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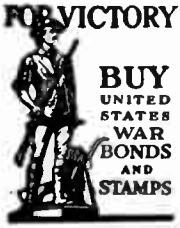

Nine East Orange St.,
Lititz Pa.

HINTS ON SERVICING RECORD CHANGERS*

A simple, logical procedure has been developed through the years for efficient radio servicing. Servicemen have found that such a routine saves time and insures a good job. But automatic changer servicing has been approached by many servicemen by the "cut and try" method, with the result that these servicemen regard changer servicing as difficult. Too many servicemen, when servicing a mechanism, seem to forget the lessons radio servicing has taught; forget that common sense, systematic methods always pay.

It is no more possible to properly repair a changer without knowing "what goes on inside" than it is to properly repair a radio without understanding the signal path through the radio. If you remove parts or change adjustments of a radio without a thought as to their relation to other parts and adjustments, you've made yourself a long, hard job getting that radio to give proper performance. In the same way, removing a part from a record changer without being absolutely certain it is at fault and without an understanding of its relation to the rest of the changer, may disturb several adjustments that will make your job many times more difficult. Study the action of the changer—not everything at once, but action by action, step by step—just as you trace the signal through a radio. Reason out the cause of the failure by studying the effects on the natural sequence of events in the changer cycle, just as you reason from effect to cause in radio servicing.

Standard Procedure

The automatic record changer should be serviced by following exactly the same logical procedure as for radio servicing: By questioning the owner, determine the complaint. By operating the changer, observe the action of the changer and verify the complaint. By carefully tracing the sequence of actions in the changer, determine the particular action at fault. By careful and repeated observation of the action at fault, and by comparison with the service notes, determine the particular part or adjustment needing attention.

To service a radio, the chassis must be out of the cabinet and in position so you can apply your test instruments efficiently. In the same way, the record changer must be in position so you can operate it and see and study every detail of the action. The changer should be removed from the cabinet and mounted on legs. Place it on a table high enough for ease of observation from all sides.

Sometimes it is advantageous to operate the changer through its cycle by rotating the drive by hand so the actions may be studied under "slow motion" conditions, just as your oscillograph slows down the high frequency signals so you can study them.

Spring Tensions

Values of resistors and condensers in a radio must be correct for proper operation. Similarly, spring tensions must be correct in a changer. Levers are pushed by cams or other levers and are kept in place and returned to original positions by springs. If a spring is stretched, or is unfastened, or is missing, the lever will not be where it belongs at the proper time and erratic or faulty operation will result. Or if a spring is too stiff, the tension will be too great and the lever will be pulled out of position. In some operations, one spring pulls against another. If the tension of either spring is incorrect, one will overpull the other causing improper action and positioning of levers. Springs showing a tendency to become unfastened should be cemented in place at each end. Each spring in the changer must be in place and must exert exactly the correct tension for proper operation.

* *By Courtesy of R. C. A. Mfg. Co.*

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Clean the Surfaces

Some levers and studs are pushed by the sides or ends of other levers or studs. If burrs or roughness intervene, there will be binding, incorrect positioning, or "jump" action. These surfaces must be clean and smooth to provide "slide" action and positive positioning of parts. If levers become bent, the contacting surfaces will not meet accurately, so that instead of meeting squarely and moving the proper part smoothly, they may not meet at all, or may slip off, or may bind or jam. Or if dirt or filings get in the eccentric step on the main cam gear shaft, the projection on the ratchet lever will not enter the groove fully with the result that the end of the ratchet lever will not be able to meet the drive cam pawl, again causing continuous or erratic tripping.

Studs may become loose. Notice each stud while running through the cycle, and see that it does not "give" as the lever or cam bearing against it is moved. A loose stud will cause binding, jamming, or erratic and intermittent action since it will allow its lever or cam to be out of place.

Friction Problems

High resistance connections in a radio cause loss of power and improper action of circuits. Such high resistance must be located and eliminated for proper results. In the same way, friction in bearings or between rubbing or sliding surfaces causes loss of power and improper action in a changer. Complaints of lack of power or slow speed may nearly always be traced to friction. For example, with the single bearing, condenser-type motor, insufficient lubrication of the motor bearing will result in slow speed and lack of torque. Remove the armature and clean it and the bearing with carbon tetrachloride. Judicious polishing with crocus cloth may be advisable. Then use a good lubricant, making sure it is proper for the job it has to do. Ordinary oils will not lubricate properly when the motor warms up in normal use. Forty-five drops fills the reservoir. Oil circulates from the reservoir through a wick to the shaft, and back to the reservoir. Reassemble the motor and spin the armature by hand, listening for noise of grit particles, or of the fan striking the case, or of improperly aligned bearing. Apply power and lightly grasp the shaft between thumb and forefinger, applying a load to check the power of the motor. In the same way, other sources of possible friction should be cleaned, relubricated, and bearings and surfaces checked for alignment.

Exactness Is Required in This Work

"Hit or miss" alignment methods could not be expected to result in a properly adjusted radio. In the same way, adjustments of a record changer should not be attempted by the trial and error method. Follow exactly the adjustment procedure of the service notes. The inter-related adjustments will thus be correct to give smooth, efficient, and trouble-free operation.

In short, using the systematic methods of good radio servicing when servicing record changers will result in a job well done, quickly and efficiently. As in radio servicing, the very best "tools" you can use in automatic record changer servicing are: logical procedure, careful observation, and good common sense.

When You Move or Change Your Address

Be sure to notify the Mailing Dept. of "The C-D Capacitor," Cornell-Dubilier Electric Corp., South Plainfield, New Jersey, giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your co-operation.

WANTED: Signal Corps Equipment

You may have Radio-Amateur and Photographic equipment that is urgently needed by the Army Signal Corps. The Army will buy the following from private individuals.

Radio: Standard and commercial built short wave transmitters (such as Hallicrafters HT-1, etc.; Temco and Collins Model 32 and 30) and Standard and commercial built short wave receivers (such as Hallicrafter, National, RCA, RME, Hammarlund or Howard); AC and DC Voltmeters, Ammeters, Milliammeters, Radio Frequency Meters and Volt-ohm-milliammeters; Oscilloscopes, 2-3 inch; Audio sig. gen. 30-15,000 cycles; RF sig. gen. 15-215 megacycles; late model Tube Checkers, and other test equipment.

Photographic: 35 MM Motion Picture Cameras (such as Mitchell (all models), Bell & Howell - Standard Professional, Akeley-Professional (all models) and Eyemo (all models) Bell & Howell Mfg.), etc., and 16 MM Motion Picture Cameras (such as Cine-Kodak Special, Magazine Cine-Kodak, Filmo 70.D or Filmo Auto Master); Tripods; Lenses, all types for 35mm and 16mm equipment; Exposure Meters; and Cameras (such as Speed Graphic 4" x 5", and Speed Graphic 2¼" x 3¼" with or without flash synchronizers) and Leica Model III (F) or 11B (C), or equal; Range Finders; Pack Adaptors and Cut Film Holders.

If you have this type of equipment, you can assist the war effort materially by selling it to the Army. Write to:

EMERGENCY PURCHASE SECTION
PHILADELPHIA SIGNAL CORPS PROCUREMENT DISTRICT
5000 WISSAHICKON AVENUE, PHILADELPHIA, PA.

briefly describing the equipment you have and stating the price at which you can offer each item, FOB Philadelphia. Do not ship any material without specific directions from that office.

Price consideration is based upon your net cost less reasonable depreciation for use, age, and condition of equipment. Inasmuch as all equipment is being purchased FOB Philadelphia, cost of packing and shipping can be shown separately so that an allowance for the costs can be made when material is accepted.

A Free Market-Place for Buyers, Sellers, and Swappers.

These advertisements are listed FREE of charge to C-D readers so if there is anything you would like to buy or sell; if you wish to obtain a position or if you have a position to offer to C-D readers, just send in your ad.

These columns are open only to those who have a legitimate, WANTED, SELL or SWAP proposition to offer. The Cornell-Dubilier Electric Corp. reserves the right to edit advertisements submitted, and to refuse to run any which may be considered unsuitable We shall endeavor to restrict the ads to legitimate offers but cannot assume any responsibility for the transactions involved.

Please limit your ad to a maximum of 40 words, including name and address. Advertisements will be run as promptly as space limitations permit.

FOR SALE A hi-fidelity Brush sound cell type BR2S laboratory Crystal Mike, almost new condition, also adjustable full length floor stand, trade or sell cash. Will pay cash for two good quality 0-1 MA Meters Arthur Garcia, Box 335, Liberal, Kansas

EXCHANGE—Keystone projector 200 watt rewind film type, 500 ft. film, excellent condition for a tube checker of latest type tubes Dwight Studios, 102 Hancock Ave Jersey City, N. J

TRADE OR SELL—Back issues Popular Photography, Radio, Camera, 1940 to date Minicam 1941-42, radio parts, trade for photographic equipment or cash Send your want list. Want Kodak Bantam Special for cash. Fred Gommo, 46 Northwest 94 Street, Miami Shores 38 Florida

WANTED IMMEDIATELY — 1 Precision 954P or 1 920P; if not available 1 Weston 772 and 1 Weston 773. Will pay high price for instruments in new or excellent condition. Leo's Radio Service, 715-19 Hopkinson Ave , Brooklyn, New York

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FOR SALE—Supreme 560A Vedolyzer $150, 561 AM, FM and RF generator $120, Weston 669 VTVM $90, Meissner 10-1154 Analyst $115, C-B Audio Osc. 79B $100, Sersco counter tube tester $25, Tobe cond. bridge analyzer $25. Want record Changer. George Munsil, 431 Mansion Ave., Audubon, N. J.

SELL OR SWAP—Deluxe Milo bar-bell set. Complete set includes bar-bell, dumbbell, two kettle type handles Weights are cylinder plate loading type. A beautiful set that can proudly be used for exhibitions. Total weight fully loaded 225 lb. Will exchange for a good Webster record changer Anthony Passaro, 126 Fourth Ave , Paterson, N. J.

SELL OR SWAP—Univex Mercury camera 35mm, 3.5 lens, 1500 sec. speed and flash gun unit, leather carrying case, exposure indicator, red filter, 5 flash bulbs, like new. $35 or good radio instrument. George Lang, 32 W. Garrison St., Bethlehem, Pa.

FOR SALE—Most of the hard to get tubes at list prices. Write stating tubes wanted. Thos. J. Ambrose, 211 Farren Ave., New Haven 13, Conn.

WANTED—RCA Radiola Model 17 condenser block, test equipment VOM and oscillator, will consider any make. State price and make, all mail answered. John J. Puzio, Radio Service, 1250 Franklin St., Taylor, Pa.

FOR SALE OR TRADE—Radio transmitting parts, meters for fast wide angle lens cover 4x5, 127 mm Ektar lens in supermatic, or other photographic equipment or Bantam Special. Gommo' 46 Northwest 94 St., Miami Shores, 38, Florida.

FOR SALE—Hickok 188X crystal signal generator with d.b meter $80; United transformers 1 LS 10; 2 LS 50, each $8; 3 vibrator power supplies, 110 v d.c., 117 v. 60 cycles at 25 watts, each $7; Brush RC 20 crystal cutting head, $12. C. Wachspress, 7815—68 Road, Middle Village, N. Y.

WILL SWAP—Five 5.50x17 tires and tubes four almost new, for a good two or 3 in. oscilloscope, or a good short wave commercial receiver, or what have you. Joseph Bucca, 1871 W. 13th St., Brooklyn, N. Y.

WANTED — Illuminated window sign, either RADIO or RADIO SERVICE. Will pay cash or what do you want in trade. Also want new or used tubes in good condition. Byron Radio Shop, Byron, Illinois.

WANTED—Dry disc rectifier units with or without transformers, or any pack, A eliminator, trickle charger, field supply, etc., using dry disc units, Sterling, Hoyt, etc.; small 2½" or less; meters dc ma up to 500 ma. Wheel static eliminator springs similar to J.F.D. Masonite regular or tempered. Will buy or swap. See ads in June "Capacitor." Send details. Bob Eubank, 1227 Windsor Ave., Richmond 22, Va.

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FOR SALE — Portable Jackson dynamic output radio analyzer, model 535A. $25. F. Combs, 344 Peach Orchard Road, Dayton, Ohio.

FOR SALE—A.K. "B" eliminator with 607 rectifier tube, 7 short wave 4 prong plug-in coils. Bud 2.5 m.h. r.f. chokes, new in original case. 50 radio chassis with half parts still mounted, many later models, 100 used tubes, plenty of hearing aid parts; instrument cases, midget condensers, crystal mike, Astatic crystal ear piece, low impedance magnet ear piece. Edwin T. Larason, Box 46, Martinsburg, Ohio.

WANTED—A Precision tube tester, model 912P, 912CP or 912C, new preferred but will accept one in new condition. Quote price and condition. Anthony Vital, 317 Linden St., Camden, N. J.

WANTED—In good condition a McMurdo Silver Model 6 late or early model receiver, with console. Must be reasonable. Send details. Paul Capito, 637 W. 21st St., Erie, Pa.

FOR SALE — Thordarson Model T30W25 broadcast type high fidelity 25 watt 6L6 amplifier, complete with tubes, in new condition. Original price $95.00. First $50.00 takes it. George E. Beggs, Jr., c/o Leeds and Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

FOR SALE OR SWAP—1 WE output trans. for PP 211Es, tubes 1 WE 282B, 5 WE 231D, 3 WE 275A, 2 WE 211E. 4 Centralab PA Delta T pads 50 ohm; 3 RCA magnetic phono heads; 1 6v to 180 30 ma genemotor, 1 6v to 225v 50 ma genemotor, various Weston and Jewell meters, 6v pot units for trumpets. H. H. Harrison, 300 37th St., Sacramento, Calif.

TRADE—5 vol. ICS Reference Library in Industrial Management, in very good condition, for Radio Course, radio books or testing equipment or what? R. A. Lorant, Sr., RFD 1, New Kensington, Pa.

FOR SALE OR TRADE—1 Webber oscillator, battery operated, 90 kc to 25 mc range, good working condition, with battery $15.00. 1 No. 171 RCA station allocator, ac-dc or battery operation, less battery, new condition $17.50. 40 new and 20 used tubes. Want Rider's 1 to 5 incl. Glandorf Radio, Williamsburg, Iowa.

WANTED—Will pay cash for late model Hickok tube checker. Rider's manuals, any vol. Must be in good condition. What have you in radio equipment? Vernon Taylor, Box 9, Elgin, Texas.

WANTED—Hickock or Weston late tube tester and good signal generator. Have speakers, tubes, books, parts, motor, jig saw and radios for sale or trade. Royce Saxton's Radio Shop, Rt. 1, Pontiac, Illinois.

WANTED—Rider's manuals 7 to 13, Rider chanalyst, Jr. voltohmist meter, Precision E 200 series 900 tester, state price. Joseph Trahan, 45 Dyer St., Danielson, Conn.

SERVICEMEN—TUBE DEALERS — Tubes available. Many odd types can be used as alternates for hard to get types. Example—20 types will replace 12Sa7, 12SQ7, 12SK7, 35L6, 35Z5. No set, socket wiring changes. List of nearly 100 alternate types used in our shop and how to use them sent postpaid for 75c. C. E. Ranniger, Gowrie, Iowa.

TRADE—Cinaudagraph 18 in. PM speaker and Radio News hi-fi amplifier for Scott 30 tube Philharmonic, Scott Phantom 19 tube, Phantom DeLuxe 20 tube or Scott 16 tube radio. Cash for difference. Howard Abernathy, Blakesburg, Iowa.

WANTED—955 and 954 Acorn tubes. Fox Radio Service, 435 South Fifth Street, Richmond, Indiana.

WANTED — Thordarson T-90S13 or 3S22 output transformer. Send price and condition. John E. Loraine, 211 Summer Ave., Newark, New Jersey.

(Continued on page 13)

Superstability at UHF*

To fully utilize the communication channels opened up in this range requires unusual attention to factors that control circuit constancy

PART I

We all remember the articles on "How to Make a 2½ Meter Transceiver" that were so abundant in the carefree days before the war. The coil was invariably made of No. 14 wire wound on a pencil, then slipped off and soldered directly across a three plate condenser. This form of inductance could be recommended for its simplicity, low losses, and the ease whereby the turns could be spread or squeezed together to adjust the inductance.

Requires six-place accuracy

Uhf comes of age during this war and its vast possibilities for postwar use require a sustained accuracy of frequency setting far beyond anything the radio engineer has ever been called upon to design. This means that every component and circuit effect that influences frequency must be investigated to six-place accuracy. Since the accuracy of calibration of a receiver is the summation of many major and minor effects, the present need is for designs of really stable inductances.

A project was laid out to investigate solenoid type coils for the frequency range of 50mc to 400 mc. for apparatus which must have superstability—that is, an accuracy of frequency setting and maintenance equal to that of a mobile crystal. Coils were investigated in the inductance range of 5 to 200 millimicrohenries (.005 to .2 microhenries). Tuning both by variable condensers and iron cores was investigated, as well as means for obtaining maximum possible secular and cyclic stability, and the highest practicable values of Q. This report

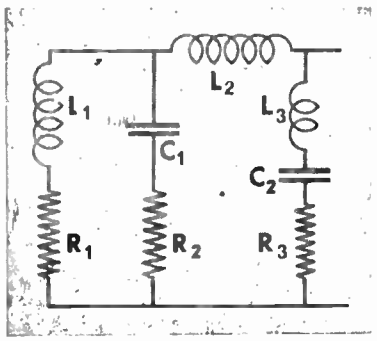

Fig. 1. Equivalent circuit of uhf tank

gives some results of the investigation and some theory developed during the research.

We shall limit ourselves to the case in which the coil is to be used in its resonant condition. Since a capacitor is a vital part of such a circuit, the complete circuit under investigation is that of Fig. 1.

* *By S. Young White in Electronic Industries.*

Equivalent circuit of uhf tank

The true inductance of the coil is shown as L_1, and the losses associated with it as R_1. This includes resistance and eddy current losses in the conductor, the terminals, and the metal parts of the adjacent tuning condenser. C_1 is the distributed capacitance and R_2 the losses therein. L_2 is the inductance of the lead to the tuning condenser, C_2, whose inductance turn is L_3, and whose losses are represented by R_3. L_1 and C_1, together with R_1 and R_2, give us the apparent inductance of the coil, but since inductance and capacitance follow absolutely different laws, they must be kept well separated in our minds.

There are several difficulties in finding proper laboratory equipment to yield reliable test data. The dc resistance of such a coil may be as low as 1 milliohm (0.001 ohm), so ordinary bridges are useless. The resistance of the conductor must be obtained by calculation of the cross-sectional area and length.

Since the inductance may be a small fraction of a microhenry, the usual good 1000-cycle bridge will not give more than one significant figure, and cannot usefully be employed.

In attempting to use a good rf bridge operating at 1mc it is necessary to place these small inductors in series with a much larger inductor, and since the bridge is only accurate to about 1 per cent, these readings likewise prove to be of little help.

Measuring Q and frequency

A Q-meter is available for use at these frequencies, but there is some doubt as to its accuracy, especially since there is great difficulty in properly connecting a small two turn coil Either the coil is connected directly to the binding posts, in which case its field is severely affected by the metallic mass of the posts, or long leads must be soldered to the coil, in which case there is some doubt as to what is actually being measured.

The method found most useful was a rather unfamiliar one: using "grid-dip" indications. We have all noticed that when we couple a tuned circuit to an oscillator, and tune the oscillator through the resonant frequency of the tuned circuit, the grid current of the oscillator will dip, as power is drawn by the tuned circuit. It is not generally realized that if we plot the shape of this resonant dip against frequency, we have plotted the shape of the resonance curve of the circuit under investigation, and have consequently measured both the resonant frequency and the Q of our unknown circuit. No correction is required if the Q exceeds about 200, but at lower values a correction is required.

Although we can measure the Q of a **complete** circuit only by this method, we have overcome binding post difficulties, and also the necessity of connecting a vacuum tube voltmeter (with its inherent high input losses) across our tuned circuit. We also require a frequency measuring setup which will permit quick determination of frequencies in this region with an accuracy of better than one kilocycle.

Our total instrumentation thus includes obtaining dc resistance by calculation, Q to an accuracy of about 1 per cent, and, at the same time, frequency to about five figures by the grid absorption method (which can

only give us those figures on a coil and a condenser together). The frequency measuring device is useful mainly when we make the circuit oscillate by connecting an acorn tube to it. This result is accurate to six figures.

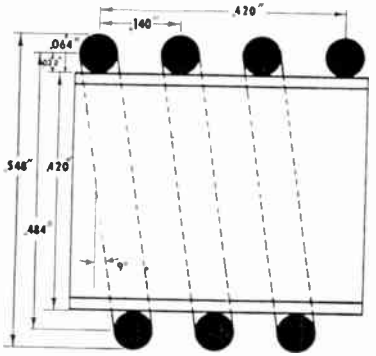

Fig. 2. Three turn wire-wound coil

With these limitations, many measurements must be made to deduce the influence of each element on the Q and frequency. The writer, having made about a quarter million such measurements, is able to make fair guesses about the reasons for some of the phenomena, but by no means all of them.

Before we consider such questions as best length and diameter of the coil, and whether we shall wind it with Invar or electroplate the winding directly on the form, let us bring out some design points by comparing theory and practice concerning two similar coils.

Round wire versus flat strap

Fig. 2 shows a coil wound on a ceramic form. The wire is No. 14 copper, and there are three turns. The length is 420 mils (center-to-center of the end turns of the winding). The o.d. of the coil form is likewise 420 mils. This is chosen so that a 3/8" core can be used for tuning if desired with the thinnest practicable wall thickness that can be commercially produced in ceramic.

Fig. 3 is a similar coil, except it is wound with ribbon or strap whose width is the same as the thickness of the No. 14 wire (64 mils). The coil form is grooved, and is likewise of ceramic. Most of this work was done with supersteatite or Alsimag 196, two very similar materials.

Our real interest in these calculations is not to design a coil to a given inductance, but to investigate what points are most important in designing for absolute cyclic and secular stability. Good cyclic stability means that we can heat and cool the coil any number of times, and that when it returns to room temperature the inductance will be the original inductance unchanged except in the sixth figure a few parts in a million. Secular stability means that the assembly will be unaffected by time. The smallest practicable change of frequency with temperature is also desired.

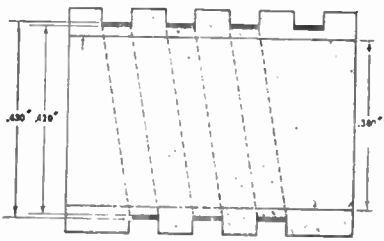

Fig. 3. Three turn strap-wound coil

Value of inductance formulas

The main point to watch in applying inductance formulas at uhf, where

the number of turns is small, and their cross-section large in relation to the size of the coil form, is the actual current path through the conductor. This is brought out in Fig. 4, where we are free to consider all the current being concentrated at 1, or 2 (the mean diameter), or 3. We know that at radio frequencies the current at 2A, the center of the conductor, will be small because of skin effect. We are also interested in how pronounced the skin effect is, how deeply the current penetrates the wire.

Fig. 4A

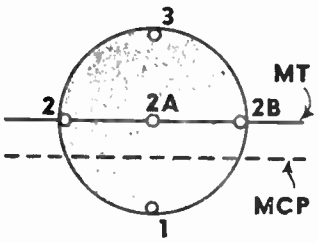

Fig. 4B

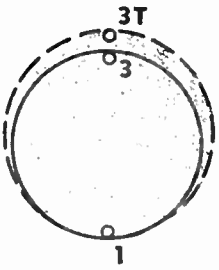

Fig. 5

Illustrating current distribution in wire and in strap conductors at high frequencies

We find that the first step in calculating rf inductance is to calculate an equivalent "current sheet inductance," wherein all doubt about the diameter of the actual current path is removed by assuming it to be an infinitely thin sheet located at the mean turn 2-2A-2B in Fig. 4. A later correction is made for eddy currents, and for actual current path.

Thus, the true current sheet inductance in microhenries of the coil of Fig. 2 is given by the formula (Bull. 74 Bureau of Standards):

$$L = 0.025 \left(\frac{d^2 N^2}{l} K \right)$$

where

d=Diameter of mean turn
N=Number of turns
l=Length of winding
K=A constant dependent on d/l, being supplied in the form of a curve.

While the formula neatly evades the question of the actual diameter of the current path by arbitrarily assuming it to be the mean turn, even this simplification leaves to us the decision as to length of winding. Since the coil is of little use without its accompanying tuning condenser, we can so arrange the connection that the current is taken off the center line of the end turn, or at the outer or inner ends, corresponding to 2 and 2B in Fig. 4. Thus the length can vary from a minimum of 356 mils to a maximum of 584 mils, a ratio of 1 to 1.64, which is a very large margin for error indeed when we are interested in a few parts in a million.

Even though we arrange to take off from the center line, the end turn is always assymetrically located in the field of the coil, and there is some reason to believe the current prefers a path toward the outer side of the end turn. If we take off from some point other than the outside, we have forced the current into a compromise path fairly difficult to evaluate. Also the constant K depends on the length,

so we have a doubly difficult decision to make when we assign a length to the coil merely by considering its geometry. This problem of course exists in all applications of the formula but is tremendously exaggerated in these tiny coils, where the wire size can be relatively enormous.

If we assign a length of 420 mils to the coil, and the mean turn is 484 mils, K becomes 0.66, and the resultant L is 82.6 millimicrohenries. This doubtful result we correct with another formula for coils wound with spaced round wire. The resultant low frequency inductance L_o is given by

$$L_o = L - 032\ aN\ (A + B)$$

where

L = .0826 microhenries

a = radius to mean turn (0.242 in.)

A = a constant dependent on the ratio of wire diameter to winding pitch

B = a constant depending on N. We obtain both from curves published in the above bulletin.

Solving, we find that L has been reduced by 9.2 millimicrohenries and the low frequency inductance is 73.4 mmh.

We must recognize we are straining this formula to the limit. Since the radius is so small and the wire so large, the result given is just a little better than guessing.

Our inability to calculate an inductance is not of great importance at this stage of the uhf art. Any serious worker will wind up dozens of coils to check the Q, stability, temperature coefficient, and tuning range with a given variable condenser or iron core, and it is easy enough to find a suitable value of uhf inductance. The matter has been reviewed to fix our minds on what factors are important in designing for thermal, cyclic and secular stability. Let us look again at the formula with that in mind.

Importance of mean current path

By far the most important element in the foregoing formulas is $\frac{d^2}{l}$. While we have defined d as the mean turn diameter, what we really are interested in is the mean current path, or the distribution of the current through the cross-section of the conductor. We are also interested in variations in that path caused by thermal effects in the coil form and the conductor itself.

Let us look at Fig. 4, and assume it is one of the center turns of the coil shown in Fig. 2. It has a companion turn on either side, and the flux through it is fairly symmetrical. The small circle marked 1 now represents the shortest path the current can take, 2 the medium length path, and 3 the longest path. We find that 3 is 31 per cent longer than 1. Of course, its dc resistance will be 31 per cent greater, so we can expect the current to divide in inverse ratio.

Path 3 is of greatest diameter, and its inductance turns out to be 75 per cent more. Adding $R + jX_L$, we find that the impedance of 3 is 2.2 times that of the shortest path. From this point of view alone we can deduce the mean current as being not at the physical mean 2—2B, but about one-third the way up from the coil form. This distribution is probably affected also by eddy currents in the wire. We shall leave the question of redistribution with temperature for later.

It is with relief that we consider the coil of Fig. 3. We have here at least an approximation of the current-sheet inductance, and the diameter of the mean turn must lay between narrow limits. We can also expect to find less complex behavior with temperature. But how does its Q compare with the coil of Fig. 2, which has so much more wire, and how thin can we make the strap? We still have the same indefiniteness with regard to length, of course.

In the course of a number of years devoted to the investigation of coils in this inductance range, it was determined that the Q of coils of Figs. 2 and 3 is just about the same, and would consistently run (with air dielectric or good ceramic or mica condensers) about 675 to 720, at frequencies in the order of 150 mc. Since we could not separate coil and condenser losses, we can only make a fair guess as to the coil losses alone. Strap of many widths and thicknesses and of various materials, from silver plated Invar to bronze, was investigated.

Dc and rf resistance

The coil of Fig. 2 was wound with 4.56 in. of No. 14 wire with a dc resistance (calculated) of 0.957 milliohms. Let us call this 1 milliohm.

The coil of Fig. 3 was wound with hard-drawn silver wire, which was then flattened, giving a strap the same width as the thickness of the No. 14 wire, (64 mils), 5 mils thick. The dc resistance was 10 milliohms, or about 10 times that of the wire. The Q at 100 mc was so similar we can call both of them 700.

The inductance of each, with a ceramic condenser across it, was measured as closely as possible (the value of the condenser being measured to three places). The coil of Fig. 2 had 69 millimicrohenries, and the strap coil 66 millimicrohenries. This is of course different from their calculated values, but is in fairly close agreement considering the vagueness of the length and mean-turn dimension.

Since the impedance of a microhenry at 100 mc is 628 ohms, 69 millimicrohenries is 43.3 ohms. Since the Q is 700, the series rf resistance of the system is 43/700, or 0.062 ohms.

From wide experience, the writer would be inclined to say that the rf resistance of the condenser is about 20 milliohms, leaving 42 milliohms as the resistance of either coil. While this value is by no means presented as being accurate, it is not very far off. In general, a very good condenser will run 2,000 Q, and the coil alone 1,000, and the combination 700, all in round figures. Thus, the ratio of rf resistances of the two coils given is one to one.

The No. 14 wire has a cross-section area of 3,225 sq. mils, and the strap only about one-tenth as much, or 320 sq. mils. We have removed 90 per cent of our conductor and still have the same rf resistance. Of course the eddy current loss in the strap is much less, since one dimension (thickness) is negligible.

How thick should the strap be? With the No. 14 wire the ratio of dc to rf resistance is 1 to 40. General experience at usual radio frequencies

would lead us to believe it can well be 1 to 3 or 4. The strap is about 10 milliohms dc, or one in 4. If we halved the thickness of the strap it would become 20 milliohms, or half of the 40 rf milliohms, and we should expect the Q to fall, which in practice it does—from 700 total Q to about 550. Thus, a 4 mil strap is about the minimum, but on the other hand it is found that an increase to 7 or 8 mils does us little good.

How deep does the current penetrate the No. 14 wire? The 5 mil strap has enough conductor to give us maximum possible Q (the writer has never been able greatly to exceed 700 as a group value of Q). We find that if we calculate the dc resistance of the outer 2 mil skin of the No. 14 wire it has an area of 390 sq. mils, and a value of 8 milliohms. This is probably increased somewhat by the crowding of the current near the coil form, and probably the current can be said to be using all of it.

Round wire of the same cross-section area as the strap is No. 24, with 317 sq. mils. Since we can deduce that the current will use only the outer two mils of the cross section, we find its resistance to be 18.5 milliohms, with a consequent loss of Q, and in addition we can expect increased eddy current losses over the strap. The Q is about 475.

This set of facts and deductions fits together pretty well. It clearly shows that a very large conductor is of little value, that wires below about No. 18 show a steady loss of Q, and that strap five mils thick and of a width somewhat in excess of 50 mils is thoroughly satisfactory.

(Continued in next issue)

THE RADIO TRADING POST

(Continued from page 6)

FOR SALE—Modern radio course National Radio Institute, good condition, $25 COD; 0-1 ma. Weston meters, etc. Write for list of sets, parts, etc. Need camera, projector, tripod, etc., similar to Kodak, Monitor or Vigilant. R. D. MacPherson, 69 Nichols Avenue, Brooklyn, N. Y.

FOR SALE—RCA Sr. Voltohmist; Triplett 1200C VOM; Triumph sig. gen.; 115 v. a.c. phono motors and relays; ATI 7" CR tube, 1500 v. power supply; saw tooth sweep; transformers; vel mike, tubes, resistors, capacitors. L. DeZube, 3900 N. Franklin St., Philadelphia, Pa.

FOR SALE — NRI fundamental radio course and 11 lessons in advanced course $10. Superior set tester $24; Readrite 0 to 50 volt meter, Gibson model L50 guitar with case, $45. All in excellent condition. Robt. Joe Helderman, Box 1, Lowell, N. C.

FOR SALE — RCA capacity electronic control model no. 41903, new in case. Two GTC model G Porta-Power and 3 model I packs, six audio transformers, four Motorola auto radio control heads and cables; one BOP control head with cables, set panel plates for auto dash mounting. Several 6 volt auto speakers. Edwin T Larason, Martinsburg, Ohio.

WANTED—Late model communications receiver. Please send particulars to Lieut. Leo Meister, Proving Center Aberdeen Proving Ground, Md.

WANTED—Tube tester, multitester, and condenser analyzer or late model combination tube and set tester, preferably dynamic conductance type, also Rider's manuals, vols. 7-13. State condition, price, and year of manufacture of testers. Paul Cumming, 422 Broadway, Peoria, Illinois.

FOR SALE—These are all Weston meters 2 model 301, 0-25 ma, 1 model 301 0-10 ma, 1 0-50 ma, 2 0-100 ma, 1 0-300 ma, 1 0-5 amps dc, 2 model 425 current squared thermo galvanometers, 1 model 269 0-350 ma. fan type milliammeter. Prices on request. Karl Neuwirth, 16 May Place, Nutley, N. J.

FOR SALE—Turner crystal microphone model 33X, brand new, $25; Turner dynamic, microphone, model 22D brand new, $25. Microphone floor stands, from $9.60 on up. All brand new, friction type. Amperite friction type banquet stand, $10. John J. Spankowitch, 239 North 9th Street Allentown, Pa.

WANTED — Model 1280 Superior set tester. Will pay cash. Please state price and condition. Could also use Superior model 1230 signal generator. White John O'Reilly, 1823 White Plains Road, Bronx, N. Y.

WANTED—Rider Chanalyst or other signal tracer. Will pay cash up to $50. Will consider home-made device if good. Henry Burwen, 17 Sheffield Road, Melrose, Mass.

WANTED TO BUY FOR CASH—September 1940, October 1940, July 1941, November 1941, July 1942, August 1942 and October 1942 issues of The C-D Capacitor, and any previous issues before August, 1940. All letters answered. State your lowest cash price. Clyde Felty, RR No. 1, Liberal, Mo.

FOR SALE—Electric Specialty Co. rotary converter, 115 dc to 110 ac voltage, 60 cycles, 160 watts.

FOR SALE—RCA portable model 4816 record player, 110 volts, 12" turntable. Burcher's Electrical Store, 513 Main St., Honesdale, Pa.

WANTED — Meters, signal generators, tube checkers, VO meters, VTV meters, receivers, etc., firearms, tools of all kinds, paint brushes, wool sponges, electric drills, etc. Describe fully. Roby's Swapmart, 3569 Cottage Grove, Chicago, Illinois.

FOR SALE — W.E. model 18-B 30 MC mobile receiver complete with dynamotor. G.E. 3 winding dynamotor 24, 750v, 750v-250-125 ma. Weston model 269 0-5 a. RF ammeter with external thermocouple. Splitdorf 0-50 v. dc. voltmeter. Rola F-4, Jensen D-12 and Jensen D- speakers. Any reasonable offer considered. G. H. Underhill, 2 North Randolph Ave., Poughkeepsie New York.

WANTED—Will pay cash for Rider's Manuals, late model tube checker, output meter, set analyzer and new radio tubes. Eugene Gilbert Radio, 1296 Sheridan Ave., Bronx, New York, N. Y.

WANTED — All kinds meters and test equipment, new and used, pay very good prices. Electronics Service and Supply, 264 West 40th St., New York N. Y.

FOR SALE—Have 9 Dunco relays 24 v. ac coils (can be operated 110 ac by series resistor). Contacts handle 30 amps. 110 ac. Single pole, double break contacts in good condition. H. Ursillo, 85 State St., E. Providence, R. I.

WANTED — Typewriter and ohmmeter, state price wanted. Milton Farber, 454 Ocean Ave., Jersey City (5), N. J.

WANTED—Majestic radio, model 250 or 250-M 5 tube ac-dc receiver complete with tubes and in good working order with or without cabinet. Will pay reasonable cash price. Drop me a line. O'Brien's Radio, 609 W. 1st St., Fulton, New York.

FOR SALE OR SWAP — Servicing by Signal Tracing, Servicing by Means of Resistance Measurement, Automatic Freq. Control, Math. for Elect. and Radiomen, Radio Physics Course, Reson. and Alignment. Sadler, 1112 Benton, Kansas City, Mo.

WANTED—Knight Little Giant 7 watt amplifier for 110-120 volts a.c. Must be complete with speaker and mike. Cash, state price, condition first letter. J A. Texeira, Jr., 28 Prospect St., Somerville, Mass.

SWAP—Jackson model 640 signal generator, just recalibrated. Want Argus C-3 or C-2, Kodak 35, Fath Derby 35mm or ½ V.P. or other photo equipment. Roy Powell, Box 422, Boynton Beach, Fla.

WANTED—Cash for pocket VOM, such as Triplett 666, 0-1 ma. meters, precision resistors, copper oxide rectifier, test equipment. Answer made to all offers. Address D. F. Causey, P. O. Box 44b, University Station, Urbana, Illinois.

FOR SALE—Kolster K-20 and K-43; Kolster-Brandeis No. 15 chassis; Kolster K-5 brand new amplifier with large dynamic speakers; Temple chassis and power pack; G. E. K-32 radio and dynamic speaker, A C. Utah dynamic speaker; Fada 8 tube chassis. All sets are in playing condition. Louis A. Goldstone, 1279 Sheridan Ave., Bronx 56, New York, N. Y.

FOR SALE—Rider's Manuals, vols. 2, 3, 4 and 5, $20.00. Perfect condition. Will consider trade for late test oscillator or channel analyzer. Make offer. W. J. Closson, 295 8th St., Troy, N. Y.

WANTED—Thordarson high fidelity transformers No. T 15R05 power; T-90A04 audio; T90S13 output; Jensen JHP-52 speaker; some 1% high resistance Morrell resistors, any wattage, state what you have and price; need 1, 2, 5, 10 meg. and .1, .2, .5 meg in particular. Want 1916 QSTs, also Aug. 1917, Feb. 1919, June 1920. Murray J. Douglas, Concord, Calif.

FOR SALE OR TRADE—Large twin cylinder Milwaukee outboard motor, complete, in good shape, with hot shot battery. Sell for $40 or trade for radio tubes, parts or equipment. Tubes such as 35Z5, 35L6, 50L6, 12SA7, 12SQ7, 12Q7, 12A8, 6A8, OZ4, 6X5, 1A5, 1C5, 1A7, 1H5 preferred. McKinley's Radio Service, Zebulon, Ga.

FOR SALE—Fundamentals of Radio, by Everitt $4; Aircraft Inspection $2.50, both new; micro-tube lab., hearing aid kit with all parts except battery cable and case; 2 M74 and 1 M54 microtubes; 1 CK503 tube and socket; two 1 meg midget volume controls; one hearing aid audio transformer. Edwin Larason, Martinsburg, Ohio.

FOR SALE—One RCA 3-inch oscilloscope, model TMV 122B. Good condition. Make me a cash offer. Write. G. J. Dohm, 438 West King Street, York, Pa.

FOR SALE—60 late phono records like new, mostly dance bands, 10c each, also 40 Edison cylinder records, bands, vaudeville, etc., in perfect shape 10c each, Lot of magazines. Best offer takes them. E. P. Schoeneck, Route 2, Box 16, Wahpeton, N. D.

SELL — Best offer will take: Clough-Brengle oscillator (model OM), Shure Uniplex and Astatic R3 crystal microphones. Meissner FM tuner, Hallicrafter S 19R. Astatic AB 8 pickup. All in perfect condition. All letters answered. Bob Joines, 236 North Palm, Upland, Calif.

FOR SALE — Clough Brengle Model 88 Vacuum Tube Voltmeter in excellent condition, no scratches and not shop worn and used but little. 0-1.2 RMS volt scale and 0-10, 0-100 peak volt scales. $45. Fox Radio Service, 435 So. 5th St., Richmond, Indiana.

FOR SALE—Neon sign and transformer 5" letters Radio Shop, $15. Carter genemotor six volt input 90 and 250 output, $10. Reids Radio Shop, Parkersburg, Iowa.

FOR SALE—All in new condition 1 yr. old: 1 Supreme multitester 592-593 $50, 1 Precision 200E signal generator $35, 1 Triplett tube tester No. 1613 $35. W. J. Luckas, 56 Spooner St., Floral Park, L. I.

FOR SALE—New, complete G. E. 5 in. television console with tubes, price $99.00. M. Abramovich, 894 Riverside Drive, New York City.

WANTED—New and used meters and test equipment, will pay very good prices, write details, M. Abramovich, 894 Riverside Drive, New York City.

WANTED—Will buy Riders manuals 9 to 13, signal generator, also RCA volt ohmyst and modern tube tester. Must be perfect Eugene Gilbert.

WANT—Astronomical or terrestial telescope with 3 inch or larger achromatic lens. Describe fully. Have new tubes, test equipment, many usable articles, cash, etc. F. Madlinger, 1704 Palmetto St., Brooklyn, N. Y.

WANTED—Following issues of "Proceedings of the Institute of Radio Engineers": Vol. 18, Nos. 2, 3; Vol. 24, Nos. 5, 7, 8, 9, 10, 11, 12; Vol. 27, Nos. 8, 10. C. G. Conn Ltd., Library, Elkhart, Indiana.

FOR SALE—One Jensen Q8P high-frequency tweeter speaker, never used. Will sell for $5, prepaid anywhere in U.S.A. W. C. Trautman, 119 N. Mansfield, Los Angeles, Calif.

WANTED—Hallicrafters S-22R or similar for cash or will trade Hallicrafters S-20 as part payment. M. J. Dodge, New Windsor, Md.

WANTED—1 all wave signal generator, 1 Precision model 920 mutal conductance tube and set tester. State prices. Frank P. Leamer, Jr., Alexandria, Pa.

SELL OR TRADE—140 pairs Chicago roller skates, perfect condition. Have complete outfit ready to roll. Excellent opportunity for right party. Want radio equipment and parts. Need Chanalyst or Voltomist, also good microphone. W. S. Frank, Route 3, Box 2, Chippewa Falls, Wis.

FOR SALE—RME99 deluxe receiver like new with speaker to match, cost $160 sell for $110, terms $25 down balance COD, also DB20 Preselector 6 bands $25 cash. E. L. Shafer, rm2c, U.S.C.G.R., 2889 E. 116th St., Cleveland, Ohio.

FOR SALE OR TRADE—1 Confidence tube tester with modernization panel; 1 Triplett Lab. complete (175 kc osc.); 1 Briggs-Stratton 1 hp motor, model FH.; 1 Remington repeating rifle, model 12A, with special Marble front sight (like new). Will trade rifle for multitester or condenser tester. Clifford D. Lessig, Frenchtown, New Jersey.

FOR SALE—2 used power trans. for 5v, 2½v, 1½v tubes, $1.00 each; 2 used 6v genemotors, good cond., $1.00 each; 4 prs. Kline 6 in. longnose pliers (new) $2.25 each; 3 15 in. heavy duty dynamic speakers, no trans., $10 to $15 each. Any of above shipped FOB on receipt of price. M. A. Porter, 1713 Larrabee St., Chicago, Ill.

SELL OR SWAP—Have a good supply of bakelite loctal sockets which take 4-prong UX base tubes. Will swap for any standard bakelite or wafer sockets, or other radio parts. Norbert Rudie, Holdingford, Minn.

TRADE—For late tube tester and oscillator. Speakers ac-dc dynamic and magnetic, dry disc rectifiers, headphones, elec. phono motor and pickup, transformers, radio generators, many used parts. All letters answered. D. Ingersoll, 1741 Lysander, Detroit, Mich.


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