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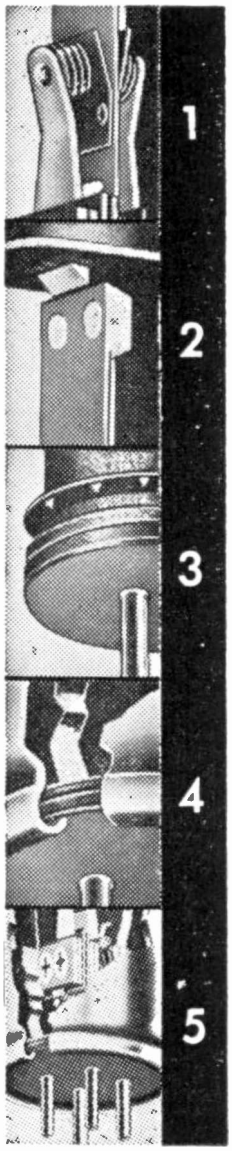

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POWER FACTOR CORRECTION

It is a well-known fact that current and voltage are not in phase in an a.c. circuit unless the circuit contains resistance only. If there is capacitance in the circuit, the current leads the voltage. And if there is inductance in the circuit, the current lags the voltage. A typical circuit containing pure resistance only might be one in which are connected incandescent lamps or ordinary electric heaters. An example of a circuit containing inductance only (with negligible resistance, of course) is one in which motors are connected. Capacitance is seldom encountered by itself in industrial circuits.

Figures 1 and 2 illustrate these phase relations. In Figure 1, vectors are used. The voltage vector is longer than the current vector in each case to show that the voltage value is higher than the current value (for example, 115 volts and 5 amperes). The vectors are assumed to rotate in a counter-clockwise direction; that is, from right to left. Thus, in Figure 1(A) the current vector (I) is moving ahead of the voltage vector (E), or current is leading voltage. In Figure 1(B), the current vector is trailing the voltage vector (current lags voltage). The angle of separation of these vectors (angle of lead or lag) is termed the **phase angle** and is designated by the Greek letter **theta** which resembles the English capital O with a horizontal cross-bar.

In Figure 2, the same phase relations are shown, using a.c. sine wave patterns for illustration. In Figure 2(A), note that the current (dotted line) has been flowing for an appreciable interval and reaches its peak value before the voltage (solid line) even leaves zero. Also, the current stops flowing before the voltage again reaches zero. Just as in Figure 1(A), this condition represents leading current. In Figure 2(B), the opposite condition holds. The voltage has reached its maximum (peak) value before the current begins to flow. And after the voltage has cut off, the current continues to flow for an interval

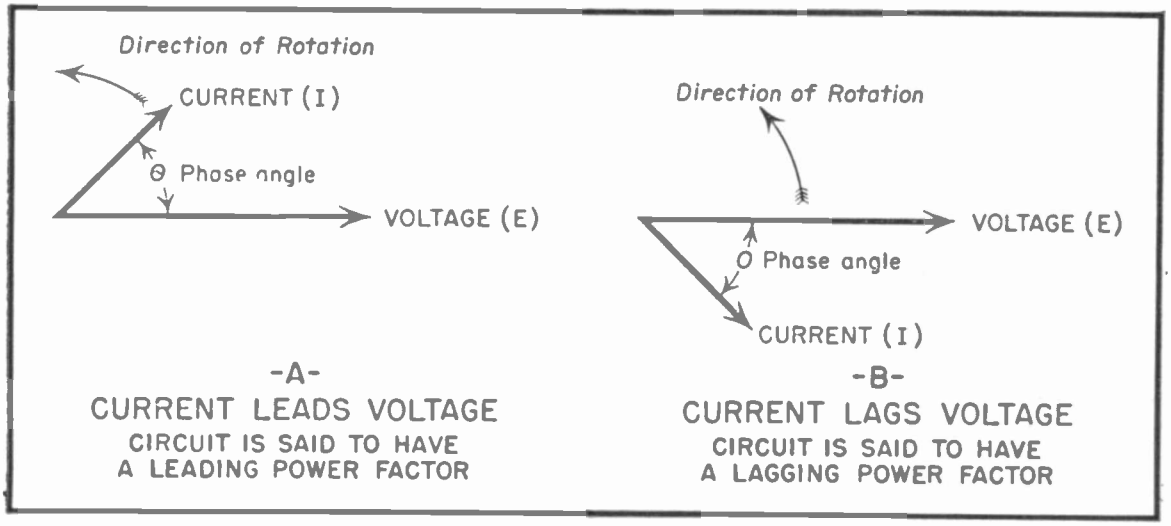

Fig. 1. Phase relationship vectors.

CHART 2.

Power Factor	Multiplier	Power Factor	Multiplier	Power Factor	Multiplier
.150	6.586	.450	1.984	.725	0.949
.160	6.163	.455	1.957	.730	0.936
.170	5.798	.460	1.930	.735	0.922
.180	5.466	.465	1.903	.740	0.909
.190	5.169	.470	1.878	.745	0.896
.200	4.900	.475	1.852	.750	0.882
.205	4.773	.480	1.828	.755	0.867
.210	4.658	.485	1.803	.760	0.855
.215	4.542	.490	1.779	.765	0.842
.220	4.431	.495	1.755	.770	0.829
.225	4.331	.500	1.732	.775	0.815
.230	4.230	.505	1.709	.780	0.802
.235	4.139	.510	1.686	.785	0.789
.240	4.045	.515	1.664	.790	0.779
.245	3.957	.520	1.642	.795	0.763
.250	3.871	.525	1.621	.800	0.750
.255	3.789	.530	1.600	.805	0.737
.260	3.714	.535	1.579	.810	0.724
.265	3.639	.540	1.558	.815	0.711
.270	3.565	.545	1.539	.820	0.698
.275	3.495	.550	1.518	.825	0.685
.280	3.430	.555	1.496	.830	0.672
.285	3.361	.560	1.479	.835	0.659
.290	3.298	.565	1.460	.840	0.646
.295	3.237	.570	1.441	.845	0.633
.300	3.178	.575	1.423	.850	0.619
.305	3.121	.580	1.404	.855	0.607
.310	3.065	.585	1.386	.860	0.593
.315	3.012	.590	1.369	.865	0.580
.320	2.960	.595	1.351	.870	0.565
.325	2.909	.600	1.333	.875	0.553
.330	2.858	.605	1.316	.880	0.539
.335	2.813	.610	1.299	.885	0.526
.340	2.765	.615	1.282	.890	0.512
.345	2.720	.620	1.265	.895	0.498
.350	2.674	.625	1.249	.900	0.484
.355	2.627	.630	1.233	.905	0.469
.360	2.589	.635	1.217	.910	0.455
.365	2.549	.640	1.201	.915	0.441
.370	2.511	.645	1.185	.920	0.426
.375	2.471	.650	1.169	.925	0.411
.380	2.434	.655	1.154	.930	0.395
.385	2.396	.660	1.138	.935	0.379
.390	2.361	.665	1.123	.940	0.363
.395	2.326	.670	1.108	.945	0.346
.400	2.291	.675	1.093	.950	0.328
.405	2.257	.680	1.078	.955	0.310
.410	2.225	.685	1.064	.960	0.291
.415	2.192	.690	1.049	.965	0.272
.420	2.161	.695	1.033	.970	0.250
.425	2.130	.700	1.019	.975	0.227
.430	2.099	.705	1.006	.980	0.203
.435	2.070	.710	0.992	.985	0.175
.440	2.041	.715	0.977	.990	0.142
.445	2.013	.720	0.964	.995	0.100

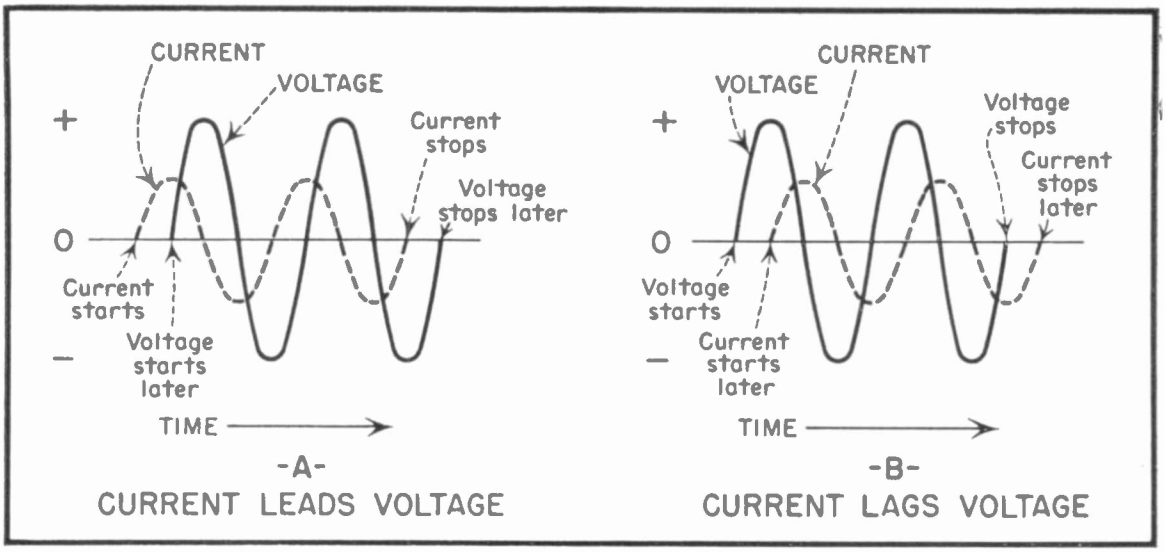

Fig. 2. Phase relationships shown with waveforms.

before it finally dies down to zero. Figure 2(B) corresponds to Figure 1(B) in showing a lagging current.

Since most a.c. circuits contain something more than resistance, current and voltage seldom are in phase in these circuits. In simple resistance circuits, a.c. power (watts) can be calculated exactly as for d.c. circuits simply by multiplying the current by the voltage. When the current and voltage are not in phase, as is the case in all reactive (inductive and capacitive) circuits, finding the a.c. power value is not so simple. We must multiply the current by the voltage and then multiply this product by the power factor. The true a.c. power value is somewhat less than the product of volts times amperes, since the power factor is a decimal in practical cases.

The best power factor would be 1. In practice, we try to keep it as close to 1 as possible. In a circuit with unity power factor, the power in watts would be equal to the simple product of volts times amperes. To illustrate the detrimental effect of low power factor, consider the example of 115 volts forcing 6 amperes through a circuit with power factor of 0.5. We ought to have 115 $\times$ 6, or 690 watts, available. But we must multiply E $\times$ I by the power factor, so our true power actually is only 115 $\times$ 6 $\times$ 0.5, or 345 watts. Economically, this means simply that we must force 12 amperes into such a circuit in order to do a 690-watt job. Heavier conductors must be installed to handle the higher current, and the voltage drop along such conductors will be proportionately larger.

Numerically, the power factor is equal to the actual power, as measured with a wattmeter, divided by the apparent power, obtained by multiplying E by I. Thus:

$$(1) \quad \text{p. f.} = \frac{\text{WATTS}}{\text{E} \times \text{I}}$$

Since the true a.c. watts in a reactive circuit will be lower in value than the apparent watts, it is easy to see from Equation (1) why the power factor will be less than 1. Numerically, the power factor is equal also to the cosine of the phase angle.

Capacitor circuits are said to have a leading power factor; inductive circuits a lagging power factor. Inductive circuits include motors which undoubtedly are the most widely used electrical machines. The leading power factor of capacitors (due to the leading current through these units) can be

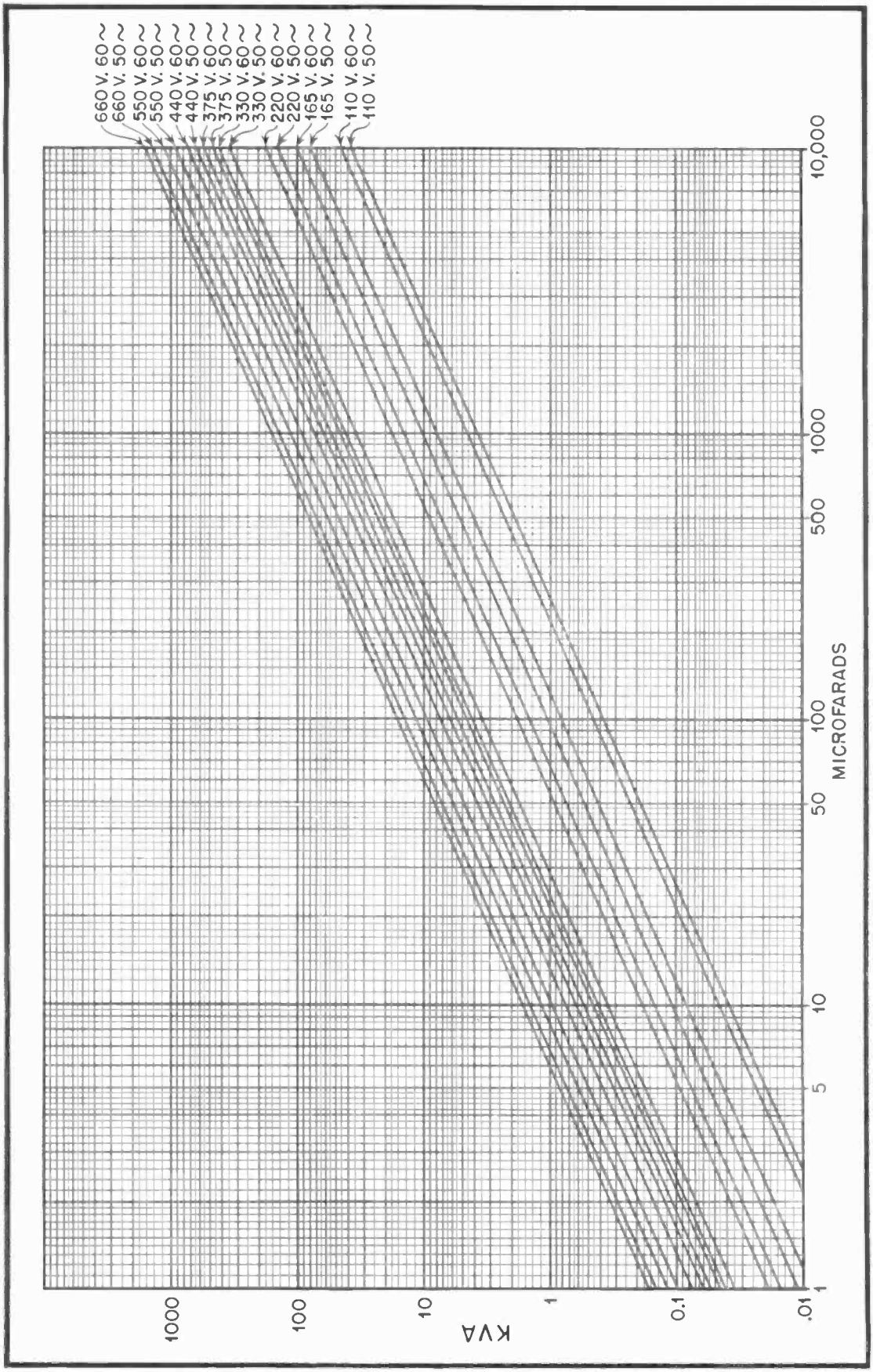

Chart 3 — KVA vs. MICROFARADS.

employed advantageously to counteract the detrimental lagging current in motors, fluorescent lamps, and other lagging-power-factor devices. The relatively simple connection of a capacitor of the proper rating in parallel with the power-line terminals at the motor will improve the motor power factor and, for a given work load, the motor will draw less current from the power line. This is beneficial both to the consumer and the electric power company. The consumer because, with power factor correction, he is able to increase the number of machines he can operate at a given total current drain and is not compelled to install heavier conductors to take care of the additional machines. The power company because it sells its product by the kilowatt hour, but must supply amperes as well, for which it does not bill. A customer with power factor correction will demand fewer unpaid amperes per kilowatt hour than the customer who does not have this improvement.

As an example of the current reduction afforded by power factor correction, consider the following illustrative example: A 220-volt, single-phase motor draws 10 amperes at full load. Its actual power drain measured with a wattmeter is 1500 watts, or 1.5 k. w. The apparent power in this case, obtained by multiplying E by I (220×10) is 2200 watts, or 2.2 k. w. The power factor of this machine, from Equation (1), is $1.5/2.2 = 0.682$, or 68.2%. If we correct this power factor to 90% (it seldom is of any advantage to "over-correct," that is to shoot at 100%), the current drain for the same measured 1500 watts will be the watts divided by $0.90 \times 220 = 1500/188 = 7.89$ amperes. This new current value is 2.11 amperes lower than the first value before power factor correction. In other instances, the current saving would be even greater.

Determining the proper value of capacitance to correct the power factor of a given electrical machine requires a rather roundabout calculation involving the trigonometry of phase angles. In order to simplify these calculations to the point that they may be handled by non-technical personnel including sales people, we have prepared Charts 1, 2, and 3 which accompany this article. In Chart 2, the POWER FACTOR values are cosines of the phase angle, while the MULTIPLIER values are tangents of the phase angle.

To determine the proper value of capacitance for a given amount of power factor correction, proceed according to the following steps in the order in which they are given:

(1) Measure the voltage (E) and current (I) of the machine for which the power factor correction is desired.
(2) Multiply $E \times I \times 0.001$ to obtain the KVA.

(3) With a wattmeter, measure the power taken by the machine. This is the KW value which will be used later in calculations. (If the meter reads in WATTS instead of kilowatts, multiply its reading by 0.001 to obtain KW).

(4) Determine the power factor of the machine by dividing KW by KVA. Thus; p. f. = KW/KVA.

(5) Decide what amount of improvement in power factor you want (for example; decide to raise the present power factor of the machine to 90%, or 0.90).

(6) On Chart 2, find first the multiplier corresponding to the present power factor you calculated in Step 4. Then, find the multiplier corresponding to the improved power factor you desire.

(7) Subtract the smaller of these multipliers from the larger one. Call this difference the "final multiplier."
(8) Multiply the KW by this final multiplier. The result is the capacitor KVA required for correction.

(9) The required capacitance in microfarads then may be found by multiplying the capacitor KVA (obtained in Step 8) by the proper figure selected from Chart 1. The Chart 1 figure, for

(Continued on page 10)

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example, will be 201 if the machine is operated at 125 volts 50 cycles. Or it will be 8.76 if the machine is operated at 550 volts 60 cycles; etc., etc.

(10) The required capacitance also may be determined from the graph in Chart 3, by following to the right the

CHART 1.

Volts	Microfarads per KVA	
	50 cycles	60 cycles
110	260	219
115	238	200
125	201	170
165	115	97.5
220	65	55
330	28.8	24.3
375	22.3	18.8
440	16.2	13.7
550	10.4	8.76
660	7.2	6.09

line corresponding to the capacitor KVA (obtained in Step 8) until it intersects with the applicable voltage-frequency line, and then following the vertical line of intersection downward to read the capacitance on the horizontal MICROFARADS scale.

ILLUSTRATIVE EXAMPLE. A 110-volt 60-cycle motor is found (by Steps 1 and 3) to draw 0.7 k. w. and 8.5 amperes. By Step 1, KVA = 110 × 8.5 × 0.001 = 0.935. By Step 4, the power factor = 0.700/0.935 = 0.750. Let us decide to improve this power factor to 0.950 (95 per cent).

By Step 6, the mutiplier corresponding to the original power factor of 0.750 is 0.882. And the multiplier corresponding to a power factor of 0.950 is 0.328. By Step 7, the final multiplier is 0.882 — 0.328 = 0.554.

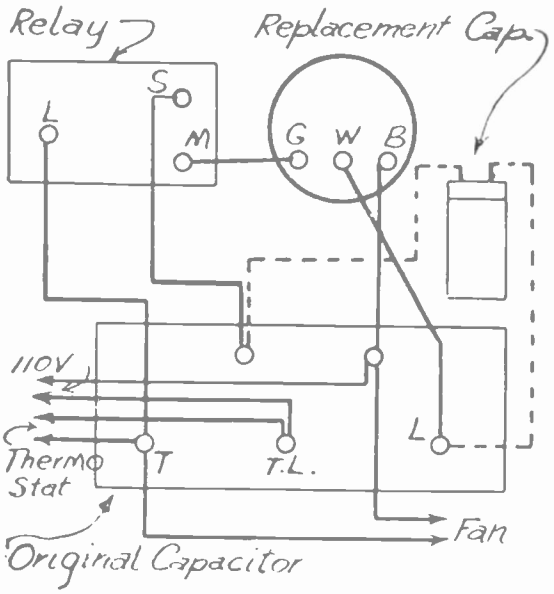
0.7 k. w. (obtained in Step 3) multiplied by 0.554 = 0.338, which is the required capacitor KVA.

Since the motor is 110 volts 60 cycles, we multiply the 110 v.-60 cycle value (219) from Chart 1 by the final multiplier (0.554) to obtain 121.3 microfarads, which is the required capacitance for correction to 95 per cent.

We also can find the capacitance value directly from the intersection of the 110-volt, 60-cycle line (in Chart 3) with the 0.554 line, reading our value on the MICROFARADS scale.

Replacement Capacitor on Kelvinator Unit

Here is a tip on replacing a 5 terminal capacitor on a Kelvinator ice cream cabinet having a sealed condensing unit that was submitted by Chas. H. Bricknell, Plympton, Mass., in "The Refrigeration Service Engineer." If the capacitor fails and you do not have a replacement capacitor with the 5 terminals, use a conventional 2 terminal capacitor as per diagram.



If the original capacitor is open circuited, as is usually the case, it may be used for binding posts connections, but if it is short circuited, make connections with a small bolt, connecting the new capacitor to "S" on the relay and "W" from the compressor.

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FOR SALE—Radio supplies. We have numerous radio parts and accessories. Send 5 cents for our large complete list. Messenger Radio Laboratory, 16 Rockhill St., Foxboro, Mass.

WANTED—Zenith "Stratosphere" 1st or 2nd series, 25 tube, 6 band receiver. Prefer receiver complete with cabinet. Will trade later types of receivers or equip. W. W. Smithers, 1709 E. Stella, Fort Worth 3, Texas.

FOR SALE—Utah record changer. Amplifier using PP 50L6's, in a Zenith demonstration case, 8" PM spkr. Sell as a lot or each singly. Best cash offer. Saxton's Radio & Electric Service, R 1, Pontiac, Ill.

SELL OR TRADE—BC 375E tuning units, $3.50 ea.; 522 receiver, $15; 522 trans., less 832's, $15; tank trans-receiver, $50. Want Rider Manuals or NRI Service Manuals and good capacitor checker. Roger Bates, Capitola Radio, Capitola, Calif.

TRADE—Pair each 813 and 803 new tubes; latest course "Practical Radio Engineering;" "Aronautical Radio Engineering," 15 lessons. Want good sig. gen., typewriter, scope. Make offer. Henry Makahon 312 Autumn Ave., Brooklyn 8, N. Y.

FOR SALE—1948-9 edition of Nilson's Master Course in Radio Communications by C.I.R.E., excellent condition, orig. cost, $157. Also Riders' Manuals vol. 9 and 11, like new. Best offers, all or separate. Ben's Radio Service, 2116 Sixth St., Peru, Ill.

FOR SALE—DXCC PP813 final grid band switching 10-80M, with all coils and tubes, Simpson sq. meters, best parts obtainable, on 10½" masonite rack panel gray ripple, $74. M. E. Lawson, 4010 River Dr., Houston 17, Texas.

FOR SALE—QST, August 1919 to December '46; 25 watt speech amplifier; UTC 1500V 500ma transformer. Also chokes, meters, transmitter parts, etc. Richard M. Krauss, 100 Berkeley Road, Glenside, Pa.

FOR SALE—Precision 920-D combination tube, set and battery tester, A-1 perfect condition. No reasonable cash offer refused. Also have all types of tubes for sale, brand new in orig cartons. P. Dymeck, 1384 Greene Ave., Brooklyn, N. Y.

FOR SALE—Radio City Products sig. gen., model 710, $10; Hallicrafters S-38 rec. in excellent condition, best offer. Both items postpaid. Lewis Mascara, 197 McKay Ave., Huntington Sta., Long Island, N. Y.

WANTED—All types of rifles and pistols, particularly a woman's 22 cal. pistol, the smaller the better. Also want photo equip. Will swap radio parts and equip. for what you have. Murray Marcus, 1865 - 52nd St., Brooklyn 4, N. Y.

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FOR SALE—Cooke's "Mathematics for Electricians and Radiomen" and Nilson and Hornung "Radio Operating Questions and Answers." In first class condition, both for $6 COD or M.O. Not sold separate. R. S. Williams, 4405 Arlington Ave., Fort Wayne 6, Ind.

FOR SALE—DeForest's 127 lesson course in Radio Sound and Television, like new, 100% complete, $25. Bill's Radio Shop, 1521 Larrabee St., Chicago 10, Ill.

FOR SALE—Jensen-Hallicrafters bass-reflex cabinet with matching 12" Jensen speaker, very good condition, $18.50. Otto Pollei, Jr., 118 No. Western Parkway, Louisville 12, Ky.

FOR SALE—Volt-ohm-milliammeter, 1000 ohm per volt, Robson-Burgess, model MT 200, 6 ranges to 1500 volts dc-ac ohms 2 meg 500 ma, $15. A. B. Bertucci, 1835 Magazine, Apt. 12, New Orleans, La.

SELL OR TRADE—TS/69-AP 340-1000mc freq. meter with 4½" meter and calibration charts, $40; cavity resonators, 500mc, and other equipment. Want 16mm camera, Cooke radio slide rule. Henry Parker, 1331 So. Kolin Ave., Chicago 23, Illinois.

FOR SALE—Webster model 80 wire recorder, almost new, cost $150, sell for $100. Perfect. Fred Hoffee, 437 Ingold Ave. N., RD 4, Massillon, Ohio.

FOR SALE OR TRADE—Pilot FM tuner; Magnavox record player; SVE 35mm roll, 5" lens, still projector, artist air compressor. J. J. Devine, 69 Merchant St., Newark 3, N. J.

SWAP—New 6" pipe vise with tripole stand, latest type (Ridgit), and 8", 12" and 24" pipe wrenches, with stock and dies ¼" to 1½", handle ratchet type. Want Precision sig. gen model E-200 and 5" oscilloscope. A. Aldorasi, 25-44 32nd St., L. I. C. 2, N. Y.

FOR SALE—Completely equipped radio shop. Testers, Hickok 288X FM-AM sig. gen., Meissner Analyst, Precision 920 tube and set tester, and a large stock of tubes and parts, $600. Reason for selling, health. Romans Radio Shop, Wellsville, Mo.

FOR SALE—Philco model 620, cone needed on speaker, $10.00; Air-King, table model, 3 bands, needs power transformer, $10; Silvertone model 1827, 11 tubes, 12" speaker, $10. Victor Kozma, 3104 Wilkinson Ave., New York 61, N. Y.

TRADE—Radio equip; parts; 7" television set, plating equip. Will trade for what have you? C. Bufano, 185 No. 15th St., Bloomfield, N. J.

FOR SALE—Hallicrafter S-40A, used less than 100 hours, $65. Charles Cerami, 146 Congress St., Newark, N. J.

FOR SALE OR TRADE—Triplett tube tester, model 2413; Superior tube tester, model 1240; Triplett model 1270-A ac watts-volts amperes meter. Fenters Radio Service, 107 Bond St., Attica, Ind.

WANTED—Schematic for tube tester and volt-ohm-milliammeter. All replies answered. Marvin R. Larson, 2149 N. La-Porte Ave., Chicago 39, Illinois.

FOR SALE—Instructagraph all electric ac code machine with ten tapes and oscillator. Best offer. Herbert Paskin, 14 Markham Drive, West Brighton, Staten Island.

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TRADE—General stamp collection of over 4,000 stamps. Want hi-fidelity 12"-15" coaxial PM speaker, low level type microphone, high impedence earphones, sig. gen., tube or set tester. Give full particulars. Austin Wardman, 106 Rossmore St., E. Pittsburgh, Pa.

WANTED—Philco part No. 27-5207 model 37116 code 121 dial scale. Schwabs Radio Service, Box 393, RD 1, Turtle Creek, Pa.

FOR SALE—Thordarsen 25 watt amplifier in a T.G.10 case, with Astatic model 200 crystal microphone and 12" speaker. There are 3 inputs, 2 mic. and one phono. All for $90. A. J. Jones, Rt. 2, Buford, Georgia.

FOR SALE—Army BC-412 oscilloscope, high class conversion parts and detailed schematic, new 5BP1 tube, everything for first class scope, $55 FOB. R. N. Holzknecht, 901 Eastern Parkway, Louisville, Ky.

TADE—W.R.L. 30 watt phone-cw transmitter; Hallicrafters Sky Champion rec. $100 cash or trade for gun, typewriter, test equip. G. W. Cobble, 1044 Boulevard Drive, N. E., Atlanta, Georgia.

FOR SALE—Webster-Chicago model 80 wire recorder, $100 — original cost, $149.50. In excellent condition. F. F. Foster, 309 Aileen St., Plainview, Texas.

FOR SALE—Radio telephone, 25 watt Motorola FM transmitter and rec., complete with control head, cable kit, Western Electric 41A control head and 106A ringer selector. Factory tuned and aligned with crystals to operate on Bell Telephone channels, $600. H. W. Bootz, Arcadian Acres, RFD 6, Evansville, Ind.

SELL OR SWAP—Supreme 504B tube and set tester, in original carton, A-1 condition, all instructions, $60. Want Solar CF-1-60 or Sprage Tel-ohmike, must be in good condition. T. L. Pennington, RFD 1, East Brady, Pa.

FOR SALE—Dumont 274 A 5" oscilloscope, practically new, never used, $85; Clough Brengle model CRA 3" oscilloscope, good condition, $40; E.L.C. Signal tracer, model C A 10, good condition, $10. Sprague's Radio Sales & Service, 31 Sheldon St., Farmingdale, Maine.

WANTED—Ballast for Majestic model 90, 91 or 92. Also standard broadcast coil for Philco model 44. Qufice Mitchell, Willsboro, N. Y.

FOR SALE—Hallicrafters S-40, used very little, in perfect shape, with all electrical seals unbroken. Will ship in orig. carton upon receipt of first check or M. O. for $75. L. R. Battersby, 31 Grant Place, Red Bank, N. J.

FOR SALE—Two Vision television boosters, models TVL channels 1-6, like new; Jackson Dynamic tube tester, model 634, needs slight repair. Best offer. All inquires answered. Henry Kolk, Washingtonville, N. Y.

FOR SALE OR TRADE—Audel's Radioman's Guide; Coyne Electrical and Radio Ref. Encyclopedia (3 vols.); Ghirardi's Radio Troubleshooters Handbook. Want Cornell-Dubilier Capacitor Analyzer, or other radio articles to trade. Yen Radio Service, Rockford, Michigan.

FOR SALE—Westinghouse Ultra-Violet sunlamp bulb, 275 watts. List $9.95, will ship postpaid for $6.00. R. A. Dressler, 355 Front St., Millersburg, Pa.

SWAP—Complete history of Northwest Flood, May 31 to July 8 inclusive, Vanport Disaster other data as published by Longview Daily News. Want any make a.c. radio in playing condition. T. Jon Gibbs, 3303 Washington Way, Longview, Washington.

SELL OR TRADE—Solar Exam-Eter CF-1-60; Presto J-5 recorder; National 1-10; RCA 30 watt amplifier with built-in superhet, phono-top; Brewster FM tuner; 6" Craftsman jointer; 3¼ x 4¼ R.B. Autograflex, accessories. Want television, communication set or ? Stan Roszewski, 22 Ellington Ave., Rockville, Conn.

FOR SALE—Several rotatable loops, MN 20E type, new and in original packing, with full directions. Make excellent TV and FM beam rotators. Also a pair of TR 1B24's, (Uhf gate), with directions. Make offer. Martin D. Johnson, 716 East 7th St., Alliance, Nebraska.

WANTED—Interested in purchasing any quantity of receiving or special purpose tubes. Write, advising type number, quantity, condition and best price. Lectronic Research Laboratories, 1021 Callowhill St., Philadelphia 23, Pa.

FOR SALE—U.T.C. SX-25 oscillator, complete with cabinet, built-in power supply, tubes, xtal, coil, and plate-current meter. Also BC-454 3-6mc receiver converted for 117 volts a.c. Make offer. All inquiries answered. John C. Strole, 18 Cooper Pl., Weehawken, N. J.

TRADE—Smith & Wesson 38 Police Special. Want Riders' Manuals or Sprague Tel-ohmike analyzer. Lloyd BoBo 308 Riverside Ave., Canon City, Colorado.

FOR SALE—Brand new Fairchild automatic direction finder. Includes loop antenna, remote control box and cable, direction instrument, etc. Receives 200-1750kcs, $120. Don Hallman 1219 E. Main St., Mankato, Minn.

FOR SALE—Supreme tube tester No. 589; Supreme pocket multimeter, No. 542; model TS-1 signal tracing analyzer. Also other radio parts, send for list. N. P. Cantrell, R 4, Box 41-M, Huntsville, Ala.

SELL OR SWAP—Two Weston 3½", bakelite case, meters, 0-125 M. A./0-2.5A. and 0-3/0-15/0-150 volts a.c. Also one telephone hand crank bell ringing generator, a.c. Want 410 or 20 ga. shotgun, long barrel 22 pistol, or what have you? G. M. Jenkins, Radio Serv., Doniphan, Missouri.

FOR SALE—Type BC-412-B Signal Corps oscilloscope. E. A. Groeteke, 4655 Elmbank, St. Louis 15, Mo.

FOR SALE—Mercury No. 2 camera. Guaranteed first class condition, with exposure meter and photo flash unit. 20 exposure film develops 32 pictures. Cost $85. Reids Radio Shop, Parkersburg, Iowa.

FOR SALE—20 watt portable P.A. system. Home built amplifier on commercial chassis; 2 mike, 1 phono inputs; mike, floor and desk stands; 27' cable; two 12" P.M. speakers, 35' cables. Paddack Radio Service, Kingsville, Missouri.

TRADE—Hallicrafters S-38 and Wollensak microscope, both fine condition. Want rare and unusual books. Gale Adkins, 607 East 18th, Austin, Texas.

FOR SALE—New Boley jeweler's lathe, with cross-slide, tailstock, tool-rest, 120V motor with rheostat, 32 collets, inside outside chucks, and 50 items of misc. special attachments. Also drill press, grinding wheel, and circular saw. Sell for $500. J. A. Chingas, 122-02 Hillside Ave., Richmond Hill 18, L. I., N. Y.

SWAP—Radio tubes, new. Want 5Y3, 6A8, 35A5, 35Y4, 12BE6, 12AT6 plus others. Have large quantities of almost all other numbers. Hub Radio, 493 Main St., Hartford, Conn.

FOR SALE—New Supreme sig. gen., model No. 576 (732); new Cathode Ray oscillograph, type 164-E; Supreme set tester, model No. 599-A; Riders' Manuals, 1 to 7, 10, 12 to 14. Fred J. Carter, Clintwood Hardware & Furniture Co., Clintwood, Virginia.

TRADE—5 band Japanese army battery portable receiver, plug-in coils cover 0.4 to 5.750mc with schematic, no tubes. Also three 703-A door-knob tubes. What's your offer? Stan Soroko, 473 Vermont St., Brooklyn 7, N. Y.

FOR SALE—U. S. Army field telephone EE-BB, used in perfect condition, $18 per pair. H. Lewis, 548 Brompton, Chicago 13, Illinois.

FOR SALE—Radio City Products tube tester in A-1 shape, will test latest tubes, $20. First come first served. Harry Northrop, Jr., Earlville, New York.

WANTED—Surplus gear, Command transmitters and receivers, etc., in large or small quantities for growing club. Will pay cash or trade equipment. Tom Dugan, P.O. Box 11, Syracuse 1, N. Y.

FOR SALE OR TRADE—Univex Mercury 35mm camera, new; complete Deforest Radio Television and Sound Equip. course. Want 8mm movie projector, wire recorder, typwriter, or cash. Roger Kolb, 343 Main St., Pennsburg, Pa.

SELL OR TRADE—150 watt ham transmitter, $100; HQ 129X rec., $125. Want signal analyzer, condenser checker, rifle, or pistol. F. A. Paul, 5441½ Hollywood Blvd., Los Angeles 27, California.

FOR SALE—An excellent selection of fine used radios of all standard makes; a well built diathermy transformer and a step up transformer, 110V to 220V. Also two 220V 6" fans. Make offer. Goldstone Radio, 1279 Sheridan Ave., Bronx 56, New York.

WANTED—1941 Studebaker auto radio in working condition. State price and particulars. Leon Abramson, c/o Electrical Clinic, 1595 N. 52nd St., Philadelphia 31, Pa.

FOR SALE—Brand new 5" oscilloscope for $65. Need cash. George Lang, 307 Hanover St., Bethlehem, Pa.

WANTED—Short wave portable diathermy set. Also small apothecary scale and suppository molds, stethascope and manometer. Must be reasonable. Mortimer S. Rossheim, P.O. Box 542, Waukegan, Ill.

FOR SALE—Supreme 5000 ohm per volt multitester, model 543-S, brand new, $10. Also 50 new, boxed tubes, late and popular numbers, $20. D. Weisenberg, 4625 N. Lawndale Ave., Chicago, Ill.

FOR SALE—Presto K8 portable recorder, used about 30 hrs., like new, $220; Argus model A 35mm camera, with black leather case, excellent condition, $20. D. Bernard Fritz, Bethlehem Pike, Colmar, Pa.

WANTED—Surplus code outfit, No. TG-10-F, does not need to be converted in any way. Please state best price or swap. Bill Hagara, Box 224, Slickville, Pa.

SWAP—Model airplane motor, ass't of kits valued at $35; airplane, photo books value $5; Meck rad. $8.50. Want VFO ham band xtals, equip., or what? S. Kopecki, 2910 W. 3rd St., Chester, Pa.

FOR SALE—Hallicrafters S41-W 6 tube ac-dc communication receiver, range 550kc to 30mc, ideal for new amateur. Best offer. J. M. Socash, 720 N. Wash. St., Wilkes-Barre, Pa.

FOR SALE—115 volt dc inverter, designed to operate 3 to 5 tube record player. Output 110V ac 60 cycle at 45 watts. Excellent, like new, $4. V. Kozma, 3104 Wilkinson Ave., N. Y. 61, N. Y.

FOR SALE—Zenith portable model 8G005-Y5, excellent condition. Send money order for $80, will send post paid. A. B. Perlin, Jr., 328 E. Catherine St., Ann Arbor, Michigan.

FOR SALE—Triplett model 1210-A tube tester, $10; Ohlsson 23 model gas engine, with coil, cond., 2 props, spark and glo-plugs, and other extras, $8. Postpaid in U.S. Lloyd E. Edwards, Lee's Lane, Box 585, Shively, Ky.

FOR SALE—Complete radio shop. Latest testing instruments; Riders' vol. 1-16; Sams Photofacts 1 to 8, clean and new; test speakers; tubes; signal analyzer; Kodak folding camera; field glasses. State your wants. F. Merrill, Callicoon, N. Y.

WANTED—2 or 3 1F7 radio tubes, also one 6B5 tube. E. Kiehnhoff Radio Service, Box 355, Wathena, Kansas.

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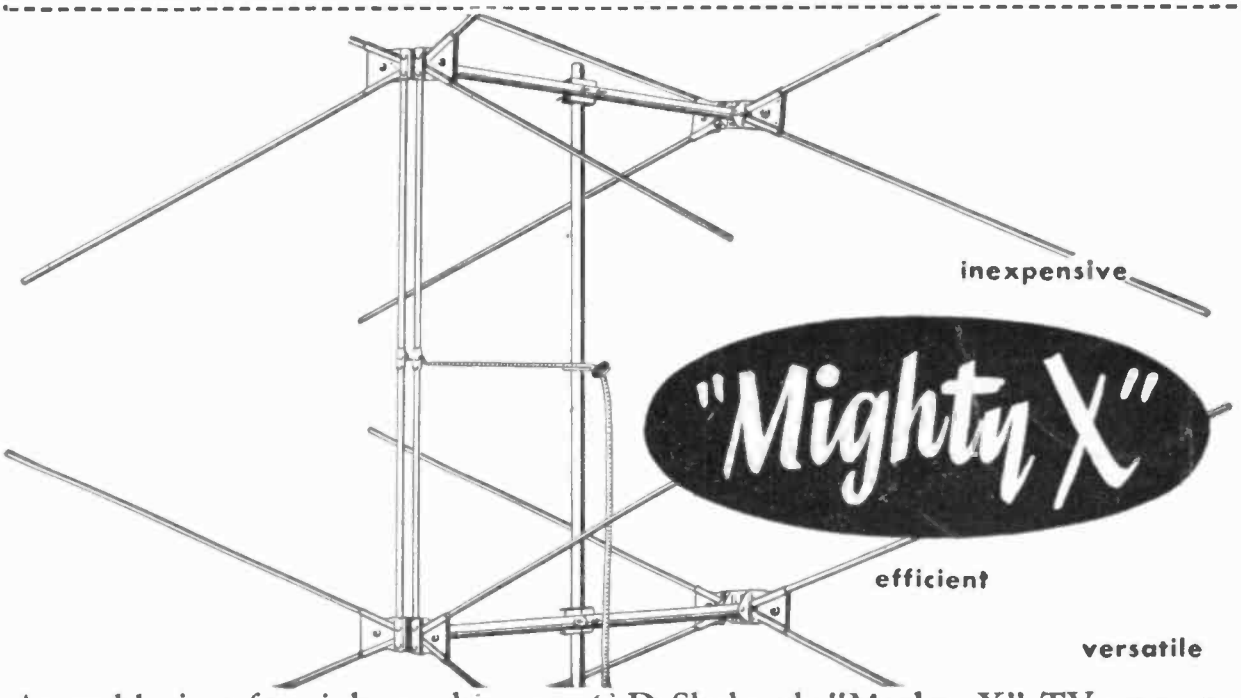

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