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Dan Fairbanks Joins C-D

OF GREAT interest to many of our service-men friends is the news that Mr. Dan Fairbanks has joined Cornell-Dubilier. Dan will be in charge of the Radio Jobber Division, as Sales Manager.

For the past twelve years, Mr. Fairbanks has held a similar position with the International Resistance Company of Philadelphia. He is one of the most widely travelled, best known executives in the radio parts business. Numbering, as close personal friends, a host of jobbers and servicemen from coast to coast, "Dan," as he is familiarly known, has played a leading part in trade work and has appeared as speaker at numerous association meetings in all parts of the country where radio service problems were under discussion.

He assumed his new duties with Cornell-Dubilier on June 1st. After spending considerable time at two of the big C-D plants at South Plainfield, N. J. and New Bedford, Mass., Mr. Fairbanks will make his headquarters at New Bedford. He will have charge of sales through the jobbing trade and plans to continue in full the distribution policy that, for years, has made Cornell-Dubilier the world's largest capacitor manufacturer.

LOUD SPEAKER RESPONSE MEASUREMENTS*

PART I

The present high level of technical achievement in the field of electro-acoustics is largely due to improvements in measurements technique. Today it is possible to measure accurately the frequency response characteristic of a loud speaker and such data provides the means by which experienced electroacoustic engineers determine how the speaker will sound to the listener in the final application. But despite the great usefulness and evident advantages of such a procedure, it is important to recognize that the frequency response of a loud speaker, as observed by listening tests or visualized from a measured response curve, is a product of the particular acoustic environment under which it is obtained. Evidently, then, a measured response characteristic will not indicate the results to be expected in the final application unless the listener will hear the loud speaker under exactly the same conditions as those under which the measurements were made.

Our purpose here is to show how frequency response measurements are made and used by engineers in the designing of loud speakers, to indicate suitable measuring methods, to show the possibilities for misinterpretation in the use of response curves, and the extent to which response curves indicate final performance in the ultimate application.

The Human Ear

It seems worthwhile here to review some of the things that have been learned about the behavior of the human hearing mechanism. Despite the fact that the ear is a rather inexact and unsatisfactory acoustical instrument in the engineering sense, a loud speaker must ultimately stand or fall on its performance as appraised by the ear. It is for this all-important reason that laboratory response curves are always checked by exhaustive listening tests.

The range of auditory sensation is described by the group of equal loudness curves in Fig. 1. Each curve shows the intensity level required at various frequencies to produce a sound judged by the listener to be as loud as the 1,000-cycle reference intensity level. The lower curve defines the "threshold of audibility" — the point where sound is as barely audible as a faint whisper. The uppermost curve is known as the "threshold of feeling," for at this intensity level sound becomes painfully loud and is not only heard but felt.

These curves are, in effect, inverted response curves of the ear, since the sound intensity level is varied as the frequency is changed to keep the observed loudness constant, and they lead to the following conclusions:

1. The ear frequency response depends on the intensity level of the sound.
2. The relative low-frequency response is poorest at very low intensity levels and improves as the intensity level is increased. This means that at low levels, the low frequency response of a loud speaker will appear to be poor compared to that at higher levels on listening tests.
3. The extreme high frequency response also appears to improve with increase of intensity although to a smaller degree.
4. The ear is most sensitive for pure tones in the 3000- to 4000-cycle region at all intensity levels.

As is well known, hearing ability varies widely between individuals and marked impairment or deafness is

* *Courtesy "Radio News."*

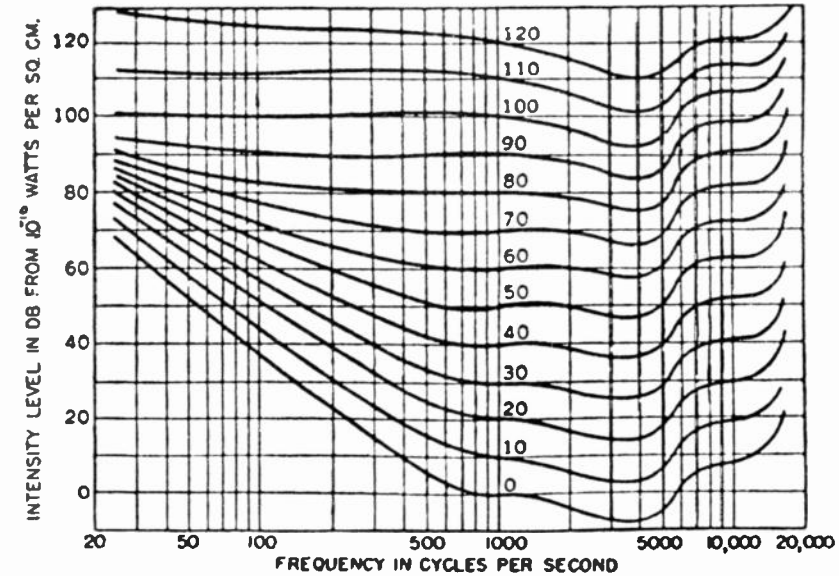

Fig. 1. Loudness level contours. Each curve shows the sound intensity required at any freq. to produce a loudness equal to that resulting from the 1000 cycle intensity indicated.

rather common. Beasley has shown[1] that only 1% of the population have thresholds as low as shown, and that 50% of the population have thresholds more than 15 db higher than that of the group illustrated.

Individual hearing ability progressively deteriorates with age. Not only is there likely to be a general loss of acuity over the entire frequency range, but the ability to hear high-frequency sounds continuously decreases as age advances. For example, representative values of the falling-off in ear sensitivity with age, at 4,000 cycles (compared to age 25), are: age 35, 10 db; age 45, 12 db; age 55, 24 db.

In addition to the individual differences and trends with age, the hearing ability of a given individual may vary considerably over a short period of time due to auditory fatigue produced by prolonged exposure to loud sounds. Illness may also cause temporary impairment of hearing.

All of these factors must be kept in mind in conducting listening tests, for the judgment of listeners can be no better than their ability to perceive the thing to be appraised. In the laboratory it is, therefore, an evident advantage to be able to eliminate ear judgments during the engineering design and development process, later utilizing listening tests to supplement and confirm data provided by response measurements.

Response of the Ear

The ear is a pressure-actuated device. The observed loudness of a sound depends on the acoustic pressure exerted on the ear drum. In telephone receiver listening, the sound is delivered directly to the ear canal, but in the case of loud speakers, the sound arrives at the listener by wave motion in the intervening space.

(Continued on page 7)

[1] The National Health Survey, Hearing Studies Series, Bulletin No. 2. The United States Public Health Service, Washington; 1938.

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.

WANTED—Maytags or other makes washing machines; state price and condition Have Stewart Warner receiver and cash. J. W. Akers, Box 96, Stone, Ky.

FOR SALE OR EXCHANGE—Test Instruments, tubes, supplies. John Trowbridge, 7936 Parnell, Chicago, 20, Ill.

FOR SALE OR TRADE—Weston mod. 772, supersenitive analyzer and Triplett mod. 1200A, volt ohm milliammeter for good med. sized camera or lenses or R.F. oscillator. E. O. Mueller, 3445 Narragansett Ave., Chicago 34, Ill.

WANTED—8 mm. camera or projector or reflex type camera or F.M. converter SWAP—Stancor 440MB modulator, 1000 and 1200 v power supply and high freq. transmitter. Like new—all tubes incld. Al Hoffmann, 275 Woodbine St., Brooklyn, N. Y.

WANTED—Late Sprayberry or N.R.I. complete radio course. State condition and lowest price. Dr. C. H. Farnsworth, 561 E. Lafayette, Jackson, Tenn.

URGENTLY NEEDED — For cash—Communication receiver, 6 to 8 tubes, ac.-dc. operation. Echophone Ec-1 or Ec-4, Howard 445 or similar type receiver. Theo Folta, 300 Nichols St., Utica, N. Y.

FOR SALE — Webster phono-meter and pickup, $17.50; over 1000 guaranteed tubes at list price; Meissner 9-1000 remote control with push buttons, list price $26.50 now $15. Can supply any tube wanted. Will trade 6-12-30v tubes. Goodwin Radio Shop, Rankin, Ill.

WANTED—Phonograph motor 78 rpm. ac. self starting with mounting brackets, etc. State cond. and price. Also pocket V.O.M. similar to Triplett 666 or Supreme 542, and small condenser analyzer. Louis Fialkoff, 143-48 41 Ave., Flushing, N. Y.

FOR SALE—14w. new amplifier, new tubes. Has radio input, phono input, and mike input; $25. Volt meter, new $40. WANTED—the following tubes: 2 1A7GT-G, 2 1N5GT-G, 2 1H5GT-G, 2 12 SA7GT-GI, 2 50L6 GT-G, 2 1R5, 2 1S5, 2 1T4, 2 6A8 GT. C. Morgan, 2209 Edison Ave. Jacksonville, 4, Fla.

WANTED—Hickok signal generator model OS10; will pay $25 if in A-1 condition All letters answered. Pasquale Calabrese, 725 Elton Ave., Bronx, N. Y. (55)

FOR SALE—De Vry 35mm. portable motion picture projector in new condition, $35. George Cannova, 40-13 Union St., Flushing, N. Y.

TRADE—Hallicrafter 5x16 receiver. Also rack and panel 250 w. Xmitter—both in A1 condition. WANTED—Test equipment, tube tester, oscillator, etc. Lew Daufman 233 S. Connecticut Ave.. Atlantic City, N. J.

FOR SALE—Gevaert Superchrome 5x7 film, 3 dozen in package. Hammer Portrait Ortho 5x7 film, 2 dozen in a package. All in factory sealed packages—$1. per dozen. Cannot sell less than full package. Big Sandy Maytag Co., Pikeville, Ky.

WANTED—Colt .22 cal. Woodsman automatic pistol. Also Rider's Manuals 5 to 13 incl. State condition and price. G. T. Iler, P. O. Box 71, Fanwood, N. J.

WANTED—Late model portable tube tester of good standard make and condition and have neon short test. State price and description. Big Sandy Maytag Co., Pikeville, Ky.

FOR SALE—Radio tubes (many hard to get) or will trade for late test equipment. Send for list. Roxy Radio Repair, Mitchell, S. D.

WANTED—Supreme model 561 and Supreme model 560A. in excellent condition. will pay $225. cash F.O.B your place. R. L. Bradford, 712 6th Ave.,W., Decatur, Ala.

SELL OR SWAP—Model Craftsman, Radio, Popular Photography, Minicam magazines, radio parts, miscellaneous photographic accessories, lenses. WANTED—Model Engineer and Electrician magazines, Hornet Engine, Kodaslide projector. Write your wants; all letters answered. Fred J. Gommo', 46 N. W. 94 St., Miami, 38, Florida.

FOR SALE—Meissner Analyst Model 10-1154 in perfect electrical condition. Price $75. C.O.D. Mathews Radio Service, P.O. Box 387, Bloomingdale, N. J.

WANTED—For Cash— obsolete pieces of Weston and Jewel equipment, like models Jewel 199, Jewel 408 & 409; Weston 565, Weston 566, Weston 563. No offers made; explain condition and give lowest price. W. S. Crooks, Box 94, Kent, Ohio.

WANTED—Amphenol connectors type 93C, 93M, and co-axial cable No. 72-12. Frank J. Polinski, Warren, N. Y.

TRADE—Philco Sig-Gen mod. U30975 5 band, nearly new; Webber mod. 20, osc. 8 band bat. good in both, either for Solar mod. QCA or BQC cond.-tester, or Superior Channel Analyzer. Have new Stuart-Warner port. radio, Elgin 7 jew. watch. Ray Parker, Kingman, Kansas.

FOR SALE—Hallicrafter Skyrider Commercial 11 tubes, 5 bands, 110Kc to 11,500 Kc. in metal cabinet for table or rack mounting. 6" speaker with metal cabinet to match. Complete and perfect with tubes, $105., Harry M. Boone, Radio WFBR, 10 E. North Ave., Baltimore, Md.

TRADE—0-1 milliammeter, Rider Manuals, test equip., tubes, radio equip., etc. WANT K&E Engineer's slide rule or equal, LC checker, Jr. v-ohmist, old watches and jewelry. Robert G. Browning, 552 Eleventh Ave., Prospect Park, Pa.

WANTED—Capacitor Analyzer, also 776 Weston A C Oscillator, 504 Supreme tube and St. tester. Must be in first class condition and lowest cash price. Rudolph's Electric Service, 33-35 E. Jackson St., Wilkesbarre, Pa.

FOR SALE OR TRADE—1-/10 hp Emerson synchronous motor, 110v single phase, 900 rpm, non-self-starting, reversible, with 1" dia. hollow outside threaded shaft. Dexter Kurs, 4525 45th St., Long Island City 4, N. Y.

WANTED — Automatic record changing, record player unit. Prefer Garrard or Capehart. State full details and price. Dexter Kurs, 4525 45th St., Long Island City 4, N. Y.

FOR SALE—Superior 1240 tube tester, Superior 1230 generator, Green Flyer phono motor and turn table, 1500v sign. transformer, tubes etc. Send for list or make offer. R. E. Rice, Fairchild, Wis.

WANTED—For cash, sm. VOM, 1" oscilloscope, sm. radios. State price and condition. H. Samkofsky, 527 Bedford Ave., Brooklyn, N. Y.

FOR SALE—64 Utah Z612 transformers at $2.49 net; 55 Utah E6P speakers at $3.15 net F.O.B. Springfield, Mass. Ralph D. Jones, Inc., 721 Worthington St., Springfield, (5) Mass.

WANTED—6v phonograph motors or turn tables, 6v amplifiers, 15 50w amplifiers, outdoor speakers, microphones. William J. Jones, 319 Convent Ave., New York 31, New York.

WANTED—Meissner FM chassis, Solar CB analyzer, Carron AF oscillator, RCP signal generator, Superior channel-analyzer. Equivalents considered. State price. Soundways, 560 Walnut St., Fall River, Mass.

FOR SALE—2 metal cabinets for transceivers. H15 1/2" W8" D6" back plates but no panels—1 metal stand for meter (3" hole) D43/4W41/2 back height 41/2 front height 2".—3 Ceramic ribbed coil forms, 2 Jewell and 2 Weston meters. John Archibald, 1722 Melville St., Bronx, N. Y.

WANTED—Analyzer, volt ohm milliammeter oscillator, tube tester. New and standard models. Send particulars. R. H. Paul, Electrician, Southern University, Scotlandville, La.

WANTED — Hallicrafters S27 FM-AM receiver or S31 tuner Also two each high fidelity magnetic phono pickups RCA 70A or WE 9A. A. C. Brooks, 70 Gibbs Ave., Newport, R. I.

(Continued on page 11)

LOUD SPEAKER RESPONSE MEASUREMENTS

(Continued from page 4)

Outdoors in free space, the sound waves move directly from the source to the listener.

Indoors, however, the situation becomes highly complicated. Here sound not only reaches the listener direct from the source, but is reflected from walls, ceiling, and floor. Each reflecting point becomes in effect a loud speaker, with the reflected sound tempered by the position and nature of the reflecting surface. What the listener hears is the resultant of the sound waves reaching him from many different positions and with different phases and amplitudes. The sound which the listener hears is further altered, at least in interpretation, because two ears (binaural effect) make possible an approximate localization of the source just as two eyes give depth and position to a view. The listener is thus enabled to exercise some subjective discrimination in favor of the direct sound over that which arrives from other directions.

In loud speaker response measurements, what is determined is the net resultant sound pressure at a specified point, or the average of the pressures over a specified area, according to the method used. While this yields some indication of what a listener would hear were he present, yet for the reasons outlined above, it must be remembered that the result is still fundamentally a measurement of the sound field produced by the speaker and not a determination of its effect on an observer.

To sum up briefly, then, it is known that the frequency response of the ear varies with the intensity level of the sound, and is most uniform at high intensities. Hearing ability varies widely in the population and impairment is common. Hearing ability deteriorates with age, especially at the high frequencies.

Loud speaker response measurements cannot indicate exactly what a listener will perceive, even if all these

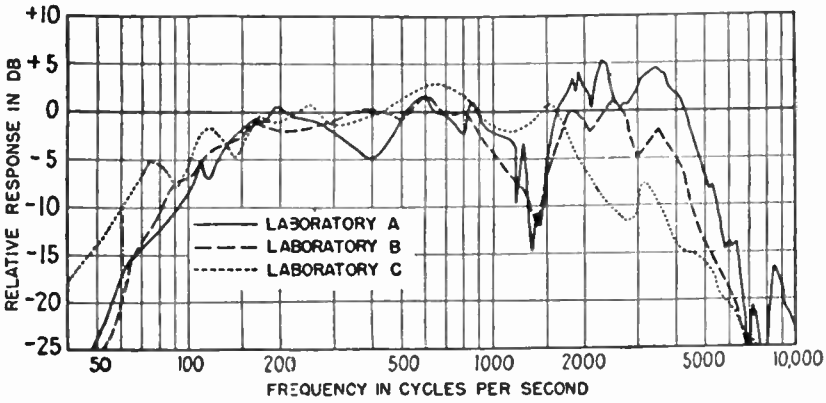

Fig. 2. Response curves of the same speaker as reported by three different laboratories, indicating need for complete familiarity with test conditions in evaluating response data from different sources. Curves have been graphically smoothed to facilitate comparison. Data showing in detail the effect of test conditions on measured results is given at length later in this article.

factors are taken into consideration, because (1), a given measuring microphone indicates the resultant pressure at a point in the sound field, whereas the pressure at the listener's ear located at the same point would be different due to diffraction around the head: (2), binaural (two-ear) localization of the position of the speaker by the listener tends to bias him somewhat in favor of the direct sound, while a given microphone (a single electroacoustic "ear" with smaller and different diffraction effects) is unable to discriminate in this manner, and indicates the resultant of all the pressure components from all directions at the measuring point.

Curves from Different Sources

To illustrate and repeat the caution frequently voiced by loud speaker engineers against the tacit acceptance of response curves without regard to conditions of measurement, let us refer to Fig. 2. Three prominent laboratories with long experience in acoustic measurements were asked to measure the response-frequency characteristic of the same identical loud speaker. The curve requested was that which the laboratory would normally publish as representative of the speaker. The resulting individual curves are quite different over important parts of the frequency range and would certainly lead to different judgments of merit by the reader. The accuracy of individual measurements is unquestioned. The differences in the results of the individual laboratories were due to the use of different methods, all of which were quite valid and descriptive of the speaker if properly interpreted in the light of experience.

It is common practice in loud speaker design work to make a number of different kinds of response measurements. Some of the methods give results which, while they tell only a part of the complete performance story, indicate immediately what changes the designer may have to make. Long experience in interpreting response curves and instinctive allowance for unmeasured but well-understood effects inherent in the general design, permits this "short-story" technique within the laboratory. However, when the results are passed on to engineers who are not daily workers in the field of electroacoustics, it is a matter of practical experience that misunderstandings and misinterpretations are more the rule than the exception.

Factors Influencing Measurement Techniques

The response-frequency characteristic of a loud speaker involves a determination of the sound pressure in the acoustic field resulting from constant input to the amplifier driving the loud speaker, the frequency being varied over the range of interest. The sound pressure is measured by means of a calibrated microphone and associated amplifiers.

By far the most important factor in loud speaker measurements is the purely acoustical portion of the system. The space surrounding and linking the speaker and microphone not only provides a transmission system of a highly complex nature between the transducers, but also reacts upon the speaker and determines the acoustic impedance which the radiating system "sees." Stated in another way, the efficiency of the speaker and the total power radiated by it, depend on whether it is radiating into (1) free space outdoors, or (2) into a room or bounded space. For the room case, there are general differences depending on location of the speaker with respect to the boundaries. As will be shown later in typical curves for a representative direct radiator speaker, the indoor efficiency in the frequency range below about 800 cycles is highest when the speaker is located on the floor (or ceiling) at the corner intersection of two walls, less when located on the floor (or ceiling) against a wall near its center, and least when mounted on a wall midway between floor and ceiling. These effects are due to the progres-

sively greater solid angles[2] into which the speaker radiates in the respective positions described.

Another important feature of the room is its behavior as a complex acoustical resonator. In a rectangular room there are a large number of resonant frequencies or normal modes of vibration whose location in the frequency spectrum is dependent on the height, length, and width of the room. These modes, as they are excited from the loud speaker, produce wide fluctuations in response at any given point in the room. In moderate to small rooms, the low-frequency modes are relatively widely spaced in frequency, thus making it difficult to obtain truly satisfactory low-frequency reproduction compared to that observed in larger rooms. At high frequencies, the modes are very closely spaced, even in small rooms. On this account also, then, it is essential to consider the room as a vital part of the acoustical system and no study of loud speaker performance (for types intended for indoor use) is complete without measurements of the response-frequency characteristic in a typical listening room.

While outdoor measurements at great heights simplify the acoustic surroundings and eliminate room effects, the accompanying disadvantages of interfering weather, wind, and temperature conditions make it necessary to perform the majority of routine development measurements indoors, even on speakers designed for outdoor applications. The exact performance in any particular application, for reasons just discussed, can only be determined from measurements taken on location after the speaker has been installed.

For many years it has been customary to make indoor "dead-room" measurements, in which room resonances are partially damped out by the use of highly absorbing wall treatment. This, combined with close placement of the microphone, serves to produce fairly smooth response curves which are convenient in development work and demonstrate the result of de-

[2] A solid angle is the three dimensional angle enclosed by a set of boundaries intersecting at a common point. These boundaries often reduce to some simple form such as, for example, an infinite baffle which restricts the sound radiation to a hemisphere.

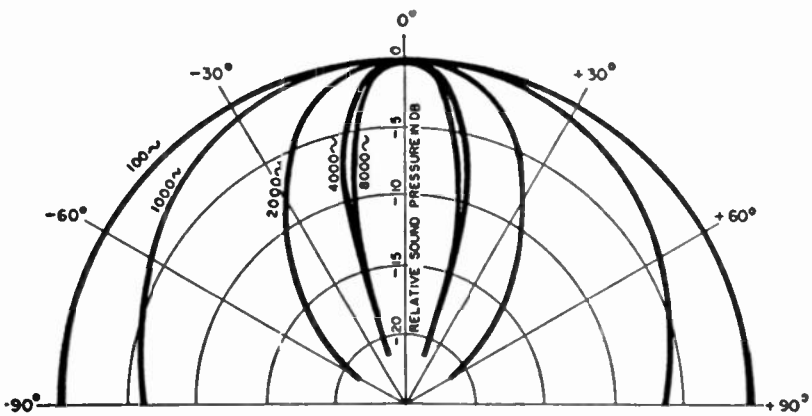

Fig. 3. Theoretical polar characteristic of a 12-inch speaker represented by an equivalent vibrating piston in an infinite baffle. At low frequencies the radiction is non-directional, but at high frequencies is increasingly concentrated on the axis of the speaker, falling off rapidly as the azimuth angle is increased. Characteristics are for free space at infinite distance and only major lobes are shown.

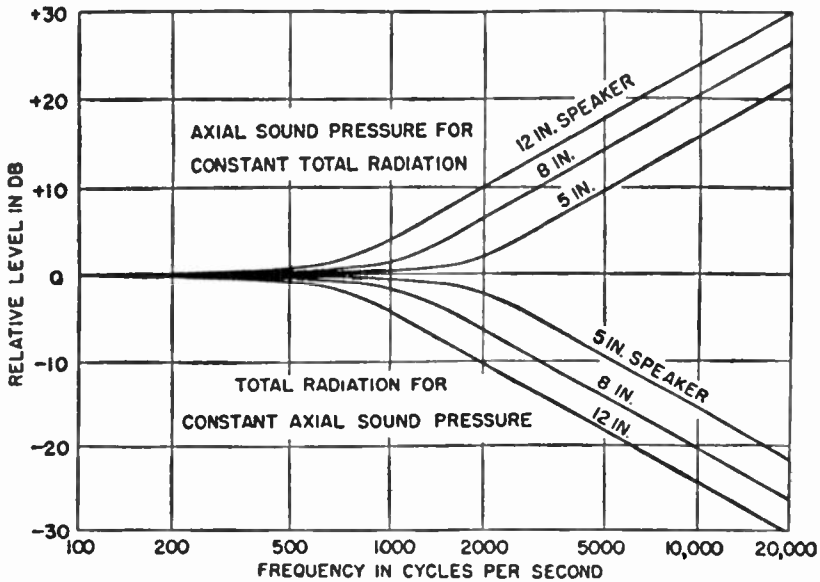

Fig. 4. Theoretical sound pressure on axis required to maintain constant total radiation, and total radiation resulting from constant axial pressure for speakers of various sizes. The speaker is assumed to be replaced by an equivalent piston, vibrating in an infinite baffle in free space.

sign changes in a particular type of speaker. Such curves, of course, show neither outdoor performance, nor indoor performance under representative listening conditions; their main justification is one of convenience to the development engineer.

The new trend in sound room construction for precision acoustical measurements is the so-called free-space room. Here the wall absorption is especially designed to reduce reflections by providing a closer acoustical impendance match between the air and the absorbing system at the inner surface of the boundary. Experience justifies the rather heavy expense of free-space sound rooms for organizations carrying on extensive research programs, although an approach to true free-field conditions has been only approximated at frequencies above a limiting value in the general region of 100 cycles per second.

In considering measuring techniques and evaluating response curves, it is essential to keep in mind the importance of directivity, for most conventional speakers are non-directional at low frequencies and highly directional at the higher frequencies. If we represent a conventional cone-type direct radiator speaker by means of a vibrating piston and compute the theoretical directivity characteristic shown in Fig. 3, we obtain the familiar polar pattern for this type of speaker with its characteristic progressive concentration of radiation on the axis as the frequency is increased. This confirms our practical experience, namely, that a listener on the axis of the speaker observes the maximum high-frequency response, and that the high-frequency response drops off as the listening position is shifted away from the axis. There is no such effect at low frequencies as in-

dicated by the circular non-directional pattern in the illustration. Directional characteristics are nearly always taken out of doors or under free field conditions to eliminate the interfering effects of reflections. For speakers intended for outdoor use, a group of response curves taken at various angles to the axis will indicate the relative response at different positions in the audience. Outdoor data of this type cannot be used to predict indoor performance at different listening positions because in small rooms reflected sound and normal modes introduce wide fluctuations in response from position to position, even at the same azimuth angle of the speaker. At moderate distances from the speaker, the total sound energy from all directions (in a fairly large listening room) arriving at the reference position is likely to be many times that of direct sound from the loud speaker.

Further consideration of the influence of directivity leads to two important conclusions: (1), that significant measurements representative of performance in live rooms require a determination of the total-radiation-frequency characteristic (as contrasted with the simple axial pressure response-frequency characteristic); (2), a flat axial response frequency characteristic in a conventional direct radiator speaker means that the total radiation is falling off at the high frequency end because of the limited angle throughout which sound is radiated due to directivity. The converse is also true—a constant total radiation frequency characteristic demands that the axial pressure rise as the frequency increases; the more directional the speaker, the greater the required axial pressure rise at high frequencies to maintain constant total radiation.

The second point above is illustrated by the computed curves in Fig. 4 in which the loud speaker has been assumed to be a rigid piston of equivalent size. It will be seen that for constant axial pressure, the total radiation of a 12-inch speaker falls off approximately 18 db at 5,000 cycles. If constant radiation is desired, the axial pressure must rise 18 db over the low frequency value at 5,000 cycles. With smaller speakers the effect is less because they are not as directional at high frequencies. However, the effect of directivity is still pronounced even for 5-inch speakers. In an actual speaker, the concentration of radiation is somewhat less than that indicated due to cone flexing. It should be mentioned here that while the principle of a rising axial response to maintain total radiation at the higher frequencies has been applied to improved single-unit direct radiator speakers in recent years, the highest performance specifications for wide-range reproducing systems have thus far been met only with reproducer designs in which the low and high frequency ranges are divided and separately reproduced by units designed for best performance in their respective ranges. The best practice involves the use of diaphragm-type driver units working into subdivided cellular or other special horns for wide-angle radiation at the higher frequencies.

(To be continued in next issue)

THE RADIO TRADING POST

(Continued from page 6)

WANTED — Automatic record changer, .001 millimeter, National type SE 50 or 75 UUFD variable condenser. Oscar M. Tupancy, 2036 25th St., Detroit, 16, Mich.

WANTED—For cash. Tubes, new and used from 6 to 117v—Send list and price Keating's Radio Service, 928 7th St., Port Arthur, Texas.

FOR SALE—Diehl 1/3 HP motor and Delta ¾ HP motor, both DC, 115v., 1725 rpm. Wallace, Muller & Co., Ltd., 120 Greenwich St., New York 6, N.Y.

FOR SALE—Emerson B Power Unit, style 116, 32 to 180v, 4 amps to 40 m.a., terminal voltage from 22½ to 180. Highest cash offer takes it. Loomis & Co., 128 N. Main, Las Cruces, N. M.

FOR SALE—G M Delco auto radio and speaker, $15. Remington p.a. rifle $20. vice and parts data factory manuals. Also Arvin factory parts and service manuals. Paul Capito, 637 W. 21 St., Erie, Pa.

FOR SALE—Code practice osc., 8" AC fan, 6v genemotor, AC-DC phono amplifier with tubes and speaker, 2 amp charger, 200 pieces mica conds. Philmore crystal set, elect. clock, tubes 2B7, 224, 238, 57, 56, $40. takes all Stanley J. Zuchora, 2748 Meade St., Detroit 12, Mich.

SELL OR TRADE—4-tube Philco, 2-77, 80, 42; phono amplifier from Rockola mach., 2 6B5 driven by 6A6 tube, 12" speaker; NEED K & E Slide Rule Log-Log Deciding or Vector and miniature camera with fast lens. Wm. Tucker, 393 Elizabeth Ave., Newark, N. J.

SALE OR TRADE—Clough-Brengle CRA 3" oscilloscope, audio osc., both perfect. 3" meters. Quantity Xmting gear. Typewriters. WANT 16mm. movie equip., films, etc. Warren S. Gilman, Winter St., Tilton, N. H.

FOR SALE—Zenith Pocket radio with tubes $10. Dictagraph earphones 3000 ohm $1.75. JFD. radio battery adapter harness for Philco BO Paks, $1. RCA Electronic Control model 41903, $6.75. A.K. 12" 32v speaker, $1.50. A.K. "B" Eliminator with 607 rectifier tube, $2. Parmak 6v fencer, accessories, display rack, $15. Edwin T. Larason, Box46, Martinsburg, O.

WANTED—Triplett model 1600E VOM. Precision model E200 sig. gen. FOR SALE OR TRADE — Webster port. recorder, single speed motor and feather pickup complete in airplane luggage case, but no amplifier. Valley Radio, 867 Broad St., Central Falls, R. I.

WANTED—Fly rod and reel both in good condition. Will pay cash. F. A. Witkowski, 32 Daymond St., Trenton, 10, N. J.

FOR SALE — Supreme Audiolizer model 562 recently overhauled by factory. Best offer—half down, bal. C.O.D., Henry House, 306 So. 2nd St., Guthrie, Okla.

WANTED—Late model dynamic tube testet and an all wave signal generator in A-1 condition. State model and price. George Shimamoto, 8-7-C, Relocation Branch, McGehee, Ark.

TRADE OR SELL—Radios, parts, tubes, test equip., meters, rectifiers, phono motors, pickups, electric drills, tools manuals, text books, neon bulbs, magazines, etc. Describe your goods fully. Stamp for list. Roby's Swapmart, 820 E. 61st St., Chicago, Ill.

WANTED — Meissner high fidelity P.A. Tuner 101152 or foundation kit for same, consisting of 4-gang tuning cond. and TRF band pass coils. E. J. Rome, 222 Coolidge St., New Orleans 20, La.

FOR SALE—Microphones, amplifiers, pickups, speakers, baffles, auto aerials, intercommunication wire (12 pr) Mallory 554 vibrapac and amplifier chassis. write for list. Fox Radio Service, 435 So 5th St., Richmond, Indiana.

FOR SALE—Tubes: HY75, HY615, 954, and 955. Fox Radio Service, 435 So. 5th St., Richmond, Indiana.

WANTED—15 to 100W amplifiers, turn tables, microphone stands, pickups and intercommunication units. Fox Radio Service, 435 So. 5th St., Richmond, Ind.

FOR SALE—Inverter from 32v d.c. to 110v a.c. 110v port. light plant like new, suitable for operating mobile PA system. WANTED—Voltomyst Jr., perfect cond. Also test equip. and P M speakers. W. S. Frank, R. Rt, 3, Chippewa Falls, Wis.

FOR SALE—Mod. 551 Supreme analyzer, used very little. $35. Dundee Radio Shop, Dundee, Mich.

WANTED—Hickok 510X tube and set tester in good cond. for cash or part trade. What do you need? F. U. Dillion, 1200 N. Olive Dr., Hollywood 46, Calif.

WANTED—Analyzer and tube tester for cash. J. A. Brown, 315 Santafe St., Waynoka. Okla.

WANTED—Superior Test Instruments, any type or age. RCP Analyst., also other make test instruments, radio parts, phono parts. Send list and prices. Radio Shop, 1504 La Baig, Los Angeles 28, Calif.

WANTED—Superior Model 1280 comb. tester with cover. State condition and lowest price. M. Seltzer, 223 Keap St., Brooklyn, N. Y.

FOR SALE—Various used communication receivers. Send for list. Gerald Sankofsky, 527 Bedford Ave., Brooklyn, N. Y.

WANTED—Correspondence with radio men with parts, I.F. speakers or experiments or ideas in S.W., etc., Henry Ecklund, 290 E. Lawson St., St. Paul, Minn.

WILL TRADE—Oliver typewriter No. 9; also 1/4 h.p. motor for multimeter. Smith Radio Service, 132 S. 7th St., Steubenville, Ohio.

URGENTLY NEEDED—Philco 030 signal tracer and C.D.B.F.50, Solar, Sprague & Jackson or Aerovox LC condenser analyzer, Jack's Radio Service, 34 W. Hoffman Ave., Lindenhurst, N. Y.

FOR SALE — Sprayberry correspondence Course 1941 Diag Man. by Radcraft, and misc. equip. WANTED—Small V.O.M. phono motor and pickup; 7" bench saw, flex. shaft. Royce Saxton's Radio Shop, R 1, Pontiac, Ill.

WANTED—Any quantity—must be perfect and boxed—1A7GT, 7A8, 7B7, 5Y3, 5Y4, 5U4, 12SA7, 12SK7, 12SQ7, 12A8, 12K7, 35A5, 35Z3, 35Z4, 35Z5, 25L6. 35L6, 50L6, 43, 47, 50Y6, 50Z7, 45Z5, all 117v series. Give full particulars first letter. Leading Radio, 114 East 3 St., Mt. Vernon, N. Y.

FOR SALE—Complete stock of Radio tubes. NEED Mobile PA systems, Xtal mikes with rubber-covered shielded cable—best price for burnt out Cathode ray tubes—also 83 tubes.,V. Kozma, 3104 Wilkinson Ave., N. Y. 61.

FOR SALE—Service magazines—Feb. 1932 to Mar. 1942, incl.—122 copies. $5. takes lot. Ira I. Walker, 1612 Center Ave., Great Falls, Mont.

SELL OR SWAP—Control units for most cars and sets: Univex 8mm movie camera, orig. pkg.—WANT—phono motors, crystal pickup, tubes or cash—what have you? Leo Stein, 7 Monroe St., Mt. Vernon, N. Y.

FOR SALE — Clough Brengle OC signal generator, re-aligned with chart—factory pack. and bill. $50. cash. Supreme Mod. 89. excel. work. cond., with chart and extra tube testing charts. $30. Precision Radio Service, 40-13 Union St., Flushing, N. Y.

WANTED—Garrard RC30 record changer or GI C125L. Also other makes. State age, condition and price. Leonard C. Pochap, 2930 Upton St., N. W., Washington 8, D. C.

WILL BUY—Used crystals, 20c ea., any quantity—must be intact and not opened. Cash by return mail., Leading Radio Service, 114 East 3 St., Mt. Vernon, N. Y.

WANTED—Rider's Manuals, vol V1 and all later issues. Cash or radio merchandise in exchange. E. D. Cook, Radio Dept., 1071 Union Ave., Memphis, Tenn.

FOR SALE—Portable Diathermy mach., "Eleo" & Violet ray; Port. Health mach. for Sinusodal and Faradic and Violet ray treatments; 2 Brunswick 9 tube Supers with or without spkrs; 4 Kolster radios, mod. K20; 1 Temple chassis and power pk. good job. Louis A Goldstone, 1279 Sheridan Ave, Bronx, New York 56.

FOR SALE OR TRADE—Supreme 5 in. fan meter from tube tester. 01 ma. WANTED .303 Savage rifle in good cond., Roberts Radio Service, Wheeler, Mich.

WANTED—Superior tube tester mod. 1240 or late Supreme tube tester & ohmeter comb. SELL OR TRADE N.R.I. Radio Snd & Tvsn Course. Also small mica capacitors, odd coils for R.F. exps., coupling transformers—Desire tubes—what have you? Pesarchic's Electronic Serv., 123 McCormoughy St., Johnstown, Pa.

FOR SALE—Supreme No. 85 tube checker with adapters, $20. — WANTED—Rider's Manuals from 6 to 13, and radio tubes. Castle Hill Radio, 2228 Newbold Ave., Bronx New York, 61.

FOR SALE—Complete N.R.I. Course incl. advanced course. $15. Arthur Kruger, 1316 Morgan Ave., North, Minneapolis, 11, Minn.

WANTED—For Cash—Good used televsn receiver. Also 8mm. movie camera and projector. Give details. Michael A. Petko, 4322 Wayne Ave., Philadelphia 40, Pa.

FOR SALE—Starrett O 1 in. Vernier micrometer No. 238—best cash offer. Walter Kryger, 912 W. 151 St., East Chicago, Ind.

TRADE — 3 asst. power transformers, 3 chokes, 2 output transformers, 3 asst. speakers, 2 radio chassis, 25 asst. 2F R.F. Ant., 2 osc. coils., 25 asst. bypass condnrs., 25 asst. resisters, 1 lb. radio hardware—for just ONE Rider Manual, 8 to 13. Troch, 413 Hummel Ave., Lemoyne, Pa.

FOR SALE OR TRADE—6 tube Western Electric mod. 4D receiver; also one tube WE regenerative receiver, both in working order with all tubes (215A types) WANT test equip. or ham receiver. George S. Maxey, 174 Taurus Ave., Oakland 11, Calif.

FOR SALE—Ultra-High Frequency Techniques, by Brainerd, Kohler, Reich and Woodruff, $4. Frequency Modulation by John Rider, $1. General Radio Service, 1203 Eckart St., Fort Wayne 5, Ind.

WANTED—Wireless phono oscillator, 1, 2 or 3 tube,in working order.Also 35 mm. candid camera or 127 size for cash. Have sound picture supplies; projectors, lamp houses, generators, rectifiers, sound heads. John Arnold, P. O. Box 84 Bluffs, Ill.

FOR SALE—One 5AP4 5 in. White C.R. Television tube, unused, orig. carton; 1 Philco signal generator, good condition. WANTED—All types high-grade laboratory equipment in any condition. Charles C. Littell, Jr., 308 W. High St., Piqua, Ohio.

WANTED—Signal generator, V-O-M small battery charger. FOR SALE — Correspondence Radio Course, 1941 Diag Manual by Radcraft, all A-1. Royce Saxton's Radio Shop, R 1, Pontiac, Ill.

WANTED — Recorder and play back unit with two speed motor; also O1 ma. or O200 mma. meter. I Dowbin, 3211 N. 17 St., Philadelphia, 40, Pa.

WANTED—Will pay cash for copy of instructions and schematic diagrams for Clough-Brengle OMA or CRA oscilloscope. Vin Taverna, 16 Innis St., S. I. 2, N.Y.

WANTED—Rider Chanalyst mod. 162, also Precision EV10MCP V-T multi-range tester and set of Rider Manuals. State condition and price. Houston Radio Service, Box 31, New Florence, Pa.

WANTED—Late mod. tube tester and signal generator. Also Voltohmeter ranging to 1000v ac.-dc. and measuring 3 megs. Will pay top price. V. Bashman, 1753½ N. Highland Ave., Hollywood 28, Calif.

WANTED—Superior mod. 1280 set tester in good condition. Cash waiting. Forest Park Radio Service, 29 So. Euclid Ave., St. Louis 8, Mo.

WANTED—Tube tester, Precision 912 or equivalent in new condition. Dawson Radio Service, 11 Lisbon St., Providence 8, R. I.

WANTED—RCA television signal generator, RCA or Dumont 3 or 5" oscilloscope, Hickok or Rider signal chaser, RCA, GE or Dumont television receiver, Riders Vol. X. State condition and price. Will trade Philco 45-2926 Dipole antenna kits and 45-2928 reflector kits. Richard G. Devaney, 216 South 60th St., Philadelphia 39, Pa.

WANTED—9" oscilloscope; 60 cy gas driven generator; Xtals for 25kc, 50kc, 75kc, 100kc; 100w audio amplifier; 40w audio amplifier; RCA 833A tubes or equiv.; RCA 872A rect. tubes. H. N. Luke, 2113 Somerset Place, Oklahoma City 6, Okla.

SERVICE—Engineer will repair or revise your test equip. Will accept meters and parts towards payment. Also equipment designed and built at low cost. I. Dlugatch, 10 Ocean Parkway, Brooklyn 18, N.Y.

WANTED — Following Victor Records: "Three Shades of Blue"; "Doll Dance"; "Blue Heaven"; "Nola"; "Smoke Gets In Your Eyes"; "Broadway Melody"; also 16 mfd 450, 475v Electrolytic condensers. Frank W. Jones, Gabbs, Nev.

SELL OR SWAP — Cathode Ray 5BP1.. Never used and 2 RCA 813. Best Offer. J. Middleton, 25 Hartford St., Newark, N. J.

FOR SALE—35 battery set chassis, over half parts steel mounted, $1.25; with speakers $2.; 6 auto chassis with speakers, $2. A.K. "B" Pak with 607 rectifier tube, $3. Several hearing aid parts and tubes left. Edwin Larason, Martinsburg, Ohio.

WANTED—Standard make 3" oscilloscope, signal generator, and either a Cornell-Dubilier Capacitor Analyzer, a Solar or an Aerovox. State make, condition and price. George J. Vervilos, 2180 Gerber Ave., Sacramento, California.

WANTED—Set of service manuals and signal generator. Must be good. Cash. R. E. Carr, Box 155, Harper, Kansas.

WANTED—Precision E200 signal generator, Stencer dc. power pak, mod. 132 or 131. Cash. W. H. Carney, 170 Wool Ave., Portsmouth, Va.

FOR SALE—Radio tube tester, Jewell Pattern 209—110-120v— 10 and 50 milliampere meter, 5 4-prong and 1 5-prong socket, black bakelite case, in excellent condition. DePalma Service, Fancher, N. Y.

WANTED—For Cash—Portable radio, battery and electric comb. in good condition batteries included Miss Angie Ciafui, 402 Genesee St., Trenton 10, N. J.

FOR SALE—Used radio parts for building sets. Send stamp for list and price. Richard Wolf, Box 49, Route 2, Wishek, North Dakota

FOR SALE—Misc. chemical equip and reagents; new and used radio tubes. Raymond H. Ives, RT 1c; Radio Lab. Bldg. 813; U.S.C.G. Base, Berkley, Norfolk 6, Va.

WANTED—Tube tester and signal generator. State price and condition. B. Sexton, 420 Hartman St., Missoula, Mont.

HELP WANTED—Experienced radio man, draft exempt or physical discharge good. Steady position or partnership. E. End Radio Service, 634 E. Pike St., Clarksburg, W. Va.

FOR SALE—3 Brunswick 9 tube superhet chassis. Majestic mod. 370 chassis superhet; Fada chassis; 2 RCA dc. superhet chassis; Majestic 90 power pk; Espey A eliminator. Louis A. Goldstone, 1279 Sheridan Ave., Bronx, N. Y., 56.

WANTED—Triplett pocket VOM; also Hallicrafter receiver with "S" meter. Mosier Radio Service, 313 Mamaroneck Ave., Mamaroneck, N. Y.

FOR SALE—In sealed cartons—3 6A4; 1 1F4 1 1A4; 1 1J6; 2 12A5; 1 1A6; 1 1C6; 1 6A6; Best offer. French Radio Electric Store, 476 Main St., Stanford, Conn.

FOR SALE—Crosley Xerval in new condition, complete with accessories. French Radio Electric Store, 476 Main St., Stamford, Conn.

FOR SALE—Clough Brengle mod. oc. oscillator recalibrated at factory; $40 cash. Precision Radio Service, 40-13 Union St., Flushing, N. Y.

FOR SALE—Radio panel—9" dial ac. cond. check ac.-dc. cond. check, speaker voice coil and output check. Size 32x22x9. Vogue Radio, 2725 W. Boston, Detroit 6, Mich.

FOR SALE—25w Setchel-Carlson P.A. amplifier with astatic mike, speaker and two extra cones; A-1 condition—$40. Glen Wolfe, 2127 Milford, Houston, Tex.

WANTED—510X Hickok tube tester — FOR SALE — Several radios and test sets. Central Film, Hastings, Mich.

WANTED—20 or 30w amplifier; wireless phono oscillator, 1, 2 or 3 tubes. Cash or trade. Have 35mm. sound heads and equip. of all kinds. John Arnold, P.O. Box 84, Bluffs, Ill.

WANTED—Small radios—any condition—any quantity. State best cash price. G. Samkofsky, 527 Bedford Ave., Brooklyn, N. Y.

FOR SALE — McElroy transmitting key, $2.20; Signal ½k key, $1.45; signal high frequency busser, 70c postpaid. New; must sell at once. Ralph Featy, Liberal, Mo., R. R. 1.

FOR SALE OR TRADE — Speed-O-Print mimeograph mach. 8½x11; with 5 reams paper, 1 quire stencil paper, inking brush and pads, can of ink. First $25. gets it, express ppd. WILL TRADE, plus some cash—Record changer; recorder; high imped. vel. mike, Hickok 510X tube tester, sig. generator, capacity tester. What have you for trade? Write details. F.U. Dillion, 1200 N. Olive Dr., Hollywood 46, Calif.

WANTED—500 mmf. calibrated low loss variable condenser. State price and make. Joseph Bucca, 1871 West 13th St., Brooklyn, N. Y.

WANTED — Tube tester, oscillator, and other test equip.; tubes, parts, radio sets. State condition and price. H. G. Radcliffe, 1013 High St., Petersburg, Va.

TRADE—New 8mm. Revere 88 F2-5 camera for Precision 920 and Hickok 510X or other set and tube tester. State make, condition, etc. E. Sujak, 5321 W. 30th Place, Cicero 50, Ill.

FOR SALE—I.C.S. Radio course. 75 lesson texts and Sterling Radio Manual, operating and code, theater sound recording and projection, servicing, etc. included. Make offer, C. A. Brethen, 150 Saranac St., Rochester, N. Y.

FOR SALE OR TRADE—Triplett Analyzer, Gardiner levering code machine, McElroy semi-automatic bug key and ten-piece set of Henschel, drafting set. Cash or swap for communications receiver and camera. Earl F. Little, 2724 Erickson St., E. Elmhurst, L. I., N. Y.

FOR SALE—Confidence Master tube tester, 1933-4-5 QST and other radio magazines. Also match book collection. WANTED television receiver in good condition, also electric clock to turn radio on and off at predetermined time. Glenn D. Simmons, 517 E. Grand Lake Blvd, W. Chicago, Ill.

FOR SALE—GM Delco auto radio separate speaker $15. Buick or LaSalle 1938 single unit auto radio $25. Remington pump action .22 rifle $20. Paul Capito, 637 W. 21 St., Erie, Pa.

WANTED—Air rifle such as Haenel, Crosman, Benjamin, etc. Cash. H. J. Fogetti, 1901 Park Drive, Los Angeles 26, Calif.

TRADE—2 Triplett meters, Model 221, 0-250 mils, 0-100 mils, brand new. Green Flyer turntable, model A, new. 5 each 6SC7, 6SQ7, 6x5, 6K7, 6L6; 3 2A4G, 2 2051, 1 954, 1 955 in original cartons, new. Want—3 or 5 in. oscillograph and RCA Voltohmyst in new condition. Will pay difference. Henry Kadas, 763 Blair Ave., St. Paul, Minn.

WANTED—0-1 milliammeter, 14 in. 25 watt speaker and good carbon mike. FOR SALE—1936 model "Sky-Buddy," fair condition. John E. Thiel, 742 No. Denver, Tulsa, Okla.

FOR SALE—Solar cond. tester, model 9C $10.00. Superior Inst. sig. gen., model 1230 $15.00. Draft, postal order or express. R. A. Reid, Parkersburg, Iowa.

TRADE—DM-36 converter gray, like new, made by RME, works with any receiver that tunes to 10,000 kc. Scale has 28 to 30 and 56 to 60 megacycles. Want Meissner deluxe signal shifter. Elmer Shafer, 2889 E. 116th, Cleveland, Ohio.

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"The first day I entered business I decided to try C-D Capacitors," reports Mr. Baldwin. "*You couldn't get me to try another brand.* I find 100% satisfaction in C-Ds. There's certainly a C-D Capacitor for every purpose." Thank you, sir, thousands of veteran servicemen favor C-Ds as strongly as you. There's a reason: For 32 years, Cornell-Dubilier has concentrated on the one job of building good capacitors better. C-Ds are *copied, imitated . . . but never duplicated!*

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