-m data into the useful forms of currents, voltages, shaft positions, frequency spectrum display, etc., are discussed in detail.

The kinematics of simple fire-control problems is developed, and specific f-m radar equipment needed to solve such problems is described. Detailed treatment is given to special principles and circuits typical of f-m radar.

SEE THIS BOOK 10 DAYS FREE

**McGRAW-HILL**

McGraw-Hill Book Co., Inc. 330 W. 42nd Street
New York 18, N. Y.

Read the book's FREQUENCY MODULATED RADAR for 10 days examination or approved. In 10 days I will return $4.00, plus a few cents for delivery, or return book postpaid. We pay for delivery if you return with this coupon; same return privilege.

Name
Address
City Zone State
Company
Position

This offer applies to U. S. only

April, 1950 — ELECTRONICS
When a material requirement calls for low dielectric constant, low loss factor, high heat-resistance, toughness, resiliency—there is one material that has all these properties, Du Pont "Teflon" tetrafluoroethylene resin. That's why "Teflon" is superior to all other materials for use in high-frequency connectors. That's why Sperry uses "Teflon" for the insulation in the coaxial connectors for this marine radar set. "Teflon" provides unequaled transmission efficiency plus outstanding durability.

First, "Teflon" has a low dielectric constant (2.0), constant over the entire range of frequencies measured to date. This minimizes step discontinuities that produce reflections of power. In addition, it has a low loss factor (0.0005)—so that little power is lost at the connector, and the insulation does not heat up in service.

Along with these outstanding electrical properties, "Teflon" has high heat resistance (serves up to 500°F.), eliminates danger of melting the insulation when soldering connections during assembly. It's tough, too, even at temperatures as low as -90°F., won't break or crack if connectors are dropped or bumped, has just enough resiliency to give and conform when stressed during installation.

"Teflon" is supplied by Du Pont in standard shapes (rods, tubes, sheets and tape) and molding powders. Or we will recommend molders or fabricators who can supply finished parts of "Teflon." Write today for more information. Our technical staff will be glad to help you. E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Plastics Sales Offices: 350 Fifth Ave., New York 1, N. Y.; 7 S. Dearborn St., Chicago 3, Ill.; 845 E. 60th St., Los Angeles, California.

*REG. U.S. PAT. OFF.

Better Things for Better Living...through Chemistry
HOW TO Solve YOUR CARTRIDGE PROBLEMS Easily!

Check the features!

TO GET EVERYTHING YOU WANT

Specify E-V Torque Drive*

- FREQUENCY RESPONSE tailored to the requirements of your system. Clean, wide range... roll-off... or cut-off characteristics... to your specifications.

- OUTPUT VOLTAGE sufficient for full power output without sacrificing desired compliance.

- LATERAL COMPLIANCE for excellent low frequency tracking at 5-6 grams force.

- VERTICAL COMPLIANCE to minimize record and tip wear.

- RUMBLE PICK-UP audibly suppressed without alteration of frequency response characteristics.

- MOISTURE PROTECTION from high humidity at no extra cost.

- PERFORMANCE DEPENDABILITY to assure stable response despite temperature change.

- MINIMUM TRACKING FORCE. Guaranteed tracking throughout the frequency spectrum at only 5-6 grams force.

- STYLUS QUALITY. Long wearing, precision ground tips for high fidelity reproduction and minimum record wear.

- UNIFORMITY IN PRODUCTION. Precise conformity to laboratory established specifications in quantity production.

- DUAL STYLUS SET-DOWN. Precise set-down unaltered by stylus replacement.

- E-V Torque Drive cartridges, resonated only by crystal stiffness and low mass driving system, offer wide range, peak-free response. The system can be mechanically tuned to obtain any curve desired.

- By mechanical step-up, stylus force is multiplied 20 times in the Torque Drive system, producing a high voltage output to compliance ratio.

- Lateral compliance exceeds unity in E-V cartridges because bearings, bushings, and other types of friction are eliminated.

- The absence of bearing rigidity makes Torque Drive a vertically compliant drive system.

- Torque Drive cartridges respond only to lateral tip motions and cancel output of vertical motions.

- All E-V cartridges are moisture inhibited for longer trouble-free life by a special coating of silicone... at the cost of ordinary weather sealing.

- The response of E-V cartridges depends only on a mechanical drive system which does not employ temperature sensitive pads or damping materials.

- E-V cartridges track well at 5 grams force because of high lateral compliance and clean, wide range response.

- Accurate inspection, exacting tests and highest quality materials assure superior performance from each E-V single-tip or dual-tip stylus.

- The performance of Torque Drive cartridges depends only on a simple harness system and crystal; not on a multitude of minute parts.

- The E-V in-line, dual tipped stylus admits no set-down variation. *Pat. Pend.

TUBES AT WORK

Gimbal flight table moves in same manner as plane whose flight performance is being checked automatic control system of a plane or missile just as it would be tested in actual flight. The gimbal frame table rolls, pitches, and goes through all the motions the plane would make in the air under stated conditions.

A problem is worked out on the apparatus by setting electronic computer dials that represent the various important characteristics of the aircraft to be studied—weight, velocity, altitude, wing span and many others. Before the simulator can be used, many of these characteristics are obtained from wind tunnel tests of small models of the proposed aircraft.

Then the question is fed into the
For Microwave Applications Requiring Dependable U-H-F Performance!

Here are well-known G-E planar types that take in stride frequencies of thousands of megacycles. Proved in military radar—proved in commercial u-h-f work—Lighthouse Tubes serve reliably, give long use, as high-level detectors; as pulsed and CW oscillators; and as frequency multipliers and power amplifiers.

If you design or build equipment of the following types, G-E Lighthouse Tubes should have your first consideration:

- Police, taxicab, and other mobile and fixed radio apparatus operating in the 450–460 mc band.
- U-h-f equipment for emergency communications work.
- Aircraft traffic and location control devices of various types.
- Communications multiplex equipment.
- Broadcast relay equipment.
- Telemetering transmitters.
- Microwave test apparatus.

By specifying General Electric Lighthouse Tubes, you further protect your customers in that replacements can be obtained locally. From coast to coast, G-E tube distributors with stocks on hand are equipped to give fast delivery.

Read the facts below about these modern, high-efficiency u-h-f tubes; then ask for prices and complete information. Also . . . G-E tube engineers will be glad to work personally with you in choosing the right types for your circuits. Address Electronics Department, General Electric Company, Schenectady 5, New York.

Application

**GL-2B22**
H-f detector up to 1,500 mc.

**GL-2C40**
R-f amplifier, converter, and local oscillator up to 3,370 mc.

**GL-2C43**
R-f amplifier and oscillator from 200 mc up to 1,500 mc, and in special plate-pulsed circuits up to 3,370 mc.

**Maximum Plate Ratings**

<table>
<thead>
<tr>
<th>GL-2B22</th>
<th>GL-2C40</th>
<th>GL-2C43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissipation</td>
<td>6.5 w</td>
<td>6.5 w</td>
</tr>
<tr>
<td>Voltage, CW</td>
<td>500 v</td>
<td>500 v</td>
</tr>
<tr>
<td>Voltage, pulsed</td>
<td>100 v</td>
<td>100 v</td>
</tr>
<tr>
<td>Voltage, peak inv.</td>
<td>300 v</td>
<td>300 v</td>
</tr>
<tr>
<td>Current, average</td>
<td>20 ma</td>
<td>25 ma</td>
</tr>
</tbody>
</table>

**General Electric**

ELECTRONICS — April, 1950
VULCAN ELECTRIC HEATING UNITS

IMMERSION

For heating oils, water, paraffin, chemicals, etc. in tanks, boilers, kettles, urns.

Various types of Bolt-on Flanges and Threaded Bushings.

Single and Three-heat, with metal casings. Complete with gaskets, terminal cover, etc.

VULCAN ELECTRIC COMPANY
DANVERS, 10, MASS.

Makers of Vulcan Electric Soldering Tools, Electric Solder Pots, Electric Glue Pots, Electric Branding Irons and Electric Heating Units, including the new Vulcan 900 series, for changing over any hot water heater to electric operation.

ONLY THE Potter DECADE COUNTER offers the simplest, most reliable circuit

The POTTER 4-tube Decade Counter Circuit has been proven by over five years of actual operation in Government proving grounds, as well as in numerous industrial applications in which a precise count is required for packaging or automatic machine control. The Decades are available either as components to be used in your equipment, or in a packaged POTTER Scaler, Predetermined Counter, or Precision Counter Chronograph. Modified or specially-designed counting, timing and calculating equipment can be supplied for special applications.

For an accurate appraisal of your problem, call or write Dept. 6-P.

The POTTER 4-tube Decade Counter Circuit has been proven by over five years of actual operation in Government proving grounds, as well as in numerous industrial applications in which a precise count is required for packaging or automatic machine control. The Decades are available either as components to be used in your equipment, or in a packaged POTTER Scaler, Predetermined Counter, or Precision Counter Chronograph. Modified or specially-designed counting, timing and calculating equipment can be supplied for special applications.

For an accurate appraisal of your problem, call or write Dept. 6-P.

APPLICATIONS:
- Automatic Packaging
- Precision Timing
- Frequency Measurements
- Radiation Measurements
- Frequency Dividing
- Machine Control

POTTER INSTRUMENT CO.
INCORPORATED
126-56 ROOSEVELT AVENUE, FLUSHING, N. Y.

A new low unit price of $4500 is announced as a result of wide acceptance and quantity production.

CONTINENTAL ELECTRIC CO.
America's Leader in Quality Electronic Tube Manufacture
GENEVA, ILLINOIS

April, 1950 — ELECTRONICS
That's why **TEMFLEX 105** Plastic Tubing excels in transformer duty

This tubing hits a new high in retained flexibility and elongation. Tested in oils at 90°C for 60 days, TEMFLEX 105 shows absolutely no change in flexibility...no cracking or checking whatever...no loss in elongation. Stands up, too, under overload tests.

You won't have to worry about dielectric strength—it actually increases after 60 days in oil at 90°C. The U.L. tests demonstrating this also show that TEMFLEX 105 does not corrode conductors, or increase in thickness after aging. And it's permanently identified with the printing of TEMFLEX 105 along the entire length.

**Be Sure To Send For U.L. Report**

Check the complete report and see for yourself how TEMFLEX 105 surpasses any tubing you can buy for transformer service. Generous samples and full data will be sent promptly on request. Write.

---

*The only plastic tubing approved by Underwriters' Laboratories for use in high-temperature mineral oil.*

**Look to Irvington**

for Continued Leadership in Insulation™

IRVINGTON
Varnish & Insulator Company
Irvington 11, New Jersey
FOR ULTRA-PRECISION CATHODE RAY TUBES...

KAHLE CUSTOM-BUILT MACHINERY

Perfect performance in the finished product requires machinery built to meet your need in the production stage. Kahle's years of experience in meeting the specific requirements of ultra-precision operations with custom-engineering, has helped many outstanding manufacturers of cathode ray tubes operate efficiently and profitably. This Kahle know-how may solve your unusual problem, too. Kahle specialists are available for consultation, without obligation.

Consult Kahle On Any Requirement • Write For Complete New Catalog

Kahle Specializes in Equipment and Methods for the Manufacture of Complete Production Units For

- Cathode Ray Tubes
- Subminiature Tubes
- Electronic Tubes
- Fluorescent Lamps
- Neon Tubes
- Photocells
- X-Ray Tubes
- Glass Products

Kahle ENGINEERING COMPANY
1309 SEVENTH STREET • NORTH BERGEN, NEW JERSEY

British Television Relay

BY JOHN H. JUPE
Enfield, Middlesex
England

The radio relay system for television recently demonstrated in Britain comprises a chain of uhf radio transmitters and receivers working on frequencies of about 900 mc to link London and Birmingham (about 120 miles) for television programs in a continuous public service. The equipment, which was designed, manufactured and installed by the General Electric Co. Ltd. of England for the United Kingdom Post Office, will ultimately enable programs to be sent in both directions simultaneously but initially only one-way traffic will be possible.

There are two terminal stations and four repeaters, at present working on frequencies of 870 and 980 mc, and a station which receives on one frequency will transmit on the other so that the receiving antenna cannot pick up energy from the local transmitter. When the two-way link is brought into use there will be two additional frequencies of 917 and 937 mc.

Frequency modulation is used in
QUALITY... Plus ADAPTABILITY

CLEVELAND

COSMALITE* AND CLEVILITE* SPIRALLY LAMINATED PAPER BASE PHENOLIC TUBES

Cosmalite is known for its many years of high quality performance. Clevelite is the new improved tubing designed to meet more exacting specifications.

"Cleveland" has an enviable record of service and dependability. Your orders receive prompt attention. Deliveries are made in time for your production schedules.

For the best... "Call Cleveland." Samples on request.
The Superior Electric Company packs into its voltage control equipment a wealth of research, design and production experience. Each unit is guaranteed to deliver — over normal periods of operation and life-expectancy — all the performance characteristics stated in Superior Electric advertising.

WHY THE GUARANTEE

Every STABILINE Automatic Voltage Regulator shipped from The Superior Electric Company has been inspected and tested to the most rigid mechanical and electrical specifications. It is your assurance that they will perform as advertised.

THESE ARE THE SUPERIOR ELECTRIC VOLTAGE REGULATORS

THE VARICELL (above left)
The latest Superior Electric development in voltage control equipment. Delivers DC voltage, variable from 0 to 30 volts, from an AC source. Output is stabilized — held to set values regardless of line variations. Output is regulated — unit automatically compensates for load fluctuations. Operates from any 95-135 volt, 60 cycle, single phase AC line. Stabilization and regulation are ±0.25% for output settings between 6 and 30 volts. R.M.S. ripple voltage does not exceed ±0.1 volts.

STABILINE TYPE IE (above center)
Completely electronic and instantaneous in operation. No moving parts. Maintains output voltage to within ±0.1 volts of nominal for line voltage variations; to within ±0.15 volts for any load current change — or for any load power factor change from 0.5 lagging to 0.9 leading. Waveform distortion never exceeds 3%. Available in a wide range of capacities.

STABILINE TYPE EM (above right)
Maintains constant voltage on heavily loaded lines. Features zero waveform distortion; complete insensitivity to magnitude and power factor of load; no effect on power factor; no critical adjustments; high efficiency; adjustable output voltage. Available for a wide range of applications in 115, 208, 230, 440 volt, single and three phase ratings; capacities to 100 KVA.

GET COMPLETE INFORMATION BEFORE YOU BUY

The Superior Electric Company welcomes inquiries regarding any of its voltage control equipment. Your questions will receive prompt and complete answers. We’re always ready to consult with you on voltage regulation problems — at no obligation to you.

WRITE 404 MEADOW STREET, BRISTOL, CONNECTICUT

TUBES AT WORK (continued)

the system and modulation of the carrier is achieved at a terminal station in two steps. The incoming video signal from the studios is used to frequency-modulate an oscillator between 32.5 and 35.5 mc, and the modulated output is amplified and fed to the final stage of the transmitter, together with the output of a 900-mc generating chain. In the transmitter output stage appear frequencies which differ from that of the r-f chain by plus or minus the modulated oscillator frequency, and both of these frequencies (above and below carrier) are also frequency-modulated by the video signal to the same degree as the original 34-mc oscillation. Filters select one of these frequency-modulated carriers to be the signal that is transmitted.

Repeater Circuits

At a repeater station the received signal is heterodyned by a local oscillator to give a difference frequency of 34 mc and the resultant intermediate frequency is amplified and the transmission process repeated. The fact that the carrier signal is not demodulated to video frequency until the end of the link is reached is very important since it obviates the difficulties in connection with amplifier design and operation at low video frequencies.

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TUBES AT WORK

(continued)

peater station, the local oscillator frequency is obtained from part of the transmitter master oscillator output by heterodyning it with the output of a crystal-controlled oscillator whose frequency is equal to the difference between the transmitted and received frequencies.

This arrangement of the local and master oscillator frequencies—being each above (or below) the received and transmitted frequencies respectively results in the transmitted frequency being independent of the drift of the station master oscillator and is affected only by the extremely small drift of the crystal-controlled oscillator. Since only two frequencies are used for a channel the shift frequency is the same at all repeater stations and is alternately added to or subtracted from the station master oscillator frequency.

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CABLED leads attached to chassis mounted on a transmitter cabinet door bent and broke readily when the door was opened and closed. Substitution of spaghetti for the cabling cord provides better distribution of strain along wires and eliminates broken leads.

Westinghouse Electric Corp.
Baltimore, Maryland

CALIBRATOR on a coil-winding machine continued to indicate turns after wire snapped accidentally. Because each coil took about 17,000 turns, it was impossible to gage the number of turns wound before the break. A mercury switch is now
Too bad all the ocean isn’t this clear. There’d be no need for complicated under-water detection equipment, no need for constant research and development of depth-finding instruments and sonar equipment such as Edo engineers are working on now.

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mounted on an arm with a small pulley that rides the wire. If the wire snaps, the switch shuts off the machine and stops the count. Wire can be spliced and operation resumed with an accurate record of number of turns wound. Cost of coils has been virtually cut in half and suggestion won $1,500 for Hazel Williams, a worker in the plant.

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Magnetic Modulation of Phototube Currents

To avoid the difficulties involved in successive stages of d-c amplification in measuring continuous values of light or heat flux, some means for chopping or otherwise providing an alternating signal is

FIG. 2—Synchronous motor and spiral restoring spring are geared to control potentiometer. Snap-action switch, actuated by driveshaft cam, is closed at end of flyback.

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FIG. 1—Physical setup for magnetic modulation of phototube currents

often used to allow use of a-c amplifiers. A new method is described here. The space currents within the phototube are modulated with an alternating magnetic field applied transversely across the path of photoelectrons.

Figure 1 illustrates the basis for the system. The phototube is located between the poles of a magnet in such a way that the electrons are forced back to the cathode if the magnet field is energized. Whenever the magnetic field is zero, the electrons are free to flow to the anode.

The space-current modulation will, of course, be double in frequency compared with the frequency of the modulating wave.

The system described eliminates the harmful effects caused by the presence of leakage currents, since the leakage electrons are not modulated, as they are in systems which vary the output signal from the phototube electrically. No compensation or zero setting is required; with no light, there is no a-c output from the phototube. Compensation for line-voltage fluctuation may be provided automatically by overexciting the modulating coil slightly, since an increase in excitation beyond that point, as might occur if the line voltage rises, will decrease modulation, thereby compensating for accompanying increases in amplifier gain.

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Study of Skin Impedance

By Robert C. Burns
Stanford University
Stanford, California

Potentials generated by the contractions of muscles and muscle fibers are recorded and studied with the aid of electromyograph equipment. An attempt is then made to interpret the records in terms of absolute physical movement. In this interpretation there exist three major variables: frequency, phase, and amplitude. The frequency spectrum to be analyzed appears largely between 40 and 500 cycles per second, the signal amplitude generated by the muscle reaches a peak around 200 microvolts, and the phase of electrical measurement depends on the reactive elements acting in the entire measuring scheme.

These three interrelated factors can be fairly well controlled in the electrical amplifying device, but the question arising is, "What happens within the muscle, and what is actually measured between the two electrodes?" It follows then, "What source impedance does the muscle potential act through?"

Most of the past publications have mentioned, in a loose fashion, that the skin behaves like a leaky capacitor. This paper attempts to evaluate this past statement in terms of more definite quantities so to the required level. This first stage, which acts essentially as an impedance transformer, should have a gain of 2.2. Additional parallel-T networks may be used to eliminate 60 and 120-cycle hum from the low-level stages.

In a paper presented at the AIEE Winter meeting, Henry P. Kalmus of the National Bureau of Standards announced that a light-meter using the principles summarized here is more stable and has higher sensitivity than other commercial types, and has the advantage of requiring no zero adjustment.
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that muscle source potentials may be more accurately determined.

Electrodes Used

There are two types of electrodes in use: the sub-dermal and the surface type. The former are simply needles which, inserted into the muscle, provide the potential measurement. The latter are metallic disks placed on the surface of the skin, in the vicinity of the muscle, with or without prior skin preparation. This paper will be largely concerned with the surface electrode. Size, shape, spacing and application of the electrodes are factors which enter into each impedance measurement. These will be discussed later. All measurements described herein were made on the skin of the pretibial area.

Four tests were made with three-fourths inch diameter copper electrodes separated one inch between edges under the following conditions: (1) shaved and dry skin, (2) shaved skin with electrode paste applied, (3) shaved skin with surface then sanded, and (4) shaved skin, sanded surface, and electrode paste applied. The graphical results obtained are presented in Fig. 1. The four curves represent the measurements made on one subject using the above-mentioned electrode applications in the order listed.

A study of the curves of Fig. 1 indicates a much higher impedance for application 1 than for application 4. This is quite outstanding at the lower frequencies. However, the most striking difference is the nearly constant impedance with application 4. This indicates an im-

---

**Fig. 1**—Skin impedance, with 3/4-inch electrodes applied to sanded skin with electrode paste, is almost entirely resistive, as indicated by constant impedance for changing frequency.
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THE ELECTRON ART

(continued)

pedance which is nearly entirely resistive. With such an electrode application the output potential available at the electrodes is nearly independent of the period of the transient generated by the muscle contraction. This important factor makes many assumptions valid with small error.

Detailed Study

To study the internal impedance further a more extensive search was made; the results appear in Fig. 2. A flattening of the impedance curve at both the high and low frequencies indicates an asymptotic resistive component of the internal tissue structure of the muscle. Insert shows equivalent internal impedance of the skin.

FIG. 2—Flattening of impedance curve at high and low frequencies indicates resistive component of the internal tissue structure of the muscle. Insert shows equivalent internal impedance of the skin.

frequencies indicates an asymptotic resistive component of the internal tissue structure of the muscle. The curve may be divided into three major segments and the equivalent electrical behavior determined. A simplified version of the equivalent internal impedance of the skin is shown in the insert of Fig. 2.

Equivalent Skin Impedance

The values of these three parameters are affected by each electrode application. Nevertheless, the relative value of the parameters, especially the capacitor, are indicated. It might be expected, since there exists such a large difference between shunt and series resistors, that the slope of the impedance curve should be unity during a portion of the frequency-impedance graph. However, since the internal tissue is of quite complex nature,
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the slope of the curve did not quite reach unity.

Measurements made on electrode separation showed no large variation after the separation exceeded one-half inch. The effect of electrode size was noticeable by a small increase in impedance with a decrease in electrode size. The diameter-to-spacing ratio was revealed as the most important relationship. This was reflected by measurements made with the subdermal electrodes. It was expected that the internal impedance would be quite low with the needles inserted in the muscle, but it was found that the impedance exceeded that of application 4 by a slight amount. It is believed that the small surface area of the needles contributed to this fact.

From the experimental data obtained the electrode application should consist of shaving the hair, sanding the surface, and the application of electrode paste for minimum skin impedance. With this type of application, variations in the resulting signal measured between electrodes, due to reactive effects, can be minimized. With further and more detailed study for each case, perhaps an absolute measurement of muscle activity can be made. This knowledge of source potential should be useful in the study of isolated spastic muscles.

Acknowledgment

The author is indebted to Marian Williams and Lucille Daniels, of Stanford University, for the opportunity to make this study. Also, many thanks to the many students of physical therapy at Stanford who contributed their time so patiently.

Resistor Behavior at High Frequencies

Various types of resistors exhibit different characteristics when operating in the region above ten megacycles, depending on their physical size, nature of resistance element and physical location. The analysis of an isolated resistance element was first considered by Howe' and later by Hartshorn'. It has been
The new Type 1023-A Amplitude Modulator, while designed particularly for use with the G-R Type 1022-A F-M Generator, may be used equally as well with other standard-signal generators at frequencies between 3 Mc and 220 Mc. It produces an amplitude-modulated signal with no appreciable incidental f-m. A feature of this modulator when used with the Type 1022-A Generator is the i.f. operating range switch which provides a gain of 10 at the 10.7 Mc standard f-m receiver intermediate frequency. Output voltages up to 3 volts can be obtained without serious envelope distortion. The output impedance is exceptionally constant.

TYPE 1023-A AMPLITUDE MODULATOR $250.00

For measurements of sensitivity on balanced lines for f-m and tv bands, the Type 1000-F5 V-H-F Transformer plugs into a standard-signal generator having a 50-ohm unbalanced output and supplies an equal balanced open-circuit voltage behind a 300-ohm balanced impedance. Its frequency range is 50 Mc to 250 Mc.

TYPE 1000-F5 V-H-F TRANSFORMER . . . . . $27.50

FOR TESTING F-M BROADCAST RECEIVERS
SIMPLE - INEXPENSIVE - NO SPURIOUS SIGNALS

This new G-R Standard-Signal Generator is designed especially for testing f-m broadcast receivers. All unessentials have been omitted in order that it can be moderately priced. Its features include:

- Carrier Frequency Ranges — 10-11.5 Mc and 88-108 Mc
- Very Low Incidental Amplitude Modulation — less than 5%
- F-M Noise Level Very Low — more than 50 db below 75 kc deviation
- Slow Drift — less than 0.005% after 20 minutes operation
- High Output Voltage — 88-108 Mc from less than 0.1 mv to more than 1 volt; open circuit; 10-11.5 Mc from less than 0.1 to 0.25 v
- No Spurious Signals in Output System — generates only one frequency
- Extra-Low Generator Leakage — undetectable on high-grade commercial f-m receiver
- Semi-Logarithmic Meter Scale — easier to read low deviations
- Constant and Purely Resistive Output Impedance — 50 ohms nominal
- Auxiliary Tuning Scale — for easy interpolation, 200 kc intervals on 88-108 Mc range and 20 kc on 10-11.5 range

TYPE 1022-A F-M STANDARD-SIGNAL GENERATOR . . . . $625.00
MODERN ELECTRONIC DESIGN MEANS PLUG-IN UNIT CONSTRUCTION

With basic elements as units—that plug-in, slide-in, lock-in, break away easily—so that electronic equipment is instantly accessible—ready for rapid checks, servicing, and unit replacement.

More and more engineers are finding that plug-in unit construction is the type of design that makes many of the new complex electronic projects feasible to operate and maintain. It’s also recognized that plug-in unit principles make present electronic equipment much more practical for wider general use.

Up to now there has been no one place where components specifically designed for plug-in unit construction were available. To get this type of construction—it has been necessary for engineers to design and have parts custom made or improvise with standard components in make shift arrangements.

Here at Alden’s we are designing and manufacturing components for plug-in unit construction. We are setting up to work with manufacturers on as many of these problems as possible. Very frankly, much of our work is still in the pilot run stage—but, in every instance—proven in use. If you don’t see the answer to your problems here—let us work it out with you.

The electron art (continued)

found that experimental values compare quite well with theoretical values.

The experimental equipment used in determining the behavior of resistors at high frequencies includes two G-R resistance bridges, a Measurements Corp. signal generator, and a Hallicrafters SX-42 receiver which served as the detector. Various values of resistors between 50 and 77,000 ohms were measured, and their equivalent resistances calculated by Hartshorn’s method.

It was found that for standard types, the equivalent resistance of a resistor decreases more rapidly with frequency for high d-c value resistors than for low-value resistors. For the same value of d-c resistance, the smaller the physical size of the resistor, the better are its high-frequency characteristics.

The carbon type proved to be superior to composition for high-frequency work, but both of these types are inferior to resistors made with a carbon coating on an insulator. Wire-wound resistors are too reactive for use as resistors above about 10 mc. For resistors whose construction permits analysis by Hartshorn's calculations, the experimental and calculated values conform within 10 percent. Thus it may be concluded that the equivalent resistance of almost any resistor under one megohm may be predicted with fair accuracy from Hartshorn’s curve, shown above. The falling off of resistors of greater d-c value may be explained qualitatively by combining this and

At last—a base specifically designed for plug-in units.
No more broken bosses, bent pins, "shorted" circuits.

More and more engineers have been unitizing the basic elements of their circuits into compact, easily replaceable plug-in units. Since the conventional octal and tube socket bases have been the only component readily available, they have been constantly plagued by the broken bosses, bent pins, and "shorted" circuits caused by these bases.

This suggested an entirely new approach was necessary, so we went to work with some of these engineers. Out of this work the Alden Noninterchangeable plug-in base was developed.

Pins have been made strong and stubby—for long, rugged use. The boss is eliminated entirely. Slight lead in center pins and locating rings in mount in the socket allow quick lining up of plug-in units. Further, this base is supplied with 2 to 11 contacts—in variable pin patterns —so that even where the same number of contacts are used, the pin layout may be varied so only the correct unit will mount in its proper socket. Pin patterns can even be selected to isolate critical voltages or signals.

Hartshorn’s curve for predicting the behavior of resistors at high frequencies. Distributed capacitance C, is that of the isolated resistor plus the proximity effects
Throughout history, scouting parties have gone out ahead of man, ahead of settlements, ahead of civilization itself. Today, Bell System scouts are engaged in a new kind of exploration—charting a path for microwaves—using equipment specially designed by Bell Telephone Laboratories.

The portable tower shown is constructed of light sections of aluminum and in a few hours may be built up to 200 feet. Gliding on rollers, the "dish," with its microwave transmitter or receiver, is quickly positioned for line-of-sight transmission, then oriented through electric motors controlled from the ground.

Test signals show how terrain and local climate can interfere with microwave transmission. Step by step, Bell's explorers avoid the obstacles and find the best course for radio relay systems which will carry television pictures or hundreds of simultaneous telephone conversations.

A radio relay link similar to the one between New York and Boston will be opened this year between New York and Chicago. Later it will be extended, perhaps into a nation-wide network—another example of the way Bell Telephone Laboratories scientists help make the world's best telephone system still better each year, and at lowest cost.
Donnelly Manufacturing is supplying aluminum sheet metal work of all types to meet the most exacting Army, Navy and Air Corps specifications. All Donnelly men and equipment are U.S. Armed Forces certified. That's why you can be sure Donnelly can do your toughest aluminum fabricating job better, cheaper, faster.

5-point superiority:
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(2) Complete equipment
(3) Unexcelled sheet metal “know-how”
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(5) Greater economies thru improved methods.

Please send me your folder, listing your equipment, facilities and experience in sheet metal work.

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DEPT.: ________________________________

COMPANY: ________________________________

ADDRESS: ________________________________

CITY: ________, STATE: ____________

Wide-Range Electrostatic Generating Voltmeters

Electrostatic generating voltmeters find wide application in industrial and experimental applications, where a vectorial measurement of an electric field intensity, in volts per meter, is required.

By suitable distribution of several electrostatic generating voltmeters over the surface of a rocket projectile, it is possible to separate the field due to a charge on the rocket from that due to potential gradients already existing in regions above the earth. To evaluate these electric field components, several recent Aerobee and V-2 projectiles have carried electrostatic generating voltmeters. Figure 1 shows a drawing of the equipment used to measure fields from 1 to 10,000 volts per meter. The rotor consists of six blades, rotating at 5,000 rpm, while the stator is
a
"live
wire"
for
hot
spots

Vitrotex* Magnet Wire with Glass Fiber Insulation withstands temperatures of 130°C.

Highly Flexible . . . Amazing Space Factor — made possible by insulation of alkali-free glass, the insulation that's soft as silk and strong as steel!

High Dielectric Strength and Smooth Surface . . . resists moisture, acids, oils and corrosive vapors!

Vitrotex Windings Give Tighter, Safer Coils — for operation in confined spaces under high heat!

Ask the Anaconda Sales Office nearest you for complete information on the entire ANACONDA Magnet Wire Line. Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y., or 20 N. Wacker Drive, Chicago 6, Ill.


The right wire for the job ANACONDA® WIRE AND CABLE
For the U.S. Air Force rocket program, Workshop engineers have developed a unique antenna system. Strategic placement of flush-mounted slot antennas around the rocket provides essential slot antennas around the rocket provides optimum reception by isotropic radiation for optimum reception by ground stations. The related problems of frequency, power distribution and phasing were solved by Workshop engineers to make this notable achievement.

Antennas for high-speed rockets are typical of the specialized products being developed regularly in the Workshop laboratories. Under contracts with the armed forces and private industry, Workshop engineers constantly work to solve the most difficult antenna problems.

In describing the theory of operation in Instrum ents, November, 1949, John F. Clark, Jr., points out that the peak-to-peak value of voltage developed across the input capacitance $C$, as the uncovered stator area varies from zero to $A$, is $K_A E/C$, where $K_A$ is the permittivity of free space ($8.84 \times 10^{-12}$ farads per meter), $A$ is the total stator area ($6.0 \times 10^4$ square meters), $C$ is the input capacitance ($1.0 \times 10^{-12}$ farads), and $E$ is the incident electric field intensity in volts per meter.

In the above relationship, $K_A$ is a universal constant, while $A$ and $C$ are constants of a given instrument. Thus the peak-to-peak amplitude of the sawtooth voltage is $5.81 \times 10^4$ volts for a field of 1 volt per meter, and varies linearly with the applied electric field.

The peak value of the fundamental component of the above voltage is $4/\pi^2$ of this value, and its frequency 500 cps. Thus, the fundamental component of the developed voltage is $2.15 \times 10^{-1} E \sin 1,000 \pi t$. Measured values of developed voltage are generally about 90 percent of the calculated value. The difference is probably due to fringing of the electric field around the rotor.

**Equipment**

The electrostatic generating voltmeter head, connecting cable, and associated amplifier and power supply are shown in Fig. 2. The dynamotor furnishes plate voltages, and the 12-volt tubes are connected in series pairs to operate from a 24-volt battery. Battery current drain is about 4 amperes. Despite extremes in physical operating conditions of shock, acceleration and

---

**THE ELECTRON ART**

(continued)

![Diagram of Electrostatic Generating Circuit](image)
ARE THESE GATES '50 DECADE PRODUCTS MAKING MONEY FOR YOU?

1. 52-CS Studioette Speech Console.
2. BC-1F Air-conditioned 1KW Broadcast Transmitter.
3. SA-50 Dual Channel Speech Console.
5. Typical 4-Tower Centralized Phasing Cabinet.
6. HF5-10 High Frequency Phone and Telegraph Transmitter.
7. SA-40 Single Channel Speech Console on CB4 Control Desk.
8. GY-48 Complete 250-watt Radio Broadcasting Station.
9. 50-watt Telephone and Telegraph Communications Transmitter.
10. BC-3B 5KW Transmitter with Phasor.
11. HF-15 15,000-watt Telegraph Transmitter.

Quality PLUS*** makes GATES ***a MUST***

ELECTRONICS — April, 1950

203
The 5841 sub-miniature corona regulator now in production is another Victoreen component developed to make fine instrumentation finer. This regulator supplements other specially designed electron tubes required in radiation measurement and in the broader field of laboratory instruments.

...subminiature
ELECTRON TUBES

<table>
<thead>
<tr>
<th>Tube Type</th>
<th>Typical Service</th>
<th>Volts Ec1</th>
<th>Volts Ec2</th>
<th>Volts Eb</th>
<th>µA</th>
<th>β</th>
<th>Gm</th>
<th>Signal grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>*5800</td>
<td>** Electrometer Tetrode</td>
<td>42.4</td>
<td>***=3</td>
<td>4.5</td>
<td>12</td>
<td>1</td>
<td>15</td>
<td>2x10^-15</td>
</tr>
<tr>
<td>*5803</td>
<td>Electrometer &amp; R.C. Amp.</td>
<td>-1.7</td>
<td>-----</td>
<td>7.5</td>
<td>100</td>
<td>2.0</td>
<td>150</td>
<td>10^-14</td>
</tr>
<tr>
<td>*5828</td>
<td>D.C. Amp.</td>
<td>-1.0</td>
<td>-----</td>
<td>45</td>
<td>250</td>
<td>17.5</td>
<td>450</td>
<td>10^-9</td>
</tr>
</tbody>
</table>

--- and a complete line of counter tubes including the universally used 1B85, the 1B67 end window mica window tube, gamma ray counters, and sub-miniature counter tubes --- not forgetting Victoreen hi-meg resistors vacuum sealed in glass, values 100—10,000,000 megohms.

Write for data sheets

THE ELECTRON ART

---(continued)---

vibration, there has been no evidence of malfunctioning of the generating voltmeters. On a recent flight, when a V-2 rocket reached a peak velocity in excess of 3,000 mph at an altitude of approximately 100,000 feet, two generating units were carried aloft, recovered upon completion of the flight, and subsequently reused.

The following requirements were fixed by limitations in telemetering facilities: (1) A dynamic range of 1 to 10,000 volts per meter had to be compressed to the telemetering voltage range of 0 to 5 volts. (2) Field changes had to be followed within 0.1 second.

Satisfaction of these requirements was obtained by use of the system shown in the block diagram, where the amplitude cathode follower provides an accurate indication of the larger field strengths, 50 to 10,000 volts per meter. The third amplifier, in conjunction with the commutator, operates as a synchronous amplifier. Either a positive or negative peak of amplified signal, depending on the polarity of the electric field, is momentarily switched to ground at the same instant each cycle, by the commutator. The a-c component of the resulting pulsating voltage is filtered by an R-C network at the grid of the polarity cathode follower. This circuit is a peak-reading voltmeter which gives a reliable measure of the amplitude of small fields from 1 to 50 volts per meter, and the polarity of any field strength greater than 1 volt per meter.

With the exceedingly wide dynamic range of the instrument as described, the absolute accuracies
Announcing

NEW MEMBER OF THE MYCALEX FAMILY

9 Pin Miniature Tube Sockets

We are proud to announce the addition of a 9 pin (NOVAL) miniature tube socket to the MYCALEX line. It has all the electrical characteristics of the widely used MYCALEX 410 and 410 X 7 pin tube sockets and fully meets RMA standards.

The NOVAL is injection molded and produced in two qualities to satisfy different requirements.

MYCALEX 410 for applications requiring close dimensional tolerances. Insulation loss factor of .015 (at 1 MC) yet compares favorably in price with mica filled phenolics.

MYCALEX 410X for applications where general purpose bakelite was acceptable but with an insulation loss factor of only .083 (at 1 MC). Prices compare with lowest quality insulation materials.

Write us today and let us quote you prices on your particular requirements. We will send you samples and complete data sheets by return mail. Our engineers are at your disposal and would be glad to consult with you on your design problems.

Mycalex Tube Socket Corporation
"Under Exclusive License of Mycalex Corporation of America"
30 Rockefeller Plaza, New York 20, N. Y.
THE ELECTRON ART

EDWIN L. WIEGAND COMPANY uses this terminal pin on their versatile Chromalox seamless blade-type immersion heaters, which operate as high as 750°F. It is one of many special fasteners made by Progressive.

The design provides for electrical clearance between the pin and the metal heating blade casing — for secure fastening of the pin in the refractory — and for attaching electrical wiring connections.

Progressive is equipped to handle special fastener production with speed, precision and economy. Do what many leading manufacturers do — IF IT'S SPECIAL, see PROGRESSIVE.

WRITE FOR OUR CATALOG IT MAY SAVE YOU MONEY

Other typical PROGRESSIVE "Specials"

THE PROGRESSIVE MANUFACTURING COMPANY
50 NORWOOD ST., TORRINGTON, CONN.
SALES OFFICES: SAN FRANCISCO, LOS ANGELES, PORTLAND, DETROIT, PHILADELPHIA, CLEVELAND, SEATTLE, BOSTON, SYRACUSE, ST. LOUIS, CHICAGO.

April, 1950 — ELECTRONICS
NEW INSTRUMENTS DEMONSTRATED
at the I.R.E. Show in
New York City.

THE DUAL MEGA-MARKER SR.
A Crystal-Controlled High Output TV RF Marker Generator Provides both sound and picture RF markers on each TV channel. Crystal Controlled 4.5 mc signal also available. Output Attenuators on RF and 4.5 mc signals. Carrier Frequency Accuracy 0.01% for Picture. Carrier Separation 4.5 mc ±500 cps. Price: $350.00.

WIDE BAND ATTENUATORS
Models 20 and 21
Frequency Range—D.C. to 500 mc.
Attenuation Steps—20, 10, 5, 3, 2, 1 DB: Fixed Insertion Loss 10 DB.
Terminal Impedances: Model 20:50 ohms, Model 21:70 ohms.
VSWR at Terminals—Very Low
Attenuation Accuracy—0.1 DB/DB Loss at 500 mc. Better Accuracies at Low Frequencies.
Price: $50.00

THE MICROWAVE MEGA-NODE
Random Noise Sources Covering Frequency Range 3000-12,500 mc.
Price: Standard Unit One Waveguide and Power Supply $295.00
Standard Unit plus two Extra Waveguides $600.00

THE MEGA-PIX
A 12 Channel Crystal Controlled TV Generator Useful for Final Air Check of Receivers on All Channels. Provides Both Carriers with Adjustable internal FM Sound Modulation and Adjustable Video Modulation from External Source. Carrier Frequency Accuracy—0.01% for Picture—Carrier Separation 4.5 Mc ±500 cps.
Price: $990.00.

OTHER NEW INSTRUMENTS

INDUSTRIAL
The ROTALYZER — An indicator of instantaneous rotational speed vs. time.

AUDIO
The SONACTOR—a speech pitch extractor

The SONA-STRETCHER—a phonetic method of slowing down speech without altering frequency content.

ELECTRIC KAY COMPANY
25 Maple Avenue
Pine Brook, N. J.
Phone Caldwell 6-4000

ELECTRONICS — April, 1950
207
Here's What it Takes—
TO MAKE A
CLOSE TOLERANCE,
HIGH QUALITY CRYSTAL

The BEST Research and Engineering
The BEST Manufacturing Facilities
The BEST Production "Know How"
The BEST Testing Equipment

And these are the reasons why Reeves-Hoffman Crystals are specified for—Government Uses, Television, Mobile Radio, Aircraft and Commercial Radio, Marine Radio, Test Equipment and Special Purpose Equipment.

Remember—"There's No Substitute For Quality." For the Crystal units you need insist on the best . . . call on Reeves-Hoffman.

Voice-Operated Busy Signal
Certain special types of telephone networks use voice calling over a single speaker for a multiplicity of lines. The circuit shown in Fig. 1 enables the party at the called end to identify the particular line on which the voice call is being heard. The system is voice operated, and its sensitivity is such that low-level talking will light an appropriate lamp, but noise will not.

Since voice talking levels rarely exceed +10 vu (10 milliwatts), and are often as low as -30 vu (1 microwatt), an amplifier is required; and since line noise will also be amplified, some kind of frequency discrimination is required to prevent false operation. Another design factor is adjustment of release delay time, so that the busy signal will not flash between words or short pauses.

Input resistors R3 and R5 assist in providing high input impedance so that the transmission loss caused by bridging the busy signal across the line is small. With no input signal, V1 is biased almost to cutoff by the voltage drop across R5, and the relay is non-operated. When speech appears on the line, it is amplified by V1 and V2. The output signal current of V1 flows mostly...
Now!
Get extra quality—without extra cost—in wire-wound components!

CHECK YOUR NEEDS AGAINST THIS LIST:

I-T-E FOCUS COILS
Available in two types: The first utilizes an electro-magnet; the second combines a permanent magnet with an adjustable electro-magnet. I-T-E Focus Coils are made for use with tubes 10", 12", and 16" in size. Information required to manufacture: Type of tube; second anode voltage; focusing current; types of mountings and leads desired.

I-T-E DEFLECTION YOKES
I-T-E Deflection Yokes are built to have uniform characteristics. During manufacture, wire size and quality are checked constantly. Coils are impregnated with a special moisture-resistant thermo-plastic material which has been properly cured to insure a firm coil with a minimum of losses. Deflection Yokes can be had with wire leads, resistors, and capacitors made to your specifications.

I-T-E "METCLADS" (Metal-Clad Resistors)
Made of highest-grade resistance wire, wound on a special heat-resistant bakelite strip, and insulated by special phenolic coating. The resistance element is completely enclosed in a metal case of either brass- or zinc-plated steel. Brass terminals are securely anchored to the bakelite base strip and are tinned for easy soldering. I-T-E "Metclads" are available in lengths from 2" to 12"; in wattages from 7 to 42. Mountings can be made to your specifications.

I-T-E ENAMELED RESISTORS

For complete information on any I-T-E wire-wound products, write, specifying your needs.

RESISTOR DIVISION
I-T-E Circuit Breaker Company
19th & Hamilton Streets, Philadelphia 30, Pa.

I-T-E Wire-Wound Products: RESISTORS • DEFLECTION YOKES • FOCUS COILS • SPECIAL PRODUCTS
NOFLAME-COR

the TELEVISION hookup wire

PROVEN BEST, and specified regularly, by leading manufacturers of television, F-M, quality radio and all exacting electronic equipment. For maximum output and minimum rejects. Available in all sizes, solid and stranded. Over 200 color combinations.

PRODUCTION ENGINEERS: Specify "NOFLAME-COR" for absolute uniformity of diameter, permitting clean stripping of insulation without damage to the copper conductor...

NO NICKING OF CONDUCTORS
NO CONSTANT RESETTING OF BLADES

<table>
<thead>
<tr>
<th>Rubber</th>
<th>75°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic</td>
<td>80°</td>
</tr>
</tbody>
</table>

"NOFLAME-COR" 90°

- Flame Resistant
- High Insulation Resistance
- Heat Resistant
- Facilitates Positive Soldering
- High Dielectric
- Easy Stripping
- Also unaffected by the heat of impregnation — therefore, ideal for coil and transformer leads

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15 Park Row, New York 7, N.Y.
1237 Public Ledger Bldg., Philadelphia 6

Manufacturers of quality wires and cables for the electrical and electronic industries

FIG. 2—Frequency response of the voice-operated busy signal

through the combination of $C_1$, $C_3$, and $R_n$, since the relay winding has a very high impedance. The signal is rectified by the copper-oxide varistors and appears as a positive charge on the left side of $C_n$. This charge drives the control grid positive and the resultant increase in plate current operates the relay whose contacts are used to control a lamp or other indicator.

When speech ceases, the charge across $C_n$ will leak off to ground through the back resistance of the rectifiers and $R_n$. When the plate current has decreased to the value of current at which the relay releases, the lamp or indicator is extinguished.

The release or holdover time of the relay is governed by the rate of discharge of $C_n$, which depends primarily on $R_n$ and the back resistance of the rectifiers. By adjusting $R_n$, the release time may be varied from approximately three to ten seconds.

Discrimination between noise and signal is obtained by frequency weighting. This is accomplished in the voice-operated busy signal circuit by attenuating the frequencies below about 300 cycles in the input transformer, and by attenuating frequencies above about 3,000 cycles by by-passing them to ground through a 0.01-uf capacitor. The input transformer is wound on the core of a G-type relay, and has a sufficiently low mutual inductance to suppress the low frequencies and yet have a satisfactory response in the middle voice-frequency range. The frequency response of the voice-operated busy signal is illustrated in Fig. 2.

The circuit described was developed by the Bell Telephone Laboratories for use by the Interstate
10 Times More Rugged -

New Sylvania shock-tested tubes withstand shocks greater than 400 G's

Ideal for industrial radio applications...
for aircraft...buses...trains...police cars...
or wherever shock and vibration are problems

Troublesome problems of tube failure resulting from shock or heavy vibration are now being solved... for keeps... by these new Sylvania "Ruggedized" or "W" tubes. Originally designed to government specifications to withstand shock and vibration caused by artillery action, these tubes keep operating under vibration up to 2-1/2 G's... withstand shocks more than 400 times the force of gravity.

A dozen new design techniques have gone into the perfection of these tubes. More than that, they are precision-built from precision parts. Exhaustive lab and field tests have definitely proved them as much as 10 times more rugged than ordinary tubes. Electrical characteristics are similar to those of standard types.

Note too, their reduced overall length and their straight glass bulbs... features which make possible smaller and more compact equipment design.

Maximum ratings and other characteristics of these new "Ruggedized" tubes are available from Sylvania Electric Products Inc., Dept. R2104, Emporium, Pa.

CHECK THESE 10 "RUGGEDIZED" FEATURES
for longer life and better performance

1. Double thickness micas
2. Heavier side-rod supports
3. Shorter leads
4. Straight glass bulb
5. Flat, circular header
6. Fewer internal connectors
7. Shorter elements
8. Reduced overall height
9. Additional mount supports
10. Low-loss phenolic base

SYLVANIA ELECTRIC

RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FITTINGS, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTO LAMPS

ELECTRONICS — April, 1950 211
Day in and day out operation on a 24-hour schedule of mobile 2-way police radio demands equipment that can stand the most rigorous conditions.

It is no mere coincidence that more police and state highway patrol cars and motorcycles are equipped with Ward aerials than with any other kind. Police officials know that Ward aerials always give maximum performance.

Scientifically designed Ward aerials are made of a special alloy to resist corrosive atmospheric conditions such as ice, snow, sleet, rain, and fog, because police vehicles must work a 24-hour-a-day schedule, 365 days a year.

For motorcycle use, the durable 42 inch whip rod is mounted in a heavy rubber shock mounting base. It is available in two styles—Model SPP-6 with Ring Tip or Model SPP-6A with Boll Tip.

Glass-encased Resistors for d-c amplifiers and G-M circuits can be made essentially independent of humidity in values up to $10^{12}$ ohms by cleaning the surfaces first with carbon tetrachloride, baking for several hours at 120° C and varnishing with GE varnish No. 9978. Details are given in an AEC report, "An Investigation of the Properties of High-Valued Resistors and Methods of Reducing Surface Leakage", now declassified and available at 10 cents from Technical Information Branch, Oak Ridge, Tenn. The technique was also successful on steatite and porcelain when higher temperatures and longer baking times were used.
Strong, Durable Wire Splice Uses Duronze III Jaws

Automatic electrical line splices, applied without solder, screw driver or wrench, reduce installation costs for outside overhead wiring jobs. Illustrated is the latest type made by Fargo Mfg. Co., Poughkeepsie, New York. Through copper-base alloys these units are corrosion resistant, and the splice is as strong as the conductor itself, and electrical conductivity is greater.

Hard, Strong Material For Jaws

The stripped wire is merely pushed into the ends of the splice forcing the jaws of the chucks to open as they move back on the taper. The spring between the chucks keeps the teeth of the collet type jaws in contact with the wire until they obtain a good grip. From that point on, the greater the tension, the tighter the jaws grip.

Since the chuck takes the brunt of the load, its jaws must be made from a strong, hard alloy as they are the vital elements of the connector. Duronze III, aluminum silicon bronze, answers this requirement exceptionally well. In the annealed condition it has the remarkably high tensile strength of 90,000 pounds per square inch, and a Rockwell hardness of B85.

The jaws are made from round rod on a screw machine which drills, forms the taper, bores the recess and cuts off the part. The thread is cut on a tapping machine and the slots are milled in a hand miler after the four expansion holes are drilled.

On a dial feed press, a brass disc which acts as a stop to keep the wire from entering too deeply, is inserted in the counterbore and secured by turning the edges over in a die.

Hard Drawn Copper Tubing; Phosphor Bronze Spring

The body or outer shell, which has an inside taper to correspond to the taper on the chuck, is made of hard-drawn copper tubing for its high electrical conductivity, excellent corrosion resistance and adequate strength. Since the spring, which holds the chucks against the shell tapers until the wire is engaged, is under constant compression and may be subject to deterioration from the elements, phosphor bronze has been chosen for maximum reliability and its high corrosion resistance.

Bridgeport's long experience in making high strength, corrosion resisting copper-base alloys containing various amounts of tin, silicon, aluminum, cadmium, phosphorus, arsenic, etc., is available for products that must meet modern high engineering standards.

Did You Know...

That Bridgeport Brass Once Made Coal Oil Lamps?

Although Bridgeport Brass is not anxious to claim the doubtful honor of being the maker of the oil lantern that Mrs. O'Leary's cow kicked over to start the 1871 Chicago fire, there is a possibility that Bridgeport's "Farmer Model" may have been the offender.

In 1859, six years before Bridgeport Brass was founded, the famous Drake Well at Oil Creek, Pennsylvania was brought in. This inaugurated the Age of Petroleum. Although it took some little time to swing over from candles and chimneyless lard oil and whale oil lamps, America took on a brighter outlook as more and more Bridgeport's Lincoln and National kerosene lamp burners invaded the homes. This was followed by Bridgeport Leader student lamps and finally by the famed Rochester lamps with the tubular wick and petticoat lamp shade.

With the advent of electric illumination, Bridgeport gave up the manufacture of kerosene burners and lamps and discarded the tools for making them. Today, these tools would have been invaluable to produce "genuine antique reproductions" of brass student lamps and Rochester lamps which gladden the hearts of home decorators.

BRASS • BRONZE • COPPER • DURONZE — STRIP • ROD • WIRE • TUBING

MILLS IN
BRIDGEPORT, CONNECTICUT
INDIANAPOLIS, INDIANA

In Canada:
Noranda Copper and Brass Limited,
Montreal

ELECTRONICS — April, 1950
here's your answer to problems in OSCILLOSCOPE RECORDING!

FAIRCHILD Oscillo-Record CAMERA

This new engineering tool is finding more and more use in—
2. Comparison of performance after changes have been made.
3. Study of complex high-frequency signals.
4. Comparison of two or more simultaneous phenomena.
5. Telemetering.
6. Analysis of high-speed transients.
7. Monitoring of random transients.
8. Maintenance of laboratory records.

A remote control connection plus dynamic braking makes it possible to start and stop the camera automatically by the signal itself, thereby making a complete record of irregularly occurring phenomena without wasting film and without any attention on the part of the operator. Other features include:

a) Sharp, clearly defined images on inexpensive 35mm film or paper; b) writing speeds up to 270 inches per microsecond; 20 seconds to 20 hours of recording on 100-ft. rolls of film, or 3½ minutes to 8½ days of recording on 1000-ft. rolls; d) no obstruction of oscilloscope controls; e) permits viewing of 'scope while photographing phenomena.

The Oscillo-Record Camera, designed by Fairchild in close cooperation with leading users and manufacturers of cathode-ray oscilloscopes, is the product of the world's foremost manufacturer of precision specialty camera equipment. It can be adapted to practically all 3-in. and 5-in. oscilloscopes.

Complete details may be obtained by writing to Dept. WS, Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

NEW PRODUCTS
(continued from p 126)

Small Boat Radar
RAYTHEON MFG. Co., Waltham, Mass. The Mariners Pathfinder Jr. is a marine radar system specially designed for small craft. It operates on a wavelength of 3.2 centimeters. Minimum range is 75 yards and maximum, 20 miles. Range accuracy is within 2 percent and bearing accuracy is within 2 degrees. It is available for vessels equipped with 32-volt d-c, 110-volt d-c, 220-volt d-c or 115-volt a-c power systems. Power consumption in all cases is less than 750 watts.

Portable Radiation Detector
GENERAL ELECTRIC Co., Schenectady 5, N. Y., has announced a
**ANOTHER WESTINGHOUSE FIRST**

**ULTRA HIGH FREQUENCY STABILITY**

**WESTINGHOUSE BEACON CAVITY 1Q SERIES GIVES TOP UHF CONTROL**

Typical of the leadership of Westinghouse Laboratories in the field of electronics is the performance of these new Reference Cavity tubes. Operating above 9000 megacycles, the frequency shift of this master control unit is maintained at less than .5 of a megacycle in the most extreme conditions of temperature, barometric pressure and vibration shock. Its outstanding precision and stability places it alone in the field of ultra high frequency control.

The research which is built into Westinghouse electronic products is your assurance of top performance for the job to be done—whether it be the latest advances in microwave techniques or the designing experience needed to meet extraordinary conditions of service and hard usage.

Write for information about the complete line of Westinghouse Tubes: Lamp Division, Westinghouse Elec. Corp., Bloomfield, N. J.

For many control applications, as in Resistance Welding, sturdy durability is a major requirement. With the W.L.5796 Gas Thyatron, Westinghouse has engineered more ruggedness into a smaller tube—a development in space-saving and increased dependability.
THE HYPERVAC 100
Dean of Mechanical Pumps
produces extremely high vacuum at high speeds. It is the highest capacity pump of its kind that reaches an ultimate vacuum of better than 0.1 micron, often 0.02 micron of mercury. At 1 micron, the speed is 11 liters per second.

Here is a unit that backs diffusion pumps, or for purposes within the range of 0.1 micron performs reliably without a second stage. Applicable to evacuating vacuum spectrographs, lens and mirror coating, vacuum furnaces, etc. Quiet operation and long service are assured.

Write Dept. B. 1 for Engineering Bulletin 10B describing Cenco High Vacuum Pumps, Gages and accessory equipment, including prices.

Regulated Power Supply
CHATHAM ELECTRONICS CORP., 475 Washington St., Newark 2, N. J.
Model EA-50A regulated power supply is a laboratory source of d-c power. It is continuously variable in output voltages from 0 to 500 volts. Ripple is less than 10 mv. Power input is 105 to 125 volts, 60 cycles. Regulation is 1 percent between 30 and 500 v, 2 percent between 10 and 30 v.

Recorder Pen
BROWN INSTRUMENTS DIVISION, MINNEAPOLIS-HONEYWELL REGULATOR CO., Minneapolis, Minn. A solenoid-actuated pen which avoids ink-
Joining the More than 2,000,000 in Service in Radio and Television!

Presenting...
New Additions to the

Seletron
SELETRON
SELENIUM RECTIFIER
Family

A new leaflet on Bias Type 8Y1, describing its circuit possibilities is available. For your copy, write Dept. ES-28.

Designed Especially for Power and Bias Supplies in TELEVISION

SELETRON Selenium Rectifier miniatures have long been widely used with complete satisfaction by manufacturers in the Radio, Television and Electronics industries for receivers and other equipment.

Now SELETRON brings you these two new models ideally suitable in size and rating: No. 5S1 at 500 Mils — No. 8Y1, the “baby” of them all, measuring only 1/4” square and rated at 20 Mils, 130 volts. While these rectifiers are designed to meet television needs, engineers will find many applications for them in other electronic circuits. Other bias type rectifiers rated up to 250 volts will also be available.
The case of the Troublesome Coils

A True Detective Story

THE VICTIM: A concern whose product is handled in large measure by automatic vending machines which refused to vend with regularity.

THE VILLAINS: Coil windings which apparently met original specifications but broke down in service.

THE REMEDY: New coil windings, designed and wound by Coto-Coil, with special insulation to withstand humidity, low temperatures and difficult working conditions.

CASE CLOSED: No more trouble. With the new coils, the vending machines resumed uninterrupted vending.

WE ARE SPECIALISTS
For 32 years we have produced nothing but coils, designing and winding them for leading manufacturers. If you are troubled by coil failure, send us your specifications. We can serve you well.

COTO-COIL CO., INC.
COIL SPECIALISTS SINCE 1917
65 PAVILION AVE
PROVIDENCE 5, R.I.

Motor Controller
HEINEMANN ELECTRIC Co., Trenton, N. J., has announced a manual motor controller and enclosed general-purpose circuit breaker which is fully magnetic in operation. It is available in single, two and three-pole construction. Maximum ratings are: 50 amperes, 250 volts, a-c; 7.5 h-p, single phase, 60 cycles; 10 h-p, three phase, 60 cycles; 5,000-ampere interrupting capacity.

Variable Transformers
THE SUPERIOR ELECTRIC Co., Han- non Ave., Bristol, Conn., announces

throwing while providing speedy recording has been developed for use on circular chart electronic potentiometers. The V-type pen uses an amplifying linkage designed so that the solenoid's high velocity reaction is almost spent before the pen is picked up and moved. It is used for such applications as thermal limit recording in continuous pasteurizing processes and for temperature measurements on tire presses or rubber curing and plastic molding.
Announcing the NEW Magnecorder

PT7

NOW ALL 3!

NEW POSITIVE DRIVE
Two-speed hysteresis synchronous motor prevents timing errors, lost program time.

N.A.B. 10½" REELS
Now get long playing time even on portable equipment. No overlap on rack mount.

PT7's Greater Flexibility Means Greater Value
The PT7 Recorder Mechanism and Amplifiers incorporate Magnecord's exclusive Unit Construction. The same equipment can be used in console cabinet, rack mount, or for portable operation. New PT7-P amplifier features high-level mixing for 3 high impedance microphones.

Write For Detailed Information
Revolutionary new PT7 specifications have just been released. Write for your copy today.

3 HEADS
Separate heads for Erase, Record, and Playback now allow monitoring off the tape.

PUSHBUTTON CONTROLS
Separate buttons for "Forward," "Rewind," and "Stop" can be operated by remote control.

Magnecord, INC.
360 N. MICHIGAN AVENUE • CHICAGO 1, ILLINOIS

World's Largest and Oldest Manufacturers of Professional Magnetic Recorders
The "DOUGLAS" Double Bank Fully Automatic Multi-Winder is eminently suitable for the high-speed production of large quantities of coils with or without paper interleaving.

It will wind round, square or rectangular coils from 1-inch (25.4 mm.) to 5-inches (127 mm.) in length and up to 4-inches (102 mm.) diameter or diagonal. As many as 24 coils can be wound simultaneously (depending on the gauge of wire being used), the total winding length of the machine being 30-inches (762 mm.).

Wires from 42 to 30 a.w.g. can be handled at variable headstock speeds of between 600 and 2,000 r.p.m., the machine being fitted with a specially designed rapid-change gear box and a variable speed totally enclosed motor.

The machine, which incorporates the most up-to-date refinements is supplied complete with a special sliding seat which enables the operator to effect complete control without undue effort.

Our complete catalogue contains illustrations of numerous other Coil Winding and Taping Machines. A copy will be sent to interested executives on application.

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD
Winder House • Douglas Street • London • S.W. 1 • England Cables: "Autowind, Savoy, London" Code: A.B.C. 5th
WHAT WILL THE 1950 CENSUS DO FOR YOUR BUSINESS?

CONSUMER MARKET INFORMATION
The 1950 Census will provide a huge amount of information about the characteristics of the consumer market. It will tell you what kind of income groups live where... what they have and what they need in the way of commodities from automobiles to television sets down to plumbing fixtures. The Census is an accurate survey of economic conditions in your market area. It will not only tell you where your customers are, but what they need that you have to sell them!

It will show where improved transportation and shipping facilities are needed... better harbors and waterways... stepped-up Public Service.

That is why the 1950 United States Census is vital to your business!

COOPERATION
You know that the Census-Taker is not just "counting heads." He's actually making a survey of existing conditions in industry, business, employment, housing, education. You know census information is as confidential as the vote you cast! Because you know all these things you'll cooperate with the Census-Taker in every way when he calls on you.

WHAT ABOUT THE OTHER FELLOW?
But! What about the people who work for you? The man in the shop... your own secretary... the fellows in the shipping room. Do they know all this about the Census? Chances are some of them do, so the idea is to get the right information across to those who don't!

WHAT'S THE BEST WAY?
If it's possible, call everyone together and talk about it... ask questions... exchange ideas. If your outfit is too big for that, direct a Census information memorandum to all your employees. Post information on the bulletin boards. Run a Census story in the company house organ. Talk about it. Every way you can... get the people who work for you to cooperate with the Census.

WHAT DOES THE 1950 CENSUS MEAN TO YOUR EMPLOYEES?
Better schools... school buses... school lunches. It means finer roads, bridges and highways... increased transportation facilities... improved safety regulations. It creates more efficient Public Service and furthers adequate distribution of utility services such as telephones, gas, water and electric power. It will help your community plan better parks, playgrounds, recreation areas and housing. It will mean higher living standards and accurate congressional representation. The Census is everybody's voice in America's future!

YOU OWE IT TO YOURSELF...
Mister Businessman... to your business and your community! Put your efforts behind the 1950 United States Census for an even better country to live in... the best country to do business in!

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McGraw-Hill Publications
ECONOMY
ACCURACY
STABILITY
COMPACTNESS

Have your Cake ... and Eat it, too, with
JELLIFF ALLOY 1000 RESISTANCE WIRE

The new high in Resistivity—100 ohms/cm²—
plus an impressive array of important electrical
and physical characteristics, make our new
ALLOY 1000 the most desirable material for
windings in compact, precision resistors of all
types. And the best thing about it is that you
don't gain one characteristic at the cost of seri-
ous losses elsewhere. Write today for Bulletin
17, with the full story and technical data on
JELLIFF ALLOY 1000 RESISTANCE WIRE

All you need...

for complete oscillographic recording

The S-8 Oscillograph, long the standard of oscillographic recording, has
been improved to meet the expanding demands of modern research. The
NEW Type S-8 Oscillograph has all the inherent capabilities you need to
record rapidly changing phenomena such as vibration and dynamic strain.

A few of the newest features are:

- QUICK-CHANGE TRANSMISSION—16 record speeds over range of 120:1
- FULL RESILIENT MOUNTING makes possible use of super-sensitive galva-
nometers
- CHART TRAVEL INDICATOR provides continuous indication of chart motion
- NEW GALVANOMETER STAGE takes all Hathaway galvanometers for
  recording milliamperes, microamperes, and watts.
- NEW RECORD-LENGTH CONTROL and NUMBERING SYSTEM for long,
  trouble-free service.

All the other valuable features characteristic of the S-8 are retained.
Investigate the NEW Type S-8 and its 170 types of galvanometers.

Write for Bulletin 281 A-G.
tures of model 602 by providing a greater range of response curves and additional compensation to accommodate pickups of different characteristics. The high-frequency characteristics obtainable comprise 5 steps, ranging from flat response to a heavy roll-off for worn records. A selection of 150 or 200-ohm output can be made by making appropriate connections to the terminal board.

D-C Amplifier
C. G. S. Laboratories, Inc., 36 Ludlow St., Stamford, Conn. The d-c amplifier illustrated has an output of 200 µa or 3 volts across 15,000 ohms, for an input of 500 µv; a multiplier switch extends this input to 5 mv, 50 mv, and 500 mv. Input impedance is one megohm. Noise generated in its air-coupled chopper is equivalent to 2 to 3-µv input signal. Use of an electronic ripple filter and paper capacitors assures satisfactory operation over an ambient temperature range from -55 C to +85 C.

Vibrator Inverter
Cornell-Dubilier Electric Corp., South Plainfield, N. J. The Power-con line of d-c to a-c inverters is
New Terminal Attaching Machine

attaches and solders various sizes and types of pre-soldered tandem terminals (supplied on reels) at rates up to 1200 per hour. Machine cuts off, clinches and solders terminals in one instantaneous operation. Eliminates handling of loose terminals, solder and flux to increase production and lower costs on long runs. Standard types available. Strong, perfectly soldered joints are assured, as absolute control of heat is maintained. Send for detailed information, enclose sample of wire and terminal now used. Address Dept. E. For ordinary runs in moderate quantity we continue to produce.

SEPARATE TERMINALS for ELECTRIC WIRES

We also make SMALL METAL STAMPINGS, exact to Customer's prints. Modern Plant, Equipment and Methods. Precision Work, Moderate Die Charges. Prompt, Dependable Service.

PATTON-MACGUER COMPANY
17 Virginia Avenue, Providence, R.I.

SYNTHESIS IS A HIGH CLASS WORD FOR DESIGNING SERVO MECHANISMS

...SERVOSCOPE IS A HIGH CLASS INSTRUMENT FOR SERVO SYNTHESIS!

WRITE FOR INFORMATION

SERVO CORP. OF AMERICA
NEW HYDE PARK, N.Y.

Now Terminal Attaching Machine

For SERVO CORP.
NEW INFORMATION
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signals

3. Provides an analysis, both theoretical and experimental, of the factors which affect the perception of desired signals in the presence of various kinds of interference, principally inherent receiver noise. In addition to signals which consist of trains of pulses, a treatment is given of pulse trains which are amplitude modulated in some desired way. By J. Lawson, Gen. Elect. Research Lab., and G. Uhlenbeck, Univ. of Mich. $5.60.

Vacuum Tube Amplifiers

4. Brings you modern research findings on the principles, constructional techniques, and special problems of vacuum tube amplifiers. The amplifiers discussed are designed to have extreme values in one of several of the pertinent characteristics: bandwidth — sensitivity — linearity — constancy of gain over long periods of time, etc. By G. E. Valley, Jr., M.I.T., and H. Wallman, M.I.T. $18.60.

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McGraw-Hill Book Co., Inc., 330 W. 42 St., N.YC is bound by the above corresponding to number enclosures below (on 10 days examination on approval). If you and I will send for these books, plus five cents for delinquent, or return book(s) postpaid. (We pay for delivery if you return, with this coupon, same return privilege.)

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This offer applies to U. S. only

April, 1950 — ELECTRONICS
generally used to create 110-v, 60-
cycle a-c from battery or other d-c
sources. All for use with radio or
tv equipment are filtered for clear
reception and are capable of starting
under full load without the necessity of starting the converter
first and then applying the load.
Information on various models is
available.

Superhet Tuner

APPROVED ELECTRONIC INSTRUMENT
Corp., 142 Liberty St., New York 6,
N. Y. Model A-600 broadcast
superhet tuner is completely fil-
tered and hum free. It is designed
for use in public address systems,
portable amplifiers, record players,
wire and tape recorders and motion
picture sound projectors. Output
is adjustable in 3 steps of 10 v, 5 v
and 1 v. The unit has a self-con-
tained 115-volt a-c/d-c power sup-
ply.

Resistance Box

ANALYSIS INSTRUMENT Co., P.O.
Box 231, East Paterson, N. J., is
now offering a resistor decade for
We’re not in the standard vacuum tube business. But we are definitely in the business of developing and manufacturing special purpose vacuum tubes — tubes that are not generally available. During the past three years, for example, our facilities have produced, such devices as the Chronotron thermal time delay tube, the Convectron vertical sensing tube, the TT-1 3000 mc temperature limited noise diode tube, counter tubes, glass enclosed spark gaps, and phono pickup tubes. Quantities of all these are now serving many phases of industry in a wide variety of applications. We invite your use of our facilities to develop and produce your requirements of special purpose vacuum tubes. Your inquiries concerning the scope of our facilities or details of any of our tubes will be given immediate attention.

Eclipse-Pioneer Division of TETERBORO, NEW JERSEY

Precision Paper Tubes assure better coils by providing a superior coil base of finest dielectric Fish Paper, Cellulose Acetate, or combination, that improves insulation, has lower moisture absorption, spirally-wound and heat-treated for greatest strength, they’re lighter, afford greater heat dissipation.

Whether your coils be round, oval, square, rectangular or other shape—regardless of their length, ID or OD—we can supply a Precision Coil Form made exactly to your specifications. Write or wire today for new Mandrel List of over 1,000 sizes. Ask about new Precision Di-Formed Paper Tubes that allow making more compact coils at no extra cost.

PRECISION PAPER TUBE CO.

Also makers of Precision Coil Bobbins
2041 W. Charleston St., Plant #2, 79 Chapel St.,
Chicago 47, Ill. Hartford, Conn.
electronic production and laboratory use. Model 101 contains all RMA 10-percent resistance values from 47,000 ohms to 2.7 megohms, 1-watt dissipation and 10-percent accuracy; model 102, values from 680 ohms to 39,000 ohms. These decades make it possible to place RMA resistor values in a circuit without drawing a number from stock for trial. It also eliminates the potentiometer-ohmmeter method of first approximation of circuit values.

Miniature Receiving Tube

GENERAL ELECTRIC Co., Syracuse, N.Y. Type 6CB6 miniature receiving tube can be used as a wideband amplifier in the i-f or r-f stages of television and f-m receivers. This sharp-cutoff pentode has a transconductance of 6,200 micromhos and a plate current of 9.5 ma under typical operating conditions. The suppressor and cathode of the tube are brought out on separate base pins to allow greater flexibility in design.

Ceramic Coil Forms

CAMBRIDGE THERMIONIC CORP., 437 Concord Ave., Cambridge 38, Mass.,
TOROIDS—for Performance

Close tolerance toroidal coils wound on 3/4 inch diameter, or larger, cores. Inductance tolerances can be maintained to 0.1%. Available with balanced windings, taps and close-coupled secondaries.

Where a wide frequency range of operation is required, coils with extremely low distributed capacity are available.

LENKURT ELECTRIC CO.
SAN CARLOS - CALIFORNIA

Moisture-Resistant Electrical Connectors

No question about it... JOY plugs and sockets are today's outstanding electrical connector value! Molded as one-piece Neoprene units and factory vulcanized to cords, they won't crack or shatter under hard blows— are surprisingly immune to climatic changes— and are trim, safe and easy to handle. Whenever advantageous, JOY Connectors are equipped with the famous MINES "Water-Sealing" face. Cut-away illustration in circle shows how close-fitting segments on mating Male and Female plugs positively "Seal-out" dirt and moisture by enclosing contacts in a resilient rubber housing. Ask for a complete description on this and other advantages that only JOY Connectors provide.

A wide variety of sizes, shapes and pin combinations are available to meet the portable power requirements of TV, FM, AM or PA Circuits. Illustrations show JOY'S No. 2C156M Portable Male Plug and No. 2C156F Portable Female.

MODEL 1035 Provides FAST SWEEPS, from 1.5 Sec. to 24 Microsec., and Video Frequency Amplifiers. Request — VE Feedback Type, with Gain of 2 at 1 Mc. Bandwidth to Gain of 3000 at 80 Mc. Bandwidth, ± 1.5 DB. FOUR Triggered Sweeps, Suppressed Pictorial, ± VE Sync.

MODEL 1049 Provides SLOW SWEEPS from 1.5 Sec. to 50 Microsec., and D.C. Amplifiers Completely Stabilized Throughout, Response 0-100 Mc. ± 1.5 DB. Gain 900, PLUS Beam Blanking Circuits, Triggered Sweeps, ± VE Sync.

PLUS
Unique TWIN BEAM Flat Face CRT in BOTH Instruments Providing Instant Directly Calibrated Measurement for Accurate Voltage, Time and Phase Comparisons.

WRITE TODAY FOR LITERATURE AND DEMONSTRATION

COSSOR (CANADA) LIMITED
WINSTON ST., HALIFAX, N.S.

BEAM INSTRUMENT CORP.
Room 208, 55 W. 42nd St., New York 18

April, 1950 — ELECTRONICS
recently announced two new ceramic coil forms. Coded LS-5 and LS-6, they are made of silicone impregnated ceramic (grade L-5, JAN-I-10) for high resistance to moisture and fungi. The LS-5 is 1½ in. high and ½ in. in diameter; LS-6 is ¾ in. high and ⅞ in. in diameter. Ring terminals are adjustable. Both sizes are provided with a spring lock for the slug, and both are available with high, medium or low-frequency slugs.

Midget Capacitor

ERIE RESISTOR CORP., Erie, Pa., is now manufacturing a 0.01-µf disc Ceramicon capacitor which is 19/32 in. in diameter. Voltage rating is 400 volts d-c, which is based on a life test of 800 volts d-c at 85°C for 1,000 hours. Power factor is 2.5 percent maximum at 1 kc at not more than 5 volts rms. Insulation resistance is 7,500 megohms minimum.

Precision Switch

W. L. MAXSON CORP., UNIMAX SWITCH DIVISION, 460 W. 34th St., New York 1, N. Y. Type SXX snap-acting precision switch is rated at 15 amperes, 250 volts a-c; 20 amperes, 125 volts a-c; ½ h-p

with BALL BEARINGS

- the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished mechanism.

with TRACING CLOTH . . .

The small extra first cost of Arkwright Tracing Cloth, over that of tracing paper, repays many times over in the efficiency and durability of valuable drawings.

Through continued research and development plus skilled manufacturing processes, Arkwright Tracing Cloths meet every requirement of exacting draftsmanship. You’ll find no pinholes, stains or other imperfections to detract from drawing quality—nor smudging or feathering after repeated erasures. Most of all, you’ll have highly transparent, long lasting usefulness that perishable tracing paper can never match.

For every drawing worth keeping for future use—specify permanent Arkwright Tracing Cloth. Send now for generous working samples. Sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.
IMPROVED ULTRA-SENSITIVE DC AMPLIFIER

1. This new and improved DC amplifier of the General Motors breaker type offers many advantages in the measurement of DC and low frequency AC voltages in the microvolt and fractional microvolt regions. It is useful for the amplification of low level thermocouple voltages, infrared detectors, photovoltaic cells and the like. It can be used to replace suspension galvanometer systems.

2. This new amplifier (Model 10) features very high immunity to the effects of AC pickup in the input circuit. The discrimination ratio against 60 cycle pickup is over 1000. It has an improved life breaker. Convenient and accurate coarse and fine gain controls, zero position controls and calibration signals are provided.

3. This instrument has a zero stability of better than .005 microvolts per day after warm up. The noise level approaches the limit imposed by the Johnson noise of the external circuit. This amplifier is available for operation with input circuits from 0 to 1 megohms. The DC output of the amplifier is sufficient to operate standard recorders, milliammeters and DC relays. For 110 volts, 60 cycle operation.

Price $580.00

For complete information, write

LISTON-FOLB
Division of Atlas Coil Winders, Inc.
DEPT. M
P.O. BOX 1334
STAMFORD
CONNECTICUT

RECEIVING TYPE CONDENSERS

National's famous receiving-type condensers are available with either straight-line wavelength plate shape or straight-line capacity plate shape. Special features can be supplied in quantity, such as serrated rotor plates, staked rotor and stator plates, shaft extensions for ganging and special capacities as high as 335 mmf. for single-section and 100 mmf. per section for dual condensers. Commercial inquiries invited.
NEW PRODUCTS (continued)

125, 250 and 460 volts a-c. Force and movement specifications are as follows: operating force—9 to 13 oz; release force—4 oz minimum; movement differential—0.005 in. maximum; pretravel—0.025 in. maximum; overtravel—0.005 in. minimum.

Inputuner

ALLY B. DU MONT LABORATORIES, INC., 35 Market St., East Paterson, N. J., has introduced the four-section Inputuner, incorporating the latest spiral-type Inductuner. Tuning range is continuous from 54 to 216 mc, inclusive, covering the tv channels 2 to 13 as well as the f-m band. It requires only 5.9 turns of tuning motion as against 10 turns for previous models. It operates efficiently on either 300 or 72-ohm antenna systems by means of an input transformer.

Nylon Lacing Cord

HEMINWAY & BARLET MFG. CO., Watertown, Conn., has developed a new Nylon lacing cord for winding around the leads and wires of electronic equipment to bind them firmly together and prevent their fouling with working parts. Its coating resists mold and microorganisms and, at the same time, retains malleability. Tensile

WEBSTER ELECTRIC

Quality Cartridge Model A

- No Installation Problem
- No Servicing Problem
- Positive Tracking at all Speeds

Furnished with complete twist mechanism for mounting in tone arms.

Fits All Standard Tone Arms
Plays 33 1/3 and 45 RPM or 78 RPM Records

Webster Electric Cartridge Model A is a versatile, miniature-size cartridge which is furnished complete with brackets permitting its use in nearly every record changer tone arm on the market today. Designed to play 33 1/3 and 45 RPM or 78 RPM records, it tracks at only 7 grams. Its extremely light weight simplifies counter-balancing problems. Its small size and simplified, foolproof mechanism make it the ideal cartridge for three-speed record changers.

Write us for complete information, prices or samples for tests.

WEBSTER ELECTRIC

Webster Electric Company, Racine, Wisconsin • Established 1909

"Where Quality Is a Responsibility and Fair Dealing an Obligation"
POLARAD LABORATORY  Equipment
for studio  laboratory  manufacture

• Flat frequency response from 100 cps to 20 mc ± 1.5 db.
• Uniform time delay of .02 microseconds.
• Gain of 50 db.
• Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
• Fine attenuator covers a 10 db range.
• Phase Linear with frequency over entire band.

This unit is designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of extremely short duration and rise time, and contains the Video Amplifier Unit, Power Unit and a low Capacity Probe.

Specifications
Input Impedance: Probe—10 mmf 470,000 ohms; Jack—50 mmf 470,000 ohms; Output Impedance: 18 mmf 470,000 ohms each side push pull;
Max. Input Volts 500 peak to peak; Max. Output Volts 120 volts peak to peak (push pull); Power: 115 volts 50/60 cps AC Line;
Size 19¹/2"x22-x14%20 MC VIDEO AMPLIFIER
Model V, tea. c1.1,.

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Improved processing of our hermetically sealed TYPE 20 Unit has made it possible to eliminate the cost of temperature control.
Type 20 meets all government specifications.

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Cramer DESIGN QUALITY ACCURACY

RUNNING TIME METERS
Synchronous motor driven. Register automatically and cumulatively total operating or idle time on circuits, machines, systems.

TIME DELAY RELAYS
Provide adjustable or fixed time delay between operation of a control circuit and subsequent opening or closing of a load circuit.

SYNCHRONOUS MOTORS
Permanent magnet type for applications requiring a constant speed at a given frequency. Small size. 30° ounce torque. Twenty-eight speeds from 60 rpm to 1/24 rph.

For a wide range of standard timers and controls . . . or special adaptations for specific applications...consult R.W. CRAMER CO., Box No. 3, Centerbrook, Conn.

April, 1950 — ELECTRONICS

SPECIALISTS IN TIME AS A FACTOR OF CONTROL

INTERVAL - DELAY - CYCLE - IMPULSE - PERCENTAGE

POLARAD LABORATORY  Equipment
for studio  laboratory  manufacturer

• Flat frequency response from 100 cps to 20 mc ± 1.5 db.
• Uniform time delay of .02 microseconds.
• Gain of 50 db.
• Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
• Fine attenuator covers a 10 db range.
• Phase Linear with frequency over entire band.

This unit is designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of extremely short duration and rise time, and contains the Video Amplifier Unit, Power Unit and a low Capacity Probe.

Specifications
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Max. Input Volts 500 peak to peak; Max. Output Volts 120 volts peak to peak (push pull); Power: 115 volts 50/60 cps AC Line;
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Improved processing of our hermetically sealed TYPE 20 Unit has made it possible to eliminate the cost of temperature control.
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April, 1950 — ELECTRONICS

SPECIALISTS IN TIME AS A FACTOR OF CONTROL

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strength is 52 lb. The synthetic resin finish has a melting point over 190 F.

Pack Set
MOTOROLA INC., 4545 Augusta Blvd., Chicago 51, Ill., has designed a new f-m 2-way pack radio for law enforcement agencies, fire departments, construction outfits, forestry services and similar organizations. The unit uses a 16-tube receiver and an 8-tube transmitter. Power output is 500 mw in the 25 to 50-mc band; and 250 mw in the 152 to 174-mc band. It is designed for operation from pack set to pack set, with a nominal range of 2 to 5 mi; from pack set to mobile unit, with a range of 7 to 10 mi. Subminiature tubes and cellular construction with individual plug-in stages are used.

Frequency-Deviation Monitor
MOTOROLA INC., 4545 Augusta Blvd., Chicago 51, Ill., has announced for operators of two-way f-m radio systems a unit which measures: (1) the relative strength...
"Recently, one of our customers sent us, unsolicited, the findings on a test he conducted. In this experiment, Pel-X was tested along with seven similar tracing cloths and when the results were in, Pel-X topped the list on every count including evenness of pencil lines and workability—and by a substantial margin, too!"

This is proof that Pel-X can do everything as well as any other tracing cloth and some things better.

Find out for yourself just how good Pel-X really is by trying it on your drawing board. Put it to any test against any competitive tracing cloth and compare the results. We're sure you'll want to switch to Pel-X. Write for generous sample. *Name on request.

"PEL-X is BEST by TEST!"

THE HOLLISTON MILLS, INC.
NEW YORK  PHILADELPHIA  CHICAGO

Waterman products include...
S-10B GENERAL POCKETSCOPE
S-11A INDUSTRIAL POCKETSCOPE
S-14B WIDE BAND POCKETSCOPE
S-15A TWIN-TUBE POCKETSCOPE
Also, RAKSCOPES, Linear Amplifiers, RAYONIC tubes and other equipment.

April, 1950 — ELECTRONICS
of signals being transmitted, (2) the magnitude of frequency modulation, and (3) error displacement of the signal from assigned center frequency. Designed for 117-v, 60-cycle operation, the unit monitors up to five carrier frequencies in either the 20 to 50-me or 152 to 174-me band. Other frequencies may be monitored by exchange of control crystals. These temperature-compensated crystals introduce an error of less than 0.00005 percent.

Solderless Terminal Lug
Buchanan Electrical Products Corp., 1290 Central Ave., Hillside, N. J. The new Termend solderless lug can be installed on all wire sizes from No. 16 to No. 8 AWG with a single crimping tool. These features enable considerable economy through allowing purchase, stocking and handling of fewer items. The lugs are available in ring, spade and locking spade-tongue styles.

Attenuators
Kay Electric Co., Pine Brook, N. J. Two new attenuators provide low signals and attenuating signals by known amounts, and cover the frequency range of 0 to 500 mc. Model 20 has constant input and output impedance equal to 53.5 ohms and
Bendix-Pacific offers the aircraft industry the fully tested and proven AN/DKT-3 Subminiature Telemetering System.

The complete Telemetering Services offered by Bendix-Pacific include:
1. Application engineering to adapt the Bendix-Pacific System to each specific instrumentation problem.
2. Standard and special FM/FM sub-miniature components and assemblies.
3. Installation engineering and calibration services.
4. Aircraft and missile antenna design.
5. Flight testing, providing ground station facilities and reduction and analysis of data.

Indicative of the engineering leadership which Bendix-Pacific has attained is the fact that a typical six-channel telemetering system complete with power supply weighs 12 pounds and occupies only 130 cubic inches. Equipment now available to provide line of sight ranges up to 100 miles or more for Bendix-Pacific Telemetering Systems. Inquiries from qualified companies and agencies for complete engineering data are invited.

Plug-in components provide the utmost in flexibility for the instrumentation engineers in your company.

Bendix-Pacific

Pacifiic Division
Sngrd Avionics Corporation
North Hollywood, California

DUAL CONTROL

- Series 37, linear and tapered resistance, 1000 ohms min. to 5 meg. max.
- Series 43, 10,000 ohms max. linear. Limited tapers available.
- Resistance values within 10% plus/minus, standard, on Type 42, 20% plus/minus on Series 37 under 100,000 ohms, 30% plus/minus over 100,000 ohms (RMA Standard).

CONCENTRIC-SHAFT TANDEMS

- Concentric dual knobs control two independent circuits independently. Typically Clarostat's s-m-o-o-th rotation thanks to centerless-ground concentric shafts. With Series 37 (composition-element) or Series 43 (wire-wound) 1 1/4" dia. controls. With switch if desired. Reinforcement strap for rigid tandem assembly.

WRITE FOR BULLETINS 112 AND 116. LET US QUOTE!

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Sigmund Cohn Corp.
44 Gold St., New York
Since 1901

Made to meet your specifications... for gold content, diameter and other requirements.

Write for details and list of products

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model 21 equal to 70 ohms. A fixed insertion loss of 10 db and switchable insertion loss in 1-db steps to a total of 41 db are provided.

Audio Connectors
CANNON ELECTRIC, 3209 Humboldt St., Los Angeles 31, Calif. Designed and manufactured to meet RMA standards, the UA series of audio connectors consists of two plugs and four receptacles, carrying three 15-ampere contacts rated at 1,500 volts minimum flashover. Cable entry is ¼ inch. Rubber bushings and cable relief collar protect the connectors from shock and moisture. Bulletin UA-1 is available on request.

Ultra-High-Speed Relay
STEVENS-ARNOLD INC., 22 Elkins St., South Boston 27, Mass. The Milliseec relay now offered has an operating time as short as ½ millisecond, is hermetically sealed and is available in 6-pole double-throw construction. Contact rating is 110 volts d-c, 0.5 ampere. Life ex-
Announcing!
The FURST WIDE BAND D. C. AMPLIFIER
MODEL 120
A precision instrument designed for use as a preamplifier in conjunction with an oscilloscope, vacuum tube voltmeter or other instruments.

SPECIFICATIONS
Frequency Response: Within ± 1 db (or better) between D.C. and 100,000 cycles per second.
Gain: Approximately 100.
Input Connection: Double channel, can be used for single ended and push-pull signals or as a differential amplifier.
Input Impedance: One Megohm shunted by approximately 15mff in each channel.
Dual Input Attenuator: One to one, 10 to one, 100 to one and "off" positions in each channel independently adjustable.
Output Connection: Push-pull or single ended.
Output Impedance: Less than 50 Ohms single ended or 100 Ohms push-pull.
Hum and Noise Level: Below 40 Microvolts referred to input.
Low Drift due to operation of heaters of input stage from regulated D.C. power (± 1 Millivolt) referred to input.
Mounting: Metal cabinet approximately 7" wide by 7" high by 11" deep.

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time saving...cost saving!

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dependable instruments

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ARGON • KRYPTON • XENON
Now available in commercial-size cylinders in addition to glass bulbs. Write for information on sizes, prices, rigid purity tolerances, special rare gas mixtures...

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April, 1950 — ELECTRONICS
pectancy varies from 22 million operations at 0.5 ampere to about 100 million operations at 0.25 ampere.

Electrolytic Capacitors

SPRAGUE ELECTRIC Co., North Adams, Mass. Type All 116-volt electrolytic capacitors for continuous duty a-c service are ideally suited for across-the-line power factor improvement at low voltages, particularly with appliances and light industrial equipment. They are also useful in applications where a voltage drop is required without power dissipation. Engineering bulletin 301, giving complete standard ratings, is available.

Literature

X-Ray Apparatus. Picker X-Ray Corp., Waite Mfg. Division, 17325 Euclid Ave., Cleveland 12, Ohio. A recent 32-page booklet illustrates and describes a wide variety of all-purpose x-ray apparatus. Included are the Century 100-amp, self-rectified single-tube radiographic-fluoroscopic unit with monitor control; and the 200-amp full-wave two-tube radiographic and fluoroscopic diagnostic unit with Pictronic control.

Ignitron Substations. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. A 16-page booklet, B-4239, treats of ignitron unit substation. The substations described provide a source of d-c power near the load directly within the mine or factory building and are being applied to

Timing Ideas

PRECISION PERFORMANCE

Manufacturers, recognizing that components of quality insure outstanding product performance, look to Haydon® at Torrington for timers and timing devices. All Haydon timers are made with the same precision as the Haydon motor — your guarantee of satisfactory performance. If you need a special design, you'll find Haydon's extensive engineering and development facilities without equal for service and results.

A few examples of basic Haydon timing units are featured below.

SERIES 8010 INTERVAL TIMER WITH BUZZER
Compact, low cost timer for volume production. Wide range of intervals. Audible (buzzer) signal optional. Quick break. Load contact rated 10A, ½ HP 250 VAC.

SERIES 8006 INTERVAL TIMER
Designed for heavy duty, this unit is available in quantities in standard models. Wide range of intervals. HOLD feature optional. Quick break. Totally enclosed. Switch rated 28A, 1 HP 250 VAC.

SERIES 5900 TIME DELAY RELAY
For use where positive, accurate time delay relay is imperative. Automatic reset. Fixed models for volume production; adjustable models in 4 delay ranges for general use.

SERIES 5700 ELAPSED TIME INDICATOR
Synchronous timing motors with cyclometer type counters for metering elapsed time. Rugged models for wide range of timing, recording operations; in several registers, resettable or non-resettable.

For complete design and engineering specifications, write for catalog: Timing Motors No. 322 — Timers No. 323 — Clock Movements No. 324. Yours without obligation.
PHILAMON LABORATORIES manufacture temperature-compensated, hermetically-sealed tuning fork resonators in fundamental frequencies from 1,000 to 3,000 cycles per second — and in accuracies from 1 part in 3,000 to 1 part in 100,000. Accuracies up to 1 part in 20,000 are obtainable for operation over temperature ranges as wide as 100 Degrees Centigrade without benefit of oven control.

PHILAMON
5717 THIRD AVENUE BROOKLYN 20, NEW YORK

FOR ORIGINALITY
LOOK TO XCELITE

Have Your Dealer Show You This Set In UNBREAKABLE Transparent Box!

* 3 fast-change double-end screwdrivers (3 regular, 3 Phillips) for only $3.95!
  (See regular XCELITE handle fits all blades)

A REAL SAVING over buying individual screwdrivers!
* Box of Transparent plastic good for plenty of punishment!
  * You can also buy XCELITE removers to fit some handles — and save money!

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A preferred source of precision-made WASHERS and STAMPINGS. 46 years of experience and up-to-the-minute facilities, assure highest quality and service.

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Detroit 16, Michigan

Insensitive to atmospheric and relative humidity variations — the resonators are available individually — as a part of compact sub-assemblies — or in completely engineered equipment.
railway, mining, electrochemical, general industrial and other specialized fields.


Capacitors. The Allen D. CARD- well Corp., Plainville, Conn. Catalog No. 50 is a 24-page treat- ment of a wide line of variable and fixed air capacitors. Illustrations, general specifications and dimen- sional drawings for all are given. An insert is also included giving list prices for the various types.

UHF Impedance Measurements. Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. Volume I, No. 5 of the Journal de- votes its 4 pages to a description of how an accurate slotted line section is an effective aid in the determination of impedance or investigation of impedance mis- match and power wastage at ultra- high frequencies. Specifications for two models of slotted lines and one standing-wave indicator are given.

Speakers. Oxford Electric Corp., 3911 S. Michigan Ave., Chicago, Ill. A new 4-page catalog gives complete listings and pertinent data on a line of speakers, along with illustrations of several types. The line described includes the following types: electrodynamic, permanent magnet, television, public address, auto, intercom and weather proof speakers.

Marine Radar. Westinghouse Elec- tric Corp., Baltimore, Md. An eight-page bulletin covers the type MU-1 marine radar with special- ized design which incorporates all of the features necessary to meet operational requirements. Fea- tures of the radar described include a 121-in. flat-face scope, a com- plete system check, one-mile range,

PUSH BUTTON
ATTENUATOR

True V.H.F. loss measurement at last!

An outstanding development which in the first year of production has fully established itself with leading British communication organisations and remains the first and only accurate instrument of its kind.

Two models available

Type 74600- A : 0 - 9 db in 1 db steps
Type 74600- B : 0 - 90 db in 10 db steps

Both have a 75-ohm characteristic impedance and will handle inputs up to 0.25 watts.

50 Mc/s Performance *

<table>
<thead>
<tr>
<th>MODEL</th>
<th>VARIATION BETWEEN 50 Mc/s and D.C.</th>
<th>ACCURACY OF D.C. ADJUSTMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 9 db</td>
<td>± 0.01 db per step</td>
<td>± 0.05 db at all settings</td>
</tr>
<tr>
<td>0 - 90 db</td>
<td>± 0.1 db per step</td>
<td>± 0.03 db per step</td>
</tr>
</tbody>
</table>

* Insertion loss relative to zero setting

Ready for building into your own equipment

Calibration charts for frequencies up to 100 Mc/s for the 0-9 db model or 60 Mc/s for the 0-90 db model can be supplied on request.

Standard Telephones and Cables Limited
An I. T. & T. Associate
TRANSMISSION DIVISION, NORTH WOOLWICH, LONDON, ENGLAND

ELECTRONICS — April, 1950
LITTLEFUSES
"Quicker than a short-circuit"

Used Everywhere for
Delicate Equipment
PROTECTION

Galvanometers Microameters
Milliammeters Radio Tubes, etc.

Stock sizes 1/32, 1/16, 1/8, 1/4, 1/2, 1 and 2 Amps.
Convenient Mountings.

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Approved for Veteran Training

NEW EXTENDED RANGE
Model 250-B IMPEDANCE BRIDGE

TEN TIMES THE RANGE
Resistance: 1 milliohm to 11 megohms,
Capacitance: 1 microf to 1100 mfd.
Inductance: 1 microhenry to 1100 henrys.

TWICE THE ACCURACY
Better than 1/4% on most measurements.

MANY TIMES THE CONVENIENCE
Simplified switching — Colored indexed dials — Unique
direct reading LRC dial — No AC power connection re-
quired — Lightweight, 15 lbs. — Compost, 9½" x
10½" x 10½" . Accessory null amplifiers available.
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further information.
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... anybody with a hand can operate it!
The Green Engraver offers great speed and
convenience. Quickly cuts up to four lines
of letters from 3/64" to 1" on curved or flat
surfaces whether made of metal, plastics or
wood... operates by merely tracing master
copy—anyone can do an expert job. Special
attachments and engineering service avail-
able for production work. Just the thing
for radio, electronic apparatus and instru-
ment manufacturers.

*Price does not include master type and special work
holding fixtures.

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PHOTOVOLT VIDEO
Brightness Tester
MOD. 205

A photoelectric instrument for measuring the brightness of
television tubes and screens in foot-lamberts.

Price, $68
Write for literature to
PHOTOVOLT CORP.
95 Madison Ave., New York 16, N. Y.
Photoelectric and
Electronic Measuring Instruments
improved sea suppression and centralized control. Installation information and mechanical and electrical characteristics are given.

TV Viewing Tubes. Sylvania Electric Products Inc., Emporium, Pa., has published a 20-page booklet providing television picture tube and general purpose c-r tube characteristics, replacement tube data, base diagrams, suggestions for tube handling, and a concise description of c-r oscilloscope use in tv servicing. Information contained covers 165 tube types with faces ranging from 2 to 20 inches maximum dimension utilizing electrostatic or magnetic deflection systems.

Ovens for Electronic Industry. Steiner-Ives Co., 8-16 Ave. L, Newark 5, N. J., recently issued a four-page folder dealing with ovens for the processing of c-r and vacuum tubes for the electronic industry. It illustrates units designed for special jobs, concerning which further information is available.

Mass Spectrometer Leak Detector. Vacuum-Electronic Engineering Co., 316 37th St., Brooklyn 32, N. Y. Bulletin LD-6 describes typical applications of the model MS-2 mass spectrometer leak detector for use wherever a vacuum, fixed pressure or special atmosphere must be maintained for extended periods of time. Principle of operation, features and pertinent data pertaining to vacuum testing and pressure testing are given with explanatory illustrations.

Magnetic Amplifier Design. Vickers Electric Division, 1815 Locust St., St. Louis 3, Mo., has issued a collection of bulletins in a loose-leaf bound handbook dealing with magnetic amplifier design. Applications, technical data, performance characteristics and ratings are given in 44 well-illustrated pages.

Laboratory Standards. Measurements Corp., Boonton, N. J. Catalog C is a 44-page booklet presenting a line of standard signal
NEW PRODUCTS (continued)
generators, television signal generators, pulse generators, square-wave generators, megacycle meters, vacuum-tube voltmeters and other laboratory standards.

House Organ. Measurements Corp., Boonton, N. J. The first issue of Measurements Notes is a 4-page illustrated brochure describing the use of the model 89 megacycle meter in the design and construction of traps and filters for the elimination of television interference.

Timing Devices. Muirhead & Co., Ltd., Beckenham, Kent, England. Four types of phonie motor timing devices are covered in the single-sheet bulletin B-601-C. An illustrated description and overall dimensions of each unit are given. More minute details of the motors may be found in bulletin B-615.

Transformer Catalog. Peerless Electrical Products Division, Altec Lansing Corp., 161 Sixth Ave., New York 13, N. Y., has published a new transformer catalog containing new models and including a complete line of transformers for broadcasting and other professional applications as well as for amplifier constructors, audio enthusiasts, the replacement field and hams. The line includes output, input, interstage, plate and filament, power smoothing and swinging chokes, modulation and replacement types.

Electrical Insulation Price Catalog. Insulation Manufacturers Corp., 565 West Washington Blvd., Chicago 6, Ill., is offering the 128-page price catalog No. 14, giving complete price information on electrical insulating materials. Divided into 13 sections for quick reference, it covers a variety of materials including tapes, tubings and sleevings, varnished cloths, mica, papers, wedges, plastics, vulcanized fibre, cordage, varnishes and numerous other products.

TV Replacement Guide. Merit Transformer Corp., 4425 N. Clark St., Chicago 40, Ill., announces its 1950 television replacement guide, listing approximately 400 popular...
BIRCHER STAINLESS STEEL - LOCKING TYPE TUBE CLAMPS

83 VARIATIONS
Where vibration is a problem, Birtcher Locking TUBE CLAMPS offer a foolproof, practical solution. Recommended for all types of tubes and similar plug-in components.

FREE CATALOG
Send for samples of Birtcher stainless steel tube clamps and our standard catalog listing tube base types, recommended clamp designs, and price list.

THE BIRCHER CORPORATION
5087 HUNTINGTON DR. LOS ANGELES 32

FOR EFFICIENT MAINTENANCE
SPECIFY REMLER TILT-UP EQUIPMENT SLIDES
Remler slide rails for rack or cabinet mounting permit complete withdrawal or inspection of top and bottom of apparatus chassis. Positive...self-locking. Full roller type...handles equipment up to 50 lbs. Stainless steel for military applications: cadmium plated cold rolled steel or bonderized cold rolled steel. Nickel plated brass rollers; roller studs in stainless or copper flashed cold rolled steel.

Remler Company Ltd. 2101 Bryant St. San Francisco 10, Calif.
MINICHOPPER

Servomechanisms, Inc. Announces the MINI-CHOPPER
A precision miniature device for use in
Modulation . . . .
Demodulation . . . .
Rectification . . . .
Inversion . . . .
The ultimate in miniature functional packaging
combining the maximum in
Performance . . . .
Stability . . . .
Dependability . . . .

INFORMATION FOR SPECIFIC APPLICATIONS ON REQUEST.

Designers and Producers of precision electronic devices for military and commercial application.

NEW PRODUCTS (continued)
television receiving sets made by 60 manufacturers. The guide is intended to cut repair-bench time by providing a simple, quick method of determining the correct replacement parts.

Insulation Testers. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. Two new models of the Meg type instruments for laboratory, production and other repetitive field tests of insulation resistance are described and illustrated in bulletin 21-46. Applications, electrical circuit diagrams and specifications are included.

Antenna Stacking Information. Technical Appliance Corp., Sherburne, N. Y. Explanation and detailed drawings of the proper procedure in stacking highband antennas are found in engineering bulletin No. 58. Dimensions and proper phasing of antennas are given for providing maximum signal strength with both the two-stacked arrays and four-stacked arrays.

Slotted Line. Federal Telecommunication Laboratories, Inc., 500 Washington Ave., Nutley 10, N. J. The FTL-30A slotted line, a precision device designed for making impedance and wave length measurements in the 60 to 1,000-me range, is covered in a single-sheet bulletin. General description, special design features, characteristics and accessories required are outlined.

Resistor Catalog. Cinema Engineering Co., Burbank, Calif., has issued catalog 11AX in three colors, 36 pages, with charts, tables, photographs, diagrams and schematic drawings of precision wire wound resistors, resistive devices and sound equipment. It is supplementary to the general catalog and includes more than a score of new items with description and prices.

Audio Equipment. Sun Radio & Electronics Co., Inc., 122 Duane St., New York 7, N. Y., has issued a handbook dealing with radio a-m and f-m tuners, phonograph pick-

Cold Heading

This special steel stud, used in heavy duty power transmission equipment, combines two different shapes with four diameters.

Some of the steps involved in cold heading this part from a length of steel wire. (Shown one-half actual size.)

Production of this steel part by ordinary methods would involve the use of high cost machines, plus other costly operations. Cold heading not only provides economy and speed of production, but also produces a much stronger part.

Possibly this special technique can help you with your fastener problems. Send your sample or blueprint to Scovill first.

"Guide to the Profitable Use of Cold Heading"—Bulletin No. 2 describes the advantages and limitations of this process. It's free for the asking.

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Garden City 7-0754-5-6

this complex shape is being made at low cost by ...
ELECTRONICALLY REGULATED LABORATORY POWER SUPPLIES

- INPUT: 105 to 125 VAC, 50-60 cy
- OUTPUT #1: 200 to 325 Volts DC at 100 ma regulated
- OUTPUT #2: 6.3 Volts AC CT at 3A unregulated
- RIPPLE OUTPUT: Less than 10 millivolts rms

For complete information write for Bulletin

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NEW! 10 MC BANDWIDTH HIGH GAIN OSCILLOSCOPE

TOP PERFORMANCE FOR $279.50

Laboratories—Industry—Broadcasters...

AT LAST! an engineer's scope built by engineers for you.

- Y-AXIS: 10 mv rms/in; 10 cps, 10% tilt; —3 db at 10 MC.
- SWEEPS: 10 cps to 50 KC; recurrent and driven, expansion 5x full scale.
- SUP—Int. Calibrator—Int. 60 mV Phase Shifter—40 lbs.

Write TODAY for data sheet. See it at Booth 330-IRE Show.

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The short time breakdown voltage of a well-made D.C. capacitor is not less than 5 to 6 times the actual working voltage at 20°C—

\[ E = 5 \times e \min \]

Where:

- \( E \) = Breakdown voltage
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Is the manufacture of R.F. Coils a "step-child" operation in your plant? Does it lead to startup up production because of inadequate facilities and endless engineering detail? If so, Clippard Instrument Laboratory can help you out in a hurry!

Now at your disposal is efficient new high-speed coil winding equipment of our own design, plus a staff of production and control technicians schooled in laboratory accuracy. We deliver the quality coils and sub-assemblies you want when you want them with a minimum of rejects, fuss and bother.

Call on us, like many of the biggest names in radio and television today, to free your production facilities for more important work. For intelligent help and a prompt quotation, mail your requirements, now, to Department 2-E.

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VERSATILE . . . The Tektronix Type 512 Oscilloscope is capable of meeting most requirements in the varied fields of SONAR, RADAR, GEOPHYSICS and BIOPHYSICS. With a vertical amplifier band width of DC to 2 mc and sweep speed range from .3 sec/cm to 3 microsec/cm the observation of either low or high speed phenomena is readily accomplished.

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DIFFERENTIAL INPUT - DELAYED TRIGGER - SWEEP MAGNIFICATION

Please write or wire for complete specifications.

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NEW PRODUCTS (continued)

ups, records, amplifiers and speakers, and also with the installation of such equipment.

Millisecond Timer. Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y. Bulletin 1030 devotes four pages to an illustrated description of the Chronetest electronic millisecond timer, an instrument designed for measuring short time intervals between 0.1 and 10,000 milliseconds with an accuracy of 1 to 2 percent. Principles of operation and methods of application are included.

Resistance Percentage Bridge. Specialties, Inc., Skunks Misery Road, Syosset, N. Y. Brochure S142 illustrates and describes operation of a resistance percentage bridge having an accuracy of 0.01 percent throughout its range of indication. The instrument described is used for quick, accurate calibration of high-precision potentiometers.


Circuit Panel. Kepco Laboratories, Inc., 149-14 41st Ave., Flushing, N. Y. A four-page folder contains complete information on the model 104 circuit panel for experimental electronics. The unit described consists of the panel, 27 keyed circuit diagrams, 3 keyed master charts, 12 blank keyed sheets and one keyed protective diagram cover.

Vibration Test Stands. L. A. B. Corp., 31 Union Pl., Summit, N. J. Types RVCG and RVCA two-dimensional, reaction-type vibration test stands are covered in a four-page bulletin. An illustrated description, dimensions and specifications are included.

Selenium Rectifiers. Seltron Division of Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y., has prepared a 6-page pam-
The FLEXLOC is one-piece, all-metal... has ample tensile and long life. It is a Stop and Lock-Nut that can be reused many times. Its "chuck-like", resilient locking segments lock the FLEXLOC securely in any position on a threaded member. It positively "won't shake loose", yet can be removed easily with a wrench.

See us at Space 128, A.S.T.E. Exposition, April 10-14, Convention Hall, Philadelphia.

Write for Catalog 619, it's full of Information.

ALTEC presents the A-332A Amplifier, the first amplifier designed specifically for use with the famous ALTEC 21B Miniature Microphone! Internal power supplies eliminate the need for additional associated equipment, making it one of the finest compact, flexible public address amplifiers ever produced. It will accommodate any of the basic 21B Microphone types (stand, lapel or chest plate). Two mike channels... plus one for variable reluctance pickup... are provided with individual gain and bass controls. Overall high-frequency droop control is also provided. Inputs may be mixed in any ratio.

The A-332A is truly the answer to high quality public address or sound reinforcement systems that will meet the most stringent requirements of schools, churches, clubs, places of entertainment.

Amplifier is housed in grey metal cabinet. Front panel is lighted and slanted for easy manipulation of controls.

Ask for ALTEC brochures showing the best components to complete your high quality system.

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1161 N. YUEN ST., HOLLYWOOD 38, CALIF.
161 SIXTH AVE., NEW YORK 12, NEW YORK
Color Matching Instrument. Instrument Development Laboratories, Inc., 541 Willis Ave., Williston Park, New York. A four-page folder covers the Color-Eye, a new industrial color measuring and comparison instrument. Inaccuracies due to stray light, variations in photocell characteristics, or illumination level variations, have been effectively eliminated by the basic design of the measuring instrument described.

High-Frequency Tweeter. Mark Simpson Mfg. Co., Inc., 32-28 49th St., Long Island City, N. Y. Catalog HF950 gives an illustrated description of the HFT-100 high-frequency tweeter. The unit described eliminates distortion, cumbersome horns and the need for crossover networks.

Television Transmitter. Federal Telecommunication Laboratories, Inc., 500 Washington Ave., Nutley, 10, N. J., has available a bulletin dealing with the FTL-17A five-kilowatt air-cooled television transmitter. General description, design features and technical characteristics are included.

Hum Eliminators. Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Calif. Model 503A Bridged-T filters which attenuate hum at least 50 db are adequately described in a single-sheet catalog. Included are graphs showing typical attenuation and impedance curves. A price list is also given.

Production Test Equipment. Tel-Instrument Co., Inc., 50 Paterson Ave., East Rutherford, N. J. A single-sheet bulletin presents a complete line of production test equipment for tv manufacturers. Eight units for advanced techniques are described and illustrated.
A quality Tube Guard that is Bargain Priced

Gives support two ways—Keeps pressure downward and gives sideways support. The spring action is constant and resilient permanently. Send for catalog sheet.

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Design engineers and manufacturers in the radio, electrical and electronic fields are finding in LAVITE the precise qualities called for in their specifications—high compressive and dielectric strength, low moisture absorption and resistance to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

Complete details on request.

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ELECTRONICS—April, 1950
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At last Carter answers the age old question "WHEN SHOULD BRUSHES BE REPLACED?" and now ALL Carter products are equipped with this exclusive safety feature developed in the Carter laboratories. LINE-O-LIFE is a visual indicator mark, now on every new Carter brush. LINE-O-LIFE gives a positive one-second check for brush life expectancy . . . shows WHEN replacement is needed to assure full performance, and to avoid sparking and damage to commutator. Takes guess-work out of brush renewals. Easily replaced last minute, with this new feature.

The exclusive Carter LINE-O-LIFE feature is fully explained in new circulars illustrating (1) the entire line of Carter Converters and (2) Carter Generators. These new circulars are now available on request, together with Converter Catalog No. 349. Write today, on your letterhead.

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and Catalog

Carter Motor Co.
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MODEL 80

STANDARD SIGNAL GENERATOR

2 to 400 MEGACYCLES

MODULATION: Amplitude modulation is continuously variable from 0 to 30%, indicated by meter on the panel. An internal 400 or 1000 cycle audio oscillator is provided. Modulation may also be applied from an external source. Pulse modulation may be applied to the oscillator from an external source through a special connector. Pulses of 1 microsecond each can be obtained at higher carrier frequencies.

FREQUENCY ACCURACY is .5%

OUTPUT VOLTAGE 0.1 to 100,000 microvolts

OUTPUT IMPEDANCE 50 ohms

MEASUREMENTS CORPORATION

BOONTON NEW JERSEY

NEWS OF THE INDUSTRY

(continued from page 130)

facilities by governmental and nongovernmental agencies. It will also make and present to the President evaluations and recommendations in the national interest concerning (a) policies for the most effective use of radio frequencies by governmental and non-governmental users and alternative administrative arrangements in the government for the sound effectuation of such policies, (b) policies with respect to international radio and wire communications, (c) the relationship of government communications to non-government communications, and (d) such related policy matters as the Board may determine.

Radiological Instructor Courses

THREE five-week instructor training courses in radiological monitoring techniques were recently announced by the Atomic Energy Commission. The announcement was made in cooperation with the National Security Resources Board, responsible for civil defense planning, and the General Services Administration, responsible for planning in the field of wartime disaster relief. Courses are open to qualified educators and technicians selected by State governors.

Two of the courses began March 13 at Brookhaven National Laboratory, Upton, Long Island, N. Y., and the Atomic Energy Project, U. of California, Los Angeles, Calif. The third will begin April 3 at Oak Ridge, Tenn. The latter course will be administered jointly by the Oak Ridge Institute of Nuclear Studies and the Oak Ridge National Laboratory.

Basic purpose of the courses is to provide technical information to selected individuals who could instruct local science teachers in monitoring techniques. The local science teachers could then be used to teach monitoring teams as part of state and municipal civil defense activity.

New Atomic Element

DISCOVERY of a new element, the heaviest known in the atomic scale, was recently announced by scient-
NEWS OF THE INDUSTRY (continued)

ists of the radiation laboratory of the U. of California. Known as element 97, it is tentatively called berkelium, having the chemical symbol Bk, in honor of the city of Berkeley where the discovery was made by use of a 60-inch cyclotron.

This has been the culmination of four years of work, sponsored by the Atomic Energy Commission, in which the necessary background information of both the chemical and nuclear properties of the heavy elements has been investigated and systematized using both the 60-inch and the 184-inch cyclotrons at the U. of Calif.

BUSINESS NEWS

KUPFRIAN MFG. Co., Binghamton, N. Y., is a new firm established for the manufacture of flexible-shaft couplings and wire shielding particularly for the electronics and instrumentation fields.

VULCAN ELECTRIC Co., manufacturers of electric soldering tools, has purchased the business of Jackson Electro Corp., New York City, and transferred the latter's manufacturing operations to Danvers, Mass.

AMERICAN TRANSFORMER Co., manufacturer of transformers and allied products, recently completed consolidation of all its operations into one building at 285 Emmet St., Newark, N. J.

EMERSON RADIO & PHONOGRAPH CORP. has purchased the Continental Can Building in Jersey City, N. J., to provide about 450,000 additional sq ft of space to set up production lines for tv and radio receivers.

WESTERN ELECTRIC Co. recently withdrew from the manufacture of broadcast equipment. Service to the industry in this field will now be made available by a new company,
the Standard Electronics Corp., Providence, R. I., with distribution through Graybar.

The Brush Development Co., Cleveland, Ohio, manufacturers of piezoelectric devices, sound recorders and prevision instruments, recently formed its new Hypersonic Division for experimentation and industrial application of ultrasonic energy.

PERSONNEL

Merle M. Andrew, formerly engaged in operational research with the Naval Operations Evaluation Group, has joined the staff of the machine development section of the National Bureau of Standards' applied mathematics laboratories, where he will supervise the preparation of mathematical problems to be solved by the Bureau's electronic computers.

Philip J. Freed has been promoted from project engineer to business manager of Haller, Raymond and Brown, Inc., State College, Pa., an electronic research and engineering organization.

Titus G. LeClair, assistant chief electrical engineer at Commonwealth Edison Co., Chicago, Ill., was recently elected president of the AIEE for the term beginning Aug. 1, 1950.

Clare C. Fisher, formerly associated with Magnavox Co., is now chief engineer with Utah, Inc., Huntington, Ind.

C. C. Fisher  \hspace{2cm} R. L. Grove

R. L. Grove, previously with the Centralab Division of Globe Union, Inc., Milwaukee, Wisc., has been appointed chief engineer of Cornell-Dubilier's Ceramic Division in New Bedford, Mass.

These two new slug tuned coil forms by Cambridge Thermionic Corporation are designed to give you top performance while fitting easily into small or hard-to-reach places. Illustrations are actual size.

Both have silicone impregnated ceramic bodies, grade L-5, JAN-1-10 for high resistance to moisture and fungi. Ring terminals are adjustable. Both sizes are provided with a spring lock for the slug, and the mounting stud is cadmium plated to withstand severe service conditions.

The LS-5 and LS-6 are available with high, medium or low frequency slugs. Mounting hardware is supplied.

Ask for CTC's new Catalog #300 describing our complete line of Guaranteed Components.
New! DIRECT-COUPLED
Thyratron Controlled
STABILIZED and REGULATED
Adjustable D. C. Power Supplies

Designed for universal industrial and laboratory use where high speed (0.05 sec) load regulated and line stabilized heavy duty adjustable direct current power supplies are required. All models employ a new type of direct-coupled stepless control voltage correction amplifier which provides a constant DC output (+within ± 0.1%) under conditions of simultaneous variation of power line from 90 to 130 volts and load from no-load to full rated output.

Models available for output currents up to 10 amperes (filtered to less than 1%) and output voltages up to 500 volts.

Write for complete technical literature and prices on 10 different models.

Industrial Division
AMPLIFIER CORP. OF AMERICA
398-7 Broadway, New York 13, N. Y.

NOTICE TO MANUFACTURERS
AND SUPPLIERS OF
ELECTRONIC COMPONENT
PARTS AND
ASSOCIATED MATERIALS

Attention is invited to the qualification approval stipulation appearing in most Military (JAN) specifications coming under the purview of the Armed Services Electro Standards Agency. This in substance is as follows:—In the procurement of products requiring qualifications, the right is reserved to reject bids on products that have not been subjected to the required tests and found satisfactory for inclusion on the Army-Navy-Air Force Qualified Products List. The attention of suppliers is called to this requirement, and manufacturers are urged to communicate with the Armed Services Electro Standards Agency (ASESA), Fort Monmouth, N. J., and arrange to have the products that they propose to offer to the Army, the Navy, or the Air Force, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by these specifications. Information pertaining to qualification of products covered by these specifications and a complete index of the specifications may be obtained from the Armed Services Electro Standards Agency (ASESA), Fort Monmouth, N. J.

Any physical, optical or electrical events which can be translated into changing voltages can be counted for a specific time interval by this new Berkeley *Events-per-Unit-Time-Meter.

Signals of unknown occurrence rate are amplified, properly shaped by the input circuit and admitted through the time base controlled electronic gate to the Decimal Counting Units. The instrument then reads directly in Events-Per-Unit Time.

Send for bulletin for full, detailed description.

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SIXTH AND NEVIN AVENUE • RICHMOND, CALIF.

SELF BONDING TAPE
for Insulating and Hermetic Sealing
Radio • Television • UHF Component • Installations
- Excellent HF Dielectric—S.I.C. 2.13 and P.F. 0.004 @ 10 mc. Breakdown over 1000V/MIL.
- Fusible to a solid mass—positive, permanent moisture seal.
- Unaffected by moisture, corrosive fumes, ozone, sunlight, oxygen, or corona.
- Shapes to any contour.

Ideal for sealing HF pi inductances, HV lead-ins, and HF power supply parts. Provides arco resistance at high altitudes—used for coaxial or flat line splicing and sealing.

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VARIABLE HIGH VOLTAGE
RF POWER SUPPLY—1 to 40 KV
POSITIVE OR NEGATIVE OUTPUT

Carefully designed and engineered to answer the needs of Industrial users and Research Engineers in the fields of electrostatic painting, nuclear and physics research, insulation testing, precipitators, projection television, etc.

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INDUCTOGRAPH PRODUCTS
Dept. A, 236 W. 55 St., N. Y. 19, N. Y.
for high speed **DIE-LESS DUPLICATING**

The new Di-Acro POWERSHEAR has remarkable speed and accuracy for the production of small parts.

1. CONTINUOUS SHEARING ACTION—no clutch to engage! Feeding speed determines shearing speed.
2. VARIABLE SPEED—cycle quickly set for each shearing operation.
3. EASE OF OPERATION—fatigue is reduced, production soared.
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Any plant doing high speed precision shearing on smaller parts cannot afford to be without the DI-ACRO POWERSHEAR. Available in 12" and 24" shearing widths, capacity 16 gauge sheet steel.

**DOES PRECISION WORK ON ALL SHEARABLE MATERIALS**

- MICA
- SILVER
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- PLASTICS
- MAGNESIUM
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- BIMETALS
- COPPER
- STAINLESS STEEL
- FIBRE
- ALUMINUM
- and Many LEATHER
- SILICON STEEL
- Other Materials

Pronounced "DIE-ACK-RO" See Di-Acro Exhibits! Booth 316


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**NEW BOOKS**

(continued)

implies, it deals with the measurement of the important quantity, time, both in an absolute sense (total time elapsed between two events) and in a relative sense (the difference between two elapsed times of almost equal—but not predetermined—values.) In the latter case, the term electronic in the title is a bit misleading, as the only means considered is that of the ultrasonic delay line.

The good as well as the bad features of Volume 19 are retained in Volume 20, which is really a companion book to the preceding work. Every circuit discussed is shown in schematic form, with most containing component values and special component type numbers. If anything, this volume leans a little more heavily on descriptions of the methods of operation of existing equipments. The typography is excellent and the style amazingly consistent considering the large number of contributors. (It is interesting to note that practically every reviewer of a Radiation Laboratory Series volume has included the above comments on style).

As before, however, this reviewer feels that the terminology employed is unnecessarily elegant and is not that which is familiar to the engineer. The value of the book would be enhanced if an effort had been made to adapt the technical language to that of the ultimate user, the engineer.

Although some mention is made of phase and frequency-modulation methods of measuring time, the major part of the work is devoted to methods employing pulse techniques. Methods of pulse-time measurements and the generation of both fixed and movable indices are discussed. Measurements of time by both manual and automatic means are described, with special emphasis on some of the well-known systems which were products of wartime requirements for accurate bombing and gun laying. The last portion of the book deals with the special problems of data transmission (essentially the reproduction of the time intervals between a series of events) and the measurement of relative time intervals by delay and cancellation methods.

This reviewer finds himself in
the peculiar position of heartily recommending this volume for the tremendous amount of valuable information it presents, and at the same time criticizing the language which was used in its presentation.

—MATTHEW T. LEBENBAUM, Receiver Section, Airborne Instruments Laboratory, Mineola, N. Y.

Saturating Core Devices


A RATHER COMPLETE work giving explanations and numerous illustrations showing most of the basic saturating core devices. It describes, theoretically, several basic modes of operation and shows their applications to practical devices such as relays, controllers, regulators, amplifiers, field measuring devices and servomechanisms.

The book is written for the student who may not be well founded in mathematics or in alternating current theory. As in most other works, the explanations are mainly based on the steady-state a-c characteristics of saturating core devices.

This reviewer feels that more space should have been devoted to giving the reader a physical understanding of the reactor as an instantaneously nonlinear device.

The book contains a good list of references and is recommended for the novice as well as a refresher for the experienced electrical engineer.

—F. H. SHEPARD, JR., Consulting Engineer, Summit, N. J.

More Contacts . . . In Less Space!

GRAYHILL
Series 5000
MINIATURE
MULTI-DECK SWITCH

Two Types:
Shorting—(Make before break)
Non-Shorting—(Break before make)

Rated:
To break 1 amp. at 115 volts AC—carries 5 amp.

The most versatile miniature switch out. It will accommodate from 1 to 10 positions. Available for complete 360° clockwise or counter-clockwise operation. When less than 10 positions are used, stops may be provided so as to permit rotation only through given number of contacts. Additional decks up to 10 may be added, permitting up to 100 contacts in only 4-15/32".

Dependable!
JOHNSON PRESSURIZED CAPACITORS

Use of a gas dielectric under pressure permits high voltage ratings and large values of capacity in a small volume of space, yet all the advantages of air dielectric capacitors are retained. Construction prevents erratic performance due to changes of barometric pressure or humidity as well as excluding all foreign matter which could cause flashovers. In contrast to comparable solid dielectric capacitors, permanent damage to JOHNSON pressurized capacitors from flashovers is improbable.

JOHNSON designed and built pressurized capacitors are available in fixed, variable and semi-variable types. Capacity values to 10,000 mfd., voltage ratings to 32,000 volts peak and currents from 40 to 80 amperes are available in standard units. Special units with even higher voltage and current ratings can be supplied.

Plates are polished aluminum with rounded edges. Shells are copper plated steel, impervious to moisture and oil, is stable and does not deteriorate with age. Dielectric is 200 P.S.I. oil pumped nitrogen.

The reliable performance of JOHNSON pressurized capacitors is due to conservative design and excellent workmanship. Complete dependability is assured.

Illustrated JOHNSON Catalog and Prices

Books Received for Review

CLINICAL ELECTROENCEPHALOGRAPHY. By Robert Cohn, Director of Neurological Research, U. S. Naval Hospital, Bethesda, Md. McGraw-Hill Book Co., New York, 1949, 639 pages, $14.00. Interpretation of human electroencephalograms as obtained with a six-channel electroencephalograph fed by electrodes positioned to pick up brain potential variations. The 272 EEG recordings shown, each with case histories, statistical data and diagnostic data on facing pages, are appropriately chosen from studies of approximately 10,000 patients. Technical introduction analyzes wave phenomena encountered and gives performance requirements of amplifying and recording equipment required.

THE RADIO AMATEUR'S HANDBOOK. American Radio Relay League, West Hartford, Conn., 47th edition (1950), 736 pages including catalog section, $2.00. Revised and restyled, with increased emphasis on high-frequency equipment.

NEW BOOKS (continued)
light was actually a cluster of five hairpin filament lamps operated in series on the 800-volt trolley circuit.

Further experimenting at home with a similar lamp bulb disclosed that on 60 cycles a low-pitched tone resulted. I was curious to see whether a continuous wave was emitted under d-e excitation and accordingly connected up a motor-generator. I was not able to filter the commutator ripple well enough to produce a steady carrier; however, it was obvious that the trolley signal was likewise tone modulated by the various commutator ripples on the line. A further experiment was run using r-f from a ham transmitter to light the filament. Modulation of the exciter transmitter in turn produced modulated vhf lamp output.

It was noticed that electrically charged areas were formed on opposite sides of the glass envelope. A piece of brass sheet or the hand held near these places broadened the frequency band being emitted. A magnet held near the lamp lengthened the wavelength.

It was discovered that the filament length (temperature for a given voltage) affected the frequency. This came about when the above magnet experiment nearly destroyed one filament. The magnetic field caused the filament to vibrate mechanically so strongly that a portion of one hairpin was shorted out and welded together. The next step was to vary the filament voltage while observing the wavelength.

As a result of my experiments I reached the conclusion that a form of Barkhausen oscillation or "electron dance" was the cause of the radiation. The electrons emitted on one side of the lamp were subjected to the potential across the lamp (some 160 volts peak) whereupon the more positive filament portion became an anode. The smallness of the target of course produced many "misses" with resulting Barkhausen oscillation. The charges on the glass (or darkened metallized areas thereof) were possibly due to some of the spent electrons although they may have aided in the mechanism of buildup.

Several years later I was able to construct a vacuum tube to prove...
PROFESSIONAL SERVICES
Consulting—Patents—Design—Development—Measurement
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Radio, Audio, Industrial Electronic Appliances

AMPLIFIER CORP. of AMERICA
Research, Design, Development and Manufacturing Engineers
Specializing since 1936 in All Phases of MAGNETIC TAPE RECORDING FOR ALL APPLICATIONS
Precision Regulated Power Supplies
A. C. Shuter, Chief Engineer
268-1 Broadway New York 13, N. Y.

WHEN TIME IS SHORT . . .
put the solution of your problems up to 6 a specialized Consultant whose professional card appears on this page. His broad experience may save you months of costly experimentation.

ELECTRONICS
330 West 42nd St., New York 18, N. Y.

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Analysis and Evaluation of Radio Systems
Research, Development & Design of Special Electronic Equipment
210 Highland Ave., Needham Ht, Mass.

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Television, Tube Technicians, Video Amplifiers, Phasing, Networks, Industrial Appliances
Affiliated with MANAGEMENT TRAINING ASSOCIATES
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Garden City 1-6284

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Consulting Engineers
Research, Development and Manufacture of Electronic and Propagating Equipment
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Specialized Research and Manufacture
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for Experimentation and Production
New Buffalo Michigan

Eugene Mittelmann, E.E., Ph.D.
Consulting Engineer & Physicist
High Frequency Heating — Industrial Electronic Applications Physics and Mathematics
540 W. Washington Blvd. Chicago 6, Ill.
State 2-8621

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Specializing in solution of problems of electronic and electro-physical instrumentation for the research or analytical laboratory. Industrial plant problems also invited.
Andover, New York Cable Address: NIATIONLAB

THE REAL VALUE
of placing your unusual problem in the hands of a competent consultant is that it eliminates the elements of chance and uncertainty from the problem and provides real facts upon which to base decisions.
my theory. I supported two parallel filaments within a bulb and made one hot cathode and the other a cold or hot anode at will. The same oscillation at vhf was produced.

In the light of the foregoing I think you should revise your explanation of how the lamp produces a radiation. It seems perfectly clear to me that the oscillation will possess pulse character on 60 cycles a-c since the potential must be suited to the transit time before oscillation can start. Therefore only the peaks of the house current produce an oscillation.

Several diode oscillators are patented which come close to the subject; however, I believe that Bruce (Bell Telephone, 2,254,264), comes closer to making a practical thing out of it than anyone. The earliest reference I can find is British 258,989 dated October 1926. Fritz, 2,197,338 and Hollman 1,978,021 describe a similar device.

Possibly some day a citizens band transmitter will be made using specially made tubes working on this principle.

Leo J. Hruska
Lutherville, Maryland

L and k

DEAR SIRS:
I was pleased to see the Tubes at Work article, "Simplified Measurement of L and k", by V. A. Sheridan, in the August, 1949 issue of ELECTRONICS. Sheridan's work corroborates my own conclusions that this is a very practical method of measuring the coefficient of coupling between two coils, and is far superior to the usually described methods.

The effect of coil Q on the measurement is also interesting. It is easy to show (see my article "Note on Measuring Coupling Coefficient", Radio, Feb. 1945), the primary coil Q does not enter the equation.

In many instances, (if the secondary coil Q, \( \geq 10 \)) the test may be performed at 1,000 hertz with the coils in situ and without removing connecting wires.

Pierre M. Honnell
Associate Professor
Washington University
St. Louis, Missouri
REPLIES (Box No.): Address to office nearest you:
NEW YORK: 100 W. 34th St. (18)
CHICAGO: 701 N. Michigan Ave. (11)
SAN FRANCISCO: 60 Post St. (6)

POSITION VACANT

ASSISTANT TO Chief Engineer — Large special transformer manufacturer wants man experienced in small transformer work—excellent opportunity for qualified man. Please state education and work experience and salary on application. All replies held strictly confidential. Suitable applicants will be made to interview qualified applicant.

EMPLOYMENT SERVICE

SALARIED PERSONNEL $5,000-$25,000. This confidential service, established, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send hand-written signed address and details. Personal consultation invited. J. Thompson, 261 Dept. L, 541 Orange St., New Haven, Conn.

POSITIONS WANTED

ELECTRICAL ENGINEER, recent graduate, desires transfer position: research or development field with progressive company. Former B.T. single, 22. Will relocate. PW-2982, Electronics.


ELECTRICAL ENGINEER: M.S. Physics, M.S. Electronics 10 yrs. research, development, design experience in radar, magnetic recording, acoustic and measured magnetic recording systems for computer applications. Engineering work—6 yrs. change to smaller co. or consulting organization. PW-2984, Electronics.

EXECUTIVE ENGINEER seeks new connection. Harvard graduate in communications. Senior Member I.R.E., member American Institute of Physics. Associate A.E.E. Registered professional engineer. Divisions of experience: invention, development, design, production and marketing of electronic and computer products on a national scale. Also university teaching experience—e.g., circuitry, senior and graduate communication engineering. PW-2984, Electronics.

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WANTED RADIO and TV. Accounts for West Coast representation. Pioneer radio engineer with wide acquaintance, former naval officer, radiation lab executive and consulting engineer, will handle radio and electronic accounts. P. O. Box 277, Palo Alto, California.

WANTED

ANYTHING within reason that is wanted in the field served by Electronics can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

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Financially responsible radio and television components manufacturer selling direct to set manufacturers desires inventions, ideas or any new developments applicable to the television, radio or electronic field, electrical or mechanical. Compensation will be made by purchase, royalty or percentage. All inquiries will be received in absolute confidence.

Address BO-2453, Electronics

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Required qualifications of man to be selected:
1. Audio amplifier specialist.
2. Five to ten years experience.
3. Record of successful leadership of an electronics design group.
4. Aggressive but friendly personality.
5. Ability to select best ideas and be able to sell them to supervisors and top management.
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Position to be filled offers rare opportunity to man who can quality.

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Address P-2434, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

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MINIMUM REQUIREMENTS:
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2. Not less than five years experience in advanced electronic circuit development with a record of accomplishment giving evidence of an unusual degree of ingenuity and ability in the field.
3. Minimum age 28 years.

Hughes Aircraft Company
Attention: Mr. Jack Harwood
CULVER CITY, CALIFORNIA

OPPORTUNITY FOR TELEVISION ENGINEERS

SENIOR DEVELOPMENT ENGINEER

Man, experienced in commercial design, wanted to supervise development of new receivers for important manufacturer of quality instruments. Must have strong academic and theoretical background.

JUNIOR TELEVISION ENGINEERS

Men with practical experience and good academic background.

Write today, furnishing complete details including salary required, to

DIRECTOR OF RESEARCH & DEVELOPMENT
FREED RADIO CORPORATION
200 Hudson Street, New York 13, N.Y.

SEVERAL ENGINEERS needed by contractor for work at Naval Air Missile Test Center, 50 miles northwest of Los Angeles. College degree and several years experience essential. Radar, computer, or telemetering experience preferable.

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Los Angeles 5, California

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Established management consultant seeks an engineer with the following qualifications: educational background in electronics including degree and preferably graduate training. At least 5 years' experience with one or more manufacturers of electronic apparatus or components in one or more of these areas: industrial engineering, production management, plant engineering or design and development. Must be willing to travel. Salary open.

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PULSER TRANSFORMERS
G.E. #217445 $25.50
G.E. #274024 $12.40
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G.E. #274222 $1.95
G.E. #274322 $2.95
G.E. #274422 $3.85
G.E. #274522 $4.25

PULSER NETWORKS
1A-4-100 ohm: 100, 1.5 oz. KV, .1" ckt. microspeaker, 50 ohms, 50 microfarads, $42.50
1E-H-3-200 ohm: 100, 2 oz. KV, .25 oz. ckt. microspeaker, 3.75 oz. KV, 100 microfarads, 50 ohms, $65.00
G.E. #82400 130 ohms, 1/2 oz. ckt. microspeaker, 150 microfarads, 50 ohms, $60.00
G.E. #82401 150 ohms, 7 oz. ckt. microspeaker, 600 microfarads, 50 ohms, $60.00
G.E. #82402 2 ohms, 15 oz. ckt. microspeaker, 7 microfarads, 50 ohms, $60.00
G.E. #82403 6 ohms, 3 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82404 10 ohms, 7 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82405 15 ohms, 1 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82406 20 ohms, 3 oz. ckt. microspeaker, 25 microfarads, 50 ohms, $60.00
G.E. #82407 25 ohms, 5 oz. ckt. microspeaker, 50 microfarads, 50 ohms, $60.00
G.E. #82408 30 ohms, 3 oz. ckt. microspeaker, 50 microfarads, 50 ohms, $60.00
G.E. #82409 40 ohms, 3 oz. ckt. microspeaker, 75 microfarads, 50 ohms, $60.00
G.E. #82410 50 ohms, 4 oz. ckt. microspeaker, 150 microfarads, 50 ohms, $60.00
G.E. #82411 60 ohms, 1 oz. ckt. microspeaker, 50 microfarads, 50 ohms, $60.00
G.E. #82412 100 ohms, 1 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82413 150 ohms, 1 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82414 200 ohms, 1 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82415 300 ohms, 1 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82416 400 ohms, 1 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82417 500 ohms, 1 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00
G.E. #82418 600 ohms, 1 oz. ckt. microspeaker, 15 microfarads, 50 ohms, $60.00

DELAY LINES
D-18514 Delay Line Small quantity available...$5.00
D-18480 M. microshee 1000 to 2000 ohms, 1800 ohms 1 Hz 6.8. AC. Designed for use with 200 watt driver. New...$4.40
D-187490 25, 755/50.5, 7 microsec, 80, 600 ohms, 50 microfarads, $16.00
D-16957 $1.75 microfarad, $1.75

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MICROWAVE EQUIPMENT

30' US ARMY SIGNAL CORPS RADIO MASTS

Complete set for erection of a full top tent antenna. Of aircraft aluminum tubing fabricated into 3 tent sections for easy storage and transportation. A fixed 10' section is mounted on top of mast, complete mast, hardware, shipping crate, shipping $6.75. Additional mast section, $2.50 ea. New...$15.00
New...$15.00
Pre-owned...$10.50 per set

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E4
Phone: Digby 9-4124

ELECTRONICS — April, 1950
265

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MICROWAVE ANT. RF EQUIPMENT
first time in RHS history!
Special Purchase
while quantities last!

Diode Ray—Special Purpose
Brand New! Standard Brands! No Seconds!

We made a once-in-a-lifetime purchase—and now you can benefit by the terrific savings. No need to tell you these are the most sensational values in our history! Just look at the list below...compare the prices...you’ll know what we mean when we say that you may never again come across a real savings opportunity like this!

**DIODE GAS RECTIFIERS**

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**CATHODE RAY TUBES**

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**PHONE DIGBY 9-0347**

Prices Subject to Change
Without Notice
All Merchandise Guaranteed
F.O.B. N.Y.C. Minimum
Order $10
20% Deposit Required
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TRANSFORMERS—115v 60 cpc

---

SHELLS—Herm. Sealed

OF—Open Frame

FE—Fully Enclosed

SECONDARIES

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PHONIC DIGBY 9-0347

Write for quantity prices

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F.O.B. N.Y.C. Minimum Order $10

20% Deposit Required

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ELECTRONICS — April, 1950

267
A.C. MOTORS

5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m.
Price $4.50 each net.

36936-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w.; 4/5 r.p.m.
Price $3.00 ea. net.

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with break
Price $4.00 each net.

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m.
Price $3.00 each net.

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.3 w., 4 r.p.m.
Price $2.70 each net.

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m.
Price $2.70 each net.

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gears
Price $3.30 ea. net.

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/160 r.p.m.
Price $3.00 each net.

Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m.
Price $8.50 each net.

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w.
Price $5.00 each net.

Barber-Colman Control Motor, Type AYL C 5091, 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote position or a beam or television antenna rotator, will operate on A.C. 60 cycle.
Price $6.50 each net.

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle.
Price $10.00 each net.

CK 2, Pioneer, 2 phase, 400 cycle.
Price $4.25 each net.

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear.
Price $7.25 each net.

FPE-49-6 Diehl, Low-Inertia, 115 V., 60 cycle, 2 phase, .3 amps, 10 watt, output .345 ft.-lb., 3000 r.p.m.
Price $34.50 each net.

FPE-25-16 Diehl Low Inertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., 85 amps.
Price $15.00 each net.

FP 25-3 Diehl, Low Inertia, 20 V., 60 cycle, 2 phase, 50 amps, 3200 r.p.m.
Price $10.00 each net.

CK2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear.
Price $6.50 each net.

MINNEAPOLIS-HONEYWELL TYPE B
Port No. 3203AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque.
Price $8.50 each net.

REMOTE INDICATING MAGNESYN COMPASS SET

Type Pioneer AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle.
Price $40.00 per set new sealed boxes.

Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, 26 V., 400 cycle.
Price $12.50 each net.

GYROS

Schwein Free & Rate Gyro type 45600. Consists of Wb 26 V., D.C. constant speed gyros. Size 8" x 4.25" x 4.25".
Price $10.00 ea. net.

Schwein Free & Rate Gyro, type 46800. Same as above except later design.
Price $15.00 each net.

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase.
Price $17.50 each net.

Sperry A5 Vertical Gyro, Part No. 644841, 115 V., 400 cycle, 3 phase.
Price $20.00 each net.

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter.
Price $10.00 each net.

Sperry A5 Control Unit Part No. 644836.
Price $7.50 each net.

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube.
Price $5.50 each net.

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase.
Price $10.00 each net.

Norden Type M7 Vertical Gyro. 26 V., D.C.
Price $19.00 each net.

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V., D.C. Contains 28 V. D.C. constant speed gyro.
Price $10.00 each net.

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A.
Price $17.50 ea. net, with tubes.

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37 EAST BAYVIEW AVE., GREAT NECK, N. Y.
Telephone Imperial 7-1147

Write for Catalog NE100

U. S. Export License-2140

April, 1950 — ELECTRONICS
INVERTERS


12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. Price $22.50 each net.

12117-2 Pioneer. Input 26 V.D.C. Output 26 v. 400 cycle, 6 V.A. Price $20.00 each net.

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 volts. Price $100.00 each net.


METERS

Weston Frequency Meter. Model 637, 350 to 450 cycles, 115 volts. Price $10.00 each net.

Weston Voltmeter. Model B33, 0 to 130 volts, 400 cycle. Price $4.00 each net.

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C. Price $4.25 each net.


Weston Ammeter. Type Fl. Dwg. No. 116465, 0 to 150 amps. D. C. Price $6.00 each net. With ext. shunt $9.00 each net.

Westinghouse Ammeter. Type 1090, D120, 120-0-120 amps. D. C. Price $4.50 each net.

Weston Model 5R. Type 859E Indicator. Calibrated 0 to 3000 RPM. 2¾" size. Has built-in rectifier, 270° meter movement. Price $15.00 each net.

VIBRATOR

Rauland Corp. vibrator non-synchros type Stock No. 12564-11. 6, 12 or 24 V.D.C., Input. Frequency 200 cycle. $3.50 each net.

Sperry Phase Adapter. Part No. 661102. Used for operating three-phase equipment from a single phase source. 115 volts 400 cycle. Maximum load 50 watts. Price $15.00 each net.

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle. Price $5.50 each net.

AY14D, 26 V., 400 cycle, new with calibration curve. Price $15.00 each net.

AY20, 26 V., 400 cycle. Price $7.50 each net.

AY31, 26 V., 400 cycle. Shaft extends from both ends. Price $10.00 ea net.

AY38, 26 V., 400 cycle. Shaft extends from both ends. Price $10.00 ea net.

PRECISION AUTOSYNS

AY101D, new with calibration curve. Price—WRITE OR CALL FOR SPECIAL QUANTITY PRICES

AY131D, new with calibration curve. Price $35.00 each net.

AY130D, new. Price $35.00 each net.

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle. Price $15.50 each net.

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle. Price $30.00 each net.

PIONEER TORQUE UNIT

Type 12602-1-A. Price $40.00 each net.

Type 12606-1-A. Price $40.00 each net.

Type 12627-1-A. Price $80.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. Price $8.50 each net.

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A. 5 tube amplifier, Magneto input, 220 vac, 400 cycle. Price $17.50 each net with tubes.

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ELECTRONICS—April, 1950

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BLOWER ASSEMBLY

MX-215/AGP

John Oster, 28-07, $17.50 each net.

Westinghouse Type FL Blower, 115 V., 400 cycle, 6700 r.p.m., Airflow 17 C.F.M. Price $3.70 each net.

RATE GENERATORS

PM2, Electric Indicator Co., .0175 V. per r.p.m. Price $8.25 each net.

F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m. Price $12.00 each net.

J36A, Eastern Air Devices, .02 V. per r.p.m. Price $9.00 each net.

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase. Price $14.00 each net.

Weston Tachometer Generator (aircraft type) model 752-J4 single phase. A.C. output. 115 V., 60 cycle. Price $17.00 each net.

SINE-COSINE GENERATORS

(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle. Price $20.00 each net.

SYNCHROS

1F Special Repeater, 115 V., 400 cycle, Will operate on 60 cycle at reduced voltage. Price $15.00 each net.

7G Generator, 115 V., 60 cycle. Price $30.00 each net.

2J1F3 Selsyn Generator 115 volts, 400 cycle. Price $5.50 each net.

2J1M1 Control Transformer 105/63 V., 60 cycle. Price $20.00 each net.

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. Price $1.90 each net.

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle. Price $3.25 each net.


5G Generator 115 volts, 60 cycle. Price $5.00 each net.

5G Special, Generator 115/90 V., 400 cycle. Price $15.50 each net.

5SF Repeater, 115/90 V., 400 cycle. Price $19.00 each net.

2J1F1 Selsyn Generator, 115 V., 400 cycle. Price $3.50 each net.

5SDG Differential Generator 90/90 V., 400 cycle. Price $12.00 each net.

1CT Control Transformer, 90/90 volts, 60 cycle. Price $4.00 each net.

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratio 2:1. Price $15.00 each net.
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April, 1950 — ELECTRONICS

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Guaranteed
Surplus

40 K 1/16 W. W. Resistors, Precision... .51
.07 MFD 1000 VDC Type C Mica... .39
.35 at 16 KV plus 75 at 25 KV... .35
.1 MFD 7000 VDC Oil Cond... .75
2 MFD 330 VAC Oil Cond... .75
Meter Multiplier 2 MEG 1/8 1/2 KVC... .49

Miscellaneous Bargains

2.50 New 250 Volts ac cond... .50
1.90 New 10 volt ma cond... .49
Heinemann 25 amp 1/10 volt ac ckt breaker... 1.90
Ceramic 3000 mfd... .75
0.04 600 volt dc pi-pal mica... .75
0.01 600 volt dc pi-pal mica... .75
0.001 600 volt pi-pal mica... .75
Butterfly cond 2 to 11 mfd ball arms... .95
60 volt mica... .75
Variable variable cond (50k50k)...
2 mfd... .75
2 mfd... .75

Oil Condensers

1 mfd 500 vdc... .29
2 mfd 500 vdc... .55
3 mfd 500 vdc... .85
5 mfd 500 vdc... .11
10 mfd 500 vdc... .19
25 mfd 500 vdc... .24
100 mfd 500 vdc... .25
1000 mfd 500 vdc... .20

Silver Mica Capacitors

MFD: 10, 15, 20, 33, 100, 220, 330, 1000... .69 ea.

High Voltage Vacuum Condenser

50 MFD 250VDC FILM 40-50-20-20... .75
Mossman Switches

4 Watt Single Lamp 110V 60 Hz 3.10
3 PDL, 60 Hz 2.70

30 Watt Wire Wound Resistors

Ohm: 100-200-300-500-1k-2k-3k-5k-10k-20k-30k.
10k-15k-1k-2k-3k... .95 ea.

Adjustable Resistors

20 Watt: 1, 5, 10, 20, 30, 50, 100 Ohms...
30 Watt: 10, 15, 100, 200, 500, 1000 Ohms...
75 Watt: 10, 15, 100, 200, 500, 1000 Ohms...
150 Watt: 50, 100, 200, 500, 1000 Ohms...
300 Watt: 50, 100, 200, 500, 1000 Ohms...

WIRE WOUND RESISTORS

5 Watt type AA, 20-35-50-75-100-150-200-
300 ohms... .0075
10 watt type AB, 25-45-65-125-250-
450 ohms... .0085
50 watt type AC, 500-1000-2000-4000-
7000-8000-10000 ohms... .0095

Midget Variable Condensers

15 MFD (50K) 25-15-10-7.5-5-2.5-1-0.5-
1.5-1-0.5-0.25-0.15-0.1-0.05-0.01-
0.005-0.002-0.001-0.0005-0.0002.
250 MFD (MC250) .65

U. F. F. COAX. CONNECTORS

UG14-UG14-UG14-UG14-

Choke Bangers

5 Henry 50 ma 1000 cpm...
5 Henry 50 ma 220 cpm...
5 Henry 150 ma 120 cpm...
5 Henry 150 ma 72 cpm...
15 Henry 250 ma 72 cpm...

Solid Plated Horsehead 100 ma 120 cpm...

Filament Transformers

110 V 60 CY Pri. Coiled... .05
110 V 60 CY Pri. 30 Volt... .05
25 Volt 30 Amp... .25
25 Volt Oil 4 Amp... .35
25 Volt 5 Amp... .42
60 Volt 30 Amp... .45
60 Volt 25 Amp... .45
230 Volt 250W... .60
220 Volt 250W... .60

Heavy Duty RHEOSTATS

25 Ohms, 675 Watts Max. with Knob and Hardware... .75
25 Ohms, 675 Watts Max. with Knob and Hardware... .50

Electronic's—April, 1950

271
LINE VOLTAGE STABILIZERS

RAYTHEON—Navy Type: CEP, 250-50,000 Volts, 500 VA. RAYTHEON—Standard: E.Y., 1.20-1300 Volts. 50,000 VA. RAYTHEON, 1 Q. Reg. 9,90 WATT. Weight 4 lbs. Overall size: 26" high x 30" wide x 121/2" deep. Enclosed in Navy Type Stabilized Unit for Wall Mounting. Brand New $69.50.

THYRATRON POWER TRANSFORMERS

Raytheon TUX876, 400/1000 cy. PH1 115V. 1 P H SEC: 50-600 V.G. 6.3 V. 1.2 A. Traf F.M. $2.75

PULSE TRANSFORMER

Utah No. 9550 $1.35

BLOCKING OSC. TRANS.

Westinghouse 112 AMF Fused $4.95

12 and 24 Volt POWER KIT

Contains Power Trans. and filter bridge assembly rectifier. Input: 115/250 A.C. Input: 15/24V D.C. at 1.1 amperes. Fits for operating relays, small motors, sockets, etc., for low voltage D.C. source in laboratories, etc. Brand New $7.95.

SWEEP GENERATOR CAPACITOR

High speed ball bearings, light strap assembly, slanted coaxial type. 3/16" mmd. Brand new. $12.50

All prices indicated are for O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

MICROWAVE RECEIVERS

APR. 1, APR-4, APR-SA.

Tubes included in this kit are the fixed type used as converters or as repeaters tuned to 50 Mc. MODEL AN/APA-10 PANORAMIC ADAPTER Provides 4 Types of Presentations:

Panoramic (2) Aurol (3) Oscilloscopic (4) Oscilloscopic Designed for use with receiving equipment AN/ ARQ-1, AN/MPR, AN/APR-4, CCB-85 or any receiver with P.F. of 55000, 33mc, or 30mc. With 21 tubes including 20 output tubes. Converted for operation on 115 V. 60 cycle source. Includes 80 pages 7.4 195.00

MERCURY CONTACT VACUUM RELAYS

WE Type D-164479 Glass sealed, mercury-contact contact switches surrounded by operating coils mounted in metal housings on either 24 volt base, S.P.D.T. contacts, 7 coils and 400 ohms. Operating voltage 0-250 V. 20 ampere capacity. See table. Operating life 5000 K. at 50 operations per hour. Use for operating switches, relays, keying, potentiometer, etc. Brand New $4.75 ea. Brand New

THERMOSTATIC TIME DELAY RELAY

Aprile type 115 No.—46 heater voltage 250. Normally open or contacts 45 sec. delay. Contact rating 115V-A.C. 4.44V. A.C. 5A max. voltage on contacts—1000 max voltage. contacts and 1000 microampere. Made for U. S. Navy $1.10

CRYSTAL DIODE

Sylvania 1N21B. Individually tested and sealed in leaded foil. Brand new $1.00

HIGH VOLTAGE CAPACITORS

ON FILLED .25 MFD., 6.300V $1.15.75 .5 MFD. 25K $2.35 .5 MFD. 100K $3.00 50 MFD. 6.300V $4.95. All brand new. Made by prominent manufacturers.

LAVOIE FREQUENCY METER MICRO-WAVE

375 to 725 MCS Model TB-127/7, is a compact, self-contained, precalibrated, prealignment (1-1 MC) frequency meter which provides rapid, accurate, accurate readings. Requires only 12 volt battery. Has 1 minute time service. Contains stubborn and meter with average of 115/7000 working directly into power line. Instrument is complete, new includes tubes and instruction book. $19.50

PARABOLOIDS

Spun Magnesium diborate 17" dia., 4" deep. Mounting brackets for elevation and azimuth control on erect. 115 V. 1250 watt opening in center for dipole. Brand new per pair $8.75.

MOTOR GENERATORS

Allis-Chalmers 115V. D.C. to 120v. 60 cy. 1Ph. 125A. K.F.A. F.P. 30 Centrifugal starter. Fully assembled.

New $97.50

Same as above but for 200v. D.C. input $125.00

Sparks Parts Kit for either machine $15.00

Dinco 120v. D.C. to 120v. A.C. 60 cy., 1 Ph. 2.5 K.V.A., F.P. 4. Complete with magnetic controller, 2 field contacts and full set of spare parts including spare armatures for generator and motor.

New $185.00

O'Keefe and Merritt, 115v., D.C. to 120v. A. C. 50 cy. 12.5 KVA, F.P. 3.5. 2 Author 35 2 as a 3 phase synchronous motor on order.

New $165.00

Electrolux dynamo 105/120V. D. C. at 6 amp. to 12 or 24v. D.C. at 50 amps or 400 amps. Reversing. Reaction to react and complete with Square "D" lineswitch. Navy type LAM-5114M. Brand New $74.50

SHOWN above are selections from our inventory. A complete listing is now available. Write for it today.
IMMEDIATE DELIVERY - LOW PRICES - FULLY GUARANTEED

AC-SERVO MOTORS

Pioneer Type CK-1. 28 v. 400 cycles fixed phase. 45 v. max. 40:1 gear reduction. Stock ZSA-67A. Price $6.50 each. Also available less gear train. Price $4.25 each.

KOLLMAN 776-01


FORD INS'T SERVO MOTOR

115 volt 60 cycle two phase low inertia motor. 15 watts output. 4 x 3/4 diam. 9 471 in./oz. stall torque. Split phase. Stock ZSA-281. Price $49.50 each.

MINNEAPOLIS-HONEYWELL

Type 6303AY2CA4


BROWN TELEPLOTTING RECEIVER

Price $375.00
Model 791X1R
115 volt
60 cycles

Contains a pen driven by two low balancing motors which writes on output paper, rear of a chart. Pen arm position in terms of two co-ordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate with function of two varying R.F. frequencies varying about mean of approx. 130 kc. Further data on request. (Shipping weight 40 lbs.)

SERVO AMPLIFIER


DC SERVO MOTORS

C-1 Autopilot Servo Unit-28 v. d-e Shunt motor. $250 rpm. 2 magnetic clutches, reduction gear, differential and 2 magnetic brakes. Output shaft 15 rpm. Torque 226 in./lbs.

Stock ZSA-180. Price $10.00 each.

John Oster A-21E-2R-12R
Stock ZSA-222. Price $135.00 each.

Forney 6505 (D-12R) - Split field series reversible motor. W.E. KS-6505-LD-4. 400 cycles, 9.4 amps. 2 watts output, 5 in. diameter. 11/2 x 1/2 in. ig. Ideal for relay and synchronization servos. Stock ZSA-223. Price $6.75 each.

G.E. SP6500H18 - Split field series reversible motor. 6 v. 12-cycle at 14 amperes 5500 rpm. 3 diam. x 1 1/2 in. ig. Ideal for servo applications. Stock ZSA-225. Price $8.75 each.

SPERRY D.C. SERVO-MOTOR


MAGNETIC AMPLIFIER ASSEMBLY


PIONEER TORQUE UNITS

Types:
21601-A-1
21601-8-A-1
21627-1-A, 12627-7-A.

Prices on Request

Blower Assembly
MX-215/AGP

Join Oster C-2P-1L
28 v. DC. 7000 RPM
1/100 H.P. #2 L-B Blower.

400 CYCLE MOTORS


D.C. MOTORS

Universal Electric DC
W.E. KS-6503-1-02. 28 v. d-e 66 am. 1 1/2 hp. 120 volt shunt motor. (Stock ZSA-253. Price $2.50 ea. plus 15% p.p.)

John Oster B-9-2
1 1/4 amp.
6600 rpm.
1 3/4 diam, x 2 1/2 in. Gear, Drive adapter, C. W. No.
rotation.
Stock ZSA-46. Price $1.95 each.

DELCO CONSTANT SPEED MOTOR

A-7153
1/3 hp. 27.5 v. d-e 3600 rpm. Cont. duty 2 1/2 x 45/64 in. x 1/2 in. O.D. 2 1/2 diam. 4 holes base mounting. Stock ZSA-25. Price $4.25.

Delco 656959 Constant Speed DC Motor. 27 v. d-e 1250 rpm. Governor controlled. Stock ZSA-42. Price $2.50 each.

General Electric 2 RPM Motor. Type 5DA10P6136. 27 v. d-e @ 0.46 am. 36 lb/in torque at 2 rpm. Shunt wound. D-C noise filter. Stock ZSA-274. Price $6.75 each.


General Electric Type 5DA10A52DC 146 volts 24 volt. 27.5 v. d-e @ 0.15 am. 24 in./oz. torque. Shunt wound four lead reversible. Stock ZSA-218. Price $4.75 each.

D-C ALNICO FIELD MOTORS

Delco 5050156. 27.5 volts. 10.800 rpm. 1" diam., x 2" ig. Stock ZSA-259. Price $8.75 each.

Other models also available.

IFSY SYNCHRO SPECIAL

Navy Ordnance Type 161 Special. Designed for 115 volt 400 cycles operation. Use as either generator or repeater. May be used on 24 or 115 cycles.

Stock ZSA-29. Price $19.50 each.

SYNCHROS

Navy Types
1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HT, 5SF, 5HSF, 5DG, 5HT, 5SF, 7G, 7D, etc.

Prices on Request

W.E. KS-5910L-21

Type XXI 115 v. 60 cycle repeater. 2 1/2" diam. x 2 1/2" ig. Use as transmitter or repeater. Stock ZSA-42. Price $4.75 each.

SELSYN SPECIALS

W.E. KS-5910L-21

Type XXI 115 v. 60 cycle repeater. 2 1/2" diam. x 2 1/2" ig. Use as transmitter or repeater. Stock ZSA-42. Price $4.75 each.

SERVO-TEK

4 Godwin Ave. Paterson, N. J.
**ORDER from ARROW!**

Receiver Easily Converted for Use in Citizens Band

**HERMETICALLY SEALED CHOKES**
10 H. 100 M.A. 50¢
50 H. 100 M.A. 50¢
1,54x11 H.—winding layer wound $1.50
3.5¢ A 100 ohms, 150 H at 6.5¢ A 32 ohms...
...New 43¢

**TEN TUBE SUPERHET RECEIVER**
with crystal controlled local oscillator. Max. provisions for six crystal channels between 100 to 112 MC complete with tubes and crystals but less dynamotor.
NEW $9.75
Like new $9.50
Less tubes and dynamotor but new... $3.95

**TUBES**
Practically Reduced from 10 to 50% Nationally Advertised Brands
Type Net Price Type Net Price Type Net Price
IAP 29.24 6SH7GT... $7.94 6SH7... $7.95 6801... $7.94
HBE 7... 6SH7GT... $7.94 6SH7... $7.95 6801... $7.94
12AT7... 6SH7... $7.95 6801... $7.94 6801... $7.94
12AT7-22A 6SH7... $7.95 6801... $7.94 6801... $7.94
12AT7-22A 6SH7... $7.95 6801... $7.94 6801... $7.94
12AT7-22A 6SH7... $7.95 6801... $7.94 6801... $7.94
12AT7-22A 6SH7... $7.95 6801... $7.94 6801... $7.94
12AT7-22A 6SH7... $7.95 6801... $7.94 6801... $7.94
12AT7-22A 6SH7... $7.95 6801... $7.94 6801... $7.94
12AT7-22A 6SH7... $7.95 6801... $7.94 6801... $7.94
12AT7-22A 6SH7... $7.95 6801... $7.94 6801... $7.94
WRITE FOR QUANTITY PRICES

**MIKES—HEADSETS**
HR-23 Hi Imp. New $2.95
HR-33 Lo Imp. New $2.95
HR-37 Hi Imp. New $2.95
T-17D Carbon Mike New $2.95
T-24 Hi Imp. Carbon Mike New $2.95
T-24 Hi Imp. Carbon Mike New $2.95
T-24 (or Navy) Lip Mike New $2.95
CD-100 Extension Cord for Headsets... New $0.98

**CONDENSERS**
2 mfd. 4000 VDC Oil-Filled... Each $2.95
3 mfd. 4000 VDC Oil-Filled... Each $2.95
1 mfd. 6000 VDC Oil-Filled... Each $2.95
1 mfd. 10000 (or Navy) Oil-Filled... Each $2.95
1 mfd. 10000 (or Navy) Oil-Filled... Each $2.95
1 mfd. 6000 VDC Oil-Filled... Each $2.95
1 mfd. 6000 VDC Oil-Filled... Each $2.95
1 x 1 x 1—1200 VDC Oil-Filled... Each $2.95
50 mfd.—SKV—5 Amp Vacuum Cond... New $1.19

**BC-605 INTERPHONE AMPLIFIER**
Easily converted to an ideal intercommunication system for office—home—factory—original.... New $4.95
Like new... $3.95
(WITH SCHEMATIC)
All necessary parts and instructions included to convert the above to a two-tube two-wire remote station. Additional... $12.50

**BC-604 TRANSISTOR FM 20-28 MC**
11 and 15 meters. Can be operated on 10 meters—16 channel push button crystal. With all tubes and meter but less dynamotor.
Excellent Condition... $12.50
Crystals—Set of 8... $10.00
RC-90—Complete receiver to above with tubes but less dynamotor... Used $17.50

**BEAM INDICATORS**
I 83—5... New $4.95
Transmitter Selsyn for above... Used $2.45
I 83—3 both for $7.00
I 83—2 Selsyn for above... New $2.45
I 81 Used $2.45

**T-85/APS UHF TRANSMITTER**
Operating over a frequency range of 250 to 1400 MC with a nominal output of from 16 to 28 watts. Unit is equipped with 175 V 600 CV transformer. Power is fed by lecher wire frequency set, channel, and 300 V 20/20 (220/200) interstage and 450 V 20/20 (220/200) power supply; and 500 V 20/20 (220/200) power supply for operating S-meter. New in original box with Operating Instruction Manual... $69.50

**MICROPHONE**
Send for free 8-page illustrated Bulletin #103
Listing many EXCEPTIONAL VALUES

**COMMAND (SCR 274 N) EQUIPMENT**
Used New

<table>
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<th>Model</th>
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<td>BC-460</td>
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<td>BC-460—3 Receiver Remote</td>
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**ARROW SALES, Inc.**
Dept. 51
1712-14 S. Michigan Ave., Chicago 16, Ill.
PHONE: Harrison 7-3274

**SEARCHLIGHT SECTION**

All shipments FOB Chicago. 20% Deposit required on all orders. Minimum order accepted—$5.00. Illinois residents, please add regular sales tax to your remittance.

April, 1950 — ELECTRONICS
## Electronic Research Labotatories

**GUARANTEED BRAND NEW**

**TUBE SPECIALS**

<table>
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<th>Number</th>
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**STANDARD BRANDS ONLY**

**SPECIAL!**

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<th>Tube</th>
<th>Description</th>
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<tr>
<td>6SN7GT</td>
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<td>6SN7GT</td>
<td>12A7/12AX</td>
<td>$79.79</td>
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</tbody>
</table>

**Searchlight Section**

**Guaranteed 60 Cycles Original Prices—Our Price—$8.22 each—$50.00 each—Lots of 10**

**WESTINGHOUSE HYPERSIL TRANSFORMER**

PR1-1SV, 60CY % KVA

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
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<td>240V - 165A</td>
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<td>100</td>
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**KOLLMANN INSTRUMENT LOW INERTIA SERVO MOTOR**

Fog Cycles: 100 Reel-Phase 2 360°

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<td>300V - 165A</td>
<td>$11.51</td>
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**MOLDED OIL-IMPREGNATED PAPER**

0.80 600 VDC 20K Paper $3.00 per 100

**METAL CLAD TUBULARS**

OIL-IMPREGNATED—HERMETICALLY SEALED

0.06 630V 600 VDC 150.8.50 per 100

<table>
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**RADIATION COUNTER TUBES**

188 & 3A5 AMPLIDYNE Motor-Generator

Consists of G.E. 10511 P.D. 150 VDC 250V 500 RPM DC 6A 0.5KVA 350 VHF Amplidyne generator

<table>
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**GENERAL ELECTRIC AMPLIDYNE Motor-Generator**

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<td>$11.51</td>
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</tbody>
</table>

**ELECTRONICS — April, 1950**

**Telephones - MARKET 7-6590 and 6591**

**275**
New and in original shipping cartons! Way, way below regular prices! Built by Delco Division of General Motors. Million household, commercial and marine uses: photo darkrooms, cooling acids, fuel, basement boosters, machinery motor units,ailers, hair dryers, kitchen ventilations, etc. No brushes to cause radio interference. Quiet, continuous duty 115 V 60 cycle Delco shadedpole motor with skewed squirrel-cage type rotor. Two multi-blade squirrel-cage type fans and pressed-steel welded 3-piece small size housing. Die cast alloy case and mounting brackets. Operates at 2800 rpm; 2500 rpm velocity, 129 cfm free volume air delivery 62 watts input. Black lacquer finish. Weight 11 lbs. Overall 10 21/32" by 5 27/32" by 6 7/32", with universal mounting brackets.

$19.50 Holzer Cabot AC Synchronous Motor
- Reversible!
- Gear-Reducer!
A $19.50 Value
Yours for ONLY
$6.95

Huge Savings on New Supreme MiniMeters!
Burlington’s bargain-saving RADIO BLACKSTICK draw-drawer meters IN HALE with a special purchase of new (not surplus) SUPREME MiniMeters. Saves $55 and $44 on voltmeters, milliammeters, microamneters and ohmmeters! Servicemen, home, experimental school and industrial users like their small size - 2 1/4" x 2 3/4 x 1 1/8" - only slightly larger than ordinary meter movements alone!

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 400, DC volts: 500-10-1000</td>
<td>$9.65</td>
</tr>
<tr>
<td>Model 401, DC volts: 5-25-250</td>
<td>9.65</td>
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<tr>
<td>Model 410, DC micro: 0-25-250</td>
<td>9.65</td>
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<tr>
<td>Model 411, DC micro: 1-50-5000</td>
<td>9.65</td>
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<tr>
<td>Model 420, DC micro: 0-1-5-15</td>
<td>10.65</td>
</tr>
<tr>
<td>Model 430, DC micro: 50-0-500-500</td>
<td>10.65</td>
</tr>
</tbody>
</table>

Stewart-Warner Demand Indicator ONLY $2.49, Worth 5-10 Times More!

Cut current costs, INCREASE equipment life with 20 amp range, thermally operated Model 744A (Type 8711) demand indicators for 600 volts or less. These 2-wire instruments are "most" for Electrical Contractors, production lines, tube, college, electrical substations. Approximately 600 (Type 8711) demand indicators for 600 volts or less, model 744A. Brand NEW! Individually tested with data. Only $2.49 each!

Orders filled promptly. Terms: cash or 10% deposit, balance C.O.D.

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167 East Washington St., Boston, Mass., U.S.A.
April, 1950 — Electronics
Selsyns
115 V, 60 Cyc. #276240
3 1/4" dia. x 5 1/2" long.
$7.95 pair
Mounting Bracket — (Bakelite) for selsyns, and differentials shown above.

W.W. Precision Resistors, 1% or Better
1/8 Watt—25Ω.. 6.6Ω... 12.3Ω... 22.0Ω... 47Ω... 100Ω... 220Ω... 470Ω... 1KΩ... 2KΩ... 4.7KΩ... 10KΩ... 22KΩ... 47KΩ... 100KΩ... 220KΩ... 470Ω... 1MΩ
1/2 Watt—25Ω. 5Ω... 10Ω... 15Ω... 22Ω... 47Ω... 100Ω... 220Ω... 470Ω... 1KΩ... 2KΩ... 4.7KΩ... 10KΩ... 22KΩ... 47KΩ... 100KΩ... 220KΩ...
1MΩ

Differential 115 V, 60 Cyc. #276249
3 1/4" dia. x 5 1/2" long.
$7.95 pair
Used between two #276240's as damper. Can be connected in series to increase tolerance.
Conversion sheet supplied. (Converted—$3.00)

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115 V.A.C. in, 110 V.D.C. out @ 75 Ma. $1.99
55 in, 50 V.D.C. out @ 150 Ma. $2.99

Toggle Switches
Ball, R.P.D.T. 6A, 125V. 0-10 on plane. 24¢

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Carbon Resistor Assortment
Color coded, insulated. Use only for small purposes.

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X 124, T2, UT, GA, marked 100Ω, small gray cans. Ratio 1:2. G. M. sphere. $2.99
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X-130, 50 Ohm. 1:2. $2.99
X-132, 100 Ohm. 1:2. $3.99
X-134, 100 Ohm. 1:2. $3.99
X-136, 200 Ohm. 1:2. $4.99
X-138, 200 Ohm. 1:2. $4.99
X-140, 400 Ohm. 1:2. $5.99
X-142, 400 Ohm. 1:2. $5.99
X-144, 800 Ohm. 1:2. $7.99
X-146, 1600 Ohm. 1:2. $9.99

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Hartley UXK 2440 KS 10K-100—Sec. 115 V., 60 Cycles. 40-7000 Seconds. $4.50

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Arch St. Cor. Croskey Phila. 3, Pa. Telephone Rttenhouse 6-4927
PORTABLE (Chromometric) TACHOMETER

- Can be used for speeds up to 20,000 R.P.M.
- Can be used for linear speed measurements to 10,000 F.P.M.
- Ideally suited for testing the speeds of motors, particularly of fractional horse power, generators, centrifugal fans, etc.
- Very small Torque—requires practically no power to drive.
- Unequaled Readability—open face dial—each division on large dial equals 10 R.P.M. each division on small dial equals 1000 R.P.M. (Each division equals 10 R.P.M.)
- Greatest Accuracy—meets Navy specifications—guaranteed to be within 1/6 of 1%.
- Entire meter of test readings remains on dial until next test taken.
- Push button for automatic resetting.

Complete with the following accessories:
- 1-Large precision rubber tip
- 1-Large hollow rubber tip
- 1-"O" tolerance wrench
- 1-Operating Instructions
- 1-Temperature Correction chart

The combination of the above features will give accurately, within a few seconds, by direct reading, the R.P.M. or shafts or the linear speeds of surfaces without any accessories or fitting of any kind. Each unit comes complete in a red velvet lined carrying case (case and accessories not illustrated). Net List Price $75.00

Your Cost $24.50 fob, N. Y.

GASOLINE HEATER MOTOROLA

Model GN-3-24

An internal explosion type heater which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, sheds, hangars, farmhouses, schools, farm offices, and laboratories, etc. Complete with transformer, relay, circuit breaker, etc., and any place where a climb is not required.

Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.

This heater is designed primarily for aircraft installation. 24 volts d.c., but can be readily adapted to a 110 or 220 volt d.c. power supply to use as a transformer and rectifier. Simple circuit diagram for adaptation to 110 or 220 volt d.c. power source supplied with each unit. Can be used on 2 volt d.c. or 110 volt a.c. systems as is without the installation of any additional equipment.

Power consumption approximately 75 to 100 watts.

This heater is designed for temporary use only.

No 60 cycle sine wave electrical power is used.

All units are complete with exhaust pipe, 3" air duct elbow, control switch and cord, as illustrated, and are supplied with Technical Manual and Parts Catalog.

SIMPLE TO INSTALL—SAFE TO USE—

BRAND NEW—IN ORIGINAL CARTONS—

READY TO USE—

Made by Galvin (Motorola) Mfg. Company.

NET PRICE $22.50

PORTABLE A.C. AMMETER

WESTON MODEL 528

DUAL RANGE 0-3 A.m. and 0-6 A.m. full scale for use on any frequency from 25 to 500 cycles. The ideal instrument for all engineers, industrial, experimental, home, radio, storage, and general repair bench testing. Unique complete with a galvanometer, laminated carrying case and a pair of test leads. A very convenient pocket sized test meter priced at less than 25% of manufacturers list.

Your cost only $12.00

COMBINATION OFFER

150 VOLT A.C. METER

30 AMP A.C. METER

Triplet 331-JP, 31/2" Triplet 331-JP, 31/2"

Rd flush case

Both meters for $7.95

We carry a complete line of surplus new meters suitable for every requirement, such as portable, panel, switchboard, laboratory standard, etc.

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We carry a wide assortment of aircraft type electrical meters, precision tabular multipliers and meter shunts. Your inquiries will receive our prompt attention.
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AMERICA'S LARGEST ELECTRICAL CONVERSION HOUSE

ALLIS-CHALMERS MOTOR GENERATORS

Input: 115 VDC at 14 amps. 5600 RPM. Ball Bearings. Output: 1.55 KVA. 66% PF 120 Volts, AC. 1 Ph. 16.4 amp. Centrifugal automatic controller permits line start operation. Fully enclosed. Brand New $99.50. Also available for 230 VDC operation at the same price.

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Input 3-Phase, 400 amps. Output 56 Volts at 256 V. A. 400 amps. 116 Volts at 500 V. A. 400 cycles. Rebuild like new. Special Price $247.75

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Operates at 440/550, single phase, 60 cycles, 360 ampere adjustable output. Rebuild like new. Special Price $119.75

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PINCOR ROTARY CONVERTERS


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Type HS: 1 HP. 220/240 Volts. 14 Amps. 3800 Speed Rebuilt. Special Price $63.80

RAYTHEON DISTRIBUTION TRANSFORMERS: 75 KVA; Pri: 220/240 Vac. 110 Volts, single phase, 60 cycles. Brand New

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Motor: 32 volts, 5 HP 81 lbs., 50 watt. 3800 R.P.M. directly connecting 120 volts. A.C. 2.75 KVA. emb. wgt. Single Ph. 50 cycle. 600 ampere, control of field rheostat, Brand New $119.50

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These tape winders consist of a motor responsive at 110 volts D.C. and 110 volts A.C. 1800 speeds. A motor responsive to the speed of the tape from the rest of the unit and which can be employed for a multitude of purposes, alone or with the gear reduction box to which it is connected. Separate shunt wound and the speed thereof is controlled by a built-in rheostat. This makes an invaluable laboratory unit. Special Price $109.00

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Input: 110 VDC. Output: 1600 Volts. 2500 ams. 60 cycle. Marine Type with regulator and frequency controller. Rebuilt Same unit as above with 32 VDC Input and same Output. 299 V.A. $14.50

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399 VA: 115/240 Volts, Brand New. Special Price $3.35

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC; IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Established in 1922
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CIRCUIT BREAKERS
Heavy duty molded case, 220 V.A.C. 35 Amp. (D.E. Type) Trip Switch, Double Pole Single Switch. $1.79
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3 cm. Flax milled and silver plated inside. Slats Gray Interior. 5 Hearties with Rains fittings and hardware. New and sealed. Each $3.35

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SPECIAL VARIABLE CONDENSER
5 amp., 15 to 400 Mf, per section. Ceramic insulating and ceramic shaft isolates each capacitor. Thumb knobs rotate contact wires. 1/2" x 1/4" shaft. Ball bearings. Hinge individually shielded. Split rear end pieces for placement. Overall size 2½" x 3½" x 7". Cadmium plated. New, Each $1.75

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0.0005 4000 1000 2000 $0.85
0.001 5000 750 1250 $1.05
0.002 6000 600 1000 $1.25
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0.004 8500 500 1000 $1.45
0.005 10000 500 1250 $1.55
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0.015 15000 500 1250 $1.95
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1000 Ohms 172 20 Ohms 25c
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3000 Ohms 172 25 Ohms 50c
5000 Ohms 172 1000 Ohms 3 1/2c
10000 Ohms 172 2500 Ohms 7c
20000 Ohms 172 10000 Ohms 12c

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14,000 Ohms $0.85
PER 100 $6.85

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10 W. KOLODIN 50000 Ohms 25c

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A reliable sturdy modulator built HC. C.C. variable: 125 to 910 Mc. (Approx.) Pulse modulated at 469 C.C. Sweep, 125 to 75 Mc. leads at 110 V. 60 C.C. May be modified for T.V. Grounding. New with tubes. Shld. Wire. Approx. 42 Ls. $12.50

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**X BAND SPECTRUM ANALYZER, 8500-9000 MC, calibrated below cut-off attenuator, calibrated frequency 20 mc, bandwidth 50 kc, 110-250 V 60-80 c.p.s.**

**S BAND SPECTRUM ANALYZER, 2700-3600 MC, similar to above.**

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**TS-125/SP S BAND POWER METER.**

**X BAND BELOW CUT-OFF WAVE GUIDE ATTENUATOR, with calibrated dial and built in slotted test set, 120-1600 mc, 9.5 mc, and 20 mc, good working order.**

**APR-1 or APR-4 RADAR SEARCH RECEIVER, 20 mc, 10 mc.**

**TUNING UNITS**

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**X BAND PICK-UP HORN,** $10.00

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**Clough, BRENISTIC RESISTANCE CAPACITY BRIDGE, model D248, new.**

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**WAVEGUIDE BELOW CUT-OFF ATTENUATOR, same as above except input is matched in range of 200-3000 mc, $30.00.**

**WAVEGUIDE BELOW CUT-OFF ATTENUATOR, 2 db, frequency range 600-2000 mc, $32.00.**

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**50 RADAR, used but in good working order, with complete with antenna, control unit.**

**Radar, used, modified working order.**

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2. X Band Spectrum Analyzer
3. X Band Signal Generator Types
4. T561 A
5. T561 B
6. T561 A
7. T561 B
8. X Band Power Meter

Oscilloscopes
9. BC 127CA
10. BC 327CA
11. BC 327CA
12. BC 327CA
13. BC 327CA
14. BC 327CA
15. BC 327CA
16. BC 327CA

Standard Broadcast and Short Wave Equipment
17. TS 69
18. FerriX 20B Microvolter
19. Rider 12G Chassis
20. Rider 12G Chassis
21. RCA Audio Chassis
22. Telechron Synchronous Clock Gen.
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CIRCUIT BREAKER — 10amp 30 volt D.C.

GLASS VIAS — to use as a permanent level on equipment...

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TELECHRON 26-4... 1 watt Synchronous Motor 5/8 RPM on 60 cycles...

DETROIT THERMOCOUPLE EXPAN.
SIGN 274A 3-1/4" 274C 3-3/4" 274S 3 1/2"...

WHEYHOLME METER SINGLE PHASE 240 V... G.E. type 1-16 two wire 5 amp. 115 volt 60 cycle...

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PLEASE!
Write us about your needs. Chances are
50 to 1 we've got what you want. If we haven't—we can get it! I'll pay you
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RECTICHLARGER
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Supply current at a constant
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AC-DC power system.

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Constant source of power at a
constant voltage and a variable power
infinite; 110 V. 60
cycles built in
power supply.

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SIGNAL GENERATOR
Input 8-15 V., 50-60 cycles; output 115 V 100
amps. Excellent con.$75.00
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25% deposit with order. Balance C.O.D.
All items subject to price change.

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0-250 6-300 10-300 0-5 A G.E. DO $6.00
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R.F. MILLIAMMETERS
0-10 0-20 0-50 0-100 0-250 A Weston $7.50
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PORTABLE INSTRUMENTS
Single or multi-range
D.C. Microammeters, from 5 µ to full scale
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Designed for continuous duty ground
operation and bench testing of aircraft
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Full wave bridge Selenium Rectifiers
ensure instantaneous and efficient opera-
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output voltage is accomplished by a
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DC POWER SUPPLY
Limited quantity
Available Ready to operate.
Full wave bridge copper-oxide rect-
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Filter Kit, 2½ipple 6.65

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Input 0-115 V, 50-60 cycle; output 115 V 100
amps. Excellent condition $50.00
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0-250 6-300 10-300 0-5 A G.E. DO $6.00
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Single or multi-range
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F-KS5881 Brand New—Heavy Duty
Sirotec type blower, capacitor start, 1/4 HP.
2400 RPM. 115 VAC 60 cycle. Designed
for 125% of C.P.M. Extrememly quiet opera-
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Video transformer, 22-24
amp, output: 115-220
VAC 60 cycle. Input
110-220
VAC 60 cycle:

Edison THERMO TIME DELAY RELAY
Heater operates on 115 VAC or DC.
Contact SPST rated at 30 A., 115 V., or 50 A. 220 V. plus auxiliary contacts for
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and aluminum construction. Bulb
replaceable from front panel. For
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7¾± or 0-2¾± size. Dimensions:
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An all purpose self-reactivating dehydrating unit. To be used for removing moisture from gases. Numerous applications in the fields of Physics, Electronics and Chemistry. Dual insulated tanks with ther-
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<th>Symbol Cap</th>
<th>Voltage</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>E19</td>
<td>1000 V</td>
<td>3/4 mfd</td>
<td>.50 per &quot;C&quot;</td>
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<td>E20</td>
<td>600 V</td>
<td>1 mfd</td>
<td>.55 per &quot;C&quot;</td>
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<tr>
<td>E21</td>
<td>250 V</td>
<td>3/4 mfd</td>
<td>.50 per &quot;C&quot;</td>
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<tr>
<td>E22</td>
<td>200 V</td>
<td>3/4 mfd</td>
<td>.50 per &quot;C&quot;</td>
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</tbody>
</table>

**CERAMIC CONDENSORS.**

10. 50 & 100 & 250 mfd...$5.00 per "C" 1000 & 5000 mfd...$5.00 per "C"

**TUBULAR OIL FILLED COND.**

- **TUBULAR OIL FILLED COND.**
  - 60 & 60 mfd-400 V...$8.00 per "C"
  - 1 mfd-1000 V...$5.00 per "C"

**POTENTIOMETERS.**

2 Watts 10k Ohm

<table>
<thead>
<tr>
<th>Type</th>
<th>Shank and Shaft</th>
<th>Ohms</th>
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</thead>
<tbody>
<tr>
<td>Wire</td>
<td>5/1 x 1/4</td>
<td>5000</td>
</tr>
<tr>
<td>Carbon</td>
<td>5/1 x 1/4</td>
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<tr>
<td>Carbon</td>
<td>5/1 x 1/4</td>
<td>5000</td>
</tr>
</tbody>
</table>

See Feb. issue for Type "C" Pots.

**TUBES.**

- **TUBES.**
  - E314...24...528A...1.45...$1.00
  - 12BR...15...914...2.25...$1.00

**COAXIAL CONNECTORS.**

- **COAXIAL CONNECTORS.**
  - UL-10-U...15...9U-30-U...59...9U-30-U...59...
  - UL-22-U...9U-30-U...59...9U-30-U...59...
  - UL-22-U...9U-30-U...59...9U-30-U...59...
  - UL-22-U...9U-30-U...59...9U-30-U...59...

**SILVER MICA COND.**

- **SILVER MICA COND.**
  - 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 150, 200, 240, 300, 400, 500, 600, 700, 800, 900, 1000 mfd @ 500 V...$7.00 per "C" Kit

**MISCELLANEOUS.**

- **MISCELLANEOUS.**
  - Trans 115 V 4.5...100 V 70 Ma CS...$2.00
  - Trans. 125 V...3.00
  - Jack midget closed g...$8.50
  - Cond...8 mfd-450 V Canal...$25.00
  - Trim...5 plate 1/4 x 1/4...Ceramic...$2.50
  - Meter R.F.A. coupled type 0-1000...$3.00
  - Socket. acting plate...$3.00
  - Switch...10-100 W...$4.00
  - Resistor 1/2 w 1%...1000 ohms...$1.50 per "C"
  - Resistor 10 Meg. Log...$2.00

**MONMOUTH RADIO LABORATORIES**

BOX 159 OAKHURST, N. J.

---

**SEARCHLIGHT SECTION**

**SPECIAL**

- **SPECIAL**
  - 5-5 mfd—400 vdc Oil Cond.

**GOVT. SURPLUSES**

**GOVT. SURPLUSES**

- **GOVT. SURPLUSES**
  - C. P. A. O. & D. P. C.
  - B. C. B. F.
  - W. S. L.
  - W. H. A. M.
  - W. M. A.

**ELECTRONICS CO. INC.**

Dept. 103-02 NORTHERN BLVD. CORONA NEW YORK

Electronics Co. Inc.

**DUBIN**

**DUBIN**

- **DUBIN**
  - $8.40
  - $10.00
  - $1.50
  - $1.25

**W. S. L.**

- **W. S. L.**
  - $1.50

**ELECTRONICS CO. INC.**

**ELECTRONICS CO. INC.**

We carry a large and varied inventory which includes:

- Air Connectors
- Cable Connectors
- Capacitors
- Chokes
- Circuit Breakers
- Coax Connectors
- Coils
- Coupling Units
- Filters
- Fuses
- Inverters
- Klystrons
- Magnets
- Magnesium
- Microphones
- Meters
- Motors
- Potentiometers
- Resistors
- Switches
- Telephone Equipment
- Test Equipment
- Transformers
- Transmitters
- Tubes
- Waveguide
- Wavemeters
- Wire

A Penny Post-Card Will Put Your Name On Our Mailing List.

**GRAPHTONE LAMPS**

**GRAPHTONE LAMPS**

- **GRAPHTONE LAMPS**
  - Used for illuminating meters, comparator boxes, signal lights, and telephone. Bounding iron removes lamp from base to repair. Special economical bulb. Dimensions: 2" dia. 600 V....$3.00

**MARKTIME**

**MARKTIME**

- **MARKTIME**
  - 5 hour Switch

**GONIOMETER**

**GONIOMETER**

- **GONIOMETER**
  - CFT-47263
  - CFT-47732

**GRAIN OF WHEAT LAMPS**

**GRAIN OF WHEAT LAMPS**

- **GRAIN OF WHEAT LAMPS**
  - M. P. S. 10-20 Watt 1-1/2" dia. 3.5 V 50-60 Hz. Ideal for sensitive microscopes.

**ISOLATION TRANSFORMER**

**ISOLATION TRANSFORMER**

- **ISOLATION TRANSFORMER**
  - Not known Makers. 50 watt 2 windings, 115 V. to 115 V. 60 cy. Ideal for general household, portable and 100 watt 2 in stock.

**GOWLAND**

**GOWLAND**

- **GOWLAND**
  - 50 watts 1000 ohms...$5.00 to $17.50

**GONIOMETER**

**GONIOMETER**

- **GONIOMETER**
  - CFT-47263
  - CFT-47732

**RADAR MAGNETS**

**RADAR MAGNETS**

- **RADAR MAGNETS**
  - 100 iron 5000 Gauss 1950...

**BAGLEY**

**BAGLEY**

- **BAGLEY**
  - $1.25
  - $1.50

**CRYSAL DELUXE**

**CRYSAL DELUXE**

- **CRYSAL DELUXE**
  - $1.25

**KNOB/CRYSAL DELUXE**

**KNOB/CRYSAL DELUXE**

- **KNOB/CRYSAL DELUXE**
  - $1.25

**CENTRAL MACHINE**

**CENTRAL MACHINE**

- **CENTRAL MACHINE**
  - 72.50

**BAGLEY**

- **BAGLEY**
  - 1000 iron 5000 Gauss 1950...

---

April, 1950 — ELECTRONICS
"Speech plus Duplex Telegraph Terminals" derives carrier telegraph circuit from telephone circuit while retaining voice circuit.

**MASPETH TELEPHONE & RADIO CORPORATION**

142 ASHLAND PLACE  BROOKLYN 1, NEW YORK

**MAIN 4-2982—TWX: N. Y. 2-1123**

**COMMUNICATION EQUIPMENT**

Line Terminal and composite panel

W.E. Co. X-61823C for terminating composed open wire and cable circuits using 1000 cycle signaling.

Teletype Model 19—Page—Sending—Receiving & Tape Perforating Set.

Teletype Model 14—Sending—Receiving Typewriter Set.

**CABLE - MASTELRAD**

**SOUNDTRONICS SPECIALS**

RA 38 POWER SUPPLY COMPONENTS Consist of original plate from Ten 521, 522, one rectifier, one exp. Output 5 V. @ 50 MA. $18.00

6 V. @ 12 amp. Trans: 115 V @ 60 cy. inst. Open Frame 5 1/2" x 8 1/2" $6.85

3 C.W. FLEX WAVE GUIDE SECTION 2" long w/ 10" IN. $1.25

FERRIS PREC''H-FREQ. 5 STEP ATTEN. 1, 14, 100, 1 K & 10 K. $10.75

RENOF CONTROL M2 AMPLIFIER 115 V. 60 cy. Input 2 channels of Mono 20 W. used for servo control less tubes $87.50

14 PIN T. V. SOCKET for BPI1A, 1214M etc. Black bakelite lid: Mica filled $28.75

UHE CHOKES P.A. CASES 10 FY @ 58 MA 1.52 10 FY @ 110 MA 1.52 10 FY @ 150 MA 1.52 10 FY @ 300 MA 1.52 T.G. 10 RESISTORS 1310 MA 324.95

FOLLOWING EQUIP. USED BUT LIKE NEW

U.F. SIGNAL GENERATOR similar to R.C.A. Type T10A, 210 to 560 Meg. Ideal for citizens band. $145.00

TRANSTATS 3-8 T.V.A. 1 Phase 50/60 cy. Fixed winding 115/230 V. output 0-200 V. Max. power 15. $42.00

5.50 T.V.A. 1 Phase 50/60 cy. Fixed winding 110 230 V. Output 6-250 V. Max. amper. 225. $32.00

SINE & SQUARE OSC. VAR. 20% @ 100 CPS 50 ma. out. receives G123 & G124 Tube and 5200 V. 16 MA. V. 6 V. @ 3 amp. $10.00

LARGE QUANTITY OF SEMI-PRECISION FACTORY TEST EQUIP. Please Gen. tube amp.- Multi-Volt, Mag. Gen., Wavemeters, Delay lines, etc. Write Requirements.

**SOUNDTRONICS LABS.**

632 Arch St., Phila. 6, Pa. MA 1-2715

**ELECTRONICS—April, 1950**

**SEARCHLIGHT SECTION**

**PATCH CORDS**

*6" rubber covered, two conductor, twisted with W.E. Type 214A plug at each end...*$4.30 each

Western Electric 214A plug. Price $2.00 each

W.E. 217D plug with 600 ohm load. $2.05 each

MASPETH TELEPHONE & RADIO CORPORATION

142 Ashland Place  Brooklyn 1, N. Y.

**GEARED MOTOR**

Ideal reversible motor for rotating antenasc, displays, etc. (Similar to MOTOR Type 565. 48 V. 2.25 amp.) 4.2 amp. Overall size 4 1/2" x 4 1/2". Shaft size: 1/4". Motor size 4 1/2" x 4 1/2". Operates from 3 to 15 volts Dc. for 10 milliamperes. $4.50 each

Price $5.75 24 Volt Transformer $2.95

**WHIP ANTENNA EQUIPMENT**

Mast Bases—Insulated:

M.P. 125—1" taper solid copper. 1/8" insulated. Price $3.55

M.P. 126—1/2" taper solid copper. Steel insulated. Price $3.55

M.P. 127—2" taper solid copper. 1/8" insulated. Price $3.55

M.P. 128—2" heavy coil spring. 1/8" insulated. Price $3.55

M.P. 129—2 1/2" heavy coil spring. 1/8" insulated. Price $3.55

M.P. 130—2 1/2" heavy coil spring. 5/16" insulated. Price $3.55

Mast Sections for Above Bases:

M. P. 125—11 tubes each 5 feet long. Price $5.00 each

M. P. 126—11 tubes each 10 feet long. Price $5.00 each

M. P. 127—11 tubes each 10 feet long. Price $5.00 each

M. P. 128—11 tubes each 5 feet long. Price $5.00 each

M. P. 129—11 tubes each 5 feet long. Price $5.00 each

M. P. 130—11 tubes each 5 feet long. Price $5.00 each

**Synchronous Motor**

26 V. 60 cycle. 60 R.I.M. Price $25.00 each. $15.00 each

26 V. 240 cycle. 9 R.I.M. Price $5.00 each. $3.00 each

** Alsino Woggle D.C. Voltage Generator**

Type P2 12 Volt Amplifier Co. 0.0075 V. per RPM. 24v x 2 1/2". Shaft 3 1/2" x 3/32" $6.55

**FAIR RADIO SALES**

132 SOUTH MAIN ST.

LIMA, OHIO

**VACUUM PUMP SALE!**

Cenco Megavac Pumps—$150.00 each

Cenco Hypervac Pumps—$150.00 each

Naturally used, guaranteed perfect operating condition. Write for list. AMERICAN ELECTRICAL SALES CO.

67 E. 8th St.

New York 3, N. Y.

**DYNAMOTORS:**

Input 0 Output Stock No. Price

12 V. D.C. 1200 rpm. M48-400 $7.95

6 V. D.C. 1200 rpm. M48-400 $7.95

24 V. D.C. 1200 rpm. M48-12 $7.95

48 V. D.C. 1200 rpm. M48-24 $7.95

110 V. D.C. 1200 rpm. M48-48 $7.95

**PERMANENT MAGNET FIELD DYNAMOTORS:**

12 V. D.C. 1200 rpm. M48-24 $12.95

24 V. D.C. 1200 rpm. M48-12 $12.95

500 V. D.C. 1200 rpm. M48-48 $12.95

P.I. FIELD DYNAMOTOR Power Supply—Completely Different. H.F. Dynamos as listed directly above. $15.00

WRITE TODAY FOR QUOTATION ON OTHER DYNAMOTOR OR INVERTER NEEDS!

**CONDENSER ASSEMBLIES:**

5 GAG—w/comm. input 25 MA/FD to 450 MA/FD each section. Price each $2.95

1 GAG—w/comm. input 110 MA/FD to 500 MA/FD each section. Price each $2.95

**3 GAG**

55 MA/FD to 140 MA/FD each section. Size: 6" x 2 1/2" x 2 1/2" Price each $1.95

**GENERATOR**

12 Volt. 100 Amp. Mfg. by Emerson 100 D.F. with 5 1/2" x 5 1/2" shaft and 6" dia. holes on each end for right or left. Motor size: 8 7/8" x 7/4" Price each $12.95

**PI GENERATOR**

12 Volt. 200 Amp. Price—N.D. $19.00

Address Dept. E. * * * * * All Prices are F.O.B.

Lima, O. * 25% Deposit on C.O.D. Orders
BRAND NEW

POWER REHEOSTATS

<table>
<thead>
<tr>
<th>Ohms watt ex.</th>
<th>Ohms watt ex.</th>
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</thead>
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OIL CONDENSERS

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<th>Mfd Volt Each</th>
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<th>5000</th>
<th>7000</th>
<th>10000</th>
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BATH TUBS

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</tbody>
</table>

WILL BUY

Any quantities of new or used Electronic Surplus Equipment:

APN-9, RTA-18, TS-67, TS-170 AR-1, AR-3, ART-13, BC-221, BC-348, SCR-522, etc.

State Condition and Best Price

W-1476, Electronics
330 W. 42nd St., New York 18, N.Y.

WANTED TO BUY

Large and small quantities of new or used electronic government or manufacturers' surplus tubes and equipment. Highest prices paid. State quantity, condition and best price in first letter.

W-2590, Electronics
330 W. 42nd St., New York 18, N.Y.

WANTED WESTERN ELECTRIC VACUUM TUBES


WANTED

Teleprinters complete, components or parts. Any quantity and condition.

W-2654, Electronics
330 West 42nd Street, New York 18, N.Y.

WANTED

Sears

W-1150, Electronics
330 W. 42nd St., New York 18, N.Y.

WANTED

Teletypewriters, complete or parts. Any quantity and condition.

W-0054, Electronics
330 West 42nd Street, New York 18, N.Y.

WANTED

WANTED

OIL CONDENSERS

<table>
<thead>
<tr>
<th>Mfd Volt Each</th>
<th>3000</th>
<th>5000</th>
<th>7000</th>
<th>10000</th>
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</tbody>
</table>

WANTED


WANTED

Test Equipment

state asking price, age and condition in first letter.

W-1150, Electronics
330 W. 42nd St., New York 18, N.Y.

April, 1950 — ELECTRONICS
A. C. POWER ANYWHERE with Katolight Plants and Generators

CONVERTERS
One 500 Watt, 115 Volt D.C. input, 115 Volt A.C. output...$52.00
Three 5.5 KW, 230 Volt D.C. input, 115 Volt A.C. output, 60 cycle...$160.00 each.

MOTOR GENERATOR SETS
One 2000 Watt, 120 Volt D.C. output, driven by a single phase, A.C. 110/230 Volt Motor...$246.00.
One 1000 Watt, 115 Volt A.C. Generator, driven by a 110 Volt, D.C. Motor...$225.00.

LIGHTING PLANTS
Three 500 Watt, 115 Volt, 60 cycle, A.C. $250.00 each.

All offered subject to printer sale.

Manufacturers of electrical machinery since 1928.

KATO ENGINEERING COMPANY
105 Maxfield Avenue
Mankato, Minnesota

FEDERATED "MOVING DAY" SPECIALS
HIGH VOLTAGE, HEAVY DUTY OIL CAPACITORS
In steel rectangular cases, with sturdy porcelain insulators. Made by a leading capacitor manufacturer. This is in war surplus (Brand New). Our sale price is a fraction of the regular price.

FED-200 200 Volt DC Manufacturer's list price...$151.00.
Your cost at Federated...$22.50.

FED-100 100 Volt DC Manufacturer's list price...$151.00.
Your cost at Federated...$22.50.

SPECIAL PURPOSE TUBES
Brand new—in original manufacturer's cartons.

W.L. 155/105 (Westinghouse) Regular price $14.00.
NOW $7.50.

W.L. 152/525 (Westinghouse) Regular price $21.50.
NOW $3.90.

R27R (RCA) Regular price $17.50.
NOW $3.60.

SPECIAL PURPOSE TUBES (surplus)
RX233A .......................... only 90c.
RKR73 .......................... only 39c.

SENSATIONAL PRICE REDUCTION on RCA TEST OSCILLATOR WR67A
Frequency range continuous, 50Hz to 25Mc, to six hands. Calibration accuracy plus or minus 3%. Output voltage measurable to within 5% of 1 Volt RMS. Internal modulation 400 CPS adjustable from 0 to 50C. Regular price $89.50.
NOW $49.50.

* We are now located at new facilities at 26 Day St., New York City. These improved facilities make it possible for us to offer you better service and greater values than ever before.

SELECTED PARTS

CLARE STEPPING SWITCHES
Type SD-14, 20 steps, 6 levels. Coil 12V, DC. Lists at $40.00; our low price $12.00. Brand new in original boxes—not war surplus. Quantities of four or more. $12.25 each guaranteed or money refunded.

NEOMATIC, INC.
879 Wellesley Ave., Los Angeles 49, Cal.
Arizona 3-4891

FOR SALE
20-30 Mc BROAD BAND CONVERTERS
a five position pre-tuned unit employing 3 tubes with output frequency of 5Mc is offered at the low price of 500. Completely guaranteed. Suitable for BC348, BC342 etc.

Weston Laboratories, Weston 93, Mass.

Radar Equipment

SCHR-117F AP-2-5 AP-4 5-9 Search Radars Complete
AP-11 and AP-4 Receivers with Tuning Units
1F-13 Direction Finder
TS-51 AP-4 Test Set

W. E. COMPUTER POTENTIO METERS
D-17048 D-17049 D-17050 D-17051 D-17052
D-17054 D-17045

LEHR LABORATORIES, INC.
360 Beecker St.
New York 14
OR 5-3525

FOR SALE
55916—18 Contact Male Chassis
55919—3 Contact Female
55910—3 Contact Male Chassis

Write for listings of other surplus items.
TUBES

<table>
<thead>
<tr>
<th>Code</th>
<th>Tube</th>
<th>Voltage</th>
<th>Current</th>
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WIRE WOUND RESISTORS

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<tr>
<td>1500</td>
<td>12</td>
<td>15</td>
</tr>
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<td>500</td>
<td>12</td>
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<td>1500</td>
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</tr>
<tr>
<td>250</td>
<td>85</td>
<td>75</td>
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We have on hand a tremendous stock of popular sizes in the above resistors.

ACORN ELECTRONICS CORP.
76 Vesey St., Dept. E-4, New York 7, N. Y.

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3 centimeter; complete with 725A magnetron, carrier, two 721A/B Players, one 721C, four 12F, one 12J, one 828B, two 728A, two 8AC4, one 1N25 crystal rode. High voltage supply, two roof fan, blower, etc. Input: 115
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Quantities of 25 or more, deduct 10%.

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BIRCHER CLAMPS

CERAMIC TRIMMERS

APC AIR TRIMMERS

WESTON METER 506

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Quantities of 25 or more, deduct 10%

0.001 2000 2.25 0.002 2000 2.25
0.002 2000 2.25 0.005 2000 2.25
0.004 2000 2.25 0.005 2000 2.25
0.006 2000 2.25 0.005 2000 2.25
0.008 2000 2.25 0.005 2000 2.25
0.010 2000 2.25 0.005 2000 2.25
0.012 2000 2.25 0.005 2000 2.25
0.015 2000 2.25 0.005 2000 2.25
0.018 2000 2.25 0.005 2000 2.25
0.020 2000 2.25 0.005 2000 2.25

TERMS: 20% cash with order. Balance COD unless printed. All prices F.O.B. our warehouse in New York. No orders under $2.50.

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$250.00

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$350.00

AMEC ELECTRONICS
399-405 ATLANTIC AVENUE
BOSTON 10, MASSACHUSETTS
LIBERTY 2-7890

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Cory Type B57, Single Key Op: Interlocking of double or twin switches, for enclosed, or open switches, etc. New...
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$2.40
Cory Type D1136, Supervisory Op: 2 key logo. New...
$5.00

GE GLYPTOL #1253, Dark gloss green 1 gallon, fresh stock...
$14.00
GE GLYPTOL #1280, Semi-gloss black 1 gallon, fresh stock...
$3.95

ANTENNA CHANGE-OVER SWITCH, mfld. Square D; SPDT, New...
$9.00

DAVEN SOUND ATTENUATORS
Type 350-A, Network, ladder, linear. Imped. 36/60 ohms. 35B attenuation. 10 W dissipation. Brand new...
$3.50

SIGNAL CORPS TUNING UNIT BC-335, Mfr. Bendix Radio, W. 150 cycle...
$18.50

25 VDC MOTOR
John Oster B-2-2.7 amp 5600 rpm. 1/8 hp. Start current 10% max...New...
$1.05

PE20, Landol. Input 28 V DC at 96 amps. Output 125 V, 400 cycle at 1.65 KVA...
$44.00

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$9.45

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$10.75

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New...
$9.50

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Mines capacitor Cat. #A7548. Rated at 2880 VDC at 225 MA...New...
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ELECTRONICS - April, 1950

Case lots of (3) $8.00 or (10) cases, special...
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High Frequency · High Power · Proven Life

FOR HIGH FREQUENCY OPERATION to 150 Mc.

FOR GREATER EFFICIENCY
High Pervience · Thoriated Filaments · Low Filament Inductance · Specially Coated Grids · Low Grid Lead Inductance

ESPECIALLY IN GROUNDED GRID CIRCUITS—Minimized Filament-Plate Capacitance

FOR ECONOMY
Low Initial Cost · Low Operating Cost

NEW!

Types 492/5757 and 492-R/5758
(water cooled) (air cooled)

- Filament — Thoriated Tungsten
- Voltage……………………………………… 5.0
- Current (Amps)…………………………… 110
- Amplification Factor……………………… 28
- Maximum Ratings —
  - Class "C" Telegraphy
    - Plate Voltage…………………………… 7500
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